Implications of the introduction of global maritime distress and safety system (gmdss) for Pakistan

Afzal Maqsood

World Maritime University

Follow this and additional works at: https://commons.wmu.se/all_dissertations

Recommended Citation
Maqsood, Afzal, "Implications of the introduction of global maritime distress and safety system (gmdss) for Pakistan" (1987). World Maritime University Dissertations. 1279. https://commons.wmu.se/all_dissertations/1279

This Dissertation is brought to you courtesy of Maritime Commons. Open Access items may be downloaded for non-commercial, fair use academic purposes. No items may be hosted on another server or web site without express written permission from the World Maritime University. For more information, please contact library@wmu.se.
IMPLICATIONS OF THE INTRODUCTION OF GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS) FOR PAKISTAN

by

Afzal Maqsood

Islamic Republic of Pakistan

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

MASTER OF SCIENCE DEGREE

in

MARITIME EDUCATION AND TRAINING (NAUTICAL).

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

Signature: [Signature]

Date: 01 December 1987

Supervised and assessed by:

GUNTHER ZADE

Professor
World Maritime University

Co-assessed by:

J.C. BELL

Manager, Market Development
International Maritime Satellite Organization
London, UK
Visiting Professor World Maritime University
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>vi</td>
</tr>
<tr>
<td>ABBREVIATIONS</td>
<td>vii</td>
</tr>
<tr>
<td><strong>CHAPTER I - THE GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM</strong></td>
<td>1</td>
</tr>
<tr>
<td>1.1 Introduction</td>
<td>3</td>
</tr>
<tr>
<td>1.2 The World Wide Navigational Warning Service</td>
<td>7</td>
</tr>
<tr>
<td>1.3 The Standard Marine Navigational Vocabulary</td>
<td>7</td>
</tr>
<tr>
<td>1.4 Applications of Telecommunications</td>
<td>10</td>
</tr>
<tr>
<td>1.5 Coverage Areas of Ships</td>
<td>13</td>
</tr>
<tr>
<td><strong>CHAPTER II - REASONS FOR ADOPTING THE SYSTEM</strong></td>
<td>18</td>
</tr>
<tr>
<td>2.1 General</td>
<td>19</td>
</tr>
<tr>
<td>2.2 The Introduction of Satellite Communications</td>
<td>25</td>
</tr>
<tr>
<td><strong>CHAPTER III - PLANNING THE NEW SYSTEM</strong></td>
<td>27</td>
</tr>
<tr>
<td>3.1 General</td>
<td>28</td>
</tr>
<tr>
<td>3.2 Areas of Operations</td>
<td>29</td>
</tr>
<tr>
<td>3.3 Satellite Communications</td>
<td>30</td>
</tr>
<tr>
<td>3.4 Terrestrial Communications</td>
<td>31</td>
</tr>
<tr>
<td>3.5 Functions of the System</td>
<td>33</td>
</tr>
<tr>
<td>CHAPTER IV - OPERATION AND PROCEDURES OF SEARCH AND RESCUE</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.1 General</td>
<td>41</td>
</tr>
<tr>
<td>4.2 Search and Rescue Operations</td>
<td>47</td>
</tr>
<tr>
<td>4.3 Organization</td>
<td>52</td>
</tr>
<tr>
<td>4.4 Preparatory Measures</td>
<td>54</td>
</tr>
<tr>
<td>4.5 Operating Procedures</td>
<td>55</td>
</tr>
<tr>
<td>4.6 Ship Reporting Systems</td>
<td>57</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER V - EQUIPMENT REQUIRED IN THE SYSTEM</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 General</td>
<td>62</td>
</tr>
<tr>
<td>5.2 MF/HF Equipment</td>
<td>64</td>
</tr>
<tr>
<td>5.3 VHF Equipment</td>
<td>69</td>
</tr>
<tr>
<td>5.4 Enhanced Group Call Ship Earth Station Receiver</td>
<td>71</td>
</tr>
<tr>
<td>5.5 L-Band EPIRB Satellite System</td>
<td>78</td>
</tr>
<tr>
<td>5.6 406 MHz Beacons: (ELT/EPIRB/PLB of COSPAS-SARSAT System)</td>
<td>81</td>
</tr>
<tr>
<td>5.7 Survival Craft Radar Transponder</td>
<td>84</td>
</tr>
<tr>
<td>5.8 INMARSAT Ship Earth Station (Standard-A)</td>
<td>86</td>
</tr>
<tr>
<td>5.9 INMARSAT Ship Earth Station (Standard-C)</td>
<td>88</td>
</tr>
<tr>
<td>5.10 Coast Earth Station (CES)</td>
<td>90</td>
</tr>
<tr>
<td>5.11 Local Users Terminals (LUT)</td>
<td>96</td>
</tr>
<tr>
<td>5.12 Mission Control Centre (MCC)</td>
<td>96</td>
</tr>
<tr>
<td>5.13 Rescue Co-ordination Centre</td>
<td>102</td>
</tr>
<tr>
<td>Chapter VI - The Role of the Radio Officers in Future</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>6.1 General</td>
<td>105</td>
</tr>
<tr>
<td>6.2 Satellite Communications</td>
<td>107</td>
</tr>
<tr>
<td>6.3 Maintenance Course</td>
<td>109</td>
</tr>
<tr>
<td>Chapter VII - Conclusions and Recommendations</td>
<td>114</td>
</tr>
<tr>
<td>7.1 Conclusion</td>
<td>115</td>
</tr>
<tr>
<td>7.2 Recommendations</td>
<td>117</td>
</tr>
</tbody>
</table>

Bibliography                                           | 121  |

List of Charts and Tables                              | 122  |

List of Illustrations                                  | 123  |
In preparation of this paper, I am deeply indebted to all those who provided me with the guidance, information and above all encouragement, which made it possible for me to write this paper.

I would like to express particularly my sincere thanks to:-

International Maritime Organization for awarding me the fellowship for two years Master of Science degree course in the World Maritime University.

Director General, Ministry of Communication (P & S Wing.) the Selection Committee and Commandant Pakistan Marine Academy for selecting and sponsoring me to join the World Maritime University for a period of two years extensive studies.

Captain I.M.K. Samdani Chief Nautical Surveyor, Ministry of Communication (P & S Wing.) for his valuable assistance and guidance.

Officials of the ports and shipping wing for their cordial assistance with valuable information.

Professor Günther Zade, Vice Rector & Academic Dean World Maritime University for his valuable guidance, information whilst directing and assessing this paper.

Captain J.C. Bell from INMARSAT for his constructive comments and guidance whilst co-assessing this paper.

All the distinguished resident and visiting professors for their dedicated and knowledgable lectures during the course.
My wife who have put up with the suffering of lengthy separation and her undaunted support and encouragement made it possible for me to continue my studies at the World Maritime University.

Finally, I dedicate this paper to the memory of my late father.
Pakistan is a country situated at the North West of Indian Subcontinent, having a coast line of about 870 kilometers facing the Arabian sea and the adjoining coast of Iran.

Pakistan has long been entrusted as the area coordinator of NAVAREA IX which covers the parts of the Arabian Sea, Red Sea, and Persian Gulf. In these areas all navigational warnings are broadcasted by the NAVAREA IX co-ordinator.

The Global Maritime Distress and Safety System has been planned according to the area of operations, which will also determine the equipment required for appropriate ships.

Existing medium frequency arrangements will be rationalized. A long range capability using Satellite and HF will be provided. Watchkeeping on relevant distress and safety channels will be maintained by automatic means.

Means will be provided for automatic reception for all relevant safety, meteorological and navigational warnings.

Radio-telephony, Digital Selective Calling (DSC) and Narrow Band Direct Printing (NBDP) will be used in terrestrial radio system.

Morse Radio Telegraphy will not be used in the new system.

The role of the Radio Officer will drastically be changed to a Maintenance Officer.
ABBREVIATIONS

IMO International Maritime Organization
INMARSAT International Maritime Satellite Organization
GMDSS Global Maritime Distress & Safety System
WARC World Administrative Radio Conference
ITU International Telecommunication Union
CCIR International Radio Consultative Committee
DSC Digital Selective Call System
CES Coast Earth Station
SES Ship Earth Station
EPIRB Emergency Position Indicating Radio Beacon
ICAO International Civil Aviation Organization
NAVTEX Narrow Band Direct Printing Telegraphy
NBDP Narrow Band Direct Printing
TOR Telex Over Radio
SSB Single Side Band
SAR Search and Rescue
SART Search and Rescue Transponder
LUT Local User Terminal
COSPAS-SARSAT Satellite Aided Search and Rescue System Based on Low Orbiting Polar Satellite
RCC Rescue Co-ordination Centre
RSC Rescue Sub Centre
ENEM Electronic Navigational Equipment Maintenance
COSPAS Space System for Search of Distress Vessels
SARSAT Search and Rescue Satellite Aided Tracking
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCC</td>
<td>Mission Control Centre</td>
</tr>
<tr>
<td>VHF</td>
<td>Very High Frequency (30-300 MHz)</td>
</tr>
<tr>
<td>MF</td>
<td>Medium Frequency (300-3000 KHz)</td>
</tr>
<tr>
<td>RDSS</td>
<td>Radiodetermination Satellite Service</td>
</tr>
</tbody>
</table>
CHAPTER I

THE GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM
Figure 1: General Concept of the Global System

Source: Ocean Voice, January 1987
1.1 INTRODUCTION

Despite the widespread use and proven success of the present system, there are some disadvantages with the present maritime radiocommunication which includes the following for the present system (Table 1)

CONGESTION:
The number of radio frequencies available for maritime communications is physically limited and cannot be increased. In certain instances this results in congestion which could be serious since a ship has no alternative means of communication.

RECEPTION DIFFICULTIES:
The quality of some messages can be adversely affected by changes in the ionosphere.

UNCERTAINTY OF MESSAGES BEING RECEIVED:
The successful receipt of a radio message even a distress message depends on the propagation characteristics of the frequency on which it is transmitted, the geographical location of ships and the time of day and season. In many parts of the world the density of shipping is light and the number of coastal radio stations limited. As a result it may under certain conditions be impossible for a ship in distress to alert other ships or coast radio stations, or assistance may be delayed for several hours.

The Global Maritime Distress & Safety System is designed for following reasons:

- To improve distress, urgency and safety communications.
- To relieve the present congestion in the medium frequency (MF) and high frequency (HF) bands.
- To improve reliability, quality and speed of communications.
<table>
<thead>
<tr>
<th>Equipment</th>
<th>Radiotelephone ships</th>
<th>Radiotélégraph ships</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHF emergency position-indicating radiobeacon (EPIRB) for survival craft</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>Portable radio apparatus</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>VHF radiotelephone installation</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>Main radiotelegraph installation (transmitter and receiver)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Reserve radiotelegraph installation (transmitter and receiver)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Radiotelegraph keying device and auto alarm receiver</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Direction finder (MF)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Radiotelephone installation (transmitter and receiver)</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>Radiotelephone device for generating the alarm signal</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>Radiotelephone distress frequency watch receiver</td>
<td>X</td>
<td>x</td>
</tr>
</tbody>
</table>

Source: IMO Publication No. ISBN 92-801-1216-3
To improve geographical coverage and continuous availability of services.

To provide more reliable circuits and permit automation of radioteleprinters.

To cater for services not possible at present in the MF and HF bands, such as high speed data transmission.

Recent advances in communication technology and the establishment of the INMARSAT system have been the catalyst in the planning for a future system. A reliable long range communication link continuously available will significantly improve the probability of a distress alert being received and equipment currently being developed will provide automatic alerting in the case of a sudden disaster at sea. (see Fig. 1)

To use this system to its full potential it will be necessary to introduce greater shore authority involvement in distress response, improve long range terrestrial communications, including the use of digital selective calling and to establish an international search and rescue infrastructure.

