

World Maritime University

# The Maritime Commons: Digital Repository of the World Maritime University

---

World Maritime University Dissertations

Dissertations

---

1988

## Investigation into end-on collisions at sea

Ali Moftah Belhag Ahmed  
*World Maritime University*

Follow this and additional works at: [https://commons.wmu.se/all\\_dissertations](https://commons.wmu.se/all_dissertations)

---

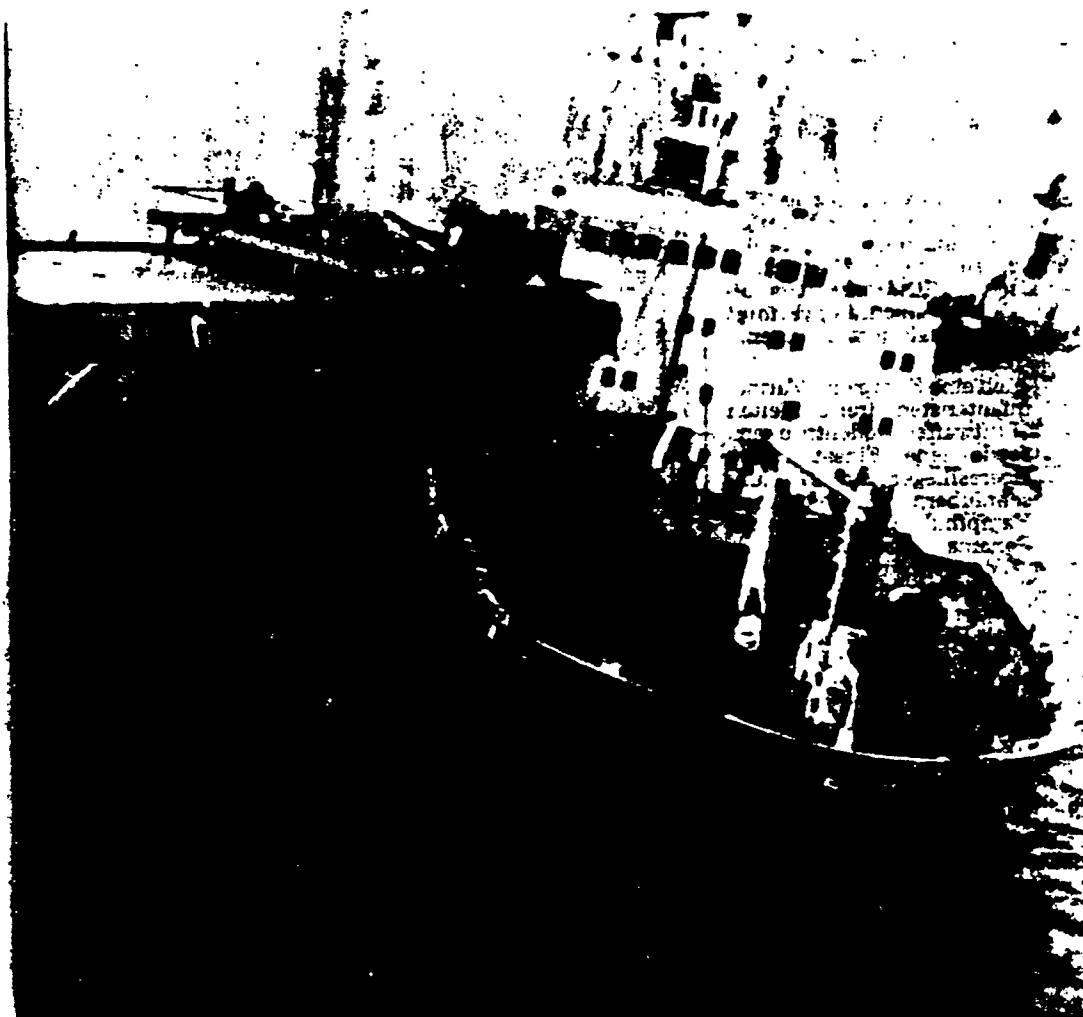
### Recommended Citation

Belhag Ahmed, Ali Moftah, "Investigation into end-on collisions at sea" (1988). *World Maritime University Dissertations*. 1302.

[https://commons.wmu.se/all\\_dissertations/1302](https://commons.wmu.se/all_dissertations/1302)

This Dissertation is brought to you courtesy of Maritime Commons. Open Access items may be downloaded for non-commercial, fair use academic purposes. No items may be hosted on another server or web site without express written permission from the World Maritime University. For more information, please contact [library@wmu.se](mailto:library@wmu.se).

# An Investigation into End-on Collisions at Sea



**An Investigation  
into  
End-on Collisions  
at Sea**

**by**

**Ali Mofteh Belhag  
Malmö, Oct. 1988**

WORLD MARITIME UNIVERSITY  
MALMÖ, SWEDEN

AN INVESTIGATION INTO END-ON COLLISIONS  
AT SEA

by  
Ali Moftah Belhag Ahmed  
Libya

A paper submitted to the Faculty of the World Maritime University  
in partial satisfaction of the requirements for the award of a

MASTER OF SCIENCE DEGREE  
in  
MARITIME EDUCATION AND TRAINING (NAUTICAL).

The contents of this paper reflect my personal views and are not  
necessarily endorsed by the UNIVERSITY.



Signature:

A handwritten signature in black ink, appearing to be "A. Moftah Belhag Ahmed", written over a horizontal line.

Date:

31 October 1988

Supervised and assessed by:

Günther Zade  
Professor  
World Maritime University

A handwritten signature in black ink, appearing to be "Günther Zade", written over a horizontal line.

Co-assessed by:

Wladyslaw Rymarz  
Technical Officer  
International Maritime Organization  
formerly  
Rector  
Higher Merchant Marine Academy  
Gdynia, Poland

A handwritten signature in black ink, appearing to be "W. Rymarz", written over a horizontal line.

Visiting Professor World Maritime University

## CONTENTS

|   | <u>Page No</u> |
|---|----------------|
| ABSTRACT  | iv             |
| ACKNOWLEDGMENT  | v              |
| ABREVIATION LIST  | vi             |
| <br>  |                |
| CHAPTER I : INTRODUCTION  | 1              |
| Scope and limitations of this dissertation                                  | 3              |
| Reports on investigations into collisions                                   | 6              |
| <br>  |                |
| CHAPTER II : COLLISION CASES  |                |
| <u>Part (a)</u> : End-on-collision in clear visibility                      |                |
| Case 1 : Collision between<br>M/V PENNSYLVANIA GETTY & M/V WORLD NOBILITY   | 8              |
| Case 2 : Collision between<br>M/V LYSAGHT ENDEAVOUR & sailing yacht GRUNTER | 13             |
| <u>part (b)</u> : End-on-collision in restricted visibility                 |                |
| Case 3 : Collision between<br>M/V REGAL SWARD & S/T EXXON CHESTER           | 18             |
| Case 4 : Collision between<br>M/V LIMON & M/T BETHIOUA                      | 24             |
| Case 5 : Collision between<br>M/T VENDIL & VENPET                           | 28             |
| Case 6 : Collision between<br>M/V EASTERN ROSE & M/V PETRA                  | 34             |
| Case 7 : Collision between<br>M/V APPLE BLOSSOM & (ship) AN TING            | 39             |
| Case 8 : Collision between<br>M/V STRAIT CONTAINER & M/V EASTERN CORRIDOR   | 43             |

|             |  |    |
|-------------|--|----|
| Case 9      | : Collision between<br>M/V FEDDY & M/V SOUNION                   | 49 |
| Case 10     | : Collision between<br>M/V LASH ATLANTICO & M/V HELLENIC CARRIER | 53 |
| CHAPTER III | : ANALYSIS TO END-ON-COLLISIONS                                  | 58 |
| (a)         | : When both ships are in sight of each other                     | 58 |
| (b)         | : When both ships are not in sight of each other                 | 64 |
| 3.1         | : A CLOSE QUARTERS SITUATION                                     | 65 |
| 3.2         | : DETERMINE RISK OF COLLISION                                    | 66 |
| 3.3         | : TAKING AVOIDING ACTION IN AMPLE TIME                           | 67 |
| 3.4         | : ACTION TO BE TAKEN   | 68 |
| 3.5         | : WHAT IS THE SOLUTION?  | 69 |
| CHAPTER IV  | : THE HUMAN ELEMENT IN COLLISION                                 | 74 |
| 4.1         | : PROBLEMS FACED IN ANALYSING HUMAN FAILURE                      | 76 |
| 4.2         | : HUMAN PROCESSES IN CASUALTIES                                  | 78 |
| 4.2.1       | : GENERAL CONCLUSION   | 78 |
| 4.2.2       | : MAJOR FACTORS INVOLVED IN COLLISIONS                           | 78 |
| 4.2.2.1     | : KNOWLEDGE, SKILL AND EXPERIENCE                                | 78 |
| 4.2.2.2     | : THE NO RISK ASSUMPTION   | 79 |
| 4.2.2.3     | : ORGANIZATION AND COMMUNICATION                                 | 79 |
| 4.2.2.4     | : MASTER-WATCH OFFICER RELATIONS                                 | 80 |
| 4.2.2.5     | : THE EFFECT OF AUTOMATION ON THE<br>ROUTINE JOB "auto-syndrome" | 80 |
| 4.2.2.6     | : MASTER PILOT RELATION SHIP                                     | 81 |
| 4.3         | : AREAS OF CONCERN OR CONTRADICTION                              | 82 |
| 4.3.1       | : TECHNOLOGY AND HUMAN REQUIRMENTS                               | 82 |
| 4.3.2       | : THE PROBLEM OF COLLISION CONSCIOUSNESS                         | 82 |

|                   |   |   |     |
|-------------------|---|---|-----|
| 4.3.3             | : | INVESTMENT IN TECHNOLOGY AND ORGANIZATION   | 83  |
| 4.4               | : | PREVENTIVE STRATEGIES   | 84  |
| 4.4.1             | : | SAFETY CONSCIOUSNESS STRATEGY   | 84  |
| 4.4.2             | : | TRAINING STRATEGY   | 84  |
| 4.5               | : | SOME PRACTICAL MEASURES TO REDUCE RISK  | 86  |
| CHAPTER V         | : | CONCLUSION  | 87  |
| BIBLIOGRAPHY      | : |   | 92  |
| ANNEX 1           | : | Computer programme to caculate the change of CPA due to an alteration of course in an end-on meeting. | 96  |
| APPENDIX          | : | The effectiveness of ship routing off North West Europe.  | 107 |
| LIST OF DIAGRAMS: |   |   | 113 |
| LIST OF CHARTS :  |   |   | 113 |
| LIST OF TABLES :  |   |   | 113 |
| LIST OF FIGURS :  |   |   | 113 |

## ABSTRACT

This thesis is a study of collision cases, with particular reference to END-ON collisions at sea.

The main section deals with 10 collision cases. They are summarised in such a way as to serve as the basis for teaching materials, when teaching the collision regulations for prevention of collision at sea to the students of the Merchant Marine Academy in Libya. In each case Rules violated and lessons learnt are highlighted. Rules concerned here are The Rules Of The Road (COLREG).

This study of END-ON collisions has shown that the collision rules dealing with this particular type of encounter are frequently ambiguous and consequently cause some confusion. In light of this fact these rules are explained and emphasized in order to ensure their proper understanding by the students studying the RULES OF THE ROAD.

One of the main factors likely to affect the incidence of ship collision is the human factor, which is considered in Chapter (IV). The problems faced in analysing this factor and some practical measures to reduce the risk of collision are presented.

The final chapter is a summary of lessons learnt and a recommendation for how the investigation of collisions can serve the teaching of marine personnel. The need for global co-operation is emphasized in this connection.



## ACKNOWLEDGEMENTS

I owe my sincere gratitudes and thanks to all those who provided me with information, guidance and encouragement and made it possible to complete this project. In particular I wish to express my sincere thanks to:

Professor G. Zade for providing valuable information and guidance while directing this project.

Visiting Professor Wladyslaw Rymarz for his encouraging remarks while co-assessing the paper.

Professor H.V.Walen and Professor Bernhard Berking for their valuable advices and assistance in preparing the CPA computer programme.

To other distinguished resident and visiting professors, faculty and administrative personnel of WMU for their advice, guidance and assistance.

Last but not least, to my company GNMTC and to the Libyan Merchant Marine Academy for giving me the chance to study at WMU, Malmo.

### Abbreviation List

|        |   |
|--------|---|
| a/c    | alter course  |
| b/c    | bulk carrier  |
| COLREG | The International Regulations for the<br>Prevention of Collision at Sea, 1972 |
| CPA    | Closest Point of Approach   |
| C.S.T. | Central Standard Time i.e.<br>(Greenwich Mean Time + 6 hours)                 |
| CAS    | Collision Avoidance System  |
| deg.   | degrees   |
| D.R.   | Dead Reckoning Position   |
| E/R    | Engine Room   |
| G.M.T. | Greenwich Mean Time   |
| G.R.T. | Gross Registered Tonnage  |
| hrs.   | hours   |
| Kts.   | Knots   |
| L.O.A. | Length Over All   |
| M.V.   | Motor Vessel  |
| M.S.   | Motor Ship  |
| M.S.O. | Master Standard Orders  |
| O.O.W. | Officer Of the Watch  |
| PAD    | Possible Area of Danger   |
| p.d.v. | power driven vessel   |
| PI     | Parallel Index  |
| STBD   | Starboard side  |
| TSS    | Traffic Separation Scheme   |
| VHF    | Very High Frequency (used for communication)                                  |

# CHAPTER

## I

# INTRODUCTION

## INTRODUCTION

The world's merchant fleet has grown dramatically over the years. Ships are today generally larger and faster and carry a greater variety of cargoes, some of which pose health hazards and are associated with risk of fire and explosion, and pollution of the marine environment. The seas are more crowded today and consequently the risk of collision has increased.

The past few decades have seen many ships involved in collisions, foundering and incidents involving pollution(1). Several measures and efforts have been taken by concerned parties in the maritime field to prevent similar accidents from reoccurring. Unfortunately, such safety measures are often taken only after a disaster or catastrophe. In other words, most safety measures have been developed from the lack of safety.

Two questions arise here. First, is it essential to have an accident in order to improve safety standards? Second, are those accidents which have already occurred in the past not enough to learn from?

The answer to the first question is obviously "NO" due to the fact that most accidents have a human element among their causes and that the human in particular is subject to unpredictable errors which safety standards may not be able to remedy. We can improve all technical equipment related to safety (on board vessels as well as ashore) but even if we succeeded in doing so, an uncertainty about the influence of the human factor would still remain.

The answer to the second question is difficult to find and that is because the real causes of many accidents are not clear, especially when the human factor is involved. This is due to the fact that persons involved in accidents often avoid giving true explanations or simply may not be able to.

This tendency is of course natural, as they try to protect themselves by hiding facts or destroying evidence that may be used against them. They may also not be able to correctly recollect the events which have led to an accident. Another reason should not be forgotten, namely that the crew involved, in addition to protecting themselves, may also try to protect the interests of their owners with regard to insurance and underwriting. Moreover, a normal investigation is usually a long process and many facts may have been forgotten by the time the individual is questioned.

Thus it will never be possible to eliminate all accidents at sea but they can be kept to a minimum. This is where the maritime education and training can play a crucial role.

In every accident there will always be a cause or causes, most of which can be attributed to human errors or mistakes. Proper analysis of the accident on the basis of sufficient data will surely reveal some or perhaps all of these causes and errors.

## **SCOPE AND LIMITATIONS OF THIS DISSERTATION**

As mentioned before it is not easy to find the causes, nevertheless many of the reports which are available now contain quite a lot of causes and many lessons can be learnt from them. Thus they can be used for teaching marine personnel.

The original intention of the author was planning to write about lessons that can be learnt from collisions in teaching marine personnel. But because of the secrecy and restrictions imposed on disclosing the casualty reports it was not possible to collect a sufficient number of reports to cover all classes and types of collisions.

By looking randomly into the reports which were available it was found that one type of encounter, namely END-ON collisions, was the most prevalent in restricted visibility. Moreover in a paper written by A.N.Cockcroft, "Collision statistics and analysis of the causes of collision", it was shown that 90 % of approximately 750 collision cases, about which he was able to collect information, involved vessels proceeding in opposite or nearly opposite directions, in particular, in restricted visibility(2).

In some collision cases it appeared that to a certain extent it seems that the Rules dealing with this type of encounter" whether in clear or restricted visibility" cause mariners quite a bit of confusion.

A close look at the collision cases revealed that in some, the 1960 Rules apply and in others the 1972 Rules apply.

Though the differences are not great, in order to remove any excuse that may arise because of the new or old Rules, it was decided to restrict the study to collision cases which occurred after the 1972 Rules came into force, i.e. after 1977.

It seems that the new International Regulations for the Prevention of Collision at sea (COLREG), together with the introduction of Traffic Separation Schemes (TSS) (3), has reduced dramatically the number of collisions specially the head-on encounter. Because of the reduction of collisions an insufficient number of cases were available, and if any collision has taken place in the last 10 years there are some problems in obtaining the investigation reports. The following are some of the reasons that the investigation reports are difficult to get hold of:

There are two types of investigation, namely governmental investigations and civil actions. The first type normally will be a one-sided investigation and this is generally not enough to establish the real cause(s) of the accident. Moreover these reports are normally sent to IMO and the policy is to keep them confidential. If they are disclosed, then they are distributed to the governments concerned and it is not easy to obtain them.

The second type of investigation, i.e. civil actions, is not the one from which we can expect to see reports due to the fact that most of the cases, over 90 %, are settled outside the court and therefore the investigation will never be brought to light.

The considerable costs and extensive time needed to conduct investigations make some governments reluctant to

initiate them. In some countries there are no investigations at all, though IMO is encouraging all member countries to conduct casualty investigations, specially in cases from which safety measures might emerge and consequently some rules or amendments to existing Rules can be made.

Some administrations do not like to disadvantage their own ships by publishing the investigation reports. The problem is also the same when the two ships are carrying the same flag, as they might be under different insurance policies and/or a difference of interest between the charterer and the owner in case of chartered ship is involved.

The language in which these reports is written may not always be English and this makes it difficult to obtain the vast number of cases which are written in other languages than English. For all the above mentioned reasons It was not possible to collect a sufficient number of cases.

In this paper the intention is to look at the investigation of END-ON collisions, and some specific cases will be mentioned to illustrate how lessons from such an investigation can be used for teaching ship personnel.

Reference will be made to the specific rule which deals with such encounters, namely Rule 14 (Head-on Situation). In addition Rule 19 (Conduct of vessels in restricted visibility) will be looked at, since it is the only Rule which governs all type of encounters in restricted visibility. Some explanation of these Rules will be given in light of the collision cases available, together with



the way they should be taught. But before proceeding a few points should be noted regarding the casualty reports:

### REPORTS ON INVESTIGATIONS INTO COLLISION

These reports concerning 10 collision cases. They are from Liberia, USA, and Australia, and the first thing which may be noticed about these reports is that they are all written in a different way, even those which are issued by the same administration.

For example in one report some details of the ships involved are available and in some others they are not. Also the sequence of the reports can vary, meaning that events are not organized in the same manner. Moreover it was noticed that in some reports emphasis is put on one part of the investigation e.g. events before the collision or after the collision, and in the others emphasis is put on something else.

The next step taken was the planing of a format which would provide the minimum amount of data about the ships involved, and about the accident circumstances to enable us as educators (or others dealing with statistics, etc.) to have a clear picture of a particular collision. This format will appear before every case.

The cases themselves are summarized in such a way that they can serve the teaching of a certain number of Rules, rather than illustrating whose fault it was. Each case is also made clearer with the aid of a diagram which is unfortunately not a precise one due to the fact that data surrounding the accident, e.g. times, bearings, distances,

given by crew members of one ship involved may differ from those given by others. Nevertheless these diagrams may serve for the purpose of education.

Having the human element as the main factor in collisions, considerations will be given to the problems faced in analysing this element and some practical measures proposed in this respect.

At the end of the paper there will be a conclusion on this research.

**Notice: (1), (2),**

Reference is made to indicate the attached Tables and Figures at the end of this Chapter.

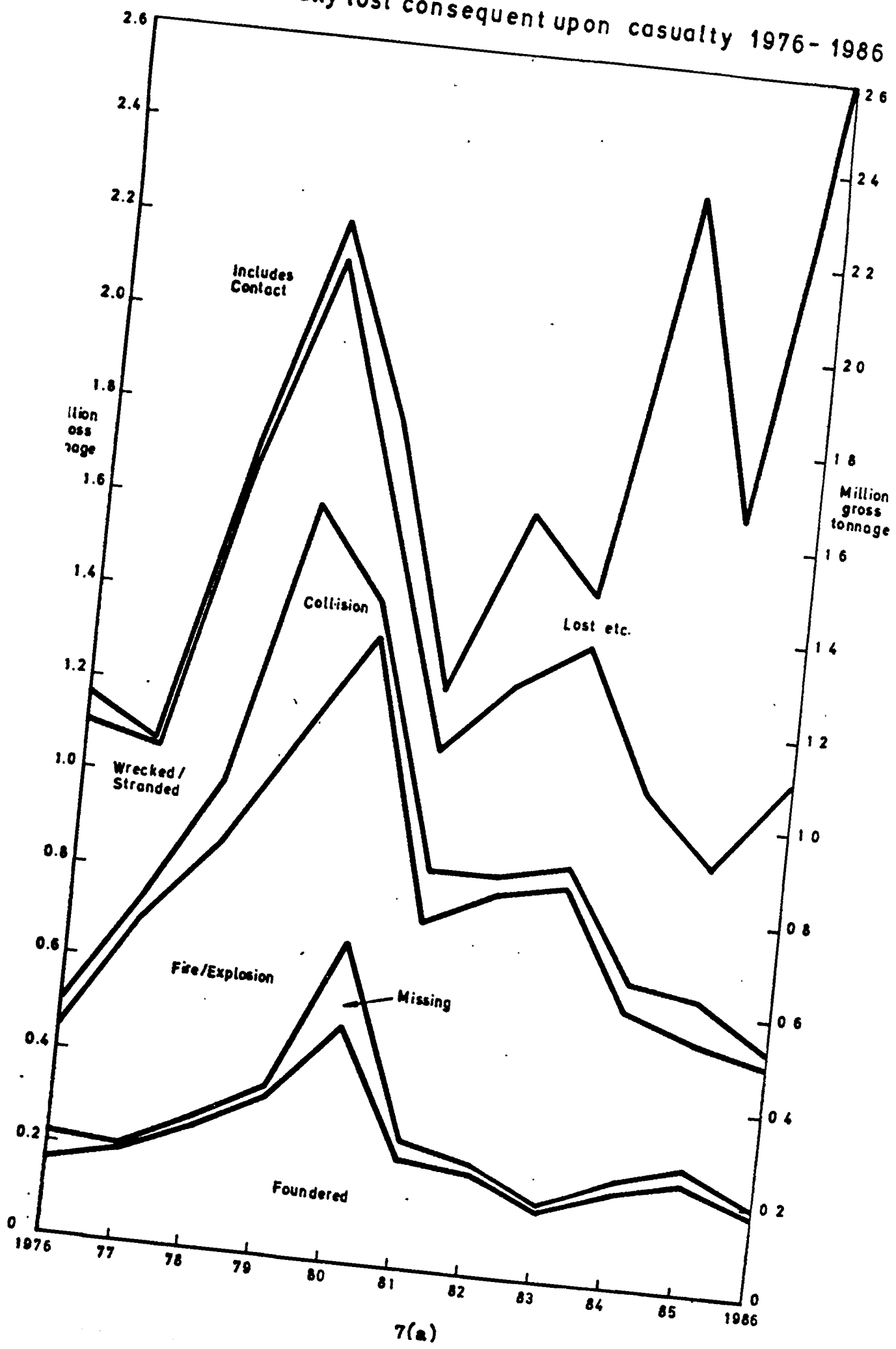
**Figure (a):** Merchant ships totally lost consequent upon casualty 1976-1986, page 7(a). Source; Lloyds Register Casualty Returns, 1986

**Table (b):** Numbers of collisions according to encounter situation and visibility for different regions. Source; Cockcroft A.N. Analysis of Collision Cases for the years 1967-1977, page 7(b)

**Notice: (3)**

Reference is made to the Appendix at the end of this paper page 107; The Effectiveness of Ship Routing off North West Europe; Cockcroft A.N. The Journal of Navigation Vol.36 No.3, 1983.

Merchant ships totally lost consequent upon casualty 1976-1986



**Table (b)**

Numbers of collisions according to encounter situation and visibility for different regions.

---

|                             | Meetin<br>End-on | Fine<br>Crossing | Broad<br>Crossing | Overtaking |
|-----------------------------|------------------|------------------|-------------------|------------|
| <b>CLEAR<br/>VISIBILITY</b> |                  |                  |                   |            |
| N.W. Europe                 | 8                | 18               | 23                | 23         |
| Japan                       | 3                | 24               | 40                | 24         |
| Other areas                 | 7                | 26               | 21                | 14         |
| Totals                      | 18               | 68               | 84                | 61         |

---

**RESTRICTED  
VISIBILITY**

|             |     |     |    |    |
|-------------|-----|-----|----|----|
| N.W. Europe | 65  | 132 | 19 | 14 |
| Japan       | 52  | 107 | 19 | 2  |
| Other areas | 26  | 56  | 4  | 5  |
| Totals      | 143 | 295 | 42 | 21 |

---

# CHAPTER

## II

# COLLISION CASES

**Part (a)**

**End-on collision  
in  
clear visibility**

S h i p "A"

S h i p "B"

Ship's particulars

|  |                           |                     |
|--|---------------------------|---------------------|
| Name   | : PENNSYLVANIA GETTY (PG) | WORLD NOBILITY (WN) |
| Flag   | : Liberia                 | Liberia             |
| Type   | : OBO                     | b/c                 |
| G.R.T.   | : 34931                   | 22816               |
| L.O.A.   | : 799 ft.                 | 623 ft.             |
| Year of built                                    | : 1978 (re-built 73)      | 1967                |
| Maximum draft                                    | : -                       | -                   |
| Loading condition                                | : loaded                  | loaded              |
| Max. service speed                               | : 15 kts.                 | 14 kts.             |
| Bridge team nationality                          | : -                       | -                   |
| Additional factors contributing to the accident: | : -                       | -                   |
| Location of bridge.                              | : aft                     | aft                 |
| Engine control                                   | : E/R                     | E/R                 |

Accident circumstances

Day - Month - Year. : 29 December 1978  
 Time : 1818  
 Time of the day : night  
 Position : Entrance of Chesapeake Bay

Weather condition

sea : calm  
 wind : North 2-4 kts.  
 visibility : good

Type of encounter : meeting end-on / crossing  
 Speed : A(12) & B(4.2)  
 Rules violated : 5, 7, 10(f), 15, 16, 34

## THE CASE :

This accident was between two ships in a congested area near the mouth of the Chesapeake Bay. The outbound vessel (WN) on a course 147, with a speed of 4.2 knots and the inbound vessel (PG) on a course 312, with a speed of 12 knots, sighted each other at a distance of about 4 and 1/2 miles, which is nearly reciprocal heading.

