A Dissertation on

# THE USE OF MARINE SIMULATORS FOR ASSESSMENT OF MERCHANT NAVY DECK OFFICER COMPETENCE

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by

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THE USE OF MARINE SIMULATORS FOR ASSESSMENT OF MERCHANT NAVY DECK OFFICER COMPETENCE

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# ABSTRACT

FACULTY OF ENGINEERING AND APPLIED SCIENCE

DEPARTMENT OF SHIP SCIENCE

**Master of Philosophy**

THE USE OF MARINE SIMULATORS FOR ASSESSMENT OF MERCHANT NAVY DECK OFFICER COMPETENCE

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An investigation was carried out to ascertain whether a nocturnal ship's bridge simulator can be used as an assessment tool to complement the Department of Transport's oral examination. Assessment procedures used in military, civil and education authorities were studied and where appropriate applied to assessment in the simulator.

Initial experiments indicated that it was not possible to use the Warsash simulator to evaluate a Master's shiphandling skills in harbour areas due to manpower requirements, conflict between individual and team assessment and the simulator's reduced field of view.

It was found that collision avoidance behaviour as displayed in the simulator under examination conditions is similar to conditions where watchkeepers are told to behave as if "at sea".

Three collision avoidance exercises were designed and used to assess ability. Results from numerical data, verbal protocols, questionnaires and a subjective comparison of the subject's behaviour with the author's interpretation of the Internal Regulations for the Prevention of Collisions at Sea were obtained. The results suggest that although clear definable standards of collision avoidance behaviour do not exist, a simulator based assessment can complement the oral examination. It was also found that 90% of the subjects considered this form of assessment to be more effective than oral questions.

## DECLARATION

I hereby declare that the whole of the work now being submitted as a dissertation in fulfilment of the requirements for the degree of

Master of Philosophy

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is the result of my own investigation, except where otherwise indicated.

The work embodied in this dissertation has not already been accepted in substance for any degree and is not being concurrently submitted in candidature for any other degree.

[redacted]

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# INTRODUCTION

A British Merchant Navy Deck Officer's qualification to stand a watch is called a Certificate of Competency. The assessment of a candidate's competence is at the heart of the examination process. Most dictionaries define competence as being adequately or legally qualified, which in the context of a Deck Officer indicates possession of sufficient knowledge, judgement and skill for the intended purpose of being in charge of merchant ships. These abilities have to be discharged in an accomplished and authoritative manner.

Knowledge can be obtained from experience at sea or from the classroom and can be repeated to an examiner in order to answer a specific question in either a written or oral examination. The candidate may have obtained his knowledge through experience or learning by rote: the difference is difficult to detect in a written examination.

Judgement and skill can be tested by an examiner in an oral examination. It is the purpose of this thesis to suggest ways in which advanced technology can supplement existing methods of assessing these abilities.

# CHAPTER 1

# METHODS OF EVALUATING DECK OFFICER COMPETENCE

## 1.1 HISTORICAL BACKGROUND

> "The rationale for the Government's involvement in the examination and certification of seafarers has been the need to ensure a reasonable standard of competence in officers in charge of merchant ships in the interests of safety of life and property" [1].

The British government first became involved in the certification of seafarers in 1836 when a House of Commons' committee was appointed to enquire into the causes of the increased number of shipwrecks involving British ships. One of the committee's recommendations was the institution of compulsory qualifications for Masters and Officers in the Mercantile marine. In 1845, a voluntary system of examinations was established; this was followed by the Merchant Shipping Act of 1850. Under this act it became compulsory for certificated officers to be carried on foreign-going ships. In order to obtain the necessary certificated officers, Local Marine Boards were set up under the supervisory authority of the Board of Trade to hold examinations for the issue of certificates of competency. In 1854, a further Act extended the 1850 requirements to Masters and Mates of Home Trade passenger ships. Both these acts were consolidated in the Merchant Shipping Act of 1894, which remained the chief statutory authority for the examination system until 1st. September 1981.

From its inception until 1928, the syllabus for a certificate of competency comprised only two subjects - seamanship and navigation. The examination of this syllabus was divided into a number of written papers and an oral test in front of a Board of Trade examiner.

In 1928, the President of the Board of Trade appointed a committee under the chairmanship of the Rt. Hon. Walter Runciman, M.P. to advise

> "whether any, and if so what, alterations are required in the systems or in the subjects in which the candidates are examined" [2].

The recommendations that followed this report established the examination system for the next 40 years with very little change.

During the Second World War, scientists developed the rudiments of radar and hyperbolic navigation to such an extent that these pieces of equipment became standard fit on the bridge of British merchant ships in the middle 1950s. However the Board of Trade became concerned about the number of "radar assisted collisions", and in 1957 it became mandatory for all officers to have passed a Radar Observer course before the issue of a first certificate of competence. These, and similar "short" courses which have been instigated since 1957, take place at various nautical colleges throughout the country. This marked a change from the setting and marking of examination papers by the government body as it showed that

> "a level of efficiency can be achieved without the examiners becoming involved except in a supervisory way to see that the proper standards are being maintained" [2].

In the early 1970s a number of changes to the examination system took place in the U.K., and in parallel with this, discussions through the Inter-Governmental Maritime Organisation (IMO) were forming the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers,1978 (STCW). Most of the maritime nations, including the U.K. have become signatories to this document.

In 1972, the Department of Trade (previously Board of Trade) produced a new written syllabus for foreign-going certificates in order to bring the 1928 syllabus more into line with present day requirements. At the end of the 1970s, it was recognised there was a requirement for certificates of competency to be carried by Home Trade Masters and Officers in ships other than passenger ships and a need to change part of the syllabus produced in 1972. These improvements were introduced in the Merchant Shipping (Certification of Deck Officers) Regulations 1977, but were not implemented until March 1980.

Following the "Rayner Scrutiny of Marine Examinations and the Certification of Seamen" in 1985, the authority for the setting, marking and validation of the examinations passed to the Nautical colleges and BTEC/SCOTVEC. The Deck examinations are now split into non-safety subjects, which are incorporated into a BTEC HND, and safety subjects which are examined by SCOTVEC on behalf of the Department of Transport. Examinations under these new arrangements commenced in January 1988.

These alterations to the examination system have been mainly concerned with the written part; the syllabus for the oral examination, although updated has changed little. In the next part of this thesis, the purpose of the oral examination and the methods used to test competence will be considered.

## 1.2 PRESENT ASSESSMENT PROCEDURES IN THE ORAL EXAMINATION

The British and Commonwealth examination system for a Deck Officer's certificate of competency requires that each candidate be tested orally by an examiner. The British regulations state that:

> "The oral examination is intended to ascertain a candidate's competency in the practical aspects of an officer's duty" [3].

The Chief Examiner of Masters and Mates in the U.K. has stated that the oral syllabus:

> "is a feature of our system of examination which does most to put them on a practical footing and gives our certificates the international standing which they currently enjoy" [2].

In the U.S.A and Europe all competency certificates are limited to written answers only.

The oral examination is meant to test a candidate's practical abilities and, amongst other subjects, involves a demonstration of the use of the sextant, the ability to "swing the compass", and most importantly the candidates practical appreciation of the Collision regulations (IRPCS), International system of buoyage, and shiphandling manoeuvres involving berths, jetties, buoys and manoeuvres in confined waters. These latter tests are carried out on a table top using ship, jetty and buoy models. The candidate is required to answer 70% of the questions correctly although a serious weakness in, for example, knowledge of the Collision regulations may be sufficient to fail him. The average pass mark for the oral examination in 1983 was 80% [1].

Syllabuses and specimen papers for the written examination are published by the Department of Trade,[4] but although the line of questioning in an oral exam relates to the candidate's trading pattern and type of ship, it can vary from centre to centre. The oral examiner assesses a candidate's practical seamanship skills by asking him to move a desk top wooden model and coordinate these movements with a verbal summary of the likely ship movements, helm and engine orders given during that manoeuvre. If the candidate answers with a clear and plausible explanation, the examiner is likely to conclude that the candidate can understand the principles of that particular manoeuvre and the methods used for carrying out that task. Other requested manoeuvres will be assessed by the examiner in a similar manner. There is no doubt this assessment method has worked well within its limitations, but as technology has advanced other methods of assessing a candidate's practical judgement and skills are now available.

In the 1985 scrutiny of its examination system, the Department of Transport (D.Tp.) questioned whether the oral examination for deck officers was necessary. Rayner, the author of the scrutiny, noted that almost all those he spoke to regarded the oral as central to the Department's examination arrangements. He listed the arguments in favour of the oral as follows:-

a) "as it would be impractical to test all candidates by putting them on a bridge of a ship or in an engineroom, the oral is the closest one can realistically get to a practical test of the candidates ability to react to the situations he finds at sea.

b) the oral is the only way to test the practical use of navigational instruments.

c) the examiner can in the course of an oral place a candidate under pressure simulating the stress he would experience on the bridge or in the engine room of a ship in an emergency.

d) The oral allows an examiner to identify and probe particular areas of weakness in a candidate's response and is particularly good for exposing those candidates who may have learned large parts of their work by rote without acquiring a proper understanding of the subject.

e) the oral gives an opportunity for the practically oriented candidate, who may find it difficult to express himself in writing, to display his knowledge" [1].

However, this traditional system of testing a candidate's competence has shortcomings and a number of these disadvantages are listed below:

a) Lack of uniformity and standardisation as an assessment method [46].

b) Irrelevant subjective impressions may influence the examiner's opinion [1].

c) The inability of the examiner to assess a candidate in a "hands-on" environment for both navigation and seamanship tasks.

d) Except for fishing examinations, the examiner is unlikely to have seen the deck officer's written papers before the oral and will therefore be unable to test him on any apparent weaknesses.

Bratton [12] argued tendentiously for a candidate's shiphandling skills to be assessed before issuing a certificate of competency. He considered that a deck officer could obtain these necessary skills in training ships operating in a commercial manner around the coasts of the U.K. Captain Jestico, the Chief Examiner of Masters and Mates, in reply to this paper made the point that Captain Bratton had confused shiphandling with seamanship and watchkeeping [13]. Jestico reiterated that all candidates for certificates of competency are examined upon the fundamental principles of handling and manoeuvring ships, but not to the extent needed for the training and certification of pilots (Bratton's profession). Jestico commented that ship simulators and manned models are now available that can provide shiphandling training more efficiently and cheaply than training ships.

> "We are, and should be directing our attention to the improvement of ship simulator training ..... for deck officers and masters rather than trying to revive proposals for the use of merchant ships as shiphandling trainers " [13].

There have also been calls for change from the desk top wooden models to an actual or simulated shipboard environment for examining a candidate. One such suggestion came from an officer who had recently obtained a Class 1 certificate of competency [14]. In addition, Rayner has acknowledged that some parts of the oral syllabus could be tested in a simulator [1].

The ability of a deck officer to act correctly under stress is an integral part of the oral examination. When

Captain Jestico was asked whether the oral examination was a psychological examination of a man under stress or an examination requiring the reproduction of knowledge in an oral fashion, he replied that

"it is perhaps a bit of both"[5]

and added that

"the man on the bridge is required to produce the right answer in stressful situations "[5].

A number of the shortcomings caused by the present oral examination system have been mentioned, and include lack of standardisation, subjective impressions and lack of a practical medium for the analysis of a candidate's skill and judgement. The medium of a marine ship simulator is now available for the assessment of an officer's ability and it is the author's belief that this could be a more reliable vehicle for some assessment purposes and would in turn reduce the subjectivity and increase the standardisation of the assessment procedures.

Captain Jestico was asked whether he believed various simulators would become more a part of the examinations and he replied that

"this may very well be the shape of things to come"[5]

but questioned whether the learning process transferred to sea. Unfortunately, a research project designed to study this, and sponsored by the D.Tp. has not been completed. However, similar studies in the

U.S.A. have indicated that simulator training does transfer to sea [6,7].

If the deck officer's conception of the simulator as a ship model possessing high fidelity is correct, then this medium can be used to assess navigation, collision avoidance and shiphandling tasks. Chapter 2 describes the growth of ship simulators and gives details of the Warsash simulators on which the experiments were conducted.

# CHAPTER 2

# MARINE SIMULATION

## 2.1 INTRODUCTION

Just before Neil Armstrong landed on the moon on July 20th. 1969 and uttered his now famous, and well-prepared statement:

> "That's one small step for a man, one giant leap for mankind",

he uttered these less well-known words as he came in for the landing:

> "Everything is going A-OK. It throttles down .... better than the simulator."

Before embarking on this most spectacular space epic, Armstrong had practiced the manoeuvre in the most sophisticated simulator ever built. Space exploration grew out of aviation knowledge, and the simulator's antecedents are found within the earliest days of aviation. Edwin Albert Link is generally credited with planting the seed that grew into today's vast simulator industry. His first "pilot-maker" was built in 1929 [63]. Although the aviation industry has made fuller use of simulators than perhaps any other industry with the possible exception of Nuclear Power plants, marine simulators used for the training of Merchant Navy deck officers and for maritime research purposes have been available for some 20 years.

Webster's dictionary says that a simulator is:

"a laboratory device that enables the operator to reproduce under test conditions phenomena likely to occur in actual performance".

Marine simulators have been used for research purposes but are chiefly used for the training of maritime personnel.

The damage potential to ships and the environment as a result of groundings and collisions has increased considerably. Whereas the largest ship afloat 50 years ago was 6,000 dwt, some owners in the late 70s and early 80s operated ships of 500,000 dwt. Maritime simulation application and knowledge has also increased: from radar simulators in the early 50s to full task ship simulators today. This thesis is primarily concerned with the use of ship simulators and these are defined as being those marine simulators equipped with a visual scene. Common to all types of ship simulator is a wheelhouse fitted with a number of instruments and controls, a mathematical model which defines the ship's characteristics and a visual scene, as observed by the navigator (this excludes bird's eye or plan views).

The next two paragraphs of this chapter will outline the type of marine simulator system used by the operators, the validity of that system for training and assessment purposes and the limitations imposed by the chosen configuration that reduces the simulation to less than the realism "likely to occur in actual performance".

## 2.2 SHIP SIMULATOR DEVELOPMENTS

### 2.2.1 SHADOWGRAPH POINT LIGHT SYSTEM

Although the Japan Radio Communications Company Ltd was the first, in 1967, to build a ship simulator, it was never put into full commission. The Dutch simulators at Delft and Wageningen were the first to be developed and used commercially in 1968 and 1969 respectively. They used the shadowgraph point light source system. Three dimensional models of the landmass, with horizon and cloud formation shapes were cut out and with the aid of a light source were back projected on to the screen. All the coastlines were fictitious, and no other ships were possible within the visual scene but day, night and twilight exercises could be run. The Japanese made use of the same technique for their simulators at the Tokyo University of Mercantile Marine (1976) and the Ship Handling simulator at Osaka University (1975). The restriction caused by the lack of other ships in the exercise area was overcome by superimposing a TV projection system over the basic shadowgraph. This provided up to three other ships for exercise purposes. The shadowgraph system allowed a full 360 degree visual scene. The limitations of this system were its inflexibility and an inability for Own ship to approach the landmass closer than 1 mile; however, its resolution was very good. The Dutch systems were used for both training and research: the Japanese purely research.

### 2.2.2 TELEVISION PROJECTION SYSTEMS

In the early 1970s the Japanese were experimenting with a number of methods designed to produce a visual scene. A Ship Steering simulator was installed at Hiroshima University in 1971; the visual scene was provided by a colour film and displayed by television sets over a 90 degree arc.

Television cameras were also mounted over modelboards and the picture projected on to the bridge front. The modelboards represented in scaled form a known port area. A small TV camera tracked over its surface driven by commands from the bridge. Other ships could be included, but only on predetermined tracks. The Institute for Perception at Soesterberg was the first, in 1976, to be equipped with such a device. The black and white visual scene extended over a 120 degree field of view.

An extensive modelboard library of twelve port approaches was developed by the Sperry Rand Corporation for Marine Safety International and installed in their simulation facility at La Guardia airport during 1976. Used for training only, a three camera probe projected a black and white picture over a 140 degree field of view forward and included a 40 degree stern view via a monitor. Five Own ship types could be used at this facility. The disadvantage of the modelboard presentation is the initial cost of the scaled physical model, the time necessary to change from one gaming area to another and update the navigational changes on the board, and the rigid tracks that have to be followed by the Other ships in the exercise.

### 2.2.3 SLIDE PROJECTION SYSTEMS

The Japanese company, IHI and the German VFW-Fokker (later Messerschmitt-Bolkow-Blohn), have been the only companies to develop, manufacture and install a visual system which projects on to the screen colour slides previously filmed from a scaled model. IHI in co-operation with NYK line installed a £1M. simulator in Tokyo in 1975. Four colour slide projectors were used for the landmass and one colour film projector for the one Other ship. A 100 degree field of view was provided.

VFW-Fokker installed their system at the Hochschule fur Nautik, Bremen (HFN) and a similar system at the Ship Manoeuvring Simulator, Trondheim in 1979. A third system, ordered by the Maritime Institute of Technology and Graduate Studies, Maryland (MITAGS) was cancelled due to technical problems with its design. Although the static visual scene is realistic in both day and night conditions, it suffers from a poor film update rate, which allows the visual scene to "jump" from frame to frame when the Own ship is moving in excess of 10 knots. The 35mm film is wound in a continuous loop and projected on to the screen from a position on top of the wheelhouse. The film has often jammed in the sprockets. The manufacturers do not intend to produce any more of this design.

2.2.4 NOCTURNAL SYSTEMS

Two types of nocturnal display have been produced: the "turret" system which projects spots of light on to a circular screen from a position on top of the wheelhouse; and the point light source system which projects light spots on to a flat screen positioned in front of the bridge windows. The former type has been installed at MITAGS; the Royal Netherlands Naval College, Den Helder; and HFN, Bremen; the latter flat screen type at the UK Nautical Colleges in Warsash, South Shields and Glasgow. As the experiments were conducted on the Warsash simulator, further details of this system are given below.

The simulator is installed within two 'portakabins', connected end-to-end. The bridge window on which the visual system is projected is positioned at the connecting face of the two portakabins. Sixteen computer controlled projectors positioned at the far end of the portakabin throw spots of light 7 meters on to the screen. The spots of light can be combined to portray the navigation lights of a ship, or used singly as light buoys, lighthouses or lightvessels. A maximum of three Other ships can be observed at any one time within the 100 degree field of view. Star, horizon and fog projectors provide additional visual cues. A view of the ship's bow is also projected on to the screen. Situated behind the bridge window is a fully equipped bridge of modern layout, including 2 radars (non-Arpa) and other bridge equipment which is co-ordinated with the visual scene. The Watchkeeper controls the ship through the autopilot, wheel and telegraph controls. Communication with other ships and shore stations is provided by a VHF radio. Internal communication to various parts of the ship is via an internal telephone. Situated behind the bridge is the Instructors Control room, in which the exercise is monitored and hard data output to an X-Y plot sheet and matrix plotter. A suite of 13 ships are available as Own ship, ranging from a 253,000 tonne VLCC to a coastal patrol craft. The ship used throughout the experiments was an 18,000 tonne Cargo ship. Further details of this ship are provided in Appendix G.

When the simulators were introduced in 1977, they provided excellent training and research facilities at low cost when compared with later technology. The use of spot projectors has now been superseded throughout the marine simulation industry by computer generated imagery (cgi); since 1983 cgi has been used to produce the visual scene on all new marine simulators.

### 2.2.5 COMPUTER GENERATED IMAGERY.

The cgi concept is not knew: aviation simulation manufacturers have been developing the system for many years. One of the first maritime visuals was produced by cgi when, in 1973, the Swedish State Manoeuvring simulator was developed in-house and provided a 35 degree field of view through 7 black and white TV screens.

There are 3 basic steps in designing a cgi picture for an exercise: initially the planner decides which objects the watchkeeper should be able to see and from which directions they can be observed (thus deciding the number of 'faces'); the three dimensional co-ordinates are then input into the computer memory together with the colour, texture and shading of the object; finally a suite of multi-used objects such as buoys, lighthouses and fields are added. During an exercise the computer is programmed to output to the projection or TV system the visual scene that can be observed within the field of view. The increase in computer power backed by a considerable decrease in price for the same amount of memory has ensured that the cgi presentation stays at the forefront of technology.

While the Swedes were experimenting with their own cgi presentation system, the American Maritime Administration (MARAD) was discussing the use of simulators with maritime interests including the oil companies who had used the various European simulator facilities for the training of their Deck and Engine Watchkeepers. The talks led to a design specification for the most advanced shiphandling simulator to date, applying or even pushing state-of-the-art technology. Experienced U.S. mariners drew up the basic and most essential requirements [64] -

Full Colour

At least 6 different traffic ships in visual scene

Day/Night operation

At least 240 degrees azimuth

Full size wheelhouse

At least 24 degrees vertical field of view

Radar - 24 ships to commercial accuracy

MARAD built the Computer Operations Research Facility (CAORF) to house and manage the shiphandling simulator. The simulator, built by the Sperry Corporation and until mid 1987 managed by Ship Analytics Inc. (now by MarineSafety International), was claimed to be the most comprehensive, technically complex, and expensive full bridge, full mission simulator in existence (1986) [64]. The cost was approximately 16 million U.S dollars. Used solely for research purposes, the visual scene is front projected by five Eidophor colour projectors on to a cylindrical screen. CAORF has been at the forefront of simulator based maritime research since its earliest days, and has completed such projects as pilot training and an evaluation for the widening of the Panama Canal.

The main criticism of the daylight cgi presentation is its "cartoon like" quality. This is overcome to some extent by texturing that allows sharp lines to be softened and varying degrees of shading added. The nocturnal scene needs a high resolution display otherwise the light projected on to the screen is too large and gives a poor presentation of range.

The CAORF simulator has been the model on which the next generation of simulator has been based. The presentation system has become more reliable in operation (SUSAN 1982), cheaper (Tepigen as used in the CASSIM simulator 1982) [66], improved with a motion base (Royal

Australian Navy), but the initial requirements as set out above, and now validated, remain the same.

### 2.2.6 THE FUTURE

The high cost of these large simulators has meant that only a limited number exist worldwide. Appendix A (an updated table from the author's 1983 report to the College of Maritime Studies [67]) provides a complete list. All full task simulators have required some form of government finance which cannot be repaid through training cost income alone. The enormous cost of the one-off simulators cannot be sustained. The future for simulator based training and research appears healthy, however the purchasing authority is now looking for a flexible system based on software packages that can be updated, such as an extension to the field of view, and improved at low cost. The "tinware" is not so important as the flexibility of usage. Two years after the Warsash simulator was installed, the College was still offering only one course, albeit fully booked: today 25 different courses are offered, which together with the port development programme and its use for research projects ensures continuity of use but does mean the simulator is used for purposes far removed from its original intention.

A number of companies, many small and innovative, have been looking at cheaper solutions, based on using commercially available hardware instead of one-off equipment. The transputer may help to solve the problem of ouputting information in parallel. The CAPTAINS system, manufactured by Maritime Dynamics in the UK [68], is a desktop cgi simulator using sophisticated and proven hydrodynamic mathematical models, with a field of view that can be extended when extra finance becomes available to the operator. Apart from the possible one-off requirement for the Royal Navy and foreign navies, marine simulators will become far more cost effective, flexible in use, and modular in design.

## 2.3 VALIDATION OF SHIP SIMULATORS

### 2.3.1. INTRODUCTION

Validation is the process by which the realism of the medium is measured against the real system. In marine simulation terms the simulator is tested against a number of functions that describe the operation of the ship actually at sea. For a marine simulator to be accepted as a training aid, and in this particular case, as an assessment tool it is imperative that an effort is made to establish the simulator's validity, i.e. the correspondence between the simulator's behaviour and the ship it represents.

In marine simulation literature a number of claims are made as to the validity of particular simulators: realism [9], degree of similarity [45], similarity of results [55], correspondence [45].

The Federal Aviation Authority does claim realism for some of its most sophisticated simulators (para.

3.3.2.). In this particular industry, the use of simulators is interwoven into the framework of training, pilot assessment and type testing. Both the American aviation industry and Civil Aviation's acceptance of the need for simulators is supported by the availability of funds to purchase and enhance their simulators, which with simulators in the nuclear industry are amongst the most costly and sophisticated in the world.

In the maritime industry, especially in the U.K., there is no requirement for such sophisticated training aids and as a consequence marine simulators are not built to such exacting specifications. They are therefore less than realistic. As the state of the art improves and simulator components reduce in price, the gap between realism and 'representativeness' will no doubt lessen. McIlroy has noted that he expects that the

> "benefit to cost ratio will probably peak at a validity somewhat less than that of the most technically valid simulation" [45].

The degree of sophistication required of the simulator depends upon its designated purpose. This thesis indicates that the level of realism achieved at present is sufficient for training purposes and assessment of some collision avoidance skills.

There are a number of validation subject areas but only two are essential in determining the validation of a particular simulator for training purposes, namely:

i) Face validation

ii) Mathematical model validity

These categories will be discussed in general terms and as they relate to the marine simulators at Warsash, Glasgow and South Shields.

### 2.3.2 FACE VALIDITY

#### 2.3.2.1 Introduction

Face validity is the extent to which a simulator "looks and feels like the real thing" [50].

This definition by its very nature has to be a subjective evaluation, being the opinion of the man within the man machine environment coming to a conclusion based on 'feel', opinion, experience and knowledge. Not only does the bridge watchkeeper assess the internal face validity of the simulated ship in which he is travelling but is also aware of the external scene; whether by day or night, whether in a simulated harbour, estuary, port entrance, coastal or open waters. In order to achieve acceptance by watchkeeping subjects a compromise between "faith validity" [43] and complete realism has been achieved in the majority of maritime simulators. Although face validity is a function of available finance, a number of inexpensive additions can be included which add considerably to the feel of being on a real ship; as an example, the vibration system installed on the Warsash simulators is both effective and inexpensive.

One other indication of the face validity of a simulator is whether the subject in the simulator is carrying out the same procedures as he would in the real world. One of the earliest studies of this subject using marine simulators was carried out by Hammell at CAORF [56]. The study consisted of comparing the behaviour of watchkeeping subjects of the same rank at CAORF with that of watchkeepers in similar situations in similar ships at sea. A database of behaviour was compiled from a group of watchkeepers at sea and included data from Own ship and any decision taken with respect to traffic operating within radar/visual range. This database was arranged into three 4-hour watches and transferred into scenarios for use on the CAORF simulator. The behaviour of the watchkeepers on the simulator was compared with their counterparts at sea. The findings, based on a comparison of activity levels and radar behaviour, demonstrated "a degree of similarity" [56] between the watchkeepers behaviour on CAORF and at sea.

There are a number of limitations imposed by the simulators which can effect the design of both research and training exercises. Details of the limitations imposed by the Warsash simulators have been described by Dr. D.H. Taylor and the author [44] and are precised below:

#### 2.3.2.2 The field of view

The Warsash 100 degree visual scene is one of the narrowest amongst the maritime simulators. In order to allow a visual sighting by the watchkeeper, the courses and speeds of any significant ship have to be programmed such that the ship appears within an arc of 50 degrees either side of the ship's head. The other major simulators are equipped with a visual arc of 240 degrees, and thus allow visual sightings of ships at the cut - off point of 112.5 degrees between ships crossing and ships overtaking, thus allowing more extensive studies into collision avoidance behaviour.

The constraint imposed by the 100 degree field of view can be overcome to some extent by having a 'Cadet lookout' to whom a watchkeeper can speak and who would reply in the manner expected of a Cadet on the bridge wing. The Cadet lookout ( the simulator operator ) in the control room can provide information for the watchkeeper and act as his "eyes" when ships are out of the visual scene and confirm sightings when within the 100 degree arc.

In a study conducted by Hammell at CAORF [54], two groups of mariner subjects underwent training exercises; one group was given a 120 degree field of view, the other a 240 degree field of view. All relevant visual information was however concentrated within the 120 field of view. Hammell noted that the group with the limited field of view actually achieved greater training gain than the 240 degree group. Thus a 120 field of view can provide effective training.

2.3.2.3 Optical projection limitations.

The scene is generated by a maximum of 16 computer controlled projectors which display 'point lights' on a screen approximately 60 cms. in front of the bridge window. Due to the closeness of the spot lights to the watchkeeper, binoculars cannot be used to sight and verify the aspect of the light pattern which would be done by the watchkeeper at sea. In the recent research studies [10] carried out at Warsash, the "lookout" reports each ship as soon as it comes within its visual range and advises the watchkeeper whether it is showing "red" or "green" ( the colour of the sidelight on the port and starboard sides of a ship and often used to indicate the aspect of the ship.) The "lookout" also advises if and when the sidelight colour changes and can when requested by the watchkeeper give a compass bearing of another ship, or navigation light.

2.3.2.4 Bridge wings

The Warsash simulators do not have bridge wings. Some watchkeepers have expressed disappointment in not being able to walk from one bridge wing to the other, but as the exercises do not include berthing manoeuvres, all the external cues can be viewed from within the internal bridge structure.

2.3.2.5 Conclusion

As face validity is a purely subjective indication, the only method of obtaining information about a certain simulator's face validity is through questionnaires. Muirhead [46] used a questionnaire for his study and this blueprint has been adapted by the author for this project. Each subject is asked whether he felt that his level of performance was affected by unfamiliarity with the simulator or any aspect of reality. The replies to this question and the other questions in the questionnaire are contained in paragraphs 5.4.1 & 6.5.3. U Hlaing [9] asked his subjects to assess various aspects of the Cardiff simulator on a seven point rating. These aspects included the realism of the visual scene, the bridge layout and equipment including the radar, the vibration and sound of the engine and finally an attempt was made to assess whether "tension" existed in various stages of visibility. Analysis of his results showed high ratings for realism on all the aspects covered. The ratings ranged from 4.38 on the visual scene to 5.95 on the radar display. A total of 16 subjects took part in this study.

The Warsash simulator has been assessed for fidelity and validated for training purposes by the Maritime Ergonomics Research Unit (MERU) at the University of Wales, Institute of Science and Technology. This unit reported that

> "the bulk of the evidence collected .... supports the contention that most aspects of the simulation are faithfully produced. It is clear that the ship modelling has a good degree of fidelity. However, pilots to whom the visual scene gives them the majority of their cues, believed some shortcomings are apparent, especially with respect to the field of view " [8].

This criticism from the Pilots is mainly due to the Pilot's use of visual cues. In many cases a Pilot will not necessarily use a navigation mark to indicate position but rather choose a feature on the landscape; often a chimney, tall building, well lit factory, group of trees, or other conspicuous object. It is obviously difficult to include these features in any exercise scenario especially as no two Pilots will choose the same cues.

Each Master or Officer who attends the Warsash ship simulator courses at Warsash is asked to complete a critique form at the end of the course. Of the 3000 mariners who have taken the courses, less than 2% have commented unfavourably upon any aspect of "face validity", which indicates that although the subject appreciates that the medium is less than a mirror image of a real ship, it does produce a representative medium on which training and research can be undertaken.

### 2.3.3 MATHEMATICAL MODEL VALIDITY

The watchkeeping subject in the simulator does need to feel confident that the ship manoeuvre he carries out in the simulator does accord to a similar manoeuvre in the real world. Thus the manoeuvring equations, or mathematical model, have to represent as far as possible the manoeuvres of a similar ship at sea. Debate on the realism of the various centre's mathematical models has been prominent in simulator literature [47,49,51]. Those aspects of mathematical modelling that have been updated recently include the lateral movement of a ship during berthing, rudder forces, "kick ahead" effect, and slow speed equations.

The manoeuvring equations can now be validated as a result of the "Esso Osaka" trials [52] which produced for the first time actual full scale data for shallow water effects (depth / draft ratio of 1.2). These trials were followed a year later by further trials using the "Esso Bernicia" [53]. The correctness of the equations is gaining importance as the simulators are now being asked to undertake tasks in conditions far removed from the initial training tasks. The simulators in Holland and the USA now contain sophisticated equations involving the interaction of the ship with a bank or other ship. Tug forces can be applied at any angle to the ship's head and their effect also takes into account the ship's speed both fore and aft and laterally. The correct bollard pull can also be simulated. The CAORF simulator is being used for an evaluation of ships transiting the Panama Canal which involves use of all the above sophisticated equations [48].

The Warsash simulator models lack the ability to represent manoeuvres close to the river bank or seabed; the tug forces can only be applied at right angles to the fore and aft line and only a basic model for shallow waters effects is included. However, these areas notwithstanding, the mathematical models of the 13 ship types used at Warsash were produced and validated by BMT

Ltd ( previously National Maritime Institute Ltd. ) for use in coastal and open waters. They were not intended for use in areas close to river banks/ seabeds.

The mathematical models produce data representative of a certain class of ship and are not meant to represent any one particular ship. Sister ships of the same class, in similar conditions of displacement, trim and draft do not produce identical stopping or turning data.

The ship used for this study is the 18.000 tonne displacement ship 'Morlone' (see Appendix G), and like the other 12 ships has been validated by BMT Ltd., and used extensively by Masters, Pilots and watchkeepers in both training and research studies. The questionnaire given to the subject used in this study allowed them to comment upon any aspect of the mathematical model (under lack of reality) which they felt not to be representative: none considered there was any lack of mathematical modelling validity.

### 2.3.4 OTHER FORMS OF VALIDITY

Strictly speaking, it is not the simulator itself that needs validation but rather the use to which the simulator is put. In this particular case the assessment test used in the simulator should be valid for that purpose and supported by evidence.

Nunnally [69] mentions that psychological measures serve three main purposes: i) establishment of a functional relationship with a particular variable, ii) representation of a specified universe of content and iii) measurement of psychological traits. Corresponding to these three types of validity are: i) predictive validity, ii) content validity and iii) construct validity.

Predictive validity is the most pertinent as it is at issue when the purpose is to use an instrument; in this case a simulator based test to estimate some important form of behaviour. There are two parts to predictive validity which require discussion. This thesis argues that the information passed to the examiner in the form of data from the candidate's simulator exercise(s) provides him with a greater quality of information than can be provided by wooden desk top models and thus gives the examiner more predictive validity than is available at present. If this were not so, then the more expensive simulator time would provide no more information than the wooden models and as an assessment method should be discarded. Whatever test is used to measure competence, this question underlies the whole concept of certification.

The other form of predictive validity is concerned with the question of whether a good performance in the simulator predicts a competent officer at sea. Some work has been done on this and is summarised in paragraph 2.3.2.1. The author attempts to answer one further part of this question in Chapter 4 which describes an experiment carried out to ascertain whether subjects in a simulator provide different behaviours in "at sea" conditions and under examination stipulations.

Content validity is concerned with measuring performance. The simulator would obviously provide a far greater amount of performance data than could be gained from the candidate handling wooden models. Therefore the content validity of simulator based assessment is far higher than that based on wooden models.

Construct validity is concerned with establishing functional relations between important variables, for instance, reaction time, intelligence, anxiety and degree of frustration. At this stage in the development of simulator based assessment a measurement of construct validity can only be attempted well into the future.

# CHAPTER 3

# ASSESSMENT METHODS USED BY MILITARY, CIVIL AND EDUCATION AUTHORITIES

## 3.1. INTRODUCTION

The objective of considering the methods of personnel assessment used by some military, civil and education authorities is to gain an insight into some of their experiences and question whether some of their methods are transferable to the assessment of deck officers in a ship simulator. It is expected that due to the greater availability and acceptance of simulators by the military and civil authorities, lessons could be learned from their methods as well as paying due regard to the considerable changes that have taken place in educational assessment.