The basic concept of the GMDSS system is that shore search and rescue authorities as well as shipping in the vicinity of a distress, will be rapidly alerted to the distress and be capable of being involved in a co-ordinated rescue operations. The concept applies to all cargo ships and passenger ships on international voyages regardless of their geographical location. Additionally, the system will provide for urgency and safety communications, as well as the dissemination of navigational and meteorological information to ships.

The system will use both satellite and terrestrial communications. Satellite communications will be provided by INMARSAT. A distress capability for alerting by satellite EPIRBs will be provided by INMARSAT geostationary satellites as well as polar orbiting satellites.
EPIRBs have been in existence for a long time, the first IMO recommendation on these devices being adopted in 1963, and in some countries their carriage is mandatory.

Some EPIRBs transmit on 2182 kHz, the medium wave radiotelephone distress frequency. Others transmit on 121.5 MHz and/or 243 MHz, the aeronautical emergency frequencies, and COSPAS-SARSAT 406 MHz Beacons.

IMO has requested INMARSAT to include a satellite EPIRB service in its system and the International Telecommunication Union (ITU) and International Radio Consultative Committee (CCIR) is co-ordinating trials and will develop international performance standards for EPIRBs.

An interesting development involving satellite EPIRBs concerns the COSPAS-SARSAT trials with polar orbiting satellites in which Canada, France, Norway, the Soviet Union, the United Kingdom and the United States are participating. Polar orbiting satellites provide a worldwide coverage and can give a very accurate position of an EPIRB transmitting a signal. A number of rescues have already been reported through distress signals being received by the COSPAS-SARSAT system.

In the future system terrestrial communications will no longer use Morse Code radiotelegraphy but will employ digital selective calling (DSC), radiotelephony, and narrow band direct printing (NBDP).

The equipment to be carried on ships will be designed for simple operation and will be largely automated. The equipment required to be carried will depend on a ship's area of operation.
An important component of any distress system is the search and rescue operation and in 1979 a convention was adopted under IMO auspices (the International Convention on Maritime Search and Rescue) which is designed to co-ordinate Search and Rescue activities by establishing a global system in which radio communications will play an important part. The convention entered into force in June 1985. (See Table 2)

1.2 THE WORLD WIDE NAVIGATIONAL WARNING SERVICE:

While the rapid transmission and reception of distress messages is the most important task of radio at sea, it is essential that warnings be given to ships on matters which can effect their safety. These include the establishment and malfunction of lights, sound signals, buoys and other aids to navigation, the location of wrecks and other hazards and the establishment of offshore structures. (See Figure 2)

To ensure such information will be received by all ships likely to be affected by it, IMO and the International Hydrographic Organization (IHO) established a World Wide Navigational Warning Service. This service was adopted by the IMO assembly in 1977 and a revised system was adopted by the Assembly in 1979.

Under this system the world’s oceans are divided into sixteen areas (called NAVAREAS). The service includes arrangements for disseminating information by regular radio broadcasts.

1.3 THE STANDARD MARINE NAVIGATION VOCABULARY:

The use of communication satellites and other technical improvements has greatly improved the quality of maritime communications, but confusion can still arise because of language difficulties.
TABLE 2

BASIC SHIP CARRIAGE REQUIREMENTS FOR THE SYSTEM

<table>
<thead>
<tr>
<th>Area/Equipment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VHF radio-station capable of voice and DSC communications</td>
<td>MF radio-station capable of voice and DSC communications</td>
<td>MF/HF radio-station capable of voice, DSC and direct printing communications</td>
<td>NAVTEX receiver in areas covered by NAVTEX transmissions</td>
<td>INMARSAT ship earth station (Standard-A or Standard-C)</td>
<td>Satellite EPIRB operating on the 406 MHz frequency through the COSPAS-SARSAT*</td>
<td>VHF EPIRB</td>
<td>Survival craft</td>
<td></td>
</tr>
<tr>
<td>Area A1</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area A2</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area A3</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area A4</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pre-operational demonstrations of the L-band EPIRB satellite system operating in the 1.6 GHz through the INMARSAT geostationary segment will be conducted in 1978 and the result will be submitted to IMO for consideration with a view to prepare an equivalent provision whereby ships operating in the GMDSS system in areas A1, A2, and A3 may carry an L-band EPIRB instead of mandatory 406 MHz satellites EPIRB.

Source: IMO Publication No. ISBN 92-801-1216-3
Figure 2 Geographical areas for coordinating and promulgating radionavigational warnings with area co-ordinators noted in parenthesis.

Source: IMO Publication No. ISBN 92-801-1216-3
English is generally regarded as the international "language of the sea" but even when both parties speak the language, misunderstandings can still arise because of imprecision in its use, even by those whose mother tongue is English. On occasion this has led to serious consequences, sometimes resulting in loss of life.

In 1977 the IMO Assembly adopted a Standard Marine Navigational Vocabulary to overcome of these problems by standardizing the English terms used in communications at sea.

It is not intended that the Vocabulary be made mandatory, but rather that through constant repetition that phrases and terms used will become those normally used by seafarers for communications between and on board ships.

1.4 APPLICATIONS OF TELECOMMUNICATIONS:

Telecommunications is best known as a means of transmitting and receiving messages and signals. However, it has many applications and at sea is used to provide a variety of radio navigation aids.

The oldest is the radio direction finder (RDF) which in accordance with the SOLAS Convention has to be carried on most ships of 16,00 grt and over. The principle of RDF is simple.

The navigator takes a bearing of a number of radio signals which are being transmitted from shore based radio beacons. These are then used to determine the ship's position. Another important function of RDF is to take bearings of signals transmitted by a ship in distress.

Radar, which was first developed in the 1930s, can also be used as a means of determining position, but it is best known
as a collision avoidance aids. It is based on the fact that high frequency radio waves are reflected by objects such as land masses and other ships. The distance between the ship and the object is determined by electronically measuring the time taken for the pulsed radar signal to be reflected back by surrounding objects. This is displayed visually by means of a cathode ray tube. Signals are transmitted by means of a rotating aerial which gives the familiar 360 degree radar display on a plan position indicator (PPI) tube. Radar is required by Chapter V of the 1974 SOLAS Convention on all ships of 1,600 grt and above and by ships of 500 to 1,600 grt constructed from 1 September 1984.

Radio signals are also used in a number of electronic navigational systems such as Omega, Decca and Loran C. The Decca system was initiated commercially in 1949 and now provides coverage in many parts of the world, including Europe, Canada, parts of the Middle East, Japan, Australia, India and South Africa. Each part of the system consists of a master station and normally three "slave" stations. Position is determined by measuring the phase difference between signals from the stations and plotting them on a special chart. It can fix a position to an accuracy of within one mile up to 250 miles from the coast and is used primarily in coastal navigation.

Loran C (an improvement on the original Loran A) is available in the United States, the North Atlantic, Mediterranean, Persian Gulf, and North Pacific measuring time difference and uses a pulse coding system. Like Decca it is primarily used for coastal navigation.

Omega uses very low frequencies which make it particularly useful for long distance navigation allowing positions to be fixed with an accuracy of within about three miles on the high seas, using phase comparison.
Satellites are also being used for navigation, the best known being the Transit system which was originally developed for naval purposes but was made available to commercial shipping in the late 1960s. It employs six satellites emitting continuous signals which are received on board ships to determine their position by measurement of the Doppler shift. The GSP satellite system will be available in 1988 using one way ranging of four satellites. The system will be available continuously with coverage all over the world employing 18 satellites. (M. Jurdzinski, WMU, lecture 22.10.1987). The Radiodetermination Satellite Service (RDSS) using 2 or 3 satellites has been developed in United States and some other ITU regions providing accurate position information and short non-voice two way message transmissions (Professor J. Mulders, WMU, lecture, 19.10.1987).

The requirement of GMDSS will be for:

All cargo ships of 300 gross tonnage and over and all passenger ships engaged on an international voyage shall carry:

1. A VHF installation capable of transmitting and receiving DSC on channel 70 and radiotelephony on channels 6, 13 and 16. It shall be possible to send distress signals from the bridge.

2. Equipment capable of maintaining a continuous digital selective calling (DSC watch on VHF channel 70).

3. A radar transponder operating in the 9 GHz band. This transponder could be the same as the required for a survival craft.

4. A NAVTEX receiver if the ship operates in areas in which a NAVTEX service is provided.
5. A satellite EPIRB capable of transmitting a distress alert through the polar-orbiting satellite system operating in the 406 MHz band. The EPIRB shall float-free and be automatically activated when afloat. It must also be capable of being activated manually.

Until the full implementation of the GMDSS on 1st February 1997:

6. A radiotelephone distress frequency watch receiver operating 2182 kHz; and

7. Except for ships operating in Area A1 only, a device for generating the radiotelephone alarm signal on the frequency 1282 kHz.

1.5 COVERAGE AREAS OF SHIPS:

1.5.1 Ships Which Remain Within the Coverage of VHF Coast Stations (Area A-1, 20 to 30 Miles)

1. Instead of a satellite EPIRB, ships which remain within the coverage of VHF coast stations may carry a float-free EPIRB capable of transmitting a distress alert using DSC on VHF channel 70 and providing for location by means of a radar transponder operating in the 9 GHz band.

2. The ship's VHF installation shall be capable of using radiotelephony in the band 156 - 162.05 MHz.

3. A second radio system to initiate the transmission of ship-to-shore distress alerting signals from the bridge either operating:
a. on VHF;

b. by means of an EPIRB utilizing the polar orbiting satellite system on 406 MHz; or an EPIRB as provided in other paragraphs, mounted close to the bridge or provided with means for its remote activation;

c. on MF using DSC;

d. on HF using DSC or

e. through INMARSAT.

1.5.2 Ships Which Operate Beyond the Coverage of VHF Coast Stations But Remain Within the Coverage of MF Coast Stations Excluding Area A-1 (Area A-2 upto 100 Miles)

Ships operating in Area A2 shall carry:

1. An MF installation capable of transmitting and receiving on 2182 kHz and 2187.5 kHz using DSC and radiotelegraphy as appropriate.

2. Equipment capable of maintaining a continuous DSC watch on 2187.5 kHz.

3. The ship shall be capable of transmitting and receiving general radio communication using radiotelephony or direct printing telegraphy by either:

   a. an MF installation operating on working frequencies in the band 1605-4000 KHz, or

   b. an INMARSAT ship earth station.
4. A second radio system for ship-to-shore distress alerting operating either on HF using DSC or through INMARSAT or through COSPAS/SARSAT; or by means of an EPIRB suitably positioned or activated.

1.5.3 Ships Which Operate Beyond the Coverage of VHF and MF Coast Stations But Remain Within the Coverage of Geostationary Satellites Excluding Areas A-1, A-2 (Area A-3)

Ships which operate beyond the coverage of VHF and MF coast station but remain within the coverage of the INMARSAT system shall carry:

EITHER:

a) an INMARSAT ship earth station

b) on MF installation capable of transmitting and receiving on the frequencies 2187.5 kHz.

c) equipment capable of maintaining a continuous DSC watch on 2187.5 kHz.

d) A second radio system for distress purposes operating either on 406 MHz or on HF using DSC.

OR:

a) an MF/HF installation capable of transmitting and receiving on all distress and safety frequencies in the band 1605-4000 kHz using DSC, radiotelephony and NBDP.
b) equipment capable of maintaining DSC watch on 2187.5 kHz and at least one additional distress and safety frequency in the band 4000-27500 kHz.

c) A second radio system for distress purposes operating either on 406 MHz or through INMARSAT.

