RADAR SIMULATOR
TRAINING FOR
EFFECTIVE MARITIME
SEARCH AND RESCUE

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This thesis is submitted to the
Council for National Academic Awards
in partial fulfilment of the requirements
for the degree of
Doctor of Philosophy

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Abstract

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The main effort in locating and rescuing survivors of a maritime incident is borne by merchant shipping. This research shows that search and rescue is a task that will face most seafarers, but as they generally lack the necessary levels of skill and knowledge required the task will often be poorly performed. A remedy to this unsatisfactory situation lies in proper training and guidance for ships' officers. This thesis evaluates, using illuminative techniques, the first simulator course devised to provide such training.

The evaluation will be of particular use to others called upon to provide similar training. It also shows a requirement for the adoption of improved procedures in merchant ship searches, makes relevant recommendations, and identifies areas for further research.

More significantly the study has allowed, through simulation, an opportunity unparalleled in the real situation to assess the guidance contained in the Merchant Ship Search and Rescue Manual (MERSAR). This International Maritime Organization manual is the primary aid available to seafarers facing search and rescue responsibilities. The assessment concludes there is scope for extensive amendment to MERSAR amounting to overall rather than piecemeal revision. Positive recommendations are made, particularly in the areas of communications, control and co-ordination.

It is anticipated that this original research will have an important role to play in MERSAR's revision, and through this improve the effectiveness of maritime search and rescue.
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Completion of a series of visits to establishments in England, West Germany, and the United States, active in the field of study.
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<tr>
<td>ARPA</td>
<td>Automatic Radar Plotting Aid</td>
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<tr>
<td>CSS</td>
<td>Co-ordinator Surface Search</td>
</tr>
<tr>
<td>DES</td>
<td>Department of Education and Science</td>
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<tr>
<td>DF</td>
<td>Direction Finding</td>
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<tr>
<td>DTp</td>
<td>Department of Transport</td>
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<tr>
<td>FGMDSS</td>
<td>Future Global Maritime Distress and Safety System</td>
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<tr>
<td>GMDSS</td>
<td>Global Maritime Distress and Safety System</td>
</tr>
<tr>
<td>HMCG</td>
<td>Her Majesty's Coast Guard</td>
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<tr>
<td>ICAO</td>
<td>International Civil Aviation Organization</td>
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<td>IMCO</td>
<td>Inter-governmental Maritime Consultative Organization</td>
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<td>IMO</td>
<td>International Maritime Organization</td>
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<tr>
<td>MERSAR</td>
<td>Merchant Ship Search and Rescue Manual</td>
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<tr>
<td>MF</td>
<td>Medium Frequency</td>
</tr>
<tr>
<td>NCC</td>
<td>Navigation Control Course</td>
</tr>
<tr>
<td>RCC</td>
<td>Rescue Co-ordination Centre</td>
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<tr>
<td>RT</td>
<td>Radio Telephony</td>
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<tr>
<td>SAR</td>
<td>Search and Rescue</td>
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<tr>
<td>SOLAS</td>
<td>Safety of Life at Sea</td>
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<tr>
<td>STCW</td>
<td>Standards of Training and Certification of Watchkeepers</td>
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<td>VHF</td>
<td>Very High Frequency</td>
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CHAPTER 1

INTRODUCTION

1.1 Setting The Scene

1.1.1. The Incident Every year lives are lost following shipping and aircraft accidents on the oceans and coastlines of the world. Accidents happen to a wide range of vessels and in every part of the world, as the following catalogue of tragedy reveals:

(a) On 19 July 1979 a collision occurred between two tankers, the Greek registered ATLANTIC EMPRESS and the Liberian registered AEGERAN CAPTAIN, some twenty miles east of Tobago. Both vessels were abandoned, and 26 lives were lost. The survivors were picked up by rescue craft on the following day.(1)

(b) On 29 October 1979 the 224,313 dead weight tonnes Liberian registered oil/ore carrier BERGE VANGA sank in the South Atlantic to the north of Tristan da Cunha. It is thought that she sank following an explosion, but the only identifiable evidence recovered was one chair. The time of loss was established because at noon she had been sighted by a passing merchant ship, but a routine report giving the ship's position, due at 1530, was not made. All forty persons on board lost their lives.(2)

(c) On 6 November 1979 the 1,028 gross registered tonnes British coaster POOL FISHER, on passage from Hamburg to Runcorn, sank in the English Channel. The text of her distress signal was "Mayday anyone hear me Mayday going over position southwest of St Catherine's Point". Search and Rescue (SAR) helicopters rescued 2 of the crew, but 13 others lost their lives.(3)

(d) On 3 April 1980 the 109,650 gross registered tonnes Liberian tanker ALBAHAA B exploded and sank in the South Indian Ocean, when on route from Durban to the Persian Gulf. Five crew members lost their lives and the survivors were recovered by a passing merchant ship.(4)
(e) Between 9 and 14 September 1980 the 91,654 gross registered tonne British registered bulk carrier DERBYSHIRE, with a cargo of 155,447 tonnes of iron ore, disappeared without trace some 400 miles south of Japan. All 44 lives aboard were lost.

(f) On 4 February 1982, trans-Atlantic yachtsman Steven Callahan abandoned his craft to the west of the Canary Islands. Despite firing distress flares he failed to attract the attention of nine merchant ships that passed close to his liferaft during the following 76 days. He was rescued, after drifting 1,800 miles, off Guadeloupe.(5)

(g) On 14 November 1982 the 1,551 tonnes Glasgow registered NESAM, on route from Casablanca to Whitehaven, capsized and sank in heavy weather 85 miles off the Scilly Islands. The six man crew took to the liferaft and were rescued following a combined sea and air search.(6)

(h) On 23 January 1986 the 38 ft ketch Dorothy Ann sank in heavy seas in the Pacific off Mexico. All 3 persons on board took to the liferaft. Their distress flares were sighted from a Greek ship 18 hours later, and they were eventually rescued by the liner Canberra.(7)

(j) On 14 September 1986 the catamaran By Ear was abandoned by her crew of 2 west of Brest. A combined sea and air search failed to locate the survivors, who were subsequently rescued by a Spanish fishing boat, 10 days later, having drifted more than 200 miles across the Bay of Biscay.(8)

A number of the above incidents generated full scale search operations involving all elements of the rescue services. The survivors were rescued variously by helicopter, rescue craft, fishing boat and merchant vessel.

1.1.2. The Rescue Services There is a long history of provision of sea rescue services in many parts of the world. Until recently such provision has been piecemeal in nature, and has combined both voluntary and state operated organizations. The 1939/1945 World War witnessed a rapid growth in the provision of co-ordinated specialist SAR services in
all theatres of war. This growth was generated by a requirement to
rescue aircrew, rather than seafarers, but the scene of operations was
predominantly maritime. In the post war years a world wide aviation
search and rescue (SAR) organization was established, under the influence
of the International Civil Aviation Organization (ICAO). For many
years no parallel organization to deal with marine incidents existed,
though the facilities provided to meet the needs of aviation were
commonly available when ships were in distress. This was
particularly so in the area of control, through rescue co-ordination
centres (RCCs), and in the provision of specialist search and rescue
fixed wing aircraft and helicopters.

By its Resolution A.406(X) of 17 November 1977, the Assembly of the
Inter-Governmental Maritime Consultative Organization (IMCO), convened an
international conference to consider the adoption of a convention on
maritime search and rescue. In this IMCO was following the path its
sister United Nations Organization, ICAO, had taken several years earlier.

The conference was held in Hamburg from 9 to 27 April 1979, and the
"Final Act of The Conference" (9) has provided the basis for the
development of maritime rescue services in recent years. Particularly
pertinent is that the Final Act of the Conference includes "The
International Convention on Maritime Search and Rescue 1979" which
entered into force in June 1985. Para 5.8 of the Convention deals with
the designation of co-ordinator surface search (CSS) and his
responsibilities, while paras 5.10 and 5.11 consider the subjects of
search areas and patterns, all of which are subject to detailed treatment
in this study. Also of direct interest is Resolution 3 of the
Conference which recognizes the need for an internationally agreed format
and procedure for ship reporting systems. This study identifies the
requirement to further develop standard reporting procedures so as to
simplify SAR communications.

At Resolution 1 of the Conference resolved that the Inter-Governmental
Maritime Consultative Organization, (which in 1981 was retitled the
International Maritime Organization (IMO)), be invited to:

(a) continue to work closely with ICAO in order to harmonize
aeronautical and maritime SAR plans and procedures,

(b) publish all available information concerning agreements on
maritime SAR regions etc, and
(c) advise and assist States in the establishment of their SAR services.

The Safety of Navigation Committee of IMO has progressed well in response to the 'invitation' over the past few years. Inventories of available dedicated SAR forces have been compiled, and search and rescue plans for most areas of the world have been written. IMO has designated 14 areas to cover the oceans. These are:

Area 1 North Atlantic
Area 2 North Sea
Area 3 Baltic Sea
Area 4 Eastern South Atlantic
Area 5 Western South Atlantic
Area 6 Eastern North Pacific
Area 7 Western North Pacific
Area 8 Eastern South Pacific
Area 9 Western South Pacific
Area 10 Indian Ocean
Area 11 Caribbean
Area 12A Mediterranean
Area 12B Black Sea
Area 13 Arctic Ocean

These areas vary widely not only in size, but in the extent of control organizations existing ashore and in the availability of dedicated rescue forces to respond to any maritime incident. When merchant vessels are operating in those areas where the organization and facilities are thinly provided the ship masters may find they, and their ships, are required to take a co-ordinating role in any SAR operation. Such a role is beyond the basic obligations placed on masters of merchant vessels by the Safety of Life at Sea Convention (SOLAS), which include:

"The master of a ship at sea, on receiving a signal from any source that ship or aircraft or survival craft thereof is in distress, is bound to proceed with all speed to the assistance of the persons in distress...."

Resolution 6 of the Conference looked ahead into the development beyond a regional (area) approach, and into a global system. Out of this the concept of the Future Global Maritime Distress and Safety System
was evolved in 1982.(12) The system definition conceived included:

"...that SAR authorities ashore as well as shipping in the vicinity of a distress, will be rapidly alerted to a distress so that they can assist in a co-ordinated rescue operation. This concept applies to all ships on international voyages regardless of their geographical location......the system will use both satellite and terrestrial communications......the equipment to be carried on ships will be designed for simple operation and will be largely automated."

Progress since 1982 has been quite rapid, and is described in the paper "Black Box Implications in the Improvement of Search and Rescue", which was presented at a joint Royal Institute of Navigation and Nautical Institute Seminar in London on 11 December 1986. The paper is reproduced at Annex A.

The forces available for SAR include the SAR organization ashore, designated SAR craft such as USCG vessels and RNLI lifeboats, designated SAR aircraft including helicopters, other civil and military aircraft, civil and military vessels. Of these forces the common element, that may be found in any area of the world, is the merchant vessel.

1.2. Merchant Vessels in SAR The extent and nature of merchant vessel involvement in SAR is considered in para 7.1.1, where it is revealed that Her Majesty's Coast Guard (HMCG) regard merchant vessels as "the first shot in the locker" in the event of an SAR incident, even though shore based SAR units may be available. In many areas merchant vessels may provide the major effort in SAR, while in others they may provide the only effort. Clearly the success or failure of any SAR operation will depend to a large measure on the skill and knowledge of those taking part. How skilled and knowledgeable are seafarers in this task? As a starting point, this investigation sought first hand accounts from those who had played an active part in SAR. To get these accounts, letters were placed in the correspondence columns of "Seaways"(13) and "The Telegraph"(14) stating:

"It is highly probable that the survivors of any ship lost at sea will have been rescued by surface vessels. How prepared are we to take on this "their life in your hands" responsibility?"
If you have been involved as Captain, Master or Bridge Watchkeeper in any search and rescue, man overboard or similar operation, successful or unsuccessful, I would like to hear from you. Your experiences, frustrations, successes and lessons learned could be of value to others - or yourself should you ever become a potential survivor.

In responding to my request for information you will be contributing to a programme of practical research at Plymouth Polytechnic. You will not be committing yourself to any great demands on your time. In the first instance just acknowledge your willingness to help and let me have your address. A postcard will do.

The information trawl generated 23 respondents. This limited response could have indicated that SAR was a problem that seldom faced the seafarer, but there is reason to suppose indifference rather than inexperience was the cause of failure to put pen to paper. Mr Julian Parker, Secretary to the Nautical Institute, observed that if questionnaires were sent to all 5,000 members of the Institute only 25 replies could be expected, thus the response to this trawl could be considered a success! Later the research revealed that SAR is indeed a common task for the seafarer (see paras 4.1.11 and 4.3.20). A follow up letter was sent to each of the respondents, briefly stating the aims of the research programme as being (see footnote):

(a) to evaluate the effectiveness of the first SAR course in the United Kingdom for merchant service bridge watchkeepers, developed and offered at Plymouth Polytechnic, and

(b) to devise improved guidance on the selection of optimal start position and track spacing in a given SAR operation.

Respondents were asked to describe briefly their SAR experiences, following a 'prompt' list, designed to ensure that all relevant details were included. The prompt list comprised:

Footnote:
The overall investigation was not constrained by having fixed pre-conceived aims. Those given above provide a starting point for the study and gave correspondents a context in which to frame their replies. This will become more clear after reading Chapter 3.
Location and approximate date of incident
Nature of incident
Other ships, SAR forces etc involved
Extent of involvement of own vessel
Personal capacity on board
Degree of shore control exercised
Whether an on scene commander or co-ordinator surface search was appointed
Search patterns used and reasons for choice if known
Track spacing adopted and reasons for choice if known
How search datum was selected
Existence of any applicable variables to the selection of datum and track spacing such as: visibility, day/night search, weather conditions, elapsed time between incident and arrival on scene, object of search, lookout capability etc.
Method of lookout employed
How plot of search was maintained on the scene
Communication channels used, and any communications difficulties experienced on scene and ship to shore
Existence of any language problems
Success of operation
Observations on efficiency of operation and any measures that could have been taken to improve that efficiency.

At this stage six of the initial respondents dropped out, the common ground being they considered they had nothing of relevance to offer the study. The remaining 17, whose names are listed at Annex B, enlarged on their experiences, following where possible the guidance of the prompt list.

The experiences related covered a wide range of incidents, with man overboard being most common. Unfortunately failure rather than success was the most frequent outcome of such events. One account of a two hour man overboard search in the Mediterranean recalled "the operation was successful in that the cadet was recovered. His recovery was largely fortuitious however, he was picked up in the deepening twilight as the lifeboat was returning to the ship!" The writer further commented "How could seafarers be knowledgeable about effective SAR procedures if, like me, their experience was limited to just one incident in a period of 29 years at sea?" (15)
Accounts of three, four, and up to six incidents were related by other respondents, one of whom observed "a badly co-ordinated search, everyone doing their own thing, and in my personal opinion a lack of nautical appreciation in the Maritime Rescue Co-ordination Centre". The same seaman wrote, amongst a number of very valid and valuable general observations relating to his wide experiences: "co-ordination including constant updating of information is most important, particularly in protracted searching. This is a morale boosting exercise in many respects; the situation may not have changed, but everyone should be told this from time to time." (16) These feelings were endorsed by another writer who stated "the main feeling I have experienced is one of frustration at the lack of any proper co-ordination, and the lack of any positive follow up information from the authority requesting action." (17)

A number of success stories were told, but throughout the reports there was an under-current of frustration, of lack of knowledge, and of luck playing a major part. Luck, ignorance and frustration are not generally elements of a recipe for success.

1.3. Training

1.3.1. The Training Requirement. Until 1981 little attention had been paid to giving bridge watchkeepers, of United Kingdom merchant vessels, any formal training in SAR procedures. Certainly on the bridge of every merchant vessel, regardless of flag, there should be a copy of the Merchant Ship Search and Rescue Manual (MERSAR), to which watchkeepers may refer in the event of their being involved in an SAR operation. The IMO Standards of Training and Certification of Watchkeepers (STCW)(18) include the requirement for mates to have an understanding of the contents of MERSAR, and masters to have a complete understanding. But these two lines are 'lost' amongst a myriad of other recommended minimum skill and knowledge requirements. It is therefore perhaps not surprising that prior to 1981 training in SAR was cursory, and testing limited to the chance question in oral examination. Search and rescue is about other peoples lives, and their deaths, and it is to the great credit of the United Kingdom Department of Transport that in 1981 they took action to raise the status of proper SAR training for ships' officers. The vehicle for this improvement was the simulator linked Navigation Control Course (NCC)(19), satisfactory completion of which
became a prerequisite for issue of Class 2 (first mate) certificate of competency and command endorsement certificates.

1.3.2. **The Navigation Control Course**

The stated aim of the course is:

To promote command decision-making based on data supplied by navigational instruments, a full appreciation of system errors, a thorough understanding of the operational aspects of modern navigation systems and effective bridge teamwork procedures. (20)

The requirements of the course include a minimum of 36 hours devoted to simulator exercises, with additional supporting studies outside the simulator. Training establishments offering NCCs are free, within limitations, to design their own simulator exercises. The limitations are that general guidelines laid down by the Department of Transport have to be followed. These guidelines include: (21)

Stage 3 - Search and Rescue

Theme

Exercises in either open or coastal waters involving the need to conduct a search and rescue operation while continuing practice in collision avoidance and navigational techniques and procedures.

Objectives

To practise, both in-ship and inter-ship, search and rescue procedures and techniques, emphasising the need for the search to be co-ordinated and planned to carry out a rescue in the minimum time using to maximum effect the resources available.

To enhance the concept of effective bridge team work procedures.

Outline of Exercises

The casualty should be realistically controlled by the instructor and may, for instance, sink before rescue ships arrive on the scene. Each own ship, together with instructor controlled targets (including helicopters), should be involved in the response to the distress. Exercises should include:

Navigation and anti-collision considerations

The need for the casualty to assist location by others
Use of direction finding (D/F) for homing
Co-ordination and planning of the search and rescue.

Approximately 6 of the 36 hours spent on simulation should be devoted to
Search and Rescue exercises.

1.4. Extent of the Investigation

The investigation that follows confirms the importance of merchant ship
involvement in maritime search and rescue, and reveals that seafarers
generally lack the skill and knowledge to perform their SAR
responsibilities effectively.

The simulator based course, offered at Plymouth Polytechnic to meet the
SAR training requirement stated at para 1.3.2., is studied in depth. The
validity of such training is assessed and areas for possible improvement
in training identified. The study also seeks to identify those features
common to success, and to failure, in conducting maritime search
operations. A comparative view is taken of SAR training elsewhere in the
United Kingdom, and observations are made on SAR training courses in
West Germany and the United States. The question "who trains the
trainers?" is raised, and it is likely that the results of this study will
provide a partial answer, as they will be of benefit to lecturers
anywhere involved in the SAR training of seafarers.

Finally, the SAR guidance available to ships' officers is critically
reviewed, particularly that concerning the selection and responsibilities
of the Co-ordinator Surface Search, the selection of suitable search
areas, and the application of suitable patterns and procedures in ship
co-ordinated maritime SAR. The study concludes by making positive
recommendations for improvements in the guidance given to ships'
officers.

References:

(1) FOY D B Atlantic Empress - Aegean Captain Collision (More Facts on
the Double Greek Tragedy) "Seaways", The Nautical Institute, London,
November 1980 p 7-8

(2) SHEARER I and FOY D Berge Vanga - The Inevitable Disaster?,
"Seaways", The Nautical Institute, London, September 1980 p 5-7
(5) CALLAHAN S Seventy-Six Days Lost at Sea, Houghton Mifflin, Boston MS 1986
(6) Report in Western Evening Herald, Plymouth, Monday 15 November 1982
(10) International Maritime Organization Area Search and Rescue Plans, SAR2/Circ 1, published by IMO, London, 8 February 1983
(15) Lister R C, extract from letter Lister/Redfern dated 7 May 1982
(16) Brunicardi D W, extract from letter Brunicardi/Redfern dated 26 May 1982
(17) Parker J M, extract from letter Parker/Redfern dated 23 June 1982
(20) ibid p 32
(21) ibid p 37
2.1. The Training of Ships' Officers

2.1.1. Development of the Navigation Control Course

The Navigation Control Course, devised in 1981 by the United Kingdom Department of Transport in association with the Merchant Navy Training Board, has its origins in practical radar and navigational aid training for ships' officers. The roots of such training lie in the 1950s when radar observer courses were first made available for ships' masters and mates. The purpose was to instruct watch keepers in the proper use of radar, and reduce the incidence of an emergent phenomenon 'the radar assisted collision'. Although some nautical colleges possessed radar training vessels, the opportunities for training on radar in the dynamic mode, with moving targets, were limited. Radar simulation provided a solution, and during the 1960s many United Kingdom nautical colleges acquired radar simulators. The growth of facilities, coupled with the perceived potential of simulator training, resulted in possession of a radar simulator certificate becoming a pre-requisite for qualification as master from 1 January 1970. The validity of simulator training is widely accepted, and is confirmed by the results of this study (see para 4.3.17). In particular Curtis and Barratt (1) observed:

"The results (of their validation investigation) gave no reason to doubt the validity of radar simulator data; mariners at sea can be expected to behave in the same way as the subjects in the test (on the simulator)"

Further training needs resulted from a rapid growth in the number of ships fitted with electronic navigational aids, and it was in 1977 that possession of an electronic navigation aids certificate became a pre-requisite for qualification at basic watch keeper level. The marriage of radar and navigation training was a natural development, the outcome of which has been the evolution of radar/navigation simulators of great sophistication and potential. It was this evolution that paved the way for the introduction of the NCC, the aim of which was stated in para 1.3.2.

2.1.2. Plymouth Polytechnic Simulator Facilities - 1982

Colleges were permitted to offer the NCC to students from 1 January 1982. Although at
that time, the main simulator at Plymouth Polytechnic was ageing, and
below the standards set for new simulators in the Department of Trade
specification, it was unique in being the only simulator, in the United
Kingdom, fully equipped to meet the requirements of the NCC. The
relevant extracts of which are reproduced at Annex C. Specifically, each
own ship booth of the simulator was fitted with:

(a) full radar facilities, comprising radar and separate automatic
radar plotting aid (ARPA). The type of radar differed on each ship,
as did the type of ARPA;
(b) a wide range of navigational aids, covering the minimum
requirements of the NCC, including radio direction finder (D/F), echo
sounder, and Decca Navigator. These facilities were real on own
ship one and variously real, simulated, and by visual display unit on
the other two ships;
(c) real very high frequency (VHF) and medium frequency (MF) radio
telephony (R/T) installations, permitting authentic voice
communication between ships, and ship to 'shore' — played by the
instructor;
(d) an electronic clock showing exercise time.

An initial Navigation Control Course, of 16 students, ran at Plymouth
between January and March 1982 using these facilities.

2.1.3. Course Organization The Department of Transport (DTp) Regulations
and Guide (4), provides two basic forms in which the NCC may be offered;
these may be described as integrated or modular. In both cases it is
assumed that students join the course at a certain skills and knowledge
level. In particular, they will be proficient in radar navigation
techniques including plotting and parallel indexing, and knowledgeable
of passage planning procedures. When students take an integrated course it
forms part of their associated studies in preparation for the DTp Class 2
certificate of competency examinations. They receive in their mainstream
studies, outside the NCC, tuition in subject areas such as coastal
navigation and the theory and use of radar and navigation aids, such
subject matter subsuming part of the NCC requirements. For such students
the minimum time to be devoted to simulator exercises, as part of the
course, is 36 hours. A modular course must be taken by students when
the NCC does not form part of a full Class 2 certificate study course.
In this event the length of the course is extended to a minimum of 60
hours, the extra time being used to bring students up to the required
skills and knowledge levels before commencing the simulator exercises.
2.1.4. Course Development Workshops. In the summer of 1981, before the NCC was introduced, the DTp, in association with the Department of Education and Science (DES), held a two day workshop for maritime lecturers at the College of Nautical Studies Southampton. Lecturers expressed concern that students would be entering the NCC without any experience or training in the use of ARPA, and to allow for this it was agreed that initially, the duration of the simulator element of the course should be extended to 42 hours. This concern proved to be justified, and some students at Plymouth later observed that the time allocated to become familiar with the three ARPAs available was insufficient (see para 4.1.10). A follow up workshop was held in Glasgow in April 1984, by which time most nautical colleges would have had two years experience in offering the NCC. Although by 1984 students with previous formal training in the use of ARPA were enrolling on NCCs, many of them had no practical experience in the use of ARPAs in the intervening period. They had lost the benefits of their earlier training and were having to be re-taught. At the second workshop this new problem was identified and described as the "black hole effect". Until the situation changed, and in 1987 students are still entering the NCC without any relevant ARPA experience at sea, it was the intention of many colleges to continue with the interim measure of devoting 42 hours to simulator exercises.

It is a matter of particular relevance to this study, that in the DES report on the Glasgow workshop (5), the only comments on the content of the NCC related to SAR. Those comments were:

"SAR is popular and necessary since it cannot be practised at sea. There is need for revision (of content) and generally more SAR would have been liked.

SAR is due to change rapidly in the near future, and if, as seems likely, the deck officer is to become the ship's communicator proper training in this area (on simulators) will be required. SAR may eventually also become a part of such communications courses."

It is also a matter of relevance to this study that at the same workshop lecturers raised the question "who trains the trainers?" A real need for updating the knowledge of navigation systems and simulator lecturers was identified, and since the Glasgow workshop the DES has organized an annual day school so that lecturers may have the opportunity to keep up to date with developments in this area. Simulator lecturers are not usually appointed on the basis of their prior involvement in SAR, or knowledge of
SAR procedures. It is known, from attendance at International Radar and Navigation Simulator Lecturers Conferences, that lecturers have been particularly lacking in SAR awareness. This study should fill a major gap in the source material from which awareness can be gained.

2.1.5. **NCC Organization at Plymouth Polytechnic**

It was the general intention of the DTp that students should attend the NCC as a culmination of their related studies, but this intention cannot always be realized. The earliest time students can attend the NCC is dictated by the need for them to complete classroom and laboratory work, especially in passage planning techniques, before going on the simulator. The latest students can attend is dictated by student resistance to diversions from mainstream studies towards the end of their Class 2 preparation; a time when examinations are approaching. Student numbers have often exceeded the simulator capacity available between these limiting times, and on occasions it has been necessary to start simulator exercises earlier than the DTp would ideally like, and continue them later into the course than the students would ideally wish. These problems are identified in the analysis in Chapter 4.

The programme adopted for the initial NCCs run at Plymouth between January and March 1982 was far from satisfactory. It attempted to comply rigorously with DTp objectives. Two courses, each comprising 8 students, were run in parallel; one group attending one evening and the other group on a second evening each week for about twelve weeks. This approach meant that radar plotting revision could take place before basic collision avoidance exercises were conducted on the simulator, ARPA theory could be taught before ARPA practice, passage plans could be practised in the chartroom before being executed on the simulator. Students thought the programme 'dragged on', and would have preferred a more intensive course in which they could learn from, rather than forget, their earlier mistakes. In any event, on a mundane level, the course could not have followed such a programme if the student numbers had been large on that occasion, as financial constraints meant the simulator technician was only available on two evenings a week.

Learning from the organizational mistakes of the first two courses a programme was developed that has proved to work well. In this students complete their NCC over a period of three weeks, each containing 14 hours
on the simulator. Normal Class 2 studies continue uninterrupted. A typical programme following this scheme could be:

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500 - 1900</td>
<td>1300 - 1600</td>
<td>1500 - 1900</td>
<td>1300 - 1600</td>
</tr>
</tbody>
</table>

One of the two afternoon sessions coincides with a timetabled coastal navigation laboratory practical for the complete class, those students attending the NCC conduct a passage plan on the simulator, while their colleagues are in the laboratory. The second afternoon session is a private study period for those students not attending the NCC. This organizational arrangement has operated continuously since April 1982.

2.1.6. The SAR Element of the Plymouth NCC. The tuition commenced with a two hour theoretical session in which students were provided with partially incomplete lecture notes. The incomplete sections were markers for student discussion and completion in manuscript. An example of a completed set of lecture notes appears at Annex D. In each of the two weeks following the theoretical session, simulated SAR exercises were conducted. In these exercises students stayed in the same crew groupings throughout. They were allocated to own ships and respective own ship captains were nominated by the lecturer. This was to ensure that each student had the opportunity to act as master in a simulated SAR situation, and to guard against one crew grouping taking a key executive role in more than one exercise. The exercises conducted were:

(a) SAR 1. The three own ships, and three target vessels, were located in the English Channel as shown in Figure 2.1.

Figure 2.1. Initial Configuration SAR 1

![Initial Configuration SAR 1](image)

Scale

| 0 | 10 | 20 | 30 miles |

Source: Author
Captains were advised of their vessels' approximate positions, for example, "own ship 1 is some 35 miles SSW of the Lizard", the exact position of each vessel having to be determined by a DF fix. The visibility was given as 2 miles, and the wind southerly force 3. Normal collision avoidance actions were to be taken when required. Students were advised that the exercise was to take the form of a helicopter interception, with the helicopter flying from RNAS Culdrose, latitude 50° 07'N longitude 05° 13'W. Once the lecturer was satisfied that the navigational situation aboard each vessel was under control, the vessels were called in turn by Lands End radio (the lecturer). A typical message would be: "Fourah Bay this is Lands End Radio...medivac helicopter will be airborne for you from Culdrose in one zero minutes at one seven one five hours GMT...please advise true ground course for helicopter to steer at a ground speed of eight zero knots... and estimated time of interception over". Once the helicopter was airborne Lands End radio would pass the helicopter callsign to the ship for use in future communications. The ship would then be expected to contact the helicopter, pass any adjustments to the course to steer, give brief details of the ship for identification purposes, advise the position of helicopter winching area and the direction of the wind. The ship would finally have to manoeuvre onto the correct heading for the medivac, and the simulated winching would take place.

Although the simulator provided a small range of different ship types, through which the maximum speed, draught, and handling characteristics could be changed, there is no requirement in collision avoidance exercises for vessels to have individual identities. For those limited occasions when it is necessary for the vessels to communicate each of the three own ships had been assigned a name, which was used regardless of the ship type being simulated. Thus own ship one was Antilochus, own ship two Fourah Bay, and own ship three Priam. In the playing of SAR 1 the ships had no need to communicate with each other, and the assigned names were used for communications ship to shore, and ship to helicopter. Each own ship was a fast cargo vessel, making 17 knots through the water.

(b) **SAR 2** The three own ships were positioned in the English Channel off the south coast of Devon, but for exercise purposes England was an uninhabited part of the world. The exercise is
briefly described in the following extract from a paper read at the 2nd Radar Simulator Teachers' Workshop, in Bremen, 10 - 12 May 1982 (6):

SAREX 2 lasts two hours. The participating own ships are on coastal passage. This is to enable position fixing using radar, Decca, DF, and soundings. The ships receive, either on Channel 16 or 2182 kHz, a Mayday. This is from a fishing vessel on fire and requesting immediate assistance. The transmission terminates abruptly. No shore co-ordination of SAR exists for exercise purposes. The aim of the exercise is for students to assess the situation, mutually agree a co-ordinator of surface search, and commence an appropriate search pattern. There is no benefit in locating the distressed vessel, and although the "target's" reported position is marked on the plot the target has video off.

A more detailed description appears at Annex E, which has been written following the recommendations of Klerk and Singh (7), who observed:

"Documenting an endeavour after it has been completed is perhaps the more arduous project than the original endeavour. This probably accounts for the poor quality of manuals for navaids, ARPAs and simulators! We found this principle applied equally well to simulator exercises. Nonetheless, in the following pages we have tried to provide details of an exercise we have found useful, in a manner that we hope can be used for all types of exercises."

The initial configuration of SAR 2 is shown in figure 2.2.

Figure 2.2. Initial Configuration SAR 2

[Diagram of initial configuration showing Eddystone, S1, S2, S3, and Datum with a scale of 0 to 30 miles]
(c) **SAR 3** The exercise is briefly described in the following extract from reference (6):

SAREX 3 is a three hour exercise. The scenario is totally imaginary. Geographical features, soundings, seamarks, D/F beacons have been produced for a remote part of the world known as the Mythican Bight. A chart has been drawn of the playing area and dye-line copies are run off for use by the students. The three own ships are widely separated and are able to fix their positions by radar, soundings and D/F bearings. It would be possible to evolve a hyperbolic pattern for the playing area but the additional work in drawing up the charts is not felt justified. In the event good position fixing is possible. A W/T distress signal comprising SOS and a continuous tone for D/F purposes is transmitted from the 'casualty'. After 15 minutes transmission the distress signal ceases. The own ships' task is to fix the likely position of the casualty through exchange of information, agree a co-ordinator surface search, and commence a search in an area with navigational constraints. Once again no shore control exists.

The initial configuration for SAR 3 is shown in figure 2.3., and a reduced copy of the AO dye-line chart is given at Annex F.

Figure 2.3. **Initial Configuration SAR 3**
As the simulator had no facility for inserting new radio beacons, frequencies already allocated to air radio beacons had to be used, thus Berry Head, callsign BHD and frequency 318.0 kHz, became Black Hand Deep. These 'new' beacons were relocated into their correct positions in the exercise playing area. The frequency chosen for the ship in distress was 356.5 kHz, the correct distress frequency of 500 kHz not being available on the simulator. The casualty was programmed to transmit SOS SOS SOS followed by a thirty second continuous tone, the cycle being repeated continuously.

In the pre-exercise briefing students were given the frequencies and callsigns being used. They were advised that once they had fixed their vessel's position they should switch to the distress frequency and obtain a bearing of the casualty. The casualty would stop transmitting some ten minutes into the exercise, so the possibility of homing did not exist. During the exercise it was anticipated that each vessel would pass close enough to a floating mark to obtain an estimation of the set and drift being experienced. The wind was south-westerly force 3, and the visibility about 1½ miles. Finally students were advised they were expected to respond in an appropriate manner to the distress.

2.1.7. **Ship Profiles** From experience gained during the first two courses it was recognized that exercise realism would be enhanced, in SAR 2 and SAR 3, if the participating own ships had no previous knowledge of any details of the other ships taking part in the operation (see also para 4.1.3). Ship profiles were introduced, to be placed in each own ship booth prior to each exercise, so that students could by limited reading be appraised of the details of the ship on which they were 'sailing'. Knowledge of other ships' details could only be acquired by an exchange of information by radio, mirroring the real situation at sea. In brief the six exercise ships were:

<table>
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<tr>
<th>OS</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Cornwood</td>
<td>Flushing</td>
<td>Bigbury</td>
</tr>
<tr>
<td>Type</td>
<td>Geared Container</td>
<td>Mini-bulker</td>
<td>General Cargo</td>
</tr>
<tr>
<td>Tonnage</td>
<td>18,000</td>
<td>4,000</td>
<td>18,000</td>
</tr>
<tr>
<td>Speed</td>
<td>20 kts</td>
<td>15 kts</td>
<td>16 kts</td>
</tr>
<tr>
<td>Nationality</td>
<td>British</td>
<td>British</td>
<td>Pakistani</td>
</tr>
<tr>
<td>Complement</td>
<td>35</td>
<td>14</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Name</td>
<td>Dousland</td>
<td>Ermington</td>
<td>Advent</td>
</tr>
<tr>
<td>Type</td>
<td>General Cargo</td>
<td>Ro-Ro</td>
<td>Bulker</td>
</tr>
<tr>
<td>Tonnage</td>
<td>8,000</td>
<td>5,500</td>
<td>60,000</td>
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<tr>
<td>Speed</td>
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<td>18 kts</td>
<td>16 kts</td>
</tr>
<tr>
<td>Nationality</td>
<td>British</td>
<td>Spanish</td>
<td>British</td>
</tr>
<tr>
<td>Complement</td>
<td>22</td>
<td>26</td>
<td>24</td>
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</table>

The complete profiles also provided a photograph of the ship, a general arrangement plan, bridge layout and details of navigational fit, height of eye, draught, manoeuvring speeds, life-saving equipment details, and radio callsign.

2.1.8. The SAR Element of the NCC at Other English Colleges

The SAR content and the conduct of NCC at those other maritime colleges in England offering the course were considered. Those colleges were:

- College of Maritime Studies, Warsash, Southampton
- South Tyneside College, South Shields
- Liverpool Polytechnic

(a) At the College of Maritime Studies Warsash the simulator had four own ships, allowing 12 students to attend the NCC at a time. The course was run in three separate blocks, namely 12 hours collision avoidance, 6 hours ARPA, and 24 hours navigational and SAR exercises. No other studies took place concurrent with attendance on any block of the NCC. The SAR theory, including introduction to MERSAR, was taught before commencing the simulator block containing the practical SAR exercises. Two standard offshore SAR exercises were used. In both exercises the 'captain' of each ship was handed a distress message said to have been received by wireless telegraphy. In the first instance a weak distress signal was also made from which D/F bearings could be taken. The students had to react to the situation by mutually agreeing which vessel should be CSS, and by conducting a suitable search operation. In the words of the lecturer concerned (B):

"...I always tell them the objective is not to find the casualty but to go about setting up the co-ordination in the right manner...choosing the right (search) patterns and getting the communications right.....we run two exercises which cover the whole
day...and I honestly feel that if you are trying to teach them SAR it is not long enough. You can give them an idea of what it is about but you can't achieve more in six hours." and later in the same interview: "...the majority of the students find the SAR interesting....what they don't like is, as we have only two exercises to play with, if they are on a ship being co-ordinated by another which "makes a cock of it" they feel let down because they haven't achieved what they want to achieve...they would like more time."

The key concepts behind the SAR exercises at Warsash and Plymouth are similar, as are the experiences in running, and the student reaction to those exercises.

(b) At South Tyneside College both 60 hour block, and a form of integrated courses had been offered on their four own ship simulator. In general the block approach was preferred, students being taken out of their main stream classes for the two weeks duration of the NCC. The alternative integrated approach was a half day and an evening each week spread over seven weeks, and this caused the same problems as were experienced on the initial NCCs at Plymouth, described in para 2.1.5. SAR exercises were limited to one three hour session. The following extract from an interview with the lecturers concerned (9) gives a good idea of how that three hour session was presented:

"The objective is to get them to come to terms with the problems of communications ....and co-ordination. so long as they come out after the incident and say 'that wasn't as easy as we expected it to be' and its given them something to think about it doesn't matter....we hope they will set up some form of search pattern but we have no input"

Do you have a copy of MERSAR in the booths?

"It depends on whether the students bring one in with them...we originally gave then a search and rescue hand-out to read the night before to lead them into our way of thinking...but now its in the cubicle when they get there and it's up to them"

How do you start your exercise, with a Mayday?

"I go into each cubicle with SOS on a Marconigram (message form) and they have to sort something out....in the telegram it says 'all ships go to VHF' and they sort themselves out in terms of CSS."

You have a debrief?
"Yes we get them to talk about what went right what went wrong, did they ask the right questions? who was going to reach the scene first? who was going to co-ordinate it?"
Do they find the target? Is the search successful?
"It is irrelevant"
What's their reaction to SAR do they like it?
"The comments on this one have been tremendous...they'd possibly like more but the problem is once you've done it the initial shock has gone, the second one could never be the same...we only have time to fit in the one...I'm not sure that more than that would be valid."
Do students think it realistic?
"Oh yes...since we've put the VHF in the cubicles it's made search and rescue something different...it's given it an extra dimension."

Elsewhere it is commonly found that when faced with an SAR situation on the simulator for the first time, and without thorough preparation, students seldom respond in an entirely satisfactory manner. A second exercise is usually considered essential if students are to learn from a positive rather than a negative experience, but at South Tyneside the shock or negative experience appears to be the aim of the sole exercise offered.

(c) At Liverpool Polytechnic it became the practice to present the NCC as a 36 hour one week block at the end of the first, beginning of the second term of the two term Class 2 course. Student numbers made it necessary to hold one of three NCC courses during the inter-term vacation period. As at Plymouth the simulator had three own ships. A plan had been evolved whereby one of the simulator lecturers also gave the pre-NCC theory tuition on navigation aids etc, thus ensuring students were adequately prepared for the practical element of the course. Adequate preparation is not otherwise guaranteed on an integrated course. The following extract from an interview with one of the lecturers concerned (10) gives a clear indication of how the SAR element of the course was covered:

"Thursday night's homework is search and rescue, so they read up the MERSAR manual and all the notes we've given them earlier so that they are theoretically prepared for the two hour exercise on Friday morning."
Is it always the same exercise?
"Yes, they start off with the ships quite a long way off from each other and the casualty. The radio messages start to come out...by VHF, and MF using message pads, it becomes established that a casualty exists and they set off towards the casualty. The first stage of the exercise concludes when each ship has established that a casualty exists, where the datum position is, and has set off to help. Obviously it can take quite some time to get there (to the casualty) so when...everybody is going in the right direction we stop, bring them out and debrief them on that part of it. The second stage of the exercise starts where you wind the clock forward to that they're within...half an hour of the casualty...we brief them accordingly and they start to look for it during the second phase."

What about co-ordination?

"We leave it to them to find one. If they don't nominate then we go and prod it...basically there's usually one strong character who says 'I'm it'"

So its done purely on being a strong character?

"It tends to be that way...that's the way we like it, and if a strong character is not in the best position we've had those who have said 'someone ought to becoming CSS I would do it but I'm not really on the right sort of ship..you're fast..you've got the right gear..you should be CSS.' We've never had the event where nobody has (taken over) but there's a certain reluctance because they think we're watching and they don't want to perform."

Are the search patterns they adopt very much like those in MERSAR, up and down the page, north and south?

"Yes exclusively..we've never seen them divert"

Afterwards there is a debrief which they possibly find the most valuable thing?

"I think so in that they are seeking some reassurance that what they did was right. I think it ironical that it's taken so long for search and rescue to come into the course and the enthusiasm for it is tremendous."

Is that because they see it as being valuable or interesting?

"Both..I'll tell you of some of the other feed back we've had...now we've got the refresher and up-dating course we've produced in response to STCV approved by the DIP and Liberian authorities...and you're dealing with a guy with masters and five years
experience...and most of them say its (SAR exercise) one of the most important things on the course

On the NCC suppose it flops do you run a second SAR exercise?

"We haven't had a real failure, if it looks like becoming one I stop the exercise and say 'this is going wrong'...because we don't have time to give six hours"

As with South Tyneside and Warsash the value of the SAR element of the NCC was highly rated by students. This opinion will be reinforced in this thesis.

2.1.9. SAR Training at Hochschule für Nautik Bremen At the 2nd Radar Simulator Teachers' Workshop in 1982, a paper on SAR was presented by Lübbers (11), in which it was claimed:

"Search and rescue is a problem which only seldom will happen to a seafarer. It is a problem which normally will arise unprepared."

and

"The handbook (MERSAR) says nothing about the problem of how to get vessels on search courses, and simulator exercises show that this is often a great problem"

This study will show that SAR is in fact a not uncommon task facing seafarers, but it will often be met in an unprepared manner. Herr Lübbers identified the need for training and the potential of simulators in meeting that need. It became clear at the workshop that simulators were being used for SAR training nowhere other than in the United Kingdom and at the Hochschule für Nautik Bremen. Subsequent workshops have shown that the use of simulators in SAR training has yet to become a common international practice.