## 3.2. MILITARY AUTHORITIES

### 3.2.1 MILITARY AVIATION

There is a marked difference between the civil and military application of simulators for the training of aircrew. Whereas in civil aviation, the flight simulator training content is very high, in military aviation the content is much more diverse and due to often obsolete and far from optimal qualities of fidelity, aircrew often have a negative attitude towards simulation.

> " ... flying a high performance fighter aircraft is emotionally much more than a series of well-planned actions and therefore can never be substituted for by simulation" [15].

One of the concluding remarks from the same paper states

> "simulation in military aviation in the United Kingdom, Germany and The Netherlands has not reached the same level of professionalism as has civil aviation" [15].

However, it is not the intention of this thesis to compare the simulator expectations of aircrew and watchkeeping officers, but to question whether some of the aircrew assessment methods can be transferred.

A number of the more informative evaluation reports produced in the United States have been classified 'Confidential' and are therefore unavailable to this source. In the unclassified section Mitchell's paper on the performance monitoring of pilots does suggest there

> "is a great deal of emphasis placed today by military ... towards automating performance monitoring" [16],

but apart from mentioning four areas used for automatic monitoring which are involved with measuring a student's performance, gives no further details other than data recording of the aircraft instruments at set times. Mitchell states "the student is automatically judged on the order in which he performs the task as well as the time required to complete a given procedure" [16].

The only other hint he provides as to the type of assessment procedure employed is to note that a performance error is used to measure the difference between a student's performance and that

"designated as ideal for this performance"[16].

From the papers mentioned above, and other general papers, "errors" are considered as "deviations from the accepted method of carrying out a task". Considerable emphasis is placed on the order in which procedures are applied and the time in which the procedure is completed. An error is therefore objective and can be measured, as the criterion by which it is measured is known to both subject and Instructor.

Stoffer[17], outlines the performance measurement of naval pilots using the Navy's Tactical aircrew training system (TACTS). Again, in similar vein to Mitchell, it provides reasons for performance measurement, but offers very little insight into how this is accomplished. The reasons given for requiring a performance measurement system are based on the analysis of 'kill' ratios. In the 1950 Korean conflict, American F-86 Sabre jet aircraft destroyed equally capable Soviet MIG-15 aircraft at a rate of 10 MIGs for every Sabre lost. In the Vietnam conflict, this 10:1 advantage was reduced to 2:1. The "Ault Committee report" (1969) identified deficiencies in air combat training as a primary factor. The paper concentrates on the "Fighter pilot mystique" and notes that

> "the unfortunate consequence of the fighter mystique attitude present in this culture is that the skill components of the ACM (Air-to-air combat mission) task have not been translated into performance measures which could be used to provide training feedback for the majority of fighter pilots" [17].

Thus, although performance measures can be set and "errors" observed, there is no method of translating the skill component of a trained pilot into a measurable device for training and assessment.

A further paper on assessing pilot performance from a Swedish source regrets the lack of recording systems as a pre-requisite for efficient training in flight simulators. The Swedish method of assessing pilot performance on the Viggen aircraft is given as using

> "three indices of performance: ratings of the instructor, of the pilot himself and a deviation score, which means the sum of pilot deviations from optimal behaviour" [18].

Thus the sources read by the author can only offer generalised statements which cannot be turned into more explicit information without access to classified documentation.

### 3.2.2. BRITISH ARMY

In order to obtain an insight into the assessment procedures used by the British Army, a visit was made to the School of Signals, Blandford Camp, Dorset. The School is equipped with the Racal Combat Net Radio simulator, type SS3200. The simulator is furnished with an Instructor's console and four ports (equivalent to the marine simulator 'own ship'). It is usually used in a fixed mode but suitably equipped Army vehicles can be hooked into the simulator, thus providing further "ports".

The assessment procedures are carefully compiled into a job description, which is sub-divided into:

i) Training objectives
- Performance required
- Under what conditions
- To what standard

ii) Enabling objectives
- What he has to do
- The conditions
- The standards to be achieved
- Length of time allowed

Under these seven headings, the assessment procedures are tightly controlled producing as objective an exercise as possible.

The Army School of Training Support has recently written a report on the value of simulation for Army training [19]. This document describes the 50 different simulators purchased for the British Army and indicates the savings achieved by using a simulator instead of the real equipment. The document also reiterates the need for the simulator to be developed as an integral part of the training system. In a similar vein to Stoffer [17], the Army School of Training Support is concerned with the psychological fidelity of a simulator, and suggests that the investigation of the skills and knowledge necessary for successful job performance are undertaken to include tabulating the cues and responses involved in a specific task.

### 3.2.3. ROYAL NAVY

Due to their proximity and use of simulators for training, the Commanding Officer of HMS Dryad at Southwick was approached and a visit was requested to discuss the R.N assessment procedures. During the visit to Dryad, the officers responsible for the Principal Warfare Officer (PWO) course and Junior Officer course were met.

The PWO course is a year's duration of which the first 3 months are spent at Manadon in Plymouth, followed by a common training course at Dryad. A week at sea follows during which time the candidates are assessed by the training section. The PWO course members are then split into three specialisations: communications, above water warfare, and below water warfare. Another period of seatime called "streamed time" follows, during which period the candidates are again assessed. Operations room training at Dryad follows: this is split into two parts - a 5 week period followed by a break period of 2 weeks for planning and finally a further 5 week period of which the last week contains the examination. Failure to pass the course usually means no further promotion after Lieutenant Commander. It is usual for approximately 11 men to start each course of which 8 finally pass. Course members can be failed at three critical periods in their training year: during their first week at sea after Manadon, after their "streamed time" at sea and following their final examination. The candidates are assessed by their Training section up until the final examination week. This final assessment is accepted as being subjective and is based on whether the candidate will "make a good PWO". The final assessment is not carried out by the Training section but by three serving Commanding Officers who previously had passed the PWO course with high marks. Their overall comparison is based on whether they would be satisfied with the candidate as PWO in their ship. However before any conclusions are reached, the Training section's assessment is also taken into account. Assessment reporting is carried out using a 5 point scale, where 3 is the average. Personnel on point 1 or 5 would be commented upon in writing and that report forwarded to the Commanding Officer of the candidate's next ship.

The Training section assessing the Sub-Lieutenants on a 13 week training module use a fairly continuous verbal and written assessment procedure; these findings are passed to the candidates. As with the PWO course, much of the assessment is carried out at sea by their course officer, staff officer and navigation expert. The officer in charge of this training section assesses his own team, but agrees he has been given no training in assessment marking and relies on his own experience.

There are a number of good points in this assessment system. Each candidate knows, before starting the course, when assessment periods will take place, the penalty for failure, and the assessment method. The Royal Navy have attempted to overcome the problem of assessing skills by ensuring that assessment is subjective. This is not based on one individual's assessment, but in the PWO course is based on the joint decision of a Training Section and finally by the three Commanding Officers who also receive an input from the Training Section. This type of assessment procedure seems to be similar throughout the British armed forces; for instance the assessing of army candidates for the Parachute regiment. A disadvantage to this system is the power given to a few over the progress of a man's career. Obviously, members of any training and assessment section are chosen for their skills, but it is worrying that in one particular case, the Officer in charge of a Training Section had been given no training himself in assessment procedures.

## 3.3. FEDERAL AVIATION AUTHORITY

### 3.3.1. ASSESSMENT PROCEDURES

The Federal Aviation Authority (FAA) is the government body responsible in the United States for, amongst other obligations, conducting the pilot's practical tests. The Federal Aviation regulations (FAR's) specify the areas in which knowledge, judgement and skill must be demonstrated by the candidate before the issuance of a pilot certificate or rating. The FAA publish practical test standards containing specific procedures and manoeuvres in which the pilot must demonstrate his competency. These procedures and manoeuvres, covered under the word "Tasks", are contained in the FAA publication "Private Pilot - Practical Test Standards" for aeroplane, rotocraft, glider or airship [20]. This publication can be obtained for a small fee from the FAA offices in the United States, and provides the candidate with explicit information about the test standard required for each Task.

This book is arranged into Areas of operation, which commences with the preparation of the flight, gives details of the flight itself and ends with the flight's conclusion. Each Task within the Area of operation is sub-divided into the "Objective" and "Action".

The Objective lists, in sequence, the important elements that must be satisfactorily performed to demonstrate competency in a Task and includes:

a) specifically what the candidate should be able to do

b) the conditions under which the Task is to be performed

c) the minimal acceptable standard of performance

As an example of c) - the minimal acceptable standard - the candidate should maintain the desired altitude +/- 100 feet and maintain the desired airspeed +/- 10 knots.

The Action assists the examiner in ensuring that the Task objective is met and in some instances alerts the examiner to areas upon which emphasis should be placed. An example of this format is given in figure 1. The candidate is given explicit instructions on how each Task should be carried out by reading the relevant FAR.

In order for the candidate to pass this practical test the applicant must show the examiner that he has

> "knowledge and skill in sufficient depth to determine that the standards of performance listed for all Tasks are met" [20].

Tasks with similar objectives may be combined to conserve time, and when the demonstration of a Task is not practical, competency is evaluated by oral testing [22]. However the objectives of all Tasks must be demonstrated and evaluated at some time during the practical test.

> "Of utmost importance is the applicant's ability to perform safely as a pilot and the examiner's ability to recognise the applicant's weaknesses as well as satisfactory performance" [20].

The examiner in all cases is either an FAA inspector or FAA designated pilot examiner. His responsibility is

## B. TASK: TRAFFIC PATTERN OPERATIONS (ASEL)

*PILOT OPERATION – 2*

REFERENCES: AC 61–21, AC 61–23; AIM.

1. **Objective.** To determine that the applicant:

   a. Exhibits adequate knowledge by explaining traffic pattern procedures at controlled and non–controlled airports including collision avoidance.
   b. Follows the established traffic pattern procedures consistent with instructions or rules.
   c. Corrects for wind drift to follow the appropriate ground track.
   d. Maintains adequate spacing from other traffic.
   e. Maintains the traffic pattern altitude, ±100 feet.
   f. Maintains the desired airspeed, ±10 knots.
   g. Completes the pre–landing cockpit checklist.
   h. Maintains orientation with the runway in use.
   i. Completes a turn to final approach at least one–fourth mile from the approach end of the runway.

2. **Action.** The examiner will:

   a. Ask the applicant to explain airport traffic pattern operations.
   b. Observe the applicant's ability to conform with the established traffic pattern procedures, and determine that the applicant's performance meets the objective.
   c. Place emphasis on the applicant's planning and division of attention in relation to collision avoidance.

FIGURE 1 - AN EXAMPLE OF THE FAA TASK OBJECTIVE FORMAT

designated in the Practical Test Standard and includes evaluation of the candidate's knowledge and skill,

> "since there is no formal division between the oral and skills portion of the practical test" [20].

Candidates are advised that the examiner will place special emphasis on the areas of aircraft operation which are most critical to flight safety, even though they are specifically detailed under each Task.

The Practical Test Standard notes that many accidents have occurred due to the pilot being distracted during various phases of flight. In order to strengthen his evaluation of the candidate, the examiner provides realistic distractions throughout the practical test. A list of distraction examples are provided in the text.

The publication also describes, in general terms, the performance required of a candidate for a satisfactory performance and notes that Unsatisfactory performance is defined as:

> "consistently exceeding tolerances or failure to take prompt corrective action when tolerances are exceeded" [20].

There is no redress for a candidate to higher authority in the event of an unsatisfactory performance.

There are a number of differences in the assessment of military and civil candidates. In the latter, guide lines concerning the conduct of an examination are laid down in various publications, to which the candidate has access. The complete flight of a civil aircraft is controlled by strict operational procedures, and through state of the art technology, the progress of the civil aircraft can be monitored and controlled from the cockpit and monitored from the ground. This is, of course, possible within military aviation, but it is not necessarily required, for the skill components of the interdiction and attack tasks require a more individual component especially in the attack mode.

### 3.3.2. USE OF SIMULATORS

During the last thirty years, as simulator technology has improved, changes were made to the FARs in order to allow increased use of simulators for the training of aircrew. The FAA acknowledged the value of simulator training in 1954, when the airlines were allowed to perform all but four proficiency check manoeuvres in a simulator. Since those early days the FAA has continued to promote, evaluate and regulate the use of simulators for aviation training. Since the late 1960s computer generated imagery (cgi) generation has brought a breakthrough in visual systems. In 1973, the FAA issued amendments to their FARs that resulted in reducing pilot flight training to approximately 90 minutes in an aircraft for an Airline transport pilot certificate of competency. The 90 minutes actually in an aircraft was considered necessary at that time as the cgi visual scene was not considered realistic enough for assessing the pilot on landing the aircraft. A 1978 amendment allowed a simulator approved for the landing manoeuvre to be substituted for the airplane. In 1980, further amendments were promulgated that suggested a 3 phase plan to provide guidance through a progressive upgrading of the flight crew on training simulators. Under phase 2, transition and upgrade training are accomplished in a simulator. Transition training is the training required for a pilot to move from one aircraft to another in the same group - for example, co-pilot of a 727 to co-pilot of a 707. Upgrade training is the upgrading from co-pilot to captain. Thus it is not necessary for the captain of an aircraft to have actually flown that aircraft before carrying passengers: all his training can be accomplished in a flight simulator.

The fuel and operating costs that can be saved each year by using advanced simulators are estimated at over $67million by the U.S. air carriers in fuel costs and $25million in operating costs.[21]

Before the FAA legalise their regulations, a consulative document is circulated to the U.S. air carriers and requests are made for comments to the proposed legislation. One comment received recently concerned the psychological considerations of simulation; it suggested that an atmosphere of complacency is prevalent while operating a simulator irrespective of its sophistication. This psychological phenomenon is present because of the knowledge that regardless of what mistakes are committed, the consequences of actions are negated because a simulator cannot crash. The FAA reply is quoted because of its context to marine simulation:

> "In point of fact, almost the exact opposite is true. Pilots do not fly airplanes out of a sense of fear. ..... Simulator training ... is designed to facilitate training in various environmental conditions and let the trainee learn from his mistakes. The pilot's self-esteem, peer pressure, and the pressure of being observed (by others) can exceed the psychological pressure of flying the airplane" [21]. (This quotation supports Captain Jestico's contention that the "oral" examination should put the candidate under stress.)

The reliance of the FAA on simulators for training is further emphasised by their comment that NASA

> "has dramatically illustrated the ability of a pilot to successfully accomplish total training in a simulator as evidenced by its putting several men on the moon, without having flown in the craft before" [21].

Pilot organisations, air carriers, airline passenger organisations and the National Transportation Safety Board support the FAA plans for using advanced simulation.

The FAA are assessing the feasibility of using a computer based private pilot (airplane) written certification exam. In 1980, the University of Illinois administered the first certification examination via computer. The candidate's reactions to this examination method were overwhelmingly favourable [23], and considerably reduced the "cumbersomeness" experienced by candidates when taking the written examination. This computer based written examination also provides the result at the end of the examination, both for the candidate and the FAA, alleviating many days delay.

## 3.4. CIVIL AVIATION AUTHORITY

### 3.4.1. INTRODUCTION

The Air Navigation Order empowers the Civil Aviation Authority (CAA) to issue United Kingdom flight crew licences and associated ratings. These certificates entitle the holders to act as members of flightcrew in aircraft registered in the U.K. The CAA may issue licences and ratings subject to such conditions as it thinks fit.

The CAA is responsible for the certification of flightcrews operating a wide diversification of aircraft; from short air taxi and pleasure flights to world wide operations. Under the statutory provision of the Air Navigation Order, few distinctions are drawn between the operation of small scale operations and major airlines flying the world routes.

> "But in the application of these principles and of certification requirements, it is possible and it is necessary to take account

of the scale and scope of the flying activity and of the operators' particular circumstances" [24].

Before an aircraft registered in the U.K. can fly for the purpose of public transport, the CAA grants an Air Operators Certificate to the operator of that aircraft. The Operator is defined as the person for the time being having the management of the aircraft. In order to obtain the Air Operator Certificate, the applicant must lodge copies of the Operations manual with the CAA: it is a statutory requirement that the Operations manual shall contain all such information and instructions as may be necessary to enable the operating staff to perform their duties. The Operations manual

"will be regarded by the authority as a primary indication of the standards likely to be achieved by an operator"[24].

The CAA note that great importance will be attached to the suitability of the manuals for regular use by operating staff, and in particular, by the operating crews in flight.

A publication entitled Air Operators' Certificates - Information on requirements to be met by Applicants and Holders ( CAP 360 ) [24] lists the necessary information that should be provided by the operator. Included within the requirement is the appointment of Training captains and other examiners who will be required to conduct the necessary periodical tests and to give practical training as necessary.

The following tests of a pilot's competence are normally administered by examiners authorised by the CAA and employed by the operator:

a) Initial type rating tests

b) Type rating renewal tests

c) Instrument rating renewal tests

The operator's manual, approved by the CAA is used in these tests to provide the operating technique and yardstick for a pilot's performance.

### 3.4.2. ASSESSMENT PROCEDURES

Although basic international standards of training are recognised throughout the world, the CAA demands that higher standards are met. The responsibility for enforcing the appropriate standard in the U.K. is covered by the CAA. Two types of examiner are employed in the U.K.: the Flight examiner and the Authorised examiner. The 8 Flight examiners in the U.K. are employed by the CAA and are required to examine a pilot's General Flight test and the Initial Rating test.The Authorised examiner is an airline company employee, who has passed the Authorised examiner course held by the CAA at Stanstead airport. The Authorised examiner undertakes "renewals" when a pilot has to "demonstrate his proficiency", either annually or bi-annually. The Authorised examiner undertakes testing of his own company pilots on behalf of the CAA. There are approximately 900 Authorised examiners in the U.K. ( 1 in 8 pilots ) of which about 300 are employed by British Airways.

The standard of competency required by the CAA is set out in CAP 54 - The Professional pilots' licences ( aeroplanes, helicopters and gyroplanes) [70] - and includes the Instrument and Flying Instructors' ratings. This publication is available to all candidates for a small fee. The syllabus and flight test conditions for the separate examinations are given in this booklet.

The CAA has given much attention to the conduct of the tests carried out by an Authorised examiner. Their assessment procedure is carefully laid out in "Notes for the guidance of Authorised Instrument Rating examiners CAP 170 ". The purpose of this test

> "is to establish whether the holder has maintained the standards of proficiency necessary for safe operation in controlled airspace under instrument flight rules"[25].

The examiner is warned in this publication that he will have to display qualities of tact, detachment and impartiality, especially when examining a senior company pilot or close colleague.

The renewal test starts with a pre-flight briefing, which has to be carried out in a sympathetic and friendly attitude towards the candidate. All relevant CAA publications, company manuals and charts have to be available to the candidate. The examiner must give the candidate a description of the test in chronological order. Before asking for questions, the examiner points out to the candidate that excessive time spent on a procedure may mean a fail. Before concluding the pre-flight briefing, the candidate is asked to acknowledge that he has been properly briefed: if necessary, he signs a certificate to this effect.

During the test, the candidate is assumed to be the captain of the aircraft and is thus responsible for the management of the flight. The examiner can take the place of the co-pilot if necessary, but will not prompt the candidate; usually he sits in the 'jump seat'. For this test the candidate is asked to assume that icing conditions prevail from ground level upwards and the cloud ceiling is the lowest minimum specified in the company operations manual. After the external check of the aircraft by the candidate, who notes each item and tells the examiner why it is being inspected, the candidate taxies the aircraft and takes off. During the flight the main part of the test takes place. The CAA appreciates that

> "it would be impossible to devise a complete and detailed formula by which an examiner can assess whether a candidate has passed or failed the Instrument rating test, .... but it is essential that the highest possible degree of standardisation in assessment be achieved" [25].

Tolerances for the test are detailed in this publication, but nevertheless the CAA does acknowledge that even a good pilot may exceed these tolerances in special circumstances without deserving to fail the test. However,

> "how long a candidate may exceed these tolerances without being classified unsafe cannot be left entirely to the examiner's discretion" [25].

Further paragraphs in this publication give precise indications on how the tolerances should be applied to individual cases of inaccuracy. Over and above these tolerances, a list of 27 of the more usual errors and omissions are described which constitute 'fail' points.

CAP 170 also offers advice to the Authorised examiner on the debrief following the flight and the action to be taken for both the pass and fail circumstances. The form used by the examiner is detailed in Appendix B. Should a candidate fail he does have the right of appeal against the conduct of the test.

Similar assessment procedures are used by the CAA in other tests of a pilot's competence. However, in the course leading to a certificate as an Authorised examiner there is no right of appeal.

In some instances,the tests may take place in a flight simulator; a description of the types and their uses follows in the next paragraph.

### 3.4.3. USE OF SIMULATORS

The CAA does not give formal approval to simulators for training purposes. Their use for this purpose is implied under the Air Navigation Order, article 20 (10) which permits the testing of flight crew in simulators approved by the CAA. Their suitability for testing flight crews implies suitability for training.

The first flight simulator to be approved in the U.K. was the Redifon Stratocruiser, built for BOAC in 1950: Comet and Viscount simulators followed. These 3 simulators were approved for Instrument Rating renewals ( as described in para. 3.4.2.) and parts of the pilot's competency checks.

Today the CAA

> "evaluates and approves a flight simulator as if the assessment was being carried out on a real aircraft" [26].

After type approval has been given for a simulator, a Training Inspector is assigned to that simulator and submits regular reports on its performance to the CAA. In practice, this means that most approved simulators are seen by an Inspector once a month.

The major simulator manufacturers, Rediffusion, Singer Link and Lockheed are developing extremely sophisticated wide-angle visual displays. The WIDE system, developed by Rediffusion produces a display covering 150 degrees in azimuth and 40 degrees in elevation; however it is less bright and has less resolution than the conventional TV monitor. In a WIDE 2 development, Rediffusion have increased the number of projectors to 5 and increased the resolution to give a 200 degree overall coverage. Singer Link's comparable system, IMAGE 3 costs in the region of $2 million for a typical 3 channel system: texture patterns would add a further $300,000. A simple daylight database takes something like 1,200 hours to produce and costs about $40,000. The motion part of the simulator costs about $4 million for a 6-axis system [27].

The CAA have recently produced an embryo publication outlining their requirements for the approval of flight simulators. [28] Four levels of approval are proposed - levels 1, 2, 3 and 4. Levels 1 and 2 are appropriate to basic instrument flying and the instrument rating revalidation tests, whilst levels 3 and 4 are appropriate to more advanced flight simulators: level 4 is intended for aircraft type conversions entirely by the use of flight simulators. At present, unlike the FAA, transition and upgrade training cannot be completed on a flight simulator. The technical requirements specified for level 3 and 4 are similar to those of the FAA. These revised procedures are expected to

> "improve monitoring standards, introduce a technical inspection and provide quantitative data to support qualitative assessments during evaluations" [28].

## 3.5 EDUCATION SYSTEMS

### 3.5.1 INTRODUCTION

Assessment theories have been spawned by the recent growth in the U.S.A. of a new research industry studying educational evaluation, and it is from this concept that previously accepted methods of evaluating knowledge and ability have been criticised and new methods such as criterion-referenced assessment have been the object of numerous studies and research papers.

Not all these studies are relevant to this thesis. Most of the developments have occurred in the United States and are purely related to evaluation of education. However, some of these concepts will be appraised in this thesis for their usefulness in assessment of deck officers using a marine simulator. Educational evaluation is mostly concerned with assessment of a person's knowledge and does not appraise his judgement, skill and experience. In order to gain a broad perspective of assessment, it is necessary to consider the background to educational assessment.

### 3.5.2 ASSESSMENT PROCEDURES PRIOR TO 1963

Although the most significant progress in educational assessment has taken place since 1963, the concept is a lot older. Nitko [29] refers to a letter written by the Reverend George Fisher, Principal of the Greenwich Hospital School, to a certain Chadwick in 1864. The Reverend Fisher wrote that there had been established

> "a book, called the 'Scale Book' ..... which contains the numbers assigned to each degree of proficiency in the various subjects of examination: for instance if it be required to determine the numerical equivalent corresponding to any specimen of "writing", a

comparison is made with various standard specimens, which are arranged in this book in order of merit; the highest being represented by the number 1 and the lowest by 5 and the intermediate values by affixing to these numbers the fractions 1/4, 1/2, or 3/4. So long as these standard specimens are preserved in the institution, so long will constant numerical values for proficiency in 'writing' be maintained. And since facsimilies can be multiplied without limit, the same basic principle might be generally adopted." [29, p.484]

Thus one of the earliest proficiency tests was referenced to a clearly defined skill, rather than a comparison of a pupil's ability or skill with another pupil. This difference is at the root of all recent research on education and assessment.

Two years earlier than Fisher wrote his letter to Chadwick, Robert Lowe introduced a "payment by results" system. This was continued with some modifications until 1897, but made the payment of grants to School managers dependent upon their pupil's proficiency in the "three Rs"[30]. Although Brown notes that this

"probably had the effect of retarding the development of elementary education in England, ... it did have the advantage that it established standards at a time when many teachers were not trained." [30, p.21]

By 1870, proficiency levels were also used by schools in the United States. The levels were determined subjectively by the Course teachers. [31,p.17]

During the years 1909 - 1916, a number of educational textbook authors formalised all types of achievement scales. Thorndike produced two scales; for handwriting in 1910 and drawing in 1913. The scale values were similar to those used by Fisher 45 years earlier, but improved by using more sophisticated psychological scaling techniques. Specimens of handwriting, ranging from "copy-book perfect" to barely legible were located along a numerical scale. A student's handwriting could be compared to this scale, and a numerical value assigned. At one time, Thorndike's handwriting scale hung on thousands of classroom walls throughout the country [29]. Another early assessment scale was formed in 1915. This was Ayres' "Measuring scale for ability in spelling". Nitko [1980] differentiates between these types of proficiency scale and those used to assess complex intellectual or psychomotor skills, such as the English composition scales produced by Harvard-Newton in 1914. In this instance, rather than comparing a pupil's work with a set quality, the qualities that characterised each composition were described and thus the proficiency skill in a pupil's English composition could be described.

The above examples show that the idea of referencing the knowledge of a pupil to clearly defined skills, rather than a comparison with another pupil's attainment is therefore not new to British education. In 1913, Thorndike was concerned that marks assigned to pieces of work had for the most part, only relative meaning i.e. the pupil who scores 91% is judged better than one who scores 87% but no one knows exactly what either is able to do [30]. He suggested that marks should be

> ".... correct measures of either the amount of knowledge, power appreciation and skill attained or the amount of progress made " [30]

Although a number of educationalists in the 1920's agreed with the comparison of a pupil's work with a standard, the actual work needed to produce an acceptable standard and implement this standard throughout the schools became too arduous and time consuming for educationalists. Also, in Britain, assessment for the purpose of reporting and certification became increasingly important [32]. Thus the use of a comparative standard was slowly neglected and an assessment, which is essentially comparative and competitive with other pupils became the accepted norm. This method of assessment has continued in British schools to the present day.

However, in the United States, educationalists continued to develop acceptable standards. Monroe, in 1917, concluded that

"..... a standard must meet two conditions: that it be reasonable and that it be efficient" [33].

A reasonable standard was defined by Monroe as one which realistically can be obtained by students and an efficient standard was defined as one which represents a level of performance which equips students for meeting present and future demands [33]. This concept of standardised testing continued for the next two decades. Diagnostic testing was advocated under the Winneka plan in which pupils progressed at their own pace, using work books: the rate of progress was judged by diagnostic tests. A very extensive method of assessment was used by Morrison of the University of Chicago. His 'Unit plan' used a Mastery formula:

".... pre-test, test the result, adapt the procedure, teach and test again to the point of actual learning" [34].

In the United States, work in assessment procedures slowed down until the 1950's when developments occurred that led to a

"burgeoning interest in educational evaluation " [35].

In the years between the two World wars, the public education system in the United States was considered to be one of the nation's finest accomplishments. The education system allowed a citizen to advance both socially and economically, but in the 1950's a small but vociferous group of critics attacked the education system for the "life adjustment" and "progressive" educational studies. This attitude of the educationalists was considered to be too liberal and intellectually inferior to a programme of the "three Rs". The dissenters became more numerous when the U.S.S.R. launched their Sputnik 1 in 1957. American technical achievement and therefore the education system was seen to be second rate. A few years later federal lawmakers began to enact legislation that gave greater power to national government and took away the previous responsibility for education, which had rested with individual states.

Some of the early federal education laws of the late '50s provided modest funds for research activities; especially for disadvantaged pupils. In 1965, Congress passed the Elementary and Secondary Act. Senator Robert Kennedy and others considered that this new law must contain provisions for mandatory evaluation of whether local agencies had used their federal grants properly [35]. In the final version of the bill, evaluation was tied in with funding: in effect this meant that local authorities had to evaluate their projects before receiving further finance. Educational evaluation was born. Its birth was not without problems: Federal officials and external reviewers all concluded

> "that the pool of evaluation expertise among the nation's educators resembled a puddle instead of an ocean" [36].

This provided a rush of educational scholars, originally trained in other specialisations , into the discipline of educational evaluation. During the late 1960s, citizens (who paid in taxes for schools) and legislators all demanded that schools also become accountable for the funds they were given. Parents and citizen advisory boards have grown powerful in the United States and these groups continue to require educators to be accountable and to evaluate their results.

It is in the light of this relatively recent surge, that the concept of criterion-referenced assessment was coined by Glaser in 1963 and developed further by a large band of educationalists.

### 3.5.3 CRITERION-REFERENCED ASSESSMENT

The concept of identifying a pupil's absolute status against a set criterion was initiated by the Reverend Fisher in 1864 and formalised by Thorndyke in 1913. Glaser, in 1963, applied these concepts to differentiating between criterion and norm referenced behaviour.

Glaser stated

> "what I shall call criterion-referenced measures depend upon an absolute standard of quality, while what I term norm-referenced measures depend upon a relative standard .....Underlying the concept of achievement measurement is the notion of a continuum of knowledge acquisition ranging from no

proficiency at all to perfect performance. An individual's achievement level falls at some point on this continuum as indicated by the behaviours he displays during testing. The degree to which his achievement resembles desired performance at any specified level is assessed by criterion - referenced measures of achievement or proficiency. The standard against which a student's performance is compared when measured in this manner is the behaviour which defines each point along the continuum ...... Criterion levels can be established at any point in instruction where it is necessary to obtain information as to the adequacy of an individual's performance" [37].

Although it is clear from Glaser's initial definition that criterion-referenced assessment (CRA) does not depend upon the performance or knowledge of others (norm-referenced), numerous authors chose to classify CRA outside of the original definition. In 1978, Gray reviewed the considerable CRA literature and found 57 varieties of CRA [38]. His table of definitions was classified as either explicit or implicit; depending upon whether a clear definition of CRA was found. The table was also divided by a distinction between Domain and Continuum, the former term being used to indicate sampling from a number of wide objectives, without any logical sequencing. Popham (1975) argues that all criterion-referenced assessments should be domain based, purely on the fact that

"the number of tests (and the accompanying descriptive literature) would be overwhelming" [35, p.131].

He thus argues that a test based on the ability of a pupil to multiply correctly any pair of single-digit numbers is far more practical than the ability to multiply correctly 5 x 7. In the same volume, and repeated three years later, Popham declares that a CRA test

"is used to ascertain an individual's status with respect to a well defined behavioural domain" [39].

Brown (1981) notes that a number of the most respected contributors to this subject accept this definition, but others have re-defined this concept as domain-referenced testing [30].

By 1978, 15 years after the introduction of the first definition, Hambleton et al noted that 600 papers were now available on the subject. Black & Dockrell (1984) recorded another 150 entries in the two years since 1978. The great majority of these authors are American or writing from Universities or Institutions in the United States. In complete contrast, work in the U.K. was limited initially to Scotland where the Dunning committee (SED,1977) recognised that the application of CRA would pose problems. Further reviews considering the application of CRA in Scottish education have been funded by the Scottish Council for Research in Education and the Scottish Education Department.

Both Popham (1975) and Hambleton et al (1978) [40] agree that although "domain-referenced" is more descriptive of the concept than "criterion-referenced", it would be inappropriate to change the phrase purely for semantic reasons. In the most recent U.K. publication on this subject (Black & Dockrell, 1984), Popham's 1975 definition is accepted as

> "our interpretation of the definition allowed us more licence around "behaviour" than the use of rigidly defined behavioural objectives. Essentially however, we were happy to work with this rather than make a marginally different addition to the existing 57 " [32].

As already mentioned, it is Popham's interpretation of CRA - defined by some authors as Domain - referenced testing - that has been accepted throughout the U.S.A. The outcome of this has been the rapid growth of measurement specialists, employing evermore advanced statistical technology to this concept. This quantum leap from Chadwick's original "scale book" to Van der Linden's probability models [41] and Berk's continuum methods [42] has left far behind many practical educationalists. Only in a few papers on this subject are the readers warned about the overkill that has been achieved; for in most cases it is outside of the scope and ability of the teacher to understand the erudite arguments of the authors. There are other reasons for its lack of practical implementation . The analysis is complex and requires computers and advanced statistical packages to solve the data; the subject is more attuned to the American system of minimum-competency programmes and thirdly, almost all the work in this area is concerned with the basic primary school skills such as reading and arithmetic. Brown (1981) notes that

> "any extension of criterion-referenced assessment into areas where the skills and knowledge to be acquired are of a different and probably complex nature ....will probably depend upon the development of a variety of different conceptions of criterion-referencing which may be unsuited to the sophisticated technical treatment" [30].

### 3.5.4 CONCLUSION

It is against this background that the application of CRA has to be considered for use in evaluating the performance of Deck officers in a ship simulator. Being educationalists, it has been necessary to study how the latest thinking and measuring devices have been used to obtain an assessment of a man's knowledge in a particular subject. The author has traced the background and has given some indication of the uses and deficiencies of criterion-referenced assessment. Although Glaser's original definition has been widened to encompass a subject area, the power of CRA lies in the ability of curriculum specialists, or in this instance, the Department of Transport or examiner, to define clearly the nature of what is to be assessed. An officer's ability on the bridge of a ship requires knowledge of navigation and seamanship, judgement on the application of that knowledge and skill in carrying out the task. The main advantage of using a simulator for assessment purposes is to obtain a "rounded picture" of the candidate; the simulator is the medium through which the candidate can combine knowledge, judgement and skill to provide the examiner with the conviction that the candidate would be a competent watchkeeper.

Chapter 4 summarises the methods used by the military and civil arms of the aviation world, the U.K. armed forces and the educationalists. The lessons learnt are then applied to a method of assessing ships' officers in a marine simulator.

# CHAPTER 4

# APPLICATION OF ASSESSMENT METHODS FOR EVALUATION OF DECK OFFICER COMPETENCE

## 4.1 SUMMARY OF ASSESSMENT METHODS

The assessment methods used by the Military, Federal and Civil Aviation Authorities, and the Educationalists, as outlined in Chapter 3, have provided a comprehensive and not dissimilar account of how assessment procedures are carried out in their respective professions.