1.5.4 Ships Operating in Remaining Area Excluding Areas A-1, A-2, A-3 (Area A-4)

In addition to the requirements of paragraph 1, ships operating in all sea areas shall carry:

1. An MF/HF installation capable of transmitting and receiving on all distress and safety frequencies in the band 1605-4000 kHz and 4000-27500 kHz using DSC radiotelephony and NBDB.

2. Equipment capable of maintaining DSC watch on 2187.5 kHz, 8375 kHz and at least one additional distress and safety frequency in the band 4000-27500 kHz.

1.5.5 Survival Craft Requirements:

The carriage requirements for survival crafts radio equipment will be according to the revised provisions of 1974 SOLAS convention, and by 1991 it will be mandatory for vessels to be fitted with the following:

1. Radar transponder operating on 9 GHz frequency band.
2. Portable VHF equipment capable of transmitting and receiving distress messages on Channel 16.
CHAPTER II

REASONS FOR ADOPTING THE SYSTEM
Until the invention and development of radio signals for the transmission of messages, telecommunications between distant points relied entirely on the telegraphic system which depended on cables and wires between the points of transmission and the point of reception of the message. However, satisfactorily a system using cables and wires might have worked on land, it was singularly unhelpful for ships at sea. Thus in the telegraphic era once a ship left sight of land the ship and its crew were effectively cut off from all contact with other persons at sea and on land, except for the occasional random sighting of another ship.

It is therefore no exaggeration to say that the invention of radio by Guglielmo Marconi in 1895, and the subsequent development of the technique and technology of radio-communication through the efforts of several other scientists in other countries, created a revolution in telecommunications in general and maritime communications in particular.

The first recorded use of the new invention for saving life at sea occurred in March 1899 when the lightship on the Goodwin Sands near Dover, which was fitted with Marconi's wireless apparatus, used it to report that the steamer "Elbe" had run aground. A life-boat was sent out in response to the message and was able to arrive in time to rescue the crew.

The next incident involving the use of radio at sea occurred in Russia in January 1900. An apparatus built by Alexander Popov was used to send a message to the icebreaker "Yermak" as a result of which the ship was able to go to the rescue of some fishermen trapped on an iceflow in the Gulf of Finland.

These incidents served to demonstrate that radio was in fact
becoming a recognized international medium for telecommunication. Indeed within a few years, radio had become so well-established that there was some concern about whether its use could be effectively controlled. In particular there were fears that commercial rivalry could have a harmful impact on maritime safety and there was also much concern that the proliferation of radio would lead to severe and ultimately dangerous congestion.

The spark transmitters then in use had a very wide band-width. Two operators using these transmitters could obliterate any other messages within a radius of 100 kilometers, including distress messages.

In 1903, just two years after the first radio message across the Atlantic, a radio conference met in Berlin to consider preliminary studies for the international regulation of radio-communications. One of the main decisions made was that coast radio stations were obliged to receive and transmit telegrams originating from or destined for ships at sea, no matter from which radio system they originated.

In 1906, the first international radiotelegraph conference was held, also in Berlin, and adopted a convention modelled on the successful international Telegraph Convention of 1875. Further basic principles were established which were to be of great importance to the future of radio at sea. Contracting Parties to the convention were obliged to connect coast radio stations to the international telegraph network, to give absolute priority to all distress messages and to avoid radio interference as much as possible.

This conference laid the basis for the development of radio communications at sea. The increasing number of accidents at sea showed the importance of radio-communications in saving lives. In 1909 two ships, the "Republic" and "Volturno",
collided off the east coast of the United States. A radio distress message was picked up by a coast radio station and within 30 minutes of the accident another ship equipped with radio, the "Baltic", had arrived at the scene. All 1700 people on board the two ships were saved and what could have been a major disaster was averted.

In 1912, an even more well-known accident took place; the "Titanic" hit an iceberg and sank within a few hours. More than 1500 people died, but thanks to a distress message picked up by the liner "Carpathia" more than 700 were saved. Three months after the "Titanic" sank, another international radio conference met, this time in London. Inevitably, the disaster was on everyone's mind. Although it was decided that the installation of radio equipment on board all ships should not be made internationally obligatory, steps were taken to improve radio coverage, with some ships being required to maintain a permanent radio watch. The "Titanic" disaster may have been reduced had the "California", which was a relatively short distances from the scene, picked up the liner's distress message but her radio officer was off duty.

At the same conference the letters SOS were adopted as the international distress call (previously it had been CQD). Contrary to popular myth, the letters are not an abbreviation and have no special significance except that the familiar ……. is easy to remember and transmit in the Morse Code. (The MAYDAY distress call used in radiotelephony is a corruption of the French "mâidez" which simply means "help me").

Two years later in 1914 the first International Convention for the Safety of Life at Sea (SOLAS) was adopted. Chapter V of which dealt with radiotelegraphy. Ships carrying more than 50
passengers were required to be equipped with a radio installation having a range of at least 100 nautical miles. The convention made reference to the International Radiotelegraph Convention of 1912 and used the same classification of ships. An important regulation required larger passenger ships to maintain a continuous radio listening watch.

The convention also made it an obligation for ships receiving a distress call to go to the assistance of the ship concerned and gave the master of a ship in distress the right to requisition the services of any ships answering his call.

Although the convention was adopted in January, 1914, by the autumn of that year Europe was at war and as a result the convention did not enter into force. However, it had established a precedent which was followed by subsequent conference.

In 1929, the second SOLAS conference was held, again in London, which adopted a convention that entered into force in 1935. Although the convention followed the same pattern as the 1914 convention, it naturally took account of technical progress made in the intervening years.

The problem of providing a continuous radio watch, for example, had to some extent been solved by the development of the radio-telegraph automatic alarm and the 1929 convention allowed some exceptions regarding watchkeeping for ships fitted with such a device.

As early as 1914, some of the liner "Aquitania's" lifeboats had been fitted with radio equipment, but there was no international requirement for this. Pressure for this to be changed increased after 1923, when the "Trevesa" sank in the
Indian ocean. Although a distress message was transmitted and acknowledged, the ship sank before assistance arrived and the crew, in two lifeboats, sailed for 22 and 27 days respectively before finally reaching Mauritius. It was realized that there had been an international requirement for radio equipment to be carried in at least some of the ship's lifeboats this ordeal might have been prevented. One of the regulations of the 1929 SOLAS Convention did indeed require larger passenger ships to have some lifeboats equipped with radio equipment.

By 1948, however, the convention was becoming outdated and so a new conference was called to adopt a third version of the SOLAS Convention. Like its predecessor, it made the carriage of a radio-telegraph installation a requirement for all passenger ships and for cargo ships of 1,600 grt and above. The new convention also took into account other developments in radiocommunication, including radiotelephony and radio direction finding.

The radiotelephone originated in the early days of this century. One of the most important pioneers was the American, Lee De Forest who made a major contribution to radio electronics when he developed the triode valve. This discovery made it possible to transmit the human voice and as early as 1907 De Forest installed one of his appliances on a ferry boat on the Hudson River. Although its adoption was to be fairly gradual, radiotelephony was to prove very useful over relatively short distances and is now widely used.

Another major advance in radiocommunications came in the 1950s with the introduction of miniaturization in the form of transistors. This made it possible to use much higher frequencies than before and also helped to reduce the size of the radio installation and power consumption.
In 1959, IMO - then called the Inter-Governmental Maritime Consultative Organization (IMCO) - came into being and one of its first tasks was to update the 1948 SOLAS Convention.

The 1960 version followed the same pattern as far as radio-communications were concerned but the regulations of Chapter IV were made much more detailed than those of previous conventions. It placed the same emphasis on ensuring that equipment conformed to stringent conditions; the maintenance of adequate radio watches; the fitting of radio equipment in certain lifeboats and references were made to the Radio Regulations adopted by the International Telecommunication Union (ITU).

IMO adopted a new SOLAS convention in 1974, and Chapter IV which, as in previous versions dealt with radiotelegraphy, and radiotelephony, was further improved. In 1981 some of the regulations dealing with radiotelegraphy and radiotelephony were replaced and others amended. These amendments entered into force on 1st September 1984.

Chapter IV of the 1974 SOLAS Convention mainly deals with facilities intended for distress and safety purposes and does not specifically provide for equipment intended for public correspondence. The technical requirements of equipment intended for this purpose are covered by the Radio Regulations of the ITU.

By adapting the SOLAS Convention and adopting various recommendations, IMO has been also to keep pace with most of the developments taking place in maritime radiocommunications.
2.2 THE INTRODUCTION OF SATELLITE COMMUNICATIONS

Since 1962 when Telstar, the world's first communication satellite, was put into orbit it has been possible to transmit radio messages to a satellite which in turn re-directs them to the desired locations on earth. For the first time high quality speech and television picture can be transmitted instantly from one place on earth to another.

As early as February 1966 IMO's Maritime Safety Committee decided to study the operational requirements for a satellite communications system devoted to maritime purposes. The following year, the World Administrative Radio Conference convened by the International Telecommunication Union invited IMO to continue this work.

By 1971 IMO's studies had advanced sufficiently for the Organization to submit two recommendations to the ITU conference on space telecommunications. They specified, among other things, that maritime satellite communications could be used for the exchange of information by telephony and telegraphy, including data transmissions, direct printing and facsimile, and wide-band telegraphy.

In particular satellite communications offered great advantages in alerting and locating ships in cases of distress or emergency; issuing safety and urgency messages, and a number of other functions such as automatic reporting of ships' position, position determination, traffic guidance, automatic navigation warnings and weather routing. In addition maritime satellite communications promised to be of great use in the operation and administration of ships.

In 1971 IMO decided that it should, in full co-operation with the ITU, start active preparation for the establishment and
operation of a Satellite Communication System devoted exclusively to maritime purposes.

Following the extensive studies conducted by IMO experts, an international Conference was convened which, on 3rd September 1976 unanimously adopted the convention and operating agreement of the International Maritime Satellite Organization. According to the Convention INMARSAT was given the task to make provision for the space segment necessary for the improvement of maritime satellite communication, thereby assisting in improving distress and safety of life at sea.

In order to co-operate internationally an international conference on Maritime Search and Rescue was held in Hamburg in 1979, which adopted the International Convention on Maritime Search and Rescue and invited IMO to develop the Global Maritime Distress and Safety system including telecommunications provisions.
CHAPTER III

PLANNING THE NEW SYSTEM
3.1 GENERAL:

The introduction of maritime communication satellites together with the development by the international Radio Consultative Committee (CCIR) of a digital selective calling system and an automated direct-printing system for the transmission of navigational and meteorological warnings and urgent information to ships has provided the foundation necessary for a new system which would be based primarily on ship-to-shore operation. With the availability of these techniques detailed planning of the GMDSS was started in 1979.

The detailed planning is intended to provide an integrated system embodying the most suitable communication techniques, operating methods, procedures and shore based facilities to be implemented by 1991 (See Table 3). Further, to provide for amortization of existing equipment and to maintain safety services with ships not fitted with GMDSS equipment it is envisaged that the present distress system will be required to continue in use in parallel with the GMDSS upto 1990.

The planning has been undertaken in co-operation with other international organizations in particular with the ITU, whose World Administrative Radio Conference for the Mobile Services 1983, made certain allocations of frequencies for use with the Global Maritime Distress and Safety System.

The planning of the GMDSS began by defining the functional and operational requirements that it should fulfil. Consequently the bases upon which the system is being planned are:

1. Areas of operation will be used to determine the equipment appropriate for a ship.

2. Existing medium frequency arrangements will be rationalized.
3. A long range capability using satellites and HF will be provided.

4. Watchkeeping on relevant distress and safety channels will be maintained by automatic means.

5. Means will be provided for the automatic reception of all relevant safety information including meteorological and navigational warnings; and

6. Radiotelephony, digital selective calling (DSC) and narrow band direct printing (NBDP) will be used in terrestrial radio systems. Morse radiotelegraphy will not be used in the new system.