The following extracts from a later interview with Herr Lübbers (12), give an insight into the origins and nature of the simulator SAR training at Bremen:

How did SAR training start at Bremen?

"About four years ago (1980) one of our students (third year undergraduate) was looking for a project. We came to 'why not train in search and rescue?' I tried it on our courses for mates and masters and the first time of course it was a disaster. even now the first time we have such an exercise it can be the same. They didn't know what to do and we found it well worth to go on."
How much time is allocated to SAR on the simulator?
"We have eight or nine hours with the mates and masters, and between five and nine hours with the students (undergraduates)."
When you run the first SAR exercise and it doesn't go well what are the common errors?
"The common ones are 'we didn't know how to start', there is no real action. Sometimes one ship does this, one ship does that, one ships does the other thing (confusion). Getting the ships together is a real difficulty. A lack of organization."
What theory are they taught before going on the simulator?
"For students there are special lectures on safety, one term for two hours a week, which is not very extensive to my mind.. but besides that I give them a short information before we start. We have a special German book on search and rescue in our library, and we have MERSAR. The mates and masters are told 'tomorrow afternoon we are going to have an exercise on search and rescue' and what it is. So the mates won't complain next day they have been thrown into cold water, as it would be on board."
Do they choose who will be CSS?
"That's what they normally should do, but it's seldom that they take the action by themselves"
How do they receive the information that there is a distress?
"They get a telegram from the radio station"
How is the exercise terminated?
"I am quite happy when they come to this situation" (pointing to sketch showing all ships in line abreast)
Are exercises ever very successful or does something always go wrong?
"I would say something always goes wrong"

From the complete interview it was clear that the purpose of the instruction was to familiarize students with published guidance on SAR, particularly that contained in MERSAR. Success was deemed to be getting the participating vessels lined up ready to search in formation. The weakness inherent in this method of search, when adopted by merchant vessels (see para 6.2.4), was not recognized.
2.2. The Training of Rescue Co-ordination Centre Controllers

A merchant ship master acting as co-ordinator surface search has to fulfil many of the tasks carried out ashore by a rescue co-ordination centre controller. It is relevant to consider what formal training is available for RCC controllers.

2.2.1. HMCG School Highcliffe

Highcliffe offers two search and rescue courses for HM Coast Guard officers. The basic course is for station officers and lasts two weeks. This course deals with response to distress and takes students up to the determination of search datum and search area (see chapter 7). The further course, which is aimed at the officer in charge of an operations room, covers the whole range of SAR operations including effort allocation. The aims of the course are to present all aspects of the broad spectrum of SAR planning and to give the student the opportunity to practise his skills. These aims are expanded in objective terms which are reproduced at Annex G. It is the intention that all Coast Guard officers should attend the appropriate course at least every four years. Although no dynamic simulation facilities exist at Highcliff, students have the benefit of a training Rescue Co-ordination Centre on which they are exercised in planning, control, and communication skills using actual incidents as exercise models. Again the question could be asked "Who trains the trainers?" and in this case the Chief Instructor, in addition to his in-service training and experience, attended the United States Coast Guard National SAR School at Governor's Island New York.

2.2.2. USCG National SAR School Governor's Island

This school has an international reputation in the field of SAR training. It was established to promote standardization and professionalism within the SAR community by providing comprehensive SAR training to selected military and civilian personnel from around the world. The school offers a range of eight different courses of instruction, the fundamental course being directed at providing an in-depth study in oceanic planning. This is highly applicable to the work of RCCs and to merchant vessels engaged in SAR operations as CSS. An abstract of the USCG SAR School graduation list, as at 17 August 1984, is at Annex H. This shows that the school has taught 627 foreign students from 65 nations. The school also operates a travelling 'road show' providing special courses on site to meet the requirements of differing regions of the World, this work being
sponsored by the United Nations. The influence of the USCG in SAR is thus widespread. In particular, the USCG are the authors of the National SAR Manual which is perhaps the authoritative document on oceanic SAR. Extensive reference will be made to this publication in Chapter 7.

2.3. Conclusions on Maritime SAR Training

The need to provide basic and up-dating training for shore-based RCC controllers is widely recognized by national authorities. Despite the extensive involvement of merchant shipping in SAR a similar need has not been perceived for ships' officers, many of whom will have to perform the duties on an RCC controller at some time during their seafaring lives.

The United Kingdom leads the world in the provision of SAR training for ships' officers. Although general guidance is given on how such training should be conducted (see para 1.3.2), the exact nature of the courses offered by the maritime colleges varies from comprehensive to rudimentary. A common observable feature, however, is that in every instance the instruction is highly valued by the students who receive it.

In comparative terms the course offered at Plymouth Polytechnic, and reviewed in this thesis, leads those offered elsewhere in comprehensiveness and innovation. By focussing attention on a detailed study of formal SAR training for ships' officers, and the wider practical implications in the real as distinct from classroom situation, Plymouth Polytechnic is exercising special responsibility towards making maritime search and rescue more effective.

References:

(4) ibid p32

28
(6) REDFERN A. The Use of Simulators in Search and Rescue Training. Extract from paper in proceedings of 2nd Radar Simulator Teachers' Workshop, Bremen 10-12 May 1982, p 51-54


(8) Hughes T, College of Nautical Studies, Warsash. Extract from transcript of interview Hughes/Redfern, 22 November 1984

(9) Jackson J and Pochin D, South Tyneside College. Extract from transcript of interview Jackson and Pochin/Redfern, 12 June 1985

(10) Dinely W, Liverpool Polytechnic. Extract from transcript of interview Dinely/Redfern, 12 June 1985


(12) Lübbers H D, Hochschule für Nautik, Bremen. Extract from transcript of interview Lübbers/Redfern 13 March 1984
CHAPTER 3

RESEARCH METHODOLOGY

3.1 The Data Available

Radar simulator courses have been offered at Plymouth Polytechnic since 1970. The first simulator, a Solartron SY 2010 with an analogue computer, well met early requirements for collision avoidance training, and indeed was in regular operation until June 1984. In 1977 a digital Redifon NRS 8012 simulator was installed. The "own ship" booths of this second simulator were equipped with a wide range of navigational instruments (see para 2.1.2), enabling the scope of exercises to be extended to include navigational as well as collision avoidance problems. Both simulators were equipped with Bryans XY plotters (see footnote), to record the track history of participating vessels operated by the students and by the lecturer in charge. The plot produced during each exercise, appropriately annotated by the lecturer with details such as: plot scale, ship identities, names of "captains and crews", timings and so on, formed the basis of the debriefing that followed each exercise. Apart from personal details of the students, including: grade of certificate of competency held, rank in which serving at sea, length of service, type size and speed of vessels on which recent experience had been gained, no other records relating to students and their performance, or on which course evaluation could have been made, were maintained.

Participation in, and a study of the proceedings (1 to 4) of, the International Radar Simulator Teachers' Workshops (IRSTWs) held at Liverpool (1980), Bremen (1982), Hong Kong (1983) and Mariehamn (1986), confirmed that much common ground exists in the form of radar simulator courses that have been offered in different parts of the world. Common features have included a progression from simple exercises with pre-determined teaching objectives towards complex free play exercises with navigational and other constraints. Case histories of actual ship collisions are used, and prove most valuable in adding realism to the simulated situations. Such case histories also add to the quality of discussion in the post-exercise debriefings, where the lecturer's

Footnote: The Bryans plotter produces a record of the track of each vessel participating in the exercise on A3 graph paper. The plot is updated every minute, and the scale and position of the centre of the plot is varied to ensure a complete record of one exercise on one sheet of paper.
professional knowledge and experience of past students and previous simulator courses is possibly the key element. Certainly the lecturer has often controlled the exercise to some extent so as to achieve the objective he seeks. The total involvement of the lecturer introduces difficulties in making objective assessment of whether the course in general meets its aims (whatever they may be), of whether any student in particular has met the aims of the course.

Although some form of student assessment has been part of the radar simulator course structure in a few countries, Denmark and the Netherlands for example, no assessment has been required in the United Kingdom (see footnote). One problem has arisen from the lack of suitable objective measures on which assessment could be based, while another has been a lack of well-defined and clear aims for the courses. The problems of assessment, and proper debriefing procedures, have also been subject of discussion at IRSTVs (5 & 6), and indeed, perhaps stimulated by user demand, the recording and playback facilities on simulators now being constructed and brought into service go far beyond the simple XY plot previously mentioned. The opportunities for assessment are increasing if only some satisfactory objective measures can be evolved and accepted, but in collision avoidance exercises this is difficult. After all, what constitutes a close-quarters situation between two vessels? Any answer involves many variables such as safe speed, manoeuvring room, vessel size, visibility; variables which on reflection often turn out to be subjective. It is worth noting that at the IRSTV in Bremen in 1982 a speaker from the Netherlands cynically suggested, "If a British student disobeyed a string of collision regulations (?) but still avoided a collision the simulator exercise would, in the student's eyes, have been successful. On the other hand had a German student complied fully with the regulations he would have considered the exercise a success even if a collision had resulted!"

The Department of Transport (D Tp) in the United Kingdom, in conjunction with the Department of Education and Science (DES) and those colleges offering Navigation Control Courses (NCC), has been considering the problems of course assessment. Course assessment was one of the major

Footnote: The NCC forms part of the Business and Technician Education Council Diploma scheme available to Class II students. For this Diploma assessment is required, but no guidance is given regarding the form that assessment should take. In the event it is rudimentary and still subjective.
topics discussed at the workshop for lecturers held by the DTp/DES in Glasgow from 9 to 11 April 1984 (see para 2.1.4). The DTp suggested "The issue of an NCC certificate should be dependent on the professional judgement of the instructor, taking into account that at the end of the course the student should..." upon which followed a number of objective criteria including, for example, "react effectively to emergency situations." Such a formula would still involve subjectivity, in the professional judgement of the lecturer. In any event, for a number of reasons, it was not possible to agree on a satisfactory method of assessment and the concluding recommendation of the workshop was that the DTp should completely revise their document relating to assessment.

Existing measures alone would not have been sufficient for this study. Ideally any further measures adopted should allow for objective evaluation to avoid the risk of reaching conclusions conditioned by any pre-conceived ideas of the researcher. Such a risk is aptly reflected in the military observation that the situation should be appreciated rather than the appreciation being situated (see footnote). For this reason a wide range of measures has been adopted, forming a multi-methodological approach as a general research strategy. This general, eclectic, approach to research using any technique suitable for 'illuminating' the area of study has been described by M Parlett and D Hamilton (8).

A general description of illuminative evaluation is given through para 3.2, and at para 3.3 it is explained how illuminative evaluation is applied in this study.

3.2 Illuminative Evaluation

Illuminative evaluation evolved during the 1970s as an alternative to traditional experimental and psychometric methodologies then dominant in educational research. Such traditional approaches to evaluation were being criticized increasingly as leading to studies that were artificial and restricted in scope. It was argued that methodologies attempting to measure what were seen to be relevant parameters, perhaps using before and after measurements and making comparison with control groups, could produce tidy results from what was in reality an untidy situation. The

Footnote: An appreciation is a formal and rigorous method of problem solving adopted by the Services. The solution to the problem should be based on the facts. If the facts are 'adjusted' so as to achieve a pre-conceived solution then the appreciation has been situated rather than the situation being appreciated.
tendency to think in terms of parameters rather than people dehumanized the research and divorced it from the real world. Beyond this, by starting from some initial hypothesis and testing it against subsequent analysis of collected data, artificial constraints could be placed on the breadth of the evaluation. Far from being objective such research strategies could be restricted by the original hypotheses, and important truths existing in the area of study could remain unrecognized by the researcher.

Illuminative evaluation allows for a mix of quantitative and qualitative investigation methods to be used. The chosen methodology is not dictated by doctrine but by decisions based on the special characteristics of the problem to be studied. The problem defines the methods used. No method is either exclusive or excluded, rather a combination of methods is used, each throwing some light on, illuminating, a common problem. Quite apart from considering the problem from a variety of viewpoints, this approach can allow for cross checking of otherwise tentative findings.

3.2.1 Observation In general terms illuminative evaluation is concerned with description and interpretation rather than measurement and prediction. Its starting point is observation and not hypothesis, but this does not prevent theory being developed as a product of the investigation. As such theory is, in the words of B Glaser and A Strauss (9), grounded in the area of study, its relevance is more certain.

Observation can take a number of forms, but will invariably begin with a document search. Through this the researcher reads himself into an understanding of the area of study, its problems and its scope. In course evaluation continuing from, or in parallel with, the document search, a running record of the day by day functioning of the course will be maintained. This 'on site' observation will include collecting and collating material generated within the course. The value of this running record will be enhanced if the researcher is able to add, at source when possible, his interpretative comments applying to the material or the circumstances in which it was generated. This will enable allowance to be made, at the interpretation stage of the research, for nuances that may exist between otherwise seemingly similar elements of material. Also through this immediate rather than retrospective
involvement with data as they are produced, the researcher's understanding of the area of study will be heightened.

3.2.2 Unstructured Interviews

The observation is unlikely to be limited to inanimate sources of data. Recording of discussions with and between participants will be made. Recalling that the objective is to observe, rather than inquire, unstructured interviews will play an important part in the acquisition of information. The purpose of such interviews is to elicit impartial opinion from those involved in the area of study. Each interview may well start by following a formal structure, from which factual data such as personal histories can be drawn. Once the respondent is at ease the emphasis will change, and the dialogue will be kept flowing by the interviewer adopting reflective techniques, such as developing themes and topics that the respondent himself has introduced. Occasionally it may become necessary for the respondent to be given more positive encouragement in order to keep the interview flowing, but the danger of leading, and so overlaying the interview with the views of the interviewer will have to be guarded against.

It would perhaps be ideal if all having an involvement with the area of study were, at some stage, subject to interview. This would include students and staff, and even those having indirect rather than direct involvement. If the number of potential interviewees is large, the point may well be reached when the returns, in terms of new information gained or refinement of data, become marginal in comparison with the effort expended in conducting and processing the interviews. Should this situation arise then the element of the study being considered by that particular round of interviews could be considered complete. In other cases the number of potential interviewees may be large in comparison with the number of available researchers, and the potential to generate large quantities of unstructured material may then far exceed the potential for analysis. Effective management of the study, then, dictates that those to be interviewed are selected, either randomly or using some positive selection process. The aim of positive selection is to ensure, where possible, that those interviewed include any persons from groups whose points of view may be of special significance, for example: students either older or younger than the usual student body, overseas students, participants with unusual experience or backgrounds, or those playing particular roles within the area of study.
Each interview is recorded and then transcribed. Again the researcher's understanding of the area of study will be heightened if he can carry out the transcription himself. However this task may be daunting for the 'two fingered typist' and the services of a competent audio-typist will often be necessary. In any event, the researcher should listen to the tapes, while reading the transcripts, not only to ensure that nothing has been lost in the transcription but also to develop a feeling for the content of the material.

Next a detailed analysis of the transcriptions is carried out with the aim of identifying commonalities in and differences between the opinions and perceptions of those interviewed. It will then be possible to separate data from the transcripts into a wide range of themes, most of which are recurring. The phrases emergent categories, emergent issues, and areas of concern are typically used by those adopting illuminative methodology to describe such themes, and the expression category will be used in this thesis. After a number of transcripts have been so analysed and compared it will appear that some categories are more dominant than others in their importance to the interviewees, both collectively and individually. At one extreme, for example, a particular category may rate brief mention by every interviewee, while a further category may totally dominate one interview and scarcely appear elsewhere. At this early stage it will be possible to write in descriptive terms about the various categories, taking into account the various emphases placed upon them by respondents, and perhaps adding flavour by making verbatim quotes from the transcripts. It has to be recognized that such descriptive writing, while giving an impression of respondents' views, cannot be assumed to be representative, especially if it is based on a small number of interviews.

Before fully representative conclusions can be drawn further investigation is required, so as to confirm the relevance of the themes earlier identified, and to enhance the quality of the data obtained. These three stages: observation, further investigation, and explanation characterize illuminative evaluation.

3.2.3 Further Investigation The further investigation, or 'focussing' process, can be achieved by conducting a second series of interviews, this time structured so as to obtain the detail required, and using respondents not included in the first round of observational unstructured
interviews. Alternatively the researcher may choose to use a questionnaire. Such a questionnaire would contain questions derived from the categories earlier isolated by the unstructured interview data. This avoids the risk of the researcher overlaying the questionnaire with his own perceptions of areas of concern. In a similar way, the structure of focussing interviews is derived. Questionnaires have the attraction of lending themselves to quantitative analysis as well as qualitative explanation, but care must be taken to ensure that the use of questionnaires does not alienate respondents towards the study. This could be the case if the questionnaire is over long or complicated, if respondents are not given the freedom to amplify answers or express personal views outside the scope of the questions asked, and perhaps most readily if respondents have become resistant through over exposure to questionnaires in the past.

As indicated in para 3.2.2 this further investigation stage is complete when the information being gained, from the structured interviews or questionnaires, appears to the researcher to add little to that already obtained.

3.2.4 **Explanation** Finally the researcher will analyse and seek to explain his observations and investigations. Acceptance of the validity of the explanation will rest heavily on the ability of the researcher to rigorously describe qualitative data, a task which is no less demanding than that of interpreting quantitative data.

3.3 **Application of Illuminative Evaluation to this Study**

The researcher's understanding of the area of study, in this instance, stemmed naturally from the fact that the researcher also evolved the course under evaluation. This imposed special pressure on the researcher to shed any pre-conceived ideas or bias, which in turn made illuminative evaluation a particularly attractive methodology to adopt. The course under evaluation does not stand in isolation. It attempts to mirror real world situations, and seeks to suggest procedures to follow in dealing with those situations. An essential element of the understanding required by the researcher was an appreciation of those real world situations and problems. This was partly met through interviews with students on the course, all of whom were practising seafarers, and partially through an information trawl. The information
trawl, publicized through the journals of the Nautical Institute (10) and the Merchant Navy and Airline Officers' Association (11), produced 23 respondents having experience of search and rescue. Discussions, during the period of the study, with others having a professional involvement with search and rescue: officers of Her Majesty's Coast Guard, the United States Coast Guard, and officials of the International Maritime Organization for example, have all contributed to the necessary background understanding.

During the observation stage of the evaluation, annotated XY plots of track history provided material for a qualitative and quantitative appreciation. In addition, the VHF radio communication between participating vessels during the simulated search and rescue operations was recorded on tape and transcribed by the researcher. It was thought that this would provide material for a quantitative approach, relating duration of radio communication to the effectiveness of the SAR operation performed. In the event the material so gathered has proved to have even wider application. The tapes played back, or the transcripts read back, to the students during pre-exercise briefings and post-exercise debriefings has added an extra dimension to the course, while analysis of the tapes has shown the key role which effective communications play in effective SAR. Perhaps most unexpected however has been the use of the recordings to provide an unbiased 'fly on the wall' source of information, giving an insight into students' reactions to the course and to each other.

Post-exercise debriefings were also taped and transcribed. This has enabled comparison to be made between exercises within individual courses, and between one course and another. Despite fears that the presence of a tape recorder during debriefing might in some way influence the dialogue between lecturer and students, the pocket size recorder used appeared in no way to inhibit the introvert or encourage the extrovert to overact. There was a beneficial effect. Knowing that the debriefings were to be recorded, the lecturer, as each exercise progressed, noted the points he wished to cover in the debrief at its conclusion. This ensured that debriefings were comprehensive and not superficial as they might otherwise have been.

The recordings described above were made during two courses run in the 1981/82 academic year, and during seven courses run in the 1982/83
academic year. The process produced a vast quantity of raw data, which when filtered and refined reduced to a manageable size for analysis. The detailed analysis appears at Chapter 5. Throughout the same period unstructured interviews were conducted with students to obtain their reaction to the course.

The sample size available for interview was 68 students, 53 of whom were from the United Kingdom. The 15 non-United Kingdom students came variously from West Germany, Bangladesh, Hong Kong and Eire. Language difficulties existed in conducting satisfactory free flowing unstructured interviews with some of the overseas students. A further problem was that the 8 West German students were still at the 'cadet' stage of their seafaring careers, and as such had less experience, and perhaps different expectations, when compared with the remaining students. Nevertheless, two West Germans, two Bangladeshies and the Irish student were interviewed along with 23 British students. Positive selection of students for interview was made, in order to obtain a mix of respondents who had variously been 'captain' of a ship during an SAR exercise, 'captain' and 'co-ordinator' of the search, and merely crew member. Other special categories were also taken into account: the overseas students as already mentioned and the one female student on the course. All respondents were free to refuse to take part in the interview programme, but none did. The 28 students interviewed over a 15 month period constituted 41% of the sample size available. Bearing in mind that the purpose of these interviews was to observe student reaction to the course, and that positive selection had been made so as to include the widest range of student and exercise experience, the researcher is confident that those interviewed were representative of the sample as a whole.

Each interview commenced with the respondent being asked to talk briefly about himself, about his seafaring experience, particularly any SAR experience, and then go on to give his views on the NCC with special reference to the SAR element. Some respondents arrived for interview armed with notes on the points they wished to make. More normally the dialogue had to be kept flowing by the researcher using reflective techniques, and on occasions it was necessary to give more positive encouragement without actually asking leading questions. All interviews took place within a few days of the student completing his NCC, while
events were still fresh in the memory, but with a little time for
reflection rather than reaction.

Some 20 different categories were identified, and the researcher's first
impressions were written up in story form. From these first
impressions a questionnaire was devised, reproduced at Annex J, seeking
to confirm, clarify and qualify the categories that had been earlier
identified. The questionnaire sought to produce a variety of responses
from those completing it, responses such as: either/or, classification,
graduation and open. To encourage free response, anonymity for the
respondent was assured by there being no identifying code on individual
questionnaires. On the other hand respondents were invited, by the
final question, to enter their name if they would be prepared to enlarge
on any of their answers. 44% of those completing the questionnaire did
so volunteer, and some were further interviewed.

The sample size available to complete the questionnaire numbered 43
students, this number comprising all those attending the NCC from the
September entry of the 1983/84 academic year. The questionnaire was
given to students immediately after the final debrief on the SAR element
of their course. By this stage very good relationships had been built
up between the researcher and the students, and the goodwill on their
part was very evident. This goodwill was considered vital, as the same
body of students were subject to other research projects being carried
out at the same time. The pattern was for the researcher to state the
purpose of the questionnaire, students being aware that the course was
being monitored throughout, and then ask the students to read through the
questionnaire, page by page, before entering their answers to any of the
questions. Any doubts as to the meaning of individuals was then
resolved and the questionnaires were then completed. It was noticeable
that very little dialogue between students took place while the
questionnaires were being completed, and there is a high degree of
confidence that the responses were made individually and not corporately.

3.4 Conclusion

A fuller treatment of the content of the unstructured interviews with
students, of the structure of the questionnaire used to focus on emergent
categories, and of the analysis of both interviews and questionnaires
follows in Chapter 4. In Chapter 2 there was evidence to suggest that
SAR was a task seldom met at sea. Unexpectedly, the full research shows this not to be the case, and SAR is a task that will face most mariners at some time during their seafaring careers. This fact alone confirms the need for mariners to be given proper training so that they are prepared for the task when it arises. The course under review was considered valid by students. How those students performed on the courses is considered in detail in Chapter 5.

References:

(1) IRSTW, 1st International Radar Simulator Teachers' Workshop Liverpool Polytechnic, 1980
(2) IRSTW, 2nd International Radar Simulator Teachers' Workshop, Hochschule fur Nautik Bremen, 10 - 12 May 1982
(3) IRSTW, 3rd International Radar Simulator Teachers' Workshop, Hong Kong Polytechnic, 1983
(4) IRSTW, 4th International Radar Simulator Teachers' Workshop Mariehamn, 5 - 9 May 1986
(5) OVERMARK N, Directorate for Maritime Education, Copenhagen, speaking during Desirability for a Final Examination, Session 7, 1st International Radar Simulator Teachers' Workshop, Liverpool, 9 May 1980
(6) Van Dyk H, Rotterdam Nautical College, speaking during Desirability for a Final Examination [see reference (5)]
(7) International Maritime Organization, The International Regulations for Preventing Collisions at Sea, 1972, as amended by further IMO Resolution effective from 1 June 1983
(8) PARLETT N and HAMILTON D Evaluation as Illumination University of Edinburgh Centre for Research in Educational Sciences, occasional paper 9, 1972
(9) GLASER B and STRAUSS A The Discovery of Grounded Theory Aldine, New York, 1967
4.1 Review of Unstructured Interviews

4.1.1 Identification of Categories. The twenty categories (see para 3.3) identified in the unstructured interviews were:

- Individual background
- Student background
- Previous SAR experience
- General observations on NCC
- Overview of NCC
- Passage planning
- SAR element of NCC
- Ship characteristics
- Exercise realism
- Co-ordinator Surface Search
- Organization and operation of SAR element of NCC
- Shore control of SAR
- Theory versus practice
- Post-exercise debriefs
- MERSAR
- Command experience on simulator
- Language
- Communications overview
- Radio telephony
- Navigational equipment
- Direction finding
- Use of ARPA
- Looking ahead
- Future shipboard reaction
- Refresher courses

Identification of individual categories involves a degree of subjective judgement. It is quite possible that a different researcher, in reviewing the same material, may have identified more or less categories or even some different categories. However, a broad classification pattern, similar to that detailed here, would be expected following careful data analysis. What is important is that all the material contained in the transcripts, originating from those interviewed, should be allocated with reasonable consistency to an appropriate category, and no material from those interviewed should be rejected.
Initial identification of categories, and subsequent classification of each element of transcript material, was in this case carried out by the same researcher. Even though the process continued over a fifteen month period this should have ensured sufficient consistency of approach for this observational stage of the study. Sometimes material merged into more than one category, which introduced the need for cross referencing, for example:

"...when I was captain, on the exercise with the direction finding, when we were given minimal information (on what was going on), they (the crew) wondered what I was doing at one stage because I got so involved with what was happening."

In listening to the tape, as well as reading the transcript, the student's enthusiasm was apparent. He was totally involved with the exercise, and this element was assigned to the category exercise realism. But he could equally well have been referring to his command experience, making comment on a lack of information, or on the use of direction finding for SAR. The element therefore also appeared under command experience on simulator, SAR element of NCC, and direction finding.

Once assigned, the elements were excised from the individual transcripts and pasted onto sets of cards, a different set for each category. The number of cards eventually allocated to each category varied considerably. At one end of the scale fourteen cards were filled with material relating to the SAR element of the course; eight were needed for exercise realism, while only one card was required for comment made on the use of direction finding equipment.

Mozart's widow is reputed to have priced his manuscripts for sale according to the number of notes per page. The same value cannot be placed on quantity in this case when comparing one category with another. Some categories were narrow in scope while others were general. Yet other categories, passage planning and the use of automatic radar plotting aids (ARPA) for example, held no or little relevance to the SAR element of the course. Each of the identified categories will now be reviewed.

4.1.2 SAR ELEMENT OF NCC. Although the interviewees were free to lead the unstructured interviews in any way they wished, they all knew that search and rescue was the subject matter under research. Not surprisingly therefore, every student interviewed made reference to the category SAR element of NCC. The general enthusiasm for simulated SAR exercises was clearly apparent and comments such as: "Full of interest".
"time passed very quickly", "most interesting part of the course", and "exceptionally good" abounded. None of the students expressed the opinion that there was too much emphasis on SAR in the Navigation Control Course, and only one observed that the time allocation was right. On the other hand there were many comments suggesting that greater emphasis should be given to the topic. Typical were:

"I can see the difference between the first search and rescue exercise and the second. With time you gain more experience, so if you can allocate more time to SAR I think it should be helpful."

and

"I think a further (SAR) exercise would help, much more than that and you would possibly start losing interest, but an additional exercise would enable you to use the experience you have gained."

and yet again

"I enjoyed planning the ships and getting things organized...we had become more efficient at it in the second one (SAR exercise) than we were in the first, but I think may be one more and we would get it all sewn up."

It has to be remembered that students were completing their SAR exercises, on the simulator, in the evening, after a full day of classroom studies. For them to be so enthusiastic under such circumstances was gratifying, and it is worth looking for possible reasons for their enthusiasm. Certainly eight of those interviewed commented on this aspect, for example:

"The search and rescue element was something that I haven't done before, so for me it was the most interesting part of the course."

and even from an otherwise blase student:

"...unimpressed with the rest of the NC course...except for me, the search and rescue was good, as I had never done anything like that before."

A further reason could be that, even with three students to each booth on the simulator, students found they were fully occupied. Once again there was evidence of this possibility:

"...search and rescue kept you fully occupied, whereas collision avoidance on its own, or even with passage planning, tended not to."

So boredom was less likely to arise during the SAR exercises than during other more commonplace simulated situations.

The problem of boredom creeping into simulator exercises is well appreciated by most instructors, and various devices are used to combat this eventuality. On passage planning it may be possible to have students execute passages planned by their colleagues, or to have the 'ship' manned by only one watch keeper while the other watch keeper and the master (available on call) are planning a future passage. Change over of the watch can be arranged. Information can be passed to vessels
under way either by radio or by simulated NAVTEX (see footnote), and so on, all measures adding to realism by keeping the student involved.

During search and rescue exercises the need to navigate, manoeuvre, plan and communicate simultaneously generates sufficient activity to dispel the risk of boredom, but is it realistic? The question of exercise realism is considered in para 4.1.3. below, meanwhile another reason for the students' enthusiasm could be that they consider the experience worthwhile. Once again this possibility was evidenced in the unstructured interviews:

"...the search and rescue was so worth while because it is something that you don't really consider unless you're in the situation, and then it would be a mad rush for the MERSAR manual and I think that it is possibly too late then."

and

"If I were a potential survivor rather than floating around in the water thinking 'Oh God there's lots of people around here who have never done any SAR or anything like that', I must confess I think I'd be comforted by the thought that perhaps some of them had done a course like this at some stage."

Brown found similar evidence of enthusiasm.(1) Two students amongst those interviewed extended this view and thought that others should benefit through undergoing refresher courses. It concerned one students that:

"Those already qualified won't have to do any search and rescue training and that is not good."

A further example of this view was:

"I wouldn't mind doing it all again at a later date."

It is doubtful if there is any single reason for the students' enthusiasm; novelty, involvement, and an appreciation of the value of the SAR element of the course combining together as reasons. But what seemed apparent was that after a day in the classroom with 'chalk and talk', students did like to indulge in role play. What realism was there in this role play?

4.1.3 EXERCISE REALISM Twenty of the twenty eight interviewed made some mention of exercise realism, and this time not all the comments were complimentary. Four students thought realism was lacking, and in one of these cases the problem was seen to be:

"...on the simulator we are assuming that all the ships are much the same type of vessel, in real life this would not be true."

This comment was completely valid, and was made by a student from the

Footnote: NAVTEX is fixed frequency (518 kHz) radio system in which information is received in printed form by the user ships. NAVTEX provides navigational warnings, weather information, pilotage information, information on the status of radio navigational aids, distress messages etc.
first NCC course offered at Plymouth. The problem was rapidly solved by producing ship profiles (see para 4.1.5), though the ship characteristics adopted themselves became one of the themes identified within the unstructured interviews.

One interesting observation was that the tension likely to pervade a real life emergency situation was missing:

"...in a real life situation on the bridge of a ship it would be far less organized than it was here. I can imagine people running around like the proverbial "blue arsed flies", looking for this that and the other, and wondering exactly how they are going to go about it...that would preoccupy most of the time really. I mean we knew the objective...and had a distinct advantage over the real situation."

It can clearly be difficult to generate that tension. On the simulator students expect things to happen, on the ship's bridge the watchkeeper may be taken unawares by an event. Indeed on collision avoidance exercises it is not unknown for a student to appear from a booth and ask "Has the exercise started" if nothing has happened in the first fifteen minutes or so. At the other extreme, tension can occur through the inexperience of the student. Following a passage planning exercise the German captain of a ship, that had just picked up the pilot for entry into Plymouth, came out of the booth exclaiming "Phew, I was really nervous." Nervousness is not normally apparent with Class II students, and indeed, that students can be exercised in testing situations without the tensions that often exist on a ship's bridge, may be one of the major benefits of using simulators.

Another area of complaint, from one student, was lack of realism in the simulator booths:

"...an integral part of being on the simulator is that you are all closed in...10% of me is saying 'this isn't real, I can't walk out on the bridge wing'. I find it a bit claustrophobic, which makes it difficult for me to concentrate."

This particular student was the only female to have completed the course at Plymouth, and perhaps that may be relevant. Certainly realism of surroundings, rather than realism of the exercise situation, seldom seems to concern students. The booths are usually well accepted and comment seldom goes beyond the jocular "you could make the booths more like a real ship by providing a bridge kettle and a jar of coffee."

The final observation on lack of realism related to students of equal standing, in terms of qualification and experience, having to take the role of master and give orders to colleagues, and on other occasions having to take orders from those same colleagues.
Overall, those interviewed thought SAR exercise realism was good, and it is a little surprising that the limitations outlined above were not widely perceived or thought more worthy of comment. The favourable comment on realism seemed often to be linked with the general enthusiasm apparent for the SAR element of the MCC, and was highlighted by:

"...I really had the feeling that I was looking for something and at the end of the course I was really disappointed that we didn't find anything."

and

"...everybody gets really into it and you forget where you are. You definitely think you are on a ship and it does work very well."

Brown also observed on the general enthusiasm for SAR amongst students.

(2) It is worth noting at this point that, apart from the introduction of ship profiles after two courses had been run, no changes were made in the content or general format of the SAR course while observation and evaluation was taking place. This was necessary so as to ensure that like was being compared with like throughout. When the data collection ceased the first change in format to be introduced was to terminate the search exercises once the target had been located. Students do like a tangible measure of their success or failure.

4.1.4 PRE-EXERCISE THEORY AND POST-EXERCISE DEBRIEFING The practice of SAR on the course included post-exercise debriefings as well as the time spent in performing the simulated exercises. In addition, the practical SAR was preceded by a theoretical consideration of the elements of effective maritime search and rescue. Both pre-exercise theory and the post-exercise debriefings were topics introduced into the interviews by some students.

Eleven of the interviewees made mention of theory versus practice. As noted in para 2.1.5., the structure of the Navigation Control Course was changed after it was discovered that the structure adopted for the first two courses was unsatisfactory. Not surprisingly one student from an early course complained at length about the theory and practical sessions being too far apart:

"I think it was a bit too far between the actual course of lectures and then putting it into practice....I'd completely forgotten how to make a rendezvous and it took the three of us at least ten minutes (on the simulator) trying to figure it out from our notes."

At least this student had had the benefit of formal theoretical tuition, and had some notes available from which he could solve his problem. In the real life situation at sea most seafarers would be less well equipped, but the point was well made and it did not arise again after the course had been restructured. Additionally the student's comments could be
taken to mean that the theory was not adequate to support the subsequent practice. Much later on a second student suggested that the theoretical treatment was too brief by saying:

"...we really had to start from scratch in there (the simulator) taking account of...what was in NERSAR...and what we had picked up in the lecture before."

and yet a third:

"...it was too rushed really, just one lecture on the theory and straight in at the deep end."

This student had perhaps not been very receptive to the theoretical tuition, coming as it did after a full day in the classroom, but there were encouraging signs that others did benefit:

"...the theory part, that’s useful because if you didn’t have it before you go in there (the simulator) you’d be reading a book while you were doing it, which is crazy...that’s what happens at sea anyway!!"

and even more encouraging

"I enjoyed the time with the theory part, learning what search and rescue was all about."

When the surprised interviewer responded "I think you’re the first person to say that." the student continued:

"No, I think it was very good."

Even if the theory did come a little late in the teaching day to be absorbed by all students there was at least the benefit of being able to follow it up reasonably rapidly with some practical, if simulated, experience. Reporting on a badly performed first search exercise, which incidentally was the norm rather than the exception:

"...they (his colleagues) had not bothered to go away (after the theory lecture) and satisfy themselves that they did know how to do it. But we soon learned on the simulator. Nothing beats experience and the simulator is the next best thing."

Overall no clear picture emerged from the unstructured interviews on the balance of theory versus practice, but on the matter of post-exercise debriefings the situation was different.

Debriefing was seen to be of particular value. Although only seven students actually mentioned the debriefing sessions all remarks were most favourable and included:

"...and we learned a lot from the debrief (after the first search exercise) and we thought we wouldn’t let it (mistakes) happen again."

and

"obviously a lot of information came out of the debrief, but it was more a question of we were embarrassed at the debrief...and we were determined to do better next time."

As already indicated the first search exercise seldom proceeded efficiently, and as a result there was much to say at its conclusion. Those students who had been in executive roles, perhaps aboard the co-ordinator surface search vessel, were probably a little stunned by the rigour of the debriefing. It is likely that these were the students upon
whom the debriefing sessions had made most impact. It also emerged that four of those interviewed conducted their own 'wash-ups' in the week between the first and second search exercises, and the general feeling amongst those students was that "after realizing how bad they were they were determined to get it right next time". This is a student not a staff assessment, and it is possible that students would get less out of the course if the first exercise went too well!

4.1.5 Ship Profiles Reverting to the important category of exercise realism the subsidiary categories ship characteristics and command experience on the simulator have already been mentioned in para 4.1.3. Once ship profiles had been introduced students were apparently quite able to visualize the type of ship they were aboard and react accordingly. One interviewee thought there should be a wider range of ship types, to include tankers in ballast with large freeboard as well as general cargo vessels with the ability to "get men over the side". But during the period when observation of the course was being made it was not desirable to make significant alterations to content or structure. Further, as on the simulator there is no possibility of simulating the actual recovery of survivors from the water this element of search and rescue did not form part of the teaching objectives. The aim was for students to respond to a distress message, exchange information between ships in the area, agree a co-ordinator surface search, evolve and execute a search plan, and possibly locate those in distress. The exercises terminated before the recovery stage of search and rescue.

One interviewee thought there was too much written word in the ship profiles and that better use could be made of sketches, especially of bridge layout. This was because it took too much time to digest the information about the ship they were supposed to be aboard. In general, however, after the introduction of ship profiles very little reference was made to ship characteristics in the unstructured interviews with students.

4.1.6 Command Experience on Simulator The observation that exchanging roles between members of a peer group may reduce realism was made on page 45. The position of command during simulator exercise was brought up by eight of the interviewees, and evoked a wide range of attitudes. Four thought the job of being captain on the simulator generated no special problems. Interestingly the view that all students being on the same course and having identical qualifications are equal, is not
necessarily shared by the students themselves. One interviewee considered himself really superior:

"I found it awfully difficult because, of the lads on my course, X was the only other second mate. The others were not as experienced and I found it difficult in a way to be tactful. They started doing things and I wanted to say 'I wouldn't have done that' or 'that's a bit risky', but I thought I'd let them find out for themselves and say nothing. I found that hard, keeping quiet, with my gregarious nature."

and regarding another student
"There's one chap on the course who is from RFA ([Royal Fleet Auxiliary) the significance of this fact is not clear) and there was no way I was going to tell him what to do. I think that's correct, you are either captain or you are not."

The role of tact emerged when another simulator captain was talking about his German navigator:

"...he wasn't too hot on his chartwork and he uses those silly little triangles (instead of a parallel ruler) which tend to, in my experience, induce error. It meant I had to check everything he did. I didn't want to say 'get out of the way, you're useless' as I didn't want to insult him, but it involved a bit of delay."

Dominant personalities showing through is satisfactory when the dominant person is playing the role of master, but at other times it can cause problems. Three of the interviewees reported 'committee structures' existing for decision making, though collision avoidance, passage planning, and a hovercraft race played more as a game were specifically mentioned as being the occasions when this happened. For example:

"...I had one particular problem on a Friday afternoon passage plan. I think the Poets syndrome (Push Off Everyone Tomorrow's Saturday) crept in and it lacked the situation to resist it. I was in command with two other persons on the ARPA and they only wanted to play with it. It was a bit lackadaisical, and when I asked for an alteration of course the ship started swinging the opposite way, because the situation was so relaxed. I started barking, as you would if you were in command as master, but it sort of fell down because I was getting no respect."

This particular event may sound more like anarchy than rule by committee, and it highlights the fact that all simulator situations are not alike. Often three students in a simulator booth can be too many. If all cannot be kept actively involved, playing realistic roles, then something is lost. Boredom may be accepted as an unavoidable part of life on occasions on the ship's bridge, but it is not so readily accepted on the simulator. Certainly the unstructured interviews indicated the need to further investigate the role of master in the simulator, and this was done through the subsequent questionnaire.
CO-ORDINATOR SURFACE SEARCH Closely linked to internal command is the problem of overall co-ordination. Five students made comment on the choice of co-ordinator surface search. Only one thought it was a major problem:

"The problem we had mostly was the choice of command of surface search. I think it would be better from our point of view if you actually designated someone early on rather than everybody trying to offload the job onto someone else."

Significantly this observation was made before ship profiles were introduced. That there should be no further adverse comment is gratifying as one of the main aims of the course was to exercise students in the selection of CSS. Another student from one of the early courses said:

"...on the second exercise I got roped in as master of the ship in charge, and it was good fun, I enjoyed it. I think the only reason why people shied away from it (being co-ordinator) was they were not really sure how to go about it."

indicating that uncertainty about the task may have been a more significant factor than suitability for the task in deciding who was to be the co-ordinator. At other times the choice was simple:

"...I don't know whether it was planned or not but two of the ships were having difficulty in communicating with each other. I could hear both and talk to both so it wasn't just a diplomatic choice that I should be co-ordinator, it was the only choice."

Quite apart from choice of CSS other interviewees made reference to co-ordination. The 'pleasure' in co-ordinating was evident for example:

"I found myself in the CSS role which was great. It's a pity you can't sort of force people to be CSS, a lot of people just do not know what they are missing."

The importance of effective co-ordination, either from ashore or on the spot, was also recognized by some of the students. There is a myth that ship masters are loathe to hand over control of their ship to others, but this is not so if control is efficiently exercised. Few merchant vessels are taken into or out of port under the direct control of their master. The pilot has local knowledge and expertise for this task, and his advice is normally welcomed by the master. Similarly, provided the co-ordination is competent it will also be welcomed by masters of participating vessels.

"...I was surprised in fact how easy it was to get ships to cooperate, although I wasn't actually the co-ordinator I had things worked out just in case I was asked. It worked very well. I must admit I was very surprised."
It is noted in para 5.4.1 that polite and correct radio procedures help to maintain goodwill between those taking part in a co-ordinated task such as search and rescue. During the period in which unstructured interviews took place no major dissent developed between CSS and other ships in the exercise. In later exercises the plans of the CSS were sometimes challenged, and on one occasion the CSS was changed part way through the search. This was a proper decision, politely suggested and willingly accepted by those concerned. Given the right level of goodwill the ease with which ships can be co-ordinated should not be so surprising.

Two students expressed the thought that the scope of the exercises should be expanded to include shore control and helicopter or fixed wing aircraft participation. Significantly both these students were on the same course and they had probably reached this opinion jointly rather than individually. There was no scope for such a major change while the investigation was in progress, but it is a suggestion well worth following up in the future. Students would have to man the Rescue Co-ordination Centre from which Shore Control of SAR was effected, and it would also eliminate from the exercise the need for a decision being made regarding the choice of CSS. The exercise would therefore have to be an extension of the existing course, and there may be scope for this.