Both ships had a navigational watch consisting of master, chief officer and a helmsman. The (WN) disembarked the pilot and the (PG) was preparing to pick up her pilot. Neither ship had a lookout posted nor took radar plots of the other. There is no convincing evidence of any attempt to establish radio contact between the two vessels.

Just 6 minutes before the collision (PG) a/c 30 degrees to port without sounding any signal. This maneuver resulted in a clearly defined crossing situation in which (PG) became a give way vessel. At this moment the chief officer of (PG) went to pick up the pilot and left the Master and the helmsman by themselves. The Master was not aware of the crossing ship. The engine was not stopped or reversed until one to one and half minutes before the collision.

Only at that time the Master of (WN) recognised the extreme situation and ordered hard to starboard, sounded one blast and increased speed to accelerate his turning rate. Nevertheless collision took place.



RULES VIOLATED :

(a) by (PG)

Rule 5 : failed to maintain proper lookouts.

Rule 16: being the give way vessel, she failed to take early and substantial action to keep well clear.

Rule 34: failed to indicate her port turn.

(b) by both ships

Rule 7 : failure to determine risk of collision.

Rule 5 : failure to maintain proper lookouts.

LESSON LEARNT :

-When altering course in good visibility it is obligatory to indicate such alteration by sound signal. This is specially important when navigating in vicinity of other vessels and in particular in Precautionary Areas. As we can see in this accident when the distance was about 1.2 miles, the situation changed from a head-on to crossing situation when one of the vessels a/c to port without indicating such an alteration.

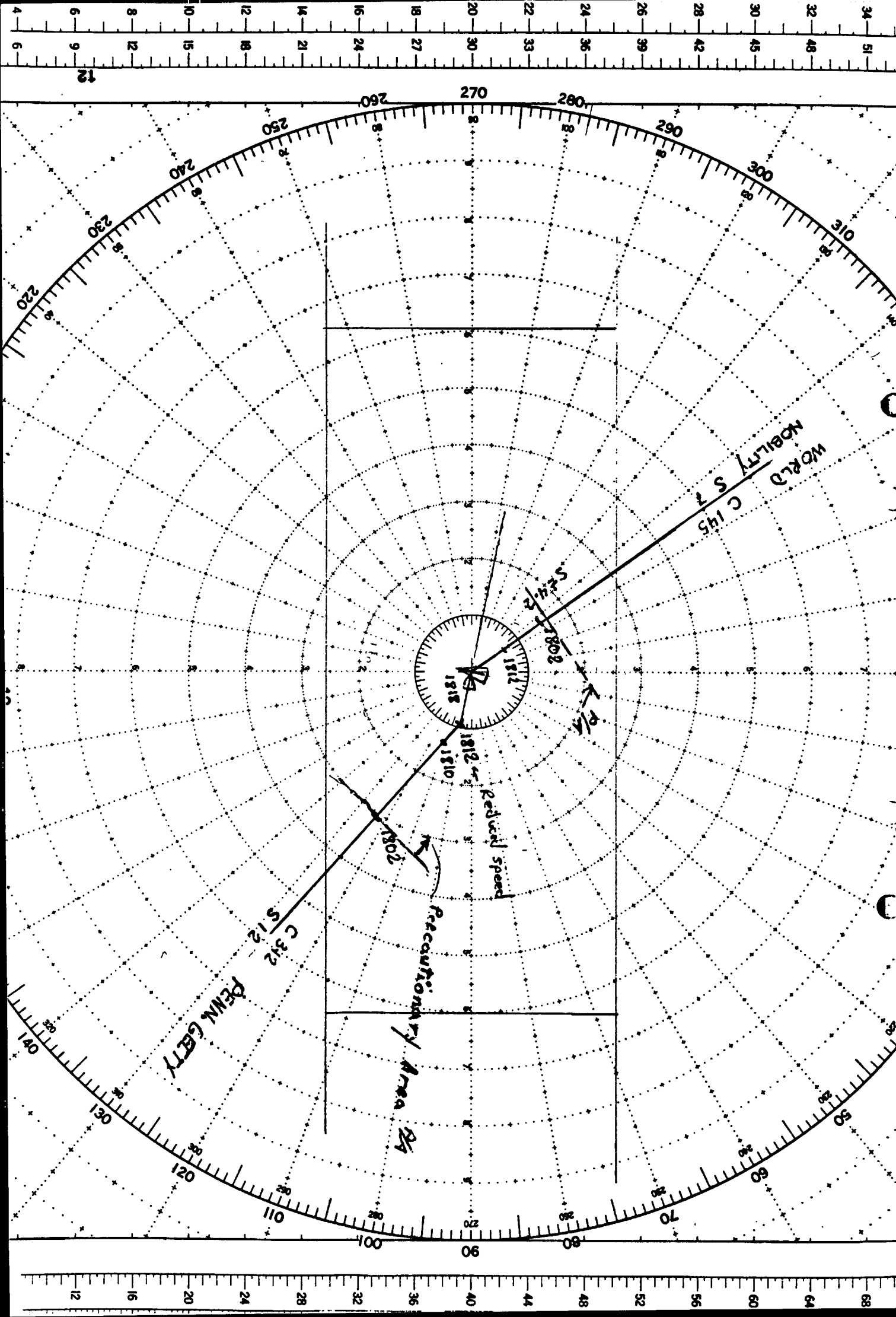
-Within the Precautionary Areas it is sometimes very difficult to do plotting because of the number of ships in the area and due to the continuously changing situation; however, sighting vessels by gyro bearings and using the radar reflector will help.

-In this connection a Bridge-to-Bridge Radio Telephone will help in understanding the intention of vessels

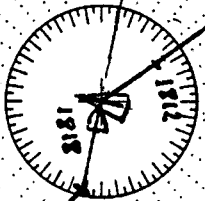
involved. Therefore the owners should provide recommended format to their masters in how to initiate communication with an unidentified vessel. Moreover, this accident shows that the officers sometimes do not set the right listening channel and/or keep the volume down. Such a simple criticism can be of an importance.

-This accident shows also the importance of the lookout. As when approaching the pilot the chief officer left the master alone on the bridge where the latter did not observe the crossing vessel "because I forget about it" as he put it. In another words, when the officer is appointed to observe a certain ship, he should not be sent away before being replaced. To this extend the absence of lookouts is considered the main and most consecutive failure.

-In this accident there was a moment when the situation was clearly becoming a dangerous one for both masters; nevertheless, they did not use the warning signal to warn each other.



WORLD C 145  
NOBILITY S 7



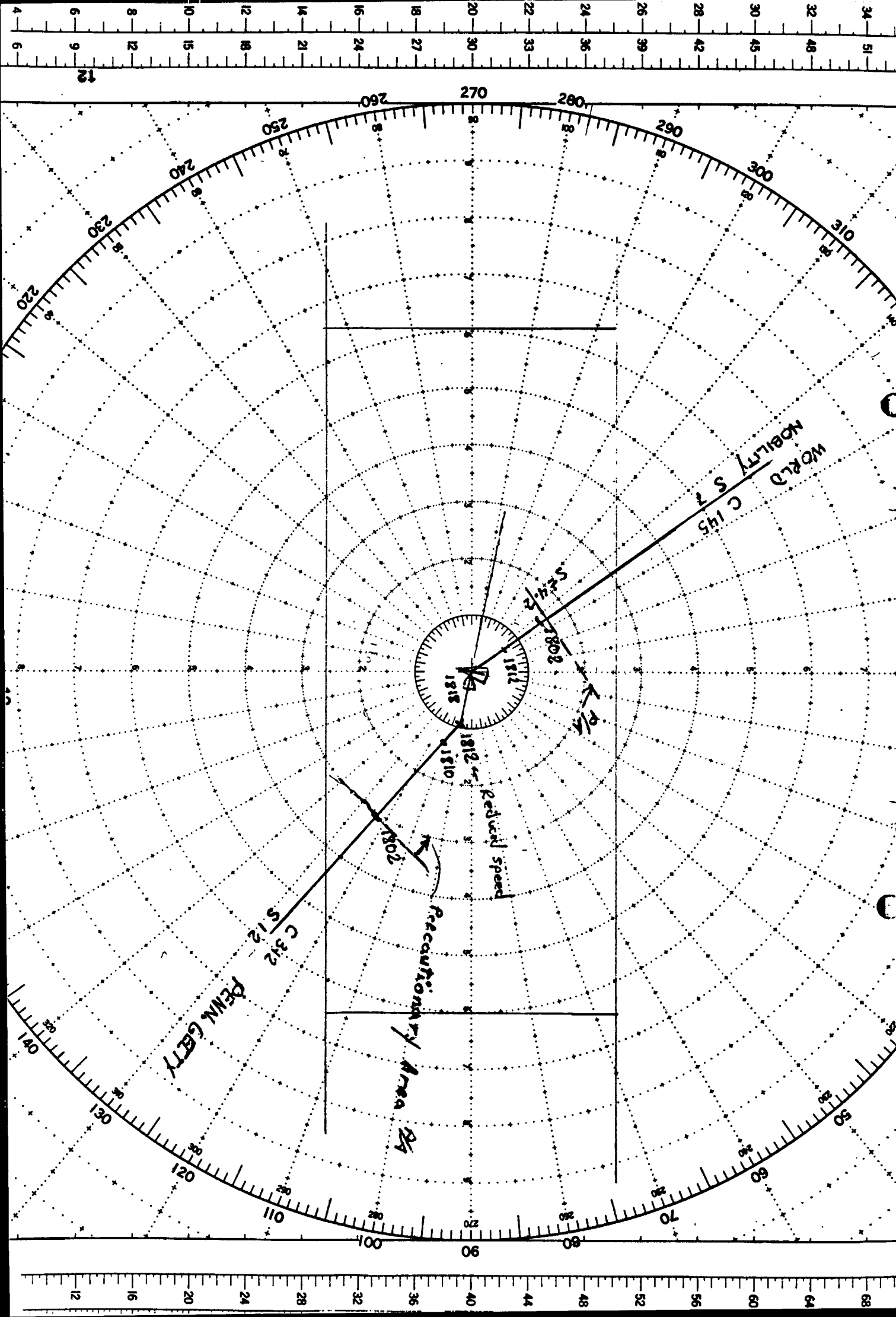
Reduced speed

Precautionary Area 24

PENN. GETTY  
C 312  
S 1/2

ST-4/2  
1802

1802



## THE CASE :

On the bridge of (LE) were only the second officer and one lookout. The former sighted, by naked eye, a WHITE LIGHT about one point on the port bow. He stated that he examined it more closely with binoculars and noticed that it was a steady white light. The echo of vessel (G) was not possible to detect by radar, as later it was found that a radar reflector was carried on board (G), but not hoisted.

After several observations by eye there were no changes, so the OOW considered this white light as a sternlight of a vessel northbound. (LE) was also northbound. He decided to a/c to port to pass other vessel's stern. Later, on the course recorder it was found that such alteration was only for two minutes and then the ship was back on her course. The OOW a/c by himself with hand and the lookout was still on the bridge.

On resuming course the OOW realised that the white light was a lot closer than he had expected. Within a few seconds, he saw a green light under the white light and found out that it was a sailing boat. He then a/c 50 degrees to STBD. A few seconds later the boat crashed with the ship.

(E) was heading south, under foresail only at a speed that was 6/7 knots. The lookout saw the light of (LE) and reported it to the Master, who assessed the situation and determined that the vessels would pass clear of each other and maintained his course. The Master and the lookout noticed when (LE) altered her course to port but apparently neither person noticed that the ship had gra-

dually altered her course to STBD. However, they realised that the ship was getting very close and at the last minute (G) a/c to port and soon after to STBD. Collision occurred at the end of such manoeuvre. No sound signals were used by neither vessel.

#### RULES VIOLATED

(a) by GRUNTER.

Rule 25 failed to exhibit "the side lights " as defined in Rule 21, namely "a red light on the port side and green on the STBD".

Rule 2(a) failed to display its radar reflector which is " required by ordinary practice of seamanship or by the circumstances of the case" .

Rule 5 failed to maintain proper look-out so as to make full appraisal of the situation and of the risk of collision.

Rule 34(d) failed to give light warning signal

(b) by LYSAGHT ENDEAVOUR.

Rule 8(d) failed to take the right action which should result in passing at a safe distance when it resumed the northerly course.

Rule 34 failed to sound the required signal to indicate its manoeuvre.

#### NOTICE :

- Rule 18 was not mentioned in this investigation though its paragraph (a) states that a power driven vessel underway shall keep out the way of a sailing vessel. Therefore it was the obligation of (LE) to keep clear of (G)

- In this accident it appears that the white light sighted by (LE) had caused the OOW a confusion to ascertain the type and the movement of the other ship in the absence of its echo on the radar screen. In the investigation report it was stated that the source of the white light sighted by (LE), may have been the port side light showing white, or the all round anchor light on top of the lantern.

- there is no specific requirement in the Rules to display a radar reflector and when vessels are in sight of each other it is expected that the carriage of proper navigation lights will enable the OOW to assess the movement of the other ship. Therefore failure of (G) to display its radar reflector was a lesser factor in the collision. Had it been displayed it may have been detected by (LE) radar and, if so, collision probably would not have occurred.

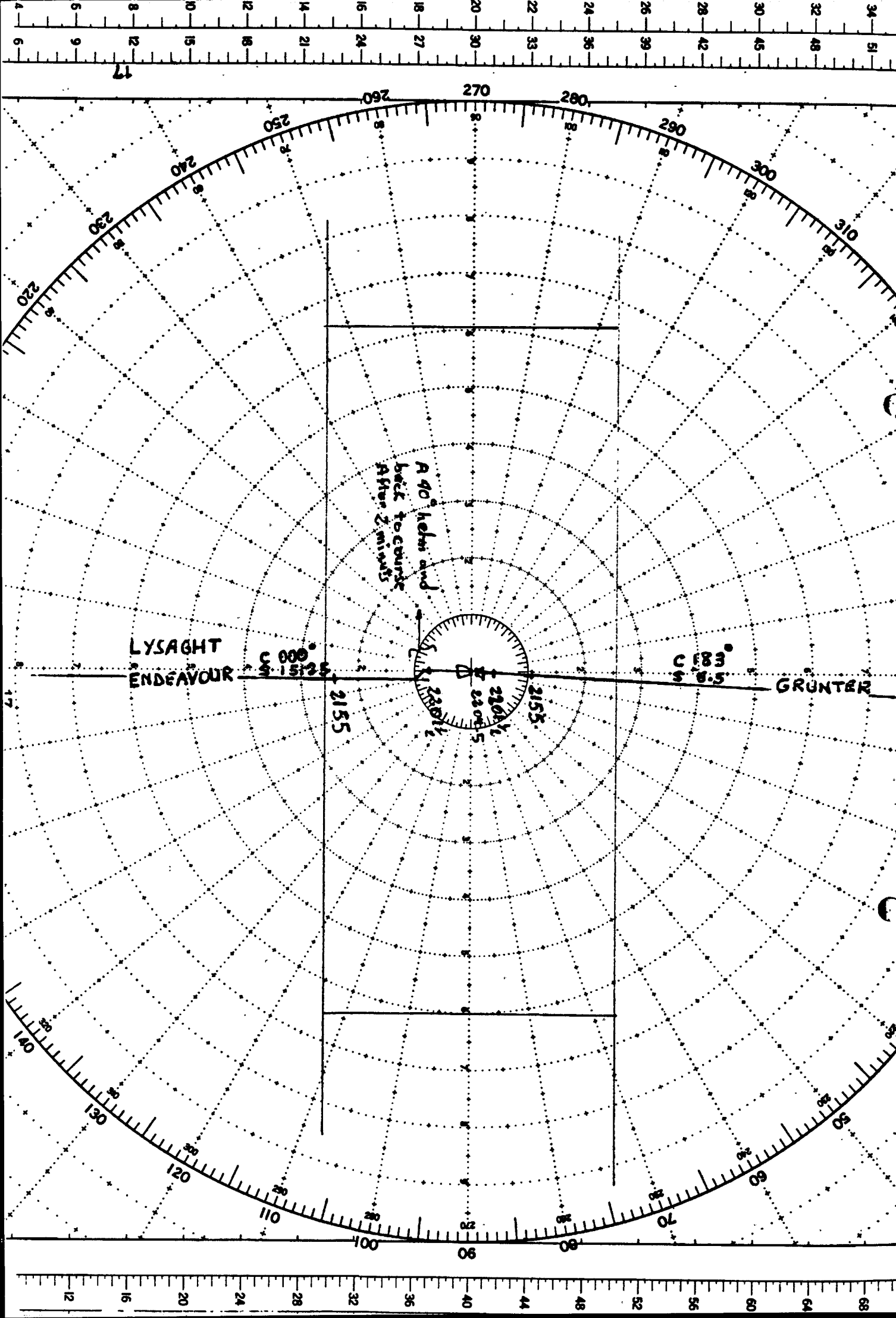
#### LESSONS LEARNT :

The OOW when unsure of a situation should call the master  
-If it has been decided to change course without certainty, which is not a wise thing to do, such an alteration should be a bold alteration and towards the open sea.

-When the OOW decides to alter course it is better to use a wheelman instead of doing the action himself so meanwhile he can observe the situation more effectively.

-In areas of hazardous navigational situations, masters should remain on the bridge or at least arrange for a bridge team, so that the OOW shall not be forced to alter course by himself.

-Yachts made out of fiberglass should carry "in position" radar reflector.



LYSAGHT  
ENDEAVOUR

GRUNTER

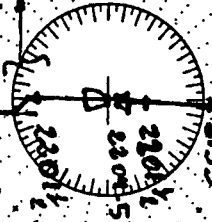
A 90° helm and  
back to course  
After 2 minuts

C 000°

C 081°

2155

2155



**Part (b)**

**End-on collision  
in  
restricted  
visibility**



S h i p "A"

S h i p "B"

Ship's particulars

|  |                               |                        |
|--|-------------------------------|------------------------|
| Name   | : M/V REGAL SWARD (RS)        | S/T EXXON CHESTER (EC) |
| Flag   | : Liberia                     | U.S.A.                 |
| Type   | : Bulk carrier                | Tanker                 |
| G.R.T.   | : 14245                       | 17327                  |
| L.O.A.   | : 175.88 m                    | 191.42 m               |
| Year of built                                    | : 1961                        | 1952                   |
| Maximum draft                                    | : 17 ft                       | 34 ft                  |
| Loading condition                                | : light condition             | loaded                 |
| Max. service speed                               | : -                           | -                      |
| Bridge team nationality                          | : Multi nationality           | U.S.A.                 |
| Additional factors contributing to the accident: | - Presence of fishing vessels |                        |
| Location of bridge.                              | : -                           | -                      |
| Engine control                                   | : -                           | -                      |

Accident circumstances

|                          |  |
|--------------------------|--|
| Day - Month - Year       | : 18 June 1979   |
| Time                     | : 17.13  |
| Time of the day          | : Day light  |
| Position                 | : SE Cape Cod, Massachusetts, U.S.A. 1 n.m. east of the inbound lane of the Boston approach TSS. (41 28'N 69 22'W) |
| <b>Weather condition</b> |  |
| sea                      | : -  |
| wind                     | : SE 8 knots   |
| visibility               | : Dense fog  |
| Type of encounter        | : Head on  |
| Speed                    | : A(12-15) & B(11).  |
| Rules violated           | : 10, 19(b)i, (d), (d)i, (e), 5, 7(c), 8(b), (c), 14.  |

### THE CASE:

(EC) had (RS) to the left of her heading flasher at a distance of 7 to 8 miles. (RS) made several alterations to port, five degrees every time assuming that (EC) will still pass port-to-port(\*). Course alterations: 150-143-138 and 133 where it remained till the moment of collision.

(EC), although PAD was considered to be one mile his CAS showed CPA of 1/2 mile. At a later stage (EC) decided to a/c to STBD two consecutive times to increase the CPA without any effect as (RS) had not changed her course to STBD.

When (RS) came as close as 3 miles it dissappeared in the sea clutter on range 3 miles; thereafter it was not possible to re-acquire the target again. No change in the speed of both ships and the collision occured at 1713.

### REMARKS

(\*) In the end-on situation (meeting on nearly reciprocal courses) it was not logic for (RS) to alter course to port assuming that (EC) will pass port-to-port. The reason of such action was not mentioned in the investigation report.

- (EC) used CAS, but no radar plot was being maintained other than pencil marking.
- the time required to update information under the CAS data course and speed varies inversely with the extent of any changes in the course and speed of other vessel.
- at the time of collision the following personnel were on their respective bridges:

(EC) bridge: master, third officer, helmsman and a lookout on the bow.

(RS) bridge: master, chief officer, 2nd/officer, helmsman and a lookout on the port wing.

- (EC) speed was 11 knots, however, the Doppler log showed 9.9 knots which was the speed input to the CAS.

- at 1701 and 1708 (RS) tried to contact (EC) by VHF but no answer was received.

- from 1400 till the time of collision, the navigation of both vessels was hampered by the presence of many fishing vessels in and around, crossing, and otherwise running contrary to the traffic scheme.

- (RS) sank and lost cargo valued at 3.5m USD in 25 minutes.

- (EC) sustained one m USD damage.

#### RULES VIOLATED:

1- (RS) violated the following rules:

Rule 10 went in the wrong direction of the traffic.

Rule 19(b) maintained excessive speed in fog.

Rule 5 failed to maintain a proper lookout.

Rule 7(c) made assumptions based on scanty radar information.

Rule 19(d) failed to take action in ample time.

Rule 8 (b) made a succession of small course alterations.

Rule 19(d)(i) changed course to port.

2- (EC) violated the following rules:

Rule 19 (b) maintained excessive speed in fog

Rule 19 (d) failed to take action in ample time.

Rule 19 (e) failed to take the way off when it became apparent that she could not avoid a close quarter situation.

Note: it was mentioned in the report that Rule 14 was in violation because of the alteration of course to port by (RS). This is in my opinion not justified since it was restricted visibility and Rule 14 applies only to vessels in sight of each other.

#### LESSON LEARNT:

- Navigating with D.R. as the only means of position fixing had lead to enter in the wrong direction in the TSS .
- This accident shows the importance of passage planning.
- It shows also that radar plotting is essential.
- Improper communication, i.e. not identifying the ship with which you want to communicate, led to a lack of reply from the other vessel.
- It is wise to allocate a lookout in the fore part of the ship specially in dense fog.
- This accident highlights the importance of bridge teamwork. As we have seen, though there were two officers present on the bridge, they were not exercising any navigational functions. The captain was conning the ship, doing the navigation, acting as a radar observer, and VHF operator. Several functions which can not be executed propably by one person.
- Relative motion on the radar screen can not be evaluated by naked eye alone without plotting.
- Small course alteration does not immediately register on the radar plot of the other ship.
- Alteration of course should not be based on scanty radar

information.

-Action, if any, shall be in ample time.

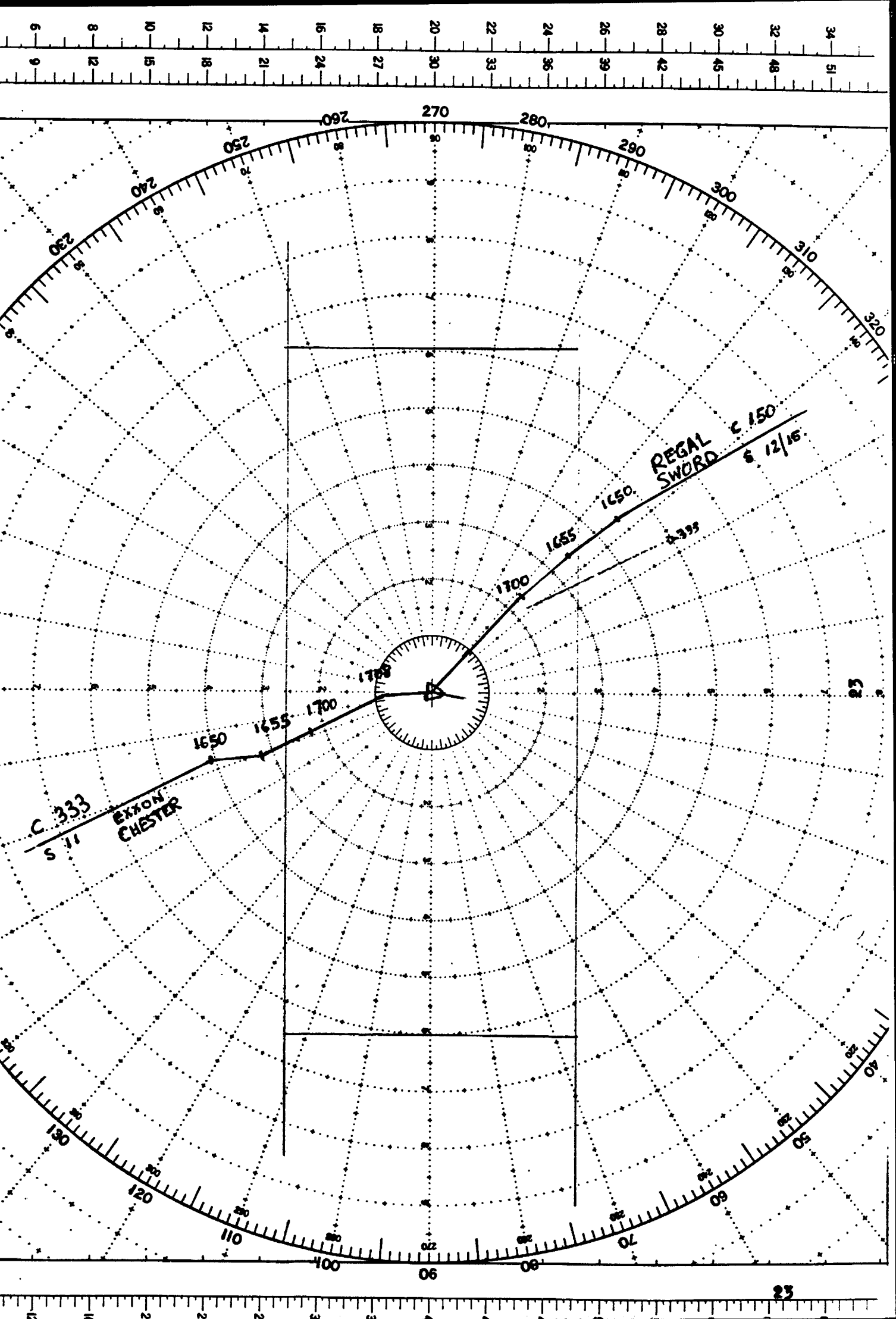
-One must not forget that the engine telegraph on the bridge is there to be used if needed.