3.2 AREAS OF OPERATIONS:

The concepts presented in this description of the Global Maritime Distress and Safety System are the joint views of International Maritime Organization and International Maritime Satellite Organization, which could be modified by the decision of WARC-87.

The basic concept of the system is that search and rescue authorities ashore as well as shipping in the vicinity will be alerted to a distress incident so that effective assistance can be provided with a minimum of delay. The system will also provide for urgency and safety communications and the dissemination of relevant navigational and meteorological information of ships.

The areas of operation have been designated as follows:

Area A1: within range of shore based VHF-stations,
Area A2: within range of shore based MF stations (excluding A1 areas)

Area A3: within the coverage of geostationary maritime communications satellites (excluding A1 and A2 areas) and

Area A4: outside the coverage area of geostationary maritime communication satellites.

The system will use both satellite and terrestrial techniques, integrated to form an efficient communications network.

3.3 SATELLITE COMMUNICATIONS:

Satellite communications will be used in both ship-to-shore and shore-to-ship directions. The INMARSAT satellite system which employs geostationary satellites and operates in the 1.5 and 1.6 GHz bands will provide a means of alerting from the ships and a capability for two-way communications using radiotelephone and radiotelex. A broadcast service to ships using radiotelex will also be provided by the INMARSAT system through either normal ship earth stations (SES) or receive-only ship earth stations (ROSES). Polar-orbiting satellites operating in 406 - 406.1 MH bands will provide a means of distress alerting and determining the location of the float-free satellite EPIRBs.

Two basic types of shipborne equipment will be used for satellite communications:

a. Ship earth stations, approved by INMARSAT, and

b. satellite EPIRBs capable of being activated manually, or automatically after floating free from a sinking ship.
3.4 TERRESTRIAL COMMUNICATIONS:

3.4.1 HF LONG RANGE SERVICE:
HF will provide long-range service for use in the ship-to-shore and shore-to-ship directions. In areas covered by INMARSAT it can be used as an alternative to satellite communications and outside these areas it will provide the only communications capability. Frequencies have been designated in the 4, 6, 8, 12 and 16 MHz bands to provide the means for transmitting and receiving distress alerts and safety calls and for passing distress and safety traffic.

Digital selective calling (DSC) will from the basis for distress alerting and safety calling. Coast stations participating in the HF distress and safety watchkeeping network will need to choose from the five available frequency bands for relaying an alert. The choice will depend on the position of the ship in distress, the geographical area to be alerted and the current propagation characteristics. It is envisaged that ships equipped with the HF option will maintain a watch on the 8 MHz alerting frequency and one of the other dedicated HF frequencies.

The latter will be the frequency most appropriate to the area in which the ship is sailing.

HF distress and safety communications will use radiotelephony and/or radiotelex (NBDP).

3.4.2 MF MEDIUM-RANGE SERVICE:
MF will provide a medium range service. The frequencies in the service. The frequencies in the 2 MHz band will be used.
1. In the ship-to-shore, ship-to-ship and shore-to-ship directions as follows:

   - 2187.5 kHz for distress alerts and safety calls by DSC and

   - 2182 kHz for distress and safety traffic by radio telephony, including SAR coordinating functions and on-scene communications,

   and

2. In the ship-to-ship direction only:

   - 2174.5 kHz for distress and safety traffic by radiotelex (NBDP).

Frequencies near 500 kHz will be used in the ship-to-ship direction. It is possible that 490 kHz may be included in the system to broadcast messages to ships. 518 kHz will be used to transmit navigational and meteorological warnings using the NAVTEX system.

3.4.3 VHF SHORT RANGE SERVICE:

This will provide a short-range service. The frequencies which will be used are:

1. 156.525 MHz for distress alerts and safety calls by DSC, and

2. 156.8 MHz for distress and safety traffic by radiotelephony, including SAR co-ordinating functions and on-scene communications.
3.5 FUNCTIONS OF THE SYSTEM:

The system has been designated so that the following functions can be performed efficiently.

3.5.1 ALERTING:

Distress alerting is the rapid and successful reporting of a distress incident to a unit which can provide or co-ordinate assistance. This would be another ship in the vicinity or a Rescue Co-ordination Centre (RCC). When an alert is received by an RCC normally via a coast station or coast earth station, the RCC will relay the alert to SAR units and to ships in the vicinity of the distress incident. Where practicable a distress incident alert should indicate the nature of the distress.

The communication arrangements are designed to enable distress alerting to be performed in all three directions: ship-to-shore, ship-to-ship and shore-to-ship, in all sea areas.

The probability of a successful alert will be high and as the alerting time is expected to be short, response should be rapid, thereby increasing the likelihood of successful rescue. However, ship-to-ship alerting is likely to be effective only at distances of up to about 100 miles. When there is no ship within about 100 miles of the ship in distress, assistance would normally depend entirely on arrangements made from the shore, using either satellite or HF communications, or a combination of both.

Ship sailing in areas A3 and A4 would transmit a ship-to-ship alert on 2187.5 kHz and a ship-to-shore alert
by a ship earth station, HF communications or a satellite EPIRB as appropriate. Ships sailing in areas A2 would transmit a ship-to-ship and a ship-to-shore alert on 2187.5 kHz and ship sailing on areas A1 would transmit a ship-to-ship and ship-to-shore alert on 156.525 MHz.

A distress alert will normally be initiated manually, except when a ship sinks and a float-free satellite EPIRB is initiated automatically. All distress alerts will be acknowledged manually.

The relaying of a distress alert from an Rescue Coordination Center to ships in the vicinity of a distress incident will be made by satellite communications to ship earth stations and by terrestrial communications using appropriate frequencies. To avoid all ships in large sea area being alerted, an a area call would normally be transmitted so that only those ships in the vicinity of the distress alert, ships in the area addressed should establish communication with the RCC concerned to enable the assistance to be co-ordinated.

3.5.2 SAR CO-ORDINATING COMMUNICATIONS:

In general these are the communications necessary for the co-ordination of ships and aircraft participating in a search resulting from a distress incident and include communications between RCCs and any on-scene commander or co-ordinator of surface search in the area of the distress incident.

For SAR operations it should be possible to transmit messages in both directions as distinct from "alerting" which is generally the transmission of a
specific message in one direction only and distress and safety traffic frequencies will normally be used for passing such messages.

The frequencies which will be available for distress and safety traffic will be radiotelephony or radiotelex or both. These communications will be carried out by terrestrial or satellite means, dependent upon the equipment fitted in the ship and the area in which the incident occurs.

3.5.2.1 Medical Transport:

A single group ZZZ in radiotelegraphy and of the expression RESCUE CRAFT pronounced as in English, in radiotelephony.

The location and identification of EPIRB's of any SAR system, including satellites, may be used in SAR operations carried out with the consent of competent authority, by medical transport.

The signal emitted by shipborne radar transponders shall consist of the group YYY for hospital ships and of the group ZZZ for the rescue craft as mentioned above.

3.5.3 ON-SCENE COMMUNICATIONS

On-scene communications will normally take place in the MF and VHF bands on frequencies designated for distress and safety traffic by radiotelephony or radiotelex. These communications will be between the ship in distress and assisting units and will relate to the provision of assistance to the ship or to the
rescue of survivors. When aircrafts are involved in on-scene communications they will normally be able to use 3023, 4125 and 5680 kHz. In addition, SAR aircraft should be provided with equipment to communicate on 2182 kHz or 156.8 MHz or both, as well as on other maritime mobile frequencies. Locating signals are transmissions intended to facilitate the findings of a ship in distress or of the location of survivors. This will be based on the use of SAR 9 GHz transponders at the scene in conjunction with the assisting unit’s radar.

3.5.4 NAVIGATIONAL AND METEOROLOGICAL WARNINGS AND URGENT INFORMATION

Provision has been made for ships to be provided with navigational and meteorological warnings and urgent information by any of three means. At MF the frequency 518 kHz has been made available for broadcasts by means of narrow-band direct-printing telegraphy using forward error correction. Similarly, the information may be broadcast via INMARSAT or on HF.

3.5.5 GENERAL RADIOCOMMUNICATIONS:

General radiocommunications in the GMDSS are those communications for distress and safety purposes between mobile stations and shore-based communication networks using non-distress and safety channels in support of distress incident operations. The communications may be conducted on any appropriate channel, including those used for public correspondence. Navigation safety communications are intership VHF radio telephone communications for the purpose of assisting the save movement of ships.
3.5.6 PREVENTIVE ACTION:

Preventive action covers those communications necessary for the collection and dissemination of information which might either help in reducing the risk of an accident, or when a distress incident occurs expedite the SAR operation. It includes ship's position and movement reports, navigational and meteorological warnings, and all other urgency and safety messages.

Communications associated with preventive action will include the passing of messages using distress and safety traffic frequencies and broadcasting messages from shore-to-ship using NAVTEX, INMARSAT or HF.

3.5.7 SHORE-BASED COMMUNICATIONS NETWORK:

The introduction of satellite and terrestrial communications into the global maritime distress and safety system will necessitate the establishment of an efficient communication network between RCCs. This will consist of interconnecting links between RCCs in accordance with arrangements made in support of the 1979 SAR Convention. In addition, each RCC will need rapid and effective communication links with its associated coast stations and coast earth stations.

The inter-connecting links between RCCs will usually use the public switched networks. Some RCCs particularly those not having sufficient access to the public switched networks, may be provided with an INMARSAT ships earth station to assist in the rapid exchange of distress and safety information between RCCs.
3.5.8 CARRIAGE REQUIREMENTS OF SHIP EQUIPMENT:

Some of the more important general principles being used to formulate carriage requirements for ships subject to the 1974 SOLAS Convention are as follows:

- Every ship shall be provided with equipment capable of performing each of the functions described earlier, as appropriate to its area of operation, using at least one of the prescribed radio communication techniques;

- Every ship shall be provided with at least two radiocommunication systems, each system using a separate and independent item of equipment, to perform the alerting function;

- Except as described above, an item of equipment fitted to a ship may perform more than one function and may be associated with more than one radiocommunication system;

- Equipment to be carried on ships will be simple to operate and wherever appropriate be designed for unattended operation;

- Survival craft shall be provided with equipment capable of performing the on-scene communications function by at least one radiocommunication system; and

- Survival craft shall also be provided with equipment capable of transmitting locating signals.

Provisional carriage requirements for ships sailing in GMDSS areas can be summarized as follows:
- Area A1 ships will carry VHF equipment;

- Area A2 ships will carry VHF and MF equipment;

- Area A3 ships will carry VHF, MF and either HF or satellite equipment;

- Area A4 ships will carry VHF, MF and HF equipment;

- All Area A2, A3 and A4 ships will carry a satellite EPIRB;

- All Area A1 ships will carry either a satellite EPIRB or VHF EPIRB; and

- All ships operating in areas where NAVTEX service is provided will carry a NAVTEX receiver.

3.5.9 CONCLUSION:

The operational requirements for the system have been established, the provisional carriage requirements identified and SAR facilities are continually being improved, trials of various elements of the system, in particular satellite EPIRBs and digital selective calling, are nearing completion and the ultimate configuration of the system is being finalised.

It is envisaged that the ITU World Administrative Radio Conference for the Mobile Services - 1987 will complete the regulatory provisions for the systems and that subsequently IMO will amend its appropriate, international instruments for the implementation of Global Maritime Distress and Safety System, to exploit advances already made in Satellite and terrestrial communications to improve the safety of life at sea.
CHAPTER IV

OPERATION AND PROCEDURES OF SEARCH AND RESCUE
4.1 GENERAL

The International Maritime Organization's most important task is the adoption of measures to improve the safety of life at sea. Many of its conventions are concerned with this subject and the majority of them are intended to stop accidents happening in the first place.