4.1.3 MERCHANT SHIP SEARCH AND RESCUE MANUAL The Merchant Ship Search and Rescue Manual (MERSAR) is the standard reference book on SAR for merchant vessels. The course exposed many students to MERSAR for the first time, and its relevance figured largely in the unstructured interviews. Five interviewees stated they had previously read MERSAR while at sea, though to what depth of understanding is not clear. One of the five claimed to be a compulsive reader and another of the five had read MERSAR on anchor watch when feeling bored. A further four interviewees had seen the book aboard their vessels, and three of these suggested that MERSAR was not the sort of book that people would pick up and read. The interviews suggested that in the event of a vessel being involved in search and rescue there was no certainty that MERSAR would be used. One student said:

"...I was surprised at the content of MERSAR as I hadn't seen it on any of our ships. We were involved in the Alexander Kielland operation..." (see footnote)

Footnote: The oilfield accommodation rig Alexander L Kielland capsized in the North Sea, with the loss of 137 lives, on 28 March 1980. A major SAR operation was mounted in the search for survivors.
Of course every SAR incident is not identical, and in some there may be no requirement to seek and follow the advice contained in MERSAR. In major protracted searches however, such as that following the Alexander Kielland disaster, one might expect the mariner to look to the manual for guidance. Apparently this is not always the case.

Certainly there was an indication of approval for MERSAR amongst the students. It was thought to be appropriate in size (by which was meant small enough to be readable rather than daunting in scope) though, following their experience on the course, there was reservation on the relevance of some of the content. Most encouraging was the indication that the course had heightened students' awareness of the book:

"..my first reaction now (if faced with SAR at sea) would be to go and get MERSAR. Certainly not before, I would never have thought of it. It has never been in a prominent place on the bridges of ships I've been on."

4.1.9 COMMUNICATIONS Efficient communications have a major role to play in any SAR task involving more than one vessel. We have already seen, in para 4.1.7, that on one occasion communication difficulties determined, over all other considerations, which vessel should act as co-ordinator surface search. Nine of those interviewed commented on communications, and the importance of good communications was widely recognized. One student observed:

"Sometimes there was too much talking (on the radio), some unnecessary and unexplicit statements were coming from commanders, they were not enough to the point."

and another typical remark was:

"better communications were the big thing that made it work quite well. I think we learned from our lack of communication on the first exercise."

Linked in closely with communications is the need to have a common and clear language:

"...and something which helped to make it more realistic from the communication point of view is that we have got the Germans with us. I think that has been a help because it made one immediately aware that there was a communication problem."

This view was shared by another student who stated:

"...it is important that the communication should be...in a language that everybody can understand....so that there is no confusion."

Because there were enough hurdles in the way, without adding extra complications, all communications on the course were conducted over VHF radio links. This was thought to be wrong by three students. They
would have liked the more complex medium frequency radio telephone to be used:

"...well everybody knows how to use the VHF, it is just a telephone, but I think the RT could be used. It's a thing only used by deck officers on small ships and we ought to get more practice. After all we might be in a situation where the VHF is out of order."

Merchant vessel manning levels are being steadily reduced in the drive to lower operating costs. At risk are radio officers whose work the Department of Transport is known to be considering putting within the range of duties carried out by bridge watchkeepers. Some mates would become qualified as communications officers, qualified to operate high frequency single side band and satellite communications equipment beyond the scope of the existing restricted RT certificate. In such an event the need to develop the communications element of the NC course, particularly in the safety areas, such as search and rescue, may well arise in the future. (see para 2.1.4)

4.1.10 AUTOMATIC RADAR PLOTTING AIDS At the time the unstructured interviews were conducted (1982/83) automatic radar plotting aids (ARPAs) were still at the novelty stage. Students with no previous ARPA experience found that the NC Course provided insufficient time for them to become proficient in the use of ARPA. Only three students made comment on ARPA, and their observations may not be significant, but only one viewpoint was expressed. With a different type of ARPA installed on each own ship on the simulator students may have been a little confused and not fully familiar with their equipment in the early days of their instruction on the NC Course. This problem should reduce as more students gain practical pre-course ARPA experience at sea. The benefits of using ARPA in SAR co-ordination were not revealed in the interviews, but use of ARPA navigation lines is an effective means of monitoring the progress of a search, in a similar manner to that described at Annex D-7.

4.1.11 PREVIOUS SEARCH AND RESCUE EXPERIENCE Fourteen of the twenty eight interviewees had been involved, as watchkeepers, with SAR during their previous service at sea. The experiences they related covered a wide range of activities from major SAR operations, such as the Alexander Kielland disaster (see para 4.1.8), through the chance mid-ocean rescue, without search, of survivors from a sunken yacht, to man overboard. Failure was more common than success.
4.1.12 Conclusions on Review of Unstructured Interviews

The unstructured interviews provided a qualitative view of student reaction to the course. First impressions suggested that:

(a) search and rescue is a task that faces many mariners, and is a task for which they are not well prepared,
(b) the SAR element of the NC Course was well received by students, and considered relevant to their needs,
(c) an acceptable degree of realism can be achieved when conducting SAR exercises on a navigation simulator.

The first impressions on the content of the unstructured interviews were written up in 'story' form, not for inclusion in this thesis, but to comprise the basis of the questionnaire that followed as part of the further investigation (see para 3.2.3).

4.2 Structure of Questionnaire

The primary aim in constructing the questionnaire was to focus on categories emerging from the unstructured interviews, and in doing so to obtain a quantitative as well as qualitative assessment of student reaction to the course. As a result aspects of categories including: theory versus practice, post-exercise debriefs, command experience on the simulator, SAR communications, coordination of surface search, and exercise realism all became subject to question. This was to identify any area of the course where variation or improvement may be necessary. The general category SAR element of the course was included and widened to determine student reaction to course content, the students' perceived aims of the course, and its future development. The opportunity was also taken to obtain a measure of the perceived value of simulator training. From the response to the information trawl (see para 3.3) it appeared that SAR was an exceptional and seldom performed task at sea, an opinion shared by Lübbers (see para 2.1.9.), while the unstructured interviews seemed to indicate otherwise (see para 4.1.11). The questionnaire was further widened to get a better assessment of the true state of affairs, and thus an indication of the importance, or otherwise, of proper SAR training for bridge watchkeepers.

An important consideration was the detailed structure of the questionnaire. Although filling in forms has become a regular feature of modern life their correct compilation can often be a daunting task. There was thus a wish not to make the questionnaire either unnecessarily long or complicated. Thirty questions sufficed, though the final
question was to ask students to enter their name on the form if they were prepared to enlarge on any of their answers. This would allow scope for further structured questioning with the respondents' acquiescence.

The questionnaire appears overleaf and at Annex J. It will be noted that the style of question asked and response required varied widely. This was partly dictated by the information sought, and partly from a desire to hold interest by adding variety to the questionnaire. Completing the form took respondents about thirty minutes. When and how this was done has already been detailed (see para 3.3), and it is restated that goodwill on the part of the students was most evident.

4.2.1 Application of Questionnaire The questionnaire was piloted, in handwritten form, with a full class of nine students in October 1983. Minor alterations were made to its structure, and all 26 students on the next three courses completed the revised questionnaire. A preliminary statistical analysis was then carried out. This analysis was compared, three weeks later, with a second analysis after the final eight students of the 1983/1984 cohort had completed the NCC. In only one area was there a significant difference between the analysis of thirty five sets of responses and that of the full forty three sets of responses. The area of difference related to NCC organization, and is considered in detail on para 4.3.17. In all other respects the return in terms of refinement of data compared with the expenditure of effort was small. To prolong the further investigation would also have involved sampling a different cohort of students, and it was therefore decided that the forty three sets of responses had provided an adequate statistical sample for further investigation purposes.

The forty three respondents comprised one Royal Air Force civilian instructor, three West German students, and thirty nine Class II students all of similar experience.
The SAR content of the NCC is:

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<thead>
<tr>
<th>Too Little</th>
<th>Correct</th>
<th>Too Much</th>
</tr>
</thead>
</table>

The balance between SAR theory and practical exercises is:

<table>
<thead>
<tr>
<th>Too much theory</th>
<th>Correct</th>
<th>Too much practical</th>
</tr>
</thead>
</table>

Post SAR exercise de-briefs have:

<table>
<thead>
<tr>
<th>No value</th>
<th>Some value</th>
<th>Much Value</th>
</tr>
</thead>
</table>

In the columns below tick the descriptions applying to any exercise on which you were Captain:

<table>
<thead>
<tr>
<th>Boring</th>
<th>Interesting</th>
<th>Challenging</th>
<th>Relevant</th>
<th>Irrelevant</th>
<th>Realistic</th>
<th>Unrealistic</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SAR 1 Helo</th>
<th>SAR 2 Mayday</th>
<th>SAR 3 D/F</th>
</tr>
</thead>
</table>

Between SAR 2 and SAR 3 did you discuss the problems of SAR with your colleagues?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Compared with SAR 2, SAR 3 was tackled:

<table>
<thead>
<tr>
<th>Worse</th>
<th>Same</th>
<th>Better</th>
</tr>
</thead>
</table>

If answer to Q(8) 'worse' state why:

If answer to Q(8) 'better' state why:

In the column below tick which statement applies to the occasions when you were Captain:

<table>
<thead>
<tr>
<th>My Authority was unquestioned</th>
<th>I sought advice but made the decisions</th>
<th>It was 'rule by committee'</th>
<th>My authority was flouted</th>
</tr>
</thead>
</table>

Should more than 3 SAR exercise be held?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

Ship profiles were:

<table>
<thead>
<tr>
<th>Adequate</th>
<th>Inadequate</th>
</tr>
</thead>
</table>

How were the 'possible' SAR course objectives listed below met?

1. Appreciation of MERSAR contents
2. Practice in SAR communications
3. Selection of CSS
4. Selection of proper search
5. Adoption of proper search
6. Real time exercise play

<table>
<thead>
<tr>
<th>Not met</th>
<th>Partly met</th>
<th>Well met</th>
</tr>
</thead>
</table>

If answer to Q(15) inadequate suggest improvements required:

State briefly any other objective SAR course should have:

56
(19) Tick any of the following statements on ‘the use of simulators during the Class II Course’, with which you agree:

(a) Their value is over estimated
(b) They interfere with ‘serious’ study
(c) They are a welcome/interesting/enjoyable diversion
(d) Their use is about right
(e) Greater use should be made of simulators
(f) Role play is a good teaching method

(20) Delete the untrue element in each of the following statements:

(a) I had/had not seen MERSAR whilst I was at sea
(b) I had/had not read MERSAR before attending the NC Course
(c) MERSAR will/will not mean more to me now I have completed the NC Course

(21) Tick which of the following statements most accurately describes MERSAR?:

(a) MERSAR is inadequate for its purpose
(b) MERSAR is adequate for its purpose
(c) MERSAR is very good for its purpose

(22) Would a standard inter-ship information exchange format be useful? [Yes No]

(23) If you answered yes to Q22 what details should the format include?

(24) Have you ever given the kiss of life to a real casualty? [Yes No]

(25) Have you ever taken part in an SAR task? [Yes No]

(26) If you answered yes to Q25 was MERSAR used during the task? [Yes No Don't Know]

(27) If you answered yes to Q25 was any search carried out efficiently? [Yes No Not applicable]

(28) Will your colleagues at sea be receptive to your SAR knowledge, gained from the NC Course, if the need arises? [Yes No]

(29) Should some form of NC Course be given to all watchkeepers and masters? [Yes No]

(30) If you would be prepared to enlarge on any of your answers please enter your name:

57
4.3 Analysis of Responses

4.3.1 Balance of Course  The balance of the various elements of the NCC, as initially conceived by the Department of Transport, owed more to intuitive feeling than design according to Connors (3). The unstructured interviews indicated the enthusiasm of students for simulated SAR exercises, an enthusiasm that is evident not only at Plymouth but wherever NC Courses are held in England (see para 2.1.8.). Question 1 of the questionnaire sought to confirm, and quantify the extent of, that enthusiasm in the eyes of the students. As shown in Table 4.1 the time intuitively allocated by the Department of Transport to SAR appears to meet the requirements of students.

![Table 4.1: SAR Content of NCC](image)

<table>
<thead>
<tr>
<th>SAR Content</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too Little</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>Correct</td>
<td>30</td>
<td>69.7</td>
</tr>
<tr>
<td>Too Much</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>100</td>
</tr>
</tbody>
</table>

The only student who thought there was too much SAR in the NC Course was the Royal Air Force civilian instructor. He had considerable SAR experience and his expectations and requirements of the course would be different to those of other students. In his research Brown noted that 36 out of 38 students expressed a desire for more time on SAR during the NCC, but this was in response to direct question at interview which could receive a different reply to an anonymous questionnaire.(5)

The response to this question is a little at variance with that to question 13: “Should more than three SAR exercises be run?”

![Table 4.2: Number of SAR Exercises Required](image)

<table>
<thead>
<tr>
<th>Number of Exercises</th>
<th>3</th>
<th>&gt;3</th>
<th>Don't Know</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>15</td>
<td>28</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>%</td>
<td>35</td>
<td>65</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Here 65% thought there should be more SAR exercises compared with only 28% thinking there should be more SAR on the NCC. This could be explained as a desire for a reallocation of time within the hours already devoted to SAR, and questions 1 and 2 addressed this possibility.
4.3.2 Balance between SAR Theory and SAR Practice  

Question 2 sought to determine whether the balance between theory and practice was acceptable to the students. Table 4.3 gives the results.

Table 4.3 Balance Between Theory and Practice

<table>
<thead>
<tr>
<th></th>
<th>Too much theory</th>
<th>Balance correct</th>
<th>Too much practical</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>2</td>
<td>39</td>
<td>2</td>
<td>43</td>
</tr>
<tr>
<td>%</td>
<td>4.7</td>
<td>90.6</td>
<td>4.7</td>
<td>100</td>
</tr>
</tbody>
</table>

The evidence shows the balance between theory and practice was correct, and no reallocation of time within the SAR element of the course was required. It may be pertinent that the 2 students stating there was too much theory were both on a course having Germans amongst the students. It is not possible to attribute positively the feeling against theory to German students, but it could be speculated that a concentrated theory lecture in a foreign language would be less attractive than simulator practicals. Indeed, for any student, practicals are likely to be more attractive than evening lectures after a full day's classes. It is therefore a little surprising to find that two students actually wanted more theory, but see also the student's remark at para 4.1.4.

4.3.3 Post-exercise Debriefs  
The staff considered post-exercise debriefs to be of great importance, and the unstructured interviews suggested that students were of a similar opinion. This was confirmed through question 3, which also attempted to quantify student response to debriefs. The results, which indicate there is no scope for reallocation of course time in the area, are given in Table 4.4.

Table 4.4 Value of Post-exercise Debriefings

<table>
<thead>
<tr>
<th>Post-exercise Debriefings have</th>
<th>No value</th>
<th>Some value</th>
<th>Much value</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>-</td>
<td>12</td>
<td>31</td>
<td>43</td>
</tr>
<tr>
<td>%</td>
<td>-</td>
<td>35.8</td>
<td>64.2</td>
<td>100</td>
</tr>
</tbody>
</table>

4.3.4 Observations on Balance of Navigation Control Course  
There is no clear cut division between the various elements of navigation control as practised at sea or on the course. During an SAR exercise on the simulator, students are also involved in navigation, collision avoidance, use of ARPA, and planning. It may be possible to introduced elements of SAR into exercises having some other primary teaching objective, and this
could, in part, satisfy the requirement for some limited extension of the SAR content. Beyond this, each course is not identical in the extent to which students solve the problems they are set on the simulator. If a good understanding of the problems of SAR has been demonstrated by success in the SAR tasks set then no further exercise may be required. However if the conduct of the SAR exercises has been poor or inconclusive, then in order to finish on a 'high note' further exercises may be necessary at the expense of some more routine part of the course, such as collision avoidance.

4.3.5 Analysis of Exercises Questions 4, 5, and 6 were designed to provide an assessment of the value of each simulator exercise in the eyes of the students. It has to be borne in mind that a number of variables existed depending on the role of each ship in the exercise, and the role of each student aboard his ship. A student who played the role of captain aboard the vessel which becomes co-ordinator surface search (CSS) was likely to be more fully involved than a student who was crew member aboard a ship that played a subordinate role in the exercise. Much depends on how each captain allocated duties aboard his ship. Some find it easy to delegate while others do not. The same is true in the real life situation. There will be little job enrichment for the capable but under employed student, and as a result he may get less value from an exercise than a more heavily involved student. A further factor was the level of manning aboard each ship. Two of the courses comprised 8 students while the remaining 3 each had 9 students. Where the normal manning was 3 students on each simulated ship, on 6 of the 15 exercises assessed there would have been one ship with only 2 students on the bridge. The workload for those students would have been heavier, and perhaps more realistic, but no attempt has been made to compare 2 student and 3 student bridge manning.

The three questions also asked students whether they found the exercises interesting and/or challenging. If a student found an exercise difficult he is more likely to consider it challenging than if few problems had arisen. An exercise could also hold the interest of students without being challenging. This element of the question therefore only has limited significance, but it is comforting for the instructor to know that he is not setting tasks at too low a level. If no student found the exercises challenging there could be grounds for concern.
4.3.6 **Analysis of SAR Exercise 1**

The exercise, which is fully described at para 2.1.6.(a), involved each ship individually in communication with a Coast Radio Station, and subsequently in making an interception with a helicopter. There was no interaction between ships. The exercise contained a number of teaching points but also a number of artificialities. This fact was evidenced in the student assessment of the exercise, as analysed in Table 4-5 below.

### Table 4-5 Analysis of SAR Exercise 1

<table>
<thead>
<tr>
<th>Role</th>
<th>Captain</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%1</td>
</tr>
<tr>
<td>Boring</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Interesting</td>
<td>12</td>
<td>92</td>
</tr>
<tr>
<td>No Reply</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Relevant</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td>Irrelevant</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>No Reply</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Real</td>
<td>7</td>
<td>70</td>
</tr>
<tr>
<td>Unreal</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>No Reply</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>

**Notes:**

1. % of those responding to question
2. % of total sample

During 5 courses 15 of the students would have played the role of captain on this exercise, while the remaining 28 students would have filled crew member roles. It is observed that about a quarter of the students made no response to whether the exercise was relevant or irrelevant, real or unreal. This is possible because they did not see the exercise in such clear cut either/or terms but scored it on some middle ground between the extremes, seeing some elements as relevant and real, others as irrelevant and unreal. The 'don't know' is of course a common feature in opinion surveys of this nature. In view of the exercise artificialities it is understandable that 28% of students definitely thought the exercise unreal. The 14% assessment of irrelevance could similarly stem from the same artificialities.

Only one captain thought the exercise was boring, and the same student considered the exercise was also irrelevant, a view not shared by his fellow captains. The significance of this is that no captain thought...
SAR exercises 2 and 3 were either boring or irrelevant (see Tables 4-6 and 4-7). SAR exercise 1 thus has an unwanted uniqueness.

SAR exercise 1 differs from exercises 2 and 3 in that it does not involve planning, control, or use of search techniques. It is an exercise in interception, which is the art in achieving rather than avoiding a collision. As such it could readily be conducted during the collision avoidance element of the NC course, or even while students are becoming familiar with the equipment of the simulator. This would then allow the production of a third 'pure' SAR exercise, which would have the advantages of both meeting the perceived need for some extension to the SAR content of the course, and ensuring that every student on the course had the opportunity to be captain during a search. It could also ensure that no course ends without having conducted a reasonably successful search operation.

4.3.7. Analysis of SAR Exercise 2

This exercise, which is fully described at Annex E, gave students their first chance to put into practice the principles of search and rescue learned during the theory lecture. Apart from the problems inherent in using simulation to mirror real life situations, no artificialities existed in the exercise. Analysis of student assessment of the exercise is contained in Table 4-6.

<table>
<thead>
<tr>
<th>Role</th>
<th>Captain</th>
<th>Crew</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boring</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Interesting</td>
<td>5</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>No Reply</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Relevant</td>
<td>4</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Irrelevant</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No Reply</td>
<td>1</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Real</td>
<td>4</td>
<td>100</td>
<td>90</td>
</tr>
<tr>
<td>Unreal</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>No Reply</td>
<td>1</td>
<td>20</td>
<td>2</td>
</tr>
</tbody>
</table>

Notes: (1) % of those responding to question
(2) % of total sample

As with SAR exercise 1, 15 students would have played the role of captain during this exercise, while the remaining 28 would have filled crew roles.
member roles. Again it is noted that about a quarter of the students made no response to whether the exercise was relevant or not, real or unreal.

SAR exercise 2 presented the students with many problems, and they seldom showed the knowledge or experience necessary to overcome those problems in a satisfactory manner. This is not an adverse reflection on the students themselves, rather an adverse reflection on the general preparedness of seafarers for search and rescue. As a result students tended to find themselves challenged by the exercise and few found it boring. That some did is possibly less a comment about the exercise than about the students concerned, or the part they were allowed to play in the exercise. The evidence is that students found SAR 2 highly relevant and realistic.

4.3.3 Analysis of SAR Exercise 3 The exercise is fully described at para 2.1.6.(c). Its purpose was to reinforce the lessons learned by students from exercise 2 and its debrief. The usual simulator artificialities existed in the exercise and, in addition, as the playing area had been specially designed to meet the needs of the exercise a 'home made', rather than standard Admiralty chart, was used. This may have removed a little of the realism, and indeed a small loss of realism is noted in the analysis when compared with SAR exercise 2. Again 15 students would have played the role of captain. The full analysis appears in Table 4-7.

Table 4-7 Analysis of SAR Exercise 3

<table>
<thead>
<tr>
<th>Role</th>
<th>Captain</th>
<th>Crew</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CSS %1</td>
<td>%2 NonCSS %1</td>
<td>%2</td>
</tr>
<tr>
<td>Boring</td>
<td>- - - - - - -</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Interesting</td>
<td>5 100</td>
<td>100</td>
<td>8 100</td>
</tr>
<tr>
<td>No Reply</td>
<td>- - - 2 - 20</td>
<td>1 - 10 - - 3 - 7</td>
<td></td>
</tr>
<tr>
<td>Relevant</td>
<td>5 100</td>
<td>100</td>
<td>7 100</td>
</tr>
<tr>
<td>Irrelevant</td>
<td>- - - - - - -</td>
<td>- - - - - - - - - - -</td>
<td></td>
</tr>
<tr>
<td>No Reply</td>
<td>- - - 3 - 30</td>
<td>3 - 30</td>
<td>1 - 6</td>
</tr>
<tr>
<td>Real</td>
<td>5 100</td>
<td>100</td>
<td>5 33</td>
</tr>
<tr>
<td>Unreal</td>
<td>- - - 1 17</td>
<td>10 - - 2 12</td>
<td>11</td>
</tr>
<tr>
<td>No Reply</td>
<td>- - - 4 - 40</td>
<td>2 - 30</td>
<td>2 - 11</td>
</tr>
</tbody>
</table>

Notes: (1) % of those answering question
(2) % of total sample
Comparison between Exercises

Table 4-8 below compares student assessment of each of the 3 exercises. Overall response is recorded, with no attempt to differentiate between the roles played by students in the exercises.

Table 4-8 Comparison of Exercises (Extracted from Tables 4-5 to 7)

<table>
<thead>
<tr>
<th>Exercise</th>
<th>SAR 1</th>
<th></th>
<th>SAR 2</th>
<th></th>
<th>SAR 3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
<td>%</td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>Boring</td>
<td>10</td>
<td>25</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Interesting</td>
<td>30</td>
<td>75</td>
<td>38</td>
<td>93</td>
<td>37</td>
<td>93</td>
</tr>
<tr>
<td>Irrelevant</td>
<td>6</td>
<td>18</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Relevant</td>
<td>27</td>
<td>82</td>
<td>33</td>
<td>97</td>
<td>36</td>
<td>100</td>
</tr>
<tr>
<td>Unreal</td>
<td>12</td>
<td>38</td>
<td>2</td>
<td>7</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Real</td>
<td>20</td>
<td>62</td>
<td>28</td>
<td>93</td>
<td>31</td>
<td>91</td>
</tr>
<tr>
<td>No Reply</td>
<td>24</td>
<td>24</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No significance is attached to the lone observation that SAR 2 was irrelevant. Although students were 'guided' through the questionnaire before its completion, and would have been appraised of the possible objectives of the course through question 17 (vide Annex J), the brief reference to objectives is unlikely to have influenced their answers to questions 4 and 5. Whether an exercise was relevant or not is more likely to be assessed by the students' own expectations of the course. SAR exercises 2 and 3 clearly met student expectations. As stated on page 61 the 28% assessment of unreality for SAR 1 must largely stem from exercise artificialities, and those few students who thought SAR 2 and 3 were unreal may have been influenced more by problems of ship simulation than situation simulation. This would accord with the minority view expressed in the unstructured interviews at para 4.1.3. Finally, it is noted that the questionnaire was completed immediately after the debriefing on SAR 3. Events from that exercise would have been fresh in students' memories, whilst those from SAR 1 and 2, which took place one week earlier, would be less dominant and generate a lower response rate.

Comparison between Student Roles

Further analysis of responses to questions 4 and 5 enables comparison between how captains and crews assess the exercises. The analysis, as given in Table 4-9 overleaf, shows that in terms of relevance and reality there is little difference between the opinions of captains and crews.
but difference does exist in assessment of level of interest. Not surprisingly students were more likely to be bored when acting in non-executive crew positions that when acting as captain. This is linked to the degree of involvement with the task, and devices are needed whereby either bridge manning can be reduced or bridge activities can be increased. This problem was considered earlier at para 4.1.2.

Table 4-9 Comparison between Captain and Crew Response

<table>
<thead>
<tr>
<th>Captain</th>
<th>Crew</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boring</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Interesting</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>97</td>
</tr>
<tr>
<td>Relevant</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>97</td>
</tr>
<tr>
<td>Irrelevant</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Real</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>84</td>
</tr>
<tr>
<td>Unreal</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
</tbody>
</table>

4.3.11 Performance Improvement During Course There would be cause for concern if student performance did not improve during the course. Questions 7, 8, 9, and 10 were designed to determine whether such improvement was apparent to the students, and if so, to what was such improvement attributed. It was generally thought that performances did improve, as summarized in Table 4-10.

Table 4-10 Comparison of Performance

<table>
<thead>
<tr>
<th>Course Number</th>
<th>SAR 3 worse than SAR 2</th>
<th>SAR 3 same as SAR 2</th>
<th>SAR 3 better than SAR 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Number %</td>
<td>Number %</td>
<td>Number %</td>
</tr>
<tr>
<td>11</td>
<td>3 33</td>
<td>2 22</td>
<td>9 100</td>
</tr>
<tr>
<td>12</td>
<td>3 33</td>
<td>2 22</td>
<td>9 100</td>
</tr>
<tr>
<td>13</td>
<td>1 13</td>
<td>7 87</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>8 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>3 7</td>
<td>3 7</td>
<td>37 84</td>
</tr>
</tbody>
</table>

The success of an exercise depended largely on the performance of the CSS, and on no occasion was the same group of students CSS for both SAR 2 and SAR 3. It may be natural to be more critical of the performance of others than of one's own performance, but this trait did not reveal itself to any marked extent in the responses given. The exception was...
on course number 11, when 3 students thought SAR 2 had been performed better than SAR 3. Through question 6 (vide Annex J) it was possible to determine that all 3 students had been aboard the ship controlling SAR 2. The reasons given (in answer to question 9) for the drop in performance were: "The CSS did not appear to be in control of the situation." and "Not taking account of the tide on the position of the distress/lack of tidal knowledge." Perhaps the 3 students really did think they had done a better job a week earlier when they had been in charge. At least they had some support in that 2 students from the other non-CSS ship detected no improvement in performance between the exercises. On the other hand all 3 students on the ship that controlled SAR 3 thought they had improved on the previous performance, giving as reasons (in answer to question 10): "organization better by CSS/more thought given/experience gained from SAR 2."

The staff appraisal of the two exercises in question was that SAR 2 was performed well for a first attempt, and that the hoped for improvement in performance on SAR 3 did not materialize. There is thus some sympathy for the 3 students who justifiably thought they could have done better than those who actually controlled SAR 3, but a fairer assessment would have been "same as SAR 2."

The student on course 13 who detected no difference in performance was not aboard the CSS ship on either exercise. In general therefore, students were quite willing to recognize that others had performed better than they had, acknowledging perhaps the benefit of learning from earlier mistakes. 86% of students thought that improvement had taken place, giving as reasons, in response to question 10:

(a) greater knowledge better appreciation of the aims/more idea after SAR 2 debrief/lessons learned from SAR 2 68%
(b) better control CSS gave more thought/CSS organization better 21%
(c) individualism we did not use MERSAR patterns 8%
(d) indulgent we were CSS!! 3%

The complete crew who attributed the improvement to their not using MERSAR search patterns could equally well have stated 'better organization by CSS', but this apparent lack of regard for the contents of MERSAR is at variance with the general feeling towards MERSAR, given at para 4.3.18. This reason was therefore given separate recognition.
It is also indicated at para 5.4.6 that once the general principles of search and rescue are well understood, intelligent improvisation can be a better road to success than rigidly following the guidance of MERSAR.

The main body of students specifically attributed any improvement to knowledge gained from or after SAR 2, with some recognition of the debrief to SAR 2 being a key point.

4.3.12 Value of Debriefings and Discussions The unstructured interviews revealed that on occasions students had discussed search and rescue problems, amongst themselves, in the week between SAR 2 and SAR 3 (see para 4.1.4). By comparing student answers to questions 3 and 7, relating to debriefs and private discussions respectively, with performance on SAR 3, as assessed in the answers to question 8, it is possible to get an indication of the value of debriefs and discussion. Table 4–11 summarizes this evaluation.

Table 4–11 Relationship between Debriefs/Discussions and Performance

<table>
<thead>
<tr>
<th>Course</th>
<th>Value of Debriefs</th>
<th>Discussion</th>
<th>% Students Stating SAR 3 better than SAR 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Some</td>
<td>Much</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>1</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

The table shows the number of students who considered debriefs had some value against those who thought they had much value. It further lists the number of students, by course, who took part in private discussion between SAR 2 and SAR 3, and identifies whether those aboard the ship that was CSS for SAR 3 had taken part in any discussion.

Least private discussion took place on courses 11, 13, and 14, and these same three courses placed most value on post-exercise debriefs. This seems to indicate that, in the absence of discussion greater dependence is placed on the debriefings. It is also noted that on the same three courses those eventually controlling SAR 3 had not taken part in any private discussion, and that on both course 11 and 13 improvement in performance was not fully recognized. Course 14 was non-standard in that it took place when students were in the final throes of preparation.
for external written and oral examinations. With their attention thus
on other things it is understandable that no discussion between them took
place. See also para 4.3.17. It is also suggested that private
discussion is beneficial. When, on courses 10 and 12, those who had
taken part in such discussion were later called upon to act as co-
ordinators, the improvement between SAR 2 and SAR 3 was acknowledged by
all. The contrast with courses 11 and 13 is evident, but only inference
rather than conclusion is possible, as the sample is small. Staff
observation is that on course 14, SAR 2 was very much a failure in
operational terms. The post-exercise debriefing was particularly
rigorous, and students would have been well aware of their short-comings.
In this event the widely recognized improvement of SAR 3 was to be
expected.

4.3.13 Command Experience on Simulator The fact that students on the
NC Course normally belonged to the same peer group, with similar
industrial background and experience, may adversely affect the exercise
of command on the simulator, see para 4.1.3. Question 11 sought to
determine the extent to which command problems existed in role play.
Table 4-12 gives a summary of the results.

Table 4-12 Assessment of Simulator Command Style

<table>
<thead>
<tr>
<th>Command Style</th>
<th>Assessment by Captains (A)</th>
<th>Assessment by Crews (B)</th>
<th>Ratio A:B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unquestioned authority</td>
<td>4</td>
<td>7</td>
<td>1:1.8</td>
</tr>
<tr>
<td>Sole command but sought advice</td>
<td>33</td>
<td>55</td>
<td>1:1.7</td>
</tr>
<tr>
<td>'Rule by Committee'</td>
<td>7</td>
<td>17</td>
<td>1:2.4</td>
</tr>
<tr>
<td>Authority flouted</td>
<td>1</td>
<td>1</td>
<td>1:1</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>80</td>
<td>1:1.8</td>
</tr>
</tbody>
</table>

The command styles are graded along a scale from autocratical to
anarchical. There were 45 occasions when students would have been in
the role of captain, and 84 when in the role of crew member. There was
considerable similarity in how captains assessed their own style of
command and how others saw it, and in general no problems of command
existed. Overall 82% of captains thought they were in command, and 78%
of crew members recognized the captain as being in command. The
difference between seeking advice and 'rule by committee' can be small,
and obviously a small number of crew members thought they had had a
greater influence in discussions than they did in the captains' eyes.
This accounts for the ratio 1:2.4 for 'rule by committee' being higher than the overall ratio of 1:1.8.

4.3.14 Additional SAR Exercises As stated at para 4.3.1, in response to question 13, 65% of students wanted additional SAR exercises during the NC Course. Question 14 attempted to determine the type of exercise that those students would like to have added to the list. The answers, giving an order of preference, are shown in Table 4-13.

Table 4-13 Further SAR Exercise Preference

<table>
<thead>
<tr>
<th>Type of Exercise</th>
<th>Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st</td>
</tr>
<tr>
<td></td>
<td>2nd</td>
</tr>
<tr>
<td></td>
<td>3rd</td>
</tr>
<tr>
<td></td>
<td>4th</td>
</tr>
<tr>
<td>Intercept (SAR 1)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
<tr>
<td>Mayday (SAR 2)</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>D/F (SAR 3)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Either Mayday or D/F</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

Only 17 of the 28 students required to answer this question attempted to place in order of priority each one of the four options, the remaining 11 students only selected their first choice. It is thus not possible, on the results obtained, to apply weightings to the answers and produce an overall order of preference. In giving 11 fourth choice, and only 3 first choice ratings, to interception exercises students made it clear there is no pressing requirement for further exercises of this type. This accords with the general student reaction to SAR 1 shown in Table 4-8. The low rating given here to the interception exercise reinforces the suggestion, made at para 4.3.6., that the exercise be moved from SAR to a different element of the NC Course.

Intuitively it appears that there is marginally more demand for an additional Mayday (SAR 2 type) exercise than for an additional D/F (SAR 3 type) exercise. SAR 2 was generally less well performed than SAR 3, and students could have been looking for an opportunity to put right their errors. No clear conclusions are possible, and a satisfactory solution may be to have a range of additional exercises available, the one being used on any occasion being determined by the needs of the particular course.
4.3.15 **Ship Profiles** The introduction of ship profiles, see para 2.1.7, for SAR exercise purposes was one of the few changes made during the course of this evaluation. Question 15 was asked to determine whether the profiles were acceptable to students. Forty students thought they were. The other three students, in response to question 16 of Annex J, suggested: include more big ship profiles, include ships' callsigns, give more manoeuvring data, and allow more time to read the profiles before commencement of the exercise. The first two suggestions can be met easily. The question of manoeuvring data is largely dependent on the complexity of ship equations available to the simulator. The Redifon 8012 was simple in this respect, and there would have been little value in giving students manoeuvring data for their exercise ship if the simulator could not mirror those manoeuvres. The request for more reading time may be better met by simplifying the profiles, which included some extraneous detail.

4.3.16 **Course Objectives** At the start of the course students were told that the reason for including SAR in the NC Course was to meet the International Maritime Organization requirement (6) that mates should have an understanding of the contents of MERSAR. No detailed objectives were given. Students were asked, through question 17 of the questionnaire, to state how well a number of 'possible' course objectives were met. Their responses are summarized in Table 4-14.

<table>
<thead>
<tr>
<th>Table 4-14 Meeting 'Possible' Course Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td>Number %</td>
</tr>
<tr>
<td>Appreciation of MERSAR's contents</td>
</tr>
<tr>
<td>SAR communications practice</td>
</tr>
<tr>
<td>Selection of CSS</td>
</tr>
<tr>
<td>Selection of search patterns</td>
</tr>
<tr>
<td>Adoption of search patterns</td>
</tr>
<tr>
<td>Exercise in real time</td>
</tr>
<tr>
<td>Overall Assessment</td>
</tr>
</tbody>
</table>

Table 4-14 Meeting 'Possible' Course Objectives

That the selection of CSS objective was deemed, by 4 students, not to have been met was a little unexpected. A standard element of each post-exercise debrief was a discussion on how the selection of CSS had
been made, whether it was appropriate, and how well it was carried out. Factors taken into account in selection of CSS were covered in the pre-exercise theory lecture, and in the course notes (reproduced at Annex D) given to each student. This objective, in addition to being apparently least well met overall, was also adjudged to be well met by a greater % of students than any other possible objective.

Generally the course appeared to meet the possible objectives. If the objectives are valid, where they are more partly met than well met a review of course content and methods would be warranted, and from this student assessment it was indicated that more attention should have been devoted to the contents of MERSAR. Students were invited, by question 18, to suggest other possible objectives the course should have. 16 of the 43 students did make suggestions, which were mainly directed at course content rather than objectives. Their suggestions included:

**Analysis of case studies.** This suggestion, made by one student, is academically attractive. Case histories are used in the collision avoidance element of the NC Course. They are essentially 'hands off' situations where the students does not control play, but observes and then analyses what has gone wrong. Case studies could not be included in the practical SAR exercises where student response to a situation is a principal objective. They would perhaps be better suited to classroom SAR studies, rather than simulator application, in which case they may fall outside the scope of the simulator based NC Course. An attractive alternative would be to have available a number of highlights from SAR case studies. These could be used to reinforce post-exercise debriefings when appropriate.

**Continuing exercise to include successful search and subsequent action.** Six students made this suggestion, which was also made during the unstructured interviews, see para 4.1.3. As previously noted, students do like to have a tangible measure of their success in searching for a distressed vessel or survivors. The validity of this suggestion was recognized early in the course, but no change was made until completion of the observation and further investigation stages of the study. Since September 1984 most of the simulated searches have ended with the location of the casualty. Once it is apparent that a reasonable search pattern has been evolved and is being executed,
and that the CSS is exercising effective co-ordination, a target is introduced at an appropriate detection range. This has provided an extra dimension to post-exercise debriefs, as students can calculate how much longer it may have taken to detect the target had it been in another part of the search area. Search can be generalized but rescue cannot. It depends on a number of variables such as ship size, condition of load, equipment, and prevailing weather conditions. The ship manoeuvring equations and the close range simulation capabilities of the Redifon 8012 did not permit simulation of recovery of survivors, but the debrief could be extended usefully to include a discussion on 'what happens next'.

Include man overboard and single ship searches. Made by only one student this is another useful comment. Man overboard problems could be injected into navigational or collision avoidance exercises, without using any time allocated to search and rescue. It has already been noted that students sometimes find collision avoidance less than challenging. Additional complications on occasions could add sparkle to that element of the course.

Use more rigid procedures for selection of CSS and search patterns. This suggestion, made by one student, is interesting as it recognizes some of the short-comings of MERSAR. These problems are considered later in this study.

Greater emphasis on correct communications procedures. Although three students made some reference to this aspect communications procedures already formed a major element of the SAR theory of the course, and poor procedures always received proper consideration during the post-exercise debriefings.

Introduce bridge log books. The one student who made this observation was very much a lone voice. Students had registered their rejection of log books by not using them when they were available during the first three NC Courses. Completion of log books is more a recording action after than an executive action during the event. Once the exercise terminated students deemed completing the log book to be an unwelcome chore.

Include joint ship/aircraft searches. This suggestion was made by two students. It is usually military aircraft that are involved in search and rescue. When joint merchant ship/aircraft search and rescue operations are conducted control always lies in the hands of the military commander. The
opportunity to practice selection of CSS and control of search would be lost if the students were only in a subordinate role. Acquire a better understanding of how to use ARPA before attempting any SAR. Two students made this observation, and it was possible, through minor amendment to other elements of the NC Course, to meet this suggestion.

4.3.17 The 'Benefits' of Simulation Question 19, see Annex J, was included so as to gain an insight to how students regard the use of simulators in their professional training. Their responses are given in Table 4-15.

Table 4-15 Opinion on Use of Simulators during Class II Course

<table>
<thead>
<tr>
<th>Statement</th>
<th>Replies in Agreement</th>
<th>% of Respondents(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Their value is overestimated</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>They interfere with 'serious' study</td>
<td>4 (2)</td>
<td>9</td>
</tr>
<tr>
<td>They are an amusing/interesting/welcome/enjoyable diversion</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>Greater use should be made of simulators</td>
<td>21</td>
<td>49</td>
</tr>
<tr>
<td>Role play is good teaching</td>
<td>20</td>
<td>47</td>
</tr>
<tr>
<td>Their use is about right</td>
<td>15</td>
<td>33</td>
</tr>
</tbody>
</table>

Notes: (1) Total 43 respondents
(2) Includes three students from Course 14, completing their NC Course just before their external examination.

Only one respondent appeared disenchanted with simulation against 21 who thought greater use should be made of simulators. This is particularly encouraging when it is considered that students attended the simulator during the evenings, after a full day of classroom activities. The fact that 47% of the students thought role play to be a good teaching tool suggests there may be merit in looking at the Class II course in general to see if there are other areas where role play methods could be adopted.

34 of the first 35 students completing the questionnaire were attending Plymouth Polytechnic on a two term Class II course. Only one of those 34 thought the use of simulators interfered with 'serious' study. An entirely different picture emerged from the next 8 respondents, 5 of whom were Class II students. Three of the 5 opined that their time on the 73
simulator interfered with 'serious' study. This was the one area of significant difference referred to at para 2.1.5, and the reason for the difference was not hard to find. The fifth NC Course took place just before students were about to sit their external examinations. It was a period when intensive revision, rather than intensive study, was taking place, and for the 3 students concerned pre-examination apprehensions are likely to have coloured their opinions on this point. On a two-term course of Class II studies most students would like to complete their NC Course during the first term. This was just not possible with the student numbers and simulator facilities existing at Plymouth Polytechnic at that time. Students having to attend their NC Course in the second term, when oral and written examinations were also taking place, felt disadvantaged.

4.3.18 *Merchant Ship Search and Rescue Manual (MERSAR)*

The unstructured interviews suggested that students were not always familiar with MERSAR before attending the NCC. Question 20 of the questionnaire attempted to assess the extent of student familiarity with MERSAR and a slightly different picture emerged, as shown below:

(a) 63% of students stated they had seen MERSAR aboard their ships at sea, the remaining students had not,

(b) 60% of students had read MERSAR before attending the NC Course, the remaining students had not,

(c) 89% of students claimed that MERSAR would mean more to them after completion of the NCC, the remainder stated it would not.

Unfortunately the structure of the questionnaire did not enable it to be determined whether those students who claimed they had read MERSAR prior to attending the NC Course did so at sea, or earlier in their Class II studies at Plymouth Polytechnic. Only 5 students thought that MERSAR would not mean more to them after the NCC than before. As MERSAR was a constantly used reference book during the SAR element of the course it is possible that those students already had a sound knowledge of MERSAR before attending the course, but Table 4-14 also reveals that if an appreciation of the contents of MERSAR was an aim of the course, 2 students though that aim had not been met.