-When you are not sure of the situation and you see that it is developing very fast it is wise sometimes to take all the way off.

-This accident shows the need for an efficient watch keeping practice.

-Owners should be blamed for the weaknesses of navigational organisation of the ship.

-When the target is lost on the radar screen you must not change course without knowing how it will contribute to developing situation.



S h i p "A"

S h i p "B"

Ship's particulars

|  |                 |                  |
|--|-----------------|------------------|
| Name   | : M/S LIMON (L) | M/T BETHIOUA (B) |
| Flag   | : Liberia       | Algeria          |
| Type   | : Reefer ship   | Tanker           |
| G.R.T.   | : 6709          | 18014            |
| L.O.A.   | : 139.3 m       | 170.7 m          |
| Year of built                                    | :               |                  |
| Maximum draft                                    | :               | 11 m             |
| Loading condition                                | : loaded        |                  |
| Max. service speed                               | : 21.5 kts      | 15 kts           |
| Bridge team nationality                          | : Spanish       |                  |
| Additional factors contributing to the accident: |                 |                  |
| Location of bridge.                              | : middle        |                  |
| Engine control                                   | : E/R control   |                  |

Accident circumstances

|                    |                   |
|--------------------|-------------------|
| Day - Month - Year | : 12 August 1979  |
| Time               | : 1225            |
| Time of the day    | : day light       |
| Position           | : English channel |

Weather condition

|            |       |
|------------|-------|
| sea        | : -   |
| wind       | : -   |
| visibility | : fog |

|                   |                         |
|-------------------|-------------------------|
| Type of encounter | : head on               |
| Speed             | : A(18) & B(12-13).     |
| Rules violated    | : 5, 6, 7(b), 8(a)&(b). |

### THE CASE:

(L) wanted to arrive at her destination at a certain time so the Master decided to adjust his speed from 21 to 18 kts. Shortly after 0000 hrs., when the ship had been in fog for two hours, the steering was changed from automatic to hand. The lookout was put on the wheel and was not substituted.

On course 063 an echo was picked up dead ahead at a distance of six and a half miles ( radar was kept on 8 miles range ). No plotting was made. Five minutes later the echo was still dead ahead and at a distance 4 miles. At this point the Master a/c 20 degrees to STBD. Three minutes later the echo was still on a collision course, and the Master a/c a further 20 degrees, when the distance was two and a half miles. Six minutes later the Master sighted (B) bearing 7 points off his port side at a distance of 2 cables. The collision occurred one minute after that. These times and distances show that the two ships were closing at 30 kts.

### REMARKS:

- The investigation report of (B) is not available, however, it seems that she must have altered her course to port and her speed was between 12 and 13 kts. at the time of collision.

- From the statement of the master of (L) it seems that the echo of (B) disappeared in the sea clutter on his radar, thus if the large radar had been put on the 4 mile range when (B) was 4 miles off, a better picture of the other vessel's course would have been seen, and the effect of clutter minimized.



**RULES VIOLATED:**

Rule 7 (b) failed to make a proper use of radar.

Rule 8 (a) failed to take action in ample time.

Rule 8 (b) failed to make a large alteration of course

Rule 6 failed to proceed with safe speed.

Rule 5 failed to maintain a proper lookout.

**NOTICE:**

The violation of the last two Rules (6 & 5) was considered in the report as a contributing cause of the accident, though they are in fact the most consensive.

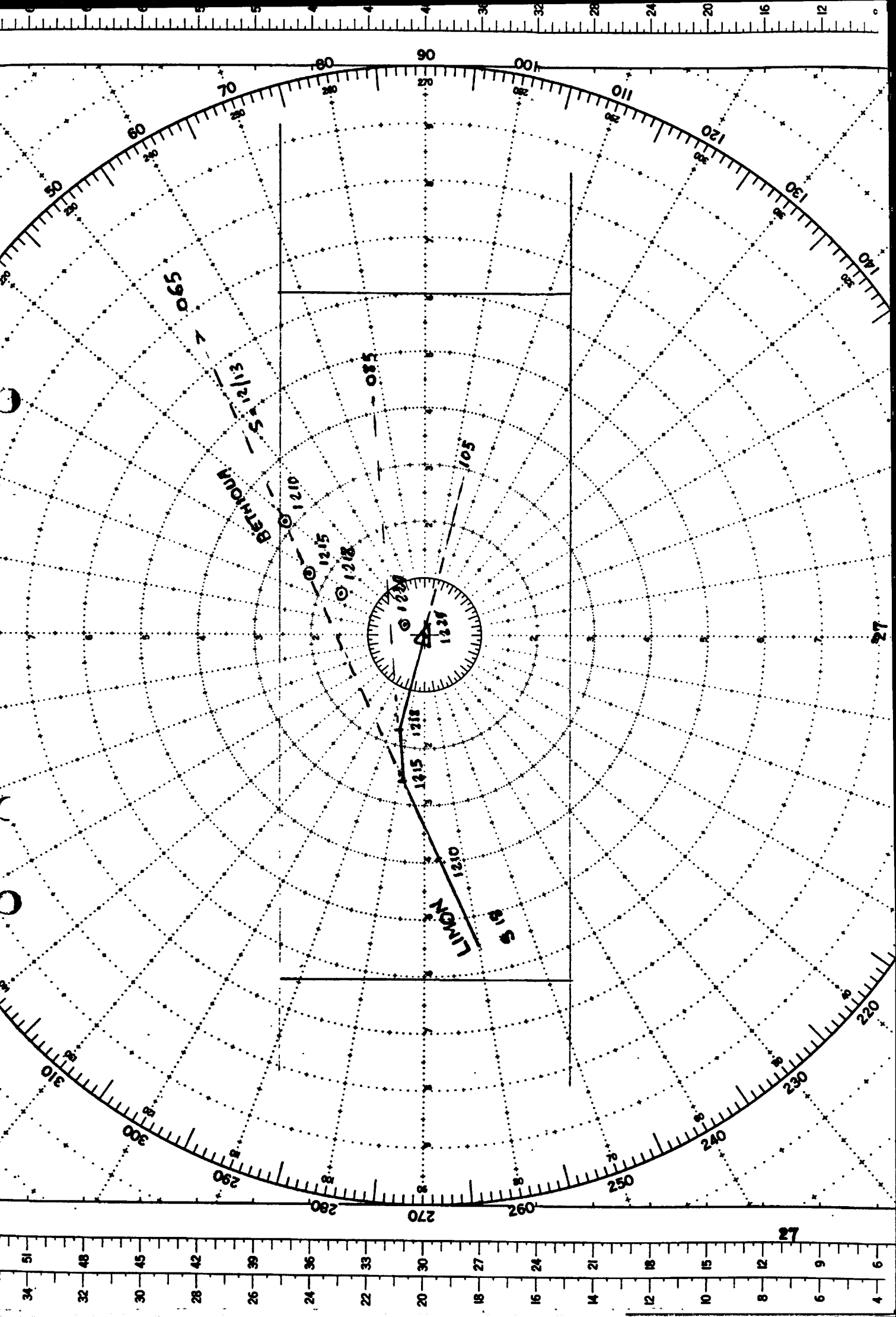
**LESSON LEARNT:**

-This accident shows the need for a proper use of radar equipment, long-range scanning to obtain early warning of the risk of collision and the necessity of plotting.

-A succession of small alteration of course and/or speed should be avoided since they constitute action which can not be detected by the other vessel. Such action shall be positive and in ample time.

-When the lookout is put on steering he shall be replaced by a new lookout it is even wiser to station one lookout forward and another in the wing so that eyes and ears can be used to the best advantage.

-In this accident, it appeared that the Master had exercised in the past some manouvers with small course alterations, and since they were completed safely he continued to repeat the same procedures. In practice this is not always the case.



S h i p "A"

S h i p "B"

Ship's particulars

|  |               |                          |
|--|---------------|--------------------------|
| Name   | : M/T VENDIL  | M/T VENPET               |
| Flag   | : Liberia     | Liberia                  |
| Type   | : VLCC        | VLCC                     |
| G.R.T.   | : 152327      | 152372                   |
| L.O.A.   | : 1115 ft.    | 1115 ft.                 |
| Year of built                                    | : 1973        | 1973                     |
| Maximum draft                                    | : 80 ft.      | -                        |
| Loading condition                                | : loaded      | ballast                  |
| Max. service speed                               | : 15/16 kts.  | 15/16 kts                |
| Bridge team nationality                          | : R.O.China   | R.O.China                |
| Additional factors contributing to the accident: | : -           | Presence of f.V/Ls.<br>- |
| Location of bridge.                              | : aft.        | aft.                     |
| Engine control                                   | : E/R control | E/R control              |

Accident circumstances

|                    |  |
|--------------------|--|
| Day - Month - Year | : 16 December 1977   |
| Time               | : 0930 or 0940   |
| Time of the day    | : day light  |
| Position           | : 25 n.m. off the coast of South Africa<br>( 34 28 S, 24 05 E) |

Weather condition

|                   |                          |
|-------------------|--------------------------|
| sea               | : -                      |
| wind              | : -                      |
| visibility        | : dense fog              |
| Type of encounter | : end on                 |
| Speed             | : A(13.5) & B(13.5).     |
| Rules violated    | : 5, 6, 7, 8, 19, 35(a). |

### THE CASE:

This accident was between two sister ships approaching each other in reciprocal courses in dense fog. VENOIL was heading west and when her O.O.W first observed VENPET, her sister ship was slightly to his port bow at 22 miles.

VENOIL was making 13 kts. and expected a beam distance of the other vessel to be 0.5 to 0.7 mile. This distance was changing very slightly.

The Master of VENOIL was on the bridge several times but at the critical time only the 3rd. officer and the helmsman who was on the wheel were there. The helmsman had executed two small course alterations to STBD according to the 3rd.officer's instructions. No lookout was posted, no reduction of speed and not even stand-by notice was given to the engine room crew. Moreover no plotting was made nor a fog signal sounded.

VENPET first observed VENOIL at a distance of 13 miles dead ahead. On 7 miles she expected STBD to STBD passage and consequently she a/c twice to port, 5 degrees each time. Her reasons were that VENOIL had moved from dead ahead to the STBD bow and that her crew observed the presence of some spots not very far away on the STBD bow, which were probably fishing vessels. However, this was not proved.

The Master later came to the bridge and saw on the radar that VENOIL was 4 miles away, but made no comments on the 3rd. officer's manouver. 10 minutes later the collision occurred. No communication was established between the two ships.

## RULES VIOLATED

- Rule 2 (a) failed to practice the ordinary seamanship by setting a different course ( this was not regarded as a contributory cause but merely set the stage for what subsequently occurred.
- Rule 5 failed to maintain a proper lookout
- Rule 6 failed to proceed with safe speed
- Rule 7 failed to plot their radar observations
- Rule 8 failed to take a positive action.
- Rule 19 failed by executing small alteration of course to port (VENPET)
- Rule 35(a) failed to sound the fog signal

## LESSONS LEARNT:

- Vessels should comply with the COLLREG. when navigating in reduced visibility.
- Vessels should maintain a continuous radar observation and plotting.
- No assumption shall be made on the basis of scanty radar information.
- Vessels should determine if a close quarter situation is developing.
- It is important to develop radar competence and a bridge team approach in close encounters, so as to eliminate all too frequent one-man navigational errors.
- In this accident, one of the masters gave an excuse that he was not familiar with the radar set. Companies procedures should encompass rules which ensure that officers are familiar with the equipment in order to prevent reoccurrence of similar incidents.
- In congested areas there is a need for TSS to control

the traffic flow.

-Administrations should make sure that officers onboard their ships have completed courses in the use of radar.

-It appeared that the tendency of vessels to navigate within the winter zone limit can cause an increase in head-on encounters. Together with this tendency, the South Africa rules governing tankers navigating in its water to keep a distance of > 12 miles have to be re-considered. For the navigator it is good to understand and to expect such encounters.

-When the lookout is asked to steer he shall be replaced.

-It has been noticed in this accident that though the Master of one of the vessels had visited the bridge several times, he left the OOW alone in the critical moment.

-In the absence of a public address system, the O.O.W. should always know how to contact the Master and where to find him.

-The two sets of radars onboard shall be of a different frequency to overcome disturbance and to enable the bridge team to make use of both radars.

-This accident shows the importance of passage planning in that when drawing tracks they shall not place the vessel in the normal routes where other vessels are using in the counter way.

-This accident shows the importance of fog signals as a method to alert other vessels.

-To comply with the safe speed definition, the engine shall be put on stand-by in a such manner that any reduction of speed can be immediately effected.

-This accident highlights the importance of communication and the need to use Walkie-talkie as a back up system in case of any failure in the main system.

-From the CPA table it can be seen that with the small alteration of course the passing distance was not more

than two cables, which is not a safe distance specially for the size and type of vessels involved.

-Part of a master's duties, is to ensure that officers onboard are properly instructed. They should also ensure that COLLREG and the company's standing orders are strictly observed.

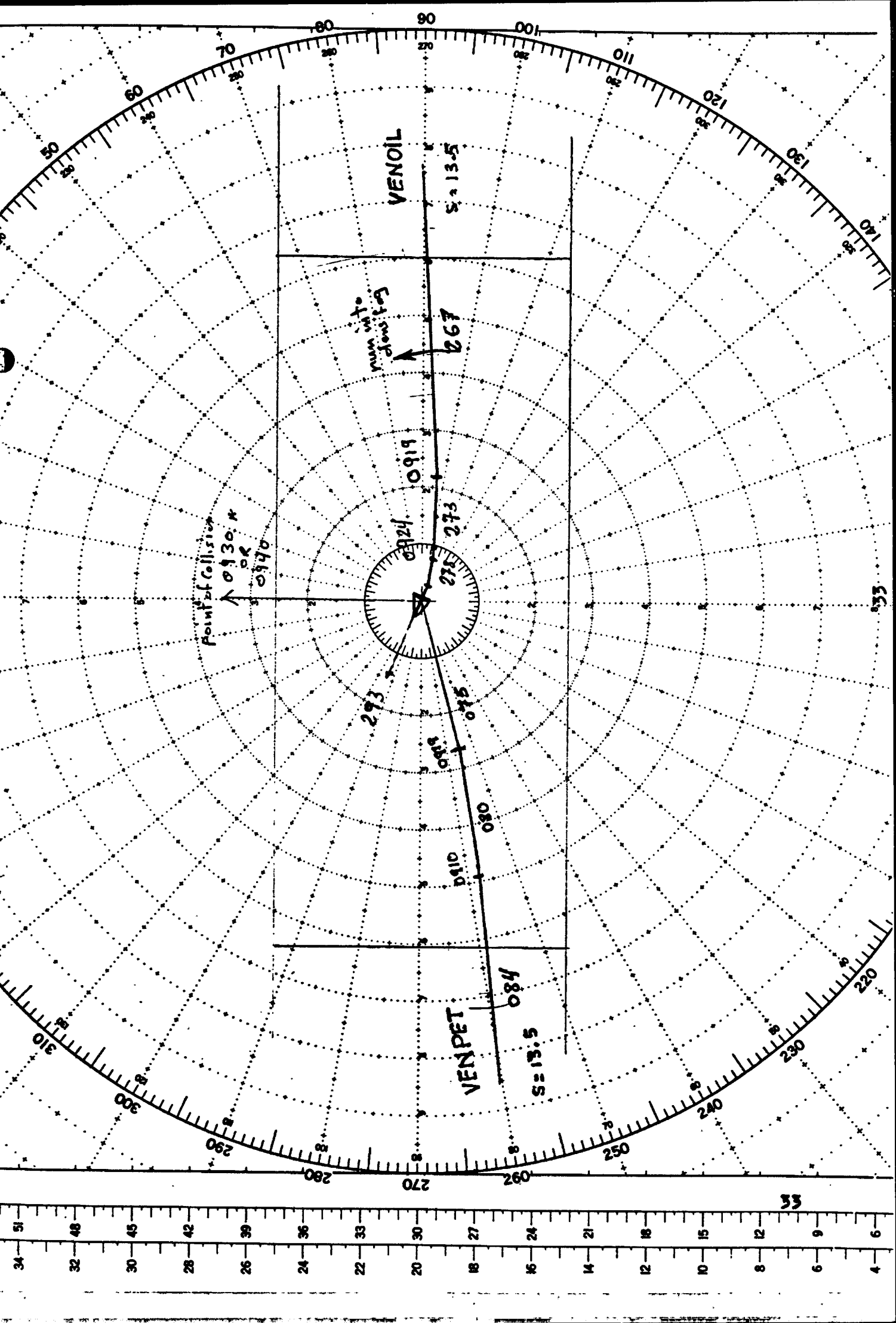
-When the Master came to the bridge and found that his ship was entering into a close quarter situation according to information received from the OOW, he should have reconfirmed such information himself and not to relied on what he had been told.

-Owners when issuing written instructions should exercise all reasonable care to see that they are carried out.

-From this accident it can be seen that the owners failed to ensure safety of navigation onboard their vessels.

-Owners should:

- \* ensure that their officers possess sufficient capability.
- \* provide them with periodical radar refresher courses.
- \* take steps to require masters onboard to ensure that his officers are up to standard, and that masters are carrying out the company's standing orders and to ask them to lay down a standing procedure so that the O.O.W. can locate the master in case of emergency.
- \* assess the relative priorities between routine ship business and safe navigation in order to ensure safety of navigation.



VENOIL

S = 13.5

267

run into  
slow fog

Point of Collision  
0130. K

0924

0919

273

273

015

090

084

S = 13.5

VENPET



S h i p "A"

S h i p "B"

**Ship's particulars**

|  |                     |                     |
|--|---------------------|---------------------|
| Name   | : EASTERN ROSE (ER) | PETRA (P)           |
| Flag   | : Liberia           | Greek               |
| Type   | : B/C               | B/C                 |
| G.R.T.   | : 9060              | 23148               |
| L.O.A.   | : -                 | -                   |
| Year of built                                    | : 1975              | 1976                |
| Maximum draft                                    | : 9.8 m             | -                   |
| Loading condition                                | : Loaded            | Partly loaded       |
| Max. service speed                               | : 17.32 Kts.        | 15.5 kts. (s.speed) |
| Bridge team nationality                          | : Korean            | -                   |
| Additional factors contributing to the accident: |                     |                     |
| Location of bridge.                              | : Aft               |                     |
| Engine control                                   | : E/R control       |                     |

**Accident circumstances**

|                    |   |
|--------------------|---|
| Day - Month - Year | : 04 March 1977                           |
| Time               | : 13.44                                   |
| Time of the day    | : Day light                               |
| Position           | : 33 24'N 135 37'E<br>Off coast of Japan. |

**Weather condition**

|            |        |
|------------|--------|
| sea        | : -    |
| wind       | : -    |
| visibility | : poor |

|                   |                         |
|-------------------|-------------------------|
| Type of encounter | : end on                |
| Speed             | : A(12.5) & B(15).      |
| Rules violated    | : 5, 6, 7, 8(e), 35(a). |

## THE CASE :

A collision between (ER) and (P) in which no details are available about the investigation of (P), however, the investigation of (ER) provides the following information:

In dense fog (ER) was heading on a westerly course at full speed and sighted two echos, one port and the other on her STBD bow at distances of 9 and 10 miles respectively and closing. The fog signal was used and in the bridge was the Master, duty officer (2nd officer) and helmsman. No radar plot was carried out.

As the port bow echo was closer than the STBD one, the Master concentrated on the closed echo, namely the port side. He apparently ignored the STBD bow echo, which appeared to be opening slightly, until he was of the opinion that the port echo was passing clear. At this time the STBD echo was approximately 2 to 3 miles away.

When the echo was 2 miles away the Master ordered five short blasts on the ship's whistle. The echo was sighted when it was 50 to 100 meters away and at this moment hard rudder was given. The collision occurred just after that and no speed reduction had taken place.

At the time of collision (P) was apparently changing course to STBD from an approximate course of 100, possibly in an attempt to avoid (ER) and the heading was probably 185 degrees

Based on the period of time between the first echo of (P) and the collision it seems that (P) was doing 15 kts.

### RULES VIOLATED:

- Rule 5 failed to post sufficient lookouts
- Rule 6 both vessels failed to proceed at safe speeds.
- Rule 35(a) (P) failed to sound the fog signal.
- Rule 8 (e) failed to do the necessary preparation in order to slacken the speed or to take "all the way off"
- Rule 7 failed to do radar plotting or equivalent systematic observations in order to obtain early warning of risk of collision.

### NOTICE

The conclusion of the investigation was based on the 1960 Rules, however according to 1972 Rules the same rules are considered to have been violated.

### REMARKS :

(ER) sunk as a consequence of this collision, two hours after the collision.

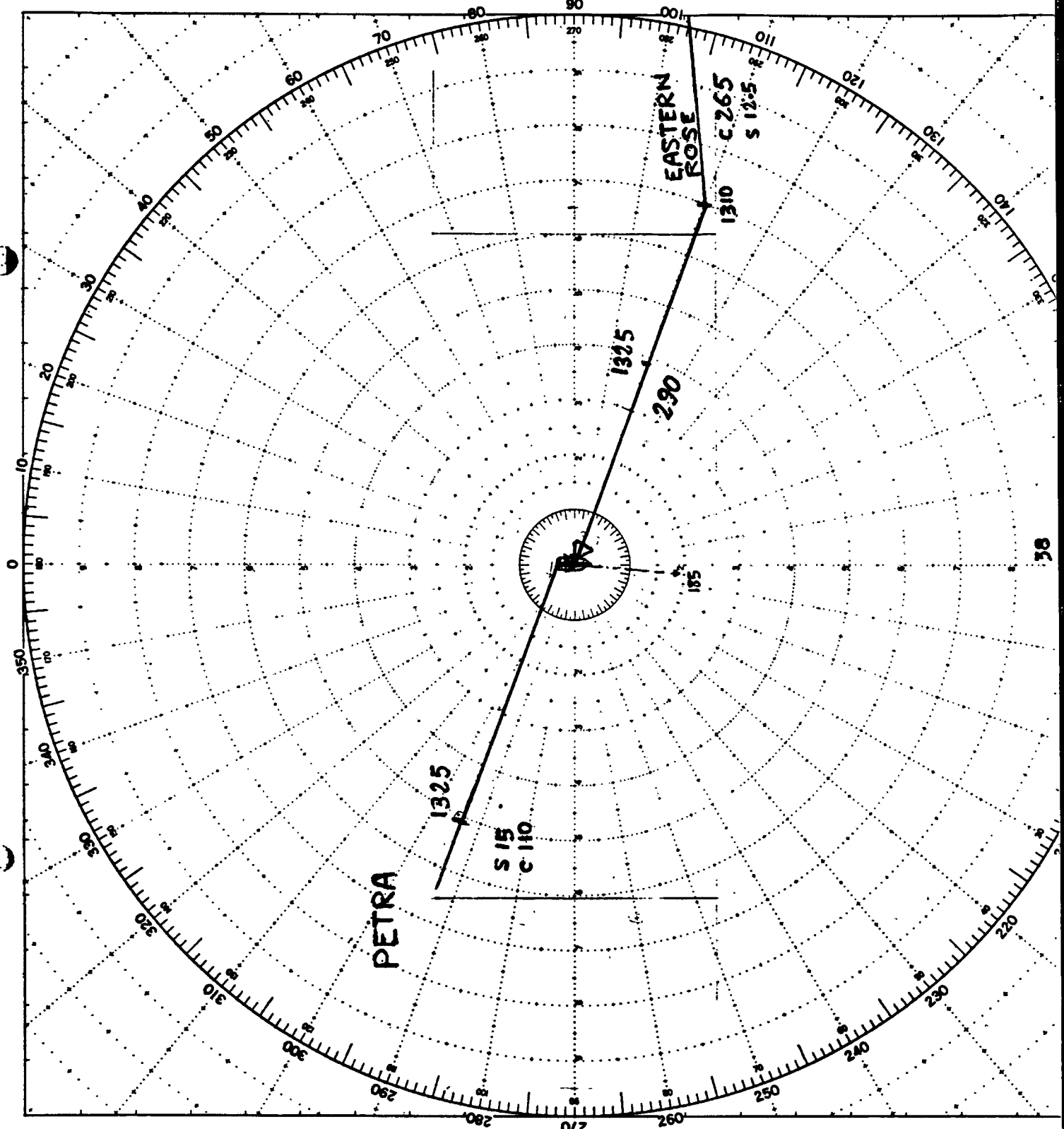
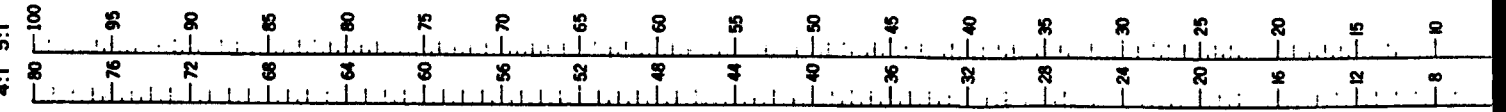
### LESSONS LEARNT :

- It is always necessary to make proper use of radar equipment.
- It is necessary to proceed at a safe speed.
- Lookouts must be posted according to Rule 5 with no extra duties.
- When having two echoes ahead no priority shall be given to any of them before assessing the situation properly.
- A closer echo does not mean that it is more dangerous than the other.