One of the greatest contributions to rescue at sea was the invention of radio. Before that the most a ship in distress could do to summon help was to fire flares and hope that another ship was near enough to see them. Radio enabled ships to send distress messages over a distance of hundreds and later thousands of miles.

The advantages of radio for maritime purposes were appreciated from the early days; the first rescue at sea resulting from a radio message was in 1899, when the lightship on the Goodwin Sands in the Straits of Dover sent a message ashore when the steamship "Elbe" ran aground, enabling a lifeboat to be launched in time to rescue the ship's crew. It soon became obvious that the use of radio would have to be regulated on an international basis if the new medium was to be properly developed, and the first international conference on radio was held as early as 1906.

Requirements covering radio on ships have formed part of SOLAS ever since the first version was adopted in 1914 and in the 1974 Convention appear in Chapter IV. This deals mainly with facilities intended for distress and safety purposes.

Ships required to be fitted with a radio telegraph installation must carry at least one radio officer and, if not fitted with a radiotelegraph automatic alarm, must listen continuously on the radiotelegraph distress frequency. For passenger
ships, radio watch must be kept for at least eight hours every day, while ships carrying more than 250 passengers must listen on the distress frequency for at least 16 hours a day (and must carry at least two radio officers). Cargo ships fitted with an automatic alarm must listen on the distress frequency for at least eight hours a day.

Ships required to be fitted with radio telephone must keep a continuous watch (which can be by means of automatic alarm) on the radiotelephone distress frequency (2182 kHz). Ships required to be fitted with a VHF radiotelephone must keep a continuous watch on 156.8 MHz (channel 16) and/or on other channels as required by their administration.

Requirements relating to the use of radio in rescue craft are contained in Chapter III of SOLAS. An approved portable radio apparatus must be carried in all ships, except those equipped with a motor lifeboat on each side containing a radiotelegraph installation (Reg. 13). Where more than 199 persons are carried, at least one lifeboat must be equipped with a radiotelegraph station and where the total number of persons on board is 1500 or more every motor lifeboat must be so equipped.

Several additional requirements regarding radio apparatus were introduced into this chapter in the 1983 amendments. They include the carriage of manually activated emergency position-indicating radio beacons (EPIRBs).

While the rapid transmission and reception of distress messages is the most important task of radio at sea, it is essential that warnings be given to ships on matters which can affect their safety. These include the establishment and malfunction of lights, sound signals, bouys and other aids to navigation; the location of wrecks and other hazards and
the establishment of offshore structures.

To ensure such information will be received by all ships likely to be affected by it, IMO and the International Hydrographic Organization (IHO) established a World Wide Navigational Warning Service. This service was adopted by the IMO Assembly in 1977 and a revised system was adopted by the Assembly in 1979.

Under this system the World's oceans are divided into 16 areas (called NAVAREAS). The service includes arrangements for disseminating information by regular radio broadcasts.

Despite advances in communication at sea, confusion can still arise because of language difficulties.

English is generally regarded as the international "language of the sea" but even when both parties speak the language misunderstandings can still arise because of imprecision in its use.

In 1977 the IMO Assembly adopted a Standard Marine Navigational Vocabulary to overcome some of these problems by standardizing the English terms used in communications at sea.

It is not intended that the Vocabulary be made mandatory, but rather that through constant repetition the phrases and terms used will become those normally used by seafarers for communications between and on board ships.

The most important development in telecommunications in the last thirty years has been the introduction of satellite communications. They enable both radio and printed messages to be transmitted instantly from one place on earth to another.
and IMO was quick to appreciate their value for maritime purposes. Research was begun in the 1960s and in 1976 a conference convened by IMO adopted a convention establishing the International Maritime Satellite Organization (INMARSAT).

The establishment of INMARSAT as an independent organization marked a great step forward for maritime radiocommunications. For the first time shipping had a communications system reserved solely for its own use and designed for its own purposes and the INMARSAT system offers advantages which cannot be provided by terrestrial radiocommunications.

The difficulties faced in Radio Communication could result in a serious delay in a distress message being received and a search and rescue operation being initiated.

However, recent advances in communications technology and the establishment of INMARSAT have provided an opportunity to overcome these difficulties and IMO is currently working a completely new maritime distress and safety system which is expected to be introduced by 1991.

The basic concept of the GMDSS is that shore search and rescue authorities as well as shipping in the vicinity of a distress will be rapidly alerted to the distress and be capable of being involved in a co-ordinated rescue operation. The concept applies to all cargo ships and passenger ships on international voyages regardless of their geographical location. Additionally, the system will provide for urgency and safety communications, as well as the dissemination of navigational and meteorological information to ships. The system will use both satellite and terrestrial communications. Satellite communications will be provided by INMARSAT.
A distress capability for alerting by satellite EPIRBs will be provided by INMARSAT geostationary satellites as well as by polar orbiting satellites.

Recent advances in communication technology and the establishment of the INMARSAT system have been the catalyst in the planning for a future system. A reliable long range communication link continuously available will significantly improve the probability of a distress alert being received and equipment currently being developed will provide automatic alerting in the case of a sudden disaster at sea.

To use this system to its full potential it will be necessary to introduce greater shore authority involvement in distress response, improve long range terrestrial communications, including the use of digital selective calling and to establish an international search and rescue infrastructure.

In the future system terrestrial communications will no longer use Morse Code radiotelegraphy but will employ digital selective calling (DSC), radiotelephony, and narrow band direct printing (NBDP).

The equipment to be carried on ships will be designed for simple operation and will be largely automated. The equipment required to be carried will depend on a ship's area of operation.

The introduction of the GMDSS will greatly improve radiotelecommunications at sea, especially for distress purposes, but electromagnetic technology has several other applications which are relevant to rescue at sea. Radio direction-finding, radar, electronic navigation systems such as Omega, Decca and Loran C, and satellite navigation systems are all based on these principles. Although primarily used for navigation these devices are also useful for search and rescue purposes.
and requirements for their carriage are contained in the SOLAS Convention.

The invention of radio and the tremendous advances made in telecommunications technology during this century have been of immense value to rescue operations at sea. The measures introduced by IMO referred to earlier in this paper have similarly improved the chances of survival following an accident at sea. But rescue ultimately depends upon help arriving in time. The greatest danger to life following the sinking or abandonment of a ship is not drowning but hypothermia - death from cold.

The sinking of the "Titanic" in 1912 provided a dramatic example of the effects of cold water immersion. Partially due to lack of preparedness with protective clothing, adequate floatation equipment, and a knowledge of survival procedures, none of the 1,489 persons immersed in the icy water was alive when rescue vessels arrived one hour and fifty minutes after the sinking. Countless lives could have been saved if almost all of the people in lifeboats were alive.

During the second world war the Royal Navy of the United Kingdom alone lost about 45,000 men at sea, of whom it is estimated 30,000 died from drowning and hypothermia. Many of those who drowned were incapacitated due to cold.

Many of the improvements introduced into the revised Chapter III of the SOLAS Convention are designed to improve chances of survival by reducing the threat of hypothermia. Most lifeboats, for example, must be totally or partially enclosed. The latter must have rigid covers extending over 20 per cent of the lifeboat's length, and be equipped with a foldable canopy to cover the rest.

While such boats do not offer the same degree of protection as
totally enclosed lifeboats they are easier to board in an emergency, especially on passenger ships where large numbers of untrained persons are involved. And they certainly offer much greater protection against the cold than the traditional open boat. The revised Chapter III requires that totally enclosed boats must also be capable of righting themselves automatically if they capsize.

As a further protection against the cold the revised Chapter III introduces a number of requirements regarding the carriage of personal aids against hypothermia. These include immersion suits, which protect the body against heat-loss and thermal protective aids, which perform the same function but do not allow the same freedom of movement.

4.2 SEARCH AND RESCUE OPERATIONS

The obligation of ships to respond to distress messages and signals from other ships is one of the oldest traditions of the sea and is also enshrined in various international conventions.

One of them is the Brussels Convention on Assistance and Salvage of 1910.

Article 11 of that convention established in international law the tradition of the brotherhood of the sea and stated that "every master is bound, so far as he can do without serious danger to his vessel, her crew and her passengers, to render assistance to everybody, even though an enemy, found at sea in danger of being lost". The convention also required Contracting Parties to adopt national laws or regulations to give effect to this provision.

The obligation to provide assistance to persons in distress at
sea has been embodied in other international conventions particularly the International Conventions for the Safety of Life at Sea and Convention on the High Seas (1958).

Regulation 10 of Chapter V of SOLAS states: "The master of a ship at sea on receiving a signal from any source that a ship or aircraft or survival craft thereof is in distress, is bound to proceed with all speed to the assistance of the persons in distress informing them if possible that he is doing so...."

The regulation goes on to outline various other obligations with regard to rescue operations and in Regulation 15 the SOLAS Convention gives basic requirements for Governments regarding search and rescue operations.

It says: "Each Contracting Government undertakes to ensure that any necessary arrangements are made for coast watching and for the rescue of persons in distress at sea round its coasts. These arrangements should include the establishment, operation and maintenance of such maritime safety facilities as are deemed practicable and necessary having regard to the density of seagoing traffic and the navigational dangers and should, so far as possible, afford adequate means of locating and rescuing such persons.

In addition, "Each contracting Government undertakes to make available information concerning its existing rescue facilities and the plans for changes therein, if any".

These international instruments operate without prejudice to each other and the repetition of the same principle in more than one convention does not introduce any inconsistencies but strengthens the legal obligations which give added force to tradition.

When IMO was established in 1959, its first major action was
to convene an International Conference on Safety of Life at Sea. This met in 1960 and adopted a new version of the SOLAS Convention. It also adopted a number of recommendations which requested IMU to take appropriate action to improve search and rescue at sea. These included the following:

a. Contracting Government should establish coast radio stations to keep a continuous listening watch on the radiotelegraph and radiotelephone distress frequencies and on frequencies used by survival craft;

b. joint studies of IMO, the International Civil Aviation Organization (ICAO), the International Telecommunication Union (ITU) and the World Meteorological Organization (WMO) should be undertaken on matters regarding the planning and provision of facilities for search and rescue;

c. urgent consideration should be given by IMO; ICAO, ITU and WMO on the best way of establishing communications between aircraft and ships involved in cases of distress;

d. Governments should encourage ships to fit emergency position-indicating radio beacons (EPIRBs) where appropriate;

These recommendations provided the basis for IMO work in this area during the next few years, but many delegations felt that more was needed to be done to improve and to standardise search and rescue organizations.

It was recognized that IMO had a crucial role to play both in providing advice and guidance and also in formulating an international search and rescue plan.

As a first step, a manual on search and rescue operations was prepared for the guidance of those requiring assistance at sea.
or who find themselves in a position to provide assistance to others. The draft was completed by 1969 and was finally adopted by the IMO Assembly in 1971 under the title of the Merchant Ship Search and Rescue Manual (MERSAR).

The MERSAR manual is primarily designed to aid the master of any vessel who might be called upon to conduct search and rescue (SAR) operations at sea.

It is divided into eight chapters which deal with SAR coordination; action by a ship in distress; action by assisting ships; assistance by SAR aircraft; planning and conducting the search; conclusion of search; communications; and aircraft casualties at sea.

Although the MERSAR manual provides valuable guidance, it was always envisaged that the international search and rescue requirements should be established. The Assembly resolution which adopted the manual note "with approval that the Maritime Safety Committee has included in its long-term work programme the formulation of an international agreement on a search and rescue system". It then goes on to request the Maritime Safety Committee to consider, in due course, the status of the Manual in the context of the agreement on a search and rescue system.