All the military and civil authorities mentioned in Chapter 3 use the data in a comparative way: subjectively, by comparison with "optimal behaviour" (Swedish airforce [18]), "that designated as ideal" (United States airforce [16]), "whether he will make a good PWO" (Royal Navy); and as objectively as possible by comparison with "the standard to be achieved" (School of Signals), "the minimal acceptable standard of performance" (Federal Aviation Authority and Civil Aviation Authority), and "clearly defined skills" (Educationalists). The CAA acknowledge that a complete and detailed objective assessment cannot be devised but do require the highest possible degree of standardisation in assessment.

Before any assessment can be conducted, data on which the performance can be judged have to be available, either through remote performance monitoring, as mentioned by Mitchell [16], or by on-going collection as noted by the Army, Royal Navy and Federal Aviation Authority. The information collected is in the form of hard data, for instance recording the aircraft instruments at set times and subjective data describing the performance of the individual engaged in the task, for instance the three indices of performance mentioned by the Swedish airforce [18]. In the Warsash ship simulator, hard data describing the track of the ship would be available for recording, and subjective data can be gained from visually monitoring the performance of the subject on the bridge.

Apart from comparative data, three other criteria were used by a number of the authorities:

i) time in which the task should be accomplished,

ii) 'failure' states and

iii) distractions.

These three criteria should be incorporated, if possible, into assessment using marine simulators.

All mariners are aware of the commercial pressures to complete a trip in a fast time. This can cause unnecessary risk-taking by the Master, but needless delays caused by poor shiphandling can mean the difference between profit and loss on a trip.

Shiphandling is an art and does not have carefully defined boundaries within which the Master operates, as in the aviation industry. To some Masters, passing over a bank with 2 feet of water under the keel when there is plenty of water available either side of the bank constitutes unnecessary risk, to other Masters the risk is acceptable. It would obviously be very difficult to assess performance when both Masters consider their action correct and the only difference being their interpretation of risk. Without detracting from the shiphandling skills, the use of 'failure' states would solve a lot of the uncertainty.

A number of notable casualties, both in the air and at sea, have occurred through the Pilot/Master becoming distracted. It is possible to use distractions in the ship simulator through vhf conversations and alarm bells at inconvenient times to the Master.

The aviation authorities place a lot of emphasis on the briefing of the individual prior to the test; the CAA requiring the candidate to acknowledge, if necessary in writing, that he has been properly briefed. The briefing for any candidate includes the availability of all manuals, charts and other necessary publications. A written description of the test with the chronological order of the tasks to be carried out is given to the candidate. These points will be noted for use in Deck Officer assessment.

Failure in any test comes from contravening the 'failure' states, and consistently exceeding the tolerance set for each task. All authorities debrief the candidate after his test. The CAA allow a right of appeal against the conduct of the test.

Therefore any assessment for Deck Officers in a Marine simulator should include the following:

1. A full written briefing

2. Availability of hard data from the simulator
3. Subjective assessment from a competent person
4. The optimum method of carrying out the task
5. 'Failure' states
6. Time set for the completion of a task
7. Distractions
8. Definitions of "unsatisfactory" performance.

## 4.2 THE PROPOSED SET OF EXPERIMENTS

### 4.2.1 INTRODUCTION

As mentioned in Chapter 1, the oral examination is the medium through which a mariner's shiphandling knowledge is assessed at present. Chapters 1 and 2 have argued that a ship simulator similar to the type used at Warsash would provide a better medium to assess the candidate's knowledge, skill and judgement in such tasks as shiphandling manoeuvres, including the approach to berths, knowledge of the International system of buoyage, and practical appreciation of the International Regulations for the Prevention of Collisions at Sea (IRPCS) [61].

The oral examination for a Masters Certificate of Competency is likely to take between one hour and two to complete. Aspects of the syllabus that can be tested using the simulator only number those mentioned in the previous paragraph: other aspects of the examination such as knowledge of fire fighting procedures should continue to be tested in the examination room. It is the intention of this thesis to show that one or a number of simulator exercises should be completed by the candidate before he sits his oral examination, and the results of the exercise made available to the examiner when the candidate sits his oral examination.

### 4.2.2 EXPERIMENTS TO ASSESS SHIPHANDLING SKILLS

#### 4.2.2.1 Shiphandling skills to be tested

Muirhead used the Warsash ship simulator to assess shiphandling skills for part of his thesis and notes that on the Warsash simulator the results

> "indicate that it is possible to carry out basic night time shiphandling tasks"[46, p.233]

The shiphandling tasks referred to above involved berthing the 18,000 tonne cargo ship port side to a jetty. Muirhead mentions that successful results are not likely to be produced by inexperienced junior or potential watchkeepers due to the reduced field of view.

The author's own view is that the simulator should not be used for berthing tasks due to the reduced field of view. It was therefore considered that the proposed experiments should not include final berthing manoeuvres, but should concentrate upon anchoring, turning short round with single and twinscrews and collision avoidance tasks.

4.2.2.2 The intended exercise scenarios

Five exercises were written, and two familiarisation runs for the single screw 18,000 tonne ship and the twinscrew Ro-Ro ferry. The exercises were designed to test the candidate's shiphandling skills in approaching an anchorage and anchoring, steaming along a set of leads, turning a twinscrew ship short round, steaming towards a berth stern first, a man overboard exercise in open waters, and crossing the traffic separation scheme in the Dover Straits.

Information for two of the exercises is given below. It was intended to pass this description to each subject during his briefing.

EXERCISE 1 (THE SOLENT - EASTERN PART)

SCENARIO

The general cargo ship 'Morlone' is bound for Esso Fawley for refuelling. Southampton Port Radio (SPR) has just informed you that your berth will not be available until midday on 2 December and have instructed you to anchor at anchorage "Bravo".

You, as Master, are on the bridge of the ship with the Second Officer and a helmsman. You have taken over the 'con' from the Second Officer. The anchors have been cleared away and the Bosun and one man are for'd.

SPR have informed you that the 'Tokyo Maru' is outward bound via the Nab Channel and is in position 2.5 cables south of the South Ryde Middle Buoy (Brg. 275 x 3.8 miles from you). The 'Winchester' is at anchor in

Anchorage "Alpha" (Brg. 286 x 4.56 miles from you). No other ship movements are expected.

OBJECTIVE

You are to anchor the ship at anchorage "Bravo". Due to the intended track of the 'Tokyo Maru', you are to approach the anchorage by going north of the North East Ryde Middle buoy. You are to stem the tide before anchoring, using your engines and wheel movements but not your anchor (Tidal stream expected at "Bravo" is 285 x 2 knots).

After anchoring, you are to check the ship's position using cross bearings.

FAILURE STATES

1. Grounding.
2. In collision with buoys or other solid objects.
3. Anchoring in excess of 2 knots over the ground.
4. 'Brought-up' position > 2 cables from position marked on chart.
5. Exceeding the duration of 1.5 hours to being 'brought-up'.

EXERCISE 3 (WESTHAVEN)

SCENARIO

You are the Master of the Ro-Ro ship 'Morlone' and are approaching the port of Westhaven. With you on the bridge is the Second Officer and a helmsman. An anchor party consisting of the Bosun and one man is forward. Both anchors are cleared away.

You have received permission to enter the port and have been informed that your berth - head west on the north side of the Westhaven terminal - is clear. No traffic is expected, and there are no ships on the south berth or on the SBM. The tidal condition of 135 x 0.5 knots is expected to remain constant until abeam of Nos. 10/11 buoys when it will reduce to zero. There will be no requirement to send the crew to stations during the exercise.

OBJECTIVE

From your start position, manoeuvre the ship on to the leads, remaining within the white sector of the rear light. Turn the ship to starboard between the West Floret and Thorn Elbow buoys and proceed towards your berth along the centre of the Westhaven channel after your turn is completed. As it is necessary to be heading west on your berth, turn the ship short round within the "Turning basin" bounded by the lines drawn between the following buoys: W2, W4, W3, W1, W2. Use the twin screws and rudder for this manoeuvre, but do not use the bow thrust or either anchor. After your turn is complete, proceed stern first towards the berth. The exercise will end when abeam of W4/W3.

The Bosun, forward, and the Third Officer, stationed aft can provide distances from nominated buoys during the turning manoeuvres.

FAILURE STATES

1. Grounding.

2. In collision with buoys or other solid objects.

3. Failure to enter the channel.
4. Consistently straying off the leads.
5. Straying outside of the area marked by the channel buoys.
6. Use of anchor or bow thrust.
7. Exceeding the duration of 1.5 hours.

#### 4.2.2.3 The procedure

It was intended that three Simulator lecturers, each with command experience, would complete each exercise and their resultant tracks, and timescale noted. After discussions, the optimum method of carrying out a particular exercise would be written out, together with what was considered 'unsatisfactory' performance. A list of distractions, commonly used by the simulator lecturers during the training courses would be drawn up.

Ten volunteer subjects were to take part in this set of experiments. Prior to their arrival at the simulator, each subject was to be given the necessary charts, pilot books, tide tables and other necessary publications. He was also to be given the printed sheet detailing the scenario, objective and 'failure' states. A maximum of two hours were to be allowed for the subject to prepare a passage plan into the harbour.

For the two scenarios given in the previous section, it is necessary to have a Watchkeeper (the Second Officer) and a helmsman on the bridge to assist the Master. It was considered unrealistic for these persons not to be present. In addition, it was necessary to have the author in the simulator control room, monitoring the exercise and gathering the hard data and a Simulator lecturer on the bridge recording subject data, such as whether the subject applies helm before engine revolutions. Thus in addition to the subject and the author, three extra persons were needed for each run.

## 4.3 CONCLUSIONS

After the methodology had been agreed and the exercises written, it became apparent that the intended assessment procedures in the simulator needed too many people actively involved in each exercise. To assess one subject in either the East Solent anchoring scenario, the Westhaven twinscrew or the Dover straits exercise, three additional persons apart from the author were required. It was intended to obtain the Second Officer and the helmsman from either the student population in the College or from the lecturing staff. After discussions with staff and College students, it became apparent that there would be considerable difficulty in guaranteeing the necessary manpower due to the work pressure on students and availability of staff. When Muirhead [46] carried out similar experiments staff instructors and simulator technicians, who were as knowledgeable as the instructors in the particular exercises were made freely available.

A second problem was foreseen in the assessment of an individual during what is basically a team effort. Although the Master subject would prepare his own passage plan, the responsibility for the execution of that plan would be divided between the Master and the Second Officer. Taking a ship into a port is a team effort. What happens in these exercises if the Second Officer plots the position of the ship inaccurately and the ship grounds ? Is the Master failed for not monitoring the Second Officer ? Perhaps he should be, but not because of his poor shiphandling skills which is what the exercises were designed to test, but rather for his lack of monitoring.

The third point concerns the simulator field of view. The SUSAN simulator on which Muirhead carried out most of his runs has a daylight capability and a 240 degree field of view which offers the subject far more information than the nocturnal 100 degrees at Warsash.

It thus became apparent, for the three reasons stated above, that the Warsash simulator was an inappropriate medium in which to test a Master's shiphandling skills in harbour areas.

However, collision avoidance procedures in open waters, with just the subject on the bridge and the ship in autopilot, could be tested.

It is considered there are three main advantages in assessing watchkeepers' collision avoidance skills: the Department of Transport places as much emphasis on collision avoidance as they do on shiphandling; full assessment experiments have not been carried before (although Muirhead included one exercise); and it is considered only the subject and the author are needed for each run. Problems are foreseen with definitions of 'failure' states, and optimum methods of carrying out the task. Therefore the direction of the research shifted from assessment of shiphandling skills to assessment of collision avoidance procedures.

Chapter 5 describes the first experiments that were carried out to study whether a watchkeeper's performance at sea is similar to an examination situation in the simulator.

# CHAPTER 5

# RESEARCH STUDY - PART 1.

## 5.1 INTRODUCTION

The end result of undertaking the proposed assessment in a simulator is to provide the Department of Transport oral examiner with details of a simulator exercise(s) undertaken by the candidate. This will then provide the examiner with further information concerning the subject's collision avoidance knowledge, skills and judgement as displayed in the simulator. If the examiner so wishes, he can use the data and information provided to question the candidate about the exercise and therefore help to satisfy himself that the subject would make a competent Master at sea.

## 5.2 RATIONALE

Before considering whether the interpretation of specific rules in the IRPCS can be examined in a simulator, it is necessary to study whether the "at sea" behaviour transfers to what is essentially an examination situation in a simulator - the converse of the transfer of simulator training to sea. This is of particular significance, as in many conversations the author had with College students, a large proportion asked whether they should act in the simulator as they would "at sea" or as the Department of Transport required. They obviously saw a considerable behavioural difference between the two criteria.

A further area of study concerns the amount of information that the examiner may need in order to understand the reasons behind a certain course of action taken by the candidate. Hard data as output by the simulator provides a plan view of all the ship tracks and further data outputs the helm and wheel changes made to achieve that track, but it does not tell the examiner the reasons behind the achieved result.

It was decided to study two methods of obtaining information about the reasons for the alterations: some subjects would be briefed to provide a verbal commentary whilst on the bridge and the other subjects would be given a structured debrief at the end of the run.

In addition, a questionnaire completed by the subjects following the exercise would provide subjective information on whether they considered this method of assessment to be effective for assessing practical collision avoidance skills.

The Bridge Manning Level (BML) study [10] identified a number of parameters by which the subject's collision avoidance behaviour could be judged. By itself, each parameter only provides a part of the overall pattern, but collectively can provide sufficient information to understand the subject's manoeuvres. Part of the analysis will compare performance according to the parameters listed in the BML study. These parameters are defined in paragraph 5.3.7.

## 5.3 METHODOLOGY.

### 5.3.1. OBJECTIVES

The first objective of these initial experiments was to study whether the collision avoidance behaviour of the watchkeeper in an examination situation would be different from that indicated in previous simulator runs when similarly qualified subjects were instructed to behave as if they were "at sea".

The second objective was to find out whether the examiner was given a better understanding of the subject's decision making process by:

i) using verbal protocols during each exercise or

ii) by a structured debrief at the end of each exercise.

The third objective was to find out whether the subjects would accept the simulator as a medium for assessing those skills.

### 5.3.2 EXPERIMENT DESIGN.

In order to study the three objectives outlined above, ten volunteer subjects were given a familiarisation period in the simulator and then a simulator exercise previously used in the BML study [10]. This provided a comparison of behaviour between the "at sea" conditions (as in the BML study) and examination conditions as used in this study. Twelve subjects completed this exercise in a part of the BML study and thus the design comprised a comparison between those 12 in the "at sea" conditions with the 10 subjects under examination conditions.

Six of the ten subjects in this group provided verbal protocols during the runs and the other four were given structured debriefs at the end of each run. It was necessary that the quality of the simulation was kept and in the case of verbal protocols, that this did not interfere with the decision making process of the subject.

Questionnaires were used to obtain a subjective report on the use of a simulator for assessment purposes. The format of the questionnaire was similar to that used by Muirhead [46] in his study. It is necessary to assess the subjective content of the answers provided by this study's subjects and to compare the answers with those supplied to Muirhead.

### 5.3.3 THE EXERCISE SCENARIO

The exercise chosen, exercise 2 in the BML study, takes place in the open sea west of the Bristol Channel. Ships in the exercise are seen visually at 6nm and at that range the "Cadet lookout" confirms their sighting and informs the subject of the colour of their sidelight ( by which means the subject can verify the aspect of the approaching ship). Figure 2 describes the scenario.

Own ship is on a course of 010 with OS3 on a steady bearing of 057. Two further significant ships (OS1 & OS2) on courses of 171 and 174 appear on radar at about 14.5nm fine on the port bow. Their tracks cross ahead of Own ship's bows by 4nm and 4.7nm and produce CPA's of 9c and 7c to starboard. Their presence can impede the desired alteration of Own ship to starboard to clear OS3.

Initial Conditions:

| | |
|---|---|
| Own ship course | 010 |
| Own ship speed | 15k: Full away |
| Autopilot | Engaged |
| Current | Nil |
| Wind | 225 x 10k: 10% gusts |
| Visibility | 6nm. |

Significant traffic at the start of the exercise:

| | | | |
|---|---|---|---|
| OS1 in 'hide' | brg. 001 x 23.1nm | Course 171 | Speed 25.0k |
| OS2 in 'hide' | brg. 004 x 20.9nm | Course 174 | Speed 16.3k |
| OS3 in 'hide' | brg. 057 x 16.5nm | Course 277 | Speed 16.5k |

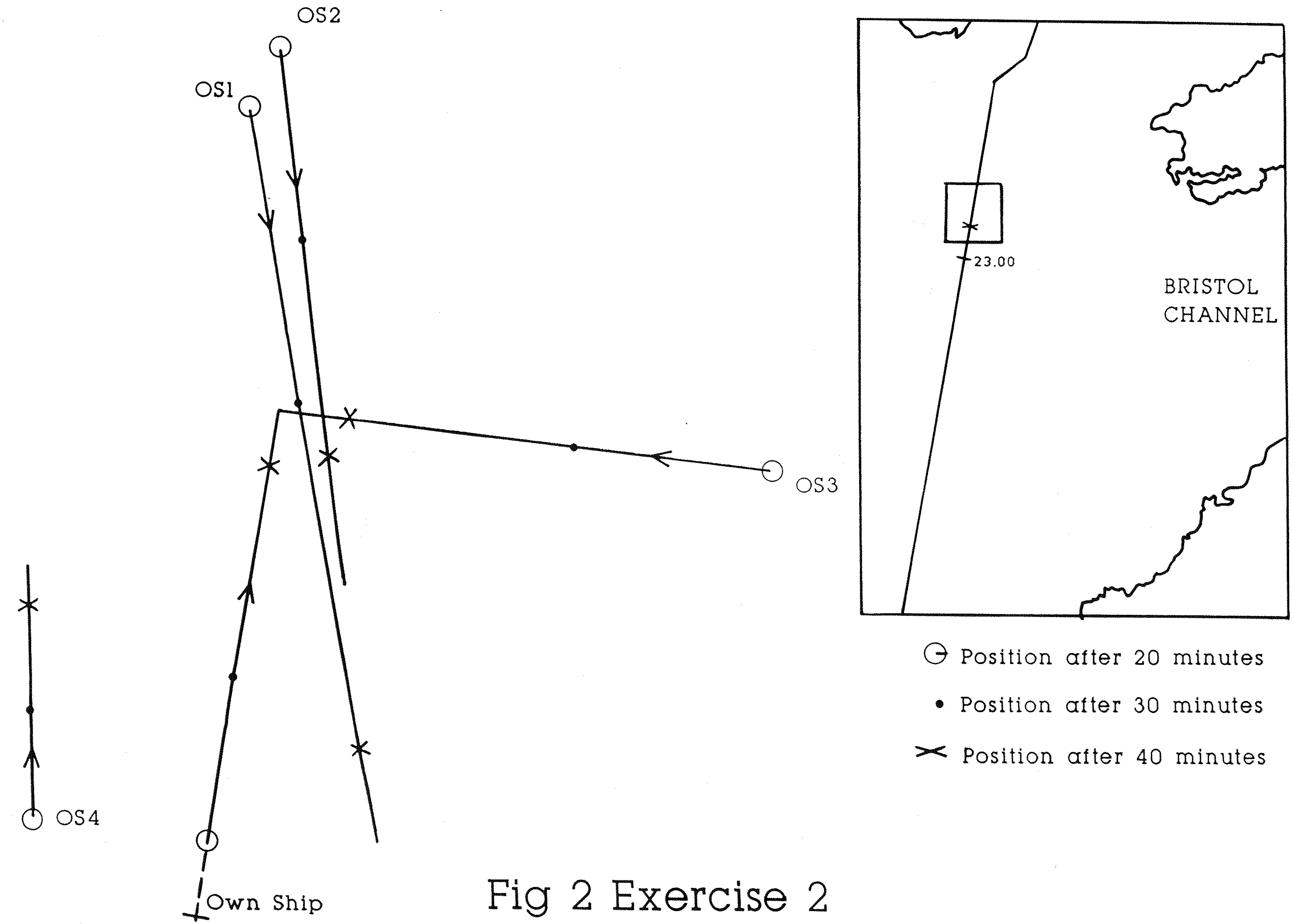


Fig 2 Exercise 2

This exercise is illustrated in figure 2, and is reproduced from the BML report.

### 5.3.4 THE SUBJECTS.

The subjects were chosen from those British watchkeeping officers attending the College for tuition leading to the examination for a Class 1 (Master Mariner) Certificate of Competency. Details of each of the subjects are given below:

| Subject | Cert. | Rank | Age | W/K Service | Company |
|---|---|---|---|---|---|
| M1 | Cl.2 | C/O | 34 | 7 years | 2 |
| M2 | Cl.2 | 2/O | 28 | 4 years | 2 |
| M3 | Cl.2 | 2/O | 27 | 3.5 years | 3 |
| M4 | Cl.2 | 2/O | 29 | 4 years | 2 |
| M5 | Cl.2 | 2/O | 31 | 6.5 years | 2 |
| M6 | Cl.2 | 3/O | 31 | 3.5 years | 2 |
| M7 | Cl.2 | 2/O | 37 | 6 years | 1 |
| M8 | Cl.2 | C/O | 27 | 6 years | 2 |
| M9 | Cl.2 | 2/O | 28 | 6 years | 2 |
| M10 | Cl.2 | 2/O | 29 | 5 years | 2 |

Company key:
1. 100,000 grt+
2. 1600 - 100,000 grt
3. Coastal trade < 1599 grt.

### 5.3.5. THE SIMULATOR

Ship Simulator 2 was used for the first six subjects as audio recording facilities necessary for the verbal protocols were only available in this simulator. However, for the remaining four subjects who were debriefed following the exercise, ship simulator 1 was used. This simulator is an earlier model but as far as the subject is concerned the only discernible difference is that the bridge of simulator 1 is smaller, although both include the same equipment.

Simulator 2's control room recording facilities are more extensive, including a matrix print out which details the wheel and engine movements ordered by the subject, as well as recording the position of the two nearest other ships in the exercise. To overcome the lack of this facility in simulator 1, more extensive notes were taken by the simulator operator.

Each subject was given a familiarisation period in the simulator to acquaint him with the the simulator equipment and the manoeuvring capabilities of the 18,000 tonne cargo ship which was used by all the subjects in this study and the BML study. A description of this ship is provided in Appendix G.

### 5.3.6 THE PROCEDURE

Approximately 60 students at the College studying for their Class 1 (Master Mariner) Certificate of Competency were approached and asked to volunteer for this project. The majority of those ten who took part were halfway through their 6 month course and therefore were expecting to sit their oral examination in three months time. The same basic procedure was used for each subject. The purpose of the study was explained to each of the subjects and they were told that they were to assume that the information obtained from the exercise would be passed to the D.Tp. examiner for discussion in their oral examination. For those subjects who were to provide verbal protocols, it was explained that they should say when ships were detected on radar, the reasons for making any decision (e.g. alter course),the rule from the IRPCS that was relevant to their situation, and anything else they considered relevant.

A familiarisation period followed before each subject's run and prior to the actual exercise, each subject was left in the Master's cabin with a pre-prepared chart of the area and a copy of the Company orders. It was explained to each of the subjects that he was the ship's Master.

When the subject went to the bridge, the watch was handed over to him in the normal manner. After the exercise, the subject returned to the Master's cabin to complete the questionnaire and if appropriate the debriefing.

### 5.3.7 THE PARAMETERS

It was decided to list each subject's attainment in the exercise according to the same parameters used in the BML study. These parameters are:

#### 5.3.7.1 Certificate Class.

The U.K. certificate of competency held by the subject:

1 = Class 1 (Master Mariner) Foreign - Going.

2 = Class 2 or Mates certificate

3 = Class 3 or Second Mates certificate.

5.3.7.2 Minimum Detection Range

In the exercise Other ships 1,2 and 3 start the run "in hide", which means that although the simulator operator is aware of their position, they are hidden from the radar screen and visual scene. Each ship is brought "out of hide" when it is 14.5 miles from Own ship. This distance allows the subject to acquire the target ship and start plotting on the 24 mile range scale. The minimum detection range is the lowest range at which a subject detects one of the 3 other ships ( OS4 is in the visual scene from the start.) This information is obtained either from the verbal protocols (Subjects 1-6), by the debriefs at the end of the run (Subjects 7-10), or through observation of the radar using the low light camera.

5.3.7.3 Radar Plot.

This parameter, either 0,1 or 2 defines the amount of radar plotting undertaken by the subject.

0 = No plotting undertaken

1 = CPA only assessed

2 = Course and/or Speed assessed in addition to CPA.

This information is obtained either from the verbal protocols, the debrief, or viewing through the camera.

5.3.7.4 First action range

This is defined as the range from OS3 at which the subject first alters course or speed. This distance provides information on how close the subject chooses to approach this ship before taking avoiding action.

5.3.7.5 First action type.

S = Alteration to starboard

P = Alteration to port

E = Reduces speed

The amount by which course was first altered to port or starboard (in the one instance where a subject reduced speed, D/S = Dead Slow Ahead.)

5.3.7.6 Number of actions.

The subject is required by the IRPCS to take action to avoid striking OS3. The number of actions he takes are detailed in this column. These figures do not include those alterations of course, following the collision avoidance manoeuvre, to regain the original course, or the increase of speed, when appropriate, to 15k.

5.3.7.7 Cross ahead distance.

A "crossing ahead" is said to have occurred if the subject's ship crosses the bows of another at a distance of 2nm (20 cables) or less. This distance was chosen as being the minimum distance at which it was considered the majority of competent Masters would wish to cross the bows of another ship in these exercise conditions. The column also indicates which other ship was involved.

5.3.7.8 Minimum CPA.

The minimum Closest Point of Approach (CPA) is a commonly used measure and indicates in this instance how close the subject's ship comes to another in the exercise. The column also indicates which other ship was involved.

5.3.7.9 Control / Experimental

In the BML study, the subjects were divided between those who did the "control" (C) and those who did the "experimental" (E) set of runs. In brief, the Masters orders were altered in the experimental set to require all subjects:

"to have assessed the CPA of all vessels on the 12 mile range and if the CPA of a vessel is less than 3 miles, then to have constructed a triangle of velocities to determine the course and speed of the ship."

5.3.8. POST ASSESSMENT QUESTIONNAIRE.

It was decided to modify the questionnaire used by Muirhead [46] for this study. Muirhead studied 29 subjects for assessment of shiphandling skills in harbour areas. Each of his subjects was requested to complete the questionnaire which included questions about the familiarisation period, their attitude to this method of assessment and whether any external influences affected their level of performance. It was considered that his questionnaire answers could be compared with those found in this study, thus also providing a larger sample for analysis.

## 5.4. THE RESULTS

### 5.4.1 TABLES OF RESULTS

Table 1 details the results achieved by the BML group.

Table 2 details the results achieved by those subjects in this study - the MPHIL group.

Table 3 compares the performance between the BML and MPHIL groups. It was also decided to add a third column for comparison - that of the six subjects who in the BML group held a Class 1 certificate.

Table 4 details the questionnaire format and summarises the answers received.

The verbal protocols for subjects 01 - 06 have been transcribed and are written out in Appendix C.

The debrief transcriptions for subjects 07 - 10 are detailed in Appendix D .

TABLE 1.

RESULTS ACHIEVED BY THE BML GROUP

| Sub. | Cert. Class | Min. Det. Range Nm. | Radar Plot | First Act. Range nm. | First Act. Type | No. of Act's | X-Ahd Dist. c | Min. CPA c | C/E |
|---|---|---|---|---|---|---|---|---|---|
| S012 | 1 | 12.9 | 1 | OS3 5.8 | 50 S | 2 | OS1 7 | OS1 3 | C |
| S008 | 1 | 13.6 | 2 | OS3 5.8 | 60 S | 2 | OS1 13 | OS1 6 | C |
| S007 | 3 | 11.7 | 1 | OS3 4.9 | 50 S | 1 | OS1* 1 | OS1 1 | C |
| S021 | 1 | 9.7 | 0 | OS3 5.3 | 50 S | 2 | OS1 7 | OS1 2 | C |
| S020 | 1 | 13.8 | 1 | OS3 11.3 | 25 S | 1 | - | OS1 14 | C |
| S018 | 3 | 11.0 | 1 | OS3 4.3 | 20 P | 2 | - | OS3 4 | C |
| S014 | 2 | 7.1 | 0 | OS3 5.1 | E D/S | 4 | OS3 18 | OS1 10 | E |
| S024 | 1 | 12.8 | 2 | OS3 6.9 | 60 S | 1 | - | OS1 11 | E |
| S011 | 2 | 14.5 | 1 | OS3 1.9 | 76 P | 1 | OS3 5 | OS2 3 | E |
| S006 | 3 | 14.5 | 0 | OS3 7.0 | 65 S | 1 | - | OS1 12 | E |
| S004 | 2 | 5.7 | 0 | OS3 4.4 | 35 P | 1 | OS3 14 | OS1 12 | E |
| S022 | 1 | 14.3 | 2 | OS3 5.8 | 50 S | 2 | - | OS1 5 | E |

* Simulator operator altered course of OS1 at last moment

## TABLE 2.

## RESULTS ACHIEVED BY THIS STUDY (MPHIL) GROUP

| Sub. | Cert. Class | Min. Det. Range Nm. | Radar Plot | First Act. Range nm. | First Act. Type | No. of Act.s | X-Ahd Dist c | Min. CPA c | VPs |
|---|---|---|---|---|---|---|---|---|---|
| M1 | 2 | 10.6 | 1 | OS3 5.5 | 65 S | 2 | OS1 13 | OS1 7 | Yes |
| M2 | 2 | 10.6 | 2 | OS3 2.5 | 140 P | 1 | – – | OS1 10 | Yes |
| M3 | 2 | 12.1 | 2 | OS3 7.1 | 60 S | 1 | OS1 28 | OS1 14 | Yes |
| M4 | 2 | 12.2 | 2 | OS3 5.1 | 45 S | 2 | OS1 1 | OS1 1 | Yes |
| M5 | 2 | 12.8 | 2 | OS3 7.6 | 60 S | 1 | – | OS1 15 | Yes |
| M6 | 2 | 12.9 | 2 | OS3 8.1 | 50 S | 1 | – | OS1 14 | Yes |
| M7 | 2 | 14.2 | 1 | OS3 5.5 | 55 S | 1 | OS1 12 | OS1 4 | No |
| M8 | 2 | 12.0 | 1 | OS3 6.1 | 60 S | 2 | OS1 20 | OS1 9 | No |
| M9 | 2 | 12.0 | 2 | OS3 5.7 | 65 S | 1 | OS1 11 | OS1 4 | No |
| M10 | 2 | 12.0 | 2 | OS3 2.4 | 45 P | 1 | OS3 9 | OS3 7 | No |

## TABLE 3.

## BML AND MPHIL GROUP COMPARISONS

| ITEM | BML | MPHIL | BML CL.1 |
|---|---|---|---|
| Number of Subjects | 12 | 10 | 6 |
| Number of runs | 12 VPs | 6 VPs<br>4 Debrief | 6 VPs |
| Av. Min. Radar Det. Range | 11.8nm | 12.5nm | 12.8nm |

| ITEM | BML | MPHIL | BML CL.1 |
| --- | --- | --- | --- |
| Minimum Radar Det. Range | 5.7nm | 10.6nm | 9.7nm |
| Radar Plotting: | | | |
| Timed Intervals | 8 = 67% | 10 = 100% | 5 = 83% |
| Course of 1 Sig. ship | Nil | 4 = 40% | Nil |
| Course of 2 Sig. ships | Nil | Nil | Nil |
| Course of 3 Sig. ships | 3 = 25% | 4 = 40% | 3 = 50% |
| Speed of 1 Sig. ship | Nil | 4 = 40% | Nil |
| Speed of 2 Sig. ships | Nil | Nil | Nil |
| Speed of 3 Sig. ships | 2 = 17% | 2 = 20% | 3 = 50% |
| Av. Dist. from OS3 @ 1st. Alter Course | 5.7nm | 5.6nm | 6.8nm |
| Av. Amount of 1st. A/C (Degrees) | 49 | 65 | 49 |
| No. of A/C to avoid ships | | | |
| - 1 | 6 = 50% | 7 = 70% | 2 = 33% |
| - 2 | 5 = 42% | 3 = 30% | 4 = 67% |
| > 3 | 1 = 8% | Nil | Nil |
| To Starboard | 8 = 67% | 8 = 80% | 6 = 100% |
| To port | 3 = 25% | 2 = 20% | Nil |
| Used Engines | 1 = 8% | Nil | Nil |
| Crossed Ahead of another ship < 2nm | 7 = 58% | 5 = 50% | 3 = 50% |
| Av. Cross Ahead Distance | 9.3c | 9.2c | 9.0c |
| Min.Cross Ahead Distance | 1c | 1c | 7c |
| Av. Min. CPA of closest ship | 6.9c | 8.5 | 6.8c |
| Absolute Min CPA of closest ship | 1c | 1c | 2c |
| Used Decca Navigator at frequent intervals | 12 = 100% | 10 = 100% | 6 = 100% |
| Certificates held: | | | |
| - Class 1 | 6 = 50% | Nil | 6 = 100% |
| - Class 2 | 3 = 25% | 10 = 100% | Nil |
| - Class 3 | 3 = 25% | Nil | NIl |

TABLE 4.

RESULTS OF THE POST ASSESSMENT QUESTIONNAIRE

SAMPLE SIZE - 10.

1. Have you undertaken any training on a shiphandling simulator before ? YES 2
NO 8

If YES go to question 2; if NO go to question 5

2. State the total number of hours of training that you have spent on the simulator prior to this exercise.
M2 = 4 hours
M3 = 6 hours

3. How many of these hours were you in command of the the ship ?
M2 = 2 hours
M3 = 1 hour

4. State the type and size of vessels handled.
Both = 16000 dwt.

-----------------

5. What time were you given to familiarise yourself with the bridge, equipment, exercise area and Own ship prior to this exercise.
Average = 1 hour 25 minutes

6. Do you feel that the time given for familiarisation was:
(a) About right 9
(b) Too short M1*
(c) Too long Nil

* Too little familiarisation with the radar and Decca Navigator controls.

7. If your answer is 6(b) or 6(c), state the time that you consider to be necessary for familiarisation.
M1 - 3 Hours
He had 1 hr. 40m.

8. Have you previously covered all theoretical aspects of the seamanship/navigation skills tested in the exercise ? YES = 9
NO = M1*

* Situations with anyone vessel at more than one time.

9. How do you rate this method of assessing your practical collision avoidance skills in comparison to oral questions from an examiner ?

| | | |
|---|---|---|
| (a) | Not as effective | Nil |
| (b) | Equally effective | M5 |
| (c) | More effective | 9 |

10. Do you feel your level of performance was affected by:-

(a) an awareness of being under observation ?

YES M1, M6, M7.*
NO 7

* M1 = because of giving Vp's.
M6 = probably gave a better performance.
M7 = the need to comply with the letter of the collision regs.

(b) Unfamiliarity with the simulator

YES M1, M4, M8.*
NO 7

* M1 = Problems using the radar. Not used the Decca Navigator for 10 years.
M4 = Unfamiliar with radars - had a habit of thinking radar similar to last ship.
M8 = With regard to confidence only - it felt as if it was a new ship - not quite home. My actions would have been the same.

(c) Lack of reality

YES M1, M3, M9.*
NO 7

* M1 = Felt restricted by not being able to use bridge wings and binoculars.
M3 = Only to a very small extent - cannot go for a stroll on to the bridge wing.
M9 = Only 100 degrees field of view.