-When navigating in reduced visibility the engine shall be put on stand-by and ready for immediate use.

-It was noticed that a few seconds before the accident both vessels sighted each other, nevertheless due to excessive speed no action could prevent the collision.

-It was not proper giving five short blasts on the ships whistle when vessels were not in sight of each other.



-----  
S h i p "A"

S h i p "B"  
-----

**Ship's particulars**

|  |                      |              |
|--|----------------------|--------------|
| Name   | : APPLE BLOSSOM (AB) | AN TING (AT) |
| Flag   | : Liberian           | Chinese      |
| Type   | : ref.ship           | -            |
| G.R.T.   | : 7004               | -            |
| L.O.A.   | : 141 m              | -            |
| Year of built                                    | : 1969               | -            |
| Maximum draft                                    | : -                  | -            |
| Loading condition                                | : loaded             | -            |
| Max. service speed                               | : 18-19 kts.         | -            |
| Bridge team nationality                          | : S. Korean          | -            |
| Additional factors contributing to the accident: | -                    | -            |
| Location of bridge.                              | : Midship            | -            |
| Engine control                                   | : E/C                | -            |

**Accident circumstances**

|                    |  |
|--------------------|--|
| Day - Month - Year | : 16 July 1978                                   |
| Time               | : 20.40  |
| Time of the day    | : Night  |
| Position           | : Off the coast of Algeria.<br>36 57'N 02 48.5'E |

**Weather condition**

|            |             |
|------------|-------------|
| sea        | : -         |
| wind       | : -         |
| visibility | : Dense fog |

|                   |                               |
|-------------------|-------------------------------|
| Type of encounter | : end on or nearly so.        |
| Speed             | : A(19.5) & B(not known).     |
| Rules violated    | : 6, 7(b), 7(c), 8(e), 19(b). |

THE CASE :

(AB) spotted a target on the radar at a distance of 7 miles, 6-7 degrees to port side.\*. Without a proper evaluation of the situation the Master executed three course alterations to STBD, and every course was kept for a few minutes and then back again to the original course. This action indicates that the Master did not understand the movement of the other vessel. The Master had posted a lookout in the forecastle and sounded the fog signal. No speed changes have taken place.

N.B. No details about the other vessel are available.

RULES VIOLATED :

- Rule 6 failed to proceed at a safe speed.
- Rule 7(b) failed to make proper use of its radar equipment.
- Rule 7(c) failed by making an assumption based on scanty information.
- Rule 8 (e) failed to do the necessary preparation in order to slacken the speed or to take "all the way off" if necessary.
- Rule 19(b) failed to make her engine ready for immediate manoeuver(\*\*).

.\*. The time and distance of the first observation is different between the Master's statement and the OOW's statement. The Master stated that it was 7 miles at 2020 and the OOW stated that it was 12 mile at 2018. The investigation showed that the OOW's judgment is closer to the reality; otherwise it would appear that the other

vessel had completely stopped or was even backing. (\*\*) The violation of Rule 19(b) contradict with what was stated in the report of investigation that (AB) had advised the engine room to be on stand-by. Perhaps it was ment that the high speed maintained by (AB) made it impossible for her engine to respond immediately.

**LESSON LEARNT :**

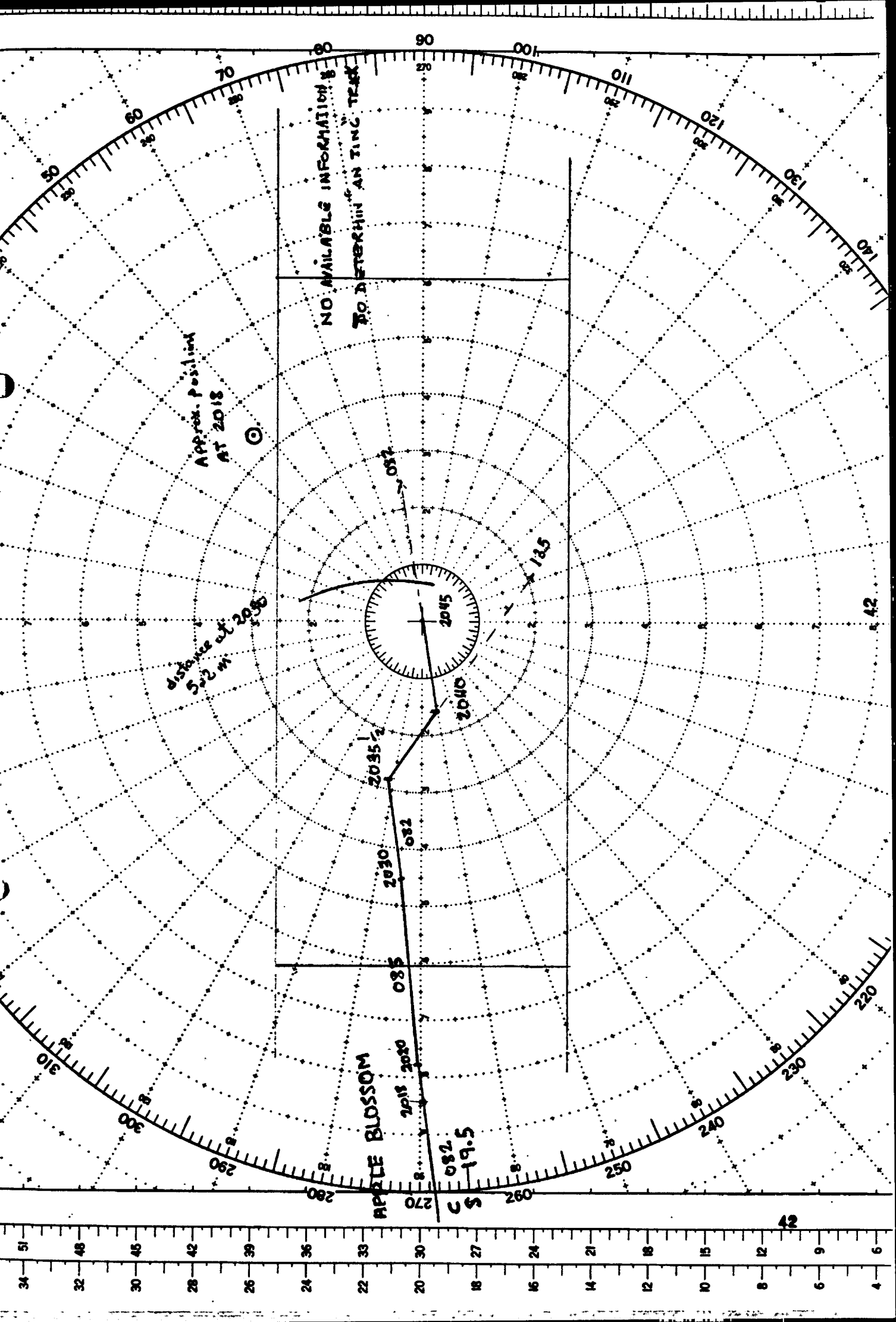
-In this accident it appears that some safety procedures were taken because of the reduced visibility namely: Three lookouts were placed in the forecastle, the engine room was advised to be ready for stand-by, and two radar sets were on 16 and 6 mile ranges respectively. Nevertheless the speed was kept at 19.5 kts. We can imagine that the lookout had reported having heard the fog signal, the range of which is usually not more than 2 miles for ships > 200 meters in length "in good weather conditions".

From the time at which this signal is reported to the bridge to the point at which it is assessed by the OOW could take at least 3 minutes. considering only own ship speed the distance between the two ships would be a maximum of one mile. Hence we can conclude that the speed was absolutely not safe. Moreover, having the E/R on stand-by will not help at such excessive speeds.

-It is important to assess the situation before changing course, and if needed, then a bold alteration is recommended.

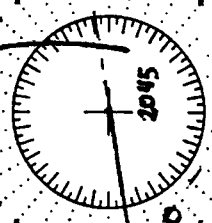
-This accident shows the importance of radar plotting. It shows also that there was a lack of communication being exercised on the bridge. Therefore, proper communication and team work is of utmost importance.





NO AVAILABLE INFORMATION TO DETERMINE ANTING TRACK

distance of 2035 5.2 mi



2035

2030

2035

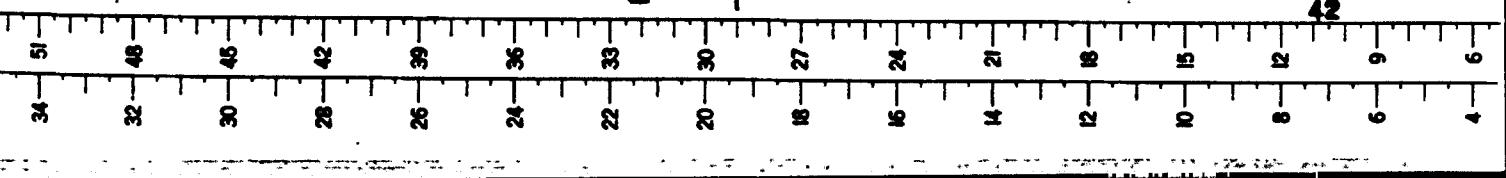
2040

2045

APPLE BLOSSOM

S 19.5

12.5



S h i p "A"

S h i p "B"

**Ship's particulars**

|  |                        |                      |
|--|------------------------|----------------------|
| Name   | : STRAIT CONTAINER (A) | EASTERN CORRIDOR (B) |
| Flag   | : Liberia              | Liberia              |
| Type   | : container ship       | general cargo        |
| G.R.T.   | : 3139                 | 4872                 |
| L.O.A.   | : 104.5 m              | 115.7 m              |
| Year of built                                    | : 1972                 | 1974                 |
| Maximum draft                                    | : 4.89 m               | 7 m                  |
| Loading condition                                | : -                    | -                    |
| Max. service speed                               | : 21 kts.              | 14 kts.              |
| Bridge team nationality                          | : R.D.China            | R.D.China            |
| Additional factors contributing to the accident: | : -                    | -                    |
| Location of bridge.                              | : -                    | aft                  |
| Engine control                                   | : E/R                  | E/R                  |

**Accident circumstances**

Day - Month - Year : 16 December 1985  
 Time : 0703  
 Time of the day : day light  
 Position : 90 miles east of Hong Kong  
 (22 28'N 116 0.3'E)

**Weather condition**

sea : -  
 wind : -  
 visibility : dense fog

Type of encounter : end-on  
 Speed : A(10.2) & B(14)  
 Rules violated : 5, 6, 7, 8, 19(b), 19(c), 19(d), 19(d)i,  
 STCW II/1 section 9(b).

## THE CASE :

(A) had her speed reduced from 12 kts. to 10 kts. and her engine on stand-by due to thick fog. She had two radars (both relative motion unstabilized), one on and the other on stand-by. In order to fix the ship, range has to be changed from 12 to 25/48 (course was distant from the coast).

At 0630 the chief officer (duty officer) observed (B) at 10 miles distance. No bearing was taken; instead he estimated that the target was 1 mile to STBD of his course, by parallel indexing lines (PI), and would pass STBD to STBD.

At 0640 on range 6 miles (B) was 5.8 miles off. Once again no bearing was taken, but the chief officer estimated a 0.5 miles passing distance (unsing PI). He felt that 0.5 miles was not enough so he a/c (18 deg.) to port. He put the autopilot on hand steering using the lookout for steering without replacing him.

The new course was maintained till 0658 where he observed on the radar vessel (B) very close then he ordered helm hard port and made two short blasts. (A) was struck by (B) at 0703. There was no plotting at all.

(B) encountered fog signal and put her engine on stand-by at 1824 (the day before the accident), and the fog signal on automatic. Radars were the same condition as (B).

At 0400 the autopilot was put on hand steering using the lookout without replacing him. At 0645 the chief officer

observed (A) on a distance of 4 mile range. He concluded that it was end-on or nearly so, accordingly he a/c 17 deg. to STBD. No further observation was made till 0655, when the target was still dead ahead and 0.4 mile off. He then a/c further 20 deg. to STBD. At 0700 when he felt that the vessels were still closing he ordered slow ahead and hard STBD wheel. The collision took place at 7003.

**Notice:** There were some plots attached to the report of investigation. They indicate that ranges taken by each OOW are suspect or that their memories are at fault. From their statements it seems that the nearest approach should have taken place at 0655. The diagram which is attached here is taking into account any courses and speeds and is worked back from the time and point of collision.

**RULES VIOLATED :**

- Rule 5            failed to post proper lookouts.
- Rule 6            proceeded with unsafe speed.
- Rule 7            failed to use the radar properly in order to obtain an early warning.
- Rule 8            failed to take action in ample time.
- Rule 19(b)        both ships failed to proceed at safe speed.
- Rule 19(d)        both ships failed to determine if a close quarter situation is developing by plotting or other means.
- Rule 19(d)(i)    changed course to port.

**REMARKS :**

There was a comment in the investigation report that Rule 14 was not complied with. However, the visibility was dense fog. Therefore this Rule should not apply.

**LESSONS LEARNT :**

-This accident shows the importance of passage planning.  
-The track followed by both ships was sufficiently distant from the coast line to necessitate changing from the anti-collision range scale of 12 miles to the 24 or 48 mile range scale to fix the ship's position.

On board both ships involved only one radar per watch was used. This is a bad practice as it can lead to unsafe navigation.

-Again in this accident the OOW found the nearest approach to be too close for comfort. Therefore he changed course to port. Such a practice should never be done. The moment it appears that CPA is small, then the course should be changed to STBD. Moreover in this case the ship which altered course to port was not restricted from changing course to STBD.

-As in many cases the lookout was not replaced when used for steering.

-It seems that the difference between signals in fog and in clear visibility was not clear. Therefore some stress on this point should be made when teaching the COLLREG.

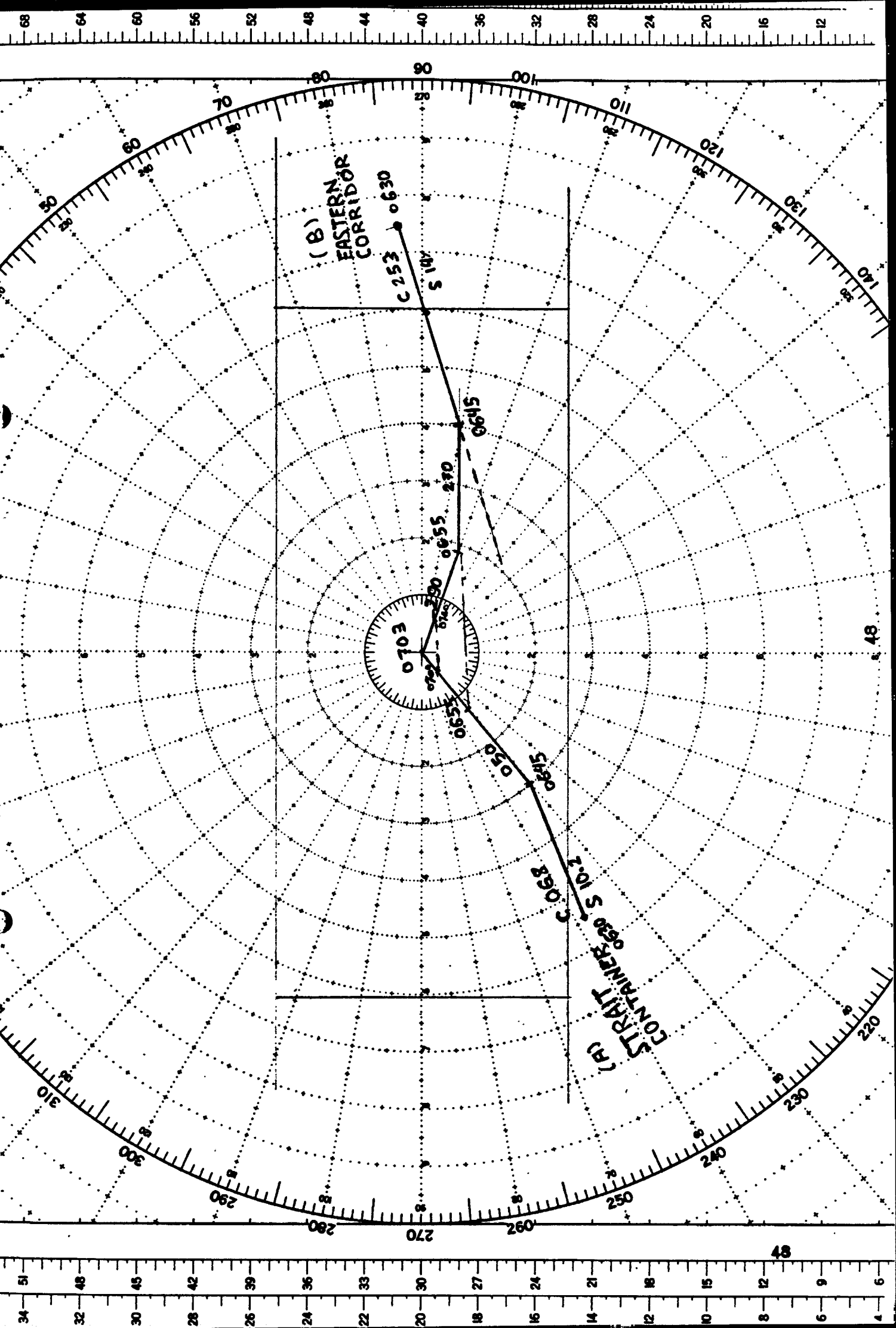
-Bridge doors shall be kept open in fog to hear signals, if any.

-The need for plotting to ascertain the target vessel's course and speed, and to determine if a close quarter situation was developing, and not to rely on PI as a method to estimate risk of collision.

-The importance of proceeding at a safe speed.

-One of the ships had a 4-meter trim, a situation which may effect the radar by having a shadow sector forward.

-It was noticed in this accident that both masters were not on their respective bridges at the moment of the accident. Therefore the Master's standing orders should contain such orders to have the master called when the OOW is in doubt of the situation.



(B)  
EASTERN  
CORRIDOR

C 253

S 107

0630

0615

0555

0530

0515

0500

0445

0430

0415

0400

0345

0330

0315

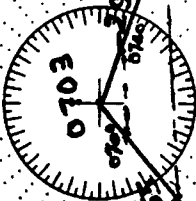
0300

0245

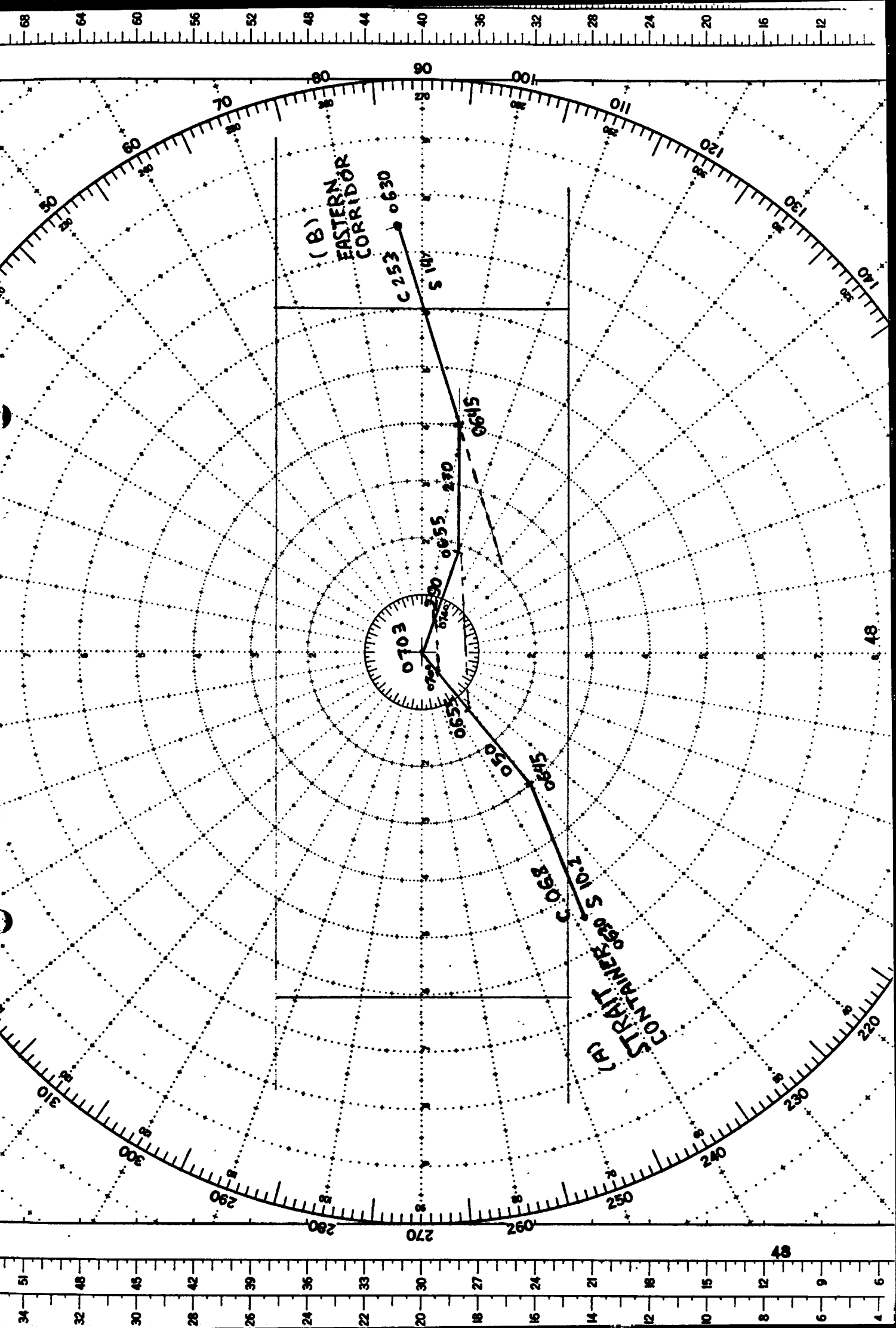
0230

0215

0200



(A)  
STRAIT  
CONTAINERS S 10.2  
C 068



S h i p "A"

S h i p "B"

**Ship's particulars**

|  |                                   |                     |
|--|-----------------------------------|---------------------|
| Name   | : FEDDY                           | SOUNION             |
| Flag   | : Liberia                         | Greek               |
| Type   | : b/c                             | single deck b/c     |
| G.R.T.   | : 11381                           | 13540               |
| L.O.A.   | : -                               | 167.65 m            |
| Year of built                                    | : 1962                            | 1968                |
| Maximum draft                                    | : -                               | 9.5                 |
| Loading condition                                | : -                               | -                   |
| Max. service speed                               | : 15 kts.                         | 15.5 kts.           |
| Bridge team nationality                          | : Hong Kong/Taiwan                | multi nationalities |
| Additional factors contributing to the accident: | Presence of another vessel ahead. |                     |
| Location of bridge.                              | : aft                             | aft                 |
| Engine control                                   | : -                               | -                   |

**Accident circumstances**

Day - Month - Year : 10 february 1981  
 Time : 0725  
 Time of the day : day light  
 Position : 9 miles north of Algier  
 (36 54.5'N 003 04'E)

**Weather condition**

sea : calm  
 wind : east 1  
 visibility : dense fog

Type of encounter : nearly end-on  
 Speed : A(10) & B(11.5)  
 Rules violated : 6, 7(b), 7(c), 8(b), 8(e), 14(a)  
 17(c) and 19(d)i



## THE CASE :

M/S Feddy (F) sank within 30 minutes after she was struck on her port side by M/S Sounion (S). (F) capsized and sank so quickly that only 3 crew members were rescued. There was a third ship involved in this casualty (TW).

(S) was heading West and (F) together with (TW) were heading East close to each other. At 0645 (S) detected echoes of two vessels on radar from a distance of 17 miles. The Master of (S) thought that both ships were on his STBD bow, however, analysis of this accident showed that they should have been 10 degrees on his port bow. At 0705 the Master of (S) altered course 13 degrees to port.

At 0720 the Master was advised that a fog signal was heard 25 - 30 degrees off his STBD bow. This signal in fact was from (TW). At 0720 he put his helm hard port, placing his ship on a collision course with (F).

## RULES VIOLATED :

- Rule 6            both vessels were running with excessive speed.
- Rule 7(b)        the Master of (S) failed to use his radar properly.
- Rule 7(c)        based his assumption on scanty radar information.
- Rule 14(a)&  
17(c)            failed to alter course to STBD (\*)
- Rule 8 (b)        made a succession of small course alterations.
- Rule 8 (e)        failed to do the necessary preparation in

order to slacken the speed or to take "all the way off".

Rule 19(d)(i) changed course to port.

Rule 19(b) maintained excessive speed in fog.

#### **GENERAL REMARKS :**

-There was a lack of proper communication.

-(\*) In the conclusion report it was stated under paragraph 5:

"the Master of Sounion ignored Rules 14(a) and 17(c) by altering his course to port".

I see no reason why these two Rules apply only to vessels in sight of each other, which is not the case here.

#### **LESSON LEARNT :**

-Even when faced with the risk of collision, some OOWS will not use the technique of radar plotting to determine the course, speed and closest point of approach (CPA) of an approaching vessel.

-Some OOWS have not acquired sufficient skills to use their radar to plot as required by Rule 7(b).

-Assumptions and actions are based on scanty radar data.

-Radar interpretation and plotting is an attained skill which can only be acquired through proper education, training and experience.