The International Convention on Maritime Search and Rescue, 1979 based its recommendations of a Search and Rescue Seminar held by the United States in October 1970, the Maritime Safety Committee established a Group of Experts on Search and Rescue which was instructed to prepare a draft International Convention on Maritime Search and Rescue.

It also prepared a second manual called the IMO Search and Rescue Manual (IMOSAR) which was adopted by the Maritime Safety Committee in 1978.
The manual provides guidelines rather than requirements for a common maritime search and rescue policy, encouraging all coastal states to develop their organizations on similar lines and enabling adjacent states to co-operate and provide mutual assistance.

Taking into account that maritime and aeronautical search and rescue organizations are complementary, the Manual has been aligned as closely as possible with the International Civil Aviation Organization (ICAO) Search and Rescue Manual to ensure a common policy and to facilitate consultation of the two Manuals for administrative or operational reasons.

Co-ordination and control of search and rescue operations is at present organized by each individual country in accordance with its own requirements and as dictated by its own resources. As a result, national organizational plans have developed along different lines. The dissimilarity of such plans and lack of agreed and standardized procedures on a world-wide basis may give rise to difficulties, particularly at the initial stages of alert. In some cases this results in an uneconomical use of search and rescue facilities or in unnecessary duplication of effort.

However, in some geographical regions neighbouring countries have established regional arrangements which operate successfully, have agreed on links of communications, and have accepted standard procedures and areas of responsibility for co-ordination and control in cases of distress.

Exchange of personnel and frequent contacts between those responsible for operating the search and rescue services, assist to resolve operational difficulties which might arise and contribute to the effectiveness of the regional system.

The technical provisions of the convention are contained in an
annex consisting of six chapters, the first of which deals with terms and definitions. The other chapters are as follows:

4.3 ORGANIZATION

This deals with the basic structure of a search and rescue organization. Parties are required to ensure that necessary arrangements are made for the provisions of adequate search and rescue services for persons in distress at sea around their coasts.

A similar (but more extensive) requirement is contained in Regulation 15, Chapter V of the International Convention for the Safety of Life at Sea, 1960 and 1974. The same paragraph of the SOLAS Convention also requires that each search and rescue region shall be established by agreement among the Parties concerned.

However, it is recognized in the SAR Convention that it will not always be possible for all Parties to reach agreement, in which case they shall use their best endeavours to reach agreement on appropriate arrangements which would provide equivalent overall co-ordination of search and rescue services.

In order to facilitate agreement on the dimensions of search and rescue region, the convention stipulates that the delimitation of such regions is not related to and shall not prejudice the delimitation of any boundary between States.

Parties should arrange that their SAR services can and do give prompt response to any distress call and must take urgent steps to provide the most appropriate assistance to any person in distress.
Information concerning SAR services must be submitted to IMO and then circulated to all Parties. Parties are required to co-ordinate their SAR facilities and services nationally by establishing rescue co-ordination centres (RCCs) and rescue sub-centres (RSCs).

They must also ensure that each RCC and RSC has adequate means for receiving distress communications and communicating with its rescue units and with RCCs and RSCs in adjacent areas.

Parties are required to designate State services as rescue units. Each rescue unit must be provided with appropriate facilities and equipment and should have rapid and reliable means of communication with other units engaged in the same operation.

The convention recommends that, subject to applicable national legislation, authorization should be given for the immediate entry into or over its territorial sea or territory of rescue units of other Parties which are engaged in a search and rescue operations. It requires that search and rescue operations in such cases shall, as far as is practicable, be co-ordinated by the appropriate RCC or RSC of the Party which has authorized entry.

A Party which wishes its rescue units to enter into or over the territorial sea or territory of another Party solely for search and rescue purposes shall send a request to the RCC or other designated authority of that Party. This request must give full details of the intended mission may be undertaken.

However, to prevent unnecessary delays and formalities, Parties are recommended to enter into agreements with neighbouring States on the conditions for entry of their rescue units into or over their respective territorial sea or territory.
The Convention also recommends that each Party should authorize its RCCs:

- to request and provide such assistance as may be needed from or by other RCCs;

- to grant any necessary permission for the entry of SAR units into or over its territorial sea or territory and to make the necessary arrangements with customs, immigration and other authorities.

Agreements with neighbouring states are also recommended for the pooling of facilities; the establishment of common procedures; the conduct of joint training and exercises; regular checks of inter State communications; liaison visits by RCC personnel; and exchange of search and rescue information.

Aircraft play a crucial role in SAR operations today and the convention recognizes the importance of this aspect by requiring Parties to ensure the closest practical co-ordination between maritime and aeronautical services. Where practicable, joint RCCs and RSCs should be established to serve both maritime and aeronautical purposes.

However, if separate RCCs or RSCs are established to serve the same area, the closest practical co-ordination must be ensured and common procedures must as far as possible be established for maritime and aeronautical purposes.

4.4 PREPARATORY MEASURES:

This chapter deals with the preparatory measures to be taken by the RCCs and RSCs and the state of preparedness of rescue units.
Each RCC and RSC must have available updated information relating to its area, including details of available rescue units and coast watching units. Rescues such as transportation facilities and supplies means of communication including names, cables and telex addresses, telephone and telex numbers of the agent, consider authorities, international organizations and other agencies, who may be able to assist in obtaining vital information on vessels identities of maritime mobile service, and other radio stations.

Each RCC and RSC should have ready access to all appropriate information concerning the vessels within its area which may be able to provide assistance to the vessels or persons in distress at sea.

Each RCC and RSC must have detail plans or instructions or the conduct of SAR operations in its area. These should contain details concerning actions to be taken by those engaged in SAR operations in the area.

4.5 OPERATING PROCEDURES:

Parties are required to ensure that continuous radio watches are maintained on international distress frequencies when this is considered practicable and necessary.

Detailed requirements are given concerning the actions to be taken by coast radio stations which receive distress messages.

Any element of the search and rescue organization which has reason to believe that a ship is in a state of emergency should as soon as possible give all available information to the appropriate RCC or RSC. These in turn must evaluate this information and determine the emergency phase and the extent
of search and rescue operation required. (A search and rescue flow chart of "First RCC" is given in Table 5)

For operational purposes there are three emergency phases:

1. **UNCERTAINTY PHASE:**
   When a vessel is overdue or has failed to make an expected position or safety report.

2. **ALERT PHASE:**
   When attempts to contact the vessel and other enquiries have been unsuccessful or when information is received that the operating efficiency of the vessel is impaired but a distress situation is unlikely.

3. **DISTRESS PHASE:**
   - When positive information is received that a vessel or a person is in need of immediate assistance; or further attempts to establish contact with the vessel have failed and it appears probable that the vessel is in distress, or
   - that its operating efficiency has been impaired to the extent that a distress situation is likely.

The operational matters which must be dealt with will be:

- Co-ordination when two or more Parties are involved
- Termination and suspension of SAR operations
- On-Scene co-ordination of SAR activities
- Designation of the on-scene commander and his responsibilities
- Designation of co-ordinator surface search and his responsibilities
- Initial action and searches
4.6 SHIP REPORTING SYSTEMS:

In view of the importance of ship reporting systems for search and rescue operations, the conference decided to include a chapter on this subject in the Convention.

However, it would not be practical nor necessary for each Party to establish such system and the provisions of this chapter are therefore only of a recommendatory nature.

The Convention says that Parties should establish a ship reporting system within any search and rescue region for which they are responsible, where this is considered necessary and practicable for search and rescue purposes. Parties wishing to do so should take account of relevant IMO recommendations.

A ship reporting system should provide up-to-date information on the movements of vessels. During a distress incident this could reduce the interval between loss of contact with a vessel and the initiation of search and rescue operations; permit rapid selection of vessels which are in position to assist; limit the search area; and facilitate the provision of medical assistance or advice.

In order to achieve the above objectives, the ship reporting system should provide information which would make it possible to predict vessel movements, including sailing plans and position reports; maintain a shipping plot; receive periodic reports of participating vessels; be simple in design and operation; and use an internationally agreed standard ship reporting format and procedures.

A ship reporting system should incorporate the following reports, each containing the name and call sign or ship station identity:
a. SAILING PLAN:
   Giving the date, time and point of departure, next port of call, intended route, speed and expected date and time of arrival;

b. POSITION REPORT:
   With date, position, course and speed; and

c. FINAL REPORT:
   Giving date and time of arrival at destination or of leaving the area covered by the system.

Parties should encourage all vessels to participate in such ship reporting systems and should pass information on the position of vessels whenever requested for search and rescue purposes. To assist in the establishment of ship reporting systems a resolution establishing general principles for them was adopted by the IMO Assembly in 1983.

The SAR conference also adopted following resolutions:

1. States are urged to co-ordinate all SAR services including those for aeronautical purposes. IMO is invited to continue to work closely with ICAO to harmonize aeronautical and maritime SAR plans and procedures.

2. States are recommended to arrange for participation in such systems to be free to the ships concerned.

3. The resolution invites IMO to develop an internationally agreed format for ship reporting systems, using as a basis a format annexed to the resolution. Such a format was adopted by the 13th Assembly of IMO in November 1983 by Resolution A.531(13).
4. The resolution encourages the use of the MERSAR and IMOSAR manuals.

5. The resolution urges the allocation of one frequency for use exclusively for distress and safety purposes in the 4, 6, 8, 12 and 16 MHz maritime mobile bands.

6. IMO is invited to develop a global maritime telecommunications system for distress and safety purposes which will support the SAR plan prescribed in the convention.

7. IMO is invited to work closely with the World Meteorological Organization to explore the practicability of harmonizing the areas of maritime meteorological forecasts and warnings with SAR regions.

8. States are urged, in consultation with and without the assistance of IMO to support States requiring technical assistance for training personnel in SAR and for the acquisition of SAR equipment and the development of SAR facilities.

In early 1990s the Global Maritime Distress and Safety System will also be instituted (although some of its provisions will come into operation before that date). This will represent another major contribution to maritime safety by improving communications and reducing the delays in receiving distress messages and initiating rescue operations.

These IMO initiatives have received universal support from Member Governments of the Organization and other international and national bodies involved in SAR activities. This has also led to improvements in SAR operations in many areas and the process is likely to continue in the years to come.
For the first time, the international maritime community has a common basis for SAR operations in the SAR Convention and the technological advances now taking place in communications and other key areas offer tremendous opportunities for the future.
CHAPTER V

EQUIPMENT REQUIRED IN THE SYSTEM
5.1 The idea behind the carriage requirements for the Global Maritime Distress and Safety System is quite simple. Each ship should carry enough equipment to allow it to perform Distress and Safety communication, as appropriate to its area of operation using at least one of the prescribed radio techniques. At the same time a vessel should be able to broadcast a Distress alert by either of at least two separate and independent radiocommunication systems.

Survival crafts should be able to communicate with the rescue service on the scene of the casualty by at least one of the communication system allocated to the function, at the same time should be able to transmit a locating signal.

Following are the requirements of the additional equipment to be carried on board as per area of operation.

AREA A-1

Definition:

Area within the range of shore-based VHF stations providing DSC alerting. (20 to 30 miles)

Additional Carriage Requirements:

VHF Radiotelephone
VHF DSC Equipment
A float free VHF EPIRB
or
Satellite EPIRB of 406 MHz.

Distress Alert Method:

Ship to ship --------- VHF DSC
Ship to Shore --------- VHF DSC
or
VHF EPIRB
or
Satellite EPIRB

AREA A-2

Definition:

Within the range of shore-based MF stations providing MF DSC alerting, excluding area A-1.
(upto 100 miles)

Additional Carriage Requirements:

MF Radiotelephone
MF DSC equipment
INMARSAT Ship Earth Station (optional).