Certainly, by the end of the course every student had seen and used MERSAR. What did they think of the book? asked question 21. The
answers, which are contained in Table 4-16, indicate that MERSAR was thought satisfactory for its purpose.

Table 4-16 Assessment of MERSAR

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Adequate</td>
<td>34</td>
<td>79</td>
</tr>
<tr>
<td>Very Good</td>
<td>5</td>
<td>12</td>
</tr>
</tbody>
</table>

4.3.19 Standard Format for Exchange of Ship Information When several vessels attend a search and rescue incident an exchange of information between vessels should take place in order to determine which vessel is best able to assume the role of co-ordinator surface search. Even with the benefit of previous instruction, students found difficulty in knowing what information should be exchanged. This problem, which is considered in Chapter 5, could possibly be partially solved if a standard check list for exchange of information existed. From their answers to question 22 it is clear that most students (93%) favoured the adoption of such a system. But when asked, by question 23, to suggest what details the standard check list should include no clear picture emerged. Their answers were wide ranging and far from conclusive, as may be expected when they were being asked to give instant answers to a complex problem. This is an area where further research would be appropriate.

4.3.20 Search and Rescue Experience From personal student details obtained on NC Course enrolment, and from the content of unstructured interviews, see para 4.1.11., it was apparent that students had considerable real search and rescue experience. Questions 24 and 25 were included in the questionnaire so that a measure of this involvement could be made, and compared with another 'commonplace' emergency situation, namely giving the kiss of life. The questionnaire indicated that 27% of students had been involved in search and rescue, while student records covering 133 students indicate the figure to be 24%. It must be remembered that NC Course students have, on average, about four years watch keeping experience as a junior officer or cadet. That one in four has been involved in SAR in such a short time at sea gives an indication of how common SAR tasks are, yet formal training for this emergency had not been given to British ships' officers prior to 1982. By comparison, the questionnaire revealed that 16% of the same respondents had given the kiss of life to a real casualty. Formal
training to deal with this apparently slightly less common emergency has been given for many years.

The questionnaire then sought to determine whether MERSAR had been used during the reported SAR incidents. For one student the answer was yes, for nine the answer was no, and the eleventh student did not know. Of course, some incidents may have been of short duration, such as man over board, with the casualty always in sight, in which MERSAR would have little part to play. Also, it has to be acknowledged that as junior officers or cadets they probably played only minor roles in the SAR operations, and may not have been fully aware of all that was happening, but the fact remains that the high incidence of SAR is not matched by evidence of the use of MERSAR.

The 11 students who had been involved in SAR were asked by question 27 to state whether the search element was carried out efficiently. On five occasions it had been whilst on three it had not. In the remaining three incidents there was no search involved. It was not possible to draw any firm conclusions from the responses to this question.

4.3.21 Implications for the Future at Sea The unstructured interviews indicated that there was some concern over the time it would take for the lessons learned during the NC Course to have any impact on navigational control at sea. Questions 28 and 29, repeated in Table 4-17 below, with the responses, addressed themselves to two aspects of these problems.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will your colleagues at sea be receptive to your SAR knowledge, gained from this course, if the need arises?</td>
<td>27  63</td>
<td>10  23</td>
<td>6  14</td>
</tr>
<tr>
<td>Should some form of NC Course be given to all watchkeepers and masters?</td>
<td>42  98</td>
<td>-</td>
<td>1  2</td>
</tr>
</tbody>
</table>

On one hand it is noted that most students believed their colleagues at sea, and this would mean superiors in most cases, would be receptive to the SAR knowledge they had gained from the course. It is encouraging to think the students had gained enough confidence and knowledge to advise
the master if necessary. On the other hand it is a little disturbing that so many other students were sure they would be ignored or were uncertain of their position. This says a lot about the people concerned and the senior officers with whom they have sailed in the past. Guile can still play a part. One student who thought his colleagues would not be receptive to his recently acquired SAR knowledge, stated at later interview that he would get MERSAR from the bookcase and leave it on the chart table for the master to see.

Students were practically unanimous in the view that all masters and bridge watchkeepers should have the benefit of some form of NC Course. This gave a measure of the high regard in which the course was held.

4.4 Conclusions

The following conclusions are drawn from the analysis of student response to the unstructured interviews and to the questionnaire:

(a) students found the SAR element of the NC Course generally interesting, relevant and realistic,
(b) students liked simulation and the use of role play,
(c) there were few problems in the exercise of command in simulated situations,
(d) student competence improved as the course progressed,
(e) the allocation of NC Course time to SAR was adequate, but some re-organization of how that time was used was indicated. In particular the interception exercise should be moved to allow time for a third pure search and rescue exercise,
(f) provision of a third pure search and rescue exercise would ensure that every student had the opportunity to act as captain during at least one exercise, and would give additional practice in selection of CSS and in use of MERSAR,
(g) a range of exercises should be available for the third exercise so as to meet the particular needs of any course,
(h) exercises should end with successful search if possible,
(i) MERSAR was deemed adequate for its purposes,
(j) a standard format for exchange of ship information is required,
(k) search and rescue is a problem facing many watchkeepers, and all should have some form of NC Course training.
References


(2) ibid p86

(3) Lubbers H D, quoted in Brown (see reference (1)) p 62

(4) Connor T F, quote from address to DES/DTp Teachers' Workshop, Glasgow, 1984

(5) BROWN W J, (see reference (1)), p91

5.1 Factors Affecting Success of SAR Operations

While luck can play a major part in the successful outcome of any SAR task (see para 1.2), success is more likely to depend on the knowledge and professionalism of those taking part. It depends on a number of factors including: effective communications and exchange of information between those taking part in the search, the selection of an appropriate vessel to act as CSS in multi-ship searches, the adoption of search patterns and procedures to suit the particular search, and an overall air of efficiency on the part of the CSS so as to spread confidence and a sense of purpose amongst those engaged in the search. The SAR operations highlighted in Chapter 1, and evidence from the unstructured interviews, indicate that in practice the required levels of knowledge and professionalism are often missing.

The students tackling SAR tasks on the simulator were lacking in wide experience, few having served at sea in capacities higher than second mate. All, however, had the benefit of an introduction to MERSAR, and a two hour lecture on SAR theory, before their knowledge and professionalism was put to the test. This preparation should have compensated in part for their lack of experience.

5.1.1 Collection of Data for Evaluation of Performance on Simulator As stated, at para 3.3, a number of data collection measures were set up, so as assess student performance during the simulated SAR exercises. These measures included making audio recordings of all radio traffic transmitted during exercise play. These recordings were subsequently transcribed for analysis. As students on one ship had no means of contacting students on another, other than by radio, the transcripts offer a rich source of information on student performance, on how decisions were reached, on action, reaction and inaction, and on occasions gave a fly on the wall insight into what was taking place in the confines of the own ship booths. It was possible to play back elements of the tape during post-exercise debriefings, providing a valuable extra dimension to
the lessons being taught. The transcription of the first six minutes radio traffic during the first SAR exercise on the first course appears, as an example, at Annex K. Extracts from other transcripts are used in the analysis that follows, to highlight good and indifferent procedures, and to illustrate points of comparison between courses and between exercises.

In general, communications should be clear and concise if they are to be effective. While it is not necessary to resort to telegraphese when passing a message, conversational styles should be avoided. The length of each transmission is of relevance. With simplex channels only one person can speak at one time. It is not possible to interrupt him, and if he speaks too long he is likely to confuse the receiver. The receiver will be unable to write down at conversation speed, or later recall, the full content of the message. By timing each transmission, the pattern of VHF traffic over the course of an exercise can be determined. This has been done for each of the exercises under analysis, and examples relating to SAR 2 and SAR 3 on course number one appear at Annexes L & M.

Graphical XY plots (see para 3.1) were obtained, showing the tracks of vessels during each exercise. These have been reproduced, to a reduced scale, and appear at Annexes N & P. Each reproduction has been annotated to enhance the basic information of the original XY plots. The tracks of the vessels during each exercise have been extended, in pecked lines, to show future intended tracks. These intentions were deduced from the content of the radio traffic exchanged between vessels during the exercise, and from questioning during post-exercise debriefings. Each plot also has a search area superimposed. The purpose of the search areas as shown is to enable measurement of the effectiveness of each search, from which comparisons can be made. The parameters upon which the search areas shown are based are described in para 5.1.3.

The final source of data available for analysis was the recordings of the post-exercise debriefings. There was no standard form of debrief, the content of each depending entirely on how the preceding exercise had been carried out. During the course of the evaluation the debriefings were possibly more comprehensive than would normally have been the case, as
additional information was sought on the reasoning behind student action during the exercises.

5.1.2 **Detail Extracted from Data** The first stage of the analysis was to extract, from the data available, detail for each exercise on the following points:

- (a) the initial response to the distress,
- (b) the exchange of information between vessels responding to the distress,
- (c) whether datum was determined and agreed between vessels, (see footnote)
- (d) the factors taken into account in deciding which vessel should be CSS,
- (e) the search pattern chosen and its suitability in terms of: leg length, track spacing, alignment and ship speed,
- (f) the quality of VHF radio traffic between vessels,
- (g) when appropriate, the attitude between participants.

From this detail it would be possible to describe, in comparative terms, how each SAR exercise was performed.

The second stage of the analysis was to determine the effectiveness of the action taken. This was done by setting, unknown to the participants, an objective for each exercise, and then measuring how close the students came to meeting that objective. By using a common objective for SAR 2, and similarly a common objective for SAR 3, it would

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**Footnote:**

The figure shows a possible pattern for a two ship search. Position 'O' is datum, defined as being the most probable position of the search target at a given time, taking into account the expected effect of drift since the initial position was established.

Track is the path followed by a single ship, eg from P through Q, R and S to T for ship one.

Leg length is the length of one long leg of the track, eg PQ or RS.

Track spacing is the distance between each long leg, eg QR or PS.

Alignment is the direction of the leg length, eg 035°/215° in the figure.

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Source: Author
be possible in the third stage of the analysis to compare one course with another. Finally, the factors contributing to the comparative success or failure of any particular exercise could be identified and, perhaps, recurrent patterns determined.

The objective used in stage two of the analysis was the search of a standard search area. The measurements taken were the time it would take the participating vessels to search the area using the search pattern adopted, and the percentage of the area effectively covered at common intervals after reception of the distress signal.

In any SAR operation the area to be searched depends on: the forces available, the accuracy that can be assigned to the position given by the vessel in distress, the accuracy with which the vessels responding to the distress know their own positions and can navigate, the time interval between reception of distress and arrival on the scene, and the way in which the distressed vessel may have drifted during that interval. Navigational constraints, such as shoal water, may also influence the limits of the area to be searched and the alignment of the search. In open waters the search is usually aligned along the expected direction of drift of the target. Once the search area and alignment have been defined a suitable track spacing has to be adopted. The track spacing chosen should not result in unwarranted risk of collision between the searching vessels, and other factors to take into account include the meteorological and oceanographical conditions such as visibility, wind speed, sea and swell state, the nature of the target being sought, own ship visibility, lookout potential, location aids available to casualty and search vessels, and whether it is day or night.

5.1.3 Exercise Search Areas. The scenario for SAR 2 placed participating vessels in radar contact with the land and good navigational fixes could be obtained. The time interval between receiving the distress and reaching the position given was short, two vessels being less than half an hour steaming away while the third was within an hour of the scene. The position given by the casualty "two zero miles south east of Eddystone" was rather imprecise. Had Calamity Jane given her position as perhaps "two two seven degrees Eddystone one nine point four miles", then it would give the impression that she know her exact position, but two zero miles seems rather a round figure and south east is a general
direction. During the post-exercise debriefs students were asked how accurate they thought the given position of Calamity Jane was likely to be. Most students thought it should be no more than five miles in error. An initial position error of five miles could quite sensibly be placed on datum, and an area ten miles square, centred on datum, adopted for the first search.

The wind was south west force three, and students would have been experiencing a north easterly set aboard their vessels. For this reason the alignment of the search should have been north east/south west.

The visibility in the area was given as two miles and the search took place in daylight hours. The search vessels had no ship targets other than themselves visible on radar and yet two of the vessels were in the immediate area of the position given by Calamity Jane. This could indicate that Calamity Jane was not a large vessel, and a check in Lloyd's Shipping Index (see footnote 1) would have revealed no vessel registered in that name. In real life further inquiries would have been possible, but first indications were that Calamity Jane was small, possibly a fishing vessel or yacht. Given two miles visibility, and the gentle to moderate sea conditions that would be associated with a force three wind, a minimum detection range (see footnote 2) of one mile would be appropriate for the first search. The track spacing for the first search would thus be two miles. Other decisions may have been reached, but for comparison purposes a one mile detection range has been assumed for SAR 2.

In SAR exercise 3 the navigational aids available to the participating vessels were radar, direction finding and echo sounding. The primary method of position fixing in the playing area was radio direction finding with soundings to provide confirmation. For brief periods during the exercise each vessel would have been in an area where radar fixes could be obtained. From such fixes a level of confidence in the accuracy of the direction finder fixes could be determined, and the direction and rate

Footnotes:

(1) Lloyd's Shipping Index is a weekly shipping intelligence document listing movements of all registered merchant shipping. Although not officially available to merchant ships most will carry an old copy on board.

(2) Minimum range here is taken to mean the range within which detection of the target by a vigilant lookout should be possible.
of any drift they were experiencing could be assessed. The indication that a vessel was in distress was received by medium frequency radio, and direction finder bearings of the source of the distress could be obtained from each vessel. Plotting the three bearings would have shown that each of the three vessels was about twenty miles away from the distressed vessel. The exact position of the distress was not certain, as, apart from any plotting errors that may have been introduced, the bearings themselves were subject to error. In the event the three position lines cut in the form of a cocked hat (see footnote). From their knowledge of the accuracy to be expected from direction finder bearings, reinforced by their experience during the exercise, students could well have assumed that the cumulative initial position error - that is the error resulting from their plotting an error prone bearing from an uncertain own position - should not exceed three miles. The first search could thus quite reasonably be concentrated on a six mile square search area.

As in SAR 2 the wind was south westerly force three. The opportunity to get good radar fixes as some stage of their passage to the distress position should have indicated a current setting north easterly at a speed of one knot. Indeed as each vessel was equipped with ARPA this information could have been determined in less than a minute without plotting. The alignment of the search should thus again have been north east/south west. As an interval of about one hour would elapse before the participating vessels reached the search area, datum should have been shifted one mile north east from the position obtained, to allow for drift of the target. It is also noted that Denim Patch, a shoal area, lies in a general north east/south west direction just to the east of the distress position (see Annex P). The presence of this navigational constraint also leads towards the adoption of a north east/south west alignment for the search.

The visibility in the area was one and a half miles and the search took place in daylight hours. In this case the area to be searched was small and could have been covered quickly by three vessels. If all three vessels were to be in area at the same time the risk of collision between

Footnote: When three position lines are plotted they often intersect in the form of a triangle. This triangle is known as a 'cocked hat'.

Source: Author
participants had to be considered, and an appropriate plan devised to reduce the risk. With this in mind an assumed minimum detection range of eight cables could have been adopted. This would have given a high probability of location while permitting a track spacing of one and a half miles between vessels. For comparison between exercises an eight cable detection range has been used.

5.1.4 Effectiveness of Search. For courses 3 to 9 the effectiveness of search was determined by plotting the actual and intended tracks of the searching vessels, through the first search area assumed for comparison purposes. On either side and ahead of the track of each vessel, the areas searched at half hourly intervals after reception of the distress, on the assumed minimum detection ranges, were marked out. An example, showing how coverage of the search progressed during SAR 2 on course number 6 appears at Annex R. The information derived from this analysis forms the basis of Table 1 to this chapter, at para 5.3.1.

The effectiveness of the searches conducted by courses 3 to 9 is compared in paras 5.3.1. to 5.5.5. Extracts from the accumulated data is then used in an attempt to explain why success attended some exercises but not others. Such comparisons cannot be made with courses 1 and 2. This is because ship profiles were introduced after the completion of course 2, and the characteristics of the vessels taking part then changed. Instead, a full analysis of the manner in which courses 1 and 2 met the problems posed by SAR 2 and 3 follows. This analysis mirrors, in many ways, the post-exercise debrief that would have followed these exercises.

5.2.1 Course 1 - SAR Exercise 2

Response to Mayday. The Mayday was transmitted on VHF Channel 16 (156.8 MHz) when the three own ships were in positions marked 'B' on the XY plot (see Annex N-1). The initial responses by Antilochus and Fourah Bay, which are given at 113344 and 113449 in Annex K, were good. The extra detail given by both vessels that they were "making all possible speed to your assistance" carried no real information. It was unnecessary as, during a distress, radio traffic on the distress frequency should be restricted to essential communication only. No serious criticism is made though, for the 'intrusions' occupied so little time. Unfortunately, as a result of communications problems, Priam did not
receive the Mayday direct from Calamity Jane. The problem was resolved some three minutes later by Antilochus broadcasting a Mayday relay on VHF and on 2182 KHz, the medium frequency radio telephony distress channel. This was a most professional action on the part of those aboard Antilochus. Doubtless in the real life situation the distress would have been similarly retransmitted on a suitable frequency by the nearest coast radio station.

Exchange of Information. The early exchanges between Antilochus and Fourah Bay, which appear at 113744, 113758 and 113812 in Annex K, were concise and appropriate. In only eleven seconds transmission time it is clear that Fourah Bay is a 5,000 ton coaster making good 15 knots, that she is off Start Point, and that she will be at the scene of the distress at 1200 hours. From this Antilochus will have an outline picture of Fourah Bay and her SAR potential.

Determination of Datum. Datum was not agreed between the vessels responding to the distress. The Mayday relay made by Antilochus would have confirmed that datum was thought to be twenty miles south east of Eddystone, but no attempt was made to convert this geographical position into latitude and longitude. In the event no confusion ensued between the three vessels.

Choice of CSS. As early as 114139, only eight minutes after the Mayday was received, the following signal was made:

"Antilochus this is Fourah Bay, I've had a word with the master and we think it might be a good idea if you take over control of the situation as you are the larger ship and probably have got more men on board than we have at the moment."

The CSS is essentially an extension of, or substitute for, the rescue coordination centre ashore. Size, in that it provides space and a stable platform, and manning levels are very important factors in determining which vessel should be CSS. The thinking aboard Fourah Bay was good, and the post-exercise debrief would have included a discussion on what other factors may have been appropriate in making the choice. Antilochus was slightly hesitant, knowing there must be a third ship in the area, and there was a wish not to assume CSS responsibility until the third ship had been contacted. Later, when Priam had been contacted, Antilochus did in fact assume control, but on the basis that because of
the radio problems existing, she was the only vessel that could communicate with both of the other two. Again this was good thinking.

Search Patterns. At 115600, when still more than four miles away from the position given by Calamity Jane, Fourah Bay advised Antilochus that she was stopped in the position of the vessel in distress, and asked what search pattern she should adopt. Perhaps with undue haste Antilochus replied:

"Fourah Bay Antilochus...can you steer your vessel into a position that I will give you as follows four zero degrees north fifty seven minutes...(got that (from Fourah Bay))...zero three degrees forty nine minutes west...if you could get your vessel into that position I will proceed to the actual position given by the distressed casualty and as soon as we are in that position we will let you know...if you could just keep a look out until then...we will use a straight line search due north two miles and we will work to the east as its a south west wind the drift from that will probably set him towards the shore...work a two mile up to the north two miles east two miles to the south over."

The transmission was rambling, confused, and lasted for one minute seven seconds, yet Fourah Bay surprisingly replied "yes understood." Amongst the many problems with this instruction was the fact that the latitude should have been five zero and not four zero north. The logic behind the two mile leg length would have to be explained at debrief, and Antilochus states she is going to the position given by the casualty, which, if Fourah Bay is already there, as claimed, seems to be duplication of effort. What was good was asking Fourah Bay to go to a clearly, if wrongly, defined position to start her search, and not some vague position such as two miles west of datum.

It is likely that the master of Antilochus was speaking on the radio, and was 'thinking aloud', making up the instructions as he spoke. Such extemporization requires skill, and far better would have been to tell Fourah Bay "Please stand by, instructions will follow."

Further analysis showed that the search speed was to be ten knots, and the reasoning behind this would have been questioned in the debrief. MERSAR suggests that the search should be conducted at the fastest speed of the slowest ship (1). Having a common search speed for all vessels has no value unless they are going to search in formation. If not in formation there is no valid reason to reduce to speeds below the fastest manoeuvring speed for each vessel, unless other factors such as proximity of navigational hazards, risk of collision, or poor visibility make it desirable.
Antilochus later revised the plan stating they were going to use MERSAR search pattern two. This is a two ship search, and initially it did not involve Priam. The message passed to Fourah Bay was:

"...if you take initial track one from that position given to you and run a four mile north...at a two mile interval to the east...and run an eight mile...a four mile track back the track there over...or...run six mile back...come two miles south of his last position...that'll be the best bet there...run an initial one four miles....two miles to the east and six miles back to the north again over."

and the reply was "Antilochus Fourah Bay roger understood out."

The transmission lasted forty seven seconds and was again muddled. The evidence is clear that the plan was not being thought through before being relayed to those having to take action. Confidence and a sense of purpose would not have been spread by this approach to co-ordination.

Later Antilochus made the following signal:

"Forty one...could you both refer to page forty one please....we've decided to alter this search....rather than...the time on the original seems to have been excessive in the visibility...we'll shorten it."

Visibility has a greater effect on the track spacing chosen than on leg length. Obviously if the track spacing has been reduced then it will take longer to search a given area. If time is limited then the search area may be modified by reducing leg length, or leg length and track spacing may remain unmodified and a reduced probability of detection accepted.

Over all there was room for wide discussion on the search planning, and improvements could well have been expected when the same course attempted SAR 3, some sixteen weeks later.

5.2.2. Course 1 - SAR Exercise 3

Response to Mayday. The exercise started at 0926 hours and within three minutes Priam had fixed her own position, obtained a radio direction bearing of the casualty, and commenced a Mayday relay broadcast on VHF giving all relevant details. This response was commendably quick, yet Priam did not alter course towards the casualty for a further eleven minutes, thereby delaying slightly her eventual arrival on the scene. The second ship to respond was Fourah Bay, who gave her position and a bearing of the casualty as soon as Priam had ceased making the initial Mayday relay. Enough information was then available to tentatively fix the casualty's position. The third vessel, Antilochus, did so before entering play at 0933, still only seven minutes into the exercise, with the message:
"Priam this is Antilochus also received Mayday...my position four nine degrees two nine minutes...four degrees five six minutes...DF bearing zero three six...estimate position of distress four nine degrees four five minutes...four degrees three nine minutes...my ETA one zero four zero my course zero three six speed one seven over."

This was not the rambling thinking aloud type signal that had been apparent during SAR 2, but was concise, precise, and clear, showing all the signs of having been thought out and written down before transmission.

Choice of CSS. Priam asked all ships to pass details of their medical facilities and SAR capabilities, and the reply from Antilochus included: "...no doctor on board at present but have one wife who is a nurse," showing that the students were entering fully into the role play of the exercise. Based on no information better than details of lifeboats and medical facilities available, both of which only come into play after a successful search, Priam signalled: "...as we appear to be the closest ship to the scene and have good capabilities for SAR we will assume on scene commander."

Admittedly this exercise was conducted before ship profiles were introduced, and students would not have the same information available as later courses on which to make a proper decision, but this action on the part of Priam can only be described as a take over bid. A check of the relative positions of the three vessels (see Annex P-1) shows that, far from being the closest to the scene, Priam would be the last to arrive. In Priam's favour it has to be acknowledged that her action was positive, that the other two ships made no objection to Priam becoming CSS, and that the subsequent operation was quite well conducted.

Search Pattern. Initially Priam directed each of the other ships to individual start positions for the search, then advised that the search pattern adopted would be from MERSAR as follows:
"...all ships this is Priam, reference the MERSAR manual request you turn to page forty two...operations will be carried out in accordance with search pattern three...search pattern three the three ship search...Fourah Bay will act as the single ship to the east of datum...Priam and Antilochus will act as the pair to the west...stand by for further instructions over."

There is a lot to commend this approach. Ships knew their start position, and the part each was going to play in the search. But it would have been better to refer to the chosen search pattern by the appropriate paragraph number in MERSAR, rather than page, as the printing format does vary from country to country. Priam later advised that the direction of search would be north made good (that is made good over the
ground), at a speed of six knots. As in sea searches both target and surface vessels taking part in the search are on the same plane of reference, namely the surface of the sea, navigation should if possible be relative to that plane and not to the Earth's surface. What was required was true course steered, not made good. No reason was given for searching at six knots, but as the search area was small, visibility was low, and three ships were involved, a reduction of search speed was perhaps justifiable.

Having got the ships into their start positions and on their initial headings a running plot of the progress of the search was maintained aboard Priam. No indication of leg lengths or track spacing was given, instead instructions were passed such as:
"Antilochus this is Priam...request you alter course two seven zero speed six knots over."

This method, almost conning (see footnote) the other vessels by radio, gave Priam a firm measure of control over the search, but doubt must exist whether this would have been acceptable in a live as distinct from simulated situation. Ship masters would wish to believe they maintained some measure of control over their own vessels. Priam's direct control could have been more subtly applied by instructions such as:
"Antilochus this is Priam...request you alter course in five minutes at one zero three six to heading two seven zero and maintain that heading for five miles at six knots over."

The message is longer but it allows the master of Antilochus time to think about what is required of him, and to object if he is not satisfied. Command would then remain in his hands and would not have been transferred effectively to the master of Priam. As it was, the tension inherent in Priam's approach surfaced later during the following exchange of signals:
"Priam this is Antilochus"
"Priam go"
"Antilochus...can you confirm that the search course will be north? over"  "Affirmative search course north"
"Roger Priam this is Antilochus estimate the current to be setting two seven zero at one knot therefore any drift will be to the west over."
"Antilochus this is Priam roger...ten out of ten for observation...if you require to take over as CSS you are quite welcome to do so."

The reaction from Priam was clearly over sensitive and may have resulted from a feeling that they were being criticized, rather than assisted, by a classmate. At sea it would be less easy to personalize as the messages would be passed between strangers joined in a common cause, and advice offered would likely to be taken seriously, considered, and perhaps acted.

Footnote: Conning is the exercise of indirect control over the movements of a vessel.
upon. Tension may grow, but more likely from frustration resulting from negative rather than positive influences. On this occasion while the attitude between participants may have been less than perfect the quality of radio communications was high. Analysis of the pattern of VHF radio traffic reveals that although Priam maintained tight control over the operation this was done with considerable economy. The duration of radio transmissions was only 14.7% of exercise time (see Annex M), compared with 21.8% sixteen weeks earlier when the same course attempted SAR 2 (see Annex L). On the earlier occasion the quality of communications had not been good. The general impression given by the CSS during SAR 2 was one of hesitant uncertainty, but this time the lead given was positive, and capable of engendering an air of confidence amongst those taking part - provided goodwill could be maintained!

As the further intentions of the CSS were not announced, it is not possible to state how the search would have progressed beyond the termination of the exercise at 1120 hours. However a good start had been made and the performance was much improved in comparison with that on SAR 2. It appears that some of the essential lessons had been learned, and perhaps more could have been achieved had the exercises been held not sixteen weeks but one week apart, as was to become the pattern later on. The feeling also exists that those on board Priam may have determined in advance that they were going to take charge and improve on the performance of the class on SAR 2.

5.2.3 Course 2 - SAR Exercise 2

The initial response by all ships to the distress was good, and was quickly followed by a further exchange of information, between the three ships, on their respective positions and estimated times of arrival at the distress position. No discussion took place on confirmation of datum during these early exchanges, although at 1147, by which time all ships had identified each other on radar, Fourah Bay broadcast that she was passing through datum (see Annex N-2). This would have ensured that all vessels were working to a common datum. During the initial exchange of information all vessels gave their positions in geographical form, such as:

"All ships this is Antilochus...we are bearing three four seven degrees twelve miles from Eddystone Rock."

and:

"...my position two zero three degrees eight point one miles from Prawle Point."
This is a recognized method of passing position by radio. It is concise but can be unclear if care is not taken. In both of the cases cited above there is risk of error. Antilochos was not in fact 347° from Eddystone (position 'A' in figure) but Eddystone bore 347° from her (position 'B' in figure), yet either position is geographically possible. Similar ambiguity does not exist in the second example, as the position 203° from Prawle Point is inland, and thus impossible. The problem this time is the choice of geographical position. It had been found on the NC course that the word Prawle can be indistinct over the radio, especially on a foreign tongue. The words Start Point, the next headland, are far more recognizable, possibly because its hard consonants are clearer to the ear. Unless care is taken to ensure that bearings from and not to the geographical position are used, and to select a position that is both well known and clear in transmission, it is safer to send positions by the longer but less ambiguous latitude and longitude method.

Beyond positions and ETAs no further exchange of information took place, and after nine minutes radio silence Fourah Bay advised the other two ships that as she was closest to the scene she considered herself to be CSS. That the selection of CSS was made on such flimsy grounds was possibly because, apart from size and speed, students had no detailed knowledge of their simulated ships. It is also likely that no one was anxious to take the lead, and Fourah Bay stepped on to fill the gap.

As a first step in selecting a search pattern Fourah Bay gave each of the vessels a sector to search, for example: "Antilochos this is Fourah Bay...intend that you patrol the sector from datum position given by the distress vessel as follows...your sector to patrol will be one eight zero to three three zero." Both ships acknowledged their individual instructions but admitted at the later debriefing they did not know what they were supposed to do in their allotted sectors. In the event they had to decide for themselves that Fourah Bay had evolved a plan based on MERSAR pattern 3, although at no time did any vessel refer to MERSAR over the radio. It transpired
that the intent was to manoeuvre all vessels into line abreast and search in formation, with four mile track spacing and an initial leg length ten miles from datum in a northwards direction. The search speed was to be seven knots, and during debriefing it was further revealed that the reduction to this speed was on account of the two miles visibility in the area. But with two miles visibility, and four miles track spacing, much of the area would remain unsearched. Speed was later increased to ten knots, even so, having started the line abreast search more or less at the level of datum it would be a long time before the search reached the southern part of the search area. An inspection of Annex shows that during the manoeuvring into position process the centre of the search area was covered to the point of "overkill". In mitigation it is accepted that when control was taken over all vessels were converging fast on datum, and little time was then available to devise a plan that would have avoided this over concentration of effort.

Communications were generally good, and transmissions lasted only 19.1% of exercise time. On reflection, a higher search speed concentrated on a smaller area, aligned in the direction of drift, would have been more appropriate. This objective was achieved sixteen weeks later when the same students attempted SAR 3.

5.2.4 Course 2 - SAR Exercise 3

The initial response to the distress was made at 1310 hours, six minutes after the start of the exercise. All three vessels had instantly altered course towards the distress, and through the exchange of positions and bearings the datum was agreed at 1318. An exchange of ship's information then took place, mainly concentrating on the medical and life-saving facilities available on each vessel. It was suggested that as Priam was the only one with a hospital she should be CSS. Medical facilities are not a factor normally taken into account in determining which vessel should be CSS, but at 1322 Priam agreed to take control. Thereafter the planning of the search was well conducted. Time was available to devise a search pattern to suit the circumstances so no decisions were made too hastily, and then just as hastily changed. The information passed to Fourah Bay and Antilochus was such that they would have known exactly what their part in the operation was to be, and what part the other vessels were playing. The sequence of events was: at 1334 each vessel was given a position from which their element of the search would commence; at 1347 each vessel was informed that the search...
would be in accordance with MERSAR pattern 3 and that the initial direction would be heading west, the direction of drift; at 1404 Priam announced that she was approaching her start position and was slowing down to allow the others to join the formation; and at 1413 Priam advised that the speed of the search would be 15 knots.

At Annex P-2 it can be seen how these instructions were converted into action. Compared with the conduct of SAR 2 by the same students great improvements had been achieved. Communications were still of a high quality and the duration of radio transmissions amounted to 22% of exercise time. The initial search area was reduced and search speed increased, ensuring that the search would be conducted quickly. The track spacing adopted still matched the visibility in the area, a mistake carried forward from SAR 2, and the selection of CSS could have been made on more valid grounds, but students would have been entitled to feel satisfied with their performance on this occasion.

5.3.1 Comparison of Performance - Courses 3 to 9  The effectiveness of search, determined as described at para 5.1.4, for each of SAR 2 and SAR 3, on courses 3 to 9 is shown in table 5-1 below:

Table 5-1 Effectiveness of Search (% of Search Area Covered by Stages)

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<th>Course number</th>
<th>T+ ¼</th>
<th>T+ ½</th>
<th>T+ ¾</th>
<th>T+ 1</th>
<th>T+ 2</th>
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<td>44.8</td>
<td>21.9</td>
<td>54.0</td>
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<tr>
<td>SAR 3 % of area covered at</td>
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<td>60.7</td>
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<tr>
<td>4</td>
<td>19.4</td>
<td>42.2</td>
<td>73.9</td>
<td>82.5</td>
<td>43.3</td>
<td>62.2</td>
</tr>
<tr>
<td>5</td>
<td>15.7</td>
<td>48.2</td>
<td>72.0</td>
<td>75.1</td>
<td>40.7</td>
<td>80.7</td>
</tr>
<tr>
<td>6</td>
<td>14.7</td>
<td>57.0</td>
<td>72.4</td>
<td>75.4</td>
<td>71.3</td>
<td>88.9</td>
</tr>
<tr>
<td>7</td>
<td>16.7</td>
<td>40.5</td>
<td>58.6</td>
<td>65.1</td>
<td>29.6</td>
<td>59.8</td>
</tr>
<tr>
<td>8</td>
<td>29.6</td>
<td>59.8</td>
<td>67.3</td>
<td>72.4</td>
<td>29.6</td>
<td>59.8</td>
</tr>
</tbody>
</table>

Note (1) Special conditions apply. Students assumed a meteorological visibility of 2.6 miles because they had detected (on radar) a buoy at this range. Coverage was assessed on track spacing of 1.4 miles instead of 0.8 miles to allow for this assumption.

For courses 4, 5 and 6 it was possible to determine for SAR 2, from the information available, how the search would progress up to three hours after reception of the Mayday (time T in table). But for the remaining four courses the coverage of the search area can only be calculated up to T plus two hours. T plus two hours is thus the latest time at which
comparison of performance between courses on SAR 2 can be made. Similarly, for SAR 3 T plus 3 hours, where T is the time of exercise commencement, is the latest time for comparison between courses. These comparisons are made in Table 5-2 below. The negative and positive values appearing in columns (b) and (c) are measures of the difference between the area covered and the average area covered, see Table 5-1, expressed as a percentage of the average. The legend 'better' or 'worse' appearing in column (d) indicates whether, compared with the average coverage achieved, the general performance of each course on SAR 3 was better or worse than on SAR 2.

Table 5-2. Comparison between Area Coverage on each course with Average Area Coverage.

<table>
<thead>
<tr>
<th>(a)</th>
<th>SAR 2 at T+2 hours</th>
<th>(b)</th>
<th>SAR 3 at T+3 hours</th>
<th>(c)</th>
<th>SAR 3 v SAR 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>%⁻</td>
<td>%⁺</td>
<td>%⁻</td>
<td>%⁺</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>31.2</td>
<td>16.2</td>
<td>Better</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1.7</td>
<td>46.3</td>
<td>Worse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>28.1</td>
<td>11.0</td>
<td>Better</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2.6</td>
<td>25.6</td>
<td>Worse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>26.7</td>
<td>33.6</td>
<td>Better</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>15.4</td>
<td>16.2</td>
<td>Better</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>15.8</td>
<td>26.6</td>
<td>Better</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition to obtaining a measure of whether there was any improvement in performance during each course, the courses can be compared with each other by placing in rank order the coverage achieved at T + 2 hours, for SAR 2, and at T + 3 hours for SAR 3. These ranking are given below in Table 5-3.

Table 5-3. Comparison between Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>SAR 2</th>
<th>SAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Coverage at T+2</td>
<td>Rank</td>
</tr>
<tr>
<td>3</td>
<td>44.8%</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>64.0%</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>46.8%</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>66.8%</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>82.5%</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>75.1%</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>75.4%</td>
<td>2</td>
</tr>
</tbody>
</table>

From Table 5-3 it appears that performance tended to improve on the later courses under assessment. Although no conscious changes were
made to course content during the period of investigation, the teaching style may have improved as the course progressed.

5.4 Factors Affecting Success or Failure in SAR 2

5.4.1. Selection of CSS. The exercise was designed so that either Bigbury or Cornwood should become CSS. The third vessel, Flushing, was small, having limited bridge space and equipment, and only a fourteen man crew. She was thus not well suited to take on the task of co-ordinating the search. The actual facilities available on the simulator vary little from ship to ship, but, on each of courses 3 to 9 it, was possible to ensure that Flushing had only two students aboard rather than the usual simulator manning of three students per ship. It was hoped this would strengthen the feeling that Flushing had limited resources. Five of the seven courses under consideration included overseas students, and on four courses it was possible to man one ship with students not having English as their mother tongue. This factor could also have influenced the decision on which ship should act as co-ordinator. Details relating to the selection of CSS are given in Table 5-4 below.

Table 5-4 Selection of CSS - SAR 2

<table>
<thead>
<tr>
<th>Rank</th>
<th>Course Number</th>
<th>CSS</th>
<th>Reasons for Selection</th>
<th>Selection made at</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>Bigbury</td>
<td>I'm one of the closer ships</td>
<td>T+19 min</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>Bigbury</td>
<td>Cornwood suggests Bigbury as being closer, Flushing not asked, but steaming away in error</td>
<td>T+9 min</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>Bigbury</td>
<td>I've a hospital and rescue boat</td>
<td>T+9 min</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>Unclear</td>
<td>Decision not clear but lead taken by Bigbury (1)</td>
<td>T+25 min</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>Bigbury</td>
<td>Not revealed (2)</td>
<td>T+13 min</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>Cornwood</td>
<td>No reason given (3)</td>
<td>T+36 min</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>Cornwood</td>
<td>Earlier ETA and better equipment</td>
<td>T+43 min</td>
</tr>
</tbody>
</table>

Notes:

(1) At T+25 minutes Bigbury signalled Cornwood: "we and the vessel Flushing are more or less in the position of the distress now....what I suggest is that we start a search from datum and you stand by at a distance to render any assistance over."

Cornwood agreed. Later Cornwood suggested that the search area was too large, and Bigbury agreed. Cornwood commenced a square search of her
own design on reaching datum, advising Bigbury of her intentions. Flushing, with a German crew, was effectively being conned directly by Bigbury. At the debrief Bigbury's captain said he thought Cornwood was CSS, while Cornwood's captain said he thought it was Bigbury. Flushing only knew that CSS was not her!

(2) At T+13 minutes Flushing suggested that Bigbury should be CSS, without giving any reasons. Bigbury accepted the suggestion without any reference to Cornwood. At debrief Flushing stated: "We looked at the file (ship's profile)...and thought we are not suitable because we have a very small crew....Bigbury was coming on strong with her information... nice big ship...large crew...we'd let them do it."

(3) At T+36 minutes Cornwood signalled: "....I suggest that Cornwood now assumes co-ordination of the surface search....following page forty two of MERSAR book....if you maintain your present track and take up track three there and I shall take up track one and Bigbury to the north and west can take up track three...Bigbury and Flushing confirm over."

In every case it was correctly concluded that Flushing should not be CSS, and, from note (2) above, there is evidence to suggest that Flushing's exclusion was being made on valid grounds. This apart, the deciding factor appears to have been time of arrival at the scene of search. On the two occasions when Cornwood became CSS the decision was taken late into the exercise. Cornwood took control on course number 5 at a time when Bigbury, with a German crew, was steaming away from the distress towards an incorrect datum. On course number 3, when Cornwood also took charge, it was Flushing that had been steaming away from the scene towards an incorrect datum. A number of close quarter situations had developed between Bigbury and Flushing (see Annex N-3), and as a result, despite starting the exercise further away from the distress than the other vessels, Cornwood was first on the scene.

The reasons for Bigbury taking control on course number 8 are invalid. Having a hospital and rescue boat may become significant when successful search becomes rescue, but during the search phase of the operation such facilities have no part to play.

Regardless of how the selection of CSS was made the timing of the decision appears to be important. The ships start SAR exercise 2 within a short steaming distance of the distress position given, and all three ships will be on the scene in under one hour. The earlier the decision is taken the more time will be available to the CSS for planning before the search begins. In the more successful exercises the decision was generally taken earlier than in the less successful. It is not just that the early decision allows more time for a workable plan to be developed, a further element was detectable from listening to the recordings of
Regardless of how the CSS was selected, when one vessel takes a positive lead in becoming CSS, rather than having the task 'wished' upon them by others, it can indicate that they feel they have the required organizational and leadership qualities aboard to successfully carry out the task. Other vessels respond well to positive leadership. Confidence engenders success. In each of the two least successful exercises responsibility fell to Cornwood late in exercise play after errors on the part of other vessels. Uncertainty was already present, and this can presage failure.

5.4.2 Quality of Communications. The main, and often only, link between vessels taking part in SAR operations is by radio. Over a limited sea area this will normally be by voice on VHF radio telephony and, although fully trained radio officers may perform this task during SAR incidents, often communications will be in the hands of the master or a bridge watchkeeper. Many watchkeepers hold a restricted R/T certificate and should be aware of good and poor communications procedures, but in practice the quality of communications can vary widely. If communications from the CSS are conducted in a proper professional manner others are likely to regard it as evidence of competence. Confidence can result, which in turn is more likely to lead to a well conducted search rather than the frustration and uncertainty attendant on poor communication practices. An analysis of the pattern of communications during SAR 2 appears in Table 5-5 below.

Table 5-5 Analysis of Communications SAR 2

<table>
<thead>
<tr>
<th>Rank</th>
<th>Course</th>
<th>Duration</th>
<th>Longest</th>
<th>Number</th>
<th>Number</th>
<th>Average</th>
<th>Overseas</th>
<th>Number</th>
<th>Number</th>
<th>Average</th>
<th>Overseas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>as % of</td>
<td>seconds</td>
<td>&gt; 20 s</td>
<td>&gt; 40 s</td>
<td>seconds</td>
<td>students</td>
<td></td>
<td>present(1)</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>32</td>
<td>52</td>
<td>12</td>
<td>2</td>
<td>7.1</td>
<td>German</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>25</td>
<td>26</td>
<td>4</td>
<td>0</td>
<td>4.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>27</td>
<td>38</td>
<td>10</td>
<td>0</td>
<td>6.8</td>
<td>Bangladesh</td>
<td>4</td>
<td>2</td>
<td>7.8</td>
<td>German</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>35</td>
<td>45</td>
<td>18</td>
<td>2</td>
<td>7.8</td>
<td>German</td>
<td></td>
<td></td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>22</td>
<td>35</td>
<td>3</td>
<td>0</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>31</td>
<td>44</td>
<td>10</td>
<td>2</td>
<td>6.3</td>
<td>German</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>19</td>
<td>27</td>
<td>4</td>
<td>0</td>
<td>5.9</td>
<td>Hong Kong</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note(1) All courses included UK students, where including students from countries having a mother tongue other than English this is indicated.