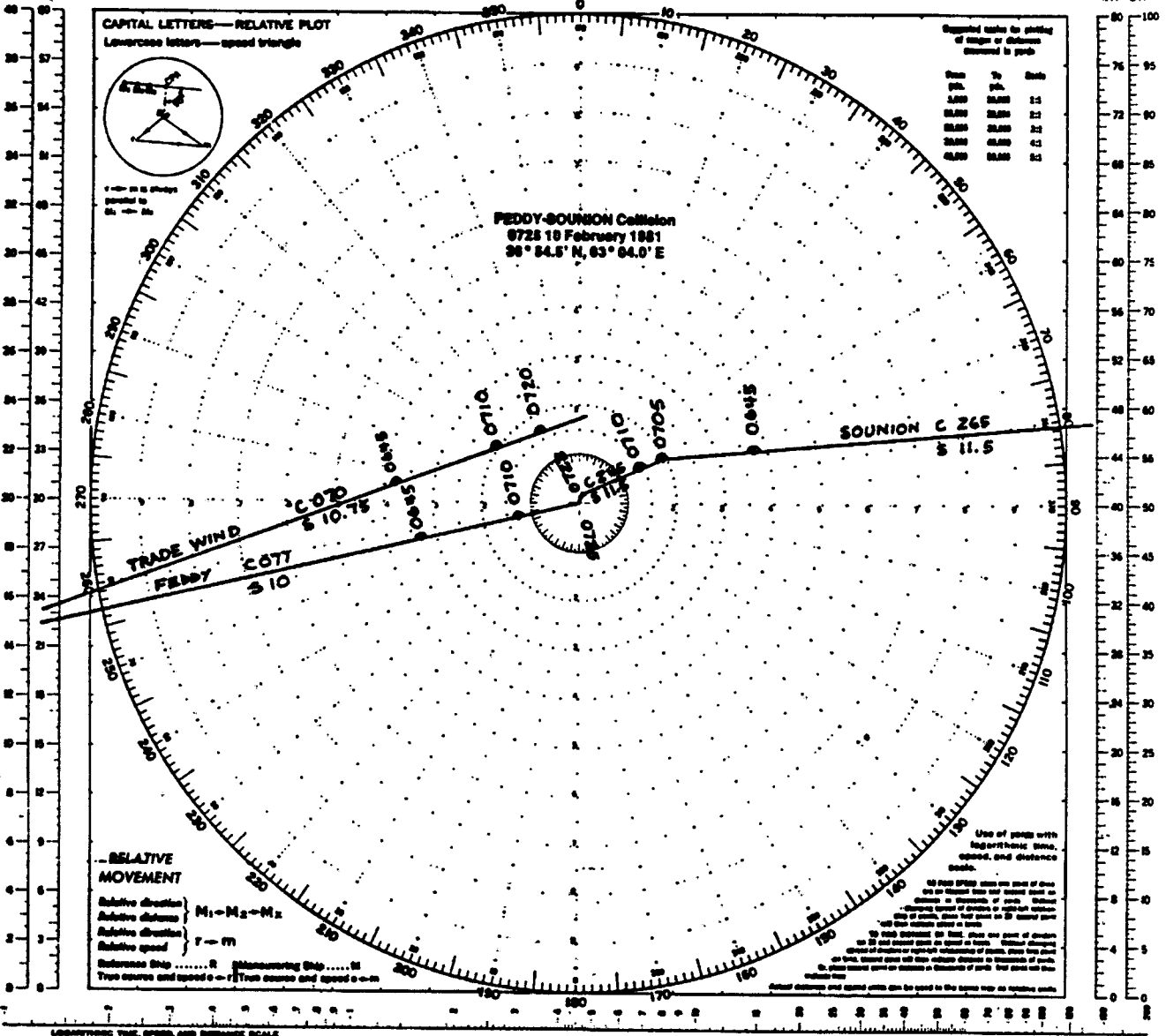
-The use of an automatic radar plotting aid (ARPA) could eliminate or reduce this problem. But a high professional standard means more than sophisticated equipment.

H.O. 2665-10

# ANNEX 1 MANEUVERING BOARD

SCALES  
2:1 3:1

SCALES  
4:1 5:1



52

Price \$1.00  
Per Pad of 50  
H.O. 2665-10

Published at Washington, D.C.  
by the U.S. NAVY HYDROGRAPHIC OFFICE  
under the authority of the SECRETARY OF THE NAVY

5TH ED., JULY 1961    H.O. 2665-10

**N.B. This Diagram is a second copy of the original investigation.**

S h i p "A"

S h i p "B"

Ship's particulars

|  |                       |                       |
|--|-----------------------|-----------------------|
| Name   | : LASH ATLANTICO (LA) | HELLENIC CARRIER (HC) |
| Flag   | : U.S.A.              | Greek                 |
| Type   | : barge carrier       | general cargo         |
| G.R.T.   | : 26406               | 8987                  |
| L.O.A.   | : 820 ft.             | 470 ft.               |
| Year of built                                    | : 1972                | 1972                  |
| Maximum draft                                    | : 32 ft.              | 32 ft.                |
| Loading condition                                | : loaded              | partially loaded      |
| Max. service speed                               | : -                   | -                     |
| Bridge team nationality                          | : U.S.A.              | Greeks                |
| Additional factors contributing to the accident: | -                     | -                     |
| Location of bridge.                              | : -                   | -                     |
| Engine control                                   | : E/R                 | E/R                   |

Accident circumstances

Day - Month - Year : 6 May 1981  
 Time : 0702  
 Time of the day : day light  
 Position : 36 15'N 75 34'W  
 about 13 n.m. NE of Kitty Hawk, North Carolina.

Weather condition

sea : calm  
 wind : calm  
 visibility : fog (0-1 mile)

Type of encounter : end-on  
 Speed : A(18) & B(14)  
 Rules violated : 6, 7, 8(b), 19

## THE CASE :

(LA) collided with (HC) in dense fog. It was nearly end-on meeting. When the chief mate of (HC) first saw the echo of (LA) on the radar, he believed that the vessels were on opposite and parallel courses and would pass STBD-to-STBD about 2 miles apart.

Similary, when the master and second mate of (LA) first saw the (HC) on radar, they believed that the vessels were on opposite and parallel courses and would pass at least 1 mile but PORT-to-PORT. No plotting was carried out by either vessel.

(LA) course was 161 and in an attempt to increase the CPA a small alteration of course to STBD was made. First 165 and then 175 and 185. However, the contact's relative movement was not changing to the left to increase the CPA. This fact should have alerted the Master and the Second mate that the changes of course to STBD were not aiding the situation.

The (LA) had observed (HC) on radar 10-12 minutes prior to the collision, that is considered enough time to plot it and to determine its CPA. However, by having the radar on the 6 mile range, the OOW provided himself with only a relatively short time period for evaluating a meeting situation.

15 minutes before the collision (HC) altered course 6 degrees to port to pass (LA) more openly. This is a statement made by the chief officer of (HC). When the two ships were 3 miles apart the OOW went to STBD bridge wing to see (LA). He stated that the visibility was from 1.5

to 2 miles. Although he remained on the bridge wing for 5 minutes, he did not see (LA). Visibility continued to deteriorate, but no sound signal was used by (HC).

About one minute before the collision, the chief mate returned to the pilot house and looked at the radar and saw the echo half mile slightly aft of his STBD beam. As he watched the contact, it headed directly towards him. He ordered hard port and collided one minute later.

#### RULES VIOLATED :

- Rule 6            proceeded with unsafe speed.
- Rule 7            failed to do radar plotting or equivalent systematic observations in order to obtain early warning of risk of collision.
- Rule 8(b)        action to avoid collision was not large enough.
- Rule 19          their behaviour was not in accordance with the following paragraphs: b, d(i), d(ii), and (e).

#### LESSON LEARNT :

-In this accident if there had been no alteration of course, the two ships would have passed safely STBD to STBD at about 1 nm. apart. This of course can only be known if a proper plotting had taken place in order to determine course, speed, CPA etc. which was not the case here. As a matter of fact no plotting has been done at all.

-There was a conflict whether the case was STBD to STBD or port to port pass. It seems that one of the ships had the presentation on the radar scope missaligned with the heading of the ship, however a plot of the movement of the contact should have indicated the correct passage.

-In such a case the use of VHF radiotelephones by the bridge watch to establish passing agreements should be encouraged.

-Long range scanning is very important to have some ideas about each other before it becomes very late.

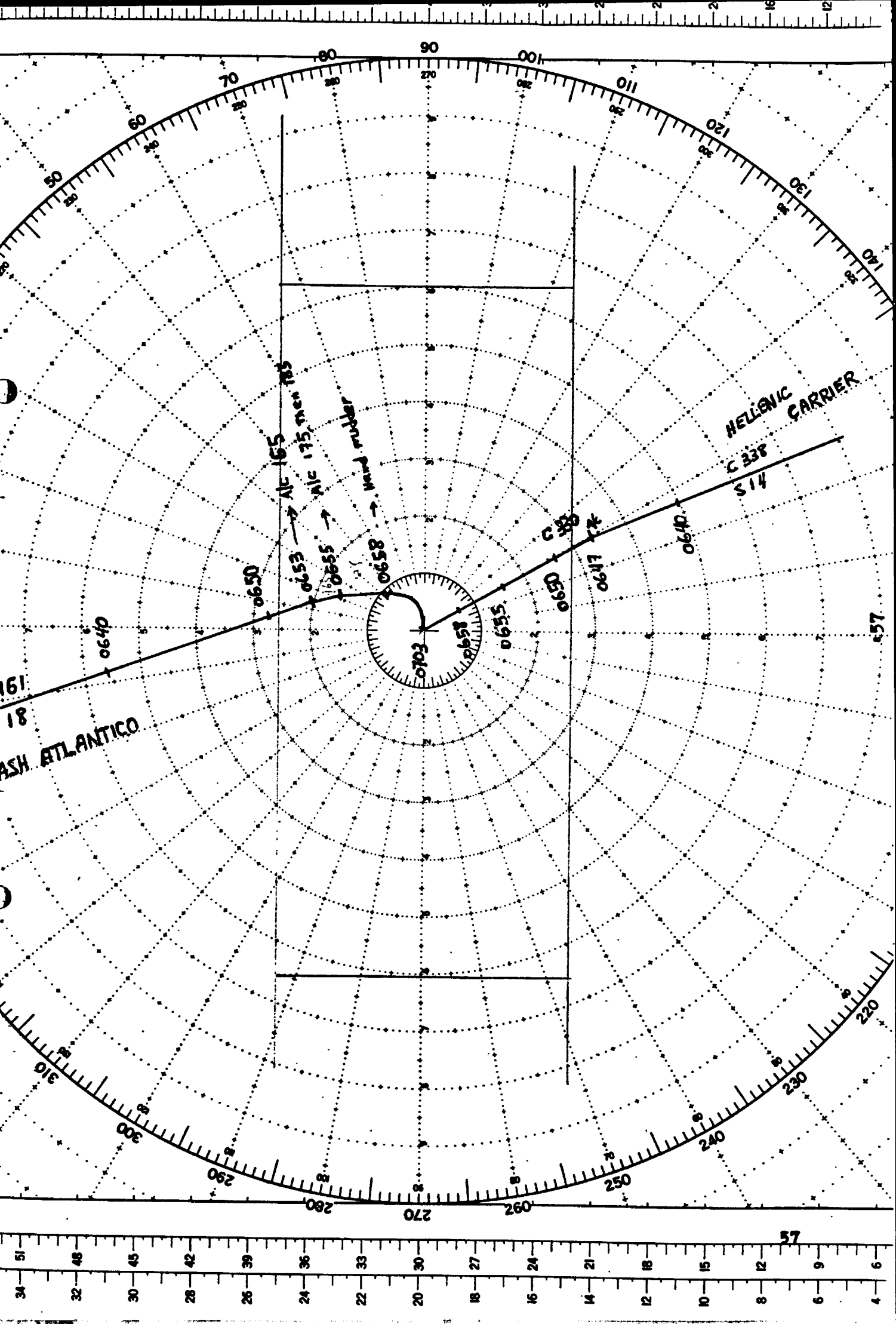
-When the situation was not clear it might have been of a help to reduce speed to a minimum until the picture was clear and to have additional time to evaluate the situation and to take any evasive action necessary to avoid collision.

-The fog signal should always be used when applied.

-Alterations of course should be large so they appear on the other vessel's radar screen. A succession of small alterations of course and/or speed should be avoided.

-There should be international agreements to require vessels to deep listening to channel 16 particularly in coastal waters where there is other traffic.

-In company's instructions to masters, there should be encouragement to use both radars on ships equipped with two radars when operating in restricted visibility conditions.



Folo  
0  
2  
4  
6  
8  
10  
12  
14  
16  
18

ASH ATLANTICO

HELLENIC CARRIER

C 338  
S 14

ALC 165  
ALC 175  
ALC 185

Hand number

0650

0653

0655

0658

0650

0655

C 338

0617

0610

161  
18

57

57

51 48 45 42 39 36 33 30 27 24 21 18 15 12 9 6  
34 32 30 28 26 24 22 20 18 16 14 12 10 8 6  
5 4



# CHAPTER

## III

# ANALYSIS TO END-ON COLLISIONS

## ANALYSIS TO END-ON-MEETING

End-on meetings may appear either when both vessels are in sight of one another or in restricted visibility. Here we have to deal with two different rules namely Rule 14 (Head-on Situation) and Rule 19 (Conduct of Vessels in Restricted Visibility) in which the above mentioned situation may take place.

### a) WHEN BOTH SHIPS ARE IN SIGHT OF EACH OTHER:

Rule 14 (a) states:

" 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 "

Here the interpretation of "nearly" is necessary in two respects:

1- to determine whether the "crossing" rule or the "end-on" rule applies.

2- to decide whether the "end-on" rule applies to two vessels approaching each other on opposite and parallel or nearly parallel tracks. This latter case can be particularly difficult in green-to-green situations as altering course to starboard involves passing ahead of the approaching vessel.

The end-on and crossing rules are only applicable to situations in which vessels are in visual sight of one another, but even more difficult situations can occur when vessels out-of-sight of each other are meeting "nearly" end-on with a risk of a "close-quarters situation and where the radar plot is indicating an apparent "green-to-green" situation, and Rule 19 is imploring the mariner to "avoid altering course to port".

We shall be concerned with the interpretation of the words "nearly" and "close-quarters", and try to find ways of better explaining to Rules 14 and 19.

Meeting vessels in sight of each other :

The term "nearly" in the in-sight situation is usually understood according to the specification of the sidelights. Although the Collision Regulation (Rule 21) state that the sidelights should show from right-ahead to 22.5 degrees abaft the beam on their respective sides, in reality, to avoid having a blank area ahead between the two sidelights owing to their usual physical separation, the side lights are required by the Collision Regulation (Annex 1, s 9 (a) (i) ) to show one to three degrees across the bow onto their "wrong side".

The courts have suggested therefore that fine crossing courses intersecting at less than six degrees should be regarded as meeting "nearly end-on". So both vessels need to alter course to starboard. Whereas if the intersecting angle is six or more degrees the situation should be regarded as a (crossing) one and the vessel which has the other on her own starboard side shall keep out of the way while the other should keep her course and speed. Thus, by night, the theory is that if only one sidelight is seen ahead, or on either side, it is not an "end-on" situation and is probably a "crossing" situation (unless the other vessel is stopped), whereas if both sidelights are seen ahead, or within three degrees of right ahead, it is an (end-on) situation.

This apparently seems to be simple solution, however, it can be more complicated when vessels on fine-crossing

courses are yawing, and in cases where vessels appear to be passing green-to-green but too close for comfort. Each of these difficult situations has been considered by the Court of Appeal.

- The first case was a collision between two ships, Kaituna and Selje, which took place 20 miles off Cape Otway in southern Australia. The two vessels were yawing on courses intersecting at 8 degrees. The Court of Appeal decided that the crossing rule applied and thereby overruled the Admiralty Court which had held that the end-on meeting rule applied(\*).

-The second case was a collision between the VLCC Horta Barbosa which was in ballast and the fully loaded VLCC Sea Star in the Gulf of Oman. The two ships were on reciprocal courses and would have passed each other green to green at about 0.75 to 1.0 mile apart if the Sea Star had not altered course to starboard. The Court of Appeal upheld the decision of the Admiralty Court which had held that the end-on meeting rule did not apply to the case, and that the Sea Star had altered course to starboard at an "improper" time.

Furthermore the three judges in the Court of Appeal accepted the advice of their two nautical assessors. Their advice was that if two VLCCs are in sight of each other and are proceeding, each at 16 knots on reciprocal courses, shaping to pass green to green, then they could pass each other safely at a minimum distance of 5 cables; and that if the predicted passing distance" was anything less than 5 cables then either or both vessels should alter course to port to turn away from each other to increase the passing distance".(\*)

\*( A.G. Corbet, Seaways Nov.86)

So the conclusion with respect to vessels in sight is that there will be doubt as to whether or not any particular ( fine ) crossing case or any particular green to green ( close ) passing situation will be regarded as a head-on situation to which 1972 Rule 14 applies.

Rule 14 (c) states :-

" When a vessel is in doubt as to whether such a situation exists, she shall assume that it does exist and act accordingly."

Well, the Sea Star was in doubt and acted accordingly, but the Horta Barbosa was not in doubt. It was sure that the end-on rule did not apply ! so Rule 14 (c) is not really of any help; in fact, it misleads by pretending or inferring that the whole of Rule 14 copes with the doubtful situation. Thus the Sea Star case proves that it does not.

In an article in SEAWAYS written by Captain A.G. Corbet he suggested some radical changes to Rule 14, namely:

- to permit the mariner to use his common sense when dealing with a ship approaching end-on and not to be inhibited from altering course to port specially in a close "green to green " passing situation.

- When altering course to put the other vessel abeam or even astern. So if one vessel alters course to port as the other alters to starboard then there is no risk of collision as each vessel has the other abeam, they are on parallel course, and it is easy to distinguish one from the other.

- to establish proper procedures for reaching agreement

to pass either green to green or red to red with the aid of VHF by broadcasting the true bearing and range of the echo being called with the identity of the calling ship.

- Captain Corbet criticised the Rules in that they do not attempt to deal with cases where more than two vessels are approaching each other with an equal risk of collision as the Rules, apart from Rule 9 and 10, deal with two vessels only.

After the study to several collision cases in which head on or near head on cases took place, it was found that in some cases it would help if such changes stated in the above mentioned artical were implemented. However, many changes in the Rules may lead to more confusion as first, as it takes a lot of time to bring such changes into being. Second, all the existing seafarers need to be notified of such changes which is not an easy thing to do.

With regard to these changes and the existing Rule 14, I think a proper explanation and simulation may overcome the ambiguity, and the following should be observed in teaching this Rule :-

- Courses which intersect in an angle of less than 6 to 8 degrees should be considered head on.

- If the starboard to starboard passing presents ambiguity and mariners wish to increase the passing distance by altering course to port, which is against Rule 14, they should consider the case as head on. That means a risk of collision does exist and they, therefore should make an early and substantial alteration to starboard to achieve

a port to port passing.

(The attached table can be of help in appreciating the passing distance).

- Rule 14 is not intended to apply to cases in which, from a vessel which is ahead or nearly ahead, one side light can be seen, but the other is obscured.

- The effect of yawing must be taken into account.

- Emphasis should be given to the wording of the Rule. In that it is the direction of the ship's head, and not the course made good, which must be used to determine whether vessels are meeting end on or crossing.

The communication process is of very much help if it can be done but in the absence of transponders for a proper identification of vessels it might lead to confusion. See Diagram (1).

(B calling A " vessel on my starboard bow 2 miles off course 140 speed 10 knots "resulting in no answer from A, but C answered the call in the believe that D is the calling ship.

Now if the agreement was to ask A to change course to starboard, instead C will do so, an action which may place her on a collision course with B).

co.140 C +  
sp.10

co.140 A +  
sp.10

D +

B +

Diagram (1)

**Unproper communication**

Finally the presence of more than one ship in a head on situation with the risk of collision from both of them at the very same time is very rare, as the two ships ahead of own ship will obviously not keep such a close distance to each other. However a bold alteration of own ship course to starboard in plenty of time with the possibility of an increase in speed may clear up the situation.

**(b)WHEN BOTH SHIPS ARE NOT IN SIGHT OF EACH OTHER**

Here the situation is different from that when both vessels are in sight of one another. By having a look at the collision regulations we will find only one rule which deals with conduct of vessels in restricted visibility namely, Rule 19. In this rule all types of encounter, when in restricted visibility, are dealt with. However, since our concern here is meeting end on or nearly end on situation, we will limit our discussion to this particular type of encounter.

Rule 19 (d) states :



"A vessel which detects by radar alone the presence of another vessel shall determine if a CLOSE-QUARTER 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".

Here it is clear that in most types of encounters including end-on meetings all vessels should try to avoid alterations of course to port for vessels forward of the beam (except for a vessel being overtaken). Before going into details I would like first to explain the underlined expressions :-

### 3.1- A CLOSE QUARTERS SITUATION :-

The distance at which a close quarters situation first applies has not been defined in miles, and is not likely to be as it depends upon a number of factors, e.g. size, type, manoevrability of ships and weather conditions.

In restricted visibility, in the open sea, a close quarters situation is generally considered to begin to apply at a distance of at least 2 miles in any direction forward of the beam as this is the typical range of audibility for the whistle of a large vessel in still conditions. A minimum distance of 3 miles is sometimes suggested when determining whether a close quarters situation is developing as allowance should be made for the effects of errors in radar observations, especially at long range. (\*)

### 3.2- DETERMINE RISK OF COLLISION

A vessel which detects another vessel by radar alone in restricted visibility is required to determine whether a close quarters situation is developing and/ or risk of collision exists.

Rule 7 (b) also requires that proper use be made of radar equipment to obtain early warning of risk of collision, and that radar plotting or equivalent systematic observation should be carried out. Assumptions must not be based on scanty information. Here I will elaborate on the dangerous of assumptions on scanty information:

The determination of risk of collision, in both clear and restricted visibility, must be based on several successive observations taken as accurately as possible.

Small errors in ranges and bearings taken in the early stage of an encounter, or inaccurate plotting, are therefore likely to have an appreciable effect on the assessment of risk of collision.

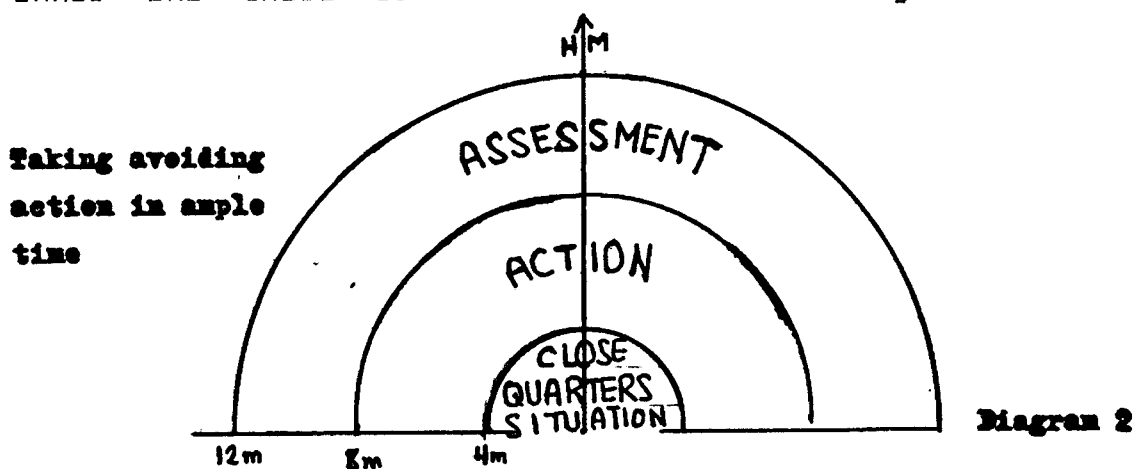
The example in Diagram(3) illustrate the danger of attempting to assess whether risk of collision exists from a small number of observations taken at long range. Errors in bearings of (+/-1 deg.) are not unlikely when using radar, as a result of which it may appear that the echo is going to cross ahead or may appear to be going on a parrallel course. Therefore several observations should be taken at short and regular intervals to reduce the effect of these random errors when there is a possibility of a close quarters situation developing. Figer (1) shows how to assess risk of collision according to Rule 7

### 3.3- TAKING AVOIDING ACTION IN AMPLE TIME :-

Avoiding action must be taken if a close quarters situation is developing and risk of collision exists. It is not necessary to take avoiding action if a vessel is expected to pass at a close distance but there is no risk of collision as, for example, when two vessels meet in a channel.

Rule (8) (a) requires avoiding action to be taken in ample time in all conditions of visibility. When the visibility is restricted it is generally necessary to take action to avoid a close quarters situation at an earlier stage. However, action should not be taken without first making a full assessment of the situation.

As a general guide it has been suggested that, using a 12 - mile range scale in the open sea, radar observation should be assessed as an approaching target crosses the outer one third of the screen to see whether a close quarters situation is developing. If so substantial action should be taken before the target reaches the inner one third of the screen. (see Diagram (2) \*



\* A. N. Cockcroft and J N F Lameijer.

Rule (19)(d) requires avoiding action to be taken in ample time if a close quarters situation is developing with a vessel approaching from any direction.

### 3.3 ACTION TO BE TAKEN :-

As I have mentioned before we are looking into meeting end on or nearly so. In such situations manouvring with speed does not help very much provided that the other ship does not take action. However it could be considered as "avoiding action" as it reduces the closing speed and gives more time for assessment and further action by both vessels. Therefore we are looking at the right action to be taken in such encounters.

First, as a general behaviour when dealing with Rule 19(d) avoiding action, the attached chart(2) shows how such rule shall apply.

Second, in an end-on meeting the most effective action is alteration of course. The Rules make it clear by stating that vessels shall avoid an alteration of course to port for a vessel forward of the beam other than being overtaken; this includes our case of study.

By observing the two rules, namely Rule 14 ( head on for vessels in sight of each other ) and Rule 19 ( for vessels in restricted visibility ), it can be seen that the action shall be alteration of course to starboard. One may ask what is the problem then if it is so clear whether in clear or restricted visibility vessels shall change course to starboard.

The answer to that is coming from investigation of the several cases of collision where the situation of " near-

ly end-on " seems to be the prevailing one. Moreover it seems that it always causes misunderstanding or missestimation in the case. Such ambiguity was always noticed, specially in cases when the other vessel was approaching from fine starboard bow ( in restricted visibility ). In most of the cases it appeared to the officer of the watch (o.o.w.) that the bearing of the other ship was slightly opening, This could have been due to an error in the radar or the gyro, and he saw that the ship was already to the starboard side so he tried to increase the CPA by altering a few degrees to port. What often seems to happen is that the other vessel acting according to the Rules, perhaps not in ample time, alters her course to starboard. Finally it ends up in collision or near-miss.