Distress Alert Method:

Ship to Ship ------- VHF DSC / MF DSC
Ship to Shore ------- VHF DSC & Either
MF DSC or
Satellite EPIRB

AREA A-3

Definition:

Within the coverage of Geostationary Satellites.
(excluding areas A-1 and A-2) Approximately
Lat + 70 degrees.
Additional Carriage Requirements:

INMARSAT Standard-A or INMARSAT Standard-C ship earth station, or HF radio or Satellite EPIRB

AREA A-4

Definition:

Remaining area (excluding areas A-1, A-2, and A-3)

Additional Carriage Requirements:

MF / HF Radio
HF / DSC Equipment

Distress Alert Method:

Ship to Ship ------- VHF / DSC, MF / DSC
Ship to Shore ------- HF Radio or Satellite EPIRB

5.2 MF / HF EQUIPMENT

1. The prototype of a MF/HF equipment which was designed for trials comprises a single unit cabinet containing a Transmit/Receive modem with its associated Visual Display Unit and keypad with a ships main receiver, with full facilities including the frequency scanning. Connected with this unit is a stand alone line printer used for printing received/transmitted messages. (Figure 3)

2. The unit contains a computer, the Modulator / Demodulator and other various circuits, a packaged power supply and interfaces for the printer and Visual Display Unit. (VDU)
Figure 3: Example of MF/HF DSC equipment

Source: IMO Publication No. ISBN 92-801-1216-3
3. The front panel contains a single keypad assembly with keys 0 - 9. Visual alarm indicators are provided together with a loudspeaker and sockets for headphone or tape recorder connection.

4. The printer is a separate unit which records continuously the traffic received and transmitted.

5. The long range service will be provided by HF in ship to shore or shore to ship direction. In areas covered by INMARSAT it can be used as an alternative to satellite communication, and outside these areas it will provide long range communication capabilities. Frequencies of 4, 6, 6, 8, 12 and 16 MHz bands which have been designated will provide necessary means of transmitting and receiving distress alerts and safety calls as well as passing safety and distress traffic.

6. Medium range service will be provided on frequency in the 2 MHz band. In ship to shore, ship to ship, and shore to ship direction 2187.5 KHz will be used for distress alerts and safety call by DSC. The radiotelephony will use 2182 KHz for distress and safety traffic, on-scene communications and search and rescue co-ordinating functions.

7. RADIOTELEX (NBDP) will use 2174.5 KHz for distress and safety traffic. NAVTEX system will use 5518 KHz for transmitting navigational and meteorological warnings. Shore to ship direction will use frequencies near 500 KHz. (Figure 4)

8. THE NAVTEX receivers uses a single frequency world wide for direct printing service with the ability to select messages to be printed according to a technical code.
Figure 4 – Examples of NAVTEX shipborne receivers

Source: IMO Publication No. ISBN 92-801-1216-3
Figure 5: Structure of the NAVTEX Service
Source: IMO Publication No. ISBN 92-801-1216-3

THE NAVTEX CONCEPT

- Coastguard
- Buoyage authority
- Electronic Navaids
- Offshore operators
- Government departments
- Ship reports
- NAVAREA co-ordinator
- National co-ordinators

Initial distress message

Navigational warning co-ordinator

SAR co-ordinator

NAVTEX co-ordinator

Meteorological message co-ordinator

Ice monitoring meteorological offices

TRANSMITTER

<table>
<thead>
<tr>
<th>OPERATOR SELECTION</th>
<th>RECEIVER 518 kHz</th>
<th>AUTOMATIC FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELECT geographic area</td>
<td>MICROPROCESSOR = DECODER</td>
<td>ASSESS signal quality</td>
</tr>
<tr>
<td>SUPPRESS UNWANTED optional information</td>
<td>PRINTER</td>
<td>COMPARE with memory</td>
</tr>
<tr>
<td>SUPPRESS UNWANTED messages</td>
<td></td>
<td>REJECT inadequate/unwanted messages</td>
</tr>
</tbody>
</table>
which appears in the preamble of each message. (the code is B1, B2, B3, B4) The standard format for NAVTEX message is given in Figure 5.

5.3 VHF EQUIPMENT:

This equipment contains a digital selective calling (DSC) unit, which together with a suitable VHF radio equipment, provides a complete shipborne VHF radio system for automatic or manual operation within the digital selective calling system for use in maritime mobile VHF service. The unit includes the following:— (Figure 6)

a. A modem for coding decoding of digital selective calls, along with a central processor sub-unit for implementing the different call formats.

b. An interface sub-unit for automatic channel control of the connected VHF radio equipment, hard copy printing and data collection.

c. An audio alarm when a digital selective call is received.

d. The received digital selective call is displayed on the front panel display, these calls can be stored in an internal memory.

e. VHF digital selective distress call from the ship can simply be initiated by pressing DISTRESS button on the front panel. The controller unit also provides facilities for including additional information concerning the distress situation in the distress call.

f. The internal register stores various information like identity number of coast station, telephone numbers, etc.
Figure 6: Example of VHF DSC equipment

Source: IMO Publication No. ISBN 92-801-1216-3
An INMARSAT enhanced group call ship earth station receiver is a single channel receiver with a dedicated message processor and printer. It has been designed in such a way that it guards continuously the transmission of important marine safety information such as navigational and meteorological warnings, weather forecasts and other urgent information beside commercial messages, subscription news services, etc.

The operation of the enhanced group call receiver will be very simple. The selection of the appropriate EGC carrier (ocean satellite transmitter) could be automatic or manual. Operator interface could be limited to a simple telephone type key. Figure 7 shows the prototype receiver. The basic operation control would permit the selection of message type to be received, e.g. navigational, meteorological, etc. It would not be possible to deselect ALL SHIP messages such as distress alerts. The controls would also be used to select languages, alphabets and geographical areas of interest for which the ship wished to receive messages. In order to avoid ALL SHIPS messages to be printed, ships updated position must be regularly fed into the system receiver. More sophisticated receivers are likely to be interfaced to the ship's electronic position-fixing system, so that EGC receivers will continuously be updated. The use of way points could also be used to determine the geographical areas of interest for message reception along the vessels intended track. This way the EGC receivers would operate completely automatically and print out all relevant messages after the start of the voyage. When a distress message is received an audio alarm will sound which can only be reset manually.

The enhanced group call has been developed by the International Maritime Satellite Organization which enables the provision of a unique global automated service capable of
Figure 7: Example of INMARSAT enhanced group call system receiver

Source: IMO Publication No. ISBN 92-801-1216-3
addressing messages to a predetermined group of ships or all vessels in a fixed (e.g. NAVAREA:) or variable geographical areas. (Figure 8)

The system is able to meet the requirements of broadcasting anywhere in the world of global, regional or local navigational warnings, meteorological warnings and forecasts and shore to ship distress alerts. Beside covering the mid-ocean areas, the enhanced group call system can also provide an automated service in coastal waters where it is not feasible to establish the NAVTEX service due to very low traffic flow.

The useful feature of this system is its ability to direct a call to given geographical area. The area may be fixed, as the case of NAVAREA or weather forecast area, or it may be uniquely defined to suit the needs of a country, such as local storm warnings or a ship to shore distress alert, for which it is inappropriate to alert all ships in the ocean. The capabilities of the enhanced group call system are shown in Fig. 9.

The enhanced group call messages can be broadcasted to the appropriate ocean region through a coast earth station, from an authorized subscriber according to the priority e.g. distress, urgency, safety, routine and commercial correspondence.

The enhanced group call system messages will be received on the ship by EGC receiver as a stand-alone device or as an optional equipment fitted to INMARSAT Standard-A ship earth stations. (It could be an in-built feature of future ship earth stations.)

In the EGC system each INMARSAT satellite transmits a single carrier on a designated channel, which insures that all navigable waters of the world can be covered by the three operational satellites of the International Maritime Satellite
Figure 8: Basic concept of the INMARSAT enhanced group call system

Source: IMO Publication No. ISBN 92-801-1216-3
Organization (Fig. 9). Any ship within the coverage area of a particular satellite will receive all messages addressed to it over the EGC channel.

The transmission will enable the signal to be monitored by any type of ship earth station, including a small receive only ship earth station, which might be dedicated to the reception of the ship within the ocean region, atmospheric conditions or time of the day.

The maritime safety information calls could be made to a geographical area. These calls would be received by those ships whose receivers are set to accept a fixed area message or ships within a temporary geographical areas. The reception of certain messages, such as distress alerts, navigational and meteorological warnings, would be mandatory and could not be suppressed. In case of NAVAREA warnings the ships would select those areas for which they want to receive the message (Fig. 10).

Access to the EGC system will only be granted to the message originators by the various coast earth station operators and would include the search and rescue authorities, NAVAREA coordinators and designated meteorological forecasting centres.

In order to avoid the dependence on international telecommunications network a regional co-ordination center (RCC) with the approval of the national authorities, could install a ship earth station at their premises to transmit distress alerting messages to an appropriate coast earth station (CES) for further transmission in the normal enhanced group call manner.
Figure 9: Coverage of INMARSAT satellites (0 and 5 degree elevation contours)

Source: IMO Publication No. ISBN 92-801-1216-3
Figure 10: Area group call addressing

Source: IMO Publication No. ISBN 92-801-1216-3
5.5 L-BAND EPIRB SATELLITE SYSTEM:

The L-band Emergency Position Indicating Radio Beacon (EPIRB) system operates in the 1.6 GHz frequency band through the INMARSAT geostationary space segment which has been tested by the interim working party of the International Radio Consultative Committee (CCIR) during the period 1982-1983. The pre-operational demonstrations will be submitted to IMO for consideration with a view to preparing a equivalent provision whereby ships operating in the Global Maritime Distress and Safety System areas A-1, A-2, and A-3 may carry an L-band EPIRB instead of mandatory 406 MHz satellite EPIRB. The basic concept of the system is shown in Figure 11. The system employs a float-free satellite EPIRB, INMARSAT satellite and INMARSAT coast earth station with additional receiver and processing equipment.

The system provides a quick distress alerting (within two minutes by the EPIRB) and the coverage is within Latitudes 70 degrees north and south, with 20 simultaneous alerts within a span of 10 minutes and the possibility of manual or automatic entry and updating of navigational data to the EPIRB. The EPIRB can be activated either automatically or manually, when floating free. After activation, the satellite EPIRB transmits the distress message containing the ship station identity, position information and additional information is repeated on a preselected duty cycle. (Figure 12)

After the L-band EPIRB distress signal is relayed by the satellite, the signal is down-converted at the coast earth station to the specified intermediate frequency to be transferred to the computer-aided multi-channel receiver for satellite EPIRB identification and message detection. After identification of signal channels, they are assigned to processor channels and after the evaluation of incoming
Figure 11: Basic concept of the L-band satellite EPIRB system

Source: IMO Publication No. ISBN 92-801-1216-3
Figure No. 12: Example of L-Band Satellite EPIRB

Source: IMO Publication No. ISBN 92-801-1216-3
signals such as error correcting code, the message is then printed. The distress message is then forwarded to an associated Regional Co-ordination Centre (RCC).

5.6 406 MHz BEACONS: (ELT/EPIRB/PLB OF COSPAS-SARSAT SYSTEM)

The basic concept of COSPAS-SARSAT system is given in Figure 13. There are at present three types of beacons, namely ELT (emergency locator transmitter) which is airborne, EPIRB (emergency position indicating radiobeacon) which is used in maritime search and rescue, and PLB (personal locator beacon) used at land. These beacons transmit signals that are detected by the COSPAS-SARSAT polar-orbiting spacecraft equipped with suitable receivers. The signals are then relayed to a ground receiving station termed as a Local Users Terminal (LUT) which processes the signals to determine the beacon location. An alert is then relayed, together with the location data, via a mission control centre (MCC), either to the national rescue co-ordination centre (RCC), another mission control centre or to the appropriate search and rescue authority to initiate search and rescue activities.