11. Please comment on this method of assessing your practical skills.

M1 = This is a far more realistic method of assessing practical skills, but a longer period of familiarisation is necessary and training in multiship instead of single ship situations is necessary.

M2 = Very good provided plenty of experience can be gained on the simulator prior to assessment. I was familiar with the gear in use having used most of it before.

M3 = Very good - this and Marchwood would be far more satisfactory than present extremely unrealistic system of oral exams.

M4 = If used for exam assessment, longer familiarisation would help.

M5 = Very good, worth doing. From personal preference would prefer longer and more varied ships (lights etc.) However brings home fact no time to plot fully (to examiner) - have to make quick assessment. Having to speak though is slightly offputting, but makes you think more about what you are doing.

M6 = Very worthwhile, albeit expensive. I am a firm believer in real-time observation of any examination candidate.

M7 = No comments provided.

M8 = No comments provided.

M9 = Good.

M10= A good method which gives a 'real' impression of reactions in practical situations. If it is possible to incorporate different types of vessel e.g NUC, fishing vessels, then its value would be enhanced accordingly.

### 5.4.2. QUESTIONNAIRE RESULTS

Two of the ten subjects had been in a bridge simulator beforehand and neither had completed the Bridge Team Training Course of one week's duration. Their time in the simulator had been provided in a days training during their stay at the College.

Nine subjects considered that the average familiarisation time of 1 hour 25 minutes was sufficient although M1 wanted a minimum of 3 hours. However 2 further subjects, M2 and M4, in answer to question 11 commented that longer familiarisation would be required before assessment.

Subject M1 in answer to whether all the theory had been covered beforehand considered that situations with more than one vessel had not been taught. The "Rules of the Road" lectures at the College provide the student with an understanding and knowledge of the IRPCS.

Ninety per cent of the subjects believed that the simulator provided a good way of assessing practical collision avoidance skills. Subject M5 thought it was equally as effective as the oral, and clarified this in question 11, by suggesting that the exercises should be longer and should provide more varied ships.

Three subjects, M2, M5 and M10 considered their performance was not affected by some aspect of the simulation. Each had his own reason but no factor appears more than once.

Since the subjects completed this study, they have taken their oral examination: nine passed, M1 failed.

## 5.5. DISCUSSION

### 5.5.1 PERTAINING TO OBJECTIVE 1

Comparisons can be made under three main headings;

5.5.1.1 Information gathering

5.5.1.2 Alterations of course/speed.

5.5.1.3 End result.

#### 5.5.1.1 Information gathering.

The greatest variation of subject performance for one activity is for radar plotting at timed intervals in Table 3. If statistical significance at the 5% level is to found, it will occur under that parameter. The parametric "t" test and Mann Witney have been tried but no statistical significance at the 5% level found. Significant trends in performance have been noticed, for instance the MPHIL examination group achieve a larger CPA (8.5c) than do the other groups (6.8c & 6.9c). This is likely to be caused by the caution of those under examination conditions.

All the subjects in the MPHIL group attempted radar plotting after detecting the three other ships at an average range of >12nm; although 3 subjects mentioned that they had problems in detection of ships on the 24 mile scale (the radars were checked at the end of each exercise and no reason could be found for this anomaly.)

However it is noticeable that all the MPHIL group assessed the CPA of the other ships, and carried out a similar amount of radar plotting as the BML Class 1 group but more than the average BML group.

### 5.5.1.2 Alterations of course/speed.

The farthest average distance from OS3 at the first alteration of course was achieved by the BML Class 1 group with the other two groups producing similar distances. The average amount of the first alteration is largest in the MPHIL group, but this is compounded by one subject making a 140 degree alteration. Without that inclusion the average for the MPHIL group is 56 degrees, which is still larger than the other two groups. The reason for these variations is probably because that Class 1 group altered earlier and therefore to achieve a desired passing distance did not have to alter course through as wide an angle as required by the MPHIL group. However, the Class 1 and BML groups obviously considered that their initial alteration was not sufficient; 67% of the Class 1 and 50% of the BML groups made further alterations, compared with only 30% of the MPHIL group. All the most experienced mariners (BML Class1) went to starboard, compared with only 80% of the MPHIL group and 67% of the whole BML group. Only one subject (in the BML group) used engines in his collision avoidance manoeuvre.

5.5.1.3 End result

The cross ahead distances of <2nm were uniform throughout: approximately 50% of all the subjects crossed ahead of another ship at an overall average of 9c. The minimum distances of 1c in the BML and MPHIL groups were as a result of, in the first case, an alteration of OS1's course by the operator to avoid a certain collision and in the second case, an insufficient initial alteration of course by the subject. The average minimum CPA varied between 8.5c (MPHIL) and 6.8c / 6.9c (Class 1 / BML). This is not statistically significant.

5.5.2 PERTAINING TO OBJECTIVE 2.

This objective sought to evaluate the best method of providing the examiner with information about the reasons lying behind the subject's decision to carry out a certain course of action.

There is no doubt that reading through the verbal protocols, as detailed in Appendix C, can provide the examiner with further information about the subject's decision making process. In a number of the vp's the subject acknowledges that OS3 is on a steady bearing and he is the give-way vessel. Subjects quote some requirements from the IRPCS[61], "making sure the action I've taken", "consider risk of collision to exist", but it is noticeable that no subject actually quotes any particular rule. A possible reason for this is that the IRPCS were formed for a one to one ship encounter, and this exercise includes three significant ships.

The information gained from the structured debriefs (Appendix D) was disappointing. The first question allowed the subject to recall what happened on the bridge since taking over the watch. It is likely that the situation complexity confused the subject's recall at the debrief, for the subsequent articulation was disjointed, and would not be of measurable assistance to the examiner. The debrief also attempted to find out about radar plotting and, in some cases, whether in retrospect the subject would have done anything differently. The answers to the plotting question could not be relied upon, and the obvious answer to the final question was given: that the subject would have altered earlier.

Previous research has found out that verbal protocols can prompt subjects into making and carrying out decisions earlier than their silent colleagues: it would appear the same could have happened in this study.

The average alter course distance from OS3 for the Vp group was 6.0nm; for the debrief subjects it was 4.9nm. However the end result is reversed: an average CPA of 10c for the Vp group as compared with that of 6c for the debrief group. The BML group also provided verbal protocols during their runs. The number of pages of verbal protocol transcript varied between 2 and 5. If it can be assumed that the fullest amount of talking will produce the most likely possibility of a subject carrying out a secondary task (i.e. talking) comparisons can be made between short and long transcripts. Three subjects provided transcripts under 4 pages (M1, M4 & M6.), the remaining three varied between 4 and 5 pages. The average alter course distance from OS3 for the first group was 6.2nm, the other 5.7nm. This result shows there is a tendency for subjects who provide longer protocols to carry out their decision later than their less communicative colleagues.

### 5.5.3 PERTAINING TO OBJECTIVE 3

Muirhead used the daylight shiphandling simulator "SUSAN" at the Fachhochschule, Hamburg. Nine watchkeeper grade students were assessed in seamanship and shiphandling berthing skills. A total of 29 simulator assessments were carried out. In addition he used the "CASSIM" simulator at Cardiff to assess 8 mariners for a total of 11 simulator exercises. Thus 40 simulator based assessments were undertaken by Muirhead, who used the same questionnaire for each run ( 3 further exercises were conducted on the Simulator No. 2 at Warsash but not included in the analysis. )

Of the Hamburg student exercises, 27 (out of 29) considered the familiarisation time was "about right"; however the students had acquired an average of 16 hours of simulator experience prior to their assessment. At Cardiff, 7 of the 11 student exercises considered the familiarisation time "about right". The time provided ranged from 35 minutes to several hours. In the main, Muirhead's students had spent a longer time on the simulator prior to assessment, so the results of this study do indicate that subjects will accept a familiarisation period of about 2 hours, as long as more time is spent on radar and navigation instrument familiaristion.

All 40 of Muirhead's questionnaires indicated that the subjects had covered the theory.

Muirhead's next question asked " How do you rate this method of assessment of practical skills in comparison to oral questions from an examiner ? - only answer if you have undertaken an oral assessment." Muirhead also gave his subjects an oral examination on shiphandling skills, but as mentioned previously, it is this author's intention that simulator assessment should complement the oral questions. It is of interest to note that in Muirhead's study,of the 40 exercise runs and oral questions, no subject passed the assessment and failed the oral, indicating a higher required standard for the simulator assessment. 83% of Muirhead's subjects considered that the simulator was more effective than the oral. This compares with 90% who said, in this study, that a simulator assessment was more effective for assessing collision avoidance skills.

Only in one instance on the Hamburg simulator was a factor of the simulation considered to affect the performance of the subject. In the Cardiff tests, 38% of the subjects noted an affecting factor; mainly "lack of reality" and "simulator unfamiliarity". Muirhead notes that this comment came from the least experienced students, who had no certificate of competency. This compares with the 30% in these tests who were asked the same question and noted a reduction in their performance caused by the simulator.

This overall comparison with Muirhead's results has shown a similar pattern of response from the subjects and indicates that over 80% of the subjects rated this method of assessment to be more effective than an oral examination. However, the questionnaire and the comparison has shown that more time must be spent in the familiarisation period on the Warsash simulator giving more radar practice to the subjects and emphasising the value of the "Cadet lookout" in reducing the drawbacks caused by the 100 degree field of view, lack of binoculars and bridge wings.

The comments provided by the MPHIL group should be considered favourable toward this method of helping to assess competence.

5.5.4 OVERALL DISCUSSION.

One aspect of this simulator assessment that hasn't been considered is the deliberations and decision of the examiner himself, even if he is provided with hard data and the reasons supporting the subject's decisions. This particular exercise has in various forms been given to approximately 100 watchkeeping subjects. It is by agreement a difficult exercise to complete satisfactorily: although only one ship is on a collision course, the presence of OS1 and OS2 do require either initial accurate radar plotting or if left too late manoeuvres that are at best, poor seamanship and at worst, downright dangerous. In the oral exam the testing of the subjects knowledge of the IRPCS only deals with 1:1 situations, and it has been argued that this exercise does involve a multiship situation. At a presentation by the author and Dr. D.H. Taylor of part of the BML study [57], a Department of Transport examiner in the audience suggested that this exercise was not typical of collision scenarios at sea. The majority of the watchkeepers there believed that this scenario can and does occur at sea. In a study of the recent editions of the three most widely read books on collisions, their causes and the legal judgement passed down [58, 59, 60], only one of the 17 open sea clear weather cases involved more than two ships. There is, therefore, a great deal of difficulty in assessing a subject's knowledge, skill and judgement in collision avoidance situations involving multiship encounters. This initial set of experiments has also shown that the decision not to include "failure states" was correct, as specific rules have not been laid down for this scenario.

## 5.6 CONCLUSIONS

1. The collision avoidance behaviour as displayed in a simulator under examination conditions is similar to situations where watchkeepers are told to behave as if they were "at sea."

2. Verbal protocols do provide the examiner with reasons for a subject's decision, but the information requested has to be less than that supplied in this experiment.

3. Bridge watchkeepers consider that the simulator provides an effective way of examining a subject's collision avoidance knowledge, judgement and skill.

4. The simulator familiarisation time should include more time spent on radar and navigation instrument familiarisation. The advantages of having the "cadet lookout" should be emphasised.

5. Collision avoidance examination scenarios should be simpler, and should only involve a 1:1 situation.

# CHAPTER 6

# RESEARCH STUDY - PART 2.

## 6.1 INTRODUCTION

The previous chapter concluded that collision avoidance scenarios for assessment purposes have to be simpler than exercise 2 used in the previous part of the study. Before deciding on the exercise design for the next part of the study, two other factors have to be taken into account: the degree of difficulty involving only one other ship has to be sufficient to warrant the use of the simulator, ( for instance a single ship on a steady bearing coming in from the starboard bow could not be considered sufficiently taxing to a mariner being examined for his Masters certificate); and the restriction imposed by the simulator's 100 degree field of view requires a rejection of any scenario with the subject's ship being overtaken by another ship outside of the visual scene.

## 6.2 RATIONALE

Part B of the steering and sailing rules of the IRPCS describe the actions to be taken in collision avoidance manoeuvres and is subdivided into sections that apply dependent upon the prevailing conditions of visibility. It was not intended to use this simulator to examine candidates in conditions of restricted visibility, as this is done in various radar simulator courses throughout an officer's career. It was also not intended at this preliminary stage to devise scenarios involving fishing vessels and "constrained" vessels. Therefore the three main areas that should be examined come under Part B, section 2 - rules 11 to 18 inclusive, and include the overtaking, head-on, crossing, give-way and stand-on situations. As the single ship crossing situation was not considered difficult enough, it was decided to devise three scenarios involving the head-on, overtaking and stand-on situations.

## 6.3 METHODOLOGY

### 6.3.1 OBJECTIVE.

To assess whether the simulator can be used as an assessment tool to complement the oral examination.

### 6.3.2 EXPERIMENT DESIGN.

Ten volunteer subjects due to sit for their Masters certificate of competency were chosen for the second part of this study. No subject had taken part 1. Note was taken of the lessons learnt from the previous familiarisation period, thus a new familiarisation exercise was written, which ensured more radar control use, and the subject was required to use the "Cadet lookout" more frequently.

Each subject was expected to complete two of the three exercises; the details are described in table 5;

for one exercise the subject was requested to supply a shortened form of the verbal protocols used in part 1, and in the other an exercise questionnaire was drawn up to be completed at the end of the run.

**TABLE 5**

**EXPERIMENT DESIGN**

| M11 | M12 | M13 | M14 | M15 | M16 | M17 | M18 | M19 | M20 |
|---|---|---|---|---|---|---|---|---|---|
| CW10 Q | OW12 VP | OW11 Q | CW10 VP | OW12 Q | OW11 VP | CW10 Q | OW12 VP | OW11 Q | CW10 VP |
| OW11 VP | CW10 Q | OW12 VP | OW11 Q | CW10 VP | OW12 Q | OW11 VP | CW10 Q | OW12 VP | OW11 Q |

Key:

CW10 = Coastal Waters 10 - Head-on scenario

OW11 = Open Waters 11 - Overtaking scenario

OW12 = Open Waters 12 - Stand-on scenario

VP = Verbal Protocols required

Q = Questionnaire at end of exercise.

Thus CW10 was completed 7 times: 4 as the first, 3 as the second exercise.

OW11 was completed 7 times: 3 as the first, 4 as the second exercise.

OW12 was completed 6 times: 3 as the first, 3 as the second exercise.

### 6.3.3 EXERCISE SCENARIOS

It was decided to write one scenario for each of the following situations: the head-on, the overtaking and the case where the subject's ship is required to stand-on.

#### 6.3.3.1 Exercise CW10 - the Head-on situation.

Rule 14 of the IRPCS, which describes the actions to be taken in this situation, is quoted below:

"(a) When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision each shall alter her course to starboard so that each may pass on the port side of the other.

(b) Such a situation shall be deemed to exist when a vessel sees the other ahead or nearly ahead and by night she shall see the masthead lights of the other in a line or nearly in a line and/or both sidelights and by day she observes the corresponding aspect of the other vessel.

(c) When a vessel is in any doubt as to whether such a situation exists she may assume that it does and act accordingly."

Although it was decided to write what is essentially a head-on situation exercise, further information can be obtained by increasing the number of ships but not the degree of difficulty as long as the subject takes sufficient time to evaluate the situation.

Exercise CW10, which is illustrated in figure 3, takes place in the Bristol Channel, with the subject's ship "Morlone" WSW of Nash Point, bound for Liverpool, having left Cardiff at low water. As the tide starts to flood three ships are approaching the Breaksea lightvessel from the west to pick up pilots before proceeding towards Avonmouth on the flood tide. All ships are seen visually at 6nm and the "Cadet lookout" confirms their sighting at that range. The Cadet also provides true bearings of shore lights and other ships when requested. OS1 is the "head-on" vessel, remaining on a steady bearing, positioned 2 degrees on the starboard bow ( within the meaning of the IRPCS [61] still a "head-on" situation.) Two other ships, also heading for the Breaksea, are due to pass 10c and 19c to starboard respectively of Own ship soon after the TCPA with OS1 is reached ( 30 minutes from the start of the run.) A fourth ship is being overtaken by the "Morlone", and will be on her port beam at 10c after 30 minutes. This ship is in the visual scene at the start of the exercise.

Initial Conditions:

| | |
|---|---|
| Own ship course | 277 |
| Own ship speed | 15k: Full away |
| Autopilot | Engaged |
| Current | Nil |
| Wind | 070 x 5k: 10% gusts |
| Visibility | 6nm. |

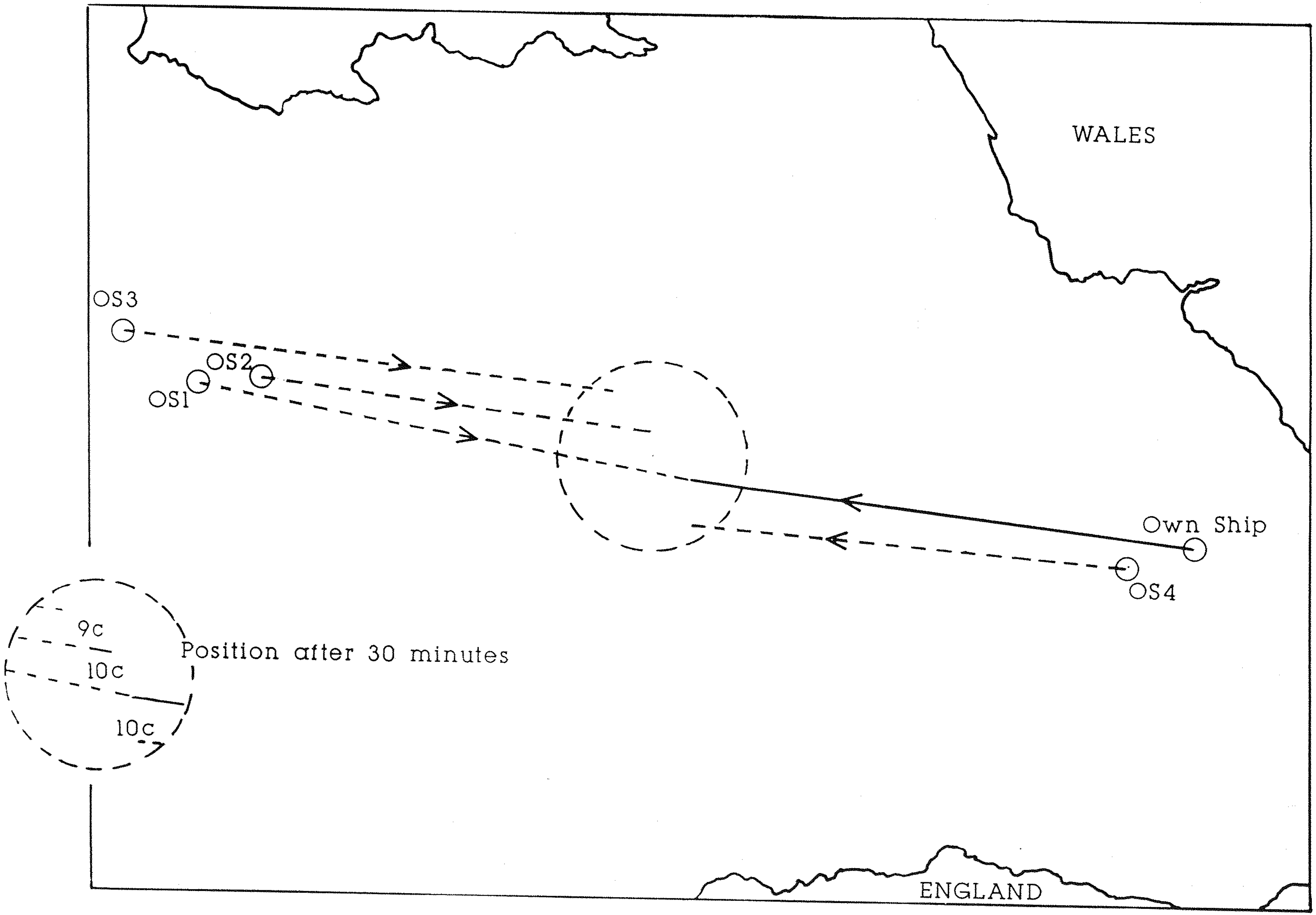


Fig 3 Exercise CW10

Significant traffic at the start of the exercise:

| | | | | |
|---|---|---|---|---|
| OS1 in 'hide' | brg. 279 x 14.81nm | Course 101 | Speed 15k. |
| OS2 | brg. 282 x 14.38nm | Course 098 | Speed 12k. |
| OS3 in 'hide' | brg. 284 x 16.88nm | Course 097 | Speed 15k. |
| OS4 | brg. 247 x 2.69nm | Course 280 | Speed 10k. |

6.3.3.2 Exercise OW11 - the Overtaking situation.

The IRPCS [61] are quite explicit on the overtaking situation. Rule 13 states:

"(a) Notwithstanding anything contained in the Rules of this Section any vessel overtaking any other shall keep out of the way of the vessel being overtaken.

(b) A vessel shall be deemed to be overtaking when coming up with another vessel from a direction more than 22.5 degrees (2 points) abaft her beam that is, in such a position with reference to the vessel she is overtaking, that at night she would be able to see only the sternlight of that but neither of her sidelights.

(c) When a vessel is in any doubt as to whether she is overtaking another, she shall assume that this is the case and act accordingly.

(d) Any subsequent alteration of the bearing between the two vessels shall not make the overtaking vessel a crossing vessel within the meaning of these Rules or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear."

This exercise, which is illustrated by figure 4, takes place in open waters and is not fixed geographically. The subject is told to assume that he is in continental waters, there is no land in sight, and that the echo sounder will remain constant at 46 meters under the keel throughout and therefore his manoeuvring will not be affected by shallow water effects. The 40 minute exercise involves one significant ship - OS1 (the one being overtaken). At the start of the run, OS1 is in the visual scene, showing a stern light. The subject is told at the watch handover that (OS1) is on a steady bearing, distance 3.1nm, that (we) are overtaking her and that the TCPA is in excess of 30 minutes. One other ship is in the visual scene at the start - OS3 is 3 points to starboard, on a nearly reciprocal course, and is due to pass 16c to starboard in 6 minutes. The 2 other ships are at distances >14.5 miles and are in 'hide', but appearing on the radar screen after 5 minutes at 13 miles. OS2 is on a steady bearing with OS1 (the overtaken vessel) and alters course to starboard as required by the IRPCS [61], after 25 minutes when 4.4nm from OS1. When OS4 appears on the radar screen she is fine to starboard and opening further to starboard to produce an intended 18c CPA to starboard of Own ship.

Initial Conditions:

| | |
|---|---|
| Own ship course | 087 |
| Own ship speed | 15k: Full away |
| Autopilot | Engaged |
| Current | Nil |

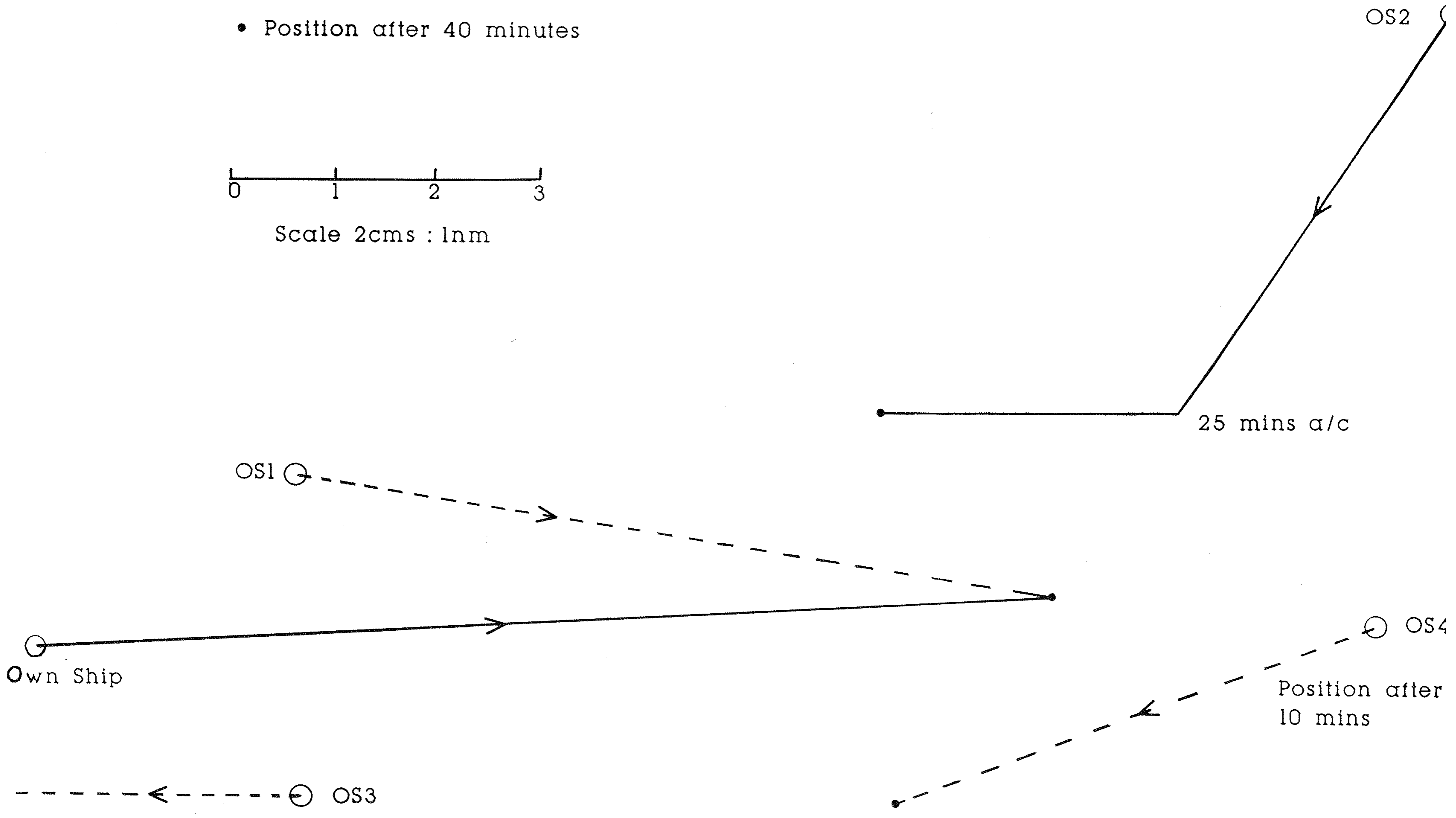


Fig 4 Exercise OW11

| | |
|---|---|
| Wind | 225 x 5k: 10% gusts |
| Visibility | 6nm |

Significant traffic at the start of the exercise:

OS1 brg. 056 x 3.1nm Course 100 Speed 11.25k.

6.3.3.3 Exercise OW12 - the Stand-on situation.

This exercise requires the Own ship to "stand-on"; in American parlance she is the burdened vessel. The action required by the "stand-on" vessel is contained within Rule 17 of the IRPCS [61], which states:

"(a) (i) Where one of two vessels is to keep out of the way, the other shall keep her course and speed.

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

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

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

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

The environment for this exercise, detailed in figure 5, is the same as in OW11 above, i.e. continental waters, no land in sight, deep water, and visibility of 6nm. Own ship is on a course of 305 degrees with OS2, the vessel that should give-way, in an initial position brg. 287 at 13.8nm. Her course is 089, on a steady bearing, with a TCPA of 30 minutes. Two other ships, OS1 fine to starboard and OS3 fine to port at the start of the exercise, distance >12nm but neither 'in hide', are on opening courses with Own ship and produce CPA's of 15c to starboard at 26 minutes and 16c to port at 27 minutes.

Initial Conditions:

| | |
|---|---|
| Own ship course | 305 |
| Own ship speed | 15k: Full away |
| Autopilot | Engaged |
| Current | Nil |
| Wind | 100 x 5k: 10% gusts |
| Visibility | 6nm |

Significant traffic at start of exercise:

OS2 Brg. 287 x 13.84nm Course 089 Speed 14k.

### 6.3.4 THE SUBJECTS.

As in part 1, ten subjects were chosen from those volunteers who were British Watchkeeping officers either attending the College for tuition, or on leave and living

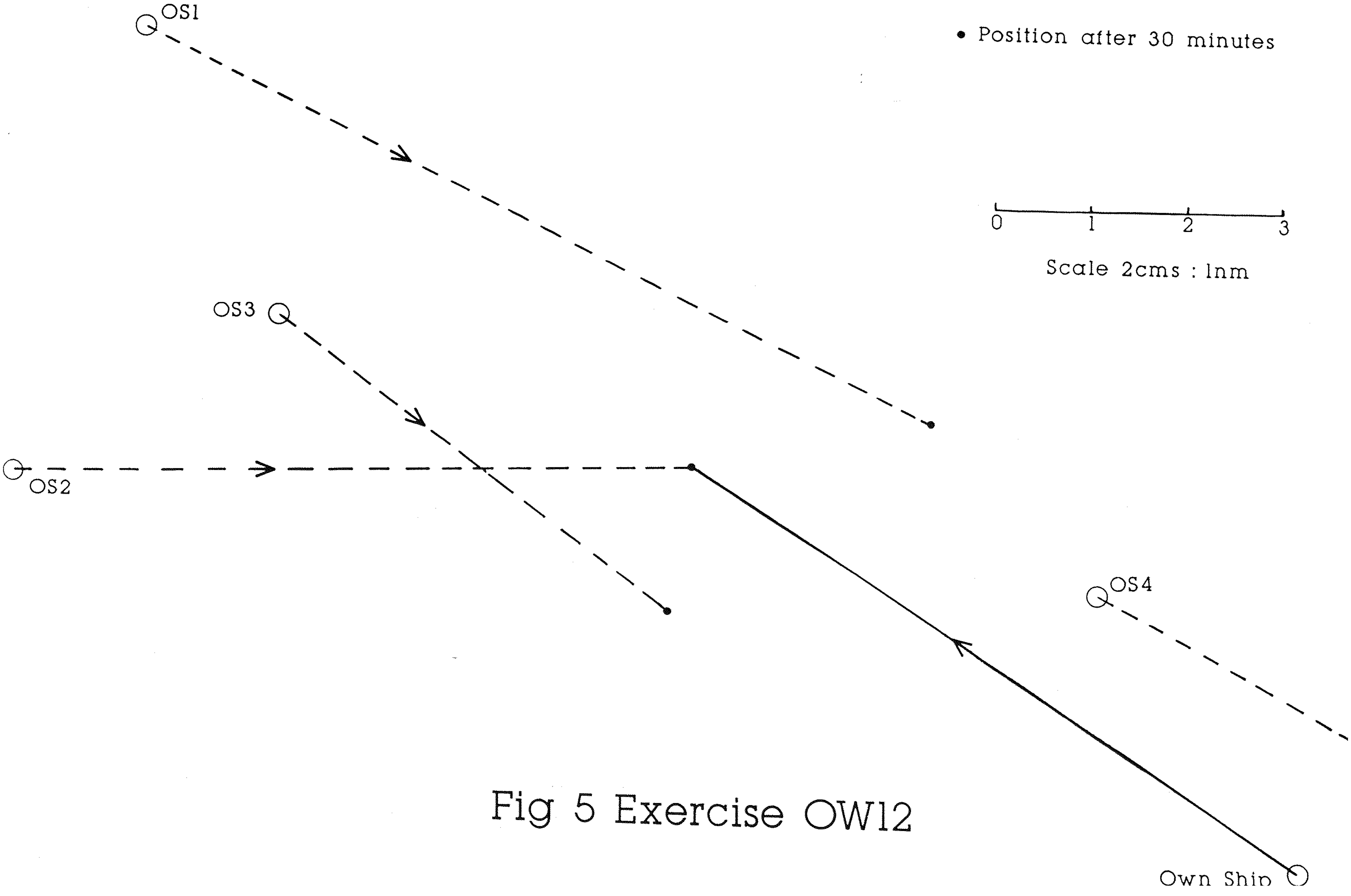


Fig 5 Exercise OW12

nearby. Seven of the ten officers were due to sit for their Masters in 3 months time; one (M11) had already sat his Masters writtens and required a further 2.5 months seatime for the oral examination; one (M12) needed a further 21 months seatime, and due to a last minute withdrawal, M20 had only a Class 3 certificate, but was studying for his Class 2 at the College. Details of each of the subjects are given below:

**TABLE 6**

**SUBJECT BIOGRAPHICAL DATA**

| Subject | Cert. | Rank | Age | W/K Service | Company |
|---|---|---|---|---|---|
| M11 | Cl.2 | C/O | 28 | 3.3 years | 3 |
| M12 | Cl.2 | 2/O | 26 | 1.7 years | 2+3 |
| M13 | Cl.2 | 2/O | 30 | 3.5 years | 2 |
| M14 | Cl.2 | 3/O | 28 | 3.5 years | 1 |
| M15 | Cl.2 | 2/O | 27 | 4.1 years | 2 |
| M16 | Cl.2 | C/O | 32 | 3.7 years | 2+3 |
| M17 | Cl.2 | 2/O | 29 | 5 years | 1 |
| M18 | Cl.2 | 2/O | 26 | 3.5 years | 2 |
| M19 | Cl.2 | 2/O | 28 | 3.9 years | 1 |
| M20 | Cl.3 | 3/O | 23 | 1.7 years | 1+2 |

Company key:
1. 100,000 grt+
2. 1600 - 100,000 grt
3. Coastal trade <1599grt.

### 6.3.5 THE SIMULATOR

Ship Simulator 2 was used throughout. Learning from part 1, each subject was given the new familiarisation exercise, and during this time was required to use the "Cadet lookout". Greater attention was paid to the radar controls and if the subject was going to do CW10, the navigation controls including the Decca Navigator were fully explained. Each subject used the 18,000 tonne cargo ship, as in part 1.

### 6.3.6 THE PROCEDURE

The same procedure as used in part 1 was carried out. Each of the subjects took part in his spare time in the evening and initially was given a period of familiarisation with the simulator and the 18,000 tonne cargo ship which he was to use.

Prior to the start of the runs, the purpose of this study was explained and each was told that for one of his runs he would be "talking out loud", but it was explained that as a result of part 1, he should only provide the following verbal information:

a) The distance at which ships were detected.

b) The plotting procedure used and any results.

c) The reasons for any decision taken, quoting the IRPCS if possible.

It was explained that further information was not required and the reason given for this request.

Prior to the start of the each run, the subject was left in the Masters Cabin, with a copy of the Company orders, a copy of the exercise data form (see Appendix E), and the scenario details with the exercise objective (see Appendix F). For exercise CW10, a pre-prepared chart was given to the subject. It was emphasised to each subject that he was the ship's Master.

When the subject went to the bridge, the watch was handed over to him. Each instrument reading was detailed, the subject was refamiliarised with the radar controls, information was given referring to the visual scene: in CW10, the subject was given the approximate course and speed of OS4, which he was overtaking, in OW11 he was told he was overtaking OS1 and that it was on a steady bearing, and that the TCPA was 30 minutes.

After the run, the subject returned to the Masters cabin to complete the exercise questionnaire if required or to prepare for the next run.

At the end of the final run the subject completed the questionnaire as used in part 1.