### 3.5 WHAT IS THE SOLUTION?

I think if every navigator sticks to the Rules by altering course to starboard in ample time after assessing the situation the risk of collision will be reduced, and in cases similar to the one I have mentioned before the following should be well explained to the students:-

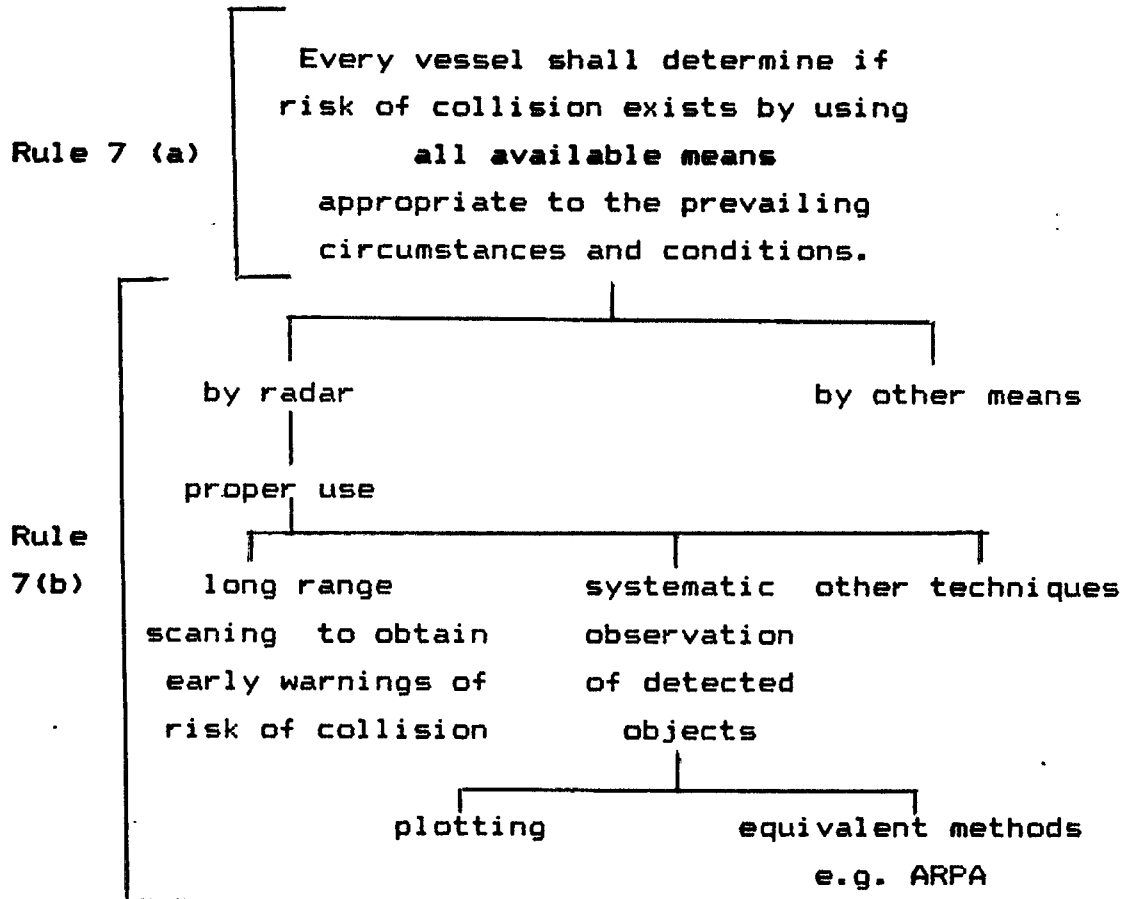
- 1- when a certain type of encounter shall be considered as a Head-on situation
- 2- after a proper plotting If the CPA is found to be not enough and an alteration of course is chosen as to avoid a close quarter situation, then a bold alteration of course to starboard would be the right action, perhaps to put the other vessel astern. Engine shall be used without hesitation and the ship shall always proceed with safe speed.
- 3- whenever possible establishment of communication with the other vessel will make things clear to both ships.

4- finally several trainings with the aid of simulators will help and will ensure full understanding of the collision prevention rules.

Chart 1

Rule 7

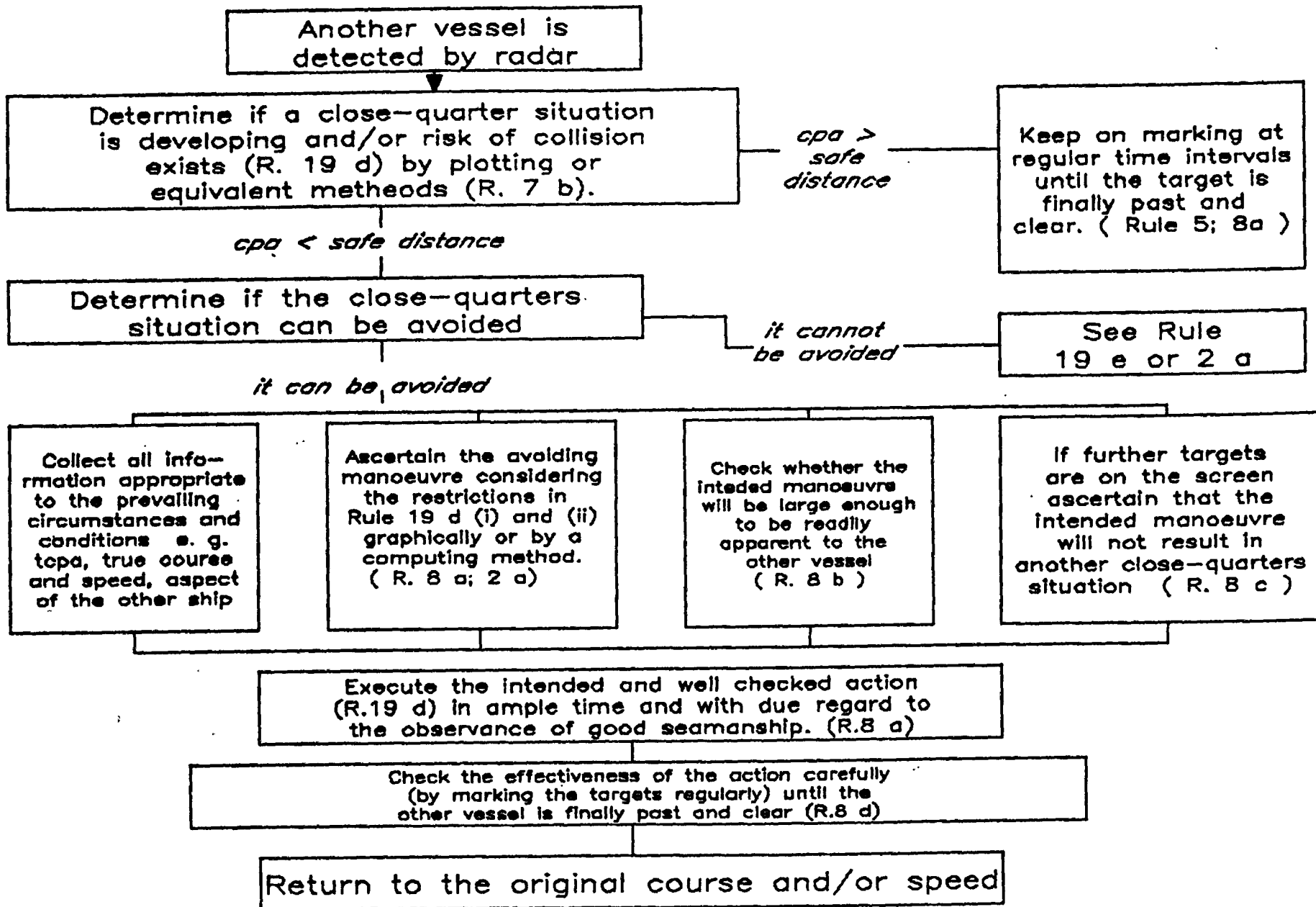
RISK OF COLLISION



Rule 7(b) plotting = a systematic observation of detected objects with the aim to determine if risk of collision exists.

to plot = to mark (or to take the bearing and distance of) a target at regular time-intervals and, by graphic or computing method, to determine the CPA and/or to determine if risk of collision exists.

# Rule 19 (d) Avoiding Action





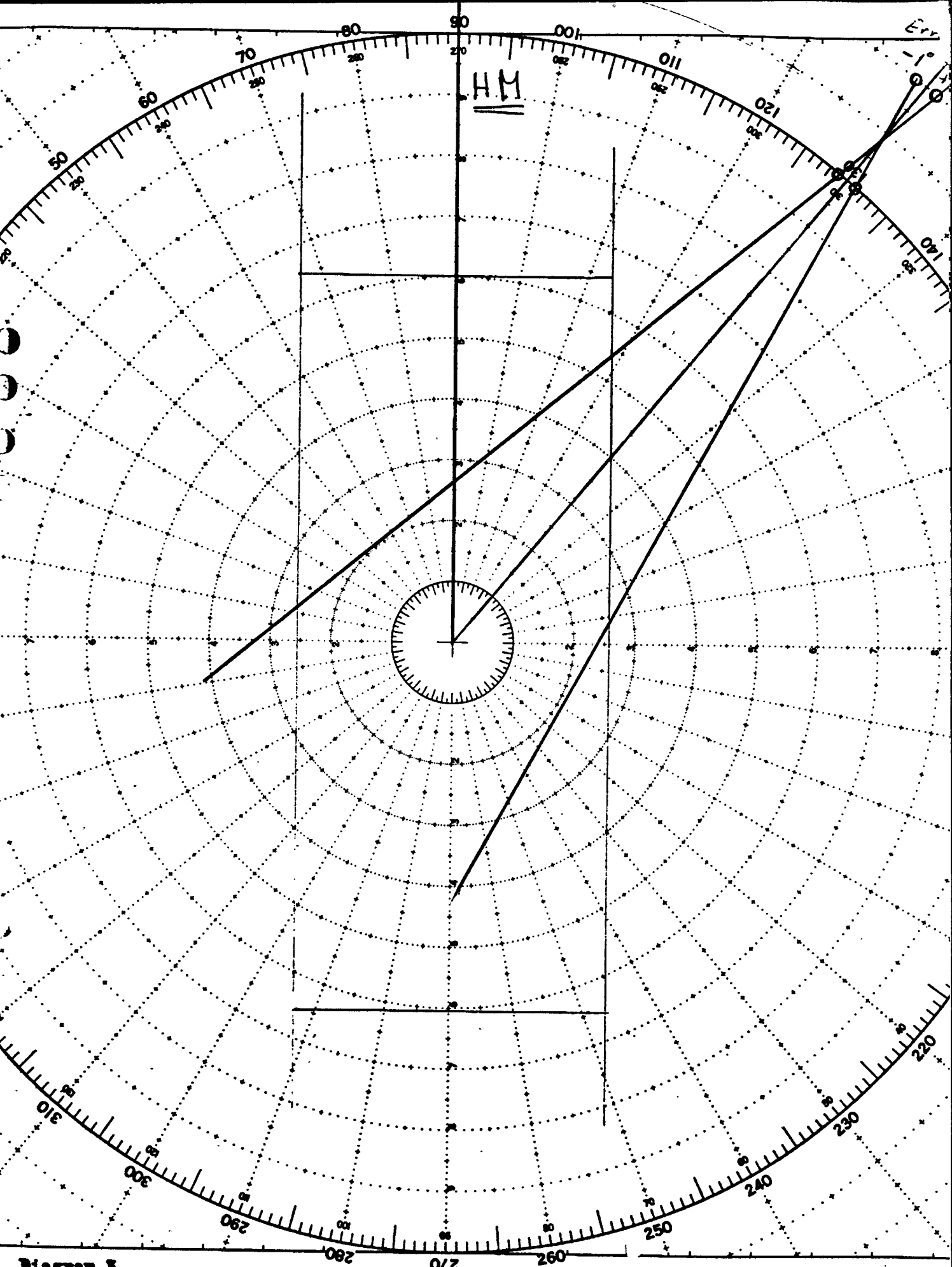
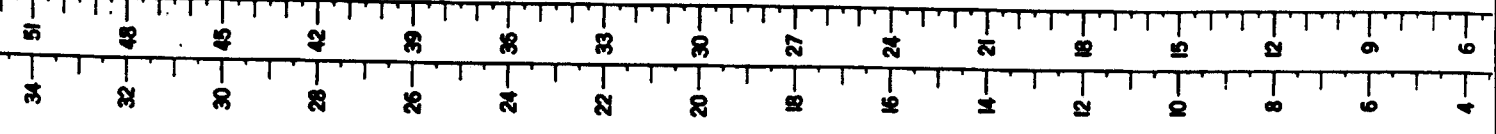


Diagram 3

73



**CHAPTER**

**IV**

**THE HUMAN  
ELEMENT IN  
COLLISION**

## THE HUMAN ELEMENT IN COLLISIONS

In most investigations of collision cases, the human factor appears in one way or another as a prime causative factor. Therefore a special emphasis should be given to this factor if we are to reduce collisions at sea. One important fact is that when we talk about errors made by those on board ships, for example, if a ship collides with another because of an incompetent watchkeeper, part of the blame must rest also with the people who employed him or issued him with his qualification. Moreover the human error has to be appreciated in its broadest sense. That means we have to see that the error is often caused by other factors, that human failure has a background.

In this chapter I will be looking at some of these factors. I will illustrate the problems faced in analysing human failure and will propose some practical measures, which have to be highlighted for the maritime students at the education and training stage as a step forward to try to reduce the risk of collisions.

### SOME SOCIAL PROBLEMS :-

In order to understand human behaviour one must ask (why do they behave like this?) Is it because their wages do not offset the discomfort and the hardships of life at sea, far from the family and from the amenities of life ashore, or is it because of the nature of the work on board the ship itself (extra stress from the superiors)?

Is the ship's trading route in a sense keeping her crew quite far away from home? Many other questions can be asked if we are to understand the reason for human behaviour.

In contrast today's industrialised shipping industry sometimes does not observe the social problems of life on board ships. Surely, the reasons are commercial ones. In a highly competitive shipping industry one can not spend time finding ways to attract men who in the end are too expensive and whose expectations are too high. Therefore, many shipping companies tend to man their ships, whether directly or through manning agencies, without paying much attention to the social problems of their crews. But with the high percentage of human failure involvement in collision, the time has come to pay more attention. If shipowners are to seek the safety of their ships and to keep their reputation high, one result of which will be the enhancement of safety at sea and the contribution to the prevention of pollution arising from collision.

#### 4.1 PROBLEMS FACED IN ANALYSING HUMAN FAILURE

1- In order to prevent or reduce collisions a thorough understanding of their causes should take place. To understand the causes depends upon collecting valid and systematic information, and since we are dealing with a human and social process the following problems will have to be considered:

1.1 The primary source of information on collision is people, not mechanical devices such as the airlines "black box". Logbooks and reports are themselves subject to human influence.

1.2 The scene of shipping accident does not remain the same.

1.3 Possibilities for reconstructing the accident and preceding events are limited.

1.4 There is no external monitoring that can provide immediate and direct information as in spacecraft accidents where it is possible to know exactly what has gone wrong, how and where, and what could have been done to prevent the accident.

1.5 It is difficult to assess what really happened, because what actually happened, what is perceived as having happened, what later is recalled as having happened, what is communicated as having happened, and what is recorded in documents as having happened may differ significantly.

2- It is also noted that apart from other considerations such as insurance and liability, the version of collision given by two ships involved may not exactly tally with each other. Indeed they may flatly contradict each other. I have found it very difficult in analysing some colli-

sion cases to establish the point of collision. The reason is that following the report of each ship sometimes after plotting it I found out that in a such case there should not be any collision; instead they should have passed each other at a safe distance.

3- When giving the accident details some might be dropped and others might be added or distorted. A common excuse used is that of not remembering the situation specially after a long time has passed.

4- Willingness to communicate to others what actually occurred to the best of one's knowledge, one's experience and one's own role and contribution to events depends on several factors:

- i - the concern about disclosing information that may prove harmful to oneself.
- ii - the need to protect one's security.
- iii- the need to protect the community ( by closing ranks against outside threats )

5- Vying with these processes are two considerations:

- i -the rational consideration: one should cooperate to the best of one's ability in analysing causes and disclosing information even if it puts oneself in a poor light.
- ii- a duty and legal responsibility exists to communicate about accidents regardless of what the individual may personally feel in the matter.

6- Because of the complexity of the above mentioned problems we need to develop an appropriate methodology that can meet rational and legal considerations whilst also providing human consideration as regards the security of the seafarer and his community. In the meantime we have

to look at the human process in collision.

#### 4.2 HUMAN PROCESSES IN CASUALTIES :

4.2.1- Based on the studies of several collision cases the following general conclusions can be drawn:

- (a) The human factor by itself should not be isolated as the sole cause of a collision. It has to be linked to other contributing factors.
- (b) When finding the cause of collision we can not go just to the action preceding the collision and say this is the cause. We have to consider the previous events.
- (c) We should not concentrate only on serious collisions because we can learn as well from minor ones.

#### 4.2.2 MAJOR FACTORS INVOLVED IN COLLISIONS :

##### 4.2.2.1 KNOWLEDGE, SKILL AND EXPERIENCE :

Knowledge, skill and experience together form the basic requirements for safe navigation and collision avoidance. A collision may occur as a result from these basics not being acquired and maintained. In these cases there is no substitute for proper education, training and seagoing experience for the navigator. However, collisions can and do occur when there is a lack of knowledge, skill and experience of "local" conditions and it is in this area that improvement may need to be sought.

#### 4.2.2.2 THE NO RISK ASSUMPTION :

A number of collisions seem to derive from a "no-risk assumption" on the part of the ship's navigator. Naturally all navigators know intellectually that some risk exists once ships are within certain areas. However, the navigator may become so accustomed to situations successfully handed in the past that he implicitly assumes no risk. At this point he is vulnerable. He may ignore or neglect first indications of the development of a potentially dangerous situation which may result in a collision.

#### 4.2.2.3 ORGANIZATION AND COMMUNICATION :

Organization and communication are probably the two main areas in which human factors play a role in collision besides qualification. Organization may be at the bridge level (e.g. watchkeeping), ship level (e.g. bridge-engine room co-ordination), or ship-shore level (e.g. co-ordination with tugs, traffic systems or harbour authorities).

Similarly a communication breakdown may occur at any or all of these levels and thereby contribute to collision. A huge number of collisions could be quoted as reflecting organisational and/or communication deficiencies.

Second line systems or back-up systems can be of help, therefore the battery system must be checked and also the availability of walky-talkies which have the working channels can help in many of these cases.



#### 4.2.2.4 MASTER - WATCH OFFICER RELATIONS :

The relationship between master and officer is very important in assessing the risk. If, for example, a junior officer notices a mistake by the master but is reluctant to bring it to his attention for fear of showing up the master, then the mistake may go unrectified and a collision may ensue. Or if the junior officer feels that the master is always looking over his shoulders he may feel he can never develop confidence in his own ability.

Traditionally in seafaring there has been little concern for such matters in the education and training of seafarers. Such matters have been left to the individual master to work out as best he can and in light of his own personality within the formal command of the ship. It is necessary to reconsider this attitude and to incorporate subjects such as human relationship on board ships in the curriculum of training institutions. Perhaps bridge team work is the solution for such a problem.

#### 4.2.2.5 THE EFFECT OF AUTOMATION ON THE ROUTINE JOB "AUTO-SYNDROME" :

In practice the navigator is doing a routine job and performing a semi-automatic watch. In the open sea, not only may the steering gear be on automatic, but the watchkeeper's mind may go on "automatic". In this condition, for example, he may sight a vessel well up ahead in calm seas and clear visibility. He may adjust his course slightly to avoid an encounter and continue with his routines of chart checks and other matters. Suddenly he may find himself in trouble with the other vessel's unantici-

pated movements and his last-minute avoiding action (LMA) may be insufficient to prevent a collision. The important point here is that the routinised nature of the situation and the apparent no-risk condition can lull the navigator into a false security putting him onto auto when he should be alert and aware.

#### 4.2.2.6 MASTER PILOT RELATIONSHIP :

Once the pilot boards the vessel, organisationally the situation becomes increasingly complex and different compared to the situation out at sea. To prevent a lack of co-ordination from developing between pilot and master, routine planning and the use of other means of co-ordination may be essential and establish the difference between being involved in a collision or avoiding it.

#### 4.3 AREAS OF CONCERN OR CONTRADICTION :

##### 4.3.1 TECHNOLOGY AND HUMAN REQUIREMENTS :

Advanced technology has brought very sophisticated equipment to the bridge. Such technology requires that navigators possess a higher level of educational and professional skills. At the same time, however, this technology has taken away from the professional seafarer many of his traditional tasks and areas of expertise and judgment. The navigator finds himself in a "push-button" relationship to his job. This affects very much the individual's job content, self-esteem and sense of worth and contribution. We have to consider the technological and human demands together and not concentrate on technology only.

##### 4.3.2 THE PROBLEM OF COLLISION CONSCIOUSNESS :

Sometimes, it was felt that the seafarer can not appreciate the consequences of casualties unless he has a direct or near miss experience of them. This does not mean that one can pursue a policy of being involved in near misses or collision as a means of increasing safety consciousness.

With modern methods of simulation and sociological analysis one can create situations analogous to those that may appear at sea in which people can experience the dynamics of collisions as well as receive information about the results of their behaviour.

#### 4.3.3 INVESTMENT IN TECHNOLOGY AND ORGANIZATION :

Technology and organization have to go along in one line. That is to say that despite the fact that huge investment is made in advancing the navigation equipment to minimise the role of the human component, the human factor is behind many accidents. Therefore, the organizational concept should also be emphasized through better training, better methods of manning arrangements, team organization, work distribution and planning.

## 4.4 PREVENTIVE STRATEGIES

### 4.4.1 SAFETY CONSCIOUSNESS STRATEGY :

Safety consciousness can be promoted by lectures, discussions, seminars, films, statistics, analysis of particular incidents, case studies, safety training and realistic simulations. These measures to enhance safety consciousness and its dynamics should be encouraged so that learning may take place. In this way something useful may come out of the collisions that do occur and other collisions that might occur may be prevented.

### 4.4.2- TRAINING STRATEGY :

Training should be done in three levels :

Level 1 : up-dating/ re-freshing of seafarers knowledge, skill and expertise with respect to new technological, environmental, legal and/or other developments. There might be both shore-based and shipboard based components to training. It might include on-the-job training in new navigational aids or systems, new legal requirements or changes in procedures for port or restricted waterway situations.

Level 2 : involves the basics of sound navigational practices and skill and be carried out to a high professional standard. This might be called technical training. It would be shore-based and require relevant seagoing experience. An example of that is the use of simulators.

Level 3 : Would be concerned with safety and casualty situations. This might be called safety or

casualty prevention training. It would deal with such issues as :

- bridge and shipboard organization,
- effective route planning,
- assessment of risk and risk-taking behaviour,
- effective handover processes,
- master-pilot relationship,
- communications,
- crisis handling,
- human and community relations aboard,
- conflicts between technical and human demands including value conflict, and
- the whole subject area of safety consciousness.

Level 4 : This might be called practical training in which the human element should be addressed by training people for new situations where they have to perform several tasks simultaneously, for example navigation besides communication or engine trouble. Training should also prepare people to operate systems in various conditions and in teams with varying numbers of members.

#### 4.5 SOME PRACTICAL MEASURES TO REDUCE RISK :

##### GOOD COMMUNICATION AND TEAMWORK

Good communication and teamwork may prevent reliance on false assumptions or incorrect data, and in so doing avoid some of the often simple misunderstandings which are at the root of many human errors and the cause of serious accidents.

##### EMOTIONAL BALANCE AND PERSONAL WELL-BEING

Emotional balance and personal well-being will tend to decrease the propensity for hasty and unguarded actions or mental short-circuit due to stress or fatigue.

##### THE ROLE OF ADMINISTRATION

The administration should verify how well the technical rules are obeyed. They should also set up operational rules and verify how well they are complied with.

##### THE ROLE OF MANAGEMENT

Crew stability at junior officer and rating levels is of a crucial role. If it can be achieved it will provide a greater sense of commitment by the individual, better job satisfaction and consequently a great safety awareness. After all most collision accidents have the human error behind them. If we give people more responsibility and trust them to perform a job well, then I believe the harvest of heightened responsibility and commitment to the objectives which we set out for efficient and safe operation will be reaped.

# CHAPTER

## V

# CONCLUSION



## **CONCLUSIONS**

End-on collisions do occur when ships are in sight of each other as well as when in restricted visibility. In this paper two cases in clear visibility dealt with and eight in restricted visibility.

In fact the number of end-on-collisions in clear visibility are not sufficient to enable me to reach a conclusion as to obtain sufficient lessons from them. Nevertheless, there are still common causes for these two and others which had occurred before the 1972 COLREG came into force.

Looking first into the clear visibility cases we find that they can be attributed mainly to bad look-out practice on one or both ships. In some cases the close presence of a third vessel was a contributing factor. The use of a whistle and light signals to indicate the manoeuver and the attempt to communicate with the other vessel seems not to be a common practice. Moreover, when the situation becomes dangerous it seems that officers are reluctant to use the whistle to warn the other ship(s). When in congested areas it is difficult sometimes to do radar plotting, yet despite this fact, visual gyro bearings are not practiced as an alternative means of plotting.

In end-on-meetings with an initial STBD-to-STBD close passing, problems can sometimes arise. If the passing distance is about half a mile, a dangerous situation can result because one ship will not see the situation as the other does. If one feels that it is an acceptable STBD-to-STBD passage but the other regards it as a nearly reciprocal meeting that requires an alteration to STBD a

very dangerous situation may develop if one ship takes no action and the other turns to STBD at a late stage.

In such circumstances if it is necessary to turn to STBD the helm action should be taken in good time. If a port turn is considered to be a solution, which is in fact against the rules, such action can be taken but early on and at a point before the rules would begin to apply. The alteration should be sufficient to be recognised by the other ship.

R.A.Cahil, In his book "Collisions and their causes" comments on "the point before the rules begin to apply":

"The question of attempting to define the point at which the Rules begin to apply in any particular situation is a complex one. It would first of all be a matter of speed of closing, which would then be translated into distance. A factor should then be allowed for a reasonable amount of time before one would discover an alteration of heading of an approaching vessel, and next a reasonable amount of time for response. A minute and a half for both together should be reasonable, providing the officer concerned is giving his undivided attention to the matter."

Once action is taken, whether to alter course or not, the latter in case of considering the CPA obtained as a safe passing distance, the DOW should not neglect the other ship but follow her till it passes clear.