On the simulator only one radio frequency was normally worked by vessels taking part in the SAR exercise. This is a simplification of the live
situation, where the CSS would normally maintain watch on the distress frequency whilst co-ordinating the search on a separate scene of search frequency. With a uniquely designated search frequency SAR traffic will not interfere with non-SAR communications. In theory therefore, there is no restriction on the volume of traffic on the search frequency, but in practice concise rather than continuous communications are required. It is noted that on each of courses 5, 6 and 7, at least one of those using the radio was an overseas student. On these three courses the overall duration of radio traffic was longer than on the remaining courses, but a study of the transcripts reveals that the extra traffic was only partially attributable to the Germans having to communicate in a foreign language. Indeed, the need to think carefully before transmitting can contribute towards brevity and economy in words, and certainly the incidence of irrelevant chatter is reduced. As an example, on course number 5, the German crewed Bigbury passed this clearly pre-prepared message: "Cornwood this is Bigbury my position is now one four one from Eddystone range nine miles...I am on course one eight zero over." Even when engaged in semi-conversational exchanges the quality of communication from the German students remained reasonable, though choice of words became more difficult. An example is the following exchange between the German manned Flushing and Cornwood on course number 6: "This is Flushing I think we are closest on...the closest now to the distress place...what do you recommend which I can....I have to understand the search pattern can you repeat it?" Cornwood replies "Yes Flushing...Bigbury suggested you do a parallel search track...do you have a copy of MERSAR over?" "Yes I have it on my table...the MERSAR at page forty one I recognize it and agree with you...should I assistance with you or who is the leader?" Cornwood replies to Flushing: "Yes if you would keep in touch with Bigbury he will be following the search track with you...it is pattern two...parallel search pattern two for two ships...I will move into the datum position when you have taken up your search over" Flushing replies: "With that I agree with you and I will wait for Bigbury to come in touch with me here."

This exchange would doubtless have been shorter, or even unnecessary, had all three ships shared a common language, for then the initial uncertainty on the part of Flushing would be less likely. Cornwood's final transmission in the exchange lasted 25 seconds, providing a good illustration of how conversation, rather than communication, lengthens transmission times as the operator searches for words rather than reading from a prepared text. It will be seen in Table 5-5 that the same three courses, namely 5, 6 and 7, were the only courses to include individual transmissions exceeding forty second in length. Each one of those transmissions was made not from a German ship, but from a ship having a British master and a German
navigator. In every case the master was performing the communications task, and the effect of thinking during rather than before transmission is evident. A particular example occurs in the initial exchange of ship information during course number 7, when the master of Cornwood radioed: "Yes thank you...I've got all that...my particulars...I'm a container ship...my minimum speed is four knots and my complement is thirty five...I have a hospital for four people...height of eye twenty six metres...I have one true motion radar...I'm a container ship of eighteen thousand two hundred and fifty tons...hello Bigbury this is Cornwood...could you give me your ETA please?"

This transmission lasted 52 seconds and can only be described as rambling. In fairness, in part, it is possible that the student was not confident on exactly what details he should have been passing, and the need to have a standard format for exchange of ship information has been expressed earlier (see para 4.3.19). But had the master first written down just what he wished to say, the message would have been both more concise and more precise.

The least successful attempt at SAR exercise 2 was by course 3. This course also made fewer and briefer radio transmissions than the others, but this can, in part, be attributed to the delay in determining which vessel should act as CSS, see Table 5-4. There were long periods of radio inactivity, while no vessel appeared willing to take the initiative. On course number 4 the decision regarding CSS was taken early in the exercise but the volume of radio traffic was still very low, and only three transmissions lasted longer than 20 seconds. On this occasion the radio operators were working from prepared notes or messages, and on no ship did the master conduct communications. A typical exchange of information during course 4 follows:

<table>
<thead>
<tr>
<th>Time</th>
<th>Text</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>164248</td>
<td>Flushing Flushing this is Cornwood Cornwood on channel one two over</td>
<td>4 sec</td>
</tr>
<tr>
<td>164253</td>
<td>Cornwood Flushing good afternoon I am a four thousand ton container vessel four thousand ton container vessel I have a small crew...a good lookout at fifteen metres above sea level...and two inflatable boats over</td>
<td>18 sec</td>
</tr>
<tr>
<td>164312</td>
<td>Received that could you repeat your height of eye please over?</td>
<td>3 sec</td>
</tr>
<tr>
<td>164316</td>
<td>Cornwood Flushing my height of eye one five metres one metres over (fifteen as given previously can be read as fifty!!)</td>
<td>3 sec</td>
</tr>
<tr>
<td>164320</td>
<td>Yes received that we are a twenty thousand ton container vessel...the speed twenty knots...out present position fourteen miles south south west of Eddystone over</td>
<td>13 sec</td>
</tr>
<tr>
<td>164334</td>
<td>Roger Cornwood Flushing received</td>
<td>2 sec</td>
</tr>
<tr>
<td>164338</td>
<td>All ships responding to Mayday this is motor vessel Bigbury how do you read over?</td>
<td>6 sec</td>
</tr>
<tr>
<td>164345</td>
<td>Bigbury this is Flushing go ahead</td>
<td>1 sec</td>
</tr>
<tr>
<td>164347</td>
<td>Yes good afternoon Flushing this is Bigbury we are an eighteen thousand ton general cargo ship we have a large crew we are well equipped with a hospital our ETA at the</td>
<td></td>
</tr>
</tbody>
</table>
Once again it is noted that the initial information given by each vessel varied considerably in content, further emphasising the need for a degree of standardization, but the message from Bigbury at 164347 is both detailed and brief. Overall the communication on course number four had an air of intent rather than of improvisation, and there was further evidence of an organized approach. First, a Mayday Relay (see footnote) was made, and second, before Flushing reversed her track from southwards to northwards at 1732 (see Annex N-4) she radioed her intentions so that Bigbury, some two miles astern, should not be embarrassed by this sudden manoeuvre.

A further advantage of signals being written down before transmission, over an *ad lib* approach, is that a record of the communication remains. When communication becomes conversation a record seldom remains.

It may appear anomalous that the communications on course four were so good, and yet the course achieved only fifth ranking in the comparison of effectiveness. But inspection of table 5-1 reveals that by $T + 3$ hours, one hour after the comparison point, on the evidence available the course would have leapt into first place.

5.4.3 Determination of Datum. Any doubts regarding the position given by the distressed vessel in SAR 2 could well emerge if a Mayday Relay is sent early in the exercise. This was done on course number five, when Cornwood made a Mayday Relay, giving the correct position of the distress, sixteen minutes after the original Mayday had been sent. The Mayday Relay on course number four was made fifty six minutes after receipt of the distress, certainly too late to play any part in the determination of datum. The only other course to think about a Mayday Relay was number six, when Cornwood, who may or may not have been CSS (see Table 5-4), announced that she had sent a Mayday Relay on R/T and W/T and there were no other ships in the vicinity. But this was an exercise artificiality on her part, no message actually being sent.

Students were briefed, and knew they were taking part in a SAR exercise before entering their own ship booth and, having fixed their vessel's position, they should have been waiting for an indication from some source that a vessel was in distress. Calamity Jane twice gave her position as being "two zero miles south east of Eddystone" before breaking off her transmission, yet this position was misunderstood more than once.

Footnote: A Mayday Relay is a transmission by a vessel not in distress either repeating the original Mayday from the distress vessel, or reporting a distress.
On course number three Flushing thought the position was two miles south east of Eddystone. In heading for this false datum she became involved in a series of close quarters situations with Bigbury (see Annex N-3), but Bigbury failed to question why Flushing should be heading in the wrong direction. It was left to Cornwood to correct Flushing, and this not until 35 minutes after the Mayday.

On course number seven, the most successful course in the comparison at Table 5-1, there was considerable confusion regarding datum, as the following exchanges show:

"Bigbury this is Flushing can you please repeat the position of Calamity Jane?" (This request was made only seven minutes after receipt of the Mayday, so any doubt was quickly resolved)

"Yes sir...Flushing this is Bigbury the Mayday position of Calamity Jane was twenty miles south of Eddystone...twenty miles south of the Eddystone over."

"Twenty miles south of the Eddystone thank you over."

"Bigbury Bigbury Bigbury this is Cornwood Cornwood Cornwood come in please twelve."  "Cornwood Cornwood this is Bigbury Bigbury over."

"This is Cornwood...could you confirm that the distress position was twenty miles south and not south east of the Eddystone over?"

"Flushing (should have been Cornwood) this is Bigbury you received it as twenty miles south east of Eddystone is that correct over?"

"Yes that's what I received over."

"Yes very good sir I think it's our mistake twenty miles south east it is then." Three minutes later Bigbury advised Flushing the correct datum.

On course number five there was disagreement aboard Flushing over whether the position of Calamity Jane had been given as two or two zero miles south east of Eddystone, and confirmation was sought from Cornwood at an early stage in the exercise. Following this request from Flushing, Cornwood made a Mayday Relay, and yet Bigbury, who had also mistaken the datum, continued to head towards the wrong position for a further forty minutes!

On course number nine Flushing was again making for a position two miles south east of Eddystone. Some twenty two minutes after the Mayday, with the CSS already nominated (see Table 5-4), Flushing advised the CSS that she had detected a target on radar two miles south of Eddystone in the approximate distress position. Bigbury, the CSS, acknowledged without questioning the position, and despite the fact that it must have been clear from Bigbury's radar plot that Flushing was going in the wrong direction. When Flushing was later given instruction for the search she again revealed her confusion by stating that in following the instructions she would be steaming away from (the wrong) datum point. Again Bigbury failed to confirm datum. Eventually a compliant but still confused Flushing asked Bigbury for the latitude and longitude of datum. This unequivocally defined datum.
The precise latitude and longitude method of defining datum was again used on course number eight, when it became clear to the CSS that she and another vessel were not working to the same plotted position. Analysis of the communication transcripts shows that on courses 5, 6 and 7 there were also small differences existing in the charted data being used by participating vessels. These remained unresolved.

From the above it appears that a pattern may have existed as Flushing mistook the position of datum on three of the seven courses. But radio communication remained otherwise satisfactory throughout and it is known that no fault existed on Flushing’s equipment. There is no obvious reason why Flushing should have had this difficulty other than her being manned by two rather than the normal three students. When there are three students in a booth one may be given the task of communicator, and another the task of navigator, by the captain. The two student ship would not have had this luxury. This possible reason is re-inforced by an event during course number six, when Cornwood, also with only two students aboard, asked Bigbury to confirm the datum as “there is some disagreement aboard our vessel”

While it is not possible to attribute the success of any particular course to the fact that they had defined datum at an early stage in the exercise, it is possible to affirm that the lack of success on courses three and five was in part due to confusion over an unconfirmed datum.

5.4.4 Search Pattern Adopted. An analysis of search patterns adopted appears in Table 5-6 below:

Table 5-6 Analysis of Search Patterns SAR 2

<table>
<thead>
<tr>
<th>Rank Number</th>
<th>Course Pattern</th>
<th>Track Spacing</th>
<th>Leg Length</th>
<th>Speed</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Original</td>
<td>3M</td>
<td>6M</td>
<td>Full</td>
<td>Worked out from middle</td>
</tr>
<tr>
<td>2</td>
<td>3 ship square</td>
<td>2M</td>
<td>Various</td>
<td>15kts</td>
<td>Success due to chance</td>
</tr>
<tr>
<td>3</td>
<td>Original</td>
<td>3M</td>
<td>Various</td>
<td>15kts</td>
<td>Each vessel given sector</td>
</tr>
<tr>
<td>4</td>
<td>MERSAR 2 ship</td>
<td>2M</td>
<td>10M</td>
<td>5kts</td>
<td>Ships in plus square line</td>
</tr>
<tr>
<td>5</td>
<td>MERSAR 3 ship</td>
<td>2M</td>
<td>10M</td>
<td>10kts</td>
<td>No line up</td>
</tr>
<tr>
<td>6</td>
<td>MERSAR 3 ship</td>
<td>2M</td>
<td>24M</td>
<td>12kts</td>
<td>No line up</td>
</tr>
<tr>
<td>7</td>
<td>MERSAR 3 ship</td>
<td>3M</td>
<td>?</td>
<td>3kts</td>
<td>Attempt to form line abreast</td>
</tr>
</tbody>
</table>
It was reasoned at para 5.1.7 that a suitable first search in SAR 2 could concentrate on an area 10 miles square, centred on datum, and aligned north east/south west. The limits of such an area appear on each of the reproduced plots at Annex N 1-9. In the visibility prevailing a track spacing of 2 miles would be appropriate, and the leg length would depend on the geometric form of the adopted search. If students adopted the parallel track search pattern for 3 ships given in MERSAR, then a leg length of 10 miles would be satisfactory. MERSAR states that the search should be conducted at the fastest speed of the slowest ship, but this presumes that all ships are searching in formation. In the exercise case there is no merit in delaying the start by manoeuvring all participants into formation, as this would unnecessarily prolong the time required to search the area.

An inspection of Table 5-6 reveals that course number 4, although ranked only fifth in order of effectiveness of search, most closely compares with the suggested search pattern. Reference to Annex N-4 shows an effective search is developing however, and as shown in Table 5-1, by T+3 hours, on the evidence available, course number 4 would have leapt into first place. But speed of search is an important factor, and the efforts of course number 4 would have been improved had the search been aligned north east/ south west, had ship speeds been faster than the 10 knots chosen, and had there been less duplication of search effort about search datum. However, the results achieved provide evidence that a search area will be effectively covered if the guidance of MERSAR is intelligently followed.

On course number 3 it was claimed that a parallel track search pattern for 3 ships in accordance with MERSAR was being adopted. Admittedly 43 minutes elapsed between receipt of the Mayday and 'selection' of the CSS, but a further 40 minutes passed before the exercise was terminated with no proper search pattern emerging. By the end of the exercise the CSS was steaming away from the area at a speed of 11 knots while the other two vessels were searching line abreast at 3 knots. Apart from the late and ineffective 'selection' of CSS, this exercise was complicated by a mistaken datum, see page 102 and Annex N-3, and by the resulting collision avoidance problems.

The parallel track search patterns illustrated in MERSAR are all drawn up and down the page. The illustrations carry a pecked arrow pointing to
the top of the page but labelled *direction of drift*. Despite this guidance, it has been noticed that when following MERSAR search patterns students have a tendency to adopt a north/south alignment of search, matching the up and down the page illustrations given. On each of courses 4, 5 and 6 the parallel track search was north/south whilst on course number 3 the alignment was east/west. At the post-exercise debrief the CSS was unable to state why he had chosen this alignment, and was also unable to state how he saw the search developing. The failures of course number 3 cannot be attributed to the search pattern however, but are linked to lack of communication and co-ordination.

It was on course number 6 that it was uncertain which ship was CSS (see Table 5-4). Reference to the plot at Annex N-6 shows that the 2 ship parallel search being conducted by Bigbury and Flushing would, in time, effectively cover the search area. The problems of alignment and too slow a search speed identified on course number 4 recurred, and there had also been needless delay while the two ships got into line for the search. At T+2 hours this search was marginally more effective than that of course number 4, but this was chiefly due to the over-lapping modified square search being conducted by the third ship, Cornwood, at a faster and more sensible speed. The over-lapping was really a wasteful duplication of effort, and perhaps would not have happened had there been proper co-ordination.

Apart from course number 4, the only course to follow fully a MERSAR search pattern was number 5. On that occasion the track spacing was good, search speed was reasonable, and time was not wasted getting the vessels lined up in formation. This last benefit possible accrued because Bigbury initially mistook datum and steamed away from the search area. The vessels were subsequently too widely separated to justify manoeuvring into line in the limited exercise time available. Where the adopted search pattern failed was in the decision of the CSS to continue the search legs 12 miles north and south of datum.

The most successful search attempts, by courses 7, 8 and 9, had a number of common factors that contributed to their success. Most obvious, and clearly revealed in the plots at Annexes N 7-9, was that the search patterns adopted were original and were not taken from MERSAR. In each case there is the suggestion that a realistic search area had been determined, and that the available vessels were then used to best effect.
to search that area. Each of the search patterns adopted tended to work outwards from the middle of the search area. This approach will clearly ensure that good coverage is achieved in the early stages of a search. In practical terms this is very important, for not only are search units generally more alert and efficient at the early stage of their involvement in a search, but the chance of finding survivors decreases rapidly with time (3). Finally, on each of the 3 searches, vessels were working at, or near, full speed.

On course number 7 there was some small attempt to align the search in the direction of drift. In their approach to datum, Bigbury and Flushing had partially covered the north east sector of the search area, and the subsequent plan involved the 2 ships working outwards to search the south west and south east sectors respectively. This left the northern part of the search area to be covered by Cornwood, her greater speed compensating for having a larger area to search. A track spacing of 3 miles was chosen, rather than the 2 miles recommended at para 5.1.3, and the effectiveness of search was further reduced by Bigbury over-running an alteration of course position by one mile. This error resulted in a track spacing of 4, rather than 3, miles on the subsequent leg. Errors of this type are best avoided by converting distance to run into time. Most watchkeepers are better clock watchers than log watchers (see footnote), and will find it easier to alter course at 1527 hours, for example, than when the log reads 327.4 miles.

On course number 8 the search area was again well defined in the mind of the CSS, and the allocation of sectors of the search area to individual ships was identical to that on course number 7. On this occasion no attempt was made to align the search in the direction of drift.

As stated in Table 5-6 the success achieved on course number 9 was in part due to chance. As Flushing initially headed towards an incorrect datum her track first crossed that of Bigbury and then diverged from it. By the time the error was detected and rectified the 2 vessels were sufficiently far apart to ensure they did not have over-lapping, and wasteful, search widths. On the positive side it is noted that the track spacing for the search was to be 2 miles, again ensuring good coverage, but the unusual 3 ship square search pattern evolved would, as the

Footnote: The log mentioned here is an instrument used to measure the distance travelled, in much the same way as an odometer on a car.
search pattern progressed, introduce extensive overlapping and wasteful duplication of effort, as shown below.

Figure 5-2  Three Ship Square Search

**Source:** Author

Figure 5-2 shows how a 3 ship square search formation may be expected to develop. All areas subjected to a duplicate search have been shaded in. This pattern has good early coverage but then becomes wasteful. It is also difficult to control and can be confusing for participants.

5.4.5 Control of Search. No matter what search pattern is chosen by the CSS for a co-ordinated search, it will be necessary for each participating vessel to be advised what part she has to play. The CSS should then monitor progress of the search so as to ensure that the plan is being followed. If the search area is large the monitoring process may involve each search unit reporting her position and progress at regular intervals. If the search area is small, it should be possible for the CSS to monitor the search on a true motion radar plot, using a
different colour pencil on the radar's reflection plotter to mark each participant's progress.

Should a readily recognizable search pattern from MERSAR be chosen each vessel will wish to know her start position, the initial course direction, leg length and track spacing. An example showing how these objectives were met on course number 3 follows:

"Bigbury Cornwood we intend to search the area using search pattern three as described on page forty two of MERSAR....over"
"Yes sir understood page forty two MERSAR pattern number three over"
"That's correct...we would like you...to take the datum line which is indicated on that page as track one over"
"Yes understood sir track one"
"Roger the datum is to be the distress position over"
"Yes understood sir"
"And the spacing between tracks is to be three miles...the space indicated in the book is four miles...amend this..we want three miles over"
"Yes sir three miles over"
"The search direction is oh nine oh two seventy...over"
"Yes sir oh nine oh two seventy over"
"That's all the information we have for you at the moment except to remind you to search at the lowest speed possible for the search over"
"Yes understood sir...just one question where would you like us to start our track search over?"
"From the datum point...if you continue to datum point and start the search from there"

These instructions were very explicit and clearly understood. The only area where doubt may have existed is regarding the use of datum instead of an unambiguously defined position using latitude and longitude. We have seen earlier (see para 5.4.3), and it is noted from the track plots at Annexes N & P, that ships often have differing ideas of just where datum lies unless it is clearly defined.

Cornwood then went on to advise Flushing, in similar fashion, that she should take up track 2 commencing from a position 3 miles north of datum, while Cornwood herself would take up track 3 from a position 6 miles south of datum. Doubtless in time Cornwood, as CSS, would also have advised the other two vessels what leg length was required. Unfortunately it will be seen from Annex N-3 that the intended plan was only partially developed.

When the proposed search pattern is not one taken from MERSAR then some other method has to be used to inform each vessel what part they have to play. An example of how this may be done is provided by course number 7, during which Bigbury passed the following instructions to Cornwood:
"Cornwood Bigbury have you got datum point marked on your chart?"
"Yes we have the datum point marked on the chart" 
"You confirm it is twenty miles south east of Eddystone is that correct over?"
"Yes confirmed twenty miles south east of Eddystone"
"Yes roger that...well when you pass north of datum on your present course of zero nine zero if you proceed for three miles further and then alter course to zero zero zero and make that track spacing three miles...and then come back round to two seven zero degrees for six miles sweep length...and proceed like that sweeping to the north"

Perhaps the choice of words could have been improved, and the executive instruction, which lasted 36 seconds, could have been broken down into elements similar to the pattern of communication used by Cornwood on course number 3 (see page 100), but on this occasion Cornwood clearly understood what was required of her.

Once the search has commenced it is possible, for the CSS to adopt a conning approach, provided she is continuously monitoring the other ships' progress. An example of this, also taken from course number 7, follows:

"Flushing Bigbury...just to confirm..you've got approximately another eight minutes on your present course before you come round to one one zero...I estimate at seventeen forty eight you should come round over"

Flushing had already been given details of her future courses and distances in much the same way as had Cornwood above, and Bigbury was just ensuring that her plan was being followed.

The fact that on course number 7 the CSS exercised such tight control over his colleagues doubtless contributed to the overall success of the search. It was a pity this success was slightly blemished by the failure to exercise such tight control over her own movements, in over running her own alteration of course position by one mile!!

5.4.6  **Conclusions on SAR 2**  Action taken to avoid collision should be positive, taken in ample time, and in accordance with good seamanship (4). In other words the action should be professional. It is not surprising that in successful search, which may be considered the reverse of successful avoidance, action again needs to be professional. The analysis above shows omission rather than commission to be the main cause of lack of success. The following points emerge:

(a) Early positive action, in particular early selection of CSS, was a characteristic present in the more successful exercises but missing from the less successful.
Failure to reach early agreement on the datum to be used for the search contributed to the lack of success on two occasions.

Lack of communications tended to indicate lack of action rather than exercise of positive control. Communication discipline was a feature of the more successful exercises.

Innovation, in evolving a search pattern to suit the circumstances rather than simply following the guidance of MERSAR, was a feature of the more successful exercises.

5.5 Factors Affecting Success or Failure in SAR 3

5.5.1 Selection of CSS

The exercise was designed so that either Advent or Dousland should be CSS. Both were British according to the ship profiles while the third vessel, Ermington, was Spanish. In the event students chose to ignore the exercise artificiality and take note of exercise reality, when one or more of the vessels was manned by overseas students. As a result Ermington became CSS on 5 of the 7 courses. On the occasions when Ermington was not CSS she first had a Hong Kong Chinese master with one UK watchkeeper, and second a UK master with a German watchkeeper. On both of these occasions Dousland, with three UK students on board, became CSS. Details relating to the selection of CSS are given in Table 5-7 below:

Table 5-7 Selection of CSS SAR 3

<table>
<thead>
<tr>
<th>Rank</th>
<th>Course Number</th>
<th>CSS</th>
<th>Reasons for Selection</th>
<th>Selection made at</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>Ermington</td>
<td>Language and manning levels</td>
<td>T+24(1)</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>Ermington</td>
<td>Communications problems on other vessels</td>
<td>?</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>Ermington</td>
<td>We are best equipped</td>
<td>T+37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dousland</td>
<td>Earlier on scene</td>
<td>T+43</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>Ermington</td>
<td>Most manoeuvrable</td>
<td>T+26</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>Dousland</td>
<td>First on scene</td>
<td>T+23</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Dousland</td>
<td>Due to nature of distress!!</td>
<td>T+24</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>Ermington</td>
<td>Volunteered for task</td>
<td>T+15</td>
</tr>
</tbody>
</table>

(1) Note: T is time when exercise commenced.

An indication of how the presence of overseas students on some courses influenced the decision is apparent in the following extract from communications during course number 7:

"Dousland Ermington sorry to bother you in the middle of your thing (Dousland had just radioed that she was checking her position) but I feel that one of the three ships ought to take control (this was 25
minutes into the exercise) I'm in two minds whether or not it should be us...we've got three men on the bridge at the moment...our bridge gear is the same as yours and I think we speak the same language whereas Advent is a German I think...it would be best if one of us took over...you're the closest and you are also bigger than we are over."

Further information on ship capabilities followed then from Dousland:

"Roger that well it's a toss up...you have three men on the bridge and I assume that you have no experience of distress and certainly I have no experience...I think if one of us takes over...I'll be...as you say...there before you and we should be able to arrange something so I start a search pattern and you join in over" Ermington replied "Roger I got all that...well in the circumstances I think we'd better assume command as it were from this bridge and we'll let you know from here what to do over" Dousland answers "Yes roger three men is handier than two...."

Once it had been decided that Ermington was British, and not Spanish as the exercise setting assumed, and similarly that Advent was German and not British, the reasoning was sound. It is also clear that the exchange was between the masters of the two vessels, and that the master of Ermington felt the need for a decision to be made but was 'sounding out' his opposite number aboard Dousland before taking over control of the search.

Whereas on SAR 2 it was important that an early decision was taken on which vessel should be CSS, on SAR 3 there was less urgency. On 4 of the courses the decision was taken at approximately the same stage in the exercise. The interval then remaining between adoption of CSS and arrival at the scene of search was long enough for a proper plan to be evolved and put into action. Indeed on the one occasion when the CSS decision was taken significantly earlier, that was on course number 4, it worked to disadvantage. The coverage achieved on course number 4 fell far short of that achieved on any of the other 8 courses. This is discussed at para 5.5.4. On course number 8 a change of CSS occurred when it became clear to those on board Dousland that Ermington was not in control of the situation. Ermington, possibly influenced by there being no positive lead from the other two vessels, arbitrarily took charge at T+37. An exchange of positional information then revealed that Ermington had been steaming away from the distress for the previous 40 minutes, a fact that destroyed any confidence Dousland had in Ermington's ability to co-ordinate the search. It was politely suggested from Dousland that as they were closer to the incident they should take over, and a relieved master on Ermington readily agreed. Even with this late decision there was still ample time to organize an effective search, as Table 5-1 indicates. It is also noted that on course number 8 the
eventual CSS, Dousland, was manned by 2 UK students, while Ermington had a UK master and Bangladeshi navigator and the third vessel was manned by 2 Bangladeshis. Given this manning it is a little surprising that Dousland did not take a positive lead earlier.

Unfortunately the radio traffic on course number 9 was not recorded, but the post-exercise debrief revealed that, because of equipment defects, Ermington was the only vessel able to communicate with each of the other two. That Ermington should become CSS was thus a natural decision, regardless of the fact that the exercise setting cast Ermington as a Spanish vessel.

5.5.2 Quality of Communications SAR 3

Analysis of the pattern of communications during SAR exercise 3 on each of the courses 3 to 8 is given in Table 5-8 below.

Table 5-8 Analysis of Communications SAR 3

<table>
<thead>
<tr>
<th>Transmission</th>
<th>Rank</th>
<th>Course</th>
<th>Duration</th>
<th>Longest</th>
<th>Number</th>
<th>Number as %</th>
<th>Average</th>
<th>Nationality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>7</td>
<td>27</td>
<td>50</td>
<td>18</td>
<td>2</td>
<td>6.3</td>
<td>German students</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>All UK students</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8</td>
<td>25</td>
<td>36</td>
<td>9</td>
<td>-</td>
<td>5.6</td>
<td>Bangladeshis</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>5</td>
<td>26</td>
<td>38</td>
<td>11</td>
<td>-</td>
<td>6.1</td>
<td>German students</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>3</td>
<td>23</td>
<td>41</td>
<td>9</td>
<td>1</td>
<td>6.4</td>
<td>HK Chinese</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>6</td>
<td>36</td>
<td>75</td>
<td>27</td>
<td>6</td>
<td>10.0</td>
<td>German students</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>4</td>
<td>20</td>
<td>50</td>
<td>13</td>
<td>2</td>
<td>7.6</td>
<td>All UK</td>
</tr>
</tbody>
</table>

Note (1) All courses included UK students. Where students from countries having mother tongues other than English attended the course this is indicated.

It is noted that, as in SAR exercise 2, it was on course number 6 that communications were longest in all respects, namely: duration of transmissions as a percentage of exercise run time; the number of transmissions in excess of 20 seconds; and the average length of each transmission. On this occasion course number 6 also had the longest individual transmission, lasting 1 minute 15 seconds. On SAR 2 a possible excuse existed for the length of the transmissions. As stated on page 99 the ship responsible had a British master and a German navigator. The master was performing the communications task and
thinking during rather than before transmission. While on SAR 3 it is true that again there was a ship having a British master and a German navigator, and again the master performed the communications task. On that occasion the transmissions of excessive length were all made by the CSS, a ship manned by 3 British students. It was affirmed at the post-exercise debriefing that the master was not on the radio aboard the CSS. The problem was one of over complication of instructions, as the following extract shows:

"Yes Ermington this is Dousland we'd like you to proceed to a new position...the position is four nine degrees three nine decimal three north four degrees three eight decimal two west I repeat forty nine thirty nine point three north four degrees thirty eight point two west and proceed your search from this position...starting from that position on a northerly course for fourteen decimal five miles passing the datum position buy one point five miles on your port side then altering course ninety degrees to starboard proceeding in an easterly direction for three miles then turning ninety degrees to starboard again for to start your southerly leg...this new position will cover a better search area on your way in south of the bank over."

This was the 1 minute 15 second duration transmission. It would have been better if Doulsand's message had been broken down into elements following the pattern given in para 5.4.2.

On SAR 2 the least successful result was achieved by the course making least use of radio. On SAR 3 the course making least use of radio, though a different course from that on SAR 2, again achieved the poorest result. The lack of success on these two courses cannot be directly attributed to brevity in communications. As stated on page a mistaken datum and subsequent collision avoidance problems were the features leading to the failure of course number 3 on SAR 2. For course number 4 on SAR 3 the situation was different. The quality of communications was generally excellent and the exchange of information leading to the assumption of CSS duty by Ermington was comprehensive and appropriate. Failure resulted from the adoption of an inappropriate search pattern.

A study of the communications transcripts reveals that the quality of communications on course number 7 was particularly high. The two transmissions exceeding 40 seconds in length occurred at the start of the exercise. Vessels were then making their initial responses to the distress in the form of MAYDAY relays not knowing the identities of any other vessels in the area. The 16 other transmissions in excess of 20 seconds duration were similarly involved with passing information, such as position reports, ship's details, and MAYDAY relays, when elements of
the text, particularly numbers, were repeated for the benefit of the receiver. When instructions, as distinct from information, were being passed the messages were concise and precise, along the lines of those in the example on page 105. The overall impression conveyed by reading the transcript is one of professionalism. While poor communications can frustrate a multi-ship search good communications by themselves cannot guarantee its success. Their contribution however can be significant, not least in giving an air of confidence and engendering co-operation from those taking part.

5.5.3 Determination of Datum. In SAR 3 the position of the distressed vessel was not given, but had to be determined by the vessels responding. This forced the search vessels to discuss and agree a datum. The datum agreed by each course is given in Table 5-9 below.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Course</th>
<th>Datum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Latitude</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>49°46.0′N</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>49°45.0′N</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>49°46.0′N</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>49°44.0′N</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>49°44.0′N</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>49°45.5′N</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>49°46.0′N</td>
</tr>
<tr>
<td>Mean Position</td>
<td>49°45.2′N</td>
<td>004°39.8′W</td>
</tr>
</tbody>
</table>

Notes: (1) Taken off chart in absence of recording of radio traffic.
(2) Position given as 120° Savings Bank Light Vessel 13.3 miles.

The origin of the distress was 49°45′N 004°39′W, but each ship was subject to a quadrantal error, on the direction finding equipment, having a maximum value of 2′. This would have two effects; first in the case of the 2 vessels having to fix their position by radio direction finding those positions would be subject to error, second the bearing of the distress obtained by each of the 3 vessels would itself be subject to error. The positions obtained in Table 5-9 were thus obtained by inaccurate bearings from uncertain positions. The 3 bearings so obtained intersect in the form of a cocked hat. On any particular exercise the 3 ships should have obtained identical cocked hats, as the 3 bearings being plotted were common. In fact the cocked hats obtained were seldom identical, partly because of minor differences in laying off
bearings, and partly because of the techniques adopted when exchanging
information between ships. Bearings could be given from a grid
reference position as follows:

"All ships all ships all ships this is Ermington Ermington
Ermington my position four nine degrees three three minutes north
zero four degrees one zero minutes west I have received SOS
bearing three zero five degrees from me over."

This transmission from Ermington on course number 4 was concise and
clear, and provides a good example of the quality of communications on
that course (see para 5.5.2). But it is likely that the position given
by Ermington has been rounded to the nearest minute of latitude and
longitude. Advent and Dousland would plot the bearing from the rounded
off position whilst Ermington would plot it from the precise position.

Bearings could also be given from a position defined by other bearings as
follows:

"Mayday relay this is motor vessel Advent we have received an SOS
on our DF and the bearing of the distress was two six nine degrees
true...our position was two eight one degrees Savings Bank and two
three eight degrees Black Hand Deep."

This rather unconventional method was used by the German manned Advent
on course number 6. Convention is that the bearings relating to fixed
objects, such as Savings Bank and Black Hand Deep light vessels, in this
case, should be from the fixed object. Those given by Advent are
bearings of the fixed object from Advent. No ambiguity exists with 2
bearings however, as they will only converge if plotted correctly, and not
as given.

More commonly, when not using latitude and longitude, vessels gave their
positions as range and bearing relative to a fixed object as in:

"My position is Black Hand Deep Light Vessel bearing zero eight
eight degrees by four miles."

This was from Dousland on course number 8. The position was 8 miles in
error and should have been given as "two six eight degrees Black Hand
Deep Light Vessel four miles." Both Advent and Ermington plotted
Dousland's bearing of the casualty from a position east, instead of west,
of Black Hand Deep because of Dousland's mistake. The positions
obtained for datum were thus widely apart, but the differences were
quickly resolved.
From the wide range of cocked hats plotted the choice of datum agreed for the casualty varied over 2 minutes of latitude and 4 minutes of longitude, giving a spread of 2 miles difference in northings and 2.6 miles difference in eastings for the 7 courses. The spread of datum is shown in Figure 5-3.

5.5.4 **Search Pattern Adopted** An analysis of the search patterns adopted during SAR 3 appears in Table 5-10 below:

Table 5-10 Analysis of Search Pattern SAR 3

<table>
<thead>
<tr>
<th>Rank</th>
<th>Course</th>
<th>Pattern</th>
<th>Track Spacing</th>
<th>Leg Length</th>
<th>Speed</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>Original</td>
<td>Various</td>
<td>Various</td>
<td>Full(1)</td>
<td>Crisscrossing</td>
</tr>
<tr>
<td></td>
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<td>3</td>
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<td>8M</td>
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<td>Advent downtide</td>
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Notes: (1) Full service speed but Advent was advised by Ermington "Your draught is quite deep for these waters if you wish to slow down you may do so...if you wish to adjust any of these courses you may do so."
(2) At the end of her allotted part Advent was to anchor in
a downtide position. (see Annex P-7).

In was reasoned, in para 5.1.3, that a suitable first search in SAR
exercise 3 could concentrate on an area 6 miles square, centred on a
datum located one mile north east of the agreed position for the
casualty, and aligned north east/south west. The limits of such an area
appear on each of the reproduced plots at Annexes P 1-9. In the
visibility prevailing a track spacing of 1.5 miles would be appropriate,
and the leg lengths would be dependent on the geometric form of the
search. If students adopted a MERSAR parallel track search pattern then
a leg length of 6 miles would be satisfactory. On this occasion, as
visibility was only 1.5 miles and the search was taking place close to
navigational constraints, some reduction in speed could be justified.

An inspection of Table 5-10 shows that course number 3 most closely
conformed with the search parameters suggested above. Unfortunately a
track spacing of 3 rather that 1.5 miles was adopted, and this single
error in judgement was sufficient to reduce drastically the effectiveness
of the search. Had Dousland's initial search track been 1.5 miles to the
north west of Ermington's (see Annex P-3), and subsequent track spacing
been 1.5 miles, the coverage achieved at T+3 hours would have been 100%.
This gives a clear indication that MERSAR search patterns can be very
effective if intelligently applied.

Adoption of too wide a track spacing was the principal weakness in the
search patterns used. On course number 4 the searching vessels were so
widely spread out that Dousland was playing no useful part in the search,
and Advent only made a marginal contribution. On that course Ermington
'volunteered' to become CSS only 15 minutes into the exercise, this meant
that it was possible to devise, and put into action, a search plan well
before the ships closed the datum. With the ships closer together
before the search started it is possible that a tighter search would have
developed, but in using 4 miles track spacing the CSS was following
exactly the guidance of MERSAR without taking intelligent account of the
local conditions. This gives a clear indication that MERSAR search
patterns can also have only limited effect if not adapted to suit any
special circumstances that may exist.
Local conditions, in particular the presence of shoal water and the deep draught of Advent, were taken into account on courses 3, 6, and 7. On course 3 and 6 a 2 ship search was adopted and Advent was held in a down-tide position ready to receive survivors. On course number 7 Advent was used to search the comparatively deep north eastern sector of the search area, with the intention of her anchoring on completion of her search, and also with the aim of using her facilities when survivors were found.

As on SAR 2 the most successful search attempts were by courses 7, 8 and 9. Track spacing chosen by the CSS on those 3 courses was in every case less than that on the less successful attempts, but again the most striking feature was that the more successful search patterns were original and not taken from MERSAR. An inspection of Annexes P 7-9, shows each of those searches to be concentrated on a realistically small area. Other good features are apparent. On courses 7 and 9 there was some attempt to align the search in the direction of drift, and on course number 8 all 3 ships were searching outwards from the centre of the search area. From the exercise debriefs and exercise charts used by the CSS on each of those three searches it is also apparent that the proposed search patterns had been plotted on the chart, and the progress of each vessel along its intended track was being monitored. Not only was planning effective but so was control.

5.5.5 Control of Search On each of the searches adopting a pattern from MERSAR the CSS used similar means to advise other vessels what was required of them. The method used was: identification of pattern in MERSAR, allocation of a start position (on 3 occasions by latitude and longitude and once by range and bearing from datum), giving the initial course and leg length, giving the second course and track spacing. This method clearly works well, especially if the instructions are passed element by element and not as a single lengthy transmission. In general there is less risk of error if latitude and longitude is used rather than bearing and distance, but on this occasion no problem arose.

On course 8 and 9 a conning approach was used, for example:

"Advent Dousland could you please continue on your course of two seven five until seventeen forty two...one seven four two...and then turn south westerly to two one zero...two one zero over."

Provided the CSS can cope with the volume of traffic this method generates, it has certain advantages. First it ensures that the CSS
maintains tight control over the progress of the search, and second it ensures that each vessel taking part in the search is in regular contact with the CSS, either to receive instructions or to pass position reports. In real, as distinct from simulated searches, it is important that all search units feel involved with the task. Regular contact with the CSS is one way to achieve this objective. Students were asked at debrief how they responded to being conned. There was no objection provided the approach was "right" by the CSS, and at no time did they feel they were surrendering command of their vessel to a third party. An important factor is that instructions must be given several minutes before they are to be executed. This then gives time for the master of the vessel being conned to consider what is being asked of him, and disagree if necessary.

On course number 7 each vessel was given a list of courses to steer and distances to run, as follows:

"Advent this is Ermington I have your position..could you steer a course from there of two seven eight degrees over"
"Ermington this is Advent go to a course of two seven eight degrees over"
"Stand by I'll give you the remaining courses in a minute over"
"Understand you over" then three minutes later:
"Advent Ermington are you ready to copy courses over"
"Ermington Advent ready to copy"
"Roger Advent first steer two seven eight degrees for eight miles over"
"Two seven eight for eight miles"
"Then zero zero two degrees for one point five miles over"
"Zero zero two for one point five over"

Ermington continued to relay courses and distances totalling 24 miles, some one and a half hours steaming at full speed for Advent. Ermington advised that the courses and distances should bring Advent to a position with "North Denim Patch buoy bearing one zero six degrees by seven point four miles," enabling Advent to reconcile her plot with that of Ermington.

Ermington maintained a radar plot on each of the other vessels and did not ask them to make any reports, but in the event each vessel advised Ermington whenever they made an alteration of course, thus ensuring that regular contact existed between CSS and all search units.

5.5.6 Conclusions on SAR 3 Whereas early positive action was required in SAR 2, in SAR 3 students had more time to assess the situation and plan effective action before arriving at the scene of search. In assessing risk of collision action should not be taken based on scanty information (5), this aspect of good seamanship has a parallel in search and rescue. From the conduct of SAR 3 it is concluded that:
(a) If time permits, there is value in delaying selection of the CSS until it has been possible to review the potential of each vessel responding to the distress, so as to ensure a proper selection is made.

(b) Conning, if properly conducted, was an effective method of controlling search units. Conning had the benefit of involving search units in regular contact with the CSS.

(c) Communication discipline was again a feature of the more successful exercises.

(d) It was shown that MERSAR, if intelligently applied, could be effective, but if blindly followed the use of MERSAR met with limited success when circumstances required that adaptations be made.

5.6. The Role of Communications

The importance of good communications in multi-ship searches has been revealed clearly in the analysis of and the conclusions to SAR 2 and SAR 3. There are problems at two levels:

(a) between mother tongue speakers, and

(b) with 'other language' speakers.

When the communications are entirely between mother tongue speakers, training in succinctness and accuracy may be relatively straightforward. When the various participants in a search do not share a common mother tongue, a common working language has to be used. Often English will be used as the working language, and for mother tongue English speakers extra discipline will be necessary so as to simplify the vocabulary and syntax of messages into a form acceptable to 'other language' speakers. In their turn 'other language' speakers will need to exercise similar care to ensure their communications are clear and unambiguous. In achieving these requirements the restricted marine navigational vocabulary (6) and Seaspeak (7) will have important parts to play.