### 6.3.7 THE DATA

#### 6.3.7.1 Numerical data

Data for the same parameters as given in Table 1 were collected and the numerical results compared with Part 1 and the BML study to ascertain whether the competence of the subject can be judged on data alone. The exercises were also analysed subjectively by comparing performance with how the author considers a candidate should interpret the IRPCS in each of these exercises. In paragraph 6.4 a number of the performance criteria are discussed.

#### 6.3.7.2 Verbal protocol data

In paragraph 5.6, the conclusions from Part 1 of the study note that the information supplied by the subject using verbal protocols should be reduced to ensure the subject is not carrying out a secondary task. Each subject was given the information detailed in paragraph 6.3.6, which outlines the reduced amount of information required. The ten cases in which verbal protocols were used have been transcribed and included in Appendix C. The questionnaire used at the end of the other exercise is detailed in Appendix H. The verbal protocols and the information supplied by the exercise questionnaire have been used to ascertain the subject's performance in each of the exercises.

## 6.4 DISCUSSION ON IRPCS PERTAINING TO THESE EXERCISES

### 6.4.1 INTRODUCTION

Before detailing the results of the 20 runs, it is necessary to consider what factors the subject should take into consideration before manoeuvring his ship with respect to the collision regulations pertaining to each exercise.

### 6.4.2 EXERCISE CW10 - HEAD-ON SITUATION

Although a head-on situation, it can become complicated by the presence of two further vessels to starboard, and a fourth vessel being overtaken to port;

therefore it needs careful thought before any decision is made. At the start, the shipping situation presents no problem; the subject is told that the ship being overtaken (OS4) will have a CPA of 10c to port, and this can be verified with a 6 minute plot. It is likely that the three other ships will have been detected on the 24 mile scale, but no serious plotting will have been started until they are on the 12 mile scale. OS2 is the first to appear on the 12 mile scale after 6 minutes, closely followed by the other two. No action should be taken until at least 12 minutes into the exercise (allowing time for a 6 minute plot on the 12 mile scale), for:

"assumptions shall not be made on the basis of scanty information especially scanty radar information" [IRPCS Rule 7c].

The plot should have shown the subject that OS1 is on a steady bearing, and that the other two ships to starboard will have CPAs of 10c and 19c to starboard respectively. At this stage Rule 14 does not apply, as it only concerns ships that are in sight of one another, ( after 18 minutes when they are 6 miles apart.)

The IRPCS only apply when risk of collision exists. The question arises as to how far apart the two vessels should be before risk of collision should be considered to exist. Cockcroft and Lameijer [58] have noted that in the courts of the United Kingdom and other countries risk of collision has not been held to apply at long distances when there is a low speed of approach, but the only time when it has been questioned in a legal case is the "Banshee-Kildare" of 1887.

"Now at what period of time is it that the Regulations begin to apply to two ships ? It cannot be said that they are applicable however far off the ships may be. Nobody could seriously contend that if two ships are 6 miles apart, the regulations for Preventing Collisions are applicable to them. They only apply at a time, when, if either of them does anything contrary to the Regulations, it will cause danger of collision. None of the Regulations apply unless that period of time has arrived. It follows that anything done before the time arrives at which the Regulations apply are immaterial, because anything done before that time cannot produce risk of collision within the meaning of the regulations." (Lord Esher 1887)

This case involved two ships involved in an overtaking situation in Dublin Bay, their speeds being 6 and 7 knots. Cockcroft and Lameijer [58] again note that:

"the distance at which risk of collision begins to apply might well be considered to be greater than 6 miles between vessels approaching one another at high speeds, in the open sea, on reciprocal or nearly reciprocal courses. The distance must depend very much on circumstances and particularly on the speed of approach."

In this exercise, the watchkeeper has to make a decision as to whether risk of collision exists up to minute 18, for at that time they are in sight and Rule 14 applies. He would understand that a possible collision situation is developing and, until the two ships are in sight, can do anything to stop it developing further. As Rule 14 does not apply before minute 18, he can alter course to port or starboard and clear the area. An obvious solution is to alter course to port under the stern of the overtaken ship and then resume course when clear and go "green to green" with all other ships. The watchkeeper cannot apply Rule 19, which concerns the conduct of vessels in restricted visibility, as all the external cues, e.g visibility of shore lights, should tell him he is navigating in unrestricted visibility. Restricted visibility is defined in Rule 3(1) as:

"any condition in which visibility is restricted by fog, mist, falling snow, heavy rainstorms, sandstorms or any other similar causes."

The watchkeeper must always make sure that he is not involved in another close-quarters situation as a result of his first alteration , for as Rule 8c states:

"if there is sufficient sea room, alteration of course alone may be the most effective action to avoid a close quarters situation, provided it is made in good time, is substantial and does not result in another close-quarters situation."

At the College the students are taught the following format when ships are in sight of one another, as a means of identifying the situation and the best course of action. In this exercise this will apply at minute 18, when OS1 becomes visual:

i) What is it ?

ii) Disposition of lights and/or shapes

iii) What is your relationship with the other vessel?

iv) Is it a situation in which you are required not to impede or give way ?

v) What is the difference between the two ?

vi) If give way, what are you going to do ?

vii) What else could you do ?

viii) Do the rules say anything you should avoid doing?

Following this format, it is worthwhile considering the options open to the watchkeeper.

i) What is it ?- the Cadet will report that (OS1) is very fine to starboard, showing red and green. The position can be verified from the radar.

ii) Disposition - no other lights are visible except for the normal power driven vessel lights (prior to the run, each subject is told that only power driven vessels under command will be involved)

iii) Relationship - "meeting on reciprocal or nearly reciprocal courses" [Rule 17a]

iv) Situation - required to alter course.

v) Difference - not applicable

vi) What to do - "each shall alter her course to starboard." [Rule 17a]

vii) What else could you do - the situation is explicit - alter course to starboard.

viii) Avoid doing - anything other than altering course to starboard.

The possible interactions with OS2 & OS3 follow from the alteration for OS1.

Therefore the criteria for this exercise are as follows:

Exercise CW10

i) No action should be taken until at least 12 minutes into the exercise.

ii) An alteration of course to port between minutes 12 and 18 is acceptable. An alteration of course to port after minute 18 is unacceptable.

iii) Only an alteration of course to starboard after minute 18 to clear OS1 is acceptable.

iv) The alteration should not involve the ship in another close-quarters situation.

6.4.3 EXERCISE OW11 - OVERTAKING SITUATION

The instinctive reaction to an overtaking situation is for the watchkeeper to alter course to starboard, although Rule 13, detailed in para. 6.3.3.2, does not recommend any specific course alteration. The choice of altering to starboard is based on good common sense, for if when overtaking, the ship is required to give-way for another ship, it is more than likely a second alteration of course to starboard will be required which could be embarrassing if the first ship is close on the starboard side. The object of this exercise is for the subject to consider a port alteration instead of the normally accepted alteration to starboard.

The subject does not have to hurry into a decision, as he is told at the watch handover that the TCPA is 30 minutes, and OS1 is still 3 miles away and he is given the approximate course and speed of OS1.

OS2 & OS4 come out of hide after 5 minutes and appear on the 12 mile scale after 6 minutes. Allowing for a 6 minute plot, after 12 minutes OS1 is 2.1 nm off, still 30 degrees on the port bow. The track of OS4 opening to starboard should caution against an alteration of course to starboard, as it will involve a close-quarters situation with OS4. The track of OS2 should indicate to the subject that she is the give-way ship, therefore, an alteration to port is preferable.

One other reason for altering to port is the requirement to make the alteration -

"....large enough to be readily apparent to another vessel observing visually or by radar; a succession of small alterations of course and/or speed should be avoided" [Rule 8b].

From the bridge of OS1, the subject's ship will be showing masthead lights and the red sidelight. An alteration of course say of 30 degrees to starboard will still show masthead lights in approximately the same relative bearing and the red sidelight; however an alteration of course to port will considerably alter the aspect of the masthead lights and show a green sidelight - and thus will be "readily apparent".

Rule 8c also applies. His alter course should not result in another close-quarters situation.

Using the format, information for parts i) - v) are either given to the subject or are self explanatory.

vi) What to do - under Rule 13a, shall keep out of the way of the vessel being overtaken.

vii) What else could you do - alter course or increase or reduce speed.

viii) Avoid doing - making small alterations, passing at an unsafe distance [Rule 8d], not taking sufficiently early action.

The criteria for Exercise 11 are given below:

i) No alteration of course or speed should be made in the first 12 minutes.

ii) The onus is on Own ship to alter course or speed to avoid OS1. The preferred alteration is to port.

iii) Own ship should avoid making small alterations and passing at an unsafe distance.

iv) The alteration should avoid a close-quarters situation with another ship.

6.4.4 EXERCISE OW12 - STAND-ON SITUATION

In this exercise, OS2 which should under the IRPCS give-way to the subject's ship does not do so. By Rule 17 (a) (i) & (ii) the subject's ship has to keep her course and speed until it becomes apparent to her that the vessel required to keep out of the way (OS2) is not taking appropriate action. OS1 & OS3 should present no problem unless the subject alters course to starboard early in the exercise which could embarrass OS1 to starboard by crossing her bows. Basic radar plotting will tell the subject before minute 12 that OS2 is on a steady bearing, and that the other two ships coming down are passing clear. OS2 comes into the visual scene at minute 17 from which time Rule 17 applies. Using the format as before -

iii) Relationship - required to stand-on

iv) Situation - required not to give-way, until it becomes apparent that OS2 is not taking appropriate action. If in doubt, required to sound at least 5 short and rapid blasts on the whistle, which may be supplemented by a similar light signal.

v) Difference - this is a stand-on situation. The difference between "not to impede" and "give-way" is not applicable to these exercises , but for information the following details are given: "impede" is used in Rule 18 (d) (i) " any vessel other than a vessel not under command or a vessel restricted in her ability to manoeuvre shall, if the circumstances of the case admit, avoid impeding the safe passage of a vessel constrained by her draught, exhibiting the signals in Rule 28." Cockcroft and Lameijer [58] mention that the term "avoid impeding the safe passage" means navigating in such a way as to avoid the development of risk of collision.)

vi) What to do - stand-on until it becomes apparent that OS2 is not taking appropriate action, then watchkeepers should signify their concern to OS2 by sounding at least 5 short and rapid blasts on the whistle and supplemented by a light signal of at least 5 short and rapid flashes [under Rule 34d].

vii) What else could you do - consider a turn to starboard as possibly the most appropriate action. Do not slow down as a last resort, for the deceleration of the ship will be insufficient if not commenced in plenty of time.

viii) Avoid doing - "not alter course to port for a vessel on her own port side." [Rule 17c]

Thus this exercise should be judged on the appropriate cautionary action taken by the subject and the subsequent collision avoidance manoeuvre.

The subjective criteria for this exercise are given below:

Exercise OW12

i) Own ship can alter her course and speed from the start until minute 17 to prevent risk of collision with OS2 from developing.

ii) Own ship should keep her course and speed from minute 17 until it becomes apparent OS2 is not taking appropriate action.

iii) At which time, Own ship should immediately sound at least 5 short and rapid blasts.

iii) A turn to starboard by Own ship is the most appropriate action, which should not be left too late. Own ship should avoid altering to port.

## 6.5 THE RESULTS

### 6.5.1. NUMERICAL RESULTS

Detailed below are the Part 2 results which follow the same criteria as used in Part 1 of the study and are described in para. 5.3.7.

**TABLE 7.**

**PART 2 RESULTS**

| Sub. | Exer. No. | Min. Det. Range Nm. | Radar Plot | First Act. Range nm. | First Act. Type | No. of Act.s | X-Ahd Dist c | Min. CPA c | VPs or Q |
|---|---|---|---|---|---|---|---|---|---|
| M11 | CW10 | 7.5 | 2 | OS4 2.1 | 13 S | 2 | - | OS3 4 | Q |
| M11 | OW11 | 11.5 | 1 | OS1 2.7 | 30 S | 5 | - | OS4 7 | VPs |
| M12 | OW12 | 12.0 | 2 | OS2 2.3 | F/Ahd | 5 | OS2 4 | OS2 1 | VPs |
| M12 | CW10 | 8 | 2 | OS1 7.5 | 17 P | 3 | - | OS1 23 | Q |
| M13 | OW11 | 13.0 | 2 | OS1 1.4 | 35 P | 2 | - | OS1 11 | Q |
| M13 | OW12 | 11.9 | 2 | OS2 2.0 | 60 S | 1 | OS2 12 | OS2 9 | VPs |
| M14 | CW10 | 11.5 | 1 | OS1 3.7 | 38 S | 2 | OS3 11 | OS2 11 | VPs |
| M14 | OW11 | 12.0 | 2 | OS1 1.3 | 47 P | 2 | - | OS2 12 | Q |
| M15 | CW10 | 12.6 | 1 | OS1 9.6 | 57 P | 1 | - | OS4 13 | VPs |
| M15 | OW12 | 12.0 | 1 | OS2 8.4 | 35 S | 1 | OS1 19 | OS1 8 | Q |

| Sub. | Exer. No. | Min. Det. Range Nm. | Radar Plot | First Act. Range nm. | First Act. Type | No. of Act.s | X-Ahd Dist c | Min. CPA c | VPs or Q |
|---|---|---|---|---|---|---|---|---|---|
| M16 | OW12 | 13.5 | 2 | OS2 3.7 | 15 S | 3 | OS2 16 | OS1 9 | Q |
| M16 | OW11 | 12.1 | 2 | OS1 1.8 | 42 P | 1 | - | OS2 14 | VPs |
| M17 | CW10 | 12.0 | 1 | OS1 5.6 | 18 S | 3 | - | OS3 4 | Q |
| M17 | OW11 | 13.8 | 1 | OS1 1.7 | 57 P | 1 | - | OS2 17 | VPs |
| M18 | OW12 | 12.0 | 1 | OS2 2.0 | 30 S | 1 | OS2 11 | OS2 6 | VPs |
| M18 | CW10 | 12.0 | 2 | OS1 4.7 | 293 S | 1 | - | OS1 12 | Q |
| M19 | OW11 | 12.0 | 1 | OS1 2.7 | 28 S | 2 | - | OS4 9 | Q |
| M19 | OW12 | 11.0 | 2 | OS2 4.7 | 95 S | 1 | OS1 14 | OS1 10 | VPs |
| M20 | CW10 | 11.2 | 1 | OS1 5.3 | 38 S | 2 | OS3 18 | OS3 8 | VPs |
| M20 | OW11 | 11.5 | 1 | OS1 1.7 | 27 P | 3 | - | OS2 8 | Q |

A direct comparison with the part 1 results is not possible as there are a number of other influences at work in this series of exercises - for instance, the accuracy of the minimum detection range quoted above could not be guaranteed in the non - VP runs, the ship indicated in the "first action range" was that detailed by the subject as being the main ship he was altering for and in some cases he mentioned more than one ship, and the number of actions include those taken to avoid other shipping.

However the cross ahead distances and minimum CPAs can be compared and are given below:

**TABLE 8**

**DATA COMPARISONS BETWEEN PARTS 1 & 2**

| ITEM | PART 1 BML | PART 1 MPHIL | PART 2 |
|---|---|---|---|
| Av. cross ahd. Dist. | 9.3c | 9.2c | 13.1c |
| Min. cross ahd Dist. | 1c | 1c | 4c |
| Av. Min. CPA. | 6.9c | 8.5c | 9.8c |
| Absolute min. CPA. | 1c | 1c | 1c |

The results above indicate that the subjects in Part 2 stayed farther away from other shipping than their colleagues in the BML study and Part 1, (this is most likely due to the comparative simplicity of the part 2 exercises when compared with those used in the BML study)

In 8 out of the 20 runs a Part 2 subject crossed ahead of another ship at a distance under 20c; in 50% of these cases it was to avoid OS2 in exercise OW12 - the vessel that should have given way - and therefore should be considered as an acceptable manoeuvre. The CPA results are comparable to those found in the two other groups. However, the result table does bear out paragraph 6.4.4. which mentions that the subject should be judged on the appropriate cautionary action taken and his subsequent collision avoidance manoeuvre, rather than data alone.

### 6.5.2 EXERCISE INFRINGEMENTS

Using the criteria set out above, recorded below is a resume of each run and any infringements made by the subjects in each of the 20 runs: (vp = verbal protocols given: q = exercise questionnaire completed)

M11 - CW10 (q)

Altered course to starboard after 8 minutes to increase passing distance from OS4 and again after 25 minutes which involved the ship in a close-quarters situation with OS3.

Subject had placed the radar range at 6nm when approaching OS3, therefore was not aware of its presence and steady bearing until in visual scene. Used vhf to call OS3 but incorrectly assessed its course as North East (097). Subject's own manoeuvre had reduced a passing CPA with OS3 of 2nm to zero, causing OS3 to alter course.

Unsatisfactory.

M11 - OW11 (vp)

Altered course to starboard after 5 minutes. Made 5 small alterations of course/speed. Involved the ship in a close-quarters situation with OS4, and required OS4 to alter.

His third alteration to port (for OS4) reduced the CPA, rather than increased it. This was due to inaccurate plotting.

Unsatisfactory.

M12 - OW12 (vp)

Theory satisfactory but poor appreciation of ship manoeuvring allowed Own ship to come within 1c of OS2.

Unsatisfactory shiphandling.

M12 - CW10 (q)

Altered course to port at minute 15. Appreciated courses of all other ships from TM radar.

Satisfactory.

M13 - OW11 (q)

Assessed situation carefully. Altered course to port at minute 22, and back to starboard at minute 30.

Satisfactory.

M13 - OW12 (vp)

Assessed course, speed and CPA of each vessel. Altered course 60 degrees to stbd. at minute 26.

Satisfactory.

M14 - CW10 (vp)

Assessed CPA's correctly. Altered 38 degrees to starboard at minute 22 and a further 50 degrees at minute 30. Crossed ahead of OS3 at 11c. Initial alteration of course not substantial enough, however appreciated need for second large alteration.

Satisfactory.

M14 - OW11 (q)

Altered course to port at minute 23, and back to starboard at minute 27. Used paper plotting sheet.

Satisfactory.

M15 - OW12 (q)

Altered course to starboard at minute 11.

Initial decision based on "scanty information".

Crossed ahead of OS1 at 19c.

Satisfactory, except for appreciation of Rule 7c.

M15 - CW10 (vp)

Altered course after only 9 minutes and made a broad alteration to port. Only had 1 minute to assess course of OS3.

Said took action to avoid a collision situation existing. Initial decision based on "scanty information".

Satisfactory except for appreciation of Rule 7c.

M16 - OW11 (vp)

Fully assessed situation and gave a broad alteration to port at minute 17, crossed ahead of OS2 at 4nm.

Satisfactory.

M16 - OW12 (q)

Assessed situation correctly. Made 3 alterations of course to starboard, commencing when OS2 was 3.7nm off. Crossed ahead of OS2 at 16c.

Satisfactory.

M17 - CW10 (q)

Initial inadequate alteration of course at minute 18 to starboard brought ship into close-quarters situation with OS3 which had to alter course to avoid collision.

Unsatisfactory.

M17 - OW11 (vp)

Assessed situation correctly. Altered course to port at minute 17, and went green to green with OS2.

Satisfactory.

M18 - OW12 (vp)

Assessed situation correctly. Altered course 30 degrees to starboard when OS2 2nm off. Crossed ahead of OS2 at 11c.

Satisfactory.

M18 - CW10 (q)

Assessed courses and CPAs. Took round turn out to starboard when OS1 4.7nm off. Crossed ahead of OS1 at 24c.

A drastic manoeuvre when situation did not warrant it.

Unsatisfactory.

M19 - OW11 (q)

Altered course to starboard at minute 05 and to port at minute 14 which reduced cross bow distance with OS4.

Unsatisfactory.

M19 - OW12 (vp)

Assessed courses, speeds and CPAs. Altered 95 degrees to starboard when 4.7nm from OS2. Crossed the bows of OS1 at 14c.

Satisfactory.

M20 - CW10 (vp)

Assessed situation correctly. Made two alterations of course to starboard, initially at minute 19. Crossed ahead of OS3 at 18c.

Satisfactory.

M20 - OW11 (q)

Made alteration of course to port at minute 17 and back to starboard at minute 28. Went red to red with OS2.

Satisfactory.

In the 20 runs carried out by the 10 subjects, four subjects completed both runs satisfactorily without any provisos; one subject showed he lacked an understanding of Rule 7c (in both runs); one subject showed a lack of shiphandling ability in one run (although the other run was competent); three subjects gave one unsatisfactory run (two first: one on the second run); and one subject gave two unsatisfactory runs.

There were varying degrees of infringement in the record of these exercises, ranging from a lack of shiphandling skills, (which wasn't basically being examined) to an obvious infringement of the IRPCS. The Oral examiner has the opportunity to examine the candidate on each of his exercises and may wish to ensure that he does fully understand the regulations pertinent to these exercises.

### 6.5.3 POST ASSESSMENT QUESTIONNAIRE RESULTS

The final questionnaire used in Part 1 was used to verify that the familiarisation had improved and to ascertain whether the subjects considered that this method of assessment was appropriate. The answers to the questionnaire for the 10 subjects are given below:

**TABLE 9**

**PART 2 - POST ASSESSMENT QUESTIONNAIRE**

SAMPLE SIZE - 10.

1. Have you undertaken any training on a shiphandling simulator before ?

   YES 6
   NO 4

If YES go to question 2; if NO go to question 5

2. State the total number of hours of training that you have spent on the simulator prior to this exercise.

   M12 = 7 hours M14 = 6 hours
   M15 = 8 hours M16 = 30 hours
   M17 = 80 hours M19 = 30 hours

3. How many of these hours were you in command of the the ship ?

   M12 = 2 hours M14 = 2 hours
   M15 = 2 hours M16 = 4 hours
   M17 = 24 hours M19 = 4 hours

4. State the type and size of vessels handled.

   All except M16 handled a Panamax;
   M16 handled an 18,000t ship.

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5. What time were you given to familiarise yourself with the bridge, equipment, exercise area and Own ship prior to this exercise.

Average = 36 minutes (mainly due to most of the subjects being in the simulator during the previous week)

6. Do you feel that the time given for familiarisation was:

(a) About right 9
(b) Too short M19*
(c) Too long Nil

7. If your answer is 6(b) or 6(c), state the time that you consider to be necessary for familiarisation.

*M19 - 1 Hour
He had 30m.

8. Have you previously covered all theoretical aspects of the seamanship/navigation skills tested in the exercise ?

YES = 10

9. How do you rate this method of assessing your practical collision avoidance skills in comparison to oral questions from an examiner ?

(a) Not as effective Nil
(b) Equally effective M19
(c) More effective 9

10. Do you feel your level of performance was affected by:-

(a) an awareness of being under observation ?

YES M15, M19, M20*
NO 7

* M15 = didn't want to make any deviation from the rules.
* M19 = a feeling that you are under D.Tp. scrutiny
* M20 = having to justify my actions

(b) Having to talk "out-loud"

YES M20*
NO 9

* M20 = having to justify my actions

(c) Unfamiliarity with the simulator

YES Nil
NO 10

(d) Lack of reality

YES M15*
NO 9

* M15 = Felt restricted by not being able to see all round.

11. Please comment on this method of assessing your practical skills.

M11 = Use of the ship simulator provides a very realistic way of assessing skills.

M12 = Effective. Would be interesting to test skills at a scale speed, say twice as fast with more situations in a given time.

M13 = A very useful addition to the training of personnel under conditions which are more likened to our job at sea rather than the use of magnetic boards in a classroom.

M14 = Advantage to candidate of feeling "at home". Disadvantage - easy to say with wooden blocks etc. Also problem with "DTI/At sea" answers.

M15 = The method is preferable. It gives a more realistic idea of what is happening. More time given to assess a situation and the ability to deal with more than one target which is usually the case at sea.

M16 = Good - but in second exercise, situation was apparent early on and so opportunity is there to "outsmart" the machine with large early alter courses.

M17 - I think this method of assessment is an excellent way of doing so as when in the simulator you are so involved with what is happening. These real life situations shows you how well or otherwise you know the rules. In my opinion the simulator should become part of the oral.

M18 - The reality is very good, but you are always waiting for the "dirty tricks" department to arrive. Worthwhile.

M19 - A good system of assessment, provided the above problem is solved (a feeling that you are under DTp scrutiny). Perhaps emergency situations may be more useful.

M20 - Very good, much better than the smarty board.

## 6.6 DISCUSSION ON THE USE OF VERBAL PROTOCOLS AND QUESTIONNAIRES

### 6.6.1 USE OF VERBAL PROTOCOLS

Where verbal protocols were used, they were certainly useful in determining the reasons for a subject's decision to manoeuvre. However, they are a cumbersome devise for obtaining information, requiring approximately a time factor of three times the exercise time of the exercise for the transcription alone. A study of the verbal protocols indicates that the first few subjects provided similar amounts of information as in the first part of the study, although they had been told to provide only that information detailed in para. 6.3.6. This amount decreased as the study progressed but this was only as a result of more emphasis placed on the need to reduce the verbalising when the author outlined the requirements to the subjects. The shortened format provided all that was necessary.

Ten verbal protocols were obtained: seven of the runs were considered satisfactory and three unsatisfactory. There is no link between length of protocol and an unsatisfactory run, which could be a sign of the subject carrying out a secondary task.

### 6.6.2 EXERCISE QUESTIONNAIRE.

The questionnaire detailed in Appendix H was used in a slightly modified form for each of the three exercises, due to the need to describe the initial position of each of the ships in the exercise.

The course and speed of other ships information could not necessarily be relied upon as the subject was providing a resume based on his memory of the run. However, it was felt that the question asking for the reasons for any alteration were more likely to be valid as he was unlikely to forget this aspect of the run.

The questionnaire could provide the examiner with the details concerning the reasons for the alterations and would complete the information necessary for the examiner to obtain a rounded impression of the exercise.

### 6.6.3 POST ASSESSMENT QUESTIONNAIRE

The subjects attending Part 2 of the study had had considerably more training experience in a ship simulator than their counterparts in Part 1; therefore the results are likely to reflect that increase in familiarisation available to the majority of the Part 2 subjects. Three of the Part 2 subjects had spent more than 30 hours each in the ship simulator before this experiment.

Although Part 1 had indicated that extra time should be available for familiarisation, most of the Part 2 subjects had been in this simulator the week before. This is reflected in the 36 minutes on average being given for familiarisation. One subject (M19) would have preferred more time: the others considered the familiarisation time was about right.

All the Part 2 subjects considered they had covered the theoretical aspects of the task (as against 90% in Part 1).

The same response as in Part 1 to the effectiveness of this method of assessing competence was given: 90% considered it to be more effective; M19 believed it to be equally effective.

A similar percentage to Part 1 considered their performance was affected by an awareness of being under observation - three subjects who considered this was due to acting within the IRPCS or feeling under DTp scrutiny.

Subject M20 was the only person who considered that his performance was affected by giving verbal protocols.

Although M19 had previously mentioned that he would have preferred more time for familiarisation, all the Part 2 subjects considered their level of performance was not affected by unfamiliarity with the simulator. This compares with only 66% in Part 1 who gave this answer. This is probably due to the extra familiarisation Part 2 subjects had in the simulator before attending this project, but also justifies the extra checks built into the familiarisation period.

Again, the extra familiarity probably accounts for only M15 being affected by lack of reality (due to the reduced field of view) as compared with 30% of the subjects in Part 1.

The answers given by the Hamburg and Cardiff students to Muirhead's questionnaire (para. 5.5.3) are very similar to those provided by the Part 2 subjects: 90% of both sets considered the familiarisation time was "about right", probably due to each subject having an average of 16 hours of simulator experience before the assessment. 83% of Muirhead's subjects considered the simulator was more effective for assessing collision avoidance skills in comparison to oral questions: the Part 2 subjects noted 90%, with the overall Parts 1 & 2 also 90 percent.

## 6.7 OVERALL DISCUSSION

Three methods, namely; the numerical data correlation, comparison with the author's interpretation of the requisite collision regulations, and information gained from the verbal protocols or questionnaires have been used to ascertain whether the candidate has shown sufficient knowledge, judgement and skill to satisfy the examiner.

Hard data in the form of a track chart, indicating alter course distances and CPAs provides the examiner with an overall impression of the exercise. Data comparison with other exercises should not be relied upon as different traffic situations require different solutions. The comparison of Parts 1 and 2 did indicate that in Part 2 a greater passing distance from other ships was achieved. This was probably due to the comparative simplicity of the Part 2 exercises, but other reasons can equally well be accepted.

The comparison of the candidate's decisions and the author's interpretation of the IRPCS provided a useful method of correlation. However, the author's interpretation is only one of a number of possible analyses.

This point was made when a Lecturer teaching the IRPCS at the College was asked to carry out the same procedure as the subjects. After his familiarisation with the simulator and the ship, he did exercises CW10 and OW11. In exercise CW10, he assessed the situation very carefully and was obviously fully aware of the traffic situation. He altered course 70 degrees to starboard at minute 19 and crossed ahead of all three ships coming down: the minimum cross ahead distance being 20 cables with OS3. He achieved an 8c red to red CPA with OS3. The Lecturer considered his actions to be correct. He did not contravene the criteria for this exercise laid down in paragraph 6.4.2. but did not accept the opportunity to go to port early in the run as he considered this would not be the normal practice at sea.

In the second exercise, OW11, he altered 20 degrees to starboard at minute 12 after undertaking a full analysis of the situation. At minute 26, when 4.5 miles from OS4 he called the ship on the vhf and "requested his intentions" (as being on his port side showing a green light OS4 was required to give way). OS4 responded to the vhf call and at minute 29 altered course to starboard. The action in calling OS4 when still 4.5 miles away was a little contrived as the situation did not warrant that course of action. Again, the criteria as laid down in 6.4.3. were not broken, but the preferred alteration to port was not taken up.

The different actions taken by the subjects and the Lecturer do emphasize the difficulty inherent in comparing decisions against a non-definable standard. However the comparison is useful to the examiner in that he is in a position to ensure that the subject understands the alternative courses of action.

Verbal protocols need to be short and to the point in order to be useful. If this method is used then the subject must be told emphatically that verbose and long winded explanations are not required. Short verbal protocols can provide sufficient information. Their use could become more acceptable if they were short enough to transcribe in under an hour. The questionnaire did provide information for the reasons behind a subject's decisions but was based on his memory of the situation. The use of questionnaires for gaining information as to whether the subject assessed course and speed suffers from asking questions that the subject might not consider important and therefore although the the courses and speeds might have been assessed, the result cannot be remembered.

The results of the Post Assessment Questionnaire compared favourably with the Part 1 results. The familiarisation period was reduced to an average of 36 minutes due to the majority of the subjects having spent considerable time in the simulator the previous week. One person would have preferred an hour familiarisation. As in Part 1, 90% of the subjects considered this method of assessment to be more effective than oral questions from an examiner. This means that over 85% of the candidates examined by Muirhead [46] and the author consider the use of a ship simulator to be an effective method of assessing competence.

# CHAPTER 7

# CONCLUDING DISCUSSION

## 7.1 SUMMARY

This thesis has attempted to show that a ship simulator, of the type used at Warsash, can be used as an assessment tool for the evaluation of a candidate's knowledge, judgement and skill in collision avoidance tasks.

The decision was taken not to proceed with the initial exercises designed to evaluate shiphandling skills in harbour areas. This was due to simulator manpower requirements, the potential conflict between whether the team or the individual was being assessed, and the simulator's reduced field of view.

Once the decision was made to assess a potential Master's collision avoidance behaviour, it also meant a critical reappraisal of the use of 'failure states'. These can only be used when performance can be objectively assessed: once any one of a number of actions are considered appropriate, the use of 'failure states' looses its significance.

Watchkeeping officers believe that the answers that they give to a Department of Transport examiner are different from what they actually do at sea in similar circumstances. This is because they believe the examiner would not accept as good practice their normal way of carrying out the collision avoidance task. This presumed difference of behaviour was tested in Part 1. It was found that although the watchkeeping subjects in an examination situation carry out more extensive information gathering, the end result in terms of alter course distance, cross ahead distance and CPA is similar.

It was also decided that any collision avoidance scenario should only involve one other ship. Two methods of obtaining information about the reason for a subject's decision were used in Part 1. It was decided that verbal protocols were very useful but too much verbalising could constiutute a secondary task. A debrief at the end of the exercise was not so successful in eliciting information.

The Post Assessment questionnaire indicated that 90% of the subjects considered that the simulator exercise was more effective for assessing collision avoidance skills than an oral examination alone.

The second set of experiments described in Chapter 6 was designed to assess whether the simulator can be used as an assessment tool to complement the orals examination. Three exercises were written and ten subjects did two each. Data were obtained from hard copy plots, verbal protocols or questionnaires, and a subjective comparison of the subjects run with the IRPCS interpretation. Hard copy data and information elicited from the verbal protocols were found to be useful but even in relatively simple exercises it was difficult to state categorically a definitive way of carrying out the exercises according to the regulations.

## 7.2 THE FUTURE OF ASSESSMENT BY SHIP SIMULATION

There is no doubt that if a candidate preparing to sit for his Masters oral examination undertook one or a number of exercises in the ship simulator and this information was made available to the examiner, then he would be in a stronger position to question the candidate on his knowledge, judgement and skill in collision avoidance tasks.

As mentioned in paragraph 1.2, the competency examination in the USA does not include an oral examination and is limited to written answers only; the US Coastguard as the licensing authority are therefore interested in investigating the practical assessment of a watchkeeper's knowledge using a simulator. The examination structue has been criticised as not providing skill in watchstanding [65].

Dr. John S. Gardenier of the US Coast Guard undertook research in 1987 to try out a prototype licencing simulator, built and adapted by Maritime Dynamics [68]. The simulator was limited to desktop size, with a 90 degree field of view and had therefore little face validity. For the "Rule of the Road" tests behaviour as expected constituted a correct answer, and behaviour inconsistent with that expectation constituted an incorrect answer. An expert panel was convened to decide what constituted behaviour "as expected". Scoring of the examination was automated within the simulator, and grading given on a percentage basis. Initially it was decided to use simple situations for which there are clear cut rules. For the tests 26 subjects undertook the examination and Gardenier, in talks with the author, mentioned that the results were consistent with the known abilities of the subjects. Watchkeepers who were virtually perfect on the written examination were virtually perfect in the simulator. On a few occasions it was found that watchkeepers with poor writing skills did better in the simulator. Of the 26 subjects, 20 (77%) said that the simulator should be used in licencing: 5 subjects wanted the simulator improved first, and only one person wanted to stay with the written test alone. Gardenier notes that:

> "The mariner community lacks clear, specific standards of professional proficiency. The quality of performance in collision avoidance and navigation tends to be appraised judgementally, with consideration of the specific situation, and with differences of opinion among professional mariners." [65]

The difficulty in using ship simulators for assessment of collision avoidance lies in the inability to define a good or bad performance. This has been shown by the author, who attempted an objective assessment of each subjects performance based on his interpretation of the International Regulations for the Prevention of Collisions at Sea [61], and this has been backed up by the work carried out by Gardenier in the USA. Although the Collision regulations are not written "on tablets of stone", it would be very optimistic to expect any change incorporating defineable performance in the foreseeable future.

The ship simulation market is changing: smaller, modular, and cheaper simulators with less emphasis on face validity will soon take the place of the large one-off simulators purchased with government money.