**Secondly, in restricted visibility:**

The investigation showed that the high frequency of the end-on-collisions in restricted visibility is mainly due to the improper use of radar data, associated with a high speed of approach. Common features of most of these cases are a wrong interpretation of the other vessel's movement and a series of small changes of course which are not readily detected.

Many collisions of this category have involved an alteration of course to port by one vessel and an alteration to STBD by the other, usually at a late stage. This is sometimes called the SEA GULL PATTERN

Another category involves only one alteration to STBD by one ship as the case mentioned previously in clear visibility. The difference here is that normally the decision to alter course is based on the radar information which is why sometimes it is called Radar Assisted Collision, and perhaps in the absence of radar such collisions may not have taken place.

To clarify these seemingly predominant two types of action the following should be mentioned:

In cases where the bearing of the target changes very slowly or not at all it is of course obvious that close quarters will develop if action is not taken. Plotting gives one the basic information on which to act to avoid such a development.

If the plot shows that the CPA will be to port but at a distance considered to be insufficient the simple action will be an alteration to STBD to increase that distance.

A plot showing a close approach to STBD, however, is a problem and here a prompt and bold alteration to STBD which will show on the other ship's radar is recommended.

If ARPA is fitted it may solve the problem of plotting, but Masters and their officers should not only have sufficient training in its use, limitations and errors, but also familiarise themselves with the particular ARPA equipment onboard. ARPA may quite possibly benefit most those who need it least, the competent professional mariners.

One of the very important aspects in reducing end-on-collisions is the presence of Traffic Separation Schemes (TSS). Head on and fine crossing collisions represented in the past nearly 90 % of collisions in restricted visibility. After the introduction of TSS such encounters have been reduced and subsequently the end-on-collisions were reduced.

So it should be possible to reduce the incidence of this type of collision by introducing further traffic separation schemes. Some routeing measures, such as those in the English Channel, can have a good effect in organizing the traffic flow in many parts of the world, especially off the coast of Japan where statistics have shown a relatively high percentage of collisions. But the most important thing here is whether mariners will make use of the TSS properly or not. Governments which have or will establish TSS should make sure that vessels use it properly.

As we have seen technology and technical advances can help to reduce the human involvement as an attempt to reduce what is called human error in collision. In spite of this fact collisions still occur. Thus the human error problem may indeed be irresolvable by purely technical means. It seems that "human resource management" in the shipping industry is particularly backward and in this area it seems that further research must take place if we are to reduce casualties at sea.

Finally, it is clear that there is much to learn from collisions of the past. We should not wait for our own misfortune to occur, rather we should study these cases and prevent as many as possible by doing so. We have seen also that there are still a lot of obstacles to be overcome in order to obtain sufficient collision reports from which we can learn.

We are in need of global cooperation as the investigation of collisions needs full cooperation between the two flag states in cases when collisions involve their ships.

For educators, it is unimportant to know what ship or crew member is responsible for collisions. Governments, via IMO, can send us the reports without the names of the ships concerned. With these reports a simulation of collision cases can take place. We can then check how our students are going to behave. Furthermore they can come to grips with the fact that collisions can take place if Rules are violated.

## BIBLIOGRAPHY

- 1- Cahil, R.A.  
Collisions and their Causes; ISBN- 0-905045-46-7, 1983
- 2- Cahil, R.A.  
Lessons to be learnt from casualties  
The Nautical Institute on Command.  
Navigation, seamanship and ship handling  
Part(V), page 238
- 3- Cockcroft, A N .  
An investigation into collisions at sea  
during the post war, August 1977
- 4- Cockcroft, A N & Lameijer JNF  
A Guide to the Collision Avoidance Rules  
ISBN- 0-540-07278-8, 1982
- 5- Cockcroft, A N  
Collision Statistics and Analysis of  
the Causes of Collisions
- 6- Corbet, A.G.  
What's a Nearly End-on Meeting Vessels? (1)  
Seaways, Nov. 1986
- 7- Corbet, A.G.  
What's a Nearly End-on Meeting Vessels? (2)  
Seaways, Dec. 1986
- 8- Det Norske Veritas Research Division  
Cause Relation ships of Collisions and Groundings.

- 8.1- Analysis of causal factors and situation dependent factor, Dec 1980
- 8.2- Final report, Apr.1981
- 9- Dyer-Smith, M.B.A. with De Bievre A.F.M  
The Human Element in Marine Accidents  
Proceedings of the Fifth IMLA conference  
at Sydney- Canada
- 10-Hall, D.  
The role of managment  
INTASAFCON 4  
Nov. 1979 (International Chamber of Shipping)
- 11-Sohsen, H.  
Safety in human terms and ship board environment  
INYASAFCON 4  
Nov. 1979 (International Chamber of Shipping)
- 12-Holdert H.M.C  
Collision Cases-Judgments and diagrams,  
ISBN 0-907432-96-4, 1984
- 13-Federal Department of Transport, Maritime Safety,  
Australia.  
Investigation into the collision between  
M/V LYSAGHT ENDEAVOUR & yacht BRUNTER  
on 16/12/85
- 14-(USA) NTSB-MAR-82-3 Collision of  
SS LASH ATLANTICO & HELLENIC CARRIER  
on 6/5/81

15- Republic of Liberia. Decision of the commissioner of maritime affairs, R.L. and report of the preliminary investigation. Manrovia; Bureau of maritime affairs.

15.1- in the matter of the collision between  
M/V REGAL SWARD & S/T EXXON CHESTER  
on 18 June 1979, dated 5 Dec 1981.

15.2- in the matter of the collision between  
M/V APPLE BLOSSOM & AN TING  
on 16 July 1978, dated 13 Aug 1979.

15.3- in the matter of the collision between  
M/V EASTERN ROSE & PETRA  
on 4 Mar 1977, dated 21 Feb 1980.

15.4- in the matter of the collision between  
M/S LIMON & M/T BETHIQUA  
on 12 Aug 1979, dated 26 Mar 1982.

15.5- in the matter of the collision between  
M/V PENNSYLVANIA GETTY & WORLD NOBILITY  
on 29 Dec 1978, dated 26 Mar 1982.

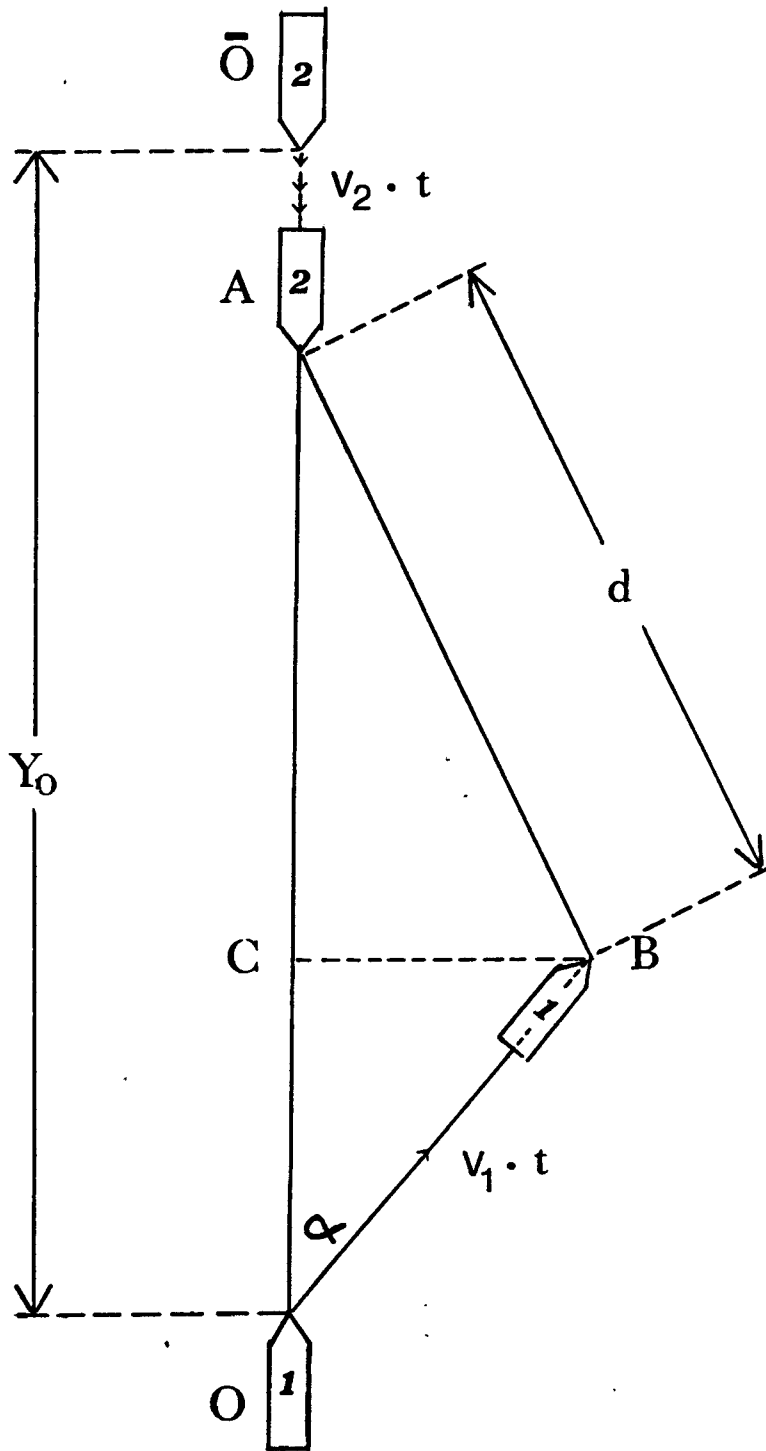
15.6- in the matter of the collision between  
M/V SOUNION & M/V FEDDY  
on 10 Feb 1981, dated 2 April 1984.

15.7- in the matter of the collision between  
M/V STRAIT CONTAINER & M/V EASTERN CORRIDOR  
on 16 Feb 1985, dated 15 Nov 1985.



- 15.8- in the matter of the collision between  
S/T VENOIL & S/T VENPET  
on 16 Dec 1977, dated 22 Nov 1985.
- 16- Roeper. H.J.  
Interpretation of the legal term "to plot"  
paper presented at the National Seminar on  
Collision Prevention, Shanghai 1982.
- 17- Rother D.  
Ship casualties- an analysis of  
causes and circumstances.  
Institute of Shipping Economics, Bremen 1980
- 18- Rymarz W  
Teaching COLLREG to students  
for nautical certificate of competence  
Series of lectures at The World Maritime University,  
Malmo, Sweden May 1987
- 19- Quinn P.T  
THE HUMAN ELEMENT IN COLLISIONS  
paper presented at the National Seminar on  
Collision Prevention, Shanghai 1982.
- 20- Zade, Gunther  
Introduction to safety of navigation  
World Maritime University  
Malmo, 1985 (lectures)
- 21- Lloyds Register Casualty Returns,  
1986.

ANNEX



Ship 1 sighted ship 2 head-on at initial distance  $Y_0$  and altered course to an angle ( $\alpha$ ).

Ship 1 is going with speed of  $V_1$

Ship 2 is going with speed of  $V_2$

After  $t$  hours ship 1 arrived at point B, ship 2 will be at point A.

$$OB = V_1 * t \quad \text{and} \quad \overline{OA} = V_2 * t$$

$$OC = V_1 t \cos \alpha$$

$$CB = V_1 t \sin \alpha$$

Our aim is to calculate the distance apart (AB) and determine the minimum value of AB, which represents the CPA.

In order to obtain this value, we need the time  $t$ , elapsed since the course alteration, in other words the tCPA.

in  $\triangle ABC$

$$AB^2 = CB^2 + AC^2$$

$$= (V_1 t \sin \alpha)^2 + \left[ Y_0 - (tV_2 + tV_1 \cos \alpha) \right]^2$$

$$AB = \sqrt{\underbrace{(V_1 t \sin \alpha)^2}_{\textcircled{1}} + \underbrace{\left[ Y_0 - t(V_2 + V_1 \cos \alpha) \right]^2}_{\textcircled{2}}}$$

$$\textcircled{1} = (V_1 t \sin \alpha)^2 = V_1^2 t^2 \sin^2 \alpha$$

$$\textcircled{2} = \left[ Y_0 - t(V_1 \cos \alpha + V_2) \right]^2$$

$$= Y_0^2 - 2Y_0 t (V_1 \cos \alpha + V_2) + t^2 (V_1 \cos \alpha + V_2)^2$$

$$\textcircled{3} = t^2 (V_1 \cos \alpha + V_2)^2 = t^2 (V_1^2 \cos^2 \alpha + 2V_1 V_2 \cos \alpha + V_2^2)$$

$$= t^2 V_1^2 \cos^2 \alpha + 2V_1 V_2 t^2 \cos \alpha + t^2 V_2^2$$

So by replacing  $\textcircled{1}$ ,  $\textcircled{2}$ ,  $\textcircled{3}$  to the original formula

$$AB = \sqrt{V_1^2 t^2 \sin^2 \alpha + Y_0^2 - 2Y_0 t (V_1 \cos \alpha + V_2) + t^2 V_1^2 \cos^2 \alpha + 2V_1 V_2 t^2 \cos \alpha + t^2 V_2^2}$$

$$\therefore V_1^2 t^2 \sin^2 \alpha + t^2 V_1^2 \cos^2 \alpha = t^2 V_1^2$$

$$AB = \sqrt{t^2 V_1^2 + t^2 V_2^2 + Y_0^2 - 2Y_0 t (V_1 \cos \alpha + V_2) + 2V_1 V_2 t^2 \cos \alpha}$$

$$AB = \sqrt{t^2 (V_1^2 + V_2^2 + 2V_1 V_2 \cos \alpha) - 2Y_0 t (V_1 \cos \alpha + V_2) + Y_0^2}$$

$$d \text{ AB}/dt = 0$$

when the distance is minimal

$$d/dt \left[ t(V_1^2 + V_2^2 + 2 V_1 V_2 \cos \alpha) - 2 Y_0 t (V_1 \cos \alpha + V_2) + Y_0^2 \right] = 0$$

$$2t (V_1^2 + V_2^2 + 2 V_1 V_2 \cos \alpha) - 2 Y_0 (V_1 \cos \alpha + V_2) = 0$$

$$t (V_1^2 + V_2^2 + 2 V_1 V_2 \cos \alpha) = Y_0 (V_1 \cos \alpha + V_2)$$

$$t = \frac{Y_0 (V_1 \cos \alpha + V_2)}{V_1^2 + V_2^2 + 2 V_1 V_2 \cos \alpha} \text{ hours}$$

multiply by 60 we get tCPA in minutes.

So with the knowledge of own speed, other ship's speed, initial distance and the angle of course alteration we can obtain t.

By replacing t in the formula below we can find the distance i.e CPA in nautical miles

$$\text{CPA} = \sqrt{t(V_1^2 + V_2^2 + 2 V_1 V_2 \cos \alpha) - 2 Y_0 t (V_1 \cos \alpha + V_2) + Y_0^2}$$

Observe that the values of the coefficients in both formulas are very much alike, which simplifies the calculations.

## THE USE OF THE TABLES

It can be seen at any moment if the speed of the other vessel is known, what will be the angle of alteration required in order to achieve certain CPA or vice versa.

A conclusion is drawn when speeds are equal, alteration of course 10 degrees will increase the CPA by 0.26 of a mile if executed at 3 miles and by 0.52 if done at 6 miles. We can conclude also that the separation would be proportionally less if other vessel is faster and greater if it is slower.

This table illustrates the bad practice of changing course 5 degrees as it was the case in many of our collision case studies.

The table can be used to assess plotting problems when teaching plotting at the school of navigation, as it can give a precise result rather than the normal drawings.

```

* Programme .....: L1:CPA
* Language .....: AmigaBasic 1.2
* Date .....: 23 August 1988
* Purpose .....: Calculates and prints CPA/tCPA
* .....: from meeting distance and
* .....: angle of course-change (deltacr)

```

\* Used variables

```

* tcpa .....: time to cpa in minutes since deltacr
* dist .....: distance between vessels

* cpa .....: passing distance
* spd1 .....: speed own ship in knots
* spd2 .....: speed target in knots
* alpha .....: deltacr in radians
* angle .....: counter for deltacr in degrees
* initdist .....: initial distance between vessels

* pi .....: constant pi
* coef1 .....: coefficient of denominator
* coef2 .....: coefficient of numerator

* title+i (string) .....: title of table with line

```

\* Used subroutines

```

* 1000 .....: prints title
* 2000 .....: prints horizontal line
* 3000 .....: calculates and prints value

```

```

LOCATE 10,5:INPUT "Speed own ship in knots -> ";spd1
LOCATE 12,5:INPUT "Speed other ship in knots -> ";spd2

```

```
pi = 4*ATN(1)
```

```

LPRINT CHR$(27)"@"; .....: reset printer
LPRINT CHR$(15); .....: printer condensed
WIDTH LPRINT 140 .....: line width printer

```

```
GOSUB 1000
```

```

LPRINT TAB(5);"Initial";TAB(20);"Angle of course alteration"
LPRINT TAB(5);"Distance";TAB(20);"5";TAB(30);"10";TAB(40);"20";TAB(50);"30";
LPRINT TAB(60);"40";TAB(70);"50";TAB(80);"60";TAB(90);"70";TAB(100);"80";TAB(110)
);"90";

```

```

* *****
* *
* * main loops *
* *
* *****

```

```

FOR initdist=.5 TO 8 STEP .5
LPRINT
GOSUB 2000
LPRINT SPC(7);
LPRINT USING "#.#";initdist;
LPRINT SPC(5);
alpha=5*pi/180
GOSUB 3000

```

```
FOR angle=10 TO 90 STEP 10
```

```
alpha=angle*pi/180
GOSUB 3000
NEXT angle
```

```
NEXT initdist
```

```
GOSUB 2000
LPRINT CHR$(27)"@"
END
```

```
* *****
* *
* *   subroutines   *
* * *
* *****
```

```
1000 :
speed1$=STR$(spd1)
speed2$=STR$(spd2)
```

```
title1$="Table 1: CPA(miles) and time to CPA (minutes)"
title2$="          speed own ship = " + speed1$ + " knots"
title3$="          speed other ship = " + speed2$ + " knots"
```

```
LPRINT TAB(5);title1$
LPRINT
LPRINT TAB(79);title2$
LPRINT TAB(79);title3$
LPRINT
LPRINT
```

```
RETURN
```

```
2000 :
FOR i=3 TO 116
  LPRINT TAB(i);"-";
NEXT
LPRINT
RETURN
```

```
3000 :
coef1=spd1*spd1+spd2*spd2+2*spd1*spd2*COS(alpha)
coef2=initdist*(spd1*COS(alpha)+spd2)
tcpa=coef2/coef1
cpa=SQR(tcpa*tcpa*coef1-2*coef2*tcpa+initdist*initdist)
tcpa=tcpa*60
```

```
LPRINT USING " ##.##_/## ";cpa,tcpa;
RETURN
```



```

*****
Date ..... 23 August 1988
Purpose ..... Calculates and prints CPA/tCPA
              from meeting distance and
              angle of course-change (deltacr)

```

\* Used variables

```

* tcpa      time to cpa in minutes since deltcra
* dist      distance between vessels
* cpa       passing distance
* spd1      speed own ship in knots
* spd2      speed target in knots
* alpha     deltcra in radians
* angle     counter for deltcra in degrees
* initdist  initial distance between vessels

```

```

* pi        constant pi
* coef1     coefficient of denominator
* coef2     coefficient of numerator

```

```

* title#1   (string)  title of table with line

```

\* Used subroutines

```

* 1000      prints title
* 2000      prints horizontal line
* 3000      calculates and prints value

```

```

LOCATE 10,5:INPUT "Speed own ship in knots -> ";spd1
LOCATE 12,5:INPUT "Speed other ship in knots -> ";spd2

```

```
pi = 4*ATN(1)
```

```

LPRINT CHR$(27)+"";          * reset printer
LPRINT CHR$(15);            * printer condensed
WIDTH LPRINT 140           * line width printer

```

```
GOSUB 1000
```

```

LPRINT TAB(5);"Initial";TAB(20);"Angle of course alteration"
LPRINT TAB(5);"Distance";TAB(20);"5";TAB(30);"10";TAB(40);"20";TAB(50);"30";
LPRINT TAB(60);"40";TAB(70);"50";TAB(80);"60";TAB(90);"70";TAB(100);"80";TAB(110);
);"90";

```

```

* *****
* *
* *      main loops      *
* *
* *****

```

```

FOR initdist=.5 TO 6 STEP .5
  LPRINT
  GOSUB 2000
  LPRINT SPC(7);
  LPRINT USING "0.0";initdist;
  LPRINT SPC(5);
  alpha=5*pi/180
  GOSUB 3000

```

```
FOR angle=10 TO 90 STEP 10
```

```

GOSUB 3000
NEXT angle

```

```
NEXT initdist
```

```

GOSUB 2000
LPRINT CHR$(27)+"@"
END

```

```

* *****
* *
* *      subroutines      *
* *
* *****

```

```

1000 :
  speed1$=STR$(spd1)
  speed2$=STR$(spd2)

```

```

  title1$="Table 1: CPA(miles) and time to CPA (minutes)"
  title2$="      speed own ship = " + speed1$ + " knots"
  title3$="      speed other ship = " + speed2$ + " knots"

```

```

  LPRINT TAB(5);title1$
  LPRINT
  LPRINT TAB(79);title2$
  LPRINT TAB(79);title3$
  LPRINT
  LPRINT
  RETURN

```

```

2000 :
  FOR i=3 TO 114
    LPRINT TAB(i);"-";
  NEXT
  LPRINT
  RETURN

```

```

3000 :
  coef1=spd1*spd1+spd2*spd2+2*spd1*spd2*COS(alpha)
  coef2=initdist*(spd1*COS(alpha)+spd2)
  tcpa=coef2/coef1
  cpa=SQR(tcpa*tcpa+coef1-2*coef2*initdist+initdist)
  tcpa=tcpa*60

```

```

  LPRINT USING "00.00_/00 ";cpa,tcpa;
  RETURN

```

Table 1: CPA(miles) and time to CPA (minutes)

speed own ship = 15 knots  
 speed other ship = 15 knots

| Initial Distance | Angle of course alteration |         |         |         |         |         |         |         |         |         |
|------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                  | 5                          | 10      | 20      | 30      | 40      | 50      | 60      | 70      | 80      | 90      |
| 0.5              | 0.02/ 1                    | 0.04/ 1 | 0.09/ 1 | 0.13/ 1 | 0.17/ 1 | 0.21/ 1 | 0.25/ 1 | 0.29/ 1 | 0.32/ 1 | 0.35/ 1 |
| 1.0              | 0.04/ 2                    | 0.09/ 2 | 0.17/ 2 | 0.26/ 2 | 0.34/ 2 | 0.42/ 2 | 0.50/ 2 | 0.57/ 2 | 0.64/ 2 | 0.71/ 2 |
| 1.5              | 0.07/ 3                    | 0.13/ 3 | 0.26/ 3 | 0.39/ 3 | 0.51/ 3 | 0.63/ 3 | 0.75/ 3 | 0.86/ 3 | 0.96/ 3 | 1.06/ 3 |
| 2.0              | 0.09/ 4                    | 0.17/ 4 | 0.35/ 4 | 0.52/ 4 | 0.68/ 4 | 0.85/ 4 | 1.00/ 4 | 1.15/ 4 | 1.29/ 4 | 1.41/ 4 |
| 2.5              | 0.11/ 5                    | 0.22/ 5 | 0.43/ 5 | 0.65/ 5 | 0.86/ 5 | 1.06/ 5 | 1.25/ 5 | 1.43/ 5 | 1.61/ 5 | 1.77/ 5 |
| 3.0              | 0.13/ 6                    | 0.26/ 6 | 0.52/ 6 | 0.78/ 6 | 1.03/ 6 | 1.27/ 6 | 1.50/ 6 | 1.72/ 6 | 1.93/ 6 | 2.12/ 6 |
| 3.5              | 0.15/ 7                    | 0.31/ 7 | 0.61/ 7 | 0.91/ 7 | 1.20/ 7 | 1.48/ 7 | 1.75/ 7 | 2.01/ 7 | 2.25/ 7 | 2.47/ 7 |
| 4.0              | 0.17/ 8                    | 0.35/ 8 | 0.69/ 8 | 1.04/ 8 | 1.37/ 8 | 1.69/ 8 | 2.00/ 8 | 2.29/ 8 | 2.57/ 8 | 2.83/ 8 |
| 4.5              | 0.20/ 9                    | 0.39/ 9 | 0.78/ 9 | 1.16/ 9 | 1.54/ 9 | 1.90/ 9 | 2.25/ 9 | 2.58/ 9 | 2.89/ 9 | 3.18/ 9 |
| 5.0              | 0.22/10                    | 0.44/10 | 0.87/10 | 1.29/10 | 1.71/10 | 2.11/10 | 2.50/10 | 2.87/10 | 3.21/10 | 3.54/10 |
| 5.5              | 0.24/11                    | 0.48/11 | 0.96/11 | 1.42/11 | 1.88/11 | 2.32/11 | 2.75/11 | 3.15/11 | 3.54/11 | 3.89/11 |
| 6.0              | 0.26/12                    | 0.52/12 | 1.04/12 | 1.55/12 | 2.05/12 | 2.54/12 | 3.00/12 | 3.44/12 | 3.86/12 | 4.24/12 |
| 6.5              | 0.28/13                    | 0.57/13 | 1.13/13 | 1.68/13 | 2.22/13 | 2.75/13 | 3.25/13 | 3.73/13 | 4.18/13 | 4.60/13 |
| 7.0              | 0.31/14                    | 0.61/14 | 1.22/14 | 1.81/14 | 2.39/14 | 2.96/14 | 3.50/14 | 4.02/14 | 4.50/14 | 4.95/14 |
| 7.5              | 0.33/15                    | 0.65/15 | 1.30/15 | 1.94/15 | 2.57/15 | 3.17/15 | 3.75/15 | 4.30/15 | 4.82/15 | 5.30/15 |
| 8.0              | 0.35/16                    | 0.70/16 | 1.39/16 | 2.07/16 | 2.74/16 | 3.38/16 | 4.00/16 | 4.59/16 | 5.14/16 | 5.66/16 |