References:


(2) ibid, Pattern 2

(4) International Maritime Organization *Regulations for Prevention of Collision at Sea*, IMO, London, Rule 8

(5) ibid Rule 7

(6) Department of Trade *Standard Marine Navigational Vocabulary* Merchant Shipping Notice No M1018, Department of Trade, London 1982

CHAPTEn 6

REVIEW OF MERSAR

6.1 Value of MERSAR

It was shown, in para 4.3.18, that after considerable exposure to MERSAR most students thought the manual adequate for its purpose. That purpose is "...to provide guidance for those who during emergencies at sea may require assistance from others or who may be able to render such assistance themselves. In particular it is designed to aid the master of any vessel who might be called upon to conduct Search and Rescue operations at sea for persons in distress." (1) It could be considered that a publication having the purpose of assisting in saving life should be more than adequate, yet only 12% of the 43 students in the sample rated MERSAR "very good". Of greater concern is the fact that 9% of the sample rated the publication "inadequate". The nature of any inadequacy was not directly investigated. It could be in content, in presentation, or a combination of both. In open discussion during the 2nd International Radar Simulator Teachers' Workshop at Bremen, one speaker stated that in preparation for the topic of simulated SAR exercises he had, the night before, started to read MERSAR in bed. Within minutes he was asleep. His proposition that the book made dull reading met no opposition. In essence MERSAR serves as a distance learning guide, and much experience has been gained in producing such guides in recent years by organizations such as the National Extension College, and the Open University. MERSAR could not be held to compare well with Open University texts, or with many technical guides, and improved presentation could well improve MERSAR's adequacy. No rigorous attempt was made during the study to evaluate the presentational style adopted in MERSAR, but through repeated use of the manual, in extensively monitored exercise situations, an appreciation of the difficulties students experience in using MERSAR has been gained. Some comment on how the presentation may be improved to reduce such difficulties is made in para 6.3.

It is easier to comment on the content than on the style of MERSAR. Through this investigation the essential elements of successful search by Merchant ships have been identified. It was also noted, in paras 5.4.4 and 5.5.4, that the most successful simulated searches did not follow
MERSAR search patterns. The observations and analysis carried out during the study lead to positive suggestions for improvement in the content of MERSAR.

6.2 Recommendations for Revision in MERSAR

6.2.1. Selection of CSS

It is stated that "if specialized SAR units (including war ships) are not available to assume the duties of an on scene commander but a number of merchant ships are participating in the operation, it will be necessary that one of these assumes the duty of co-ordinator surface search (CSS).(2) Interviews with students who have been watchkeepers aboard vessels designated CSS during searches reveal that there is a limit to the number of search units that can be co-ordinated successfully by one CSS. Unless search units are left to their own devices it is necessary to monitor and plot the actions of all vessels under co-ordination. This will require regular contact with each search unit. The research also shows that search units benefit from such regular contact with the co-ordinator, as effectiveness increases with added involvement. The number of search units that can be co-ordinated depends on the capabilities of the co-ordinating vessel, but will seldom exceed six. Plotting will usually be manual, and manual radar plotting experience indicates that with more than six targets the plot and the observer become confused. While the collision avoidance assessment is not directly comparable with SAR co-ordination, it is suggested that in both cases it is the number of vessels involved, rather than the complexity of the task, that overwhelms the operator.

Consideration should be given to qualifying the guidance given in MERSAR by stating: It will seldom be possible for one CSS to successfully co-ordinate more than six search units. When a large number of vessels is involved in the search consideration should be given to dividing the search area into different sectors, each with a different CSS. Note, it will be necessary for each sector to operate a separate scene of search radio frequency so as to avoid interference.

Advice on the establishment of the CSS is given in MERSAR, but this is limited to: "The CSS must be established by mutual agreement between the ships concerned, having due regard to their capabilities and ETA's... It is important that the CSS should have good radiocommunication facilities."(3) This is little enough guidance, and partially confusing.
It is essential that the CSS is correctly selected, for once the decision is made it may be difficult to change co-ordination later from one vessel to a better suited vessel. Rescue Co-ordination Centres (RCCs) will often control a search, using their own operations room facilities, without nomination of a CSS on scene. The CSS is essentially an on scene extension of the RCC, and when nominating a CSS the RCC controller will wish to select a vessel with a stable platform and good operations room facilities.(4) If the CSS is not nominated by an RCC, but has to be mutually agreed by the masters of the vessels attending the distress, then the same criteria should be used. Bearing in mind that RCCs are capable of co-ordinating searches without ever reaching the scene of search, the ETAs of the participating vessels is thus of marginal importance. That language difficulties may exist is recognized in MERSAR (5). This fact is of great importance and should be considered when selecting a CSS.

The proper selection of CSS may be the key to success of the search, and it is suggested that guidance on selection in MERSAR should be extended to include: The CSS mirrors on scene the role of an RCC ashore. To achieve this it is desirable that the ship selected should provide a stable platform and have good operations room facilities. and It is important that the CSS should have the language and radiotelephony facilities required for communication with the ships participating in the search. In case of language difficulties..... A standard form for exchange of information between ships responding to a distress would assist in the proper selection of the CSS. Further study into this aspect of SAR is required before positive recommendations can be made for amendment to MERSAR.

6.2.2. Contents of the Distress Message MERSAR includes amongst the important components of a distress message "...any other information which might facilitate the rescue (eg course and speed if under way; the master's intention, including the number of persons leaving the ship; type of cargo, if dangerous)."(6) Later MERSAR further states "It will also be important to furnish relevant information such as:....number of crew remaining on board.....number of seriously injured."(7) Although many of these points may be relevant in determining the scale of effort required for rescue, except for details of the vessel's course and speed, if under way, they are not directly linked to location. Without successful search there can be no successful rescue, and search really ought to take
precedence over rescue in initial thought and action. Much of the
detail considered important by MERSAR should form part of subsequent
distress traffic after the distress message has been made and
acknowledged. What is important is any information which may assist in
location of the casualty, including an indication of the quality of the
position given. For example: "no sights for two days", or "satellite
fix obtained at 1418 GMT".

6.2.3. **Conduct of Search - Track Spacing**

Although, if followed
implicitly, the guidance given in MERSAR would result in the search area
being being systematically searched, the efficiency of the resulting
search may be questioned. In particular "**Interval between ships - At
the start of a parallel track search, the interval shown in this manual
should be used.** Circumstances may occur when the CSS considers it
prudent to alter the intervals. All searching ships should endeavour to
maintain station accurately."(8) The parallel track searches being
referred to are shown in MERSAR as patterns 2 to 5, 2 being for 2 ships
and 5 for 5 or more ships. For 2, 3, and 5 or more ships the
recommended interval between ships (track spacing) is given as 4 miles,
while for the 4 ship search it is given as 3 miles. No reasons are
given why these particular track spacing have been shown, or why the 4
ship search should differ from the other models. Inspection of the
patterns shows that they may have been chosen to enable a 24 mile by 24
mile search area to be searched, though again the reason for such a
search area is not explained. Although the extract from MERSAR quoted
above does suggest that the CSS may consider it prudent to alter the
intervals, how or why such prudence should be exercised is not suggested,
beyond stating later in the manual "**Unless otherwise considered desirable,
the track spacing shown in this manual should be used.** When small
targets are being searched for (eg. yachts, small boats, liferafts or
persons in the water) the CSS should consider a reduction in track
spacing."(9) In brief, the guidance given by MERSAR on the question of
track spacing is inadequate and could be improved. This could be
achieved by listing the factors to be taken into account in determining
track spacing, and emphasizing the difference between rescue of survivors
and searching for recovery of bodies or other evidence relating to the
distress. When survivors in survival craft are being sought a wider
track spacing may generally be adopted. In this case there could be
greater motivation for keeping an effective lookout on the part of the
potential survivors than on the part of the potential saviours.
Survivors will often have visual location aids available to increase their detection range, but will not wish to waste such aids by displaying them when no search unit is in range. The key question then becomes "How far off can the searcher be detected by the casualty?" rather than "How far off can the casualty be detected by the searcher?" MERSAR alludes to this by stating "Ships should take measures to make themselves highly visible to survivors..." (10), but fails to link this suggestion to track spacing.

Of the 18 exercise searches analysed in Chapter 5, the least effective was SAR 3 on course number 4. On that course less than 40% of the comparison search area had been covered within three hours of receipt of the distress signal, whereas the average coverage achieved by the remaining courses in the same time was in excess of 80%. It is significant that the poor result followed adoption of the MERSAR recommended track spacing of four miles. On each of the remaining more effective courses the track spacing used was less than four miles.

6.2.4. Conduct of Search - Multi-ship Searches. Each of the search patterns shown in MERSAR includes a datum position. The datum is defined as: "The most probable position of the search target at a given time taking into account the expected effect of drift since the initial position of the incident was established." (11) If two of the patterns given for multi-ship searches, namely patterns 2 and 4, were strictly followed, no ship taking part in the search would pass through datum. This may be thought to be poor planning.

It is further observed that each of patterns 2 to 5 is drawn with the tracks running up and down the page. While the qualification does exist that the search should be carried out in the direction of drift, it has been noted during this investigation that the unimaginative CSS will in fact align his search north and south, following slavishly the visual guidance of MERSAR while ignoring the important qualification relating to drift. It is suggested that more imaginative graphical examples could be used in MERSAR to avoid this error being made.

The suggestion that a multi-ship search should be made with the ships in formation appears central to MERSAR advice on search planning. The fact that "all searching ships should endeavour to maintain station accurately" has already be noted above, but further references to formation keeping
exist, namely: "The CSS should normally direct ships to proceed (when conducting a radar search) in loose line abreast" (12), and "...during restricted visibility...a ship not fitted with radar, or whose radar has become defective, should consider dropping astern of the other vessels.....if and when the situation improves sufficiently, she should endeavour to resume her proper station." (13) Why a multi-ship search should be carried out like a military manoeuvre is difficult to understand. Time will be wasted getting search units into their position in the formation. Once in position the search will then proceed with "...all units ...at the same speed, which will normally be the maximum speed of the slowest ship present."(14) This is not making best use of the individual characteristics of each search vessel. The MERSAR method sacrifices time for apparent order, and time may be the vital element that differentiates between success and failure in search and rescue. Apart from slowing down the speed of search, station keeping is a demanding form of navigation, and without practice is not well performed, even by well-manned military vessels. By comparison, merchant ships will usually operate at a low manning level, and if station keeping has to be used during a search, the effort expended will divert attention from the primary task.

Search and rescue training being conducted at the Bremen Hochschule für Nautik during 1982 followed the guidance given in MERSAR, and included, as an initial objective, manoeuvring all participating search units into a line abreast formation.(15) When the need for this was questioned, the lecturer responsible suggested that unless such a search pattern was adopted, a target could drift across the search area without ever coming into sighting range of any search unit. While it is clear that drift rates may vary between ships, and between searching ships and the target, the differences would have to be large for the suggested event to occur, provided the search is correctly stabilized. Searches may be ground or sea stabilized. A ground stabilized search would be appropriate when the tracks follow a Loran C or Decca hyperbolic lattice pattern, or when a search for a sea surface target is being carried out by aircraft. The techniques described in MERSAR neither make reference to lattice searches nor apply to searches by aircraft. In the circumstances to which MERSAR addresses itself both searchers and target share the same plane of reference, the sea, and searches should normally be sea stabilized. MERSAR makes no reference to stabilization of searches, and the research showed that students were frequently confused over whether search tracks
should be made good (ground stabilized), or steered (sea stabilized). No guidance is given on this in MERSAR, and this omission should be made good.

It was observed, in the analysis at Chapter 5, that on the least effective attempts at SAR exercise 2, ships not only tried to line up in formation, as recommended by MERSAR, but the searches were aligned north and south, or up and down the page, as depicted in MERSAR. On SAR 3, three of the four least effective searches were again aligned north and south, but the lesson regarding the inadvisability of searching in formation had been learned. There is little doubt that the economy in effort, gained by not searching in formation, was a contributory factor in the improved overall effectiveness of SAR 3 in comparison with SAR 2.

It is suggested that the emphasis on searching in formation, made in MERSAR, is out of place when considering search by merchant vessels. It would be more prudent to point out that multi-ship searches may be conducted with the search units proceeding in formation, but for merchant vessels the effort so expended is likely to be counter productive.

6.2.5. **Conduct of Search - Single Ship Searches** Among the search patterns shown in MERSAR are two for single ship searches. The expanding square search, shown as Pattern 1 in MERSAR, is said to be for use "when one ship arrives on scene well in advance of the others...." (16) The pattern given is aligned in the direction of the course of the approaching vessel, and has a track spacing of four miles. In practice the expanding square search has more applications than merely acting as a holding measure while waiting for further assistance. It is also used for a concentrated search of small areas when the position of survivors is known within close limits.(17) An example is appropriate:

Red flares are sighted from a merchant ship at night. The ship alters course towards the distress signals, and a further red flare confirms the new course as correct. In time a liferaft is sighted and three survivors are rescued. On being questioned they state they were in a yacht that was run down two hours earlier by a passing merchant ship. The ship did not stop. Two other crew from the yacht were known to have escaped the accident in another liferaft. An expanding square search for the second liferaft would now be appropriate. If those rescued had streamed their liferaft's drogue it is possible that the missing persons had not. The
search would then commence in a down-wind direction. An initial search leg up-wind would be appropriate if the questioning showed the survivors had not streamed their drogue.

That improved guidance on appropriate track spacing should be given in MERSAR was suggested in para 6.2.3. Special guidance is applicable to those cases in which the square search is adopted. Whereas in multi-ship searches an appropriate track spacing would equal the sweep width (see footnote 1), if a similar track spacing were used in expanding square searches the search area may not be properly covered. An appropriate track spacing for such searches is 0.7 times the sweep width (see footnote 2).

The second single ship search is a sector search, which is described as being suitable for: "man overboard - ship returns immediately to datum;" and "search target is once sighted and then lost - ship heads for datum."(18) The second event will be recognized as one for which an expanding square search is also suitable, though the sector search will concentrate greater effort around datum and may be preferred. While MERSAR correctly describes the uses of a sector search, the figure given as Pattern 1a in MERSAR is not suitable for the man overboard incident. It fails in that it shows leg lengths of 2 miles radiating out from datum.

Footnotes:

(1) The figure graphically depicts the mathematical concept of sweep width. The number of targets missed within the sweep width distance equals the number located outside. The concept is commonly applied to searches. (see also para 7.3.7)

Source: Reference 17 Fig 8-6

(2) On each alteration of course in a search pattern a small portion of the search area will fall outside the sweep width. To avoid this occurring in square searches leg lengths should be in multiples of 0.7 times sweep width.

Source: Author
When a person has been seen to fall overboard the vessel will be returned quickly to the scene of the incident. The manoeuvres used to achieve this objective also have the effect of decaying ship's speed, a desired effect as the ship will have to stop to recover the person in the water. If, perhaps at night or in poor visibility, the person is not immediately located at datum, the sector search will commence. This will be carried out at a slow speed, typically no faster than three knots, and the ship will drop speed briefly at each turn. The search shown in MERSAR will take six hours to complete at search speed. This is far too long. There is no value in steaming two miles away from a good man overboard datum, as MERSAR would have us do. A better method of conducting this search would be to determine leg lengths by time and not distance. An appropriate leg length in the case described could be 10 minutes. The first search would then be completed in under two hours.

Pattern la

Datum

It is time that usually triggers action on the part of bridge watchkeepers, and there is merit in converting leg lengths to time when conducting any search. (see page D-6) It would be appropriate for MERSAR to include guidance on the value of converting leg length in distance to leg length in time when conducting a search. It is particularly relevant in the case of single ship searches such as sector and square searches. It is also relevant when parallel track searches are being conducted with vessels operating independently rather than in formation.

On occasions the loss of a man overboard may not be discovered until several hours after the event. MERSAR gives no guidance on a suitable search pattern for such cases, and certainly the sector search would not apply. Track crawl, or track line searches (19) may be used on these occasions, and MERSAR should include an example of a track crawl search amongst the search patterns shown in diagrammatic form.
6.3. Presentation

6.3.1. General Considerations Major research into the design of instructional text has taken place since 1970, the year when the first edition of MERSAR was published. The benefit of such research has not been absorbed by MERSAR, the fourth edition of which, published in 1986, is essentially of the same design as the original. As indicated in para 6.1., no attempt has been made in this study to rigorously analyse the format of MERSAR. The study has, however, provided the opportunity to witness regular use of the manual in the situation for which it is intended, and through this observation some of the manual's inadequacies as an instructional text have been identified. Comparison has also been made between the design of MERSAR and the guidance given by Hartley (20) on the design of instructional text.

6.3.2. Format MERSAR is constrained by the non-standard page size adopted. Hartley states:

"The size of the page determines the size of the overall visual display to the reader. The reader needs to be able to read this display easily.....readers need to be able to scan, read, and focus on both gross and fine details. The size of the page constrains the decisions writers and designers must make about these details." (21)

For his book "Designing Instructional Text" Hartley himself chooses International Standard size A4. This enables him to use a one third/two third column structure. In the narrower column he positions chapter summaries, figure captions, and key points, while in the wider column he positions the body of the text. The choice of A4 allows him to use large illustrations without cutting across columns of print. International Standard size A4 publications are already common place on board British ships, this size having been adopted by the Hydrographic Department for publications such as: Sailing Directions, Tide Tables and Light Lists. It is suggested that MERSAR would benefit from a change to A4 size, which would make it easier for its users to access the information they seek.

6.3.3. Typographic Cueing Hartley suggests (22) that although cues to focus attention on key points are commonly used, consistency in cueing techniques is desirable. Too many different types of cues can be confusing. MERSAR uses asterisks, italics, inverted comma and bracketed parenthesis, upper case print, words and paragraphs in bold type, all to make emphasis. This can be confusing for the reader, and gives the
impression that the manual has a wide range of authors and no firm editorial policy on cueing.

6.3.4. **Indexing** MERSAR makes use of extensive paragraph numbering, following a style found to be effective in Service writing. This means that every paragraph group, paragraph, sub-paragraph and sub-sub-paragraph is individually numbered as follows:

0.1 Paragraph group
0.1.1 Paragraph
(a) Sub-paragraph
(i) Sub-sub-paragraph

This method of numbering has practical advantages. It is much easier for the CSS to request that participating search units take note of MERSAR paragraph 3.9, than for the CSS to pass the same request in detail, especially where language difficulties may exist. In the 4th edition of MERSAR 56 paragraph group headings appear over a span of 57 pages, each paragraph group being listed in a table of contents at the beginning of the manual, for example:

"CHAPTER 5 - Planning and conducting the search
5.1 General page 26
5.2 Responsibility of CSS 26
5.3 Definitions 26
5.4 Planning the search 27
5.5 Visual search 31
5.6 Radar search 32 etc"

No other indexing system is used to enable the user of the manual to find the information he seeks. A full index at the end of the manual would considerably improve the usefulness of the manual. Access to information would be easier, and there would be less chance of important guidance being inadvertently ignored. This is of particular importance in those many cases in which the user is not familiar with the contents of MERSAR.

6.3.5. **Alternatives to Prose** MERSAR already includes some alternatives to prose in its presentation. Five figures are devoted to illustrations of helicopter rescue slings, baskets, nets, seats and litters. While valid, such information may be of minor significance to mariners using the manual. Of greater importance there are also figures to depict various search patterns, graphs and tables to indicate liferaft drift rates, radar detection ranges, persons in the water survival times and wind chill effects. And there are further sketches to show ship turning manoeuvres and aircraft ditching procedures. The alternative to prose
not used in MERSAR is the algorithm. An algorithm may be described as an exact procedure leading to a specific outcome. It may be used to solve a problem. MERSAR has a primary problem solving function, the problem being how to locate and rescue survivors. The potential of structured approaches to problem solving appears to be overlooked by MERSAR, in favour or a continuous prose style of presentation. Students, and therefore mariners, would welcome a more rigorous step by step presentation of action to be taken at the various stages of search and rescue, for example when responding to a distress, when selecting the CSS, when planning a suitable search, when conducting a search, when effecting a rescue, when terminating an unsuccessful search, and so on.

6.4. Conclusions on Review of MERSAR

MERSAR will be of value to any master called upon to conduct search and rescue operations at sea for persons in distress. Its value could be improved by revision of its content and presentation. The required revision extends beyond the piecemeal amendment and addition approach of earlier revisions to a complete reappraisal and rewrite of the manual.

References

(2) ibid para 1.3.2(a)
(3) ibid paras 3.6.3 and 3.6.4
(4) Bill Barnes, Chief Instructor, HMCG School, Highcliff. Extract from transcript of interview Barnes/Redfern 21 November 1984
(5) MERSAR (see reference (1)), para 3.6.5
(6) ibid para 2.2.1
(7) ibid para 2.2.2
(8) ibid para 5.7.1
(9) ibid para 5.9.4
(10) ibid para 3.9.5
(11) ibid para 5.3.1(a)
(12) ibid para 5.6.1
(13) ibid paras 5.11.2 and 5.11.3
(14) ibid para 5.8.1

133
MERSAR [see reference (1)] para 5.10.1

US Coast Guard National Search and Rescue Manual, COMDTINST M16130.2 1973, (with amendments 1 through 7), Washington, para 832g

MERSAR [see reference (1)], pattern 1a

National SAR Manual [see reference (17)], para 832d


ibid page 9

ibid page 57
CHAPTER 7

SEARCH PLANNING

7.1. Merchant Vessels in Search and Rescue

7.1.1. Extent and Nature of Merchant Vessel Involvement. In para 4.3.20 it was indicated that there is considerable merchant ship involvement in SAR. This possibility is also recognized in MERSAR which states: "In the majority of (search and rescue) regions, merchant ships will normally be able to participate (in the conduct of search and rescue operations)" (1) and "...in the more remote ocean areas, only ships may be available (to attend distress incidents)." (2) In the words of a British expert "...merchant ships, they're the first shot in our locker...in many parts of the world they could be the only rescue facility available." (3) But this investigation has also shown that even when merchant ships are 'tasked' for search and rescue by RCCs ashore, they are often left to their own devices.

One student, during unstructured interview, talked about his part in a major search operation in the North Sea:

"We were given a sector (by the RCC) and charge of a lot of Spanish fishing vessels, but there was a limit to what we could do with them. The Captain really did play it off the cuff, in fact his search pattern compared to what we did (on the simulator course) was very elementary. He just sort of sent them round in circles to see what they could find."

And did he carry out a plot to see where everybody had been?"

No, we did try to keep track of where they were going but it was very much everyone pitch in and see what you can find. It wasn't very well organized."

A little guidance from RCC could perhaps have improved the on scene organization in this case.

Another example of lack of guidance from the shore is revealed in an extract from a letter from a ship master: "Notwithstanding the success of some of the SAR operations (in which he had taken part) the main feeling I have experienced is one of frustration at the lack of any proper co­ordination and the lack of any positive follow-up action, as to result,
from the authority requesting action."(4) The writer's experience in this case was mainly in Far Eastern waters.

A further insight into how merchant vessels may be used is given in the following element of a recorded interview with a United States Coast Guard officer:

"Supposing there was a Mayday and various ships answered it, as well as Coast Radio stations. The US Coast Guard has taken charge from an adjacent RCC. Would you use the merchant ships that have responded?"

"One of the things we teach is to use every resource you have available, if they are there then we use them."

"And how do you use them, do you ask them to do something specific, do you set them a search pattern or what?"

"The MERSAR manual is carried by most US ships, most ships in the world today will carry some form of SAR manual, and I venture to say that in the majority of cases they will respond to the best of their ability."

"But do you give them an area to search?"

"We have, but sometimes we've left them pretty much on their own"(5)

The United States is fortunate in having a sophisticated professional SAR organization with many facilities. Merchant vessels may not be the first shot in their locker, but the feeling remains that nowhere is best use being made of merchant vessels in SAR.

7.1.2. Use of MERSAR In Search Planning

The contents of MERSAR have, in many respects, been kept deliberately simple in order to make them more readily usable by merchant ship masters.(6) The general aim in search planning is defined as being: "In order that surface units and especially merchant ships on scene will be able to search effectively.....it is essential that search patterns and procedures should be preplanned so as to enable merchant ships of all flags to co-operate in co-ordinated operations with the minimum difficulty and delay."(7) MERSAR goes on to state that in planning the search it will be necessary to establish a datum, and states that the factors to be taken into account include: reported position and time of casualty, time interval between ships proceeding to assist and their arrival on the scene, estimated surface movement of casualty in interval etc.(8) This is very scanty information. It makes no allowance for positional inaccuracies, gives no clues on how to estimate surface drift, and bears no comparison
with the complex procedures used by RCCs ashore in attempts to determine a satisfactory datum for the search.

In MERSAR the question of spacing between tracks is covered by "Unless otherwise considered desirable, the track spacing shown in this manual should be used." (9) No attempt is made to explain the circumstances in which the arbitrary spacing appearing in the manual should be changed, the factors to take into account, or how the track spacing given was derived. Simplicity is of course the aim, but, in the absence of better guidance from ashore to search planners afloat, more information would be desirable.

7.2. Planning Methods Adopted by RCCs Ashore

7.2.1. Manual Planning Techniques The factors to be taken into account in determining datum for an oceanic search, and how those factors are used in manual planning techniques, are covered over 36 pages in the USCG National SAR Manual (10). This text is widely considered to be the definitive work on the subject and is used by other nations either directly, as by the West German lifeboat service, (Deutsche Gesellschaft zur Rettung Schiffbruchiger, Bremen) or indirectly as by HMCG in the United Kingdom. HMCG has produced an 18 page booklet of tables and graphs (11), along with planning proformas designed to ensure a systematic approach to search planning problems, in their method of determination of datum and other search parameters. Factors taken into account in selection of track spacing, the resultant sweep widths, and probability of detection calculations, are considered over a further 20 pages of the USCG National SAR Manual (12). All these details are omitted from MERSAR.

7.2.2. Computer Assisted Planning Techniques It must be acknowledged that RCCs ashore are manned by staff trained and experienced in using the quite complicated search planning techniques that have been developed over the years. Even so, increasing use is being made of computers to assist staff in making their planning decisions. The USCG has available two sets of programmes developed by the Waggoner Corporation. The first is the Search and Rescue Planning System (SARP), which uses methods similar to those in the long established manual method to determine a single datum (it should be noted that in SAR terminology datum can be singular), and recommended search area. The second is the
Computer Assisted Search Planning System (CASP) which uses simulation methods to solve the search planning problems. In this simulation account is taken of the error probabilities for each of the planning variables to produce a wide range of possible datums over the search area, each datum being assigned its own probability. In this system it is possible to have two or more widely separated datums each with a similar relatively high probability of being correct. The search controller then has to assign his search effort according to the forces he has available, taking account of the spread of possible datums with lower probabilities.

In the United Kingdom Logica VTS Limited has produced suitable software for computer assisted planning at British RCCs, and use has been made of this facility at the Falmouth RCC since 1986.

Computer assistance is particularly valuable when there are many unknowns, and when the search operation continues through several stages over a long period. Merchant ship involvement in searches will usually be of short duration, vessels being unable spend a long period at the scene of search, and some of the complications therefore do not apply to ship co-ordinated searches. But placed in the position of having to make planning decisions regarding a search, ships' masters lack the training, experience, and planning aids of co-ordinators ashore. The gap in methods used ashore and afloat is thus vast.

7.3. Parameters Used in Search Planning

7.3.1. Incident Location When SAR services are alerted to the existence of a distress one of three situations is likely to exist. First the position of the distress may be known to some accuracy, such as when the incident has been witnessed or when the casualty has initiated the alert and has given a position in the distress message. Second, the track of the distressed vessel or aircraft may be known along with a last known position some time prior to the incident. Last, no accurate position may be known but the casualty's general area of operation may be known.

In the first case a datum at the time of the incident is known. It will then be necessary to assess the quality of that datum, and how the datum may move in the interval between alert and arrival of search units.
The search will then take place around the revised datum. A merchant vessel could readily be involved in a search operation of this nature, and could be acting as the co-ordinator of the search. In this event it would be helpful for the master of the co-ordinating vessel to know how to refine the initial distress datum into the initial search datum.

In the second case a track crawl search would be appropriate along the missing vessel's or aircraft's track from or towards the last known position. Although it was noted in para 6.2.5. that MERSAR does not include the track crawl search, merchant vessels in transit in the area could well respond to a request from an authority ashore by deviating along the casualty's last known track.

The use of merchant vessels in the third case is again likely to be in response to a request from an authority ashore. Such use could be limited to maintaining heightened vigilance while passing through the search area, or could extend to full scale search operations within the area over a limited period of time.

7.3.2. Determination of Search Datum

Determination of search datum depends on an assessment of those environmental drift forces that may affect the casualty between the initial incident and the arrival of searchers. In the ocean environment these drift forces may include (13):

1. Aerospace trajectory
2. Balloon drift
3. Parachute drift
4. Sinking drift
5. Leeway
6. Wind-driven current
7. Sea current
8. Tidal current

although only the last four will be applicable to ship/ship searches.

(a) Leeway

Leeway is the movement of a floating object, through the water, caused by local wind forces. Its rate and direction is dependent on a number of variables including wind speed, cross plane area and aspect relative to the wind of the above water surfaces of the object, and on the underwater drag, which itself is dependent on the underwater form of the object and its aspect relative to the direction of movement. SAR manuals usually provide tables or graphs to show leeway speeds that may be expected for certain craft in given conditions of wind. The National SAR Manual gives formulas
applicable to a limited range of small craft (14), for example the expected leeway rate for a trawler would be 0.04 times windspeed, while that for a small light displacement cabin cruiser would be 0.07 times windspeed. No figures are given for vessels larger than trawlers. MERSAR provides a graph (15) showing predicted rates of leeway drift, for different wind speeds, for liferafts under varying conditions. The 'worst' case being a liferaft without drogue, given as 0.07 times wind speed, and the 'best' case being a liferaft with drogue and with canopy not deployed, for which the drift rate is shown as 0.025 times wind speed.

It has been shown in leeway experiments (16) that craft are more likely to sail off the downwind direction than drift directly downwind when making leeway, with off-wind angles being as high as 60°. As there appears to be equal probability of drifting left or right of the downwind direction it is not possible to make allowance for this factor in determining datum. Instead, the normal assumption should be that the target has made leeway drift downwind, and an error of predictable maximum magnitude attaches to the calculation.

(b) Wind-driven Current. The wind blowing over the surface of the sea sets up a wind driven current. The relationship between wind direction and speed and current direction and speed is dependent on wind history and latitude. In the planning guidance for RCCs, (17) and (18), tables are provided in which the entry parameters are latitude and elapsed time in periods of six hours. If the wind history prior to the incident is known, it is possible to predict the resulting wind driven current at the time of the incident. Subsequent changes in wind speed and direction will affect the wind current, but should the wind suddenly stop blowing the wind current produced does not instantly stop. Instead, the wind current decays steadily, while constantly changing direction due to the rotation of the Earth. By example, if an incident occurred in latitude 45° north, and the wind had been blowing steadily at 10 knots from a direction 270° over the preceding 18 hours, the forecast current would comprise the following components: for the period 0 to 6 hours 131° at 0.23 knots, for 6 to 12 hours 277° at 0.10 knots, and for 12 to 18 hours 046° at 0.07 knots. When summed in vector
fashion the resultant wind driven current existing at the time of the incident becomes 125° at 0.15 knots.

Figure 7-1 Vector Addition in Wind Driven Current Calculation

\[ \begin{align*}
1 & \quad 131^\circ @ 0.23 \text{ knots} \\
2 & \quad 277^\circ @ 0.10 \text{ knots} \\
3 & \quad 046^\circ @ 0.07 \text{ knots} \\
R & \quad 125^\circ @ 0.15 \text{ knots}
\end{align*} \]

Source: 'After' Reference 10

The resulting wind driven current will be right of the downwind direction in the northern hemisphere, and left in the southern hemisphere. The calculations involved in determining the wind driven current, although not excessively complicated, would not be appropriate should control of the search be exercised from a merchant vessel. An alternative method of allowing for wind driven current in such cases is suggested in para 7.5.2.

(c) Sea Current

The sea current referred to in SAR planning is that current existing in the open sea, other than that caused by local tides or winds. The general source of information on sea currents that may exist in any oceanic area has been current charts which provide historical information. The National SAR Manual states: "This information.....will only tell you what the sea currents were in the past, not necessarily what they are at present. However, the odds are that existing currents will be similar to their climatological history."(19) This confidence is not universally shared. People have questioned the value of such charts which record what has happened and are not an accurate forecast of what may happen.(20) and (21) It has been noted that current charts are compiled from all available sources extending over as many years as possible, and they do not show whether the general circulation varies from year to year or over a period of years. Evidence shows such variations do exist.(22) Sea current varies with depth, and vessels of different draughts sailing in the same area may be differently affected. Similarly the standard of navigational accuracy, for determining both deduced and observed positions, has varied not only between vessels but as navigational systems have
developed over the years. Although current charts have been produced on the best data available at the time, by modern standards much of the data would have been of poor quality. Additionally, reporting vessels, upon whose information current charts have been produced, would have no means of separating sea current from wind driven or tidal current, currents dependent on the meteorological and astronomical conditions existing at the time of observation.

In compiling a data base for SARP and CASP (see para 7.2.2) historical information on sea currents was used. Where possible up to date sea current information, from ship reports recently received, is fed into the program. The search co-ordinator then has the opportunity to compare the two sets of data and decide what sea current data he wishes to use in his planning. It has been noted that the two sets of data are often grossly at variance with each other. Extensive sea current trials have been carried out by the United States Coast Guard Research and Development Center. In these trials satellite-tracked drift buoys were dropped into the Gulf Stream off Florida. The paths followed by these buoys appeared to be random. Some behaved as predicted, following the popular concept of the movement of the Gulf Stream, while others travelled in the reverse direction or described circles over a month or more with very little lateral movement. In the future, for major searches controlled from ashore, the use of satellite-tracked drift buoys during the search could possibly provide the best means of assessing drift in the search area. How sea current could be assessed during a search co-ordinated from a merchant vessel is considered in para 7.5.2.

(d) Tidal Current. The vertical tidal movement of the seas is caused by lateral movement of water towards the regions of high tide, and away from the regions of low tide. This lateral movement results in tidal currents, which are normally of the reversing type. That is, they flow in one direction for the duration of rising tide, and in the reverse direction for the duration of falling tide. Over a period of time tidal currents, especially in the open ocean, may be self cancelling, but near land variations may exist in the duration and strength of the tidal current in the opposing directions. Use is made of tidal stream predictions, and observations, in planning some search and rescue operations in coastal waters.
(e) **Datum Marker Buoys** When designated search and rescue aircraft are taking part in a search, free floating marker buoys will often be dropped at datum. These buoys transmit a signal on UHF radio frequencies, enabling search aircraft to plot the movement of the buoy, and hence determine the surface current existing in the search area. Initially navigational inaccuracies on the part of the search aircraft often result in a false estimation of the actual surface current, but in protracted searches, averaging over several days will give satisfactory results.

7.3.3. **Datum Errors** If there were errors in neither the datum nor in the search vessel's navigation, it would be possible to find the casualty without search. In practice a range of errors will exist, the extent of which will determine the size of area to be searched. A root mean square procedure is usually adopted (24), in which total predictable error is deemed to be the square root of $D^2 + X^2 + Y^2$, where $D$ is the total drift error, $X$ is the initial position error, and $Y$ the search vessel error.

(a) **Drift Error** Each component of the drift, such as leeway and sea current error, is liable to individual error, both in direction and dimension. Search planning is in any event based on assumptions and generalizations, and a further generalization is usually made in determining the likely maximum error applying to any component. This is taken to be $\frac{1}{10}$ of the drift distance. It is claimed that "As a practical matter this assumption has been reasonably verified over many years of search planning"(25). As individual errors may be cancelling or cumulative they should be summed to produce the total drift error.

Where it is possible to set upper and lower limits to the error that may apply to each element of the total drift calculation, a minimax approach is often adopted. In this the two datums allowing for maximum and minimum drift are determined and plotted, each with their individual $\frac{1}{10}$ drift distance error circles. The minimax drift error then becomes the radius of the circle that encompasses the two smaller circles.

(b) **Initial Position Error** When an initial position for the incident has been given, it will be necessary to ascribe a measure of confidence in the accuracy of that position. Much will depend on
the source of the information. If the information has been originated by the casualty the contents of the distress message may give some guidance, (see para 6.2.2), as to the accuracy. Without such guidance assumptions again have to be made. A well-found modern ship should, in theory, be capable of navigating to the standards of accuracy recommended by the International Maritime Organization (IMO)(26). These standards suggest that the navigational equipment fitted should be capable of providing a position accurate to 4% of the distance from the nearest hazard, and not less than 4 miles in any circumstance. Theory and practice may not meet. Even if the equipment carried has the recommended capability it may not be matched by similar capabilities on the part of the operator.

France and the United Kingdom have proposed to IMO that the Safety of Life at Sea regulations be amended to require ships to be fitted with an electronic position fixing system, but the majority of members were against the proposal, which was turned down in 1983. (27) Many vessels will not carry such equipment and will be unable to meet the standards of navigational accuracy suggested by IMO. Even if modern navigational equipment is carried errors can still be made in the stress of an emergency situation. The modern and well equipped German vessel Muenchen sank in the Atlantic, with the loss of all aboard, in December 1978. Evidence at the subsequent court proceedings in Bremerhaven suggested that the distress position transmitted by Muenchen was 100 miles in error!(28)

In June 1983 the Maritime Safety Committee of IMO instructed its Safety of Navigation sub-committee to prepare terms of reference for a study on the development of a world-wide satellite position fixing system for providing accurate positional information for the Future Global Maritime Distress and Safety System (FGMDSS). IMO has now adopted the COSPAS/SARSAT satellite system to provide such information in the future (see also "Black Box Implications for the Improvement of SAR", reproduced at Annex A). But doubt has been expressed whether COSPAS/SARSAT will provide the accuracy required. According to Johnson,(29) the system has its problems. Although it seeks to provide a 95% probability of positional accuracy within 20km, it is suggested that 10% of the positions obtained have an error greater than 50km. Further, because of interference, there is
a 40% probability of not getting enough information from the originating signal, on one pass of the orbiting satellite, to obtain a fix.

The USCG SAR Manual provides tables of navigational accuracy to be used in search planning in the absence of better information. These tables suggest, for example, that a fix obtained by a merchant vessel is assumed to be accurate to 5 miles, while that for a single engined aircraft is accurate to 10 miles.

(c) Search Vessel Error. The SAR Manual further suggests that the navigational accuracy tables be used to assess search vessel fix error. Additionally, if the search vessel has to proceed by deduced reckoning, positions so obtained should be assumed to be in error by a distance equal to 5% of the deduced distance run since the last fix. These two errors are applied cumulatively to determine the search vessel error.

7.3.4. Search Radius. Once the total probable datum error has been determined a search radius is calculated, the search radius being the product of the total datum error and a safety factor. The safety factors recommended by the SAR manual vary from 1.1 for a first search up to 2.5 for a fifth search. This range of factors is necessary because should an initial search be unsuccessful, failure could have resulted from the target being outside the search area. Further searches may then be carried out, over increasingly large search areas using recalculated datums, each with its own total datum error and appropriate safety factor, to determine search radius. A circle of the search radius, centred on datum point, is drawn, and the search is conducted to cover a square enclosing the circle and aligned in the direction of drift. An example showing progressive search areas for a moving datum point is given in figure 7.2 below.

Figure 7.2 Successive Searches With Moving Datum Point

Source: Reference 10

Figure 8.25
7.3.5. **Determination of Detection Range** The range at which a target may be detected depends on many factors including:

(a) the means of detection being used, for example; visual, radar, electronic homing,

(b) whether location aids such as: flares, smoke, Electronic Position Indicating Radio Beacon (EPIRB), radar transponder beacon, are being used,

(c) the characteristics of the target and the search vessel,

(d) the environmental conditions applying at the time of search, for example: day or night, state of visibility, sea state.

If the target is large the potential for detection is increased. Radio homing may be possible, and in any event, most search vessels will be fitted with radar and long range detection by radar is a strong possibility. But over 90% of SAR operations carried out at sea are searches for craft <65 feet in length, including lifeboats and liferafts.(33) The location of such small low profile targets will not always be easy by radar, although the carriage requirements of the FGMDS do include provision of radar transponders for survival craft,(34) and this should aid detection in the future. Visual search may often remain the primary means of detection.

7.3.6. **Visual Detection** The National SAR manual gives general information on the factors affecting the visual detectability of a target.(35) Size, shape, distance, its colour and brightness contrast with the background, its movement and its duration of exposure to an observer, all play a part. Not only should small objects be within the visible horizon of the observer, but the observer's visual perception and acuity will also limit the range at which small objects can be sighted.

It was suggested, in para 6.2.3, that when searching for survivors in survival craft, the detectability of the search vessel from the survival craft was perhaps of greater initial importance than the detectability of the survival craft from the search vessel. This was on the assumption that alert potential survivors would be able to activate visual location aids to enhance their detectability when they sight the searchers. From close to sea level, in good weather conditions, it should be possible to sight a small merchant vessel at four miles range. The ranges at which various visual location aids may be sighted is given in the National SAR Manual (36) which suggests:
(a) Heliographs are effective out to the visible horizon, provided the sun is visible to the survivor.
(b) Orange smoke in calm conditions is visible on average at 8 miles range, with effectiveness decreasing rapidly once the wind exceeds 15 knots.
(c) Pyrotechnic flares may be detected at 25 miles range by night, and 2.5 miles range by day.

These suggestions are based on reports following successful rescue operations rather than on any scientific assessment, and their validity has been questioned. During 1984 the US Coast Guard R & D Center carried out evaluation trials on a selected range of visual distress signalling devices, of the type which may be available to persons in distress in small craft or survival craft.(37) The devices tested included:

<table>
<thead>
<tr>
<th>Device</th>
<th>Altitude</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand Held Orange Smoke Flare</td>
<td>N/A</td>
<td>50 sec</td>
</tr>
<tr>
<td>Hand Held Red Flare</td>
<td>N/A</td>
<td>2 min</td>
</tr>
<tr>
<td>12 Gauge Red Pistol Flare</td>
<td>200 ft</td>
<td>6 sec</td>
</tr>
<tr>
<td>25 mm Red Pistol Flare</td>
<td>1000 ft</td>
<td>25 sec</td>
</tr>
</tbody>
</table>

It was determined that the detectability was dependent on a number of factors including:

(a) the ambient light conditions, which affect signal/background contrast,
(b) the range, which affects the visual impact of the signal
(c) meteorological visibility, which affects the attenuation of emitted or reflected light from the signal, and
(d) wind speed, which affects the effectiveness of smoke flares.

Selected trial results include:

<table>
<thead>
<tr>
<th>Table 7.1 Short Range Daytime Detection Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Hand Held Orange</td>
</tr>
<tr>
<td>Smoke Flare</td>
</tr>
<tr>
<td>12 Gauge Red Flare</td>
</tr>
<tr>
<td>Red Flare</td>
</tr>
</tbody>
</table>
In all cases it was easier to detect the distress signals in overcast conditions than it was in sunny conditions.

Table 7.2 Short Range Night Detection Rates

<table>
<thead>
<tr>
<th>Device</th>
<th>Visibility (miles)</th>
<th>Range (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;1.5</td>
<td>1.5 - 3</td>
</tr>
<tr>
<td></td>
<td>3 - 4.5</td>
<td>4.5 - 6</td>
</tr>
<tr>
<td>Hand Held</td>
<td>3.7 - 5</td>
<td>75%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>Red Flares</td>
<td>8 - 10</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>84%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>93%</td>
</tr>
<tr>
<td>12-Gauge Red Flares</td>
<td>3.7 - 5</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75%</td>
</tr>
<tr>
<td>Red Flares</td>
<td>8 - 10</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

The trial indicated there was no strong evidence that pyrotechnics 'burned' their way through poor visibility, despite the fact that 12 gauge red flares were apparently more readily detected towards the limits of poor visibility. The total trial sample of 12 gauge red flares used during the 3.7 to 5 mile visibility trial was only 36, and the investigator gives as a possible explanation for the anomaly the ability of the flares to rise above low ground mist that was present at the time of the trial.