## 7.3 MAIN CONCLUSIONS

i) A ship simulator based assessment of collision avoidance behaviour can complement the oral examination.

ii) The Warsash ship simulator is an inappropriate medium in which to test a Master's shiphandling skills in harbour areas.

iii) Ninety percent of the subjects considered that simulator based exercises were more effective than oral questions in assessing practical collision avoidance skills.

iv) Clear defineable standards for collision avoidance behaviour do not exist. It is therefore difficult to rate any performance.

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## APPENDIX A - LIST OF SHIP SIMULATORS WITH A VISUAL PRESENTATION

| TITLE LOCATION | START DATE | MANUFACTURER | TYPE | FUNDED BY | USE AND PRIORITY |
|---|---|---|---|---|---|
| SMS, Ship Manoeuvring Simulator IWECO-T.N.O. Delft. The Netherlands | 4.1968 Mk III 1976 | IWECO-T.N.O. | Colour shadow graph. No target ships. 120° field of view. 3 fictitious gaming areas. 9 own ship types. | Cost £500,000 | i) Training ii) Research |
| N.S.M.B. Wageningen The Netherlands | 11.1969 | IWECO-T.N.O. Delft I.Z.F.-T.N.O. Soesterberg | Colour shadow graph. Coastline plus other ship or buoy. 360° field of view. 7 own ship types. Second simulator added 11.76 - no visual. | | i) Research ii) Training |
| Ship Steering Simulator Hiroshima University Japan | 1971 | Ship Motion Laboratory, Hiroshima University | Colour film projection for landscape, and one target ship 90° field of view | | Research Only |
| S.S.P.A. Manoeuvring Simulator The Swedish State Shipbuilding Tank, Cothenburg, Sweden | 1973 | Swedish State Shipbuilding Tank | Computer generated through 7 Black-White T.V. Screens. Field of view ± 35° Mainly nocturnal. 7 own ship types. 3 gaming areas. Synthetic radar. | | i) Research from 1969 ii) Training |
| Shiphandling Simulator Hochschule Fur Nautik Bremen, Germany | 3.1975 | V.F.W.-FOKKER and B.K.E. Bildtechnik Norten-Hardenberg | Colour slide projection system. No target ships. 120° field of view. 3 own ships. | | i) Mainly Training ii) Little Research |
| I.H.I. Control System Engineering Division, Tokyo, Japan | 6.1975 | I.H.I. and N.A.C. | Four colour slide projectors : 1 colour Film Projector. 100° field of view One target ship and one buoy. 3 own ship types. | Co-operation with NYK Line Approx Cost £1M. | i) Research ii) Training |
| Osaka University Ship Handling Simulator Osaka, Japan | 8.1975 | Ship Dynamics and Control Laboratory Osaka University | Hybrid system of shadow graph for background and T.V. projection for one target ship 240° field of view. Open sea and canal section gaming areas. | | Research Only |
| Royal Netherlands Naval College Den Helder, Netherlands | 8.1975 | Royal Néthèrlands Naval College | Simple nocturnal point light projection system in colour. 130° field of view. | | Training Only |
| Simulator for the study of Navigation and driving behaviour. Soesterberg, Netherlands | 1.1976 | Institute for Perception, T.N.O. | Black and white T.V. camera and modelboard for other ships. 120° field of view | | Research Only. Mostly funded by Netherlands Maritime Institute |

| TITLE LOCATION | START DATE | MANUFACTURER | TYPE | FUNDED BY | USE AND PRIORITY |
|---|---|---|---|---|---|
| CAORF: (Computer aided Operations Research Facility) Kings Point, New York, U.S.A. | 1.1976 | Owner: US Dept of Commerce Many manufacturers | First truly C.G.I. ship simulator. 5 eidophor projectors over 240° field of view. 14 target ships - maximum 6 visual at one time. 10 own ship types. At least 11 gaming areas. | | Research<br>Some specific training |
| Tokyo University of Mercantile Marine, Tokyo, Japan. | 10.1976 | Unknown | Colour shadow graph system. 2 target ships. 240° field of view. | | Research Only |
| Marine Safety International, (MSI) La Guardia Airport, New York, U.S.A. | 11.1976 | Designer : Sperry Rand Corporation | Black and white T.V. camera scanning Physical model of gaming area. 140° field of view. Docking manoeuvres. Possible 5 own ship types. 12 gaming areas. | | Training Only |
| Ship Simulator The College of Nautical Studies, Warsash, Southampton | i) 3.1977<br>ii) 2.1981 | Decca Radar Ltd. | Nocturnal : 16 projectors. 100° field of view. 8 own ships. 4 target ships. 15 gaming areas. Tandem capability. | i) Dept. of Industry<br>ii) L.E.A. | i) Training<br>ii) Some Research |
| Navigation Lights Simulator H.F.N., Bremen Germany | 3.1978 | V.F.W.-Fokker | Nocturnal system using 12 coloured light projectors on a circular screen. 315° field of view. 2 own ships 3 target ships. No landscapes. | Approx cost £1M. | Training Only |
| K.H.I. Ship manoeuvring Simulator Japan. | Pre 1979 | Universities and Industry | "Birds-eye View" simulator. One fixed projector for harbour screen. 2 for target ships. C.G.I. development work. | | Research |
| Ship Analytics Inc. Stonnington, Connecticut, U.S.A. | Pre-1981 | Ship Analytics Inc. | Probably colour CGI with eidophor projection system. 4 own ships and 5 gaming areas 180° field of view. Often hired by Exxon Inc, + U.S. Coastguard. | | Training + Research for USCG + MARAD |
| Maritime Institute of Technology and Graduate Studies, Baltimore, U.S.A. | 6.1981 | Visual System from VFW-Fokker Bridge from Singer Link | 2 visual simulators. Nocturnal - 360° field of view. 60 Projectors + special effects projector. Daylight - considering VFW slide system with 320° field of view. One simulator equipped with motion platform. Extensive bridge instrumentation. | U.S. Government and Union association | Training Only. Free to Union Members |
| Ship Simulator South Shields, U.K. | 1.1982 | Decca Radar Ltd. | Updated version of CNS Simulator No.1. | Dept. of Trade L.E.A. | Training |

| TITLE LOCATION | START DATE | MANUFACTURER | TYPE | FUNDED BY | USE AND PRIORITY |
|---|---|---|---|---|---|
| CASSIM (Cardiff Ship Simulator)<br>U.W.I.S.T.<br>Cardiff, South Wales | 7.1982 | Marconi Radar Ltd.<br>Decca Radar Ltd. | Marconi Tephigen System.<br>120° field of view. 3 gaming areas<br>14 own ships. | Approx cost £2.5M<br>Funded by Dept. of Industry. | i) Research<br>ii) Training |
| SUSAN,<br>School of Maritime Studies<br>Hamburg Polytechnic<br>Hamburg, Germany | 9.1982 | Krupp-Atlas<br>Electronik,<br>Bremen. | C.G.I. through 11 colour T.V. projectors. Field of view 250°.<br>Roll + Pitch ± 5°. 3 Own ships.<br>1 gaming area 94mm x 94mm.<br>20 target ships available. | Approx cost £3M. | i) Training<br>ii) Research |
| Ship Simulator,<br>Glasgow, U.K. | 9.1982 | Decca Radar Ltd. | Similar to CNS Simulator No. 2. | Strathclyde.<br>Dept. of Industry. | Training |
| Ship Manoeuvring Sim.<br>Trondheim,<br>Norway. | 9.1982 | V.F.W.-Fokker<br>Bremen,<br>Germany | Updated daylight colour slide projection. System and Navigation light simulator. 240° field of view.<br>2 gaming areas (Daylight).<br>6 own ships inc. drilling platform. | Norwegian<br>Government | i) Training<br>ii) Research |
| Russian Scientific<br>Research Centre<br>Leningrad, U.S.S.R. | 1983 | Nor-Control A/S<br>and<br>Seagul A/S | 4 own ship radar simulator plus one possibly two nocturnal visual systems.<br>150° field of view. 24 projectors.<br>Digital landmass. | Government | i) Training<br>ii) Research |
| Greak Lakes School<br>of Marine Engineering and Navigation,<br>Toledo, Ohio, U.S.A. | 1983/84<br>? | Ship Analytics Inc.<br>Sperry Systems<br>Management. | C.G.I. visual. Field of view 180° fwd and 30° directly aft. Own ship is 1000 ft Ore carrier.<br>Gaming areas inc. rivers and ports under development on the Great Lakes. | Shipping Companies<br>and Union<br>Associations | i) Training<br>ii) Research |
| Finnsim<br>Technical Research Centre<br>Espoo, Finland. | Expected<br>mid<br>1985 | Marconi Radar<br>Racal Decca | Updated Marconi Tephigen System.<br>240° field of view. 8 own ships. | Government | i) Training<br>ii) Research |
| Quindao Maritime College<br>Quindao, China. | 1985 | Seagull<br>Norway | Nocturnal Spotlight Projection on to Circular Screen. | Government | i) Training<br>ii) Research |
| Australian Maritime College,<br>Launceston,<br>Australia | 4.1985 | Krupp Atlas,<br>Germany | 200° Field of View. Full colour CGI<br>Day Dusk Night Conditions. 9 own Ships. 20 other ships. | Cost £3M<br>Government | Training and Research |
| Royal Australian Navy<br>Sydney<br>Australia | 6.1985 | Krupp Atlas,<br>Germany | Full motion Bridge Plus 4<br>Formation ship stations. 240° field of view. Full Colour CGI. | Cost £6M<br>Government | Training |

| TITLE LOCATION | START DATE | MANUFACTURER | TYPE | FUNDED BY | USE AND PRIORITY |
|---|---|---|---|---|---|
| National College of Marine Science Technology, Kee Lung Taiwan | 1986 | Krupp Atlas, Germany | Full moton Bridge. 130° field of view. Full colour CGI. Similar to AMC. Launceston. | Government | Training |
| United States Coastguard Academy, New London Connecticut, USA | 3.1986 | Amex and Ship Analytics Inc. | "Ship Control and Navigation Training System". Full colour CGI. 130° field of view. Day or Night. Own ship is CG cutter. | United States Coastguard | Training |
| Harry Lundberg's School of Seamanship, Maryland, USA | 4.1986 | Ship Analytics Inc. | Linked to MSI's US Navy Simulator in Newport. First interactive daylight CGI simulator. | Government | i) Training<br>ii) Research |
| Maritime Technical College Achiya, Japan. | 1986 | Tokyo Keiko and Japan Radio Co. Ltd. | Full colour CGI Daylight System. Projected on to small screen. | Government | Research |
| KOBE Mercantile Marine University, Kobe, Japan | 1986 | Furuno Electric Co. Ltd. | Nocturnal system on to large radius screen. | Government | Training |
| West German Navy, Muewick, Germany. | 11.86 | Krupp Atlas Germany | Full colour CGI. Other details unknown. | Government | Training |
| US Navy, Newport, Rhode Island, USA | 6.87 | Run by Marine Safety International designed by Tracor Hydronatucs Inc. | Worlds largest complex of shiphandling simulators.<br>i) full mission bridge simulator - CGI. 220° field of view. Destroyer own ship.<br>ii) Full mission bridge wing simulator - CGI. Unique. 220° field of view. 45° vertical.<br>iii)Two visual shiphandling trainers - CGI. 180° field of view. Compact. | U.S. Navy | Training of Officer students (1200 per year) |
| Massachusetts Maritime Academy, Taylor Point, Massachusetts, USA | 9.87 | Ship Analytics Inc. | "School Ship Simulator". Full colour CGI. Projected on to bridge window screens. 200° field of view. 16 other ships. CCTV monitoring of bridge. | Academy Cost up to $2M | Cadet Training Only |
| US Coastguard Headquarters Washington DC. USA | 1987 | Maritime Dynamics Ltd and ECO Inc. | "Captains System" Desktop. 90° field of view - selectable. Colour CGI. 2 own ships. 4 other ships. | US Coastguard | Research |

## ;ivil Aviation Authority

| FOR OFFICIAL USE ONLY | |
|---|---|
| Date | |
| Enclosures | |

## ISTRUCTOR FORM 3, FLIGHT TEST REPORT

*ase complete this form in BLOCK CAPITALS and Black Ink*

1 APPLICANT'S NAME (BLOCK LETTERS) ..................................................

Licence details checked — Licence ☐ Medical ☐ C of E/T ☐ Ratings ☐ Endorsements ☐

Aircraft details checked — C of A ☐ C of R ☐ C of Release ☐ Approval and Radio Licence ☐ C of Insurance ☐

Flt. Man. ☐ Tech Lg. ☐ Noise Cert. ☐

2

| | PART A PREFLIGHT BRIEF | Ex | A/A | Av | B/A | Fail | Exercise |
|---|---|---|---|---|---|---|---|
| A | Content | | | | | | |
| B | Visual Presentation | | | | | | |
| C | Technical Accuracy | | | | | | |
| D | Clarity of Explanation | | | | | | |
| E | Clarity of Speech | | | | | | |
| F | Instructional Technique | | | | | | |
| G | Use of Models and Aids | | | | | | |
| H | Student Participation | | | | | | |
| | Overall PFB Assessment | | | | | | Weak Areas |
| | **PART B FLIGHT** | | | | | | Main Exercise — Ex. No. |
| J | Content of Demonstration | | | | | | |
| K | Arrangement of Demo | | | | | | |
| L | Synchronisation of 'Patter' | | | | | | |
| M | Student Participation | | | | | | |
| N | Correction of Faults | | | | | | |
| P | Aircraft Handling | | | | | | |
| Q | Positioning Use of Airspace | | | | | | |
| R | General Airmanship | | | | | | |
| | | | | | | | Weak Areas |
| | **PART C OTHER EXERCISES** | | | | | | Not included in B |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | *(EXAMINERS: Enter Exercise Nos. in left column)* |
| | Overall Flight Assessment | | | | | | Weak Areas |
| | **PART D GROUND ORAL** | | | | | | |
| G 1 | Teaching, Learning Admin | | | | | | |
| G 2 | Law, Rules and Procedures | | | | | | |
| G 3 | Air Navigation | | | | | | |
| G 4 | Aviation Meteorology | | | | | | |
| G 5 | Principles of Flight | | | | | | |
| G 6 | Airframes and Engines | | | | | | |
| G 7 | Instruments and Radio Aids | | | | | | |
| G 8 | Airworthiness, C of A | | | | | | |
| G 9 | Specific Type | | | | | | |
| G10 | First Aid and Safety Equip, | | | | | | |
| G11 | Aeromedical | | | | | | |
| | Overall Oral Assessment | | | | | | Weak Areas |
| FIC | Lecture Subject: | | | | | | Suitable/Unsuitable for FIC |

| Test Details: | Place | Date | Grnd Time / Flt Time | A/c Type | Reg. |
|---|---|---|---|---|---|
| Cloud | Vis | W/V | Weather/Turbulence | | |

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## 3 EXAMINER'S CERTIFICATE

(a) Examiner's overall assessment

| Ex | A/A | A | B/A | F |
|---|---|---|---|---|
| | | | | |

PASS/FAIL

(b) I have tested the candidate according to the schedule overleaf.
*The candidate has failed the test/but has received a partial pass. *Ground/Flight. The candidate failed on: ...........................................................................................................................
/The candidate has passed the test./I recommend that the candidate be issued with an Assistant Flying Instructor Rating/Flying Instructor Rating on SE/ME Aircraft/Helicopter/ Gyroplane / Restricted to No Night/No Instrument/No Aerobatic Instruction on
.................................................................................... Aircraft/Helicopter/Gyroplane type.

(c) I have/have not signed a Certificate of Test on Candidate's Rating.

(d) I recommend ........................ hours of Flying/Ground Training with FIC.

Signature .................................................................

Name .................................................................

Date .................................................................

### INSTRUCTIONS AND INFORMATION

1 Please delete items not required in Section 3.

2 When this form is completed by the Examiner it is to be returned, together with Instructor Form 2 (FCL Form 86) to: Civil Aviation Authority, FCL 3, 3rd Floor, Aviation House, 129 Kingsway, London WC2B 6NN.

3 **Flying Instructor Test Assessments**

In order to improve standardisation of assessments for instructor tests, the following five assessment definitions have been prepared for the guidance of examiners.

As explained in the Guidance for Authorised Flying Instructor Examiners (CAA Doc. 210) (para 4.8.4) the candidate should be assessed under four main headings:

(a) Flying ability and airmanship
(b) Ability to impart knowledge
(c) Knowledge of the air sequences
(d) Knowledge of technical subjects

The instructor's ability in each of these will be assessed as:

Exceptional    Above Average    Average    Below Average    Fail

In awarding an overall assessment, examiners will have to use their discretion in relation to the individual assessments given for (a), (b), (c), (d) above. However, to be awarded an 'Exceptional' overall rating, a candidate must achieve Exceptional assessments under each heading. Candidates should be assessed in comparison with instructors within the group, i.e. 'average' as 'Full' Instructors, or 'above average' as an 'Assistant Flying Instructor'.

**Assessment Ratings**

For each heading ((a), (b), (c), (d) as above) the candidate's performance should be rated in accordance with one of the following assessments that best describes the candidate's demonstrated ability.

(i) *Exceptional* The candidate's ability was to a very high standard, his performance was virtually flawless.

(ii) *Above Average* The candidate's assessed ability was to a high standard. Only minor and easily corrected errors were apparent.

(iii) *Average* The candidate displayed a sound standard of ability. His performance was without significant faults but there was room for improvement.

(iv) *Below Average* The candidate's overall performance was acceptable. However, there were significant weaknesses.

(v) *Fail* The candidate's performance was unacceptable. There were significant and crtical errors.

# APPENDIX C - VERBAL PROTOCOLS

## SUBJECT M1

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

04
Started plotting OS4.

06
OS3 out of hide.

12
"The target on the radar just coming on to the 12 mile range on the starboard side - am starting to plot it using the reflection plotter." (11.9mls)

13
OS2 & OS1 out of hide.

14
Plots position on chart using Decca.

18
"I've got two more targets on the radar half a point to port and I'm plotting them as well on the reflection plotter." (11.1 and 10.6 miles)

19
"The plot indicates that the vessel on the starboard bow is on a steady bearing."

26
Cadet reports OS1 .... very fine to port showing green.
"This is the vessel which I've been plotting fine to port, the first of the two and he's crossing very finely from port to starboard."

27
Cadet reports OS3 .... four points on the starboard bow showing red.
"The vessel four points on the starboard bow showing red I've been plotting he's on a steady bearing, he's on a collision course, I'm going to alter course, I can see the vessel now, I'm going to alter course to starboard by 50 degrees."

28
Alters course - orders Starboard 20
OS1 011 x 4.6m
OS2 008 x 6.3m
OS3 057 x 5.5m
OS4 263 x 2.5m

30
Cadet reports OS2 .... five points to port showing green.
"I'm going to continue plotting all three vessels which I have on the radar at the moment, making sure the action I've taken to avoid collision for the vessel I've altered course for is being effective."

32
Calls Cadet and asks him to take bearings of the vessel to port showing a green (OS1)
Cadet....010
"Will you give me another bearing of it in three minutes time please"
Cadet....now 011
"Thank you, repeat please"
Cadet....now 009
"This vessel is crossing from port to starboard. I'm the stand on vessel but it doesn't seem to appear to be taking sufficient action to avoid collision. Am sounding five short and rapid blasts on the whistle."
Sounds 5 short and rapid blasts on the whistle.

33
Cadet reports OS1 ....008.
"As the vessel appears still not to be taking any action to avoid collision, I'm going to take action myself and alter course by 40 degrees to starboard."
OS1 008 x 3.1m
OS2 001 x 4.4m
OS3 041 x 3.6m

34
Steady 110 degrees.
Cadet reports OS1....004 still showing green.

35
Cadet reports OS1....001
"Thank you"
Cadet reports OS1....359 showing red and green.

36
Cadet reports OS1....showing red.
Crosses bows of OS1 at 1.3m
Crosses bows of OS2 at 3.5m

37
CPA with OS3 3.2m to port
CPA with OS1 6.5c dead astern

39
Cadet reports ....all three ships showing red.
"Now going to bring this vessel back on to a course of 010."
Alters back to 010

41
Steady on 010

43
Plots position on chart using Decca.

45
CPA with OS2 1.5m to port
Alters course to 005 to regain track.

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SUBJECT M2

The figures at the start of each paragraph are the number of minutes from the start of each exercise. Verbal protocols from the subject are given between inverted commas.

01
"Am putting a mark on this ship I've been told we're overtaking, with a time on the plot."

02
I've put the second radar on the , oh it is on the 12 mile to scan further ahead. I've familiarised myself with the ship and the ship fit. I'm happy with everything at the moment."

05
"I'm marking the position of this ship on the plotter here - I can see quite clearly - its passing ..."

06
OS3 out of hide.

07
"I'm checking on the 24 mile range now to see if there is anything showing up on the greater range .... there's something at 14 miles bearing about 050"
(Detects OS3 at 13.6 miles).

08
(Indistinct, but believe marks OS3 on 24 mile scale using chinagraph on reflection plotter).

09
"I can see from my plot on the radar screen that this ship to port (OS4) is coming down .... I'm going to pass just over 2 miles." (correct)

11
"Checking on the 24 mile scale to see what is happening to this ship I marked earlier on. It appears to be coming on the 12 mile range shortly when I will plot it properly. Just looking at it.. potential close-quarters situation. So I shall turn this scale down to 12 miles now....here it is."

12
OS2 out of hide.

13
OS1 out of hide.
"The ship on my port side is keeping the same course...passing well clear. Its CPA should be at 48 minutes which is another 5 minutes."

14
Prompt by JH...I can hear everything you are saying.
"Right, I shall check the ship's position now by Decca".
Plots OS3 .

15
"Just checking the ship's plot again - still coming down on the bearing - closest approach which is just over 2 miles away (OS4) - shall again check the ship on the 12 mile range (OS3). I shall put another mark on in 6 minutes on the plot. From a first pass could be on a steady bearing, this ship."

19
"Two ships showing up at 11 miles - also mark on the plot."
Detects OS1 at 10.6 and OS2 at 11.0 miles. Marks them on aft radar.

21
"This ship on the plot, just slightly forward of the beam - passed its CPA"
Cadet reports OS4 ....On port beam showing a broad green.
"Thanks very much, that ties in with everything I've got."

24
"Right, time to check this plot then back to - it appears that - course of 265 and speed (OS3?) - check on the other two - coming down very quickly. The marks arn't- CPA."

26
Cadet reports OS1 ....very fine to port showing green.
"Right I shall plot it on the 6 mile scale."

27
Cadet reports OS3 ....Five points to starboard showing red.
"Thank you , keep an eye on the bearings of both ships. Confirm the one to starboard is steady and let me know how the one right ahead goes."
Cadet ....011 and 058
"Shall now plot the ship to starboard on the 6 mile scale."

28
"Yes, I can see the green light on the ship ahead (OS1). Yes, I can see the other ship ahead now (OS2)."

28
Cadet reports OS2 .... very fine to port showing green.
"Keep an eye on the bearing of that as well please. I can see that the ship slightly to starboard ahead of me ...."

29
Cadet reports .... 014 and 009 (OS1 & OS2)
"Yes, I can see that on the radar plot, the two ships ahead are going to cross ahead - I can see that visually - and they are coming down the bearings provided by the radar plot. This ship out to starboard is on a steady bearing and I've still got the ship abaft my port beam that we're overtaking."

32
Cadet reports OS1 & OS2 .... opening to starboard

33
Calls Cadet "Could you tell me the bearing of the ship furthest round to starboard (OS3) ?"
Cadet.... 059
"So that is still steady, thank you."

34
"Right, well, the ship to starboard is still on a steady bearing, and it is my duty to keep out of the way of her - normally I would alter course to starboard, but that's not going to be such a good proposition with the two ships showing the green coming down, so in this particular situation I have to be careful that an alteration of course to port because of the vessel we've overtaken but we're actually going faster than this vessel."

35
"So as there is a lot of searoom available, I don't want a close-quarters situation I'm going to alter my course right round to - right round to port - to - 230. I'm going to sound two short blasts."
Sounds 2 short blasts.
A/C to port to 230.
CPA OS1 1.0m to starboard.
OS2 021 x 2.2m
OS3 060 x 2.5m
OS4 246 x 3.0m
OS1 130 x 1.5m

37
CPA OS2 1.9m to starboard.

38
"Shall now plot the vessels again and confirm that my actions had the right effect."

39
Asks Cadet to advise the bearing of the ship showing red (OS3)
Cadet ....054
"Thank you."
Steadies up on 230.

40
"When the west bound ship (OS3) and the south bound ship (OS2) are astern of me I shall come round right again further round to port and resume my course again."
OS2 passes under stern at 1.8 miles.

44
Advises Cadet .... "coming round now"
Sounds 2 short blasts.
"I'm coming right round to port to complete the turn and put me on a course - heading just astern of the vessel we had coming from starboard."
OS1  140 x 4.7m
OS2  078 x 2.5m
OS3  027 x 2.6m
OS4  298 x 1.5m

47
"Its safe to come round to 030 now. That's the south east bound ship just ahead of me there."
Crosses ahead of OS2 at 2.4 miles.

48
Settles on course of 030.
"Right will start plotting these ships again and keep an eye on the one to port."
Asks Cadet to keep him "informed of the bearing of the ship to port about 3 points (OS2) - Its bearing about north at the moment."
Cadet reports .... showing red.

49
"Right, will check on the 12 mile range to see if anything ahead. Doesn't appear to be anything. The ship I'm overtaking is on the port beam at two miles. The west bound ship appears to be still west bound."

------------

SUBJECT M3

The figures at the start of each paragraph are the number of minutes from the start of each exercise. Verbal protocols from the subject are given between inverted commas.

01
"I shall be using chinagraph plotting on the forward radar with the one ship we are overtaking so I shall just keep plotting him, and keep an eye on him."
JH confirms all loud and clear.
"Position on the chart at half past - putting the aft radar on 24 miles - long range scan."

06
"Checking down on a lower range scale - its about a 6 minute interval - another plot on the radar plot for the vessel we are overtaking - she's drawing left nicely."
OS3 out of hide.

11
"Just starting to get a faint echo 4 points on the starboard bow (OS3 at 12.2 miles) - will start plotting him when he comes on the 12 mile scale."

12
OS2 out of hide
"Started plotting the echo on my starboard bow. The one on the port bow is passing clear. CPA looks like being about 1.2 miles in about 6 minutes time (OS4). As we are overtaking target is passing nicely clear."

13
OS1 out of hide.

14
"Just starting to pick up a fairly faint echo half a point to port 14 miles away (OS2 at 13.8 miles). Until it comes a bit clearer I shan't actually plot it. Echo on the starboard bow (OS3) at present seems he might be on a steady bearing which indicates a crossing vessel in which case I shall have to keep clear but will wait until I have a proper plot on."

15
"Have taken a position at quarter to - on the line still. Have plotted the one on the starboard bow at 3 minute intervals and will get another plot at 48."

16
"Just starting to get 2 echoes fine to port at 12 mile range (OS1 & OS2)."

17
"Just getting a rough plot with the chinagraph on this vessel to starboard. Just getting a mark on those ones fine to port. The one to starboard and the one we've just overtaken - or still overtaking rather. Approximate indication the one on the starboard (OS3) is heading about 275 approx. 16 knots more or less the same as us. ( correct)."

18
"He is definitely on a steady bearing and as he is crossing from starboard to port and on our starboard bow it is our duty to keep out of the way and I shall start considering action shortly."

20
Cadet reports ....vessel on the port beam now clear.

21
"Put another mark for these vessels I'm plotting. The one on the starboard bow is still on a steady bearing (OS3). The two to port (OS1 & OS2) - both have a very close CPA down the starboard side probably indicates they are heading more or less south."

22
"This indicates - I'm the stand on vessel for these two as I'm on their starboard side crossing, however I can't tell for certain their aspect until I have another plot."

23
"If these vessels are considering me as a crossing vessel I would expect them to alter to starboard for me if they consider risk of collision exists."

24
"I think I'm going to take a broad alteration of course to starboard for this one on the starboard bow although I cannot actually see him yet I am confident as to what he is doing. I shall also be taking action for these two on the port bow if they stand on or alter to starboard take --- its a 60 degree alteration so will be apparent to them if they are plotting me on radar."
A/C to starboard
OS1 007 x 7.1m
OS2 007 x 8.3m
OS3 057 x 7.1m
OS4 273 x 2.2m

25
Steadies up on 070 degrees.
"The plot I've just taken before she started to swing will finish constructing the triangle for these two to port (OS1 & OS2) just to check my action."

26
"I estimate a CPA of about 3 miles for this one which was on the starboard bow (OS3) and the two other, probably a mile or so astern. They both appear to have a course around about 160 (171 & 174). The closest one at present doing about 18 - 20 knots (25k) and the other one a similar speed to us 16 (correct). Now she is steadied up I shall plot again - will leave it until 57. I would expect to see the closest two vessels here - one a point to port and one about 6 points to port."
Cadet reports....ship 5 points to port showing green (OS1).
"Would expect it to be showing green at present with this course."

27
Cadet reports....ship one point to port showing red (OS3).

28
"I will now maintain this course until the vessel a point to port is on our beam then consider trying to resume my course taking into account these two vessels about 6 points to port for whom I am still a crossing vessel and would expect them to keep clear. Will obviously keep monitoring their progress cause when actions by them alone .. will not avoid collision I must take action to avoid collision when I consider that they are not taking action in an appropriate time."

29
"Just rubbing all the previous plots off the screen. With the alterations of course the relative speeds will obviously quicken."

30
Cadet reports .... ship 5 points to port showing green (OS2).
"Yes thank you very much, could you please take a bearing of both those two and let me know in about three minutes time whether any of them change - of both those two ships about 5 points to port."
Cadet reports ... 358
"Thank you very much."

31
"....East of the line. The plot at present would indicate that the vessel 3 points to port is opening nicely (OS3) and the two at 6 - 7 points to port - will check with the Cadet."

32
Cadet reports .... (OS1) showing red and green.
"Thank you, anything else ?"
Cadet reports ... 353...355
"Thank you very much. As expected the visual bearings confirm the radar plot, both vessels are opening."
Crosses ahead of OS1 at 2.8 miles

33
Cadet reports .... (OS2) showing red and green
Crosses ahead of OS2 at 5.4 miles.
"The Cadet reports both ships showing red and green which indicates we have crossed across their bows. The nearest one being 2.8 miles away - this is plenty of distance. They will both have reasonable CPAs - over a mile or so - would not expect them to take any action. The vessel which we were previously overtaking is proceeding much the same."

34
Cadet reports .... all ships showing red (OS1 &2 &3)
"All the ships are now showing red which indicates we have crossed ahead of those 2 heading south. I will wait until the vessel we initially altered for (OS3) is past our beam and then consider resuming my course."

36
"Yes, just had a 6 minute interval here on the plot - just to confirm what has been happening. It indicates the one to ..285 at a similar sort of speed. The closest one of those heading in a southerly direction (OS1) heading about 160 appears to be doing about 20 knots (25k). The other one appears to be doing about 12 knots (15k).
CPA OS3 3.1 miles to port

38
"The second of those ones heading south and the one heading west are now in close-quarters situations and may be altering for each other. The actual CPA of that ship (OS1) was 1.2 miles which is perfectly reasonable in this kind of visibility."
CPA OS1 1.4 miles astern.

39
"My concern now is for the other southerly heading vessel (OS2), which will be the one most likely to concern us and I won't actually resume my course until I am sure of his action."

40
"Looking at the aft radar to make sure nothing at long range. Keep checking the radar heading marker to see if there are no targets underneath."

41
"Now a velocity triangle for the second of those south bound vessels - just now checking to see what an alteration back to around about 010 would do. By swinging the vector arc should make the WO and 210. This would seem to be the relative course about 170 and CPA of 1.5 miles which would be satisfactory so I will get a position at quarter past 11 then and swing back to 010 unless anything else crops up. By that time should be very broad on his port beam and should become no cause for concern."

42
"When taking previous actions, I didn't make a whistle signal as we have been out of range anyhow."

45
"Getting a position"
Plots position on chart

46
A/C back to 010
OS2 277 x 3.3m

47
CPA OS2 3.3 miles

48
Steady on course 010.

----------

SUBJECT M4

The figures at the start of each paragraph are the number of minutes from the start of each exercise. Verbal protocols from the subject are given between inverted commas.

01
"Forward radar on 12 miles, aft radar on 6. Just the one target clearing down the port side."

06
"Keeping an eye on this vessel on the port side, although I'm overtaking I'm still the give-way vessel should she come to starboard for any reason. She's still going clear."
OS3 out of hide.

07
"Going up to range 24 miles as a check for long distance scanning .... the one vessel on my starboard side about 5 points at a distance of 14 miles ... keeping an eye on him."
Detects OS3 at 13.8 miles.

08
"Plotting intervals at 15 knots, estimate at 12 knots OW of about 1 mile and 8 minutes gives me ... of 2 miles. Vessel on my starboard side is on a steady bearing."

10
"Vessel on my port side still going clear. Vessel on my port side giving a CPA of approximately 2 miles."

11
"The one on my starboard side at 12.3 miles (OS3) 057 bearing hasn't appreciably changed over the last 5 or 6 minutes. On a collision with it, as it is on my starboard side I'm the give-way vessel but a little too far to take any action at the moment."

12
"The vessel on my port side still going clear at 2 miles."
OS1 out of hide.

13
"The vessel on the starboard side is approximately 11.3 miles and will start plotting him."
OS2 out of hide.

16
"A further two echoes .. one to port at half a point to port at 12.3 miles. Will start plotting them when on the 12 mile range."
Detects OS1 at 12.2 miles and OS2 at 12.2 miles.

18
"Vessel on my starboard side appears to be doing about 260 . Should be seeing his red light shortly. Vessel on my port side just about on my beam. A bit of a centering error on this ..."

20
"Vessels fine to port about.. the closest one is 5 miles away . Doing their relative plots appears to be going clear down my starboard side. Could prove interesting when I come round to starboard for this vessel on my starboard side."

21
"Can now see four vessels on the screen."
Checks up on the 24 mile range.

24
"One of the vessels fine to port appears to be altering its aspect ... now no longer following the original line .. relative motion."

25
"A further triangle on the one to starboard .. appears to be doing about 300. He is now just over 6 miles."

26
Cadet reports .... ship fine to port showing green (OS1).
"That vessel showing green (OS1) is a crossing vessel going my port to my starboard. Assuming no other lights are visible he is the give-way vessel."

27
Cadet reports .... ship five points to starboard showing red (OS3).

28
"His bearing (OS3) is now 054.5 and still on a collision course.... and I think this one alter course to starboard and pass round his stern. Now 4.5 miles should give sufficient. Now going to starboard."
Cadet reports ... ship fine to port showing green (OS2).

29
"Coming round to starboard now."
A/C to starboard

| | | | |
|---|---|---|---|
| OS1 | 014 | x | 3.8m |
| OS2 | 009 | x | 5.6m |
| OS3 | 057 | x | 5.1m |
| OS4 | 260 | x | 2.5m |

30
"Steering 055 at the moment. Dropping my range scale down to 6 miles. Taking the swing off her and steady up on 060. The vessel I've got to watch now is the one on my port side at 1,2, 3 miles."
Asks Cadet for bearing of vessel bearing 014 (OS1) about every minute or so.