Table 2: CPA (miles) and time to CPA (minutes)

speed own ship = 17 knots,  
 speed other ship = 21 knots

| Initial Distance | Angle of course alteration |         |         |         |         |         |         |         |         |         |
|------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                  | 5                          | 10      | 20      | 30      | 40      | 50      | 60      | 70      | 80      | 90      |
| 0.5              | 0.02/ 1                    | 0.04/ 1 | 0.08/ 1 | 0.12/ 1 | 0.15/ 1 | 0.19/ 1 | 0.22/ 1 | 0.26/ 1 | 0.29/ 1 | 0.31/ 1 |
| 1.0              | 0.04/ 2                    | 0.08/ 2 | 0.16/ 2 | 0.23/ 2 | 0.31/ 2 | 0.38/ 2 | 0.45/ 2 | 0.51/ 2 | 0.57/ 2 | 0.63/ 2 |
| 1.5              | 0.06/ 2                    | 0.12/ 2 | 0.23/ 2 | 0.35/ 2 | 0.46/ 2 | 0.57/ 2 | 0.67/ 2 | 0.77/ 2 | 0.86/ 3 | 0.94/ 3 |
| 2.0              | 0.08/ 3                    | 0.16/ 3 | 0.31/ 3 | 0.46/ 3 | 0.61/ 3 | 0.76/ 3 | 0.89/ 3 | 1.02/ 3 | 1.15/ 3 | 1.26/ 3 |
| 2.5              | 0.10/ 4                    | 0.19/ 4 | 0.39/ 4 | 0.58/ 4 | 0.76/ 4 | 0.94/ 4 | 1.12/ 4 | 1.28/ 4 | 1.43/ 4 | 1.57/ 4 |
| 3.0              | 0.12/ 5                    | 0.23/ 5 | 0.47/ 5 | 0.69/ 5 | 0.92/ 5 | 1.13/ 5 | 1.34/ 5 | 1.54/ 5 | 1.72/ 5 | 1.89/ 5 |
| 3.5              | 0.14/ 6                    | 0.27/ 6 | 0.54/ 6 | 0.81/ 6 | 1.07/ 6 | 1.32/ 6 | 1.56/ 6 | 1.79/ 6 | 2.01/ 6 | 2.20/ 6 |
| 4.0              | 0.16/ 6                    | 0.31/ 6 | 0.62/ 6 | 0.93/ 6 | 1.22/ 6 | 1.51/ 6 | 1.79/ 7 | 2.05/ 7 | 2.29/ 7 | 2.52/ 7 |
| 4.5              | 0.18/ 7                    | 0.35/ 7 | 0.70/ 7 | 1.04/ 7 | 1.38/ 7 | 1.70/ 7 | 2.01/ 7 | 2.30/ 7 | 2.58/ 8 | 2.83/ 8 |
| 5.0              | 0.20/ 8                    | 0.39/ 8 | 0.78/ 8 | 1.16/ 8 | 1.53/ 8 | 1.89/ 8 | 2.23/ 8 | 2.56/ 8 | 2.86/ 8 | 3.15/ 9 |
| 5.5              | 0.21/ 9                    | 0.43/ 9 | 0.85/ 9 | 1.27/ 9 | 1.68/ 9 | 2.08/ 9 | 2.46/ 9 | 2.81/ 9 | 3.15/ 9 | 3.46/ 9 |
| 6.0              | 0.23/ 9                    | 0.47/ 9 | 0.93/10 | 1.39/10 | 1.83/10 | 2.27/10 | 2.68/10 | 3.07/10 | 3.44/10 | 3.78/10 |
| 6.5              | 0.25/10                    | 0.51/10 | 1.01/10 | 1.50/10 | 1.99/10 | 2.45/10 | 2.90/11 | 3.33/11 | 3.72/11 | 4.09/11 |
| 7.0              | 0.27/11                    | 0.55/11 | 1.09/11 | 1.62/11 | 2.14/11 | 2.64/11 | 3.13/11 | 3.58/12 | 4.01/12 | 4.40/12 |
| 7.5              | 0.29/12                    | 0.58/12 | 1.17/12 | 1.74/12 | 2.29/12 | 2.83/12 | 3.35/12 | 3.84/12 | 4.30/13 | 4.72/13 |
| 8.0              | 0.31/13                    | 0.62/13 | 1.24/13 | 1.85/13 | 2.45/13 | 3.02/13 | 3.57/13 | 4.09/13 | 4.58/13 | 5.03/14 |

Table 3. (Continued) and time to CPA (minutes)

speed own ship = 5 knots  
 speed other ship = 25 knots

| Initial Distance | Angle of course alteration |         |         |         |         |         |         |         |         |         |
|------------------|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
|                  | 5                          | 10      | 20      | 30      | 40      | 50      | 60      | 70      | 80      | 90      |
| 0.5              | 0.01/ 1                    | 0.01/ 1 | 0.03/ 1 | 0.04/ 1 | 0.06/ 1 | 0.07/ 1 | 0.08/ 1 | 0.09/ 1 | 0.09/ 1 | 0.10/ 1 |
| 1.0              | 0.01/ 2                    | 0.03/ 2 | 0.06/ 2 | 0.08/ 2 | 0.11/ 2 | 0.13/ 2 | 0.16/ 2 | 0.17/ 2 | 0.19/ 2 | 0.20/ 2 |
| 1.5              | 0.02/ 3                    | 0.04/ 3 | 0.09/ 3 | 0.13/ 3 | 0.17/ 3 | 0.20/ 3 | 0.23/ 3 | 0.26/ 3 | 0.28/ 3 | 0.29/ 3 |
| 2.0              | 0.03/ 4                    | 0.06/ 4 | 0.11/ 4 | 0.17/ 4 | 0.22/ 4 | 0.27/ 4 | 0.31/ 4 | 0.35/ 4 | 0.37/ 4 | 0.39/ 5 |
| 2.5              | 0.04/ 5                    | 0.07/ 5 | 0.14/ 5 | 0.21/ 5 | 0.28/ 5 | 0.34/ 5 | 0.39/ 5 | 0.43/ 5 | 0.47/ 6 | 0.49/ 6 |
| 3.0              | 0.04/ 6                    | 0.09/ 6 | 0.17/ 6 | 0.25/ 6 | 0.33/ 6 | 0.40/ 6 | 0.47/ 6 | 0.52/ 7 | 0.56/ 7 | 0.59/ 7 |
| 3.5              | 0.05/ 7                    | 0.10/ 7 | 0.20/ 7 | 0.30/ 7 | 0.39/ 7 | 0.47/ 7 | 0.54/ 7 | 0.61/ 8 | 0.65/ 8 | 0.69/ 8 |
| 4.0              | 0.06/ 8                    | 0.12/ 8 | 0.23/ 8 | 0.34/ 8 | 0.44/ 8 | 0.54/ 8 | 0.62/ 9 | 0.69/ 9 | 0.75/ 9 | 0.78/ 9 |
| 4.5              | 0.07/ 9                    | 0.13/ 9 | 0.26/ 9 | 0.38/ 9 | 0.50/ 9 | 0.61/ 9 | 0.70/10 | 0.78/10 | 0.84/10 | 0.88/10 |
| 5.0              | 0.07/10                    | 0.15/10 | 0.29/10 | 0.42/10 | 0.55/10 | 0.67/10 | 0.78/11 | 0.87/11 | 0.93/11 | 0.98/12 |
| 5.5              | 0.08/11                    | 0.16/11 | 0.32/11 | 0.47/11 | 0.61/11 | 0.74/11 | 0.86/12 | 0.95/12 | 1.03/12 | 1.08/13 |
| 6.0              | 0.09/12                    | 0.17/12 | 0.34/12 | 0.51/12 | 0.66/12 | 0.81/13 | 0.93/13 | 1.04/13 | 1.12/13 | 1.18/14 |
| 6.5              | 0.09/13                    | 0.19/13 | 0.37/13 | 0.55/13 | 0.72/13 | 0.87/14 | 1.01/14 | 1.13/14 | 1.22/15 | 1.27/15 |
| 7.0              | 0.10/14                    | 0.20/14 | 0.40/14 | 0.59/14 | 0.78/14 | 0.94/15 | 1.09/15 | 1.21/15 | 1.31/16 | 1.37/16 |
| 7.5              | 0.11/15                    | 0.22/15 | 0.43/15 | 0.64/15 | 0.83/15 | 1.01/16 | 1.17/16 | 1.30/16 | 1.40/17 | 1.47/17 |
| 8.0              | 0.12/16                    | 0.23/16 | 0.46/16 | 0.68/16 | 0.89/16 | 1.08/17 | 1.24/17 | 1.39/17 | 1.50/18 | 1.57/18 |

APPENDIX

THE EFFECTIVENESS OF

SHIP ROUTING

OFF

NORTH WEST EUROPE

A.N. COCKCROFT

# The Effectiveness of Ship Routing off North West Europe

A. N. Cockcroft

(City of London Polytechnic)

**1. INTRODUCTION.** Traffic separation was first introduced on a voluntary basis in the Dover Strait in September 1967, just over fifteen years ago. Compliance with the IMO provisions relating to traffic separation schemes has been mandatory for all ships during the last five years and for some ships for as much as ten years. It may therefore be appropriate to assess the effectiveness of routing off North West Europe by comparing collision statistics for five-year periods since 1957.

The results given in the following tables apply only to collisions involving trading vessels of over 100 g.r.t. under way and not engaged in any special activities. Collisions in harbours, rivers and congested port approaches where special circumstances apply are not included. The figures quoted for the Dover Strait have been checked against the results obtained by the National Maritime Institute but are based on different criteria, and there may be some discrepancies.

The area covered is the coastal region from the south-western approaches to the Ushant TSS to the approaches to the Elbe including all parts of the English Channel and the Dover Strait, but not including waters off the East Coast of England which are well clear of the traffic separation schemes and deep-water routes.

The numbers of collisions are based almost entirely on *Lloyd's Weekly Casualty Reports*. Information relating to encounter situations is based on voyage data supplemented wherever possible by information received from additional sources relating to the actual courses steered by each vessel. It is not claimed that the figures constitute a precise record but they should provide a good indication of changes in the incidence of collision off North West Europe.

**2. NORTH SEA COLLISIONS.** Table 1 shows the numbers of collisions for five-year periods since 1 January 1957 in the southern part of the North Sea, east of 2° E., including the deep water routes and the traffic separation schemes. During the first part of the 25-year period, before separation schemes were established, there were channels swept clear of mines for use by coastal shipping. These Nemedri routes, marked by centre-line buoys, provided a form of traffic separation but in periods of restricted visibility vessels tended to move into the wrong side of the channel and there were numerous collisions.<sup>1</sup> The swept channels were relatively narrow, causing vessels to overtake at close distances.

identifying ships which are contravening Rule 10 of the Collision Regulations.

TABLE 1. COLLISIONS IN THE SOUTHERN NORTH SEA ACCORDING TO ENCOUNTER SITUATION

|                     | 1957-61 | 1962-6 | 1967-71 | 1972-6 | 1977-81 |
|---------------------|---------|--------|---------|--------|---------|
| Opposite directions | 51      | 58     | 46      | 11     | 11      |
| Broad crossing      | 7       | 6      | 7       | 9      | 4       |
| Same direction      | 11      | 9      | 6       | 6      | 3       |
| Not known           | 10      | 8      | 7       | 3      | 1       |
| Totals              | 79      | 81     | 66      | 29     | 19      |

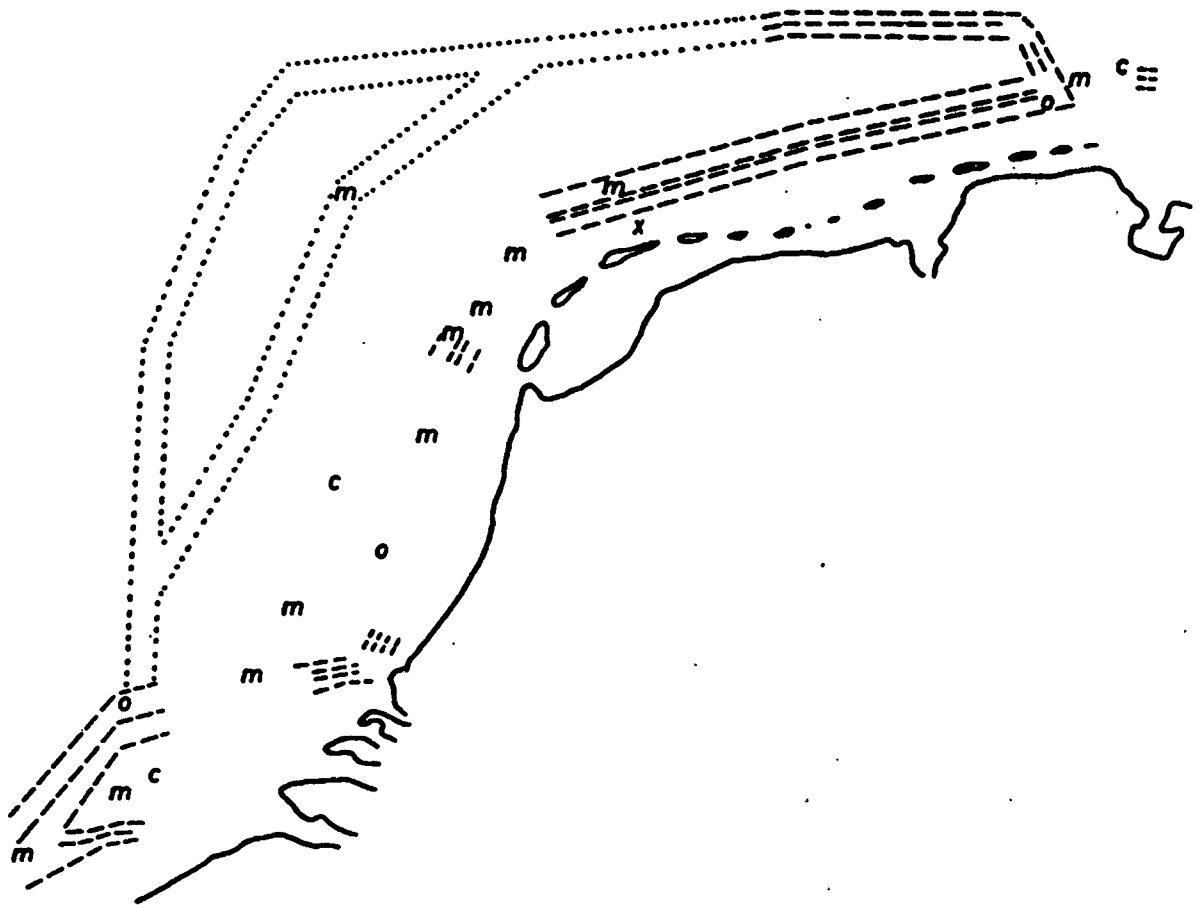


Fig. 1. Location and type of encounter for collisions 1977-81

Table 1 shows that in the last ten years the incidence of collisions between vessels proceeding in opposite directions has decreased to about 20 per cent of the incidence before routing schemes were established. There has also been a reduction of overtaking collisions, which may be mainly attributed to the traffic lanes being wider than the swept channels of the Nemedri routes.

Figure 1 shows the location and type of encounter for collisions known to have occurred in this coastal region in the last five years. Eight of the

outside the separation schemes, mainly off the Dutch coast between West Hinder and Terschelling. Only one is known to have occurred in the long TSS east of Terschelling. Two of the three reported collisions involving vessels proceeding in the same direction occurred in the traffic lanes of separation schemes.

3. DOVER STRAIT. Table 2 shows the incidence of collisions in the Dover Strait area, extending from the Greenwich meridian to 2° E. but excluding the coastal region off east Kent which is well clear of the traffic separation scheme.

TABLE 2. COLLISIONS IN THE DOVER STRAIT ACCORDING TO ENCOUNTER SITUATION

|                     | 1957-61 | 1962-6 | 1967-71 | 1972-6 | 1977-81 |
|---------------------|---------|--------|---------|--------|---------|
| Opposite directions | 45      | 47     | 27      | 7      | 3       |
| Broad crossing      | 0       | 0      | 0       | 0      | 2       |
| Same direction      | 6       | 7      | 8       | 6      | 7       |
| Not known           | 1       | 2      | 1       | 1      | 0       |
| Totals              | 52      | 56     | 36      | 14     | 12      |

The incidence of collisions between vessels proceeding in opposite directions has been reduced to approximately 10 per cent of the incidence before traffic separation was introduced in this area. There have been no collisions between vessels proceeding in opposite directions within the traffic lanes since 1972, when the Channel Navigation Information Service came into operation.

Only two collisions have occurred between vessels in a broad crossing situation, both in the last four years. The incidence of collisions between vessels proceeding in the same direction has remained relatively constant.

Figure 2 shows the location and type of collisions in the Dover Strait area in the last five years. There have been three cases involving vessels proceeding in opposite directions, two in the inshore area off the Goodwins and one in the designated inshore traffic zone off the south coast of England.

In view of the low incidence of collisions within the designated inshore zone there appears to be little justification for the new policy of restricting its use to vessels calling at a port or pilot station within the zone. According to the latest NMI Report<sup>2</sup> there were approximately 30 vessels per day proceeding through the ITZ in each direction in 1980, only about five of which would be calling at a port or pilot station. Approximately 69 per cent of vessels using the English ITZ have been found to be of less than 2000 g.r.t. and are therefore likely to be of relatively low speed. Transferring this predominantly low-speed traffic to the lanes is likely to increase the number of overtaking encounters by nearly 50 per



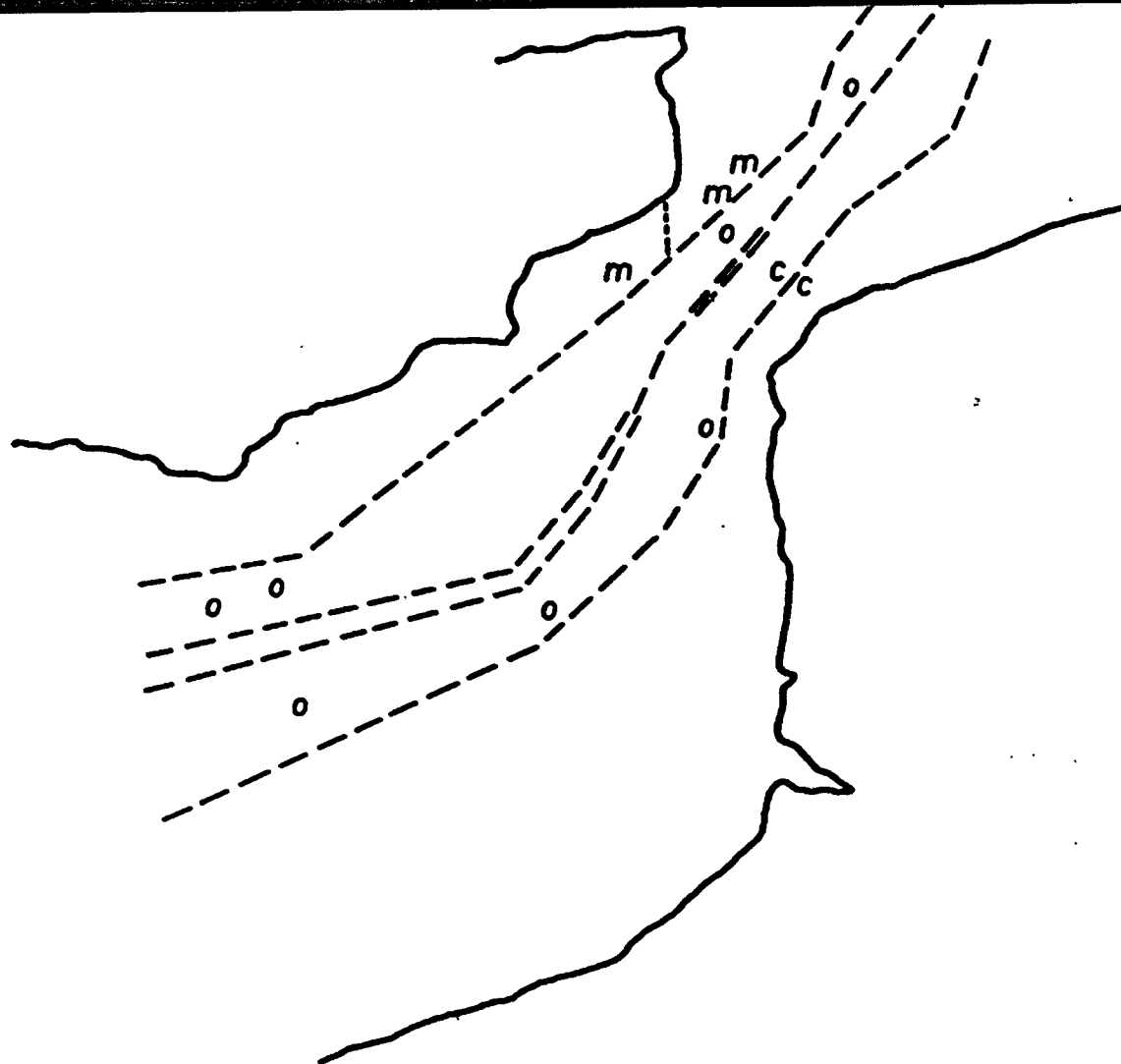


Fig. 2. Location and type of collisions in the Dover Strait 1977-81

cent, which could well result in an overall increase in the incidence of collisions.

4. ENGLISH CHANNEL. Table 3 shows the number of collisions in five-year periods in the English Channel from the Greenwich Meridian to 7° W., including the south-western approaches to the Ushant TSS. Traffic separation schemes were established off Ushant, Casquets and SW England, in 1968, but most of the area is not covered by separation schemes. Extensive changes to the separation schemes off Ushant and

TABLE 3. COLLISIONS IN THE ENGLISH CHANNEL ACCORDING TO ENCOUNTER SITUATION

|                     | 1957-61 | 1962-6 | 1967-71 | 1972-6 | 1977-81 |
|---------------------|---------|--------|---------|--------|---------|
| Opposite directions | 20      | 26     | 16      | 17     | 11      |
| Broad crossing      | 0       | 1      | 2       | 0      | 1       |
| Same direction      | 2       | 2      | 4       | 2      | 2       |
| Not known           | 1       | 1      | 0       | 2      | 0       |
| Totals              | 23      | 30     | 22      | 21     | 14      |

Casquets came into force in July 1979 and further changes were made in July 1982.

The decrease in the number of collisions between vessels proceeding in opposite directions is less pronounced in this region, but there has been no collision of this type within the traffic separation schemes during the last five years.

The incidence of collisions between vessels proceeding in the same direction is low and there is no apparent trend. There are few cases involving vessels in a broad crossing situation.



Fig. 3. Location and type of collisions in the English Channel 1977-81

Figure 3 shows the location and type of collisions which have occurred in the region in the last five years. The precise location of two collisions between vessels proceeding in opposite directions has not been determined. Since January 1979 there has been an additional eastbound lane in the outer part of the Ushant TSS with a recommended direction of traffic flow extending to the north-east for use by tankers and other ships fitted with appropriate electronic position-fixing equipment. This arrangement has been criticized as being likely to cause problems with crossing traffic west of the Casquets scheme, but so far there has been no report of a collision which could be attributed to the revised routing scheme.

Further changes to the routing schemes in the Dover Strait and English Channel were made in July 1982. The recommended directions of traffic flows and additional navigational aids between the Dover Strait and mid-Channel TSS should help to prevent collisions between vessels proceeding in opposite directions in this region. The Ushant TSS is also

to be changed, probably in 1985, but the new arrangements will not necessarily reduce crossing encounters in the western Channel.

5. CONCLUSION. There has undoubtedly been a considerable improvement in traffic safety in this coastal region, which previously had the reputation of being the worst area for shipping casualties. What further changes are called for? Is there a need for a continuous routing scheme extending over the entire region, with a comprehensive international VTS system?

Any further extension of the traffic separation schemes would involve the installation of major floating or fixed navigational aids at considerable expense and would also impose restrictions on various activities such as fishing and offshore oil exploration. However, it may be possible to achieve almost the same improvements in appropriate areas by introducing recommended directions of traffic flow with a limited number of navigational aids, as in the eastern part of the English Channel.

Extension of radar surveillance would also involve considerable cost and does not seem to be justified at the present time. The CNIS is working effectively and surveillance is clearly justified in the Dover Strait, but it seems doubtful whether any further reduction in the incidence of collisions can be achieved by extending shore-based operations. The low incidence of collisions in the TSS off Ushant and Casquets and in the long scheme east of Terschelling does not indicate a pressing need for further radar coverage.

Particular attention must be paid to the monitoring of large vessels carrying hazardous cargoes and to the possibility of reducing the risk of any type of accident to such vessels. Another major casualty causing heavy pollution may once again result in hasty action to satisfy outraged public opinion which would not necessarily be effective in preventing a recurrence.

It is doubtful whether any further extension of routing schemes and of shore-based operations could make a significant improvement to traffic safety in the coastal region of North West Europe. The greatest need is for higher standards of manning and training for world-wide shipping to improve on-board safety and to ensure that the available equipment and facilities are put to effective use.

#### REFERENCES

- <sup>1</sup> Beattie, J. H. (1964). North Sea Nemedri routes—a collision problem. *This Journal*, 17, 243.
- <sup>2</sup> *Survey of Marine Traffic in the English Inshore Zone, Dover Strait* (1980). NMI, R 95.

### LIST OF DIAGRAMS

|  | Page No |
|--|---------|
| Diagram 1 : Unproper communication                       | 64      |
| Diagram 2 : Taking avoiding action in ample time         | 67      |
| Diagram 3 : Assumption based on scanty radar information | 73      |

### LIST OF CHARTS

|  |    |
|--|----|
| Chart 1 : Rule 7 " RISK OF COLLISION " | 71 |
| Chart 2 : Rule 19 " AVOIDING ACTION "  | 72 |

### LIST OF TABLES

|  |      |
|--|------|
| Table (b): Number of collisions according to encounter situation and visibility for different regions. | 7(b) |
|--|------|

### CPA AND TIME TO CPA

|  |     |
|--|-----|
| Table 1 : own ship speed 15 kts, other ship 15 kts | 104 |
| Table 2 : own ship speed 17 kts, other ship 21 kts | 105 |
| Table 3 : own ship speed 5 kts, other ship 25 kts  | 106 |

### LIST OF FIGURS

|   |      |
|---|------|
| Figure (a) : Merchant ships totally lost consequent upon casualty 1976-1986 | 7(a) |
|---|------|