Table 7.3 Long Range Night Detection Rates

<table>
<thead>
<tr>
<th>Device</th>
<th>Range (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 - 8</td>
</tr>
<tr>
<td>12-Gauge Red Flares</td>
<td>100%</td>
</tr>
<tr>
<td>25 mm Red Flares</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>12 - 14</td>
</tr>
<tr>
<td>12-Gauge Red Flares</td>
<td>92%</td>
</tr>
<tr>
<td>25 mm Red Flares</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During this part of the trial visibility was 10 miles or better.

The trials showed that it was much easier to detect distress signals by night than by day. The fact that search for survivors is easier by night than by day is not well understood by merchant ship officers, and needs to be emphasised. During daylight, the probability of detection at ranges beyond 4.5 miles was marginal (<25%), and the investigator specifically noted "...during the day with the sun shining no visual distress signalling device was detected well except at ranges below 1.5 miles, even by alerted observers".(38)

7.3.7. Area Coverage In planning a search, RCCs often wish to have a measure of the effectiveness of the search. This will depend upon the size of the search area, and how the available search effort is used.
In determining how best to use the available search effort four related factors may be considered. These are: track spacing, probability of detection, sweep width, and coverage factor.

(a) **Track spacing** is simply the distance between adjacent search tracks. It is clearly defined in MERSAR (39), and from the evidence of the Navigation Control Course is well understood by ship's officers.

(b) **Sweep width** (see para 6.2.5) is described as being a mathematically expressed measure of detection capability having account of the target characteristics, weather, and other limitations.(40) It is a single measurement of distance defined as,

\[ \text{Sweep Width} = \int_{-\infty}^{\infty} P(x)dx \]

where \( x \) is the lateral range or closest point of approach to target and \( P(x) \) is the probability of detection at range \( x \).

Edwards states "conceptually, sweep width is the numerical value obtained by reducing the maximum detection distance of any given sweep so that scattered targets which may be detected beyond the limits of the sweep are equal in number to those which may be missed within those limits."(41) Edwards has identified 25 parameters having a potential influence on sweep width,(42) some are intangible, such as quality of lookout, and for normal planning purposes sweep width tables are used. The following extracts, evolved by reference to the HM Coast Guard SAR Graphs and Tables are given by way of example:

Table 7.4 **Sweep Width for Visual Search**

<table>
<thead>
<tr>
<th>Visibility</th>
<th>Target Height of Eye</th>
<th>Liferaft 30ft</th>
<th>Liferaft 50ft</th>
<th>Liferaft 70ft</th>
<th>40ft Boat 30ft</th>
<th>40ft Boat 50ft</th>
<th>40ft Boat 70ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 miles</td>
<td>30ft</td>
<td>1.1</td>
<td>1.2</td>
<td>1.2</td>
<td>3.2</td>
<td>3.0</td>
<td>4.2</td>
</tr>
<tr>
<td>5 miles</td>
<td>1.5</td>
<td>1.6</td>
<td>1.6</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>10 miles</td>
<td>1.8</td>
<td>1.9</td>
<td>1.9</td>
<td>6.3</td>
<td>6.2</td>
<td>6.2</td>
<td>6.2</td>
</tr>
<tr>
<td>20 miles</td>
<td>2.1</td>
<td>2.4</td>
<td>2.4</td>
<td>8.7</td>
<td>8.8</td>
<td>8.9</td>
<td>8.9</td>
</tr>
</tbody>
</table>
In poor light or rough seas the sweep width should be reduced, and correction tables also exist giving correction factors to apply to the tabulated sweep widths. For example:

Table 7.5 Whitecap Correction Factor

<table>
<thead>
<tr>
<th>Windspeed (kts)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liferaft</td>
<td>0.8</td>
<td>1.0</td>
<td>0.7</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>40ft Boat</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
<td>0.7</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Table 7.6 Lighting Correction Factor

<table>
<thead>
<tr>
<th>% Cloud Cover</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud Cover Factor</td>
<td>1.1</td>
<td>1.1</td>
<td>1.0</td>
<td>1.0</td>
<td>0.9</td>
<td>0.7</td>
</tr>
</tbody>
</table>

It is noted that whereas visual distress signals are more easily detected by day when it is overcast (see Table 7.1), Table 7.6 suggests that when visual location aids are not used, targets are more readily detected when the sky is clear.

Using the above extracts the sweep width when searching from height of eye of 50ft for a liferaft, with meteorological visibility of 5 miles, windspeed 20 knots, and sky overcast, would be:

\[1.6 \times 0.7 \times 0.7\] nautical miles, that is 0.8 nautical miles.

while when searching for a 40ft boat, from the same height of eye, with meteorological visibility 10 miles, a clear sky and light breeze, the sweep width would be:

\[6.2 \times 0.9 \times 1.1\] which is 6.1 nautical miles.

(c) **Coverage Factor** is a measure of the potential effectiveness of the search of the area being searched. The target may not be within that area, or through navigational limitations search units may have difficulty in following precisely their intended tracks, so a high coverage factor is not necessarily accompanied by location of the target. Coverage Factor is Sweep Width divided by Track Spacing.
(d) **Probability of Detection** is subject to a wide range of variables, and in initial search planning it is often coverage factor, rather than probability of detection, that is used. The National SAR Manual provides a graph, reproduced as figure 7.3 below, plotting probability of detection against coverage factor for single and repeated searches. It does not explain how the graph was derived, though this could have been through best fitting success curves on analysis of completed searches. In determining the coverage factor achieved, use will have been made of existing sweep width tables. Recent research shows a need for improved sweep width tables, taking special account of the reduction in search effectiveness with time on task. (43)

![Figure 7.3 Probability of Detection](image-url)

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**Figure 7.3** Probability of Detection

Source: Reference 10 Figure 8-65
7.4. **Time Factors in Search Planning**

7.4.1. **Survivability** The chances of locating survivors of a maritime incident decrease with time, and it is widely recognized that early positive and proper action is required in response to any distress. Records show that an injured person's survival chances decrease as much as 80% in the first 24 hours following an accident, and the survival chances of uninjured persons rapidly decrease after the first three days.\(^{(44)}\) This concept is encapsulated in the following quote from the National SAR Manual: "Studies have shown that the period within 12 to 24 hours of a distress incident is the most critical for recovery of survivors....within 48 hours the chances are still good, but after that time the chance of successful recovery decreases rapidly."\(^{(45)}\) Adverse environmental conditions, such as extreme cold or rough seas, will accelerate the reduction in survivability and will also degrade the quality of the search for survivors.

7.4.2. **Quality of Search** While the probability of detection of a target depends on many factors "A key ingredient to effective search and rescue planning is an accurate prediction of the performance of the search units in the conditions existing in the search area. Overestimating detection performance may result in premature termination of the search in a particular area, while underestimating detection performance may result in the search of any particular area being extended unnecessarily."\(^{(46)}\) Whether the search is purely visual, or includes radar, direction finding, or other location aids, the human element on the search units will be of primary importance. The quality of search will be better when the searchers are alert, experienced, and motivated, and will decrease when the searchers become fatigued or stressed in any way, and when they lose motivation. The quality of search will normally reduce with time on task.

Edward's research into US Coast Guard visual detection performance indicated that the probability of detection \(P(x)\) of a target at lateral range \(x\) was 0.95 at the start of a search. After six hours on task the probability of detection reduced to 0.81.\(^{(47)}\) The subjects of Edward's research were trained seamen in a dedicated SAR force, subject to military discipline. Their skill and motivation in performing SAR tasks may well be higher than that of merchant seamen, and on merchant ships the decrement through time in the quality of search is probably greater.
7.5. Improved Search Planning from Merchant Vessels

7.5.1. The General Requirement The need to improve the guidance given in MERSAR, so that search planning carried out aboard merchant vessels could become more effective, was stated in para 7.1.2. It was also recognized that any additional guidance should be easy to follow, for many shipmasters will lack experience or training in SAR techniques.

The scenarios in which it may be necessary for search planning to be undertaken from merchant vessels are limited both in time and scope. Although the use of merchant vessels in search and rescue may be widespread, and of great significance, they will usually be engaged as search units of opportunity. Their primary role is other than to undertake SAR tasks and their major participation in any operation will seldom extend beyond the early stages of the search, the stages when the chances of locating survivors are greatest. When searches are continued past that time merchant vessels may still be used, but more likely in a secondary role, perhaps by maintaining enhanced standards of vigilance while passing through the search area. Secondary search and rescue will not necessitate search planning aboard the merchant vessel.

The most extensive SAR planning tasks likely to face a ship master are in responding, in the initial stages of an incident, to a distress in which the position of the casualty is known with some accuracy, and is within a relatively short steaming distance of his own vessel. In such a case he may need to determine datum, search area, and track spacing. A lesser degree of search planning may face a ship master tasked by an RCC to act as co-ordinator surface search in a designated search area. In meeting this task he may need to determine track spacing.

7.5.2. Determination of Search Datum The principal factor in determining a search datum when responding to a distress, in which a position has been given, is the assessment of how the casualty may drift between the times of the incident and of the arrival of search units. The difficulties in making this assessment from an RCC ashore, remote from the scene of the incident, were stated in para 7.3.2. In an attempt to resolve the problem generalizations and assumptions are made. Drift is broken down into component elements taking account of recent meteorological conditions, as well as historical data, and a 12% error
allowance is commonly applied to each element. The same difficulties need not exist for an on scene co-ordinator.

At para 7.3.2.(c) it was noted that ship reports recently received were used in computer aided search planning. Such reports are often the best information available, and ships responding to a distress will be in an excellent position to assess the total environmental drift they are experiencing in the area of search. How this may be done will vary from ship to ship, and incident to incident. On many ships set and drift is calculated on a daily noon to noon basis, while weather conditions may vary sufficiently within a twenty four hour period for the calculation not to be completely accurate: in the absence of better information the calculation could still be used for planning purposes. Between the time of receiving the distress alert and arriving at the scene of the incident, the opportunity will often arise to obtain a positional fix. The increased use of satellite navigation in the open ocean heightens this possibility. A master should then be able to determine the total environmental drift his vessel has experienced since previous fix was obtained. If a fix can be obtained by reference to a fixed terrestrial object within radar range, radar plotting on a sea stabilized radar will give an immediate indication of the environmental drift being experienced. Such a situation existed in the simulated SAR exercise 3, analysed in Chapter 5. Regardless of how environmental drift is determined, the information can be used to predict the movement of the casualty between alert and start of search. If it is not possible to obtain fixes, the vessel responding to the distress alert is effectively navigating by dead reckoning. In this event no allowance has to be made for drift, on the assumption that in the interval between response and arrival at the scene of search, both casualty and searcher will have been equally affected by wind and current. This assumption may not be entirely correct as the response to wind of a vessel not under power, and distressed vessels will usually be in this category, can be quite different from the leeway experienced by a vessel making way under power.

7.5.3. Datum Errors Whether the search planning is conducted ashore or afloat, allowance must be made for datum errors when determining the search radius. The root mean square procedure used to calculate total predictable error was outlined in para 7.3.2. A simplified approach
would be appropriate for use by ship masters called upon to undertake search planning.

(a) Drift Error The principal cause of drift error, in datum calculations carried out aboard a vessel in the area of search, will be in determination of the effect of leeway. In para 7.3.2.(a) it was noted that the rate of leeway drift could be up to 0.07 x wind speed for some small craft having a high freeboard to draught ratio. A similar rate of drift, up to 0.06 x wind speed, has been observed with large vessels in ballast condition (48). Both in the case of large and of small vessels the direction of leeway drift will be off the wind, perhaps by 30° when wind and current are in similar directions, and by 60° when the wind and current directions are opposite. Whether the off down-wind deviation is left or right of the down-wind direction is thought to depend on the direction of the ship's head. With the wind on the port side the sailing will be to one side of the wind, and with the wind on the starboard side it will be to the other side of the wind. The tolerance to error when searching for large targets, which are likely to be radar detectable, will be greater than when searching for small targets, for which the primary location means may be visual. For this reason it will be sufficient to consider only the worst case small target situation.

In the worst case the target may have experienced leeway drift at a rate between 0.025 and 0.07 x wind speed, and may be up to 60° off the down-wind direction. The estimation of drift, made from the search vessel, will include both the effects of current and leeway (see para 7.5.2), and the leeway element of such combined drift will be between similar speed limits but for a vessel under power may be deemed to be in a down-wind direction. The situation described is shown in figure 7.4.

Figure 7.4 Leeway Drift Error

AB is arc radius 7 units centred at 0
DE is arc or radius 2.5 units centred at 0
AC is approximately 6 units
Search vessel is on line BB
When conducting search planning aboard a merchant vessel, close to the scene of the incident, the drift error may be assumed to be $0.06tW$, where $t$ is time interval in hours between alert and arrival at datum, and $W$ is wind speed in knots.

(b) **Initial Position Error** Datum error will be the square root of $D^2 + X^2 + Y^2$ (see para 7.3.3.). In assessing datum error in any particular case there will be four variables, namely time, wind speed, search vessel position error, and initial position error. It is not possible to represent four variables in simple tabular or graphical form. To overcome this difficulty, it is proposed that an assumption be made relating to initial position error, and the error value be treated as a constant. The justification for this proposal is twofold. Firstly, despite the recommendation of para 6.2.2, initial position error will be the variable of which the co-ordinator surface search has least certain knowledge. Secondly, a similar assumption is made in the more sophisticated search planning techniques adopted by RCCs ashore. It is suggested in the HM Coast Guard planning data (49) that the initial position fix error for a vessel >65 feet in length should be 5 miles, while that for a vessel <65 feet in length should be 15 miles. These values are clearly quite arbitrary, as it cannot be presumed that the navigation of a vessel 64 feet 11 inches in length is three times less accurate than the navigation of a vessel just 2 inches longer. Even though 90% of maritime searches are for vessels <65 feet in length (see para 7.3.5), such vessels may well be the survival craft of larger ships from which the initial distress position has been given. More importantly, the adoption of an initial position error much greater than 5 miles will so enlarge the resulting search radius as to put the subsequent search beyond the normal scope of a merchant vessel controlled operation. It is therefore proposed that the initial position error be taken as 5 miles for planning purposes. Simplified graphs can then be constructed, for possible inclusion in MERSAR, to be used in determining a suitable search radius.

7.5.4. **Search Radius** In calculating a suitable search radius a safety factor of 1.1 should be used, following the practice adopted by RCCs in
determining the search radius for an initial search. Search radius then becomes:

$$1.1 \times \sqrt{(0.06tW)^2 + 5^2 + Y^2}$$

The value of $Y$ will depend upon the navigation system being used by the search vessel, which in turn depends on the vessel's navigation equipment fit and the system coverage in the area in which the incident takes place. Graphs showing search radius against wind speed and time interval between alert and arrival at datum, for $Y$ values of 1 and 4 nautical miles are given at Figures 7 - 5 and 7 - 6. Four miles has been chosen as an upper limit because it is the minimum standard of navigational system accuracy recommended by IMO (see reference 26), while one mile has been chosen as the standard of navigational accuracy now widely obtainable. The Omega navigational system, for example, provides world wide coverage to a claimed 95% probability accuracy of one mile by day and two miles by night, provided fixed error corrections are properly applied.

Figure 7 - 5  Search Radius For 4 Miles Own Ship Position Error
Search Radius

<table>
<thead>
<tr>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>14</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>7</td>
</tr>
</tbody>
</table>

Source: Author
In using the graphs to determine search radius for intermediate values of wind speed and time interval, linear interpolation will always produce a small error on the side of prudence. For example: if the wind speed were 15 knots, the time interval 6 hours, and the own ship position error 4 miles, the search radius read from the graph would be 9.3 nautical miles. The search radius for the same conditions calculated using the full equation would be 9.2 nautical miles. Similarly, interpolating for values of own ship position error between 1 and 4 miles also errs on the side of prudence. If in the example used above the own ship error had been 1 mile, the search radius read off the graph would be 8.2 miles. Linear interpolation between 9.3 and 8.2 miles gives a search radius of 8.8 miles for an own ship position error of 3 miles. The full calculation in this case gives 8.7 miles.

From the search radius the area of search is determined, as described in para 7.3.4.
7.5.5. **Track Spacing** The need for improved guidance on the selection of a suitable track spacing for a search was suggested in para 7.1.2. Casualty location by electronic means, such as radio direction finding and radar, may be largely independent of whether the search is conducted by day or night. That the Future Global Maritime Distress and Safety System carriage requirements include provision of radar transponder beacons increases the future prospects of casualty location by electronic means. For the immediate future, however, primary casualty location from merchant ship search units will in most cases be by visual means. Visual location will be significantly dependent on whether the search is being conducted by day or night. It will also be dependent on the nature of the target and on the weather conditions existing in the search area, particularly visibility and wind and associated sea states.

It has been suggested, in para 7.3.6, that by day survivors in a liferaft, or boat, close to sea level, should be able to sight a searching merchant ship from 4 miles range. Visual detection trials also indicated, see para 7.3.6, that by day the probability of detecting visual distress devices beyond 4.5 miles range was marginal. It would be reasonable to accept 4 miles as the upper limit for visual detection, by day, of a target <65 feet in length, and from this a suitable track spacing can be deduced. One possibility is shown in diagrammatic form in figure 7-7.

**Figure 7-7** **Track Spacing For Daylight Visual Search**

![Track Spacing Diagram](image-url)
Assuming a maximum daylight detection range of 4 miles, and using a 5 mile track spacing, the search vessel will steam a minimum of 3.2 miles before bringing abeam any target passing within the track spacing. At a search speed of 20 kts any target will have been within detection range for at least 9 minutes before being brought abeam. For a search speed of 15 knots the time will have been in excess of 12 minutes, and clearly opportunities for detection continue once the target has passed the beam of the search vessel. Should environmental conditions reduce maximum detection range below 4 miles the appropriate track spacing may be read direct from the diagram.

Maximum detection range may be reduced by causes other than reduced meteorological visibility. Bright sunlight reduces the effectiveness of visual distress signalling devices, but any reduction may be compensated by the target itself being visually detectable at greater range. The elevation and relative direction of the Sun will also have a significant effect, detailed consideration of which would needlessly complicate the issue for practical purposes. Wind speeds in excess of 25 knots will reduce the effectiveness of the search in two respects. The first is whitecap factor, as indicated in Table 7.5, and the second is that the quality of lookout may be expected to reduce when searching to windward from a vessel which is not providing a stable platform.

It may be known that the target being sought is not a liferaft, or other small craft, in which case an increase in track spacing can be justified. To make allowance for all these variations in track spacing figure 7 - 7 should carry the following qualification:

When searching, by day, in meteorological visibility better than 4 miles, for survival or other small craft targets, a track spacing of 5 miles may be used. If meteorological visibility is less than 4 miles track spacing should be reduced, as indicated in the figure.

When wind speed exceeds 25 knots the track spacing appropriate to the visibility should be reduced by a quarter, and when wind speed exceeds 30 knots track spacing should be reduced by a half.

Track spacing may be increased if it is known that the target is large and visibly detectable beyond 4 miles. The ratio between track spacing and detectable range should not exceed 5 : 4.
Potential survivors, in liferafts or small boats, may expect to sight searching vessels at greater range by night than by day. The range at which a merchant ship's navigation lights can be seen will depend on the height of the lights, and on their intrinsic brightness. By night measures should be taken to make search vessels as visible to survivors as possible (50), and it would not be unreasonable to expect a searching merchant ship to be visible at 6 miles range from close to sea level. Additionally, pyrotechnic distress signals are visible at far greater ranges by night than by day. To allow for the enhanced detection prospects that attach to a night search the annotations to figure 7-7 should also state:

When searching, by night, for liferafts or other small craft, in meteorological visibility greater than 6 miles, track spacing may be increased to 7.5 miles.

7.5. **Coverage** Having determined datum, search radius and area, and track spacing, the Co-ordinator Surface Search should next calculate how long it will take to complete the search with the forces available, and at the individual search speeds being used. The scenario for the use of merchant vessels in search and rescue, given in para 7.5.1, has to be borne in mind, in particular that their effectiveness will decrease rapidly after the early stages of a search, as do the chances of survival for the distressed persons. If the forces available are more than adequate the CSS should consider first increasing the quality of the search by reducing track spacing, and secondly the quantity of the search by increasing the search area. It is generally better to search a small area well than a large area indifferently, for then if the first search is not successful subsequent searches can be concentrated on areas not already covered. For this reason, should the forces available for the task be inadequate, the CSS should think very carefully before increasing track spacing; an action which carries the inherent risk of reducing the quality of cover.

7.6. **Conclusions on Merchant Ship Search Planning**

The Merchant Ship Search and Rescue Manual should contain additional guidance to help masters called upon to co-ordinate a search. Such guidance should be simple as many ship masters will lack training or experience in SAR, (see para 7.1.2). Merchant ship involvement as CSS
in SAR is limited in time and scope, (see para 7.5.1.). The additional
guidance should include means to improve the determination of datum, as
outlined at para 7.5.2. The CSS needs to have a proper idea of datum
errors and hence the area to be searched, (see para 7.5.4.). Tables
similar to those produced at Figures 7-5 and 7-6 offer a simple method
of giving improved guidance on the area to be searched. The final
decision on which masters require additional guidance is the
determination of track spacing. Again, the solution can be presented in
a simple form such as Figure 7-7, with its accompanying qualifications.
As MERSAR is a manual of instruction, a worked example taking the master
through the stages of SAR from alert to rescue would be an asset.

References

(1) International Maritime Organization, Merchant Ship Search and Rescue
(2) ibid para 0.2.1.(b)
(3) Bill Barnes, Chief Instructor, HMCG School, Highcliff, Extract from
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(4) J M Parker, extract from letter Parker/Redfern dated 23 June 1982
(5) Ed Labuda, Lt Cdr USCG, Chief Maritime Instructor at USCG SAR School
Governor's Island New York, Extract from transcript of interview
Labuda/Redfern 29 March 1985
(6) Merchant Ship Search and Rescue Manual (see reference (1)), para
5.5.2
(7) ibid para 5.1.1
(8) ibid para 5.4.1.
(9) ibid para 5.9.4
(10) US Coast Guard, National Search and Rescue Manual, CG-308,
Superintendent of Documents, US Government Printing Office,
Washington DC, July 1973, with amendments 1 through 7. paras 810 to
819
(11) HM Coast Guard, SAR Graphs and Tables, HMCG Training School,
Highcliff, July 1983
(12) National SAR Manual (see reference (10)), paras 855 to 874
(13) ibid para 811(b)
(14) ibid para 811(g) and Figure 8.6
(15) Merchant Ship Search and Rescue Manual (see reference (1)), figure
5-3

162
National SAR Manual (see reference (10)), para 811(g)2

ibid para 811(b)

SAR Graphs and Tables (see reference (11)), Table 2

National SAR Manual (see reference (10)), para 811(i)


Air Ministry, Meteorology for Mariners. HMSO, London, 1956, p199


National SAR Manual (see reference (10)), para 816(a)

ibid para 816(b)


JOHNSON M A, A Satellite Based Automatic Distress Alerting System for Ships, unpublished MSc Thesis, University of Wales Institute of Science and Technology, Cardiff, 1985

National SAR Manual, (see reference (10)), Figures 8.17 and 8.18

ibid para 816 (f)

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National SAR Manual, (see reference (10)), para 845 (c) 2

ibid para 422
(37) ROBE R Q, and HOVER G L, A Static Evaluation of Selected Visual Distress Signalling Devices, US Coast Guard R & D Center, and Analysis & Technology Inc.,Groton CT, 1985

(38) ibid p 3-5

(39) Merchant Ship Search and Rescue Manual (see reference (1)) figure 5-1

(40) National SAR Manual (see reference (10)) para 843

(41) Analysis of Visual Detection Performance etc (see reference (33)) p 1-2

(42) ibid p 1-5

(43) ibid p 3-12

(44) National SAR Manual (see reference (10)) para 732

(45) ibid para 739

(46) Analysis of Visual Detection Performance etc (see reference (33)) p 1-1

(47) ibid p 3-6


(49) SAR Graphs and Tables (see reference (11)), p 6

(50) Merchant Ship Search and Rescue Manual (see reference (1)) para 3.9.5.
CHAPTER 8

CONCLUSIONS ON EFFECTIVE MARITIME SAR

8.1. The Nature of Maritime SAR

The main effort in locating and rescuing survivors of a maritime accident is borne by merchant shipping. While not a daily occurrence, this study has surprisingly shown that search and rescue is a task that will face most mariners at some time during their seafaring careers. The success or failure of search and rescue operations depends largely on the skill and knowledge of those taking part. The evidence of this study indicates that mariners in general lack the levels of skill and knowledge that the task merits.

Before survivors can be rescued they have to be found. The longer this takes the greater the probability that the task becomes one of recovering bodies rather than rescuing survivors, and successful search is arguably the most important element of the entire SAR operation. Accounts of well conducted merchant ship searches are hard to find, while reports of the reverse abound. This need not be so for an answer lies in the introduction of sound training in search and rescue. Through such training ships' officers may gain a knowledge of the facilities available to them, and an insight into the elements of a properly conducted merchant ship search operation. Appropriate training now forms part of the qualification requirements for ships' officers in the United Kingdom. This research further shows a requirement for the introduction and adoption of improved procedures for use in merchant ship searches. More significantly it reveals the pressing need to improve the guidance given in the Merchant Ship Search and Rescue Manual (MERSAR), which is the primary aid available to those called upon to take part in merchant ship search operations.

8.2. Training

Search and rescue is a matter of life and death, and as such it is not a task for which it is acceptable to train on the job. The study has shown that navigation simulators offer a valid means of providing dynamic training in SAR for ships officers, thereby ensuring that when
they meet the real situation they are not unprepared. Students recognize the validity of the training and highly rate their simulator experiences.

As the United Kingdom Department of Transport has taken the international lead in stating the requirement for SAR training, so has Plymouth Polytechnic taken the national lead in providing that training. The study reveals that not only was the training course at Plymouth the first to be offered, it was also more comprehensive than those subsequently offered at other maritime colleges in England.

By evaluating the course over a three year period the researcher has had the unique opportunity to determine the quality of the training offered, and hence make recommendations for improvement where they appear necessary. Many of the recommendations are transferable from the simulated training situation to the live situation at sea, greatly enhancing the overall value of the research.

At Plymouth 9 hours were allocated to the SAR element of the Navigation Control Course, and although a significant number of students (28%) would have liked further time devoted to SAR the overall conclusion was that the allocation was correct. It is highly desirable that every student should have the opportunity to serve as master of a ship during a simulated search and rescue exercise, and also, as it is commonplace to have three students per ship on the Navigation Control Course, this generates a requirement for a minimum of three SAR exercises during the course. The study revealed that this requirement was met only at Plymouth. 35% of Plymouth's students were content with three SAR exercises, the remaining 65% stating there was a need for more. Student competence improved as the course progressed, and the desire for more SAR exercises is linked to the desire for success on the part of those who had failed at an early stage of the course. Success is important in the eyes of the students, and exercises should end with successful search if possible. To meet the need for additional exercises without the allocation of additional time to SAR, it is recommended that situations such as interception, and single ship searches following a man overboard, be exercised during the navigation element of the course, leaving the SAR element to cover the more complex multi-ship search problems.

When new subject material is introduced into training syllabuses the question "who trains the trainers?" may be asked. SAR is such a subject.
Just as mariners in general lack the levels of skill and knowledge that performing the task at sea merits, so some lecturers will initially lack the background or awareness to instruct in the subject. This lack in no way reflects on their overall competence, and indeed lecturers in general continually seek ways to develop their abilities. The detailed analysis of merchant ship search and rescue contained in this study should provide an invaluable reservoir of knowledge for those who lecture in the area of SAR.

The study revealed the vital role of good communications in simulated multi-ship search situations. Communications will play an equally important role in the real life situation at sea, and are further considered in these conclusions at para 8.3.

The training course evaluated in this study exposed students to extensive use of MERSAR. Evidence recorded relating to recent SAR incidents indicated that in less than 10% of those incidents was MERSAR known to have been used. Admittedly at times, following a man overboard for example, location and recovery may have been speedy and MERSAR of little significance. But the fact remains that best use is not always made of the information available. If ships' masters had MERSAR behind them in their search planning, rather than behind them in the chartroom bookcase, many of the frustrations and failures commonplace in SAR would be avoided. This would be the single most significant step in improving the prospects of rescuing survivors from a maritime incident. The study showed that MERSAR search patterns can be very effective if intelligently applied. It also showed that MERSAR search patterns can have only limited effect if not adapted to suit any special circumstances that may exist.

While the training course exposed students to extensive use of MERSAR over periods of three weeks, it has, over several years, given the researcher an appreciation of the practical application of MERSAR that is unlikely to be paralleled elsewhere. From this appreciation it is concluded that MERSAR provides a sound basis for search and rescue, but the the manual has scope for amplification and improvement. Revision of MERSAR is considered at para 8.4.
8.3. The Role of Communications

The importance of good communications in multi-ship searches has been revealed clearly in this study. There are problems at two levels. Between mother tongue speakers succinctness and accuracy in communications may not exist, but training to overcome these difficulties may be relatively straightforward. Additionally, much communication lacks relevance to the problem being tackled, when seeking to determine which vessel is best suited to act as co-ordinator surface search for example. Standard formats to be used in inter-ship communication during multi-ship searches would not only reduce the problem, but would provide a framework for improving the effectiveness of merchant ship search and rescue. The need for further study in this area is indicated.

The problems highlighted above are compounded when multi-ship searches involve speakers of different nationalities without a common mother tongue. In such cases a working language has to be found and this will often be English. This can cause problems for all involved. For mother tongue English speakers extra discipline will be necessary so as to simplify the vocabulary and syntax of messages into a form acceptable to other language speakers. In their turn, other language speakers will need to exercise similar care to ensure their communications are clear and unambiguous. The importance of restricted vocabularies and precise procedures, such as those provided through the restricted marine navigational vocabulary and Seaspeak is clear.

The study has shown that while a large volume of signals traffic may indicate that communication has lapsed into conversation, with a corresponding loss of purpose, a low volume of traffic does not necessarily indicate good discipline and tight control. A lack of communications tends to indicate a lack of action. All participants in a multi-ship search like to feel they are playing an effective part in the operation. Brief but regular contact between co-ordinator and other vessels contributes to that feeling of effectiveness.

8.4. Revision of MERSAR

Recommendations for improvement in the content of MERSAR are made and justified in Chapters 6 and 7. These recommendations, which are
summarized below, are extensive but incomplete, and this is another area
where further research would be appropriate.

The proper selection of CSS may be the key to success of the search, and
it is suggested that the guidance on selection given in MERSAR should be
extended to include:

"The CSS mirrors on scene the role of an RCC ashore. To achieve
this it is desirable that the ship selected should provide a stable
platform and have good operations room facilities. It is important
that the CSS should have the language and radiotelephony facilities
required for communication with the ships participating in the
search."

and regarding the task of CSS:

"It will seldom be possible for one CSS to successfully co-ordinate
more than six search units. When a large number of vessels is
involved in the search consideration should be given to dividing the
search area into different sectors, each with a different CSS.
Note, it will be necessary for each sector to operate separate scene
of search radio frequency so as to avoid interference."

MERSAR should contain additional guidance to help ship masters called
upon to co-ordinate a search. Such guidance should be simple as many
masters will lack training and experience in SAR. The additional
guidance should include means to improve the determination of datum,
following the recommendations contained at para 7.5.2 of this thesis.
Guidance is then needed on the concept of datum errors from which it is
possible to determine the extent of the area to be searched. Tables
produced at Figures 7-5 and 7-6 of this thesis offer a simple method of
giving improved guidance on the area to be searched. The final decision
on which masters require more help is the determination of track spacing.
Again the solution can be presented in simple form, as at Figure 7-7 with
its accompanying qualifications.

In the matter of appropriate search patterns, the research shows the need
for more imaginative examples to be included in MERSAR. Further
reference should be made to whether searches should be sea or ground
stabilized, concepts well understood by ship masters. It is also
suggested that the emphasis on searching in formation made in MERSAR, is
out of place when considering search by merchant vessels. It would be
prudent to point out that multi-ship searches may be conducted by ships
proceeding in formation, but for merchant vessels the effort so expended is likely to be counter productive.

Finally, as MERSAR is a manual of instruction, a worked example taking the master through the stages of SAR from alert to rescue would be an asset.

The need for further study into standard communication formats for use during search and rescue was indicated in para 8.3. The results of such research would generate further addition to MERSAR. Similarly, it is suggested that the style of presentation of MERSAR would benefit from modernization. These factors combine to indicate that an overall rather than piecemeal revision of the manual is required. It is hoped that this study may have a part to play in such revision, and hence lead to improved effectiveness in maritime search and rescue.
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Search and rescue is both an art and a science and encompasses or draws from many diverse knowledge areas. (1)

Search and Rescue (SAR) operates in five distinct stages: awareness stage, initial action, planning, operations, and mission conclusion stage. The mission conclusion stage comprises a winding down process after successful, or unsuccessful, search. For dedicated SAR forces it will be characterized by restoring search units to readiness state, while for non-dedicated forces, such as merchant vessels, it will be characterized by the vessel resuming its passage or returning to its normal business. Other than for possible post-operation analysis of the concluded task, the black box appears to have no part to play in the mission conclusion stage. In all other stages, the likely implication of black box involvement in SAR in the future is to make the SAR task less an art and more a science.

The black box being considered by this paper is more than the flight recorder of popular image, passively waiting for an event to occur. It is instead the military concept of a black box; an active device, intended to produce a solution to a problem with limited user input.

Lloyd’s Register of Shipping Statistical Tables indicate that every year some 400 ships in excess of 100 gross registered tonnage will become totally lost. Most of these will have been subject of a search and rescue incident. When incidents which do not end in total loss, incidents involving vessels less than 100 gross registered tonnage, incidents involving aircraft, and incidents of a minor nature, such as man overboard, are taken into account the scale of maritime SAR, in which my interest lies, becomes large. SAR is a task that will face most mariners at some time during their seafaring career, it is a task for which they are ill equipped and which has in the past been poorly met. The reasons for this are varied but the quality of communications plays a key role in the success or failure of many SAR operations. Black box developments in communications give rise to hope that success may become more certain in the future than it is today.

Awareness Stage "The awareness stage is defined as the attaining of initial knowledge of the existence of an actual or potential emergency situation or incident." (2).

More than one hundred signals, many of which have international recognition, have been devised to indicate distress. For the maritime distress incident awareness will commonly originate with reception of a radio signal, often from the distressed vessel. The spark gap transmitters of yesteryear, propagating over a broad frequency band, were excellent means of alerting all within radio range of an emergency. But ships could be out of radio range of other ships or the shore, and if in range would other ships be maintaining a radio watch either manned or by auto-alarm? Additionally wireless telegraphy methods of alerting demand the presence of a trained radio officer at the receiving
station, "trained in the arcane knowledge of morse code, a code which belongs more to the last century than this one."(3) The number of ship stations operating without a telegraphist is increasing as alternative means of providing communications in an emergency are being developed. These ships are now deaf to cries for help on 500KHz WT.

"It has been said that only 60% of distress calls on 500KHz are picked up. I simply do not believe this. After 25 years at sea I have listened to ship after ship answering distress calls...time and time again I have been awakened by auto-alarm bells in many cases set off by ships thousands of miles away. Never once have I heard a distress call that no one else has."(4).

The quotation illustrates both extremes of the discussion now taking place on the future of shipborne communications. The discussion centres on the proposal to make satellite communications the cornerstone of the Future Global Maritime Distress and Safety System (FGMDSS). Ship to shore satellite communications through the International Maritime Satellite Organization (INMARSAT) are as simple and easy to make as using the telephone or telex between two offices on shore. Users confirm that the quality of communication is superb. Provision exists within the system for automatic distress alerting once the distress button is pushed, or command is given through the control teletype or keyboard. The distress message, which receives priority within the system, will identify the ship and through interfacing with the ship's satellite navigator or integrated navigation system may automatically also give her position.

Of course there are those who are sceptical about the claims being made regarding shipborne satellite communications. Users report having to alter course to a favourable heading before communications can be effected in heavy weather, not a good omen for a distress alerting system. And the above deck equipment is dependent on a stabilized antenna for which continual gyro inputs are required. Should the ship lose main power in heavy weather it may well be impossible to realign the antenna even if power is later restored. "The ship in trouble must therefore remain on an even keel, refrain from rolling violently, maintain main electrical power and adjust heading to prevent screening of the satellite."(5) On balance however user comment is favourable, and in any event INMARSAT provides for the future only one element of black box distress alerting potential. The other element is COSPAS/SARSAT.

Whereas INMARSAT utilises three satellites in equatorial geostationary orbit, each about 36,000 km above the Earth's surface, to provide almost complete cover of the 'navigable' seas, COSPAS/SARSAT satellites are in near polar orbit, at approximately 1000 km altitude. COSPAS/SARSAT became operational on 1 September this year after four years of field trials. It is still very much at the development stage but it has proved itself sufficiently to be adopted by IMO as an essential element of FGMDSS. The system shares many of the characteristics of the Transit Navigation System, in particular the use of doppler shift to determine position, a small satellite footprint with consequential gaps in coverage, and additionally the need for both alerting target and receiving Local User Terminal (LUT) to be within the usable footprint area. Currently there are LUTs in Canada, France, USSR, USA, Norway and UK. There are proposals for further LUTs in Brazil, India and Australia but existing cover is for northern waters only. These, of course, are
waters for which reasonable SAR alerting services already exist on the aeronautical distress frequencies 121.5 and 243 MHz used in COSAPS/SARSAT. The Rescue Co-ordination Centre (RCC) at Plymouth state they have yet to be involved in an SAR incident in which the only alert has been by Emergency Position Indicating Reporting Beacon (EPIRB) through the satellite. But the system does more than alert, it also indicates a position for the incident accurate to within 10 to 20 km.

Only 10 alerts can currently be handled 'simultaneously' by the satellite, and although this may seem a satisfactory number some 95% of alerts are false alarms, all of which have to be checked out. There has also been the case of a French fisherman deliberately operating his craft's beacon over a three day period to bring to attention a protest on his government's fishing policies. A little co-ordinated misuse of this sort would quickly bring the system into overload. The future lies in the more sophisticated EPIRB transmitting on 406 MHz, which IMO has adopted as part of GMDSS. Position will still be determined by doppler shift, but in the satellite rather than at the LUT after the downlink as at present. The satellite will be able to store details of signals, from a 100 or more sources, received anywhere within its usable footprint for relay to Earth when it comes within range of an LUT. The more remote parts of the world will thus fall within COSAPS/SARSAT alerting cover. Additionally by use of a hexadecimal message code EPIRBs will be able to provide details such as identity, location, and nature of distress, information which will be of immediate use in eliminating the many false alarms which will inevitably occur.

Through the use of black boxes as outlined above there will, in the future, be a more certain and earlier awareness that persons are in distress and require assistance.

**Initial Action Stage**  "The initial action stage...is the stage when the system commences its response to an incident...there are five operational events within the initial action stage (one of which is) SAR facilities alerted". (6)

In a maritime SAR incident merchant ships are the "first shot in the rescue organization's locker" (7) If the distress has been made on 500 KHz VT, 2182 KHz or 156.8 KHz RT, ships in the vicinity may well be aware of the incident and be already responding before the RCC ashore requests assistance. Of course there may be language difficulties on RT which confuse the situation, and the evolution of maritime English has its roots in such cases. If the distress has only been sent by INMARSAT and/or by EPIRB through COSAPS/SARSAT, then ships in the immediate vicinity of the casualty will be unaware that their assistance is required, until they have been alerted by a shore station. The black box potential for such alerting is most promising.

In the coastal waters off north west Europe mariners are already able to receive maritime safety information by NAVTEX. NAVTEX, which became operational in July 1983, is a single frequency time sharing telex system that requires no skill on the part of the end user. A small dedicated receiver provides for automatic reception, and rejection when appropriate, of navigational safety information including distress alerting. The user obtains the information in clear printed form, giving him a permanent record from which to work. The confusion resulting from ambiguities and misinterpretations inherent in voice communications should no longer exist when using this simple black box.
device. The success of NAVTEX on medium frequency (518 KHz) has lead to development of a similar service, through INMARSAT, for world wide application. The service will be through an Enhanced Call Group system in which users anywhere within the INMARSAT coverage areas will be able to receive navigational safety information appropriate to their needs. This will include distress alerting. The equipment required for this receive only facility is simple when compared with the full fit necessary when two way communications are required between shore and a ship earth station. In particular, the aerial of a receive only ship earth station (ROSES) can be small and non-directional, making it suitable for fitting in all types of vessels including yachts and open boats.

Addresssee selectivity, so that only vessels in the vicinity of the distress are alerted, will be possible through the enhanced group call system. But this will require an input from the user, reducing the 'blackness' of the box in automation terms. Perhaps the hands off element could be increased through a ship reporting system, such as AMVER, but in reality, after 28 years in operation AMVER can only be regarded as a partial success. It would be a rare occasion for more than 2,000 of the world's fleet of 80,000 vessels to be on the AMVER plot. There is customer resistance to voluntary reporting schemes, and when a similar scheme, JASREP, applicable to the north-west Pacific area was proposed at IMO last year not all nations were sympathetic to the idea. Automatic satellite position reporting schemes are equally unlikely to meet with favour. But overall the implications of increased black box involvement can only be a quicker response to distress calls, leading to a major improvement in search and rescue efficiency, as the chance of a successful outcome to any incident rapidly decreases with time.

Planning Stage "There are five specific events which normally occur sequentially during search planning. These events are: estimating the datum or most probable position of the SAR incident, determining the size of the search area, selecting the appropriate search pattern, determining the desired area coverage and developing an attainable search plan using the available search units." (8)

How black boxes may be involved in determining datum has already been considered. Increasingly the planning of searches at RCCs is being computer aided. This is of particular value in protracted searches, and when the probability of success needs to be weighed against many variables. To some extent, as the programmes written for use in RCCs are user friendly, this is a black box implication, but the product, in terms of additional lives saved, is not likely to be so widely apparent as in the awareness and initial action stages.

Operations Stage "During search operations facilities proceed to the scene and conduct search operations until distressed persons or craft are located or the mission is terminated."(9)

There are two elements of the operations stage to be considered, first, communication between participating search units, and then location of the casualty.

In recent years communication between search units has been primarily by voice on VHF and MF RT. There is strong evidence to suggest that for a variety of reasons the quality of communication is frequently
Poor. Typically the master of a vessel may operate the VHF, thinking on his feet, making no proper record of the message which can degenerate into conversation rather than communication. Problems with language and even dialect can hamper understanding, confusion and frustration then often results. The development of VHF and MF digital selective calling (DSC) and narrow band direct printing (NBDP), with keyboard entry for transmission and telex printing for reception of signals should remove many of the existent difficulties. More thought will go into what is transmitted, and a permanent record will exist of all traffic between search units. In brief, an important aspect of the search will become more effective as a result of black box developments.