31
Cadet reports ... bearing steady.
"She is now steady."

32
"Well under the rules she is a give-way vessel now and I shall watch her to make sure that she does take some action .. will pass closer than I thought."
Cadet reports .... 018
"At this sort of range she is not appreciably changing. She is down to 1.5 miles."

34
Cadet reports ... 019
"Still not appreciably changing .. consider risk of collision to exist. One of my options is to reduce speed or I could continue going round to starboard, and in this case I think I'm going to have to do that."

35
Cadet reports ... 022
"Still not enough ... come round ... come round ... starboard 20."
A/C Starboard 20
OS1 026 x 5c

36
"Well, I've allowed him to get too close. Should have taken action a lot more earlier. She's set right underneath my bow. Ah, can resume my course bringing her round steadily."
OS1 crossed bows of Own ship at 1c.
A/C back to port.

38
Crosses ahead of OS2 at 2.5 miles.
CPA OS3 2.2 miles to port.

40
"Will continue to bring her back on course."

41
"Bring her round to 030. Watching that other south bound vessel. Make sure I don't get too involved with him."
Steadies up on 030.

42
"Can now see the other south bound vessel showing a red side light (OS2)."

43
Cadet reports ... all ships showing red.
"Will continue bringing her round on to track .. make sure rate of turn is not too high."
A/C back to port.
Puts position on chart.
CPA OS2 9c to port.

44
"as soon as this vessel is clear down my port side I shall bring her round to 000 to bring her back on to the course line."
Cadet reports (OS2) .... clear and passing the beam.

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SUBJECT M5

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

00
"Going to plot the one ship I've got on the port side with chinagraph on radar. 32 ... 31. Present moment he is 3 miles away at a bearing of 338. Working at the moment on the 12 mile range on the radar. At the 24 at the moment not showing anything else on the radar consequently on the 12 mile range.."

02
"Right, going to check the position ... OK, still on the line."

04
"The tide should be going 326. Should be setting towards the west. Ship to port's bearing seems to be opening nicely .. 3 minutes degrees."

06
OS3 out of hide
"2232 6 minutes after initial plot on the radar screen. Too early to say exactly what the relatively plotting ship is doing, but passing approximately 2 miles off on the port side ..... closest approach."

07
"Course must be approximately north .... tracking up on the 24 mile range there's another ship on the starboard bow bearing 055 .. distance 13.5 miles .."
Detects OS3 at 13.5 miles
"Keep an eye on that one .. I'll remain on 12 miles for the moment. Check back on that vessel surely to make sure that this one on the port side is (indistinct)"

10
"Going back on the 24 mile range. Vessel over to starboard. Relative line is coming down towards us indicating that she may be a crossing vessel. Give her another look shortly and check up on that distance off - now 12.5 miles."

11
"Port side vessel still passing nicely on a relative plot down the port side keeping to the 2 mile CPA."

12
"Ship on the starboard side has now come on the 12 mile range. Start a new plot on her so I can keep an eye on both vessels on the same range scale ... bearing is 055. 056 distance 11.7 miles. Going to turn the heading marker off just to make sure nothing coming down the heading line. Everything appears to be clear."

13
OS2 out of hide.

15
OS1 out of hide.
"Just check the position at a quarter to .." (indistinct Decca readings.) "It appears to be keeping to the line nicely at present."

16
"Once again checking 24 mile range . Two more vessels coming up on the port bow. Just put a mark on them .. nearest is 13 miles away at 2246. Will put the aft radar on 24 miles just to keep an eye on those two ships on the port bow. Use the forward radar to plot on the 12 mile range. Rub out the old plots.. somebody else has been using. Check gyro against magnetic compass and so forth."
Detects OS2 at 12.8 miles and OS1 at 12.9 miles.

17
"Two ships up ahead on the port bow on the 12 mile range scale. Now they appear to be heading in a SSW direction. Just put a proper plot on them now at 2248."

18
"Ship over to starboard on a steady bearing, range decreasing, range at present 9.6 miles. Have'nt really been plotting him long .. just coming in fairly rapidly."

19
"Both these vessels on the port bow appear to be coming more on a southerly course. Maybe about 170. Haven't done a plot yet, so not too sure about the course."

21
"Vessel on the port beam is remaining to his relative plot indicating that he is maintaining his course. Do a plot on the one on the starboard bow .. now 45 was the original plot its 51 - 6 minutes later indicating that he .. his rough plot .. speed is 15 .. 1.5 miles .. 6 minutes .. approximate course .. only after a 6 minute plot which isn't very long to rely on. Approximate course is about 265 and he's doing about 20 knots. He's coming down on a steady bearing. Since I first saw him on the 24 mile range and these vessels on the port bow are still coming down. They also are on steady bearings, maybe crossing slightly ahead. And when I have to alter

course for the one on the starboard bow its best I think to alter course as soon as possible. The two vessels coming down on the port side .. they would have a CPA at present of 1.3 miles. However by altering course now while they are a good distance away should indicate to them they are watching on the radar exactly what is happening here. So I shall come round about 60 degrees to a course of 070 and they should all see what is happening."
Alters course slowly to starboard
OS1 004 x 8.3m
OS2 006 x 9.1m
OS3 056 x 7.6m
OS4 278 x 2.2m

24
"Coming around fairly slowly, we have plenty of sea room at present. Probably find the vessel on the starboard bow might alter course for the two vessels to the north but with such a short plot as this it is difficult to tell what they are relative to each other."

25
"Well will wait until she steadies up on the new course when I shall start another plot. The initial vessel that we had with us at first taking over have put a plot on him and he should be going clear now."

26
"Its coming on to 070 now, so I'll take a new plot of all three vessels in the vicinity other than the vessel which should be fairly well astern. Should have a minimum CPA of everybody of 2 miles if possible. Speed hasn't reduced much in the alteration , come down to about 14 knots which is not too bad."
Steadies up on 070.

27
Cadet reports OS1 ... ship fine to port showing green
Cadet reports OS3 ... ship 5 points to starboard showing red.

28
"Well, after a short time it appears that the vessel coming on a course of 150 should pass 2 miles off astern of us. And the vessel on the port bow should pass well clear about 2.5 miles. We've got the green light showing out about 2 points. It appears to be the vessel on the port side at a distance of 5 miles. The Cadet has reported the other vessel with the red light at six points to port which at present I can't see. Just check the other radar on the 24 mile range. It appears to be no other vessels around besides the four in our vicinity ... the vessel on a northerly course, two to the north of me now heading south and the vessel on the port bow. Can see his two white masthead lights at the moment heading in a westerly direction. All the vessels appear on a relative plot to be passing clear."

30
"Just get a new position for the chart at 2300." (Decca Navigator readings taken.)

31
Cadet reports OS1 and OS2 .... showing red and green.
"I'll plot this position."
Crosses ahead of OS1 at 3.8 miles
Crosses ahead of OS2 at 5.9 miles

32
Cadet reports OS1 and OS2 and OS3 .... showing red.

33
"Well, all the ships to the north are now showing red. They appear to altered course; no they don't they are maintaining their course to the south - belay that. The vessel now that I altered course for bearing 026. All the other vessels are passing well clear. The CPA of the closest approach on this course of about 1.8 miles. With them all showing red over there, now it is safe to bring her a little bit more to port to try and return to our course line, so I will come back to a course of 040."
Alters course back to 040
OS1 337 x 2.5m
OS2 348 x 4.9m
OS3 018 x 3.5m

34
"Keeping an eye on the plot of the vessels making sure they are going to maintain their course - just check the 24 mile range again - no other vessels in the area."

35
"Starting to steady up on 040 now. A little passed 036, coming back to 040 now."

36
CPA OS1 1.5 miles
CPA OS3 2.9 miles
Cadet reports OS1 and OS3 ... past and clear.
"Yes, the south bound vessel, the first one of the two that went .. his distance off 1.2 miles , 1.3 miles - he's on the beam. When I come back to my course line as soon as this vessel is clear - its bearing is 357 now - 3 miles away. Coming past the course of 010 to try and regain my initial course line."

37
"Try to avoid small alterations to stop confusing as to what my intentions are. However, he would probably realise that my initial course was on 010 or in that vicinity. Normally heading he would expect me to alter course as soon as I cleared him. Can no longer see the vessel, so I think I will bring her round now to 010."

38
Alters course to 010
OS3 346 x 2.8m
OS2 331 x 3.2m
"He might alter course to starboard himself for the second south bound vessel. Have to keep an eye on the two of them there to make sure situation doesn't alter to much. Can now see a single white light on the port bow now (OS3 stern light). Not too sure where that one is from, might well be..."
Cadet reports OS3 ... showing stern light.

40
"Will continue back to 010. The vessel has now gone that I was looking at a moment ago. Nothing showing on the radar in that vicinity."

41
"Checking 24 mile range again, doesn't appear to be anything around. With the alterations I've been making there shouldn't be anything under the heading marker, should have seen him because of the alterations. Will check for any blind spots as well. Visibility appears to be very nice and clear."

42
"At quarter past I will check the position and check on the course to steer to bring her back on my course line. Will now come on to 000 which should slowly bring her on to the course line and will check that at 2315."
Alters course to 000.
OS2 297 x 1.9m

43
"Now back on to 000. That second south bound vessel, 1.7 miles away will soon be coming on the beam. Too bad nothing came within a mile and a half of us. I shall be about 2 miles to the east of the line at present."

44
CPA OS2 1.7 miles to port.

45
"Its quarter past now, so will plot the position now."
Cadet reports OS2 .... on the beam and clearing.
"Its the way the phone always goes when you get a position down. What happens in real life I suppose."

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SUBJECT M6

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given below between inverted commas.

06
OS3 out of hide

09
"Just detected an object on my starboard bow bearing 056 and approximately 12.5 miles away so commence radar plotting on the 24 mile range using a reflection plotter. The vessel on my port bow is still drawing astern nicely - keep him under observation. ( detected OS3 at 12.9nm)

12
"That chap on my starboard bow is now on the 12 mile range - his initial appearance would be that he is going to be on a steady bearing, bit too early to say just yet but I will be thinking along the lines of altering course once I've determined he is on a steady bearing."
OS1 out of hide.

13
OS2 out of hide

14
"Ah, ha have also now picked up 2 ships fine on the port bow round about 14 miles - 13.5 - 14 miles. Am keeping the initial spot on them on the 24 and see how they are doing."
Detected OS1 and OS2 at 13.9 and 13.6 miles.

19
Cadet informs OOW - OS4 clear on the port beam showing green.

20
"Well, it would appear that those two chaps on the port bow are to cross fine - very close in front of me. I'm going to have to alter course for this boy on the starboard bow so I'll deal with them once I've come back - just see what he's doing. Yes, definitely a steady bearing - lets see what we've got. Must be heading due west or perhaps a bit north of west (277). So will come round to avoid him and see what that does to those two chaps up for'd there. A broad alteration of course to starboard for a vessel on my starboard side. Its my duty to keep out of the way, taking early substantial action to avoid collision."

21
Alters course to starboard
OS1 004 x 8.9
OS2 006 x 9.7
OS3 057 x 8.1
OS4 282 x 2.2

22
"Except that I now perceive that he has done something which is a bit annoying."
Steadies up on 060.

23
"Ah. well, steady on on our new course now. Lets see what he is doing. The two chaps on the port bow -

24
Cadet reports OS3 - fine to port showing red
"Yes, there he is"

26
Cadet reports OS1- 4 points to port showing green.
"Hmm"

27
"Think that chap that was on my starboard bow originally must have altered course course to port - there's something strange -

31
Cadet reports OS1 -showing red and green
"Oh good, that means that we are ahead of them now. That means they are heading about due south. That means that once we are clear of this chap on the port bow we can come round and they will be on on our port side - that should be O.K."
Crosses ahead of OS1 at 4.2 miles
Crosses ahead of OS2 at 6.0 miles.

32
"Now then got all his lights now - distance 4.5 miles- quite clear."

33
Cadet reports OS1 and OS2 - showing red.
"O.K. thanks very much, Good, that's both of them."

34
"Just to the east of the line. Its possibly time to come back to course. That will be that. Come back on course - slow - don't frighten them much."
Alters course slowly back to port
OS1 329 x 2.3
OS2 345 x 4.7
OS3 012 x 3.3
OS4 276 x 4.8

36
Steadies up on 010
"Think I can see that one there."

37
CPA OS1 1.4 nm.

39
"Ah, that's his stern light that's just come up. We must be two points abaft his beam and there goes his masthead lights and sidelights - goodo. So once those two are on the beam we can adjust the course to make the alteration - should be down to about 007, I should think, perhaps 006.

40
"Wonder if he altered because of that one - chap on my starboard bow might have altered originally because of those two south bound ships - going to pass very close - yes, only .5 mile or so."

41
CPA 083 2.5 nm

42
CPA OS2 1.6 nm

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SUBJECT M11 - EXERCISE OW11

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

03
"Started plotting both vessels"
(OS1 & OS3)

05
"I've verified that the vessel to port showing a stern light is in fact on a steady bearing , so I'm going to alter course to starboard and give one short blast."
Alters course to starboard
OS1 057 x 2.7m
OS2 065 x 13.3m
OS3 182 x 1.5m
OS4 088 x 12.4m

06
"Altering course 30 degrees"

07
CPA OS3 15c >

08

"Detected to port two other vessels, one 2 points to port about 12 miles, the other 3 points over 12 miles"
(OS2 @ 12.5m OS4 @ 11.5m)

09
"Commenced plotting the first vessel to port."
(OS4)

12
"Commenced plotting the second vessel, range 11.5 miles, 5 points to port."
(OS2)

14
"Have increased the CPA of the vessel I was overtaking, so am going to bring her back to her original course 087."
Alters course - port 20.
OS1 041 x 3.0m

22
"I can see from my plot the vessel dead ahead is on a steady bearing and moving down towards me, so I am going to alter course to starboard 30 degrees to pass port to port."

Alters course to starboard - sounds one short blast
OS1  037 x 2.4m
OS4  087 x 6.0m

23
Cadet reports OS4....very fine to starboard showing green.
Settles on 100

25
"Because this vessel is showing green I'm going to reduce speed to give me more time to assess the situation"
Reduces to 80 revs - half ahead.
OS4  087 x 5.0m

27
Asks Cadet .... "is vessel to port still showing green ?"
Cadet .... Yes, bearing 087

28
"Now the vessel showing a green light (OS4), therefore she is the give-way vessel and I am obligued to hold my course and speed and have reduced my speed, therefore I am going to maintain my course and speed"

29
OS4 still bearing 087 - steady
"This vessel doesn't seem to be taking the required action, so I am going to call it up on the vhf."
Subject .... "This is the vessel Morlone heading 100, I have a vessel 3.5 miles away heading south west showing a green light, do you copy over"

30
Instructor alters the course of OS4 to 280
OS4  087 x 3.0m

31
"So, the vessel has altered course to starboard, showing red. It appears it will pass clear but I'm going to continue plotting."

35
"My plot shows that he is going to pass fairly close, about 7c, so I am going to alter course to starboard to increase this distance."
Alters course 5 degrees to 105
OS4 x 1.7m

37
"That ship (OS4) seems to be passing well clear, so I'm going up to full speed again."
Increases to Full ahead.
OS4  051 x 1.0m

39
CPA OS4 7.4c <

41
"This vessel is now abaft the beam, so I'm going to return to my course of 087"
Alters course to port
OS1 043 x 2.6m

42
Steadies on 087

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SUBJECT M12 - EXERCISE OW12

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

01
"The four targets showing on radar - all four are being plotted by chinagraph. Plotting true motion and relative motion."

02
"One vessel visually showing a green light passing down starboard side, approximate CPA one mile (OS4). No need for any action."

05
"Continue chinagraph plotting on true motion approximately once every 3 minutes. Relative motion just regular marks to suggest whether a vessel is opening, closing or steady."

07
CPA OS4 4c<

11
"12 minutes passed, target on starboard side now clear. Three targets outside 6 mile range ahead coming towards me. True motion plot shows all maintaining their course and speed at present - no action taken."

12
"Now consider vessel on starboard quarter to be past and clear (OS4) Will cease plotting on true motion. Will continue to monitor on relative motion.

14
"Plotting at 14 minutes past. Three vessels ahead appear to be maintaining their course and speed. No action taken.

16
Cadet reports OS3.... one point to port showing red.

16
"Vessel a point to port showing red confirms visibility at 6 miles, seen visually from the bridge, positively identified from the radar."

16
Cadet reports OS1....one point to starboard showing green.

17
Cadet reports OS2....one point and a half to port showing green.

18
"Three vessels within 6 miles. Vessel to starboard approximate CPA of 2 miles showing green (OS1) considered satisfactory. Vessel close to port CPA presently 1 - 1.5 miles considered satisfactory. Vessel further to port showing green, therefore crossing. Will continue to monitor."

20
"The vessels passing down my port and starboard sides- am quite happy to pass in between them - this time there is no reason to suppose either of them will alter course. There are no vessels behind me, following me which will cause them to alter course. For the time being will continue to monitor closely the crossing vessel. Present indications are if necessary to slow down if he fails to alter for me. Until then the two vessels coming down are passing clear."

21
"The crossing vessel is now approximately 4 miles away. I would have expected him to have taken some action by now. I will sound 5 short and rapid blasts and will assume the whistle is connected to the manoeuvring light. I would also use the aldis pointing in his direction so he is under no doubt that he is being signalled to. Am not happy that he is taking action or sufficient action within the regulations."
OS2 287 x 3.6m

24
"Crossing vessel does not seem to be taking sufficient action. My options are either to slow down or I may take action to alter course to starboard. I am unable to alter course to port because I may only alter course to port for a crossing vessel at such time as action by both of us should be required to avoid a collision. The true plot indicates that this vessel has neither changed its course nor its speed, I will therefore be slowing down to manoeuvring revs. The vessels coming down to port and starboard appear to be maintaining their course and speed at present. No problems envisaged from them."
Slows down to manoeuvring full ahead
OS1 009 x 2.3m
OS2 287 x 2.3m
OS3 258 x 2.0m

26
"Sound 5 short and rapid blasts again, assuming light is connected or aldis in his direction"
Sounds 5 short and rapid blasts.

27
"Switching relative radar to 3 mile plot - continuing to plot crossing vessel."

28
"Vessel is now 1.5 miles away showing no sign of altering course. His approximate course on my true radar is 090 (089) therefore will alter round to starboard to come on to 090 and parallel his course and monitor what further action he takes."

30
"Vessel that was previously on my starboard side (OS1), I will keep fine on my starboard bow at present to avoid crossing ahead of him so at all times he can see my green sidelight. True plot indicates that crossing vessel may have altered course to port .... will steady up on 040 and monitor the situation."

31
"Indicates vessel on the starboard side has altered course (no), not happy with the present action, will continue to come round to 090. Am using helm for this rather than autopilot."
Cadet reports OS2.... showing red and green.
"Showing red and green, therefore on the same course as us, still marginally on the port quarter. Will continue to come round to 090 and continue to monitor the situation as necessary. No other traffic at this time seems to present a problem."
Crosses ahead of OS2 at 4c.

32
Settles down on 090

33
Cadet reports OS2.... showing red and seems to be getting closer.
"Showing red and vessel appears to be coming closer which suggests we are seeing its port bow which would suggest it is intending to overtake us on the starboard side. Will come back to full speed. "
Increases to Full away.
OS2 269 x 2.5c
"He's 2 cables astern of us. Presently I'm sure of its actions. It continues to be the only vessel to present a problem. Range is decreasing, check bridge wing with what colour lights its showing."

34
Asks Cadet about colour of (OS2) sidelights.
Cadet reports showing red and green.

35
"Definitely coming up the stern and closing, showing red and green. Going to assume it is more likely to alter course to starboard to overtake us. Its initial course

was in a south easterly direction (089), therefore will begin a definite alter course to port so as not to loose too much speed and signal our intentions."

36
Alters course to port
Sounds 2 short blasts
OS2 281 x 1c

37
Cadet reports OS2.... showing clear red.
"Thank f... for that. Vessel showing clear red indicates Cadet is seeing his port side therefore he is opening. Relative radar indicates the same. Will endeavour to regain track without using too much helm that will slow us down unduly. Rudder limit on 15 degrees on the autopilot considered sufficient. No other targets presenting a problem at this time.... much to my relief"

40
"Relative radar back on to 6 mile range scale. True continues to be on 12 mile range scale. Will now reset true and continue plotting targets as applicable."

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SUBJECT M13 - EXERCISE OW12

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

00
"Commenced plotting this target to port."

01
"Doing a bit of long range scanning on the 24 mile range, can see there is a target to port at 13.3 miles at a point and a half and a second - third target at very fine to starboard."
Detects OS1 at 13.7m
OS2 at 13.3m

03
"Second target to port is now showing on the 12 mile scale at 12 miles." (OS2)

04
"Target fine to starboard just showing up on the 12 mile range at extreme range."

07
CPA OS4 14c>

09
"Initial assessment of the first target which was a point to port distance off now is 8 miles and its predicted CPA is 1.6 miles on my port side and seems to be tracking down on a reciprocal course." (OS3 - correct)

12
"CPA of target 2 seems to be nil - we are on a collision course and estimated CPA of target 3 to starboard (OS1) is 1.6 miles also." (Correct)

14
Cadet reports OS3.... 1 point to port showing red.
"Yes, I can see it myself. First target a point to port showing red at 5.9 miles, which is what I expected."

16
Cadet reports OS1.... 1 point to starboard showing green.

17
Cadet reports OS2.... 2 points to port showing green.

20
"Course and speed has been ascertained now for each vessel"

21
"It appears the vessel to port is steering 095 at 16 knots ( 089 x 14K) and the vessel to starboard is steering 120 at a speed of 20 knots ( 118 x 18k). The chap on my port side crossing port to starboard by now 4 miles off but 5 miles off when I first .. I would have given him 5 or more rapid blasts on the aldis lamp to wake him up a bit. By the crossing rule, he should have given way to me. The other 2 vessels are passing clear of me. It appears the vessel to starboard will pass me first which will give me the option of going to starboard to clear this vessel to port if he does not take any avoiding action."

23
"Have estimated that vessel passing down my starboard side clear should be on my starboard beam clear at 1128 and the vessel which is crossing port to starboard should then be 2 miles on my port bow and I will then at that point alter course to starboard should the vessel not have altered."

25
"I think at 2 miles off...when this chap crossing is at 2 miles off, I shall alter course to starboard. Now appears the vessel passing down my starboard side will be well clear by then."

26
"Its now 2 miles off so..."
Sounds one short blast
Alters course to starboard
OS1 025 x 1.5m
OS2 281 x 2.0m
OS3 242 x 1.9m

28
"I altered course 60 degrees to starboard to 005"
Cadet reports OS2.... showing red and green
Crosses ahead of OS2 at 12c

29
Cadet reports OS2.... now showing red

30
"Shall continue to plot this vessel which is crossing port to starboard until he is well clear of my stern in spite of the fact I can only see a green .. its red only now because he is at quite close range, then as soon as I feel he is past and clear I shall bring her back on to the original course of 305."

31
CPA OS2 9c
"Incidentally, the CPA after I altered course appears to be approximately 9 cables."

32
"Just checking up on the other radar to make sure there is nothing else showing up, so I will bring her back on to the original course of 305."
Alters course to port
OS2 210 x 9.4c

33
Settles on 305

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SUBJECT M14 - EXERCISE CW10

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

01
"The chap on the port bow from initial information is slowly opening to port; am going to continue a plot so am going to assume a situation where the plots have been rubbed out and am starting afresh. Working with the bridge radar on 12 and 6, basically 6 and the chartroom radar on 12 and 24 miles so as to get a good span of ranges. If anything comes in closer will probably go down to 3 miles on the forward radar. Am using parallel indexing techniques on the Scarweather Light Float at a range of just less than 3.5 miles, so I can keep a track and know if I am holding my course line. Will start the initial scenario."

02
OS1 out of hide

03
Cadet reports Scarweather Lt. visible

05
OS3 out of hide
"Completed the plot on the vessel I'm slowly overtaking. It has an initial CPA of 2/3rds of a mile. Reasonably happy with the distance at the moment, but when I'm going past him I don't want to be quite as close as that, just a bit more distance clear, so will probably be coming to starboard for him in a short time." (CPA OS4 10c<)

06
"Two targets have come up fine to starboard at a range of just less than 12 miles, am going to commence a plot on them two."
Detects OS1 at 11.6m
Detects OS2 at 11.5m

07
"Can see the Scarweather buoy visually now, on my starboard bow, also 3 points."

08
"There is a possibility that the vessel I'm overtaking has made a small alteration of course - that or my plot was duff. Must have been a slight alteration of course there so am going to continue assessing him and continue plotting him."

10
"Now have got a faint echo on the starboard bow. Have just commenced a plot with that chap. He's less than a point to starboard."
Detects OS3 at 11.7m

12
"Carried out the plot on the 2 vessels to starboard that I initially saw. One of them looks as if he is going to pass very close down my starboard side and the other one looks as if he is going to pass a shade over a mile clear down my starboard side. Reassessing the plot of the vessel I'm overtaking, am now getting a distance clear of just over a mile. Considering the waters I'm in with the Scarweather Buoy over to starboard I'm happier now with a CPA of just over a mile. With waters further away from land I would prefer 2 miles clear but at this distance I'm quite happy at the moment." (CPAs correct)

14
"For some unknown reason I may have been getting a secondary target. The initial 2 targets I got on the starboard bow I can only see one target; I've checked underneath the heading marker but there is nothing there now. Visibility has been reported as 6 miles, so will be keeping an eye open just in case there is a target there, but she isn't showing now."

16
"It looks as if I've got a rogue radar. I've found that target again and she is still following the same track and it looks as if she is going to pass a cable or so down my starboard side which is very tight indeed. The third target which was on my starboard bow - the plot is now complete and she will pass about 2 miles clear down my starboard side." (OS3 CPA 20c>)

18
Cadet reports OS1.... dead ahead showing red and green
"There would have been an option available for me to go hard to port to clear the vessel I'm overtaking and let everything go clear down my starboard side but as it is at the moment I'm going nicely pass this one I'm overtaking so I have decided I am going to alter to starboard for the chap who is fine. Obviously once I go to starboard if things don't happen in the next couple of minutes, I'm going to have to go to starboard and starboard again. The third chaps moving quite fast so there is going to be a line of one and then 2 vessels."

19
Cadet reports OS2.... 1 point to starboard showing green

20
"My option of going to port has obviously gone now as I'm in a head on situation whereas previously before I saw

him I could have taken an early and substantial alteration, but that situation has totally gone now."

21
"Under the vessel ahead regulation, vessels meeting in an end - on situation, if when I initially saw him and it hadn't been both sidelights I would still have been OK to have taken action to port, but with it being both sidelights, its definitely a head-on situation."

22
"As far as the navigatings gone, the Scarweather Light Float has come nicely down the the Index line. Don't think I can last much longer, the chap is now 4 miles ahead of me and I'm going to come round to starboard."
Alters course to starboard
OS1 281 x 3.7m
OS2 291 x 4.5m
OS3 296 x 6.0m
OS4 212 x 1.2m

23
"Have checked and double checked for water around the Scarweather Light buoy but if I stay to the south of him,I've got plenty of water so draft is not a consideration.I can now see that third vessel ahead (OS3)."
Cadet reports OS3.... fine to port showing green
Crosses ahead of OS1 at 3.1m
Cadet reports OS1.... showing red and green

24
Settles on 315
"So that's the chap I initially altered for. He's nicely now showing us his right sidelight. With us making a broad alteration of course it will become readily apparent the situation is one that can resolve all three hopefully. It will become a case of monitoring all three. Am checking nothing goes wrong."

24
"If there had been a little more searoom between the first and second one I would maybe have thought of just clearing him and come back to port and then letting the second chap pass down my starboard side, but there's not that much searoom so am not going to play Dan Dare."

26
"From the fresh plot, the one that is nearest to my port bow (OS3) is nigh on in a collision situation with us, so will have to monitor that one very very closely. The one that I originally altered for is nicely moving away beyond 4 points. Have lost him on the screen."

27
I would be anticipating that that chap fine to port would be taking some action now, but he doesn't seem to be very keen to do anything."

29
Cadet reports OS2.... showing red and green
Crosses ahead of OS2 at 16c.

30
"I've been forced into a situation now when I'm going to make a broad alteration of course to starboard. The chap fine on my port bow (OS2) didn't come round, 2.5 miles less than 2.5 miles off."
Alters course to starboard
OS2  270 x 1.1m
OS3  192 x 1.1m
"I would probably have sounded the "in doubt" signal, 5 short and rapid blasts. Have now got a vessel to the north of the Scarweather Buoy and am starting to monitor him ( incorrect -  target was another buoy )

32
Settles on to 010
"Ive come round a shade too far there and put the Scarweather Buoy on the wrong bow, will put it back on the starboard bow."

33
Settles on to 005

34
"Have just checked the chart and that target that came up is actually a buoy. Can see him visually now flashing 2, 2.5 points."

34
"The aspect is just starting to change on this chap (OS3). I've got a mile and a half to run to the Scarweather then I'm going to come round to port."
Cadet reports OS3.... showing red and green
Crosses ahead of OS3 at 11c

34 Alters course to port
Scarweather Light 005 x 1.3m
OS3 266 x 9c
CPA OS2 11c<
CPA OS3 6c<

35
Asks Cadet if he still has a port aspect on that vessel on the port beam. Cadet confirms.

35
"I'm just going to come round to join up with the original course line - 260 - that should join up with the course line further on."

36
Settles on to 260
"Well, with the speed reductions in the turns I was making the chap that was originally a couple of points forward of my beam, so am going to start a fresh plot on him and see how this resolves with him."

Comment afterwards:
"Very realistic, that was."

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SUBJECT M15 - EXERCISE CW10

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

00
"Am starting a plot on the ship I'm overtaking and a plot on the Scarweather Light vessel to check on the current."

01
"Checking on the 24 mile range for any distant targets - one located on the 24 mile range, plotting him on the aft radar."
Detected OS2 at 13.7m

02
OS1 out of hide

03
Cadet reports Scarweather Light visible, bearing 305
"Cadet's bearing of the Scarweather light agrees with the radar."

04
"Now picking up 2 targets on the 24 mile range at 12.6 miles (OS2 & OS1) fine to starboard. Just starting to appear on the forward radar. Will start plotting them on the forward radar as soon as they become clear."

05
OS3 out of hide.

06
"Now plotting the 2 targets fine to starboard on the 12 mile range. Maintaining a plot on the Scarweather Light and the vessel being overtaken."

07
Asks Cadet for a bearing of the Scarweather Light, West Nash Point and West Nash Buoy.

08
Plots position on the chart.

09
"From my plot so far I can see my 2 targets to starboard are coming down fairly parallel and a third target appearing also on a parallel course, which if I alter my course to starboard will make me pass close to the Scarweather Light vessel. My port side is fairly clear apart from the vessel I'm overtaking so under this circumstance will turn to port and go under the stern of the vessel I'm overtaking, coming round to a course of 220."

Alters course to port
OS1   280 x 9.6m
OS2   284 x 9.6m
OS3   287 x 11.6m
OS4   237 x 1.9m

10
"I now have the vessel being overtaken about a point on my starboard bow.The targets previously tracking down on my starboard side will now move clear. Once I'm past the stern of the vessel I'm overtaking I will bring her round to parallel her course approximately one mile off and continue to overtake her whilst maintaining plots on these other vessels coming down. Will check that my actions are satisfactory."

12
Steadies up on 220

13
"As yet no collision situation existed, but I could see one developing; that's why I took this action. Checking on the 24 mile range, I see no further targets which could cause me trouble on this course."

14
"Scarweather Light vessel and West Nash buoy continue to track parallel to my course indicating no current. All targets moving as predicted."

16
Asks Cadet for Scarweather, West Nash Buoy and Nash point light. Cadet provides bearings of first two but reports cannot see Nash point.(out of range)
"Will plot bearings and take ranges off radar."

17
Crosses stern of OS4 at 16c

18
"No change of course or speed of any detected targets. Vessel being overtaken now 1.65 miles just forward of my starboard beam. Am now bringing my course round to 250. Should bring down my passing CPA to 1 mile."
Alters course to 250
OS1   293 x 6.7m
OS2   298 x 7.3m
OS3   300 x 9.0m
OS4   029 x 1.7m
"All other targets passing well clear."

20
"Commencing new plot on new course"

21
"Checking on 24 mile range, no further targets detected."
Cadet reports OS1.... 5 points to starboard showing green

22
"I will bring the ship round to the original course 277 at 2130. This should make the overtaken vessel pass clear one mile down my starboard side. All other targets passing well clear."

23
Cadet reports OS2.... 6 points to starboard showing green.
Asks Cadet for bearings of Scarweather Light vessel and West Nash Buoy. Cadet provides the information.

25
"Slight miscalculation made in passing distance from overtaken vessel so I'm able to come round earlier than anticipated to 277."
Alters course to 277
OS1 318 x 4.0m
OS4 322 x 1.8m
"Vessel 2.2 miles south of track."

27
"Now back on the original course and will continue to plot."

28
Cadet reports OS3.... 6 points to starboard showing green.
"Checking on the 24 mile range: no further targets, all targets passing clear."

29
"Vessel being overtaken now 1.5 miles down my starboard side."

30
Asks Cadet for bearing of Scarweather Light vessel.

31
CPA OS1 26c >

32
""Will try to regain course in one hour, therefore will steer 286. This will reduce my passing distance on the overtaken vessel down to about 1.2 miles. Now coming over to 286. All east bound targets passing well clear."
Alters course to 286
OS4 340 x 1.6m

33
CPA OS2 36c >

34
"Starting new plot on this course"
Intended CPA OS4 13c >
Intended CPA OS3 42c >

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SUBJECT M16 - EXERCISE OW11

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

00
"Initial setup - I've got one radar on 12 miles which I shall plot on and the other one I've got on 24 for long range warning of what's coming down."

01
OS2 out of hide

04
"I'm initially running a 3 minute plot on the ship I'm overtaking to give me an idea of his actual aspect, course and speed."

05
"I've got a ship come up on the big screen bearing about 066 at 13.8 miles. I've put the bearing marker and the range ring on him so I shall get an initial idea of his track - or his relative track before he comes on to the 12 mile screen when I start plotting him properly."
Detects OS2 at 13.8m
OS4 out of hide

06
"I've got a target come up bearing about 089, virtually at the edge of the screen at 12 miles."
Detects OS4 at 12.1m

06
"The guy whom I'm overtaking would appear to be steering about 113 at around 10 knots" (100 x 11.25k).

07
"I've got my first visitor coming on the 12 mile screen now, bearing about 066. Looks like he's more or less on a steady bearing."

11
"Initially, without completing a plot it would appear that the vessel fine to starboard is coming down towards me on a more or less reciprocal course"

13
"Drawing in the relative motion line for the ship ahead, he looks as if he is opening to starboard; that's over a 6 minute plotting interval that would give him a CPA of about 2 miles . The one to port still bearing 066 is still on a steady bearing."

15
"Completing a 6 minute plot on my visitor to port he would appear to be running a course of 225 at a similar sort of speed. (213 x 11.5k) Now its up to him to keep out of my way, but I've got to keep out of.... I've got to avoid the ship I'm overtaking. If I go to starboard then I'm going to land myself in trouble with the guy who is coming down from starboard so in this instance, since it is still good and early for the bloke who is still about 9 miles away to port, I'm going to bring her round in a bold alteration to port to about 045 to clear well behind the stern of the vessel I'm overtaking and at the same time to make it an early and bold alteration so as not to embarrass the ship to port who is in fact the give way vessel to me."
Alters course to 045
OS1 056 x 1.8m
Os2 066 x 8.7m
OS3 254 x 6.1m
OS4 093 x 7.8m

18
Settles on to 045.
"Steadies on the new course now, more or less so I'll start a new plot on each of my three targets and see what they do."

22
"Using the long range radar, I'm killing the heading marker to make sure there is nothing popping up under that. Initial assessment; the action seem to be quite satisfactory. We are passing about a mile and a half astern of the vessel we are overtaking. The other... the other to starboard the one that was ahead looks like she may have altered course - maybe its just my eyes."

23
Crosses the stern of OS1 at 16c
Cadet reports OS4.... 5.5 points to starboard showing green.
"Ship just reported to starboard, at 5.5 points to starboard is the one that was ahead initially so showing green she would be no problem."

24
Cadet reports OS2.... 3 points to starboard showing green.
"That's the second ship now, visible there bearing about 80, tracking down nicely."

25
OS2 alters course to 270
"So with everything behaving itself, I think we will come back."
Cadet reports OS2.... now probably altering course and now showing red.

Asks Cadet to take a bearing of OS2 and report every 2 or 3 minutes on OS2.
"So, our friend is probably altering , so will start a new plot on him. Initial bearing 082."

27
Cadet reports OS2.... 084, definitely showing red
"Most interesting, will put this radar down to 6 miles. Will keep a closer eye on the long range radar."

29
Cadet reports OS2.... 087
"Although he is still showing red, he is obviously still opening. Drawing in a relative motion line gives him a CPA of about 1.5 miles on this course."

30
Cadet reports OS2.... now showing red and green
Crosses ahead of OS2 at 40c.

31
Cadet reports OS2.... now showing green
"Just keep an eye on him. You only need report if his aspect changes again."

32
"He appears to be steering a course of 230, 240. Going quite fast, 25 knots maybe. Should pass tracking down the line quite happily. Nothing showing under the heading marker on the big screen."

34
CPA OS4 48c >
CPA OS1 30c >
"The whole picture has jumped, but whether it has jumped sideways because I touched one of the shift knobs...."

36
"He's tracking down nicely now. He's not far short of his CPA so I shall start bringing her back easily to the base course. By the time I start moving, he should be at her CPA."
Alters course to starboard.
OS2 130 x 1.8m

39
Settles on 087
CPA OS2 14c >

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SUBJECT M17 - EXERCISE OW11

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

02
OS4 out of hide
"Target detected 088 at 13.8 miles. Commenced plotting at 2201."
Detected OS4 at 13.8m.

04
OS2 out of hide
"Another target detected 066 at 13.8 miles"
Detected OS2 at 13.8m
"Commenced 3 minute plotting."

11
"Switching the plot to 12 miles. Initial indications are that the ship to starboard ( will pass ) 1.5 miles down the starboard side. The ship bearing 066 10.6 miles CPA approximately .5 miles crossing 1.5 miles ahead."

16
"On the 12 mile plot the ship to starboard CPA 1.8 miles and the ship to port .5 miles, still crossing about 1.5 miles ahead."

17
"Making broad alteration of course to port to clear vessel being overtaken, and this should take the ship crossing from port further clear."
OS1 059 x 1.7m
OS2 066 x 8.7m
OS3 254 x 6.1m
OS4 094 x 7.7m
Sounds 2 short blasts.

18
"Action taken early to give the ship crossing from port warning of my intentions. With the alteration it should now be apparent if he is observing by radar."

19
Settles on 030.

20
"Vessel settled on new course. Resumed plotting on 12 mile range. 3 minute interval plot."

23
Crosses stern of OS1 at 17c.

24
Cadet reports OS4.... 7 points to starboard showing green

25
OS2 alters course to 270
Cadet reports OS2.... 5 points to starboard showing green

26
Cadet reports OS2.... now showing red

27
"Ship bearing 087 showing a red light - 5.5 miles."
Cadet reports OS2.... now showing red and green.
Crosses ahead of OS2 at 5.5m
"Ship bearing 090 5.2 miles now showing red and green.
Will maintain my course until well clear of that ship and clear of the overtaken vessel."

29
Cadet reports OS2.... now showing green
"Will resume my course keeping the ship to starboard on my starboard bow. This will give me a CPA with the overtaken vessel of just over one mile."
Alters course to starboard
OS1 136 x 3.2m
OS2 097 x 4.4m
OS3 137 x 5.5m

30
"Coming round to 087. My green light should still be open to the ship bearing 093. He should not be able to see my red light and will then be aware I will be passing clear."

32
"Ship to starboard now observed visually from the bridge.
Starboard side light open. Masthead lights clearly separated. No risk of collision."
Steadies up on 070

35
CPA OS4 5.3m >
"On present course CPA of ship bearing 112 is 1.7 miles (OS2). No other targets detected ahead on radar at 24 miles. When vessel to starboard is abeam, will alter course to 087."

36
"Overtaken vessel well clear, bearing drawing aft."

38
CPA 052 17c >

39
"Reciprocal vessel now abeam. Am altering course to 097 to bring her back on to the course line. Vessel being overtaken well clear. Will resume plotting when on next course."

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SUBJECT M18 - EXERCISE OW12

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

03
"Third target detected now, about a point to port."

05
"Another target half a point to starboard, just starting to plot. (OS1)"

06
"Starting to plot now the one on the starboard side (OS1)"

13
Cadet reports OS3.... 1 point to port showing red.
"Closest one on the port side has come up. He is showing a red light and is passing clear (OS3). The second one out to port seems to be on a steady bearing or perhaps opening slowly (OS2). The one out to starboard appears to be opening satisfactorily at the moment and passing clear (OS1)."

16
Cadet reports OS1.... 1 point to starboard showing green.

17
"Both the ones under 6 miles seem to be passing clear."
Cadet reports OS2.... 2 points to port showing green.

20
"I have two ships passing clear. A third one 4.5 miles away on a steady bearing showing a green light. At this stage I will stand on and see how it goes."

25
"Well, he's now down to under 2.5 miles (OS2) and doesn't seem to be taking any evasive action. There is enough room to starboard to give him a little more room to make him open a bit more so am going to bring her round to 335.
Alters course to starboard
OS1 011 x 1.6m
OS2 283 x 2.0m
OS3 226 x 1.6m
OS4 114 x 8.5m

CPA OS3 16c <

26
Settles on 335
"Well have actually steadied up on the new course now, so will begin a new plot. The other two still seem to be opening nicely. He seems to have changed his aspect and is beginning to open now (OS2)."

28
Cadet reports OS2.... 6 points to port showing red and green.
Crosses ahead of OS2 at 11c

29
Cadet reports OS2.... 7 points to port showing red.
"Well under me now and passing clear. Think I shall come back a bit at a time."
Alters course to port slowly
OS2  253 x 9c

30
Steadies up on 305
CPA OS2 6c  <

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SUBJECT M19 - EXERCISE OW12

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

02
"Doing a relative plot on the ship 4 points to starboard (OS4). CPA 1.3 miles and clear."

03
"Doing a relative plot on the ship fine to port at 11 miles (OS3)."
"Target bearing 300 x 10.5 miles (OS3)."

04
"Target detected at 290 12 miles. Plotting relative now (OS2). Target detected fine to starboard 310 at 12 miles (OS1). Target fine to starboard at 299 by 9.6 (Think he meant fine to port - OS1).

10
"Target 298 at 7.9 miles coming down approximately 10 knots speed, reciprocal course almost." (OS3 128 x 10k - correct).

11
"Target 298 7.5 miles CPA 1 mile" (OS3 CPA 16c)

12
"Target 289 distance 8.1 miles, steady bearing. Risk of collision." (OS2 - correct)

14
"All ships coming down apparently nearly reciprocal courses - converging courses."

15
Cadet reports OS3.... 1 point to port showing red.
Asks Cadet for bearing - 292.

16
Cadet reports OS1.... 1 point to starboard showing green.

17
Cadet reports OS2.... 2 points to port showing green
"Please give me a visual bearing" .... 287

18
Asks Cadet to give ship to port 5 or more flashes on the Aldis -
Cadet asks .. which one ?
"Both of them, please"
OS2 287 x 5.1m

19
"The other ship doesn't appear to be giving way on the port bow so I'm going to go hard a starboard."
1 short blast.
Alters course to starboard.
OS1 324 x 4.1m
OS2 286 x 4.7m
OS3 283 x 3.8m
OS4 110 x 5.9m
"Coming round to 090 off my course line to cross ahead of the vessel on my starboard bow - that was on my starboard bow and avoid collision with the vessel coming down from port bearing 290 at 4.6 miles."

21
Steadies up on 040
"Come round to 040"

22
"Am plotting again 6 miles."

23
Asks Cadet for bearing of OS1.... 320
"The 2 targets on the port quarter seem to be dropping astern nicely now. One just forward of the port beam seems to be dropping astern."
26
"Ship now on the port beam going to pass 9.5 cables astern. The 2 targets on the port quarter will be passing 3.5 miles clear."

28
Cadet reports OS1.... showing red and green
Crosses ahead of OS1 at 14 cables
29
Cadet reports OS1.... showing red

30
"Coming back to regain the course line now. Ships now well on the quarter."
Alters course to port
OS1 262 x 1.0m

31
CPA OS1 10c <

34
Steadies up on 301.

-------------

SUBJECT M20 - EXERCISE CW10

The figures at the start of each paragraph are the number of minutes from the start of the exercise. Verbal protocols from the subject are given between inverted commas.

02
OS1 out of hide

03
Cadet reports Scarweather Light visible.

05
OS3 out of hide.

07
"Have picked up 2 targets, fine on the starboard side about 12 miles away (OS1 & OS2 at 11.3 and 11.2 miles away). Am radar reflection plotting them at the moment to see what they are doing."

17
Calls Cadet and advises him he should be seeing a ship fine on the starboard bow and to report what light he sees.

18
Cadet reports OS1.... very fine to starboard showing red and green.
"Am going to make an alteration of 30 degrees to starboard for this ship that is ahead of me showing red and green lights. That should help me clear the 2 ships also to starboard, rather than go to port which will mean contravening the the head on rule and clearing the overtaken vessel, so I am altering course to 315 now."
Alters course to 315
OS1 279 x 5.3m
OS2 287 x 5.8m
OS3 292 x 7.4m
OS4 217 x 1.5m

19
Cadet reports OS2.... 1 point to port showing green.

20
Cadet reports OS1.... now showing red.
Steadies up on 315.

22
Cadet reports OS3.... 2 points to port showing green.

23
Asks for bearing of OS3....291.

24

"Well that manoeuvre has allowed the first two ships to appear to be passing clear. The ship bearing 291 (OS3) appears to be on a steady bearing. I shall stand on and see what she does for the time being. I expect her to alter course for me."

Cadet reports OS2.... 2 points to port showing red and green.

Crosses ahead of OS2 at 35c.

25

Cadet reports OS2.... showing red.

Asks for bearing .... 277.

28

CPA OS1 16c <

30

"This ship about 2.5 miles on my port bow (OS3), I'm going to come round to starboard for him. I'm going to come round to 340 to open up. He's going to pass me about 3 or 4 cables so am going to come to starboard for him."

Alters course to starboard.

OS3 281 x 2.0m

Cadet reports OS3.... showing red and green.

Crosses ahead of OS3 at 18c.

Asks for bearing....279.

31

"Well am now across that ship's bows now so will stand on this course a little longer before coming back to port.

32

Steadies up on 340

Cadet reports OS3.... now showing red.

33

"So am now going to start to bring her slowly back to port now to clear the light vessel and bring her back on course."

CPA OS2 12c <

36

CPA OS3 8c <

"So am coming round to 270 and back to the original course."

Alters course back to 270.

Scarweather Lt. brg. 060 x 8c.

---------

# APPENDIX D - EXERCISE DEBRIEFS

SUBJECT M7

Exercise details

| | |
|---|---|
| 06 | OS3 out of hide |
| 12 | OS2 out of hide |
| 13 | OS1 out of hide |
| 26 | Cadet reports OS1 showing green |
| 27 | Cadet reports OS3 showing red |
| 28 | Alter course to starboard - 1 short blast |
| | OS1 351 x 4.5 |
| | OS2 346 x 6.2 |
| | OS3 032 x 5.5 |
| | OS4 233 x 2.4 |
| 29 | Cadet reports OS2 showing green |
| 30 | Steadies up on 065 |
| 34 | Crosses ahead of OS1 at 1.2 nm |
| | Crosses ahead of OS2 at 3.5 nm |
| 36 | CPA OS1 4c |
| 38 | Alters course back to port - 2 short blasts |
| | OS2 288 x 2.5 |
| | OS3 310 x 2.1 |
| | OS4 221 x 4.4 |
| 39 | CPA OS3 20c |
| 41 | Steadies up on 000 |
| 42 | CPA OS2 11c. |

-------------

DEBRIEF

JH
Please tell me what you did on the bridge of the ship from the time of taking over the watch.

M7
"First I started plotting that ship we were overtaking to make sure it did not alter course to starboard and this is on the reflection plotter. I picked up the first ship on the starboard side , about 4 points (OS3) at 14.2 miles on the radar and on that I put the bearing cursor to check and also the range marker.I started plotting that once it got to 12 miles, it was still steady on the bearing cursor on the reflection plotter. I picked up the first ship on the port bow at 14.5 miles (OS1) and also the second one at 14.5 miles a minute or so later (OS2) and again I plotted - put the bearing cursor on the first one and could see that was passing down fine on my starboard side. On that one which was also fast I started plotting on the reflection plotter. The second ship (OS2) which was the slower ship I put a matchstick on and continued moving the matchstick down. Once it was reported the other ship was clear I had already drawn a

line down on that one after 3 plots and it was still tracking down along the the line along the relative line I had drawn, so that was fine. I plotted 3 times on both the other ships (OS1 and OS2) and they proceeded down their lines. The faster ship (OS1) was the one on the port bow, fine on my port bow and he was sighted first. I waited until both ships, the one on the starboard side which was on a collision course (OS3) on a very steady bearing. Once it was reported he was clear, I altered course broad to starboard to cross ahead of the ship coming down to port and also to go well astern of the other ship (OS3). The action was a lot more, say about 20 degrees more because of the ship down to port. At that time he was about 2.5 miles off when I altered. He had made no change or anything like that in his bearing or in his course at all to give me greater confidence.

JH
Thank you, can you tell me how you did the plotting.

M7
I did it on the reflection plotter. I used 3 for the first one every 6 minutes (OS1). For the one on the starboard side (OS3) and also on the port bow I used 4 at every 3 minutes.

JH
And then what did you do ? Join the lines up?

M7
Join the relative lines between them

JH
And then produced it?

M7
Yes produced them.

JH
Did you make any attempt to work out course and speed ?

M7
No, I didn't make any attempt to work out the courses and speeds.

JH
Anything else you would like to say about the exercises ? In retrospect, would you have done anything differently ?

M7
I would probably altered course to starboard a lot earlier.

JH
What held you back this time?

M7
The only thing that would have held me back. If I had been at sea, I would have altered course to starboard a lot earlier once I had ascertained that the one was on a collision course and got the others when they were at 10 - 12 miles - long before I saw them to get out of the way, even though this would probably mean I was a lot further off the course line.

JH
Is that because the speed of the ship took you unawares ?

M7
The speed of the second ship (OS1) to come up . Yes, that was a lot faster but I would probably as I say when the earlier one was probably about the same distance about 10 miles away , I would have altered course, maybe not as much, maybe 40 degrees.

JH
Right, and did you believe any of the other ships should have taken any action?

M7
I would have felt the one on the port bow the fast one (OS1) should have taken action.

JH
And what should she have done ?

M7
She should have altered course to starboard.

JH
Anything you want to say ?

M7
No, (laughs), I quite enjoyed it.

------------------

SUBJECT M8

Exercise Details

06 OS3 out of hide
12 OS2 out of hide
13 OS1 out of hide
26 Cadet reports OS1 showing green
27 Alters course to starboard
OS1 359 x 5.4
OS2 358 x 6.9
OS3 045 x 6.1
OS4 250 x 2.2
28 Cadet reports OS3 showing red
29 Steadies up on 070
Cadet reports OS2 showing green
OOW asks Cadet to advise when OS1 showing red.
32 Alters course to starboard
OS1 280 x 2.3
OS2 280 x 4.7
OS3 318 x 3.8
OS4 178 x 3.3
Steadies up on 098
33 Crosses ahead of OS1 at 20c
Cadet reports OS1 showing red and green
34 Crosses ahead of OS2 at 42 c
38 CPA OS1 9c
CPA OS3 32c
39 Alters course back to port
43 Steadies up on 060
44 Alters course back to port
45 CPA OS2 26c
46 Alters course to 000

-----------

DEBRIEF

JH
Please tell me what you did on the bridge of the ship from the time of taking over.

M8
The first ship I saw was that ship I was overtaking. He was passing well clear, his CPA was going to be approximately 2 miles. As he was drawing abeam, I detected a ship at 12 miles or at the limit of the screen (OS3). So I informed the lookout to keep an eye on him and let me know when he saw him. And I started putting a plot on the reflection plotter. I plotted for 24 minutes, I think it was, and after I had started the plot, I think, after 10 minutes into the plot two other ships appeared at the limit of the screen, so I put a mark on those (OS1 & OS2). I didn't tell the lookout they were there. It looked as though from the plot the chap was

crossing on my starboard side but I wasn't sure whether I was overtaking or not. I did an OWA triangle and found it was a mute point whether I was overtaking or not, so I assumed I was overtaking. At the same time 2 ships were coming down from the north very rapidly on my port bow and it was just as I altered course or just before I altered course, I can't remember which, it was reported to me there was a green light; they were showing green lights. I realised that an alteration of course to starboard would involve me crossing ahead of these two chaps coming down from the north, but I felt an alteration of course to port might scare the ship I was overtaking causing him to do something drastic which I wouldn't have wanted. It also might have put me in a close quarters situation with him which I wanted to avoid, so I made a bold alteration of course to starboard, some 60 degrees which put me easily clear of the fellow which was bearing 060 on my starboard bow. However, I began to monitor the progress of the two vessels coming down from the north very closely and I asked the lookout to advise me when he could see the red light which would have been the moment I began to cross ahead of those two ships (OS1 & OS2). The lookout reported he could see all 3 ships showing a red light. At that point I began to consider coming back round to port. At 2300 I put a fix on the chart and seeing that I was some 2 miles off the course line and had progressed off to the east. Bearing in mind I might be in trouble with traffic leaving the separation scheme to the north, I might come into conflict with them, I bought her round as soon as possible, keeping the 2 ships travelling from the north, or keeping the ship that had moved across my bow (OS3) and the slower ship coming from the north (OS2) 2 miles distance - just over 2 miles distance. The faster ship coming from the north (OS1), I let to within just over 1 mile.

JH
Thank you, can you tell me how you did the plotting ?

M8
I had put some on here, but with my alterations of course, they began to get confused.

JH
Did you have CPA's for those 2 at the top ?

M8
At which stage ?

JH
When they appeared on the radar, what did you actually do?

MB

When they appeared on the radar, I put markers down, but they were - I altered at about 6 miles and they were nearly steady. I found a lot of beam width distortion on the radar and using the centre of the echo as best I could, I put a plot on.

JH

Do you feel any of the other ships should have taken any action ?

MB

The fellow that was initially bearing 060 he would have seen the 2 ships coming down from the north and he might have been able to determine that I could have been in an embarrassing situation with not being able to move over to port so he might have gone to starboard. The fellow being overtaken, I wouldn't have wanted him to do anything whilst I was in the immediate vicinity.

JH

Anything you would like to say ?

MB

The beam width distortion on the radars was quite large or larger than I had noticed before. I didn't give any sound signals as I didn't let anyone get within hearing distance.

---------------------

SUBJECT M9

Exercise details

| | |
|---|---|
| 06 | OS3 out of hide |
| 12 | OS2 out of hide |
| 13 | OS1 out of hide |
| 26 | Cadet reports OS1 showing green |
| 27 | Cadet reports OS3 showing red |
| 28 | Alter course to starboard |
| | OS1 000 x 4.8 |
| | OS2 358 x 6.5 |
| | OS3 045 x 5.7 |
| | OS4 249 x 2.3 |
| 29 | Steadies up on 075 |
| | Cadet reports OS2 showing green |
| 36 | Crosses ahead of OS1 at 11c |
| | Crosses ahead of OS2 at 37c |
| 38 | CPA OS1 4c |
| | Alters course back to port |
| 39 | CPA OS3 26c |
| | Steadies up on 010 |
| 40 | CPA OS2 13c. |

-----------

DEBRIEF

JH
Please tell me what you did on the bridge of the ship from the time of taking over the watch.

M9
To start off with, I had one ship on my port side going the same way, so I plotted him to make sure he was going past and clear. Then there was another ship coming in from the starboard side about 4 points.

JH
When did you detect him ?

M9
Right on the edge of the radar. I thought to myself switch the radar up. I switched the radar up and he vanished. So I thought there was no point in switching the radar up, I'll just keep it on the 12 miles. The next time I plotted him there were 2 ships coming up fine to port (OS1 & OS2 ) almost on the one echo. I plotted them as they came down. The ship to starboard was on a steady bearing, a collision bearing. The two ships on the port bow, one of them I estimated the CPA of, I mile to starboard and the other one it was so close, I said to myself, it was a collision bearing as well. First thought in my head go to port, then I thought about the chap on my port bow, port beam. I thought to myself, go to port for the chap coming down (OS1), because he was going

quite a considerable speed.I thought let him go past, then I'll come round to starboard for the other chap (OS3) then cross ahead of the one coming down (OS2).Then I decided against that and at about 5.5 miles from the chap coming down I put her hard over to starboard, brought her round to 075 and went across both their bows (OS1 & OS2) and round the stern of the ship crossing over (OS3). I thought to myself, he is on a collision course with me and the second ship coming down he was going to pass quite close to him as well so I thought that I don't know what he is going to do so I just decided to keep out of the way of the whole lot.

JH
Would you have done anything different in retrospect ?

M9
I would have altered earlier.

JH
Without seeing the lights ?

M9
Without seeing the lights. When I say earlier, I mean about 6 miles when the Cadet reported them. In good visibility, you must see the lights first, there is no point in altering earlier. You can almost say its scanty information in good visibility.

JH
What sort of plotting did you do ?

M9
Every 3 minutes on the radar screen.

JH
What did you do with the plotting ?

M9
Time, worked out a CPA for each ship.

JH
And time to CPA ?

M9
Just roughly.

JH
Did you construct any triangles of velocities ?

M9
Did it in my head

JH
Can you remember the answers you came up with ?

M9

Speed wise for the other ship - No I didn't do that. I just did that to get a rough idea.

JH

Just an approximate idea of course ?

M9

Yes, I relied on my sight and the aspect of each ship.

JH

Anything you would like to add to that ?

M9

Not really.

------------

SUBJECT M10

Exercise details

| | |
|---|---|
| 06 | OS3 out of hide |
| 12 | OS2 out of hide |
| 13 | OS1 out of hide |
| 26 | Cadet reports OS1 showing green |
| 27 | Cadet reports OS3 showing red |
| | Cadet reports OS2 showing green |
| 35 | CPA OS1 8c |
| 36 | Alters course to port |
| | OS2 024 x 2.0 |
| | OS3 057 x 2.4 |
| | OS4 246 x 3.0 |
| 38 | Steadies up on 325 |
| | CPA OS2 14c |
| 46 | Crosses ahead of OS3 at 9c |
| 48 | Alters course back to starboard. |
| 49 | CPA OS3 7c |

-------------

DEBRIEF

JH
Please tell me what you did on the bridge of the ship from the time of taking over the watch.

M10
OK, I took over the watch as the Master. What was showing on the radar was one echo on the port side which we were overtaking, that gave me a projected CPA of 2 miles. Looking further up then, later on shortly after that another echo appeared on the screen distant 12 miles. I tried checking on 24 miles on the after radar, that didn't seem to work, so I just stayed on the forward radar checking ahead on that one. That appeared at 12 miles. I started plotting there. It gave me a vessel that from my plot looked as if it was either crossing or I was just about overtaking it (OS3). And with a collision in x amount of minutes - 3 to 4 lots of 6 minutes - worked it out as it was my intention then to wait and see what the lights were, visibility being about 6 miles.

JH
Had you seen any other ships by this time ?

M10
No other echoes on the radar at this stage. It was my intention to actually see the lights, visibility was 6 miles, quite a fair distance, see the lights then if this vessel that was crossing , alter course to starboard and pass clear round her stern. In the meantime two other vessels appeared fine on the port side on the radar screen again. One , the outboard one of the two, the one more to port was travelling faster than the inboard one. I started systematically plotting these. It appeared that whilst the inboard one should cross ahead of me at 4 miles or so (correct) and the other should cross ahead at 5 miles, both with CPA's of a mile or so. However this then precluded my alteration of course to starboard at this stage otherwise I should have found myself altering right across the other two vessels. I did think at one stage of waiting until one vessel went past and then altering to starboard, however the proximity I should have got myself into with the second approaching vessel would again have been too close. So I felt that it was my best duty to alter course to port. I was the give way vessel in terms of the vessel on the collision course and whilst the rules state that you should so far as possible avoid altering course to cross ahead of another vessel, I felt that in this case crossing ahead would probably be a better course of action than crossing ahead of the oncoming vessel.I then altered course when the vessels were 3 miles, a little over 3 miles. I altered course to port 45 on to a course of 325 which by my plot would have let me cross ahead unfortunately of the other vessel (OS3) by about 1.5 miles. This was so, I monitored this on the way through. Once we were well clear, well past and clear of the other vessel, I checked my position on the chart and resumed a course that would take me to the alter course.

JH
Fine, thank you, will you tell me what sort of plotting you did.

M10
Yes, one cross when they appeared on the screen and time noted. I tried to keep crosses at similar times and then 3 minute plots after that.I had marked off on my Decca ruler my 6 minute vector which gave me a rough but quick estimate of his course and speed.

JH
Did you assess course and speed?

M10
I assessed course and speed.

JH
Of which ships ?

M10
Of the crossing vessel from the starboard side. Not the oncoming vessels.

JH
Can you remember what you made it ?

M10
315 x 12 knots

JH
In retrospect, is there anything you would do differently?

M10
In retrospect, once I had determined risk of collision existed with the crossing vessel coming on my starboard side, I wouldn't have waited until I saw his lights. I would have made a broad alteration of course to starboard there and then to pass clear of his stern. This would then have enabled me to cross well ahead of the 2 oncoming vessels. They would pass then well clear of my stern. I think that would have been the better course of action.

## APPENDIX E - EXERCISE DATA FORM

EXERCISE NUMBER CW10 EXERCISE NAME: BRISTOL CH.

CHART L(D1) 1165 MAX. DURATION: 1.5 HOURS

INITIAL POSITION: LAT. 51 22.6' LONG. 03 45.4'W

DECCA: 1B GREEN D 31.2 PURPLE B 54.4

COURSE: 277 (T) SPEED: 15 KNOTS

SHIP TYPE: GENERAL CARGO SHIP

DISPLACEMENT: 17960 TONNES

SCREWS: SINGLE BOW THRUST: NIL

DRAUGHT (F) 7m80 (A) 7m80

BOW TO BRIDGE 57m

BRIDGE TO STERN 87m

STOPPING & TURNING DATA SUPPLIED

DATE 4 FEBRUARY 1986 TIME 2100z

TIDAL DATA: INITIALLY AS DIAMOND 'J'

VISIBILITY THROUGHOUT EXERCISE: 6nms

WEATHER FORECAST: FINE AND CLEAR. WINDS ENE FORCE 2.

NAVWARNINGS IN FORCE: NIL

NAVIGATION EQUIPMENT AVAILABLE:

RADARS (No.) TWO: ONE TM/RM; ONE RM

DECCA NAVIGATOR MK. 21

EQUIPMENT MALFUNCTIONS: NIL

VHF COMMUNICATIONS: CHANNEL 16

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| | | | | | |
|---|---|---|---|---|---|
| EXERCISE NUMBER | OW11 | | | | |
| MAX. DURATION: | 1 HOUR | | | | |
| INITIAL POSITION: | NORTH WEST EUROPE | | | | |
| | COURSE: | 087 (T) | SPEED: | 15 KNOTS | |
| SHIP TYPE: | GENERAL CARGO SHIP | | | | |
| | DISPLACEMENT: | 17960 TONNES | | | |
| | SCREWS: | SINGLE | BOW THRUST: | NIL | |
| | DRAUGHT (F) | 7m80 | (A) | 7m80 | |
| | BOW TO BRIDGE | 57m | | | |
| | BRIDGE TO STERN | 87m | | | |
| | STOPPING & TURNING DATA SUPPLIED | | | | |

DATE SEPTEMBER 1986 TIME 2200bst

TIDAL DATA: NO TIDAL OR CURRENT INFLUENCES

VISIBILITY THROUGHOUT EXERCISE: 6nms

WEATHER FORECAST: FINE AND CLEAR. WINDS SW FORCE 1.

NAVWARNINGS IN FORCE: NIL

NAVIGATION EQUIPMENT AVAILABLE:

RADARS (No.) TWO: ONE TM/RM; ONE RM

DECCA NAVIGATOR MK. 21

EQUIPMENT MALFUNCTIONS: NIL

VHF COMMUNICATIONS: CHANNEL 16

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EXERCISE NUMBER OW12

MAX. DURATION: 1 HOUR

INITIAL POSITION: NORTH WEST EUROPE

COURSE: 305 (T) SPEED: 15 KNOTS

SHIP TYPE: GENERAL CARGO SHIP

DISPLACEMENT: 17960 TONNES

SCREWS: SINGLE BOW THRUST: NIL

DRAUGHT (F) 7m80 (A) 7m80

BOW TO BRIDGE 57m

BRIDGE TO STERN 87m

STOPPING & TURNING DATA SUPPLIED

DATE SEPTEMBER 1986 TIME 2300 bst

TIDAL DATA: NO TIDAL OR CURRENT INFLUENCES

VISIBILITY THROUGHOUT EXERCISE: 6nms

WEATHER FORECAST: FINE AND CLEAR. WINDS SW FORCE 1.

NAVWARNINGS IN FORCE: NIL

NAVIGATION EQUIPMENT AVAILABLE:

RADARS (No.) TWO: ONE TM/RM; ONE RM

DECCA NAVIGATOR MK. 21

EQUIPMENT MALFUNCTIONS: NIL

## APPENDIX F - SCENARIO AND OBJECTIVES

**EXERCISE CW10**

SCENARIO

The general cargo ship 'Morlone' has left Avonmouth en-route for Liverpool. You, the Master have taken over the 8 - 12 watch from the Third Officer who has reported sick. You are the sole watchkeeper on the bridge and the ship is being steered by autopilot. A 'Lookout' on the starboard wing of the bridge will report to you the lights of any ships or shore objects he sights.

Your initial position at 2100z 4 February 1986 is:

| | | | | |
|---|---|---|---|---|
| Scarweather L.V. | brg. | 302.5 | x | 8.0nm |
| Nash Point light | brg. | 079 | x | 7.7nm |
| West Nash by. light | brg. | 353.5 | x | 3.4nm |

| | | | |
|---|---|---|---|
| Decca Navigator position | GREEN | D | 31.2 |
| | PURPLE | B | 54.4 |

Your course is 277 <T>, Speed 15 knots - Full away.

OBJECTIVE

Navigate your ship keeping as close to the course line as possible.

------------

EXERCISE OW11

SCENARIO

The general cargo ship 'Morlone' is on a voyage in north west European waters. You, the Master have taken over the 8 - 12 watch from the Third Officer who has reported sick. You are the sole watchkeeper on the bridge and the ship is being steered by autopilot. A 'Lookout' on the starboard wing of the bridge will report to you the lights of any ships or shore objects he sights.

There is no land within 48 miles whilst you are on watch. Soundings will remain at 46 meters. Start time is 2200 bst.

Your course is 087 <T>, Speed 15 knots - Full away.

OBJECTIVE

Navigate your ship keeping as close to the 087 course line as possible.

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**EXERCISE OW12**

SCENARIO

The general cargo ship 'Morlone' is on a voyage in north west European waters. You, the Master have taken over the 8 - 12 watch from the Third Officer who has reported sick. You are the sole watchkeeper on the bridge and the ship is being steered by autopilot. A 'Lookout' on the starboard wing of the bridge will report to you the lights of any ships or shore objects he sights.

There is no land within 48 miles whilst you are on watch. Soundings will remain at 46 meters. Start time is 2300z.

Your course is 305 <T>, Speed 15 knots - Full away.

OBJECTIVE

Navigate your ship keeping as close to the 305 course line as possible.

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## APPENDIX G - SHIP DIMENSIONS AND ENGINE CHARACTERISTICS

### CARGO BULK SHIP MORLONE

#### Dimensions

| | |
|---|---|
| Length overall | 144 meters - 0.8 cables |
| Maximum beam | 21.2 meters |
| Bow to bridge | 57.4 meters - 0.3 cables |
| Bow to radar | 59.4 meters - 0.3 cables |
| Bridge to stern | 86.6 meters - 0.5 cables |
| Height of eye (Bridge) | 13.5 meters |

#### Summer Load Displacement - 17,960 tonnes

Ship on even keel and upright - no trim - no list

| | |
|---|---|
| Draught forward | 7.8 meters |
| Draught aft | 7.8 meters |
| Fresh water allowance | 0.2 meters |

Increase in draught due list/heel - 0.18 meters/degree

#### Propulsion and Steering

Engine - Steam Turbine - 7,400 SHP
Single - Semi-balanced Spade Rudder
Maximum Rudder angle - 35 degrees
Side thrusters - nil

#### Anchors and Cables

Port - 6.5 tonnes - 9 shackles of cable
Starboard - 6.5 tonnes - 11 shackles of cable

| Telegraph | Revolutions | Speed |
|---|---|---|
| Full away | 130 | 15.0 knots |
| Full ahead | 90 | 10.4 knots |
| Half ahead | 70 | 8.1 knots |
| Slow ahead | 45 | 5.2 knots |
| Dead Slow ahead | 25 | 2.9 knots |
| Dead Slow astern | 25 | |
| Slow astern | 40 | |
| Half astern | 60 | |
| Full astern | 70 | |

## APPENDIX H - EXERCISE QUESTIONNAIRE FORM

EXERCISE CW10 / OW11 / OW12

1. At what range did you detect the following ships on radar ?

   Ship 1 (relative bearing given dependent upon exercise number)

   Ship 2

   Ship 3

2. Did you carry out any type of plotting ? If so, was this to assess:

   CPA Yes / No

   Course of a ship Yes / No

   Speed of a ship Yes / No

   If "Yes" to any of the above, please record below the information you obtained:

SHIP 1

CPA

Course

Speed

SHIP 2

CPA

Course

Speed

SHIP 3

CPA

Course

Speed

3. Please describe below your reasons for your first alteration of course / speed.

4. If you altered course or speed a second or third time (but NOT including a return to the course line) please describe below your reasons for this (these) alterations of course / speed.

5. Did your first alteration of course / speed achieve your desired purpose ? Yes / No

If "No", please describe why.

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