Potential survivors have a greater interest in the success of the search than potential savours. Much responsibility for the success of the search thus rests with those in distress, provided they are able to make their presence known. In theory, especially in the early stages of a search before boredom dulls the searcher's senses, the activation of location aids by those in distress when they can see the searchers should guarantee rescue. Unfortunately this is not always so.

The FGMDSS provides for carriage of radar transponders, operating in the 9 GHz band, by vessels engaged on international voyages. This provision has the potential to greatly improve the prospect of locating survivors, not only during searches but also by chance. Many ships operate their radar continuously at sea, partly in response to Rule 5 of the International Regulations for Prevention of Collision at Sea, and it is difficult to conceive that a ship actually engaged in a search would not have its radar in use. That radar could in the future be operating in the ARPA mode with the guard ring facility providing visual and audible warning of newly acquired targets, such as the survival craft's radar transponder. An in band radar responder could perhaps be detectable for only some three or four sweeps of the search vessels radar scanner in each minute. Soon after acquisition it would become a lost target, setting off further ARPA alarms on a repetitive cycle until the casualty itself was detected by radar.

Carriage Requirements Without the grey box will the black box won't achieve its potential for making rescue more certain. Fortunately the IMO, in its FGMDSS, is showing it has the will. To ensure that others share that will, carriage requirements have to be adopted, and these now exist in draft form. The equipment costs for shipowners have also been estimated and compared with the equivalent costs of meeting existing Safety of Life at Sea (SOLAS) requirements. The costs vary, depending on the area of operation of the vessel and on the actual items of equipment selected by the owner from the range available. Costs can be expected to reduce as more manufacturers enter what will become a large market for sales, but at April 1986 prices they are summarized as:

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<tr>
<th>Requirement</th>
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<tr>
<td>To meet SOLAS 1974 requirements</td>
<td>8 to 57</td>
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<tr>
<td>To convert modern ship to FGMDSS</td>
<td>9 to 40</td>
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<tr>
<td>To equip new ship to FGMDSS</td>
<td>16 to 58</td>
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FGMDSS was scheduled for full implementation on 1 February 1990. Unfortunately a recent meeting of IMO's Maritime Safety Committee failed to reach agreement on how or when FGMDSS should be implemented. Delay now seems inevitable. The FGMDSS offers real hope for improved
efficiency in search and rescue and remains a bold venture which would not have been possible but for black box applications.

References:

(2) ibid para 700
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(4) R Wilson, The Telegraph, October 1986, NUMAST London
(6) National SAR Manual (ref A) paras 721/722
(7) Barnes, C1, HMCG School Highcliff, in interview with author 1985
(8) National SAR Manual (ref A) para 801
(9) ibid para 900
(10) IHO COM3/10 Annex 2, 1986
(11) ibid Annex 3
## Respondents Giving Details of SAR Experiences

<table>
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<th>Address</th>
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<td>Captain E H Gregson</td>
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<td>20 Feb 82</td>
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<td>W Stewart</td>
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<td>30 Apr 82</td>
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EQUIPMENT REQUIREMENTS

The following minimum outfit is required for the conduct of the course:

1. A marine navigational equipment simulator which has been awarded a Certificate of Type-Testing by the Department of Transport and which is installed in accommodation approved by the DTP.

2. The simulator shall drive, in real time, at least three own ship positions. Each own ship position shall be provided with:
   i. A basic radar display with trainee control of own ship manoeuvring.
   ii. Data from (a) a Decca Navigator (b) an MF/DF and (c) an echo sounder provided through real, representative, or graphic displays, or in alpha-numeric forms.
   iii. Appropriate charts, manual plotting aids, a plotting table, a time clock, and compass and ships' speed readouts. Additionally a simulated radio-telephone shall be provided (ship-to-ship and ship-to-shore (instructor's position)).

3. In addition to the requirements of paragraphs 1 and 2, at least one own ship position shall be provided with an ARPA display which may either be an integral part of the radar display required in 2i above or a stand alone facility. In either case, the display of the ARPA features shall be related to the simulation of the own ship's position.

4. The navigational displays and data outputs required in paragraph 2 and 3 above shall be controlled by the simulator computer and be related to the respective own ship position with typical errors of these displays being controlled by the instructor. Where appropriate, the relevant operating instructions and error correction data shall be made available to the trainees.

5. Each own ship position shall be accommodated in a cubicle or room separated from the other own ships, the main simulator computer and the instructor's position by adequate sound proofing.

6. A space for briefing and de-briefing shall be made available.

7. Until such time as existing simulators which do not meet the above requirements can either be updated or replaced, existing equipment may continue to be used provided DTP agreement is obtained in each case.

Notes:


2. It is foreseen that there may be a requirement for at least two own ship positions to be equipped with ARPA but a decision on this matter cannot be taken until experience of operating the course has been acquired. This additional requirement should be borne in mind when ordering new equipment.
SEARCH AND RESCUE

References: A. MERSAR (3rd Edition)  
B. N to M 4/82  
C. Post Office Handbook for Radio Operators

Introduction

General information for merchant ship watchkeepers on Search and Rescue (SAR) is contained in MERSAR at Reference A. IMO's International Convention on Standards of Training and Certification of Watchkeepers, to which the UK Government is a signatory, requires all watchkeepers to have an understanding, and masters to have a complete understanding, of the contents of MERSAR.

The basis for MERSAR is Regulation 10 of Chapter V of the International Convention for Safety of Life at Sea (1960). This regulation is repeated below:

**Distress Messages - Obligations and Procedures**

(a) The master of a ship at sea on receiving a signal from any source that a ship or aircraft or survival craft thereof is in distress is bound to proceed with all speed to the assistance of the persons in distress informing them if possible that he is doing so. If he is unable, or in the special circumstances of the case considers it unreasonable or unnecessary to proceed to their assistance, he must enter in the logbook the reason for failing to proceed to the assistance of the persons in distress.

(b) The master of a ship in distress, after consultation, so far as may be possible, with the masters of the ships which answer his call for assistance has the right to requisition such one or more of those ships as he considers best able to render assistance, and it shall be the duty of the master or masters of the ship or ships requisitioned to comply with the requisition by continuing with all speed in the assistance of the persons in distress.

(c) The master of a ship shall be released from the obligation imposed by paragraph (a) of this regulation when he learns that one or more ships other than his own have been requisitioned and are complying with the requisition.

(d) The master of a ship shall be released from the obligation imposed by paragraph (a) of this regulation, and if his ship has been requisitioned from the obligation imposed by paragraph (b) of this regulation, if he is informed by persons in distress or the master of another ship which has reached such persons that assistance is no longer required.

(e) The provisions of this regulation do not prejudice the International Convention for the unification of certain rules with regard to Assistance and Salvage at Sea signed at Brussels on 25 September 1910 particularly the obligation to render assistance imposed by Article 11 of the Convention.
Special circumstances making it unnecessary or unreasonable to comply (vide para (a)) include:

Compliance would seriously endanger own life, crew or passengers; destination hard at long range, making it unrealistic to attend at Mayday on Ray of rescue - distress heard on S.O.S. with Q.M. Gen.

Factors to be taken into account in the question of requisition (vide para (b)) include:

- Closeness in time, facility, suitability, language, nationality

The master of a ship registered in the United Kingdom who fails to act in accordance with his obligations to assist persons in distress is liable to summary conviction.

Factors to take into account in determining whether it is proper for the master of a vessel attending an SAR incident to terminate his vessel's participation in the operation include:

- Remaining prospects of saving life
- Effectiveness of role being played, coupled with arrival on scene of fresh assistance — send 'intend signal'

Organization of SAR

Forces available for SAR include:

- Merchant vessels — ubiquitous, small, service crew, good refuge
- Service vessels — may have helicopters limited availability, large, skilled crew, good communications, medical facilities
- Civilian/military aircraft — limited operational
- Designated SAR aircraft — excellent — primary task location
- SAR craft — except WAGS rather limited in range - offshore safety
- Shore based facilities — R.C.C., H.M.C.G., etc.

Those available or used in any particular incident will depend primarily on the location of the incident. Merchant ships may be found in most areas of the world, and merchant shipping must be considered a primary tool in SAR operations. Indeed in some remote areas merchant shipping may be the only SAR forces available.

Without organized co-ordination and control SAR operations are unlikely to be effective. This applies equally to ship board organization in a single ship search for a man overboard and to large area searches involving land, sea and air forces from several different countries.

The International Convention on Maritime Search and Rescue 1979 provides, amongst other things:
That parties shall ensure that the necessary arrangements are made for the provision of adequate SAR services for persons in distress round their coasts.

That parties reach agreement on delimitation of SAR regions, which may not be related to and do not prejudice the boundaries between states.

That each party authorize its rescue co-ordination centres (RCCs) to request assistance from adjacent RCCs when necessary, and to grant permission for entry of SAR services into territorial waters.

That parties should come to arrangements for joint training exercises with adjoining SAR regions.

That the greatest practical co-ordination between maritime and aeronautical services should exist.

In brief the aim is to cut away any barriers from effective SAR and in following this approach IMCO has taken a lead from ICAO.

In passing it is of interest to mariners that the Convention details a colour code for marking air drop pable survival equipment containers:
- Red  medicine/first aid
- Blue  food/water
- Yellow protective clothing
- Black  miscellaneous equipment

Co-ordination of Maritime SAR in UK Waters

Standing Committee comprising all principal SAR bodies under DTP chairmanship.

Responsibility for initiating and co-ordinating marine, civil SAR rests with HMCG, part of DTP. HMCG RCC at Falmouth is an example.

MOD operates RCCs at Plymouth and Pitreavie.

Worldwide SAR

ICAO SAR regions are established covering all airspace. Marine SAR should be similarly provided for. As far as the mariner is concerned the formal arrangements are of academic interest perhaps. If in distress a ship 'plugs into the system' by sending out a distress on the appropriate frequencies and the area or coast radio station as appropriate alerts the SAR region.

Abbreviations

CSS  Co-ordinator Surface Search
OSC  On Scene Commander

The subtle difference between a CSS and OSC is that the latter is a specialist SAR unit including warships and military aircraft. In the absence of an OSC if more than one merchant vessel is taking part in an SAR operation one will have to assume the role of CSS. Factors to consider in selecting the CSS include:
Selection of CSS:
Stable platform, good communications (equipment and language), piloting/ops room facilities, previous experience, willingness/confidence, mutually acceptable, able to remain.

If language difficulties exist between participants in the search then the International Code of Signals and Standard Marine Navigational Vocabulary should be used.

Responsibilities of CSS Include

See page 7 \textit{read MERSAR!}.

\textbf{SAR Communications}

Radiotelephony (RT) frequencies allocated to distress are:
- 2182 kHz supplemented by 4125 kHz 120°W to 60°E south of 15°N and
- 4125/6215.5 kHz 60°E to 120°W south of 25°S
- 156.8 MHz (VHF Channel 16)

Aeronautical frequencies allocated to distress are:
- 3032.5 kHz 5680 kHz 121.5 MHz and 243 MHz

Before transmitting a distress message the RT alarm should be sent to attract attention or activate automatic alarm devices. The content of an RT distress message is:

\begin{tabular}{|c|c|}
  \hline
  \textbf{Alarm} & Two tone signal \textbullet\
  \textbf{Distress Call} & \textit{Mayday Mayday Mayday This is Pelican Pelican Pelican} \textbullet\
  \textbf{Distress Message} & \textit{Mayday this is Pelican} \textbullet\
  \textbf{Prefix} & \textit{in position 180° E adrift 6 miles} \textbullet\
  \textbf{Ship} & \textit{in position 180° E adrift 6 miles} \textbullet\
  \textbf{Position} & \textit{on fire and in sinking condition require immediate assistance} \textbullet\
  \textbf{Nature} & \textit{on fire and in sinking condition require immediate assistance} \textbullet\
  \textbf{Other Info.} & \textit{ invitation to reply OVER} \textbullet\
  \hline
\end{tabular}

When to acknowledge:

If in the immediate vicinity of the incident acknowledge immediately, but if near a Coast Radio Station (CRS) allow a short interval for the CRS to acknowledge. If the distress has been heard at 'long range' delay acknowledgement for a brief period to allow ships closer to the incident to reply without fear of interference.
Content of Acknowledgement

Distress signal

Call Sign of Vessel in Distress

this is

Own Ship

Acknowledgement

Maiden

Pelican Pelican Pelican

Sea Fever Sea Fever Sea Fever

received Mayday

Subsequent action:

Every ship which has acknowledged should provide further information eg:

MAYDAY THIS IS SEA FEVER MY POSITION IS 212 DEGREES EDDYSTONE 28 MILES MY SPEED IS 15 KNOTS ESTIMATE ARRIVAL AT DISTRESS IN ONE HOUR OUT

Interceptions

Aim is to keep the two craft on a collision course. Thus the relative track of the interceptor passes through own vessel. Example: At 0900 hours own ship is in position 'A' steering 035°(T) at 12 knots. At 0930 hours craft leaves Safehaven at 15 knots to intercept. Find course for interceptor to steer and time of interception if own vessel maintains course and speed.

Construction

Mark off DR for 0930

ab = Mark off at 6 miles

Mark off ac = 7½ miles dist

Interceptor travels in 20 minutes

direction ab = course for interceptor to steer. Transfer through y. Interception is at oc

It is usual to assume each craft experiences the same set and drift. If interceptor is a helicopter then work from ground speed and course made good, or allow for windspeed and direction by vector application.

Problem could be posed as a signal from interceptor “At 0420 GMT my position will be 140° Hen and Chicken Rocks 2 miles speed 18 knots please advise my course to steer and time of interception.

Identify interceptor amongst other targets by having bearing cursor of radar on anticipated relative track. Range at any time can be easily determined eg range at 1010 hours is on a relative bearing of

Conduct of Search

Three initial condition decisions have to be taken, namely choice of search pattern, datum and track spacing.
Choice of search pattern is subjective and depends largely on the type of incident and nature of response. Standard search patterns include:

- Expanding Square Search
- Sector Search
- Track Crawl Search
- Parallel Track Search
- Combined ship/aircraft search

Further details are given below.

Datum for search also depends on type of incident. Other factors to be taken into account include:

- Position accuracy of target and own ship will affect search radius.
- Consider weather, cleared time, likely drift of target.

Before commencing a search track spacing has to be determined. Factors to take into account include:

- Weather day/night, visibility, own visibility, look out potential, nature of target, radar scanner height, instructor aids.

It should be borne in mind that all parties to a search may not necessarily have the same track spacing. Track spacing may be considered in terms of \( v \) meaning estimated detection visibility. It is important that \( v \) should never be over-estimated.

**Square Search**  Used when a good datum is known or in single ship searches.

\[
\begin{align*}
\text{1.4v} & \\
\text{1}\text{.1v} & \\
\text{1.4v} & \\
\end{align*}
\]

First sweep usually down weather from datum. Probably best to calculate sweep lengths in time rather than distance. For example, with a search speed of 12 knots and \( v \) of 1\( \frac{1}{2} \) miles the first sweep is 2.1 miles or 11 minutes, followed by sweeps of 11 minutes, 22 minutes, 33 minutes and so on. Plot may be kept in tabular form as chart is likely to become over complicated if too much detail is drawn in a small area. Plot fixes on chart rather than planned search. Using the example above with first sweep in direction 060° then:

**Sector Search**  Used for man overboard.

All turns 120° to starboard. If man in water not sighted on completion of pattern slew 30° to starboard and continue search. Leg lengths in time not distance.
**Track Crawl Search** (not in MERSAR) - Used for man overboard when time of incident not known.

Has had remarkable success, reports include ships back-tracking along their own garbage trail!!

**Parallel Track Search** (2 ships) - Used when more than one ship is available, and quality of datum uncertain.

Draw circle of radius possible datum error around datum, 'square the circle' and align in the direction of drift. Search box in co-ordinated fashion.

Patterns for 3 and 4 ships are also provided in MERSAR. Do not be stuck on those given in MERSAR. Capabilities of search units may vary and task should be allocated accordingly. In considering other options take account of available daylight, and need to reduce risk of collision between search units. Allocating defined search areas to individual ships has its merits. One ship should pass through datum at an early stage of any search.

If carrying out MERSAR parallel track search pattern reasonable control can be exercised if all ships steam at same speed and all alter course together. Achieving this manoeuvre may be wasteful of search effort.

**Combined ship/aircraft Search**

Particularly useful for searching large areas quickly. Ship's main role is to follow up sightings made from the air to identify and recover. After such a search the sea surface should be 'clean'.

**Action Aboard CSS**

Additional to logging all signal traffic the CSS will wish to maintain a log and plot of the planning and conduct of the search. The requirements and methods used may vary depending on location, proximity of navigational hazards, degree of shore control etc.

Own ship navigation and co-ordination of search can conflict. If the CSS has two radars it is suggested that one be designated for navigational/collision avoidance use, possibly in the relative motion mode of display, the second could then be designated search co-ordination radar. Ideally the search co-ordination radar should have a range scale
large enough to cover the immediate search area, and have a true motion facility. Sea stabilization gives a good indication of the effectiveness of the search pattern being used. With the radar in true motion, centred on datum, plot continuously the movement of own and other participating ships across the screen so as to build up a plot record. By simple application of the search visibility used for each vessel it is easy to ensure that no gaps are left in the search cover. Use of different 'chinagraph' colours for each vessel can aid identification. The radar plot is not permanent, and an additional chart plot will be necessary.

In areas clear of major navigational constraints the navigational plot of own vessel and the planning and plotting of the search are best separated. This is especially so in the case of multi-ship searches. The planning and plotting of the search can be carried out readily on any chart having a suitable scale and uncluttered sea area. A convenient parallel and meridian can be chosen to form the link with the navigational chart. All transfers from navigation chart to planning chart are then made using miles north/south and east/west of these reference lines. The advantage of this procedure is that the navigational chart is often not of an appropriate scale for the purpose we now have, and is often 'cluttered' with hyperbolic lattices and other information that distract from the clarity required in search planning. The tasks of planning and navigation are best kept separate.

Aboard All Search Vessels

An efficient watch must be made using all available means: visual, aural, radar and radio. Lookouts must be properly briefed and regularly kept updated with information regarding the search. The lookout maintained will depend on crew size. If lookout capability is small then search speed may be reduced to allow more time to conduct an effective search. It is more important to thoroughly search a small area than imperfectly search a large area. Consider the following:

(a) Intermittent sightings, flashing lights etc are more readily detected in peripheral vision than in line of sight. Have a plan for visual search, perhaps scan the sea near own ship and slowly raise line of sight to horizon. No sighting, select next sector say 20° round and repeat.

(b) If possible give lookouts overlapping sectors to search, and maintain system of rotation and reliefs to reduce effects of boredom.

(c) In conditions of reduced visibility have a lookout in an on deck 'silent' area.

(d) Survivors are alive. It is hoped they can assist in their own location. Search vessels must make their presence known by any means appropriate.

(e) Survival craft pyrotechnics are more visible by night that by day. There is often merit in re-searching by night, with larger track spacing, areas already searched by day.
Formalized Description SAR 2

CHAPTER 1

Search and Rescue Exercise 2

Objective

The objective of the exercise is to experience, in real time, the problems in responding to a distress and mounting an effective multi-ship search.

Suitability of Exercise

The exercise is designed primarily for Class II (Deck) students, but it will be of value to any individual involved in decision making on the ship’s bridge.

True motion radar display with reflection plotter and/or ARPA display with navigation lines will be an advantage.

Inter-ship communication facilities are required.

Each ship should have at least two and not more than three students. They should be familiar with the equipment fitted.

Brief for Instructor

The exercise takes place after students have received a two hour duration lecture on search and rescue procedures, and have become aware of the contents of MERSAR.

Allow some twelve minutes for students to self brief on own ship characteristics from ship profile folders provided, and for vessel’s precise position and navigational status to be established. When satisfied that students are aware of the general situation make the following signal on Channel 16:
"Mayday Mayday Mayday this is Calamity Jane Calamity Jane Calamity Jane. Mayday this is Calamity Jane in position two zero miles south east of Eddystone my boat is on fire and I require immediate assistance I say again. Mayday this is Calamity Jane in position two zero miles south east of Eddystone my boat is on...."

Allow time for search plan to be formed and put into operation. If no plan develops within 1 hour 15 minutes stop exercise and debrief. If plan develops, allow time for exercise of control to become evident then introduce a weak target, detection range say 1.6 miles, in a position where it will be detected on radar by one of the searching vessels. Once target has been detected allow time for locating vessel to close target then advise captain "you have seen red flares right ahead". Terminate exercise.

Preparation for Exercise

Set up exercise as detailed in Chapter 2. Provide ship stations with following:

- Ship's profile as appropriate
- Ship's name as appropriate, for VHF position

Set up following functions:

- XY plotter
- VHF Channel 16
- VHF recorder

Nominate captain for each own ship.

Set exercise clocks for three hours before sunset today's date

Student Briefing

This exercise takes place off an uninhabited part of the world known as England. The coast line you see on your radar screens is that of South Devon and the required navigational charts are in the chart drawer. There is no CRS or RCC in the area, no assistance is available from ashore. In each ship booth you will find a folder containing a photograph and full details of your vessel (brief details given at page 4). The course and speed of your vessel at commex are correct for the
passage you are making. The visibility in the exercise area is 2\text{\textdegree} nautical miles and the wind is south west force 3. It is today's date and the time is now.

At some stage after the exercise commences you will get an indication that a vessel is in distress. You will be expected to respond, select CSS, and put a search into operation. Any questions?

Physical Configuration

As Chapter 2

Monitoring

Annotate plot with time of Mayday, and with key points during exercise play. Make brief written record of key events. Evaluate search plan as you understand it from radio traffic. Mark up XY plot at Finex with intended tracks of vessels as determined from radio traffic.

Debriefing

Nature of debriefing will depend on how exercise has been conducted. Likely points to be covered include:

- Initial response to Mayday
- What type of vessel is Calamity Jane?
- Exchange of information between own ships
- Factors involved in selection of CSS
- Confirmation of datum, accuracy of datum, size of search area
- Quality of communications, any Mayday relays?
- Selection of plan
- Suitability of plan, search speed, track spacing, leg length etc
- Search in formation or independently?
- How long to cover search area and with what % coverage?
- What action if nothing found?
- How was control of search effected?
- Explain benefits of TM reflection plot of search progress
The exercise was evolved for use on the Redifon MRS 8012 three own ship simulator, using the South West Approaches plate. Initial exercise conditions are:

<table>
<thead>
<tr>
<th>Ship</th>
<th>Type</th>
<th>N</th>
<th>E</th>
<th>Hdg</th>
<th>Spd</th>
<th>Remarks</th>
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<tr>
<td>1</td>
<td>4</td>
<td>2900</td>
<td>2240</td>
<td>078°</td>
<td>20</td>
<td>Decca and DF</td>
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<td>2</td>
<td>2</td>
<td>3300</td>
<td>4950</td>
<td>259°</td>
<td>15</td>
<td>DF only</td>
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<tr>
<td>3</td>
<td>3</td>
<td>3800</td>
<td>5000</td>
<td>256°</td>
<td>16</td>
<td>DF only</td>
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<tr>
<td>T1</td>
<td>1</td>
<td>2000</td>
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<td>Video Off</td>
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<td>SP</td>
<td>1</td>
<td>3000</td>
<td>4000</td>
<td>0°</td>
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</tbody>
</table>

T1 is the casualty which is brought into play as described in Chapter 1. Depth plan in use. Set current 040° by 1 knot.

The datum for the distress is 2840N 4240E

Ship Profiles

Full details of participating ships are contained in the ship profiles. Brief description of ships is:

<table>
<thead>
<tr>
<th>OS</th>
<th>Name</th>
<th>Type</th>
<th>Tonnage</th>
<th>Speed</th>
<th>Nationality</th>
<th>Complement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cornwood</td>
<td>Geared Container</td>
<td>18,000</td>
<td>20 kts</td>
<td>British</td>
<td>35</td>
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<tr>
<td>2</td>
<td>Flushing</td>
<td>Mini-bulker</td>
<td>4,000</td>
<td>15 kts</td>
<td>British</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>Bigbury</td>
<td>Gen Cargo</td>
<td>18,000</td>
<td>16 kts</td>
<td>Pakistani</td>
<td>38</td>
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</tbody>
</table>
Objectives of HMCG Search and Rescue Course A

By the end of the course the student will be able to:

- act as the search and rescue mission controller (SMC) for SAR incidents of varying complexity,
- act as SMC for SAR incidents with minimum local knowledge,
- understand the overall picture of SAR and have the capability of co-ordinating SAR incidents large and small, simple and complex,
- determine datum, correct positions for the varying effects of sea current, wind current and leeway, understand the means of determining direction and magnitude for each factor, and solve for datum using the vector solution on a plotting sheet,
- calculate a search area, calculate a search radius, taking account of position error, search craft error, drift error, and the application of a safety factor, carry out the calculations necessary to determine datum when the accuracy of the data is so uncertain that it is necessary to calculate both minimum and maximum drift,
- understand the use and execution of the various patterns used to search sea areas, understand the factors which dictate the selection of patterns,
- understand the mathematically expressed measure of detection capability based upon the search craft, target, altitude and weather conditions, apply and be able to calculate using graphs or formula coverage factor, track spacing, sweep width and probability of detection,
- compare the desirable with the attainable, and understand the various units versus time available,
- using the available information select the best possible area and track spacing attainable,
- understand the SAR planning concept that an SMC needs a precise accurate and standard method to organize a search and assign search units,
- be aware of the various factors that affect survivor endurance which in turn limit the time available,
- understand the duties and responsibilities of an SMC, and OSC, a CSS and the relationship between them,
- appreciate the differences between search and rescue planning (SARP) and computer assisted search planning (CASP).
# Annex H

## National SAR School

USCG Training Center Governors Island NY

### International Graduate List

<table>
<thead>
<tr>
<th>Country</th>
<th>Graduates</th>
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<tbody>
<tr>
<td>Afghanistan</td>
<td>2</td>
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<tr>
<td>Bahamas</td>
<td>1</td>
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<tr>
<td>Bermuda</td>
<td>11</td>
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<tr>
<td>Canada</td>
<td>111</td>
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<td>Denmark</td>
<td>46</td>
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<td>El Salvador</td>
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<td>France</td>
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<td>Greece</td>
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<td>Haiti</td>
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<td>Iceland</td>
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<td>Iran</td>
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<td>Jamaica</td>
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<td>New Zealand</td>
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<td>Panama</td>
<td>3</td>
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<td>Saudi Arabia</td>
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<td>South Africa</td>
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<td>Sweden</td>
<td>9</td>
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<td>Trinidad &amp; Tobago</td>
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<td>Yemen</td>
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<td>Australia</td>
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<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total International Graduates - 627 from 65 Nations

<table>
<thead>
<tr>
<th>Country</th>
<th>Graduates</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Air Force</td>
<td>822</td>
</tr>
<tr>
<td>US Marines</td>
<td>5</td>
</tr>
<tr>
<td>US Army</td>
<td>5</td>
</tr>
<tr>
<td>US Coast Guard</td>
<td>4301</td>
</tr>
<tr>
<td>Civilians</td>
<td>462</td>
</tr>
<tr>
<td>US Navy</td>
<td>108</td>
</tr>
<tr>
<td>USCG Auxiliary</td>
<td>437</td>
</tr>
<tr>
<td>Civil Air Patrol</td>
<td>434</td>
</tr>
<tr>
<td>USCG Reserve</td>
<td>103</td>
</tr>
<tr>
<td>USCG Academy Cadets</td>
<td>78</td>
</tr>
</tbody>
</table>

Total United States Graduates - 6695

Date: 17 August 1984
ANNEX J

NAVIGATION CONTROL COURSE - SAR QUESTIONNAIRE

(1) The SAR content of the NCC is:

<table>
<thead>
<tr>
<th>Too Little</th>
<th>Correct</th>
<th>Too Much</th>
</tr>
</thead>
</table>

(2) The balance between SAR theory and practical exercises is:

<table>
<thead>
<tr>
<th>Too much theory</th>
<th>Correct</th>
<th>Too much practical</th>
</tr>
</thead>
</table>

(3) Post SAR exercise de-briefs have:

<table>
<thead>
<tr>
<th>No value</th>
<th>Some value</th>
<th>Much Value</th>
</tr>
</thead>
</table>

(4) In the columns below tick the descriptions applying to any exercise on which you were Captain:

<table>
<thead>
<tr>
<th>SAR 1</th>
<th>SAR 2</th>
<th>SAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helo</td>
<td>Mayday</td>
<td>O/F</td>
</tr>
</tbody>
</table>

(5) In the columns below tick the descriptions applying to any exercise on which you were NOT Captain:

<table>
<thead>
<tr>
<th>SAR 1</th>
<th>SAR 2</th>
<th>SAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helo</td>
<td>Mayday</td>
<td>O/F</td>
</tr>
</tbody>
</table>

(6) Tick if your ship was CSS:

<table>
<thead>
<tr>
<th>SAR 2</th>
<th>SAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayday</td>
<td>O/F</td>
</tr>
</tbody>
</table>

(7) Between SAR 2 and SAR 3 did you discuss the problems of SAR with your colleagues?

Yes  No

(8) Compared with SAR 2, SAR 3 was tackled:

<table>
<thead>
<tr>
<th>Worse</th>
<th>Same</th>
<th>Better</th>
</tr>
</thead>
</table>

(9) If answer to Q(8) 'worse' state why:

(10) If answer to Q(8) 'better' state why:

(11) In the column below tick which statement applies to the occasions when you were Captain

- My Authority was unquestioned
- I sought advice but made the decisions
- It was 'rule by committee'
- My authority was flouted

(12) In the column below tick which statement applied on the occasions when you were not Captain

- His authority was unquestioned
- He sought advice but made the decisions
- It was 'rule by committee'
- His authority was flouted

(13) Should more than 3 SAR exercise be held?

Yes  No

(14) If yes to Q(13) intercept place in order of:

- Mayday
- O/F

(15) Ship profiles were:

<table>
<thead>
<tr>
<th>Adequate</th>
<th>Inadequate</th>
</tr>
</thead>
</table>

(16) If answer to Q(15) inadequate suggest improvements required:

(17) How were the 'possible' SAR course objectives listed below met?

- Appreciation of MERSAR contents
- Practice in SAR communications
- Selection of CSS
- Selection of proper search
- Adoption of proper search
- Real time exercise play

(18) State briefly any other objective SAR course should have

<table>
<thead>
<tr>
<th>Not met</th>
<th>Partially met</th>
<th>Well met</th>
</tr>
</thead>
</table>

J 1
(19) Tick any of the following statements on 'the use of simulators during the Class II Course', with which you agree:

(a) Their value is over estimated  
(b) They interfere with 'serious' study  
(c) They are a welcome/interesting/enjoyable diversion  
(d) Their use is about right  
(e) Greater use should be made of simulators  
(f) Role play is a good teaching method

(20) Delete the untrue element in each of the following statements:

(a) I had/had not seen MERSAR whilst I was at sea  
(b) I had/had not read MERSAR before attending the NC Course  
(c) MERSAR will/will not mean more to me now I have completed the NC Course

(21) Tick which of the following statements most accurately describes MERSAR?:

(a) MERSAR is inadequate for its purpose  
(b) MERSAR is adequate for its purpose  
(c) MERSAR is very good for its purpose

(22) Would a standard inter-ship information exchange format be useful? Yes No

(23) If you answered yes to Q22 what details should the format include?

(24) Have you ever given the kiss of life to a real casualty? Yes No

(25) Have you ever taken part in an SAR task? Yes No

(26) If you answered yes to Q25 was MERSAR used during the task? Yes No Don't Know

(27) If you answered yes to Q25 was any search carried out efficiently? Yes No Not applicable

(28) Will your colleagues at sea be receptive to your SAR knowledge, gained from the NC Course, if the need arises? Yes No

(29) Should some form of NC Course be given to all watchkeepers and masters? Yes No

(30) If you would be prepared to enlarge on any of your answers please enter your name:
<table>
<thead>
<tr>
<th>Time</th>
<th>Text</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>113300</td>
<td>Mayday Mayday Mayday this is Calamity Jane Calamity Jane Mayday this is Calamity Jane in position two zero miles south east of Eddystone my boat is on fire and I require immediate assistance I say again Mayday this is Calamity Jane in position two zero miles south east of Eddystone my boat is on</td>
<td>27</td>
</tr>
<tr>
<td>113344</td>
<td>Calamity Jane Calamity Jane Calamity Jane Antilochus Antilochus received your Mayday</td>
<td>7</td>
</tr>
<tr>
<td>113354</td>
<td>We will make all possible speed to your assistance over</td>
<td>3</td>
</tr>
<tr>
<td>113449</td>
<td>Calamity Jane Calamity Jane this is Fourah Bay Fourah Bay Mayday received am six miles from your position out...am proceeding at full speed out</td>
<td>14</td>
</tr>
<tr>
<td>113700</td>
<td>Calamity Jane Calamity Jane Antilochus do you receive over</td>
<td>5</td>
</tr>
<tr>
<td>113722</td>
<td>Fourah Bay Fourah Bay Fourah Bay Antilochus Antilochus do you receive over</td>
<td>6</td>
</tr>
<tr>
<td>113730</td>
<td>Antilochus Fourah Bay over</td>
<td>2</td>
</tr>
<tr>
<td>113733</td>
<td>Good afternoon old man I understand you received the Mayday message from Calamity Jane what is your ETA at that position over please</td>
<td>9</td>
</tr>
<tr>
<td>113744</td>
<td>Our ETA is 1200</td>
<td>2</td>
</tr>
<tr>
<td>113748</td>
<td>Fourah Bay Antilochus er yes our ETA at the position is 1200 as well er what type of vessel are you old man what type of vessel have you got</td>
<td>9</td>
</tr>
<tr>
<td>113758</td>
<td>Er small coaster about five thousand tons</td>
<td>2</td>
</tr>
<tr>
<td>113805</td>
<td>Five thousand ton coaster yes ..what's your speed of that vessel please</td>
<td>5</td>
</tr>
<tr>
<td>113812</td>
<td>Antilochus this is Fourah Bay we're doing fifteen knots at the moment. I think that's you just to the north of us off Start Point</td>
<td>7</td>
</tr>
<tr>
<td>113827</td>
<td>Fourah Bay Antilochus our position is......south south east of the Eddystone about thirteen miles over</td>
<td>13</td>
</tr>
<tr>
<td>113849</td>
<td>Antilochus this is Fourah Bay roger.. we are south of Starr Point at approximately fifteen miles over</td>
<td>12</td>
</tr>
<tr>
<td>113911</td>
<td>Fourah Bay Antilochus yes got that old man thank you yes we are..twenty eight thousand ton twenty four thousand ton vessel twenty eight knots proceeding with a very large freeboard we'll give you a contact in a few minutes...just get sorted out here old man we'll keep on this channel over</td>
<td>22</td>
</tr>
</tbody>
</table>
VHF Transmission Pattern SAR 2 - 18 Feb 1982

Exercise duration 3,300 seconds
Transmission total duration 719 seconds

Further instructions

On scene search instructions

Selection of communications channel

Confirming radar identification of participating ships

Further instructions

Passing instructions

Further exchange of ship details

Discussion on frequencies

Priam responding

Mayday Relay
Antilochus becomes CSS
Further exchange of information

Information exchange between Antilochus and Fourah Bay

Mayday, and response from Antilochus and Fourah Bay
Exercise duration 6,000 seconds
Transmission total duration 884 seconds 14.7% of Exercise Time

Advising termination of search

Recovery of Survivors

'Spoof' sighting of target

Vessels being controlled by conning

Disagreement apparent between participants

Exchange of positions by vessels

Details of search plan passed

Initial start position for each ship passed

Ships advised that MERSAR to be used

Prior assumes CSS

Exchange of ship details

Exchange of DF bearings

Mayday relay
SAR 2 COURSE 1 18 FEB 82

Find SF Force 3 Visibility 2 Miles

'A' Distress position given by Calamity Jane

'B' Position of own ships at time distress received

No datum agreed for search

GSS

Antilochus speed 22 knots
maximum speed 26 knots

GSS

001

1200

002

1200

003

Limits of 10 miles square
search area aligned NE/SE
centred on middle of pattern

GS3 Prim speed 17 knots

052 Fourah Bay
speed 10 knots
max speed 15 knots

Scale

0 5 miles
SAR 2 COURSE 2  25 FEB 82

Wind SW Force 3  Visibility 2 miles

'B' Distress position given by Calamity Jane

'B' Position of own ships at time distress received

'C' Datum for search used by CSS

051 Antilochus
speed 26 knots

052

1110 OS2 Fourah Bay
speed 15 knots

CSS

Limits of 10 mile square search area aligned NE/SW centre on datum
SAR 2 COURSE 3 4 OCT 82

Wind SW Force 3 Visibility 2 miles
'A' Distress position given by Calamity Jane
'B' Position of own ships at time distress received
'C' Search datum

Scale
0 5 miles

Limits of 10 mile search area aligned NE/SW centred on datum

Flushed crosses \( \frac{1}{2} \) cables ahead of Bigbury at this point

053 Cornwood CSS

1616 Bigbury

1646

022 Flushing

1736
Wind SW Force 3  Visibility 2 miles
'A' Distress position given by Calamity Jane
'B' Position of own ships at time distress received
'C' Search datum

Limits of 10 mile square search area aligned NE/SW centred on datum

Scale

0  5 miles

GS3 Bigbury CSS
032 Flushing

1712
1712
1712
Wind SW Force 3 Visibility 2 miles
'A' Distress position given by Calamity Jane
'B' Position of own ships at time distress received
'C' Search datum according to CSS
'D' Datum according to Flushing

At 1722 Bigbury asks Cornwood for position of distress
at 1710 Flushing checked position of distress with Cornwood

Limits of 10 mile square search area aligned NE/SW centred on CSS datum
SAR 2 COURSE 6  6 DEC 82

Wind SW Force 3  Visibility 2 miles
'A' Distress position given by Calamity June
'B' Position of own ships at time distress received
'C' Search datum according to Bigbury
'D' Datum according to Cornwood

Cornwood conducting expanding square search at 1/2 knots. Bigbury and Flushing conducting 2 ship parallel track search at 5/2 knots

Scale

0  5 miles

Limits of 10 miles square search area aligned NE/SW centred on datum
SAR 2 COURSE 7   17 JAN 83

Wind SE Force 3   Visibility 2 miles
'A' Distress position given by Calamity June
'B' Position of own ships at time distress received
'C' Search datum according to Bigbury
'D' Datum according to Cornwood

Cornwood plotted distress position 20 miles SE instead of SE of Calamity June. This was 15 miles west of correct datum. Error not discovered until 1705 when Cornwood reversed course.
Cornwood repositioned at 1710 by instructor to bring her into exercise play

Limits of 10 mile square
Search area aligned NE/SW centred on datum

Error in track spacing by Bigbury. 4 miles effected instead of the 3 miles intended

Scale

0 5 miles
SAR 2 COURSE 8  7 FEB 83

Wind SE Force 5 Visibility 2 miles
'S' Distress position given by Calamity Jane
'S' Position of own ships at time distress received
'G' Search datum

Limits of 10 mile square search area aligned W2/S2 centred on datum

Scale

0 5 miles
SAR 2 COURSE 9  21 FEB 83

Wind SW Force 3  Visibility 2 miles
'A' Distress position given by Calamity Jane
'B' Position of own ships at time distress received
'C' Search datum

053 Bigbury CSS
082 Flushing

1700

1800

051 Cornwood

Limits of 10 mile square search area aligned NE/SW centred on datum

Scale

0  5 miles
Visibility 1 1/2 miles Wind SW Force 3
Current 270° x 1 knot
Future intentions of search vessels unclear
'A' origin of distress

Limits of 6 mile square search area centred on origin of distress

GS1 Antiochus

1000

0 5 miles

Scale

ANNEX P
SAR 3 COURSE 3
11 OCT 82

Visibility 1½ miles Wind SW Force 3
Current 050° x 1 knot
"A" origin of distress
Course 1530

Limits of 6 mile square search area
aligned NW/SW centred on origin of
distress with allowance for
1½ hours drift

Scale
0 miles
0 5

1602

OS1 Douland CSS

OS2 Rimington

033 Advent
SAR 3 COURSE 4
4 NOV 82

Limits of 6 mile square search area aligned NE/SW centred on origin with allowance for 1 1/2 hours drift.

Visibility 1 1/2 miles Wind S7 Force 3
Current 050° x 1 knot
Point of origin of distress Compass 013

OS1 Douland

Scale
0 5 miles

OS3 Advent

Denim Patch

OS2 Emlington CSS
SAR 3 COURSE 5 22 NOV 82

Visibility 1½ miles  Wind SW Force 3
Current 050° x 1 knot
"A" origin of distress
Commex 1550

Limits of 6 mile square search area centred on origin of distress with an allowance for 1½ hours drift

Scale
0  5 miles

GS1 Dousland German crew
GS2 Errington C33
SAR 3 COURSE 6
13 DEC 82

Visibility 1 ½ miles
Wind SW Force 3
Current 060° x 1 knot
'A' origin of distress
'B' datum used by CSS
Commex 1520

Limits of 6 mile square search area centred on origin of distress with allowance for 1 ½ hours drift

Scale
0 5 miles

051 Howland CSS
1610

7m depth at this point

053 Advent
German crew

Denis Patch

052 Erminston
SAR 3 COURSE 7 27 JAN 83

Limits of 6 mile square search area centred on origin of distress with allowance for 1½ hours drift.

Visibility 1½ miles
Wind S 7 Force 3
Current 050° x 1 knot
'B' origin of distress
'B' datum used by CSS
Conners 1520

Scale
0 5 miles

OS1 Douland

OS2 2mington CSS
SAR 3 COURSE 8
14 FEB 83

Visibility 1/2 miles
Find SW Forge 3
Current 050° x 1 knot
'A' origin of distress
'T' datum used by CSS
Complex 1605

Note: CSS follows 'unusual'
expanding square search pattern
with sides progressively 2, 3, 4
miles etc

051 Demolani
took over as CSS at 1630

Limits of 6 mile square search area
centered on origin of distress with
allowance for 1½ hours drift

Scale
0 5 miles
SAR 3 COURSE 9  26 FEB 83

Visibility 10 miles  Wind SSW Force 3
Current 050° x 1 knot
'A' origin of distress
'B' datum used by CSS
Compass 1700

Limits of 6 mile square search area centred on
origin of distress with
allowance for 1½ hrs drift

Scale
0  5 miles

CSS Dousland

CSS Advent

CSS Jeringham
SEARCH COVERAGE MODEL

SAR Exercise 2 - Course Number 6

Figure to show 16.7% coverage of 10 mile square search area achieved by 1705, half an hour after transmission of distress signal
SAR Exercise 2 - Course Number 6

Figure to show 36.6% coverage of 10 mile square search area achieved by 1735, one hour after the transmission of the distress signal.
SAR Exercise 2 - Course Number 6

Figure to show 57.2% coverage of 10 mile square search area achieved by 1805, one and a half hours after the transmission of the distress signal
SAR Exercise 2 - Course Number 6

Figure to show 66.8% coverage of 10 mile square search area achieved by 1835, two hours after transmission of the distress signal.
SAR Exercise 2 - Course Number 6
Figure to show 88.1% coverage of 10 mile square search area achieved by 1935, three hours after transmission of the distress signal.