The carrier frequency transmitted by the beacon is quite stable during the period of mutual beacon-satellite visibility. The frequencies currently in use are the 121.5 MHz international aeronautical emergency frequency and 406 MHz frequency is used in maritime search and rescue. The 406 MHz beacons are more sophisticated than the 121.5 MHz beacons because of the inclusion of identification codes in the messages. (Fig. 14)

Once the satellite receives the 406 MHz beacon signals, the doppler shift is measured and the beacon digital data recovered from the beacon signal. This information is converted into digital data, and transferred to the repeater downlink for transmission to any local user terminal (LUT) in
Figure No. 13: Basic concept of COSPAS-SARSAT system

Source: IMO Publication No. ISBN 92-801-1216-3
Figure No. 14: Examples of ELT/EPIRB operating on 406 MHz in the COSPAS-SARSAT system

Source: IMO Publication No. ISBN 92-801-1216-3
view. The data is simultaneously stored on the space-craft for later transmission. Low altitude near-polar orbiting satellites are used for world coverage over a period of time and shorter interval between the successive passes. An optional homing device can be integrated with the 406 MHz beacon to enable suitably equipped search and rescue forces to home in on the distress beacon.

121.5 MHz Beacons:
This type of beacons operating on 121.5 MHz frequency are already in widespread use. These beacons are used by aeronautical industry based on the standards of International Civil Aviation Organization.

5.7 SURVIVAL CRAFT RADAR TRANSPONDER:

This transponder is known as SART which provides a mean of locating a survival craft in the system. It operates on 9 GHz frequency band and generates a series of information signals when intercepted by any ordinary 9 GHz shipborne or airborne radar. The ships radar does not require any modification. (Figure 15)

The search and rescue transponder can be fitted in the survival craft permanently or it can operate in a float-free position or it could be incorporated into a float-free satellite EPIRB. It can be activated manually or automatically when placed in water.

When activated in a distress situation, it responds to radars by producing a swept frequency signal which operates as a line of 20 blips on a radar screen extending on 8 nautical miles outward from the position of SART's along its line of bearing. This signal is easily recognized and rescue vessel can approach easily to pick up the survivors.
Figure 15: Example of survival craft radar transponder

Source: IMO Publication No. ISBN 92-801-1216-3
The search and rescue transponder should have sufficient battery capacity to operate in the standby condition for 96 hours and be able to operate within the temperature range of -20 degree Celsius to +55 degree Celsius. It should operate correctly when interrogated by shipborne radar with an antenna height of 15 metres from a distance of up to 10 nautical miles. For airborne radars with at least 10 kW peak output power it should operate at a height of 2500 metres and a distance of 30 nautical miles.

5.8 INMARSAT SHIP EARTH STATION (STANDARD-A):

INMARSAT Standard-A ship earth station consist of two parts, above-deck and below-deck equipment (Fig. 16). The above-deck equipment includes a parabolic antenna, about 0.85 to 1.2 metre in diameter, mounted on a platform and stabilized, so that the antenna remains pointed at the satellite regardless of ships motion. It can also include a solid state L-band power amplifier, L-band low noise amplifier. The below-deck equipment consists of an antenna control unit. Communication electronics used for transmission, reception, access control, signalling, telephone and telex equipment.

The Standard-A above-deck equipment is less than 50 kg, which makes it suitable for installation on most types and sizes of ships and yachts. The equipment consists of various optional features like facsimile, data and slow-scan television. The unit contains a microcomputer with a visual display unit, alphanumeric keyboard, hard copy printer and a modem. The computer can be used for preparing telex messages with the ease of modern word-processing equipment. Messages can be composed, edited and transmitted directly from the screen or stored for later transmission. In some cases, the computer memorizes the satellite's coordinates and coast earth station traffic and routes the call automatically in a most economical way.
Figure 16: INMARSAT Standard-A Ship Earth Station

Source: Ocean Voice, January 1987
Additional facility like automated vessel reporting can be incorporated in the terminal for vessel management system. Those involved ashore in this system can dial the ship at any time of the day or night and they can automatically receive the information regarding ships position, course and speed as well as data on its cargo and operation. This is done without disturbing or distracting the Master or the crew. A distress message generator can be built into a terminal for the storage of basic essential information of the ship and automatic transmission in a distress situation.

5.9 INMARSAT SHIP EARTH STATION (STANDARD-C):

The Standard-C ship earth station has been developed by the International Maritime Satellite Organization and a prototype (Fig. 17) is a digital data only terminal for message transmission. This prototype terminal measures 30 cm x 22 cm x 11 cm has an integral antenna with its own radome, approximately 8 cm in diameter and 5 cm high and weighs only 6.2 kg. Production models are expected to be even smaller.

This low powered terminal with its omnidirectional antenna and light weight will be the practical solution even for the smallest type of ships to install Standard-C ship earth station, thus bringing benefits of satellite communications within the reach of all mariners. This will enlarge the user community, while providing equal access to existing and emerging satellite services to all seafarers. However, the Standard-C equipment will not provide voice communication but access to the international telex/teletex network, electronic mail service and computer data base will be available.

Additionally the Standard-C equipment could serve as a back-up for a Standard-A ship earth station on a large ship, where it can play the vital role of a fixed or portable transmitter/
Figure 17: Prototype of INMARSAT Standard-C Ship Earth Station

Source: IMO Publication No. ISBN 92-801-1216-3
receiver for use on board or in survival craft. The characteristics of its omnidirectional antenna could prove very valuable for a vessel in distress, and operating with a severe list. A distress message generator can be included in the terminal software for storage of basic essential information of the vessel, and automatic transmission in a distress situation.

5.10 COAST EARTH STATION (CES):

Ship to shore communication, as well as shore to ship is established through a coast earth station which provides a link between satellites and the terrestrial telecommunications networks. Coast earth stations are owned and operated by signatories of INMARSAT convention. (Figure 18)

A typical coast earth station consists of the following main units:-

a. The antenna which is about 11-14m in diameter.

b. Radio frequency equipment and baseband/intermediate frequency equipment.

c. Access, control and signalling equipment along with the complex software. (see Figure 19)

The antenna is used for transmission of signals to the satellite at 6 GHz and for reception from satellite at 4GHz. For L-band transmission (1.6 GHz) and reception from satellite (1.5 GHz) either the same antenna is used or another antenna is dedicated for this purpose. In order to maintain the communication link with the satellite, the antenna must follow the satellite movement accurately. For this purpose each antenna has a tracking system that detects the satellite movement. The tracking system is monitored continuously and audio
Figure 18: INMARSAT coast earth station

Source: IMO Publication No. ISBN 92-801-1216-3
Fig. 19: Example of coast earth station ground facilities for receiving and processing EPIRB signals

Source: IMO Publication No. ISBN 92-801-1216-3
and visual alarms will indicate if the contact with the satellite has been lost.

Upto 1st May 1986 there were 16 INMARSAT coast earth stations in operation, 7 for Atlantic ocean region, 5 for Indian ocean region and 4 for Pacific ocean region. (Fig. 20)

Atlantic Ocean: Southbury (USA)
Goonnihly (UK)
Umm-al-Aish (Kuwait)
Pleumeur Bodou (France)
Tangua (Brazil)
Fucino (Italy)
Odessa (USSR)

Indian Ocean: Yamaguchi (Japan)
Eik (Norway)
Odessa (USSR)
Thermopylae (Greece)
Nakhodka (USSR)

Pacific Ocean: Santa Paula (USA)
Ibaraki (Japan)
Singapore
Nakhodka (USSR)

Three coast earth stations namely Southbury (USA), Yamaguchi and Ibaraki (Japan) are serving as network co-ordination stations, which assign telephone channels to ship earth stations and coast earth stations on demand and monitor signals transmitted by these stations.
Figure 20: INMARSAT Coast Earth Stations around the world.

Source: IMO Publication No. ISBN 92-801-1216-3
Control Centres, and to provide data exchange within the COSPAS-SARSAT system and to the search and rescue networks. The data handled falls into two general categories known as Alert Data and System Information.

Alert data is the term used for COSPAS-SARSAT 121.5 and 406 MHz data derived from distress beacon information. The data comprises of beacon location (for 406 MHz beacons) and other information such as beacon identification data and coded information.

System Information is mainly used to keep COSPAS-SARSAT operating efficiently and to provide the users with the most accurate and timely alert data possible. It consists of tabulated data (ephemeris and time calibration) which is used to determine beacon locations, the current status of subsystems, and co-ordination messages for the operation of COSPAS-SARSAT system.

The COSPAS mission control centre in the Soviet Union is responsible for the co-ordination of all COSPAS activities and provides the link through the SARSAT mission control centres for all interaction with the SARSAT system. The COSPAS mission control centre computes and sends its satellite ephemeris data to other mission control centres and local user terminals, and receives, processes and transmits the ephemeris and time calibration data from the SARSAT mission control centre to the COSPAS local user terminals.

A SARSAT mission control centre in United States has been designated for the co-ordination of SARSAT satellite operations, which calculates 406 MHz beacon locations using stored data received from ground stations, distributes ephemeris data, processes time calibration data and forwards the appropriate results to other mission control centres. This SARSAT mission control centre results to other mission control
5.11 LOCAL USERS TERMINALS (LUT):

A local users terminal can be of different type and capacity according to the specific requirements of a country, but the COSPAS and SARSAT spacecraft downlink signal formats ensure interoperability between the various spacecraft and all local user terminals meeting COSPAS-SARSAT specifications. There are two types of local user terminals:-

a. First type processes the 121.5 MHz signals downlinked by repeater and those preprocessed by the 406 MHz system.

b. Second type is a simple terminal that will process local and global mode 406 MHz signals only.

In the local user terminal the antenna and the receiving system picks up the signal which is down-converted to an intermediate frequency (IF) and linearly demodulated to produce the composite band spectrum, which is filtered and separated into various bands of interest. As the signal is received, the processing of each band is completed according to the specific capabilities of the local user terminal. In some terminals a analog tape recorder is provided as a back up mode in the event of processor failure (Fig. 21). The data received from the satellite memory during each pass of 406 MHz can be processed within a few minutes of pass completion. For 121.5 MHz signal each transmission is detected and Doppler shift calculated and this data is used to determine the beacon location.

5.12 MISSION CONTROL CENTRE (MCC):

Mission Control Centre operates with a Local Users terminal. The main function of the centre is to collect, store and sort the data from the local user terminal and other Mission
Figure 21: Example of local user terminal/mission control centre and equipment of local user terminal of the COSPAS-SARSAT system.

Source: IMO Publication No. ISBN 92-801-1216-3
Table 3 – Functions of MCCs
Source: IMO Publication No. ISBN 92-801-1216-3
centres. This SARSAT mission control centre acts as a main point of contact for system operational contact between SARSAT and the COSPAS mission control centre. (see Table 3)

Various search and rescue agencies in different countries participated in determining the overall performance of the COSPAS-SARSAT system, during a two-phase test programme. In the first phase the technical evaluation consisted of engineering tests carried out under controlled conditions. The second phase of demonstration and evaluation was done by the search and rescue agencies. Following parameters were considered during the second phase of demonstration and evaluation of over 5000 beacons:

- beacon detection probability
- beacon location probability
- beacon location error
- ambiguity resolution
- capacity
- coverage
- notification time

The results of system performance are given below:

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>121.5 MHz</th>
<th>406 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection probability</td>
<td>(not applicable)</td>
<td>0.98</td>
</tr>
<tr>
<td>Location probability</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Location accuracy</td>
<td>17.2 Km.</td>
<td>90% within 5 Km</td>
</tr>
<tr>
<td>Ambiguity resolution</td>
<td>0.73</td>
<td>0.96</td>
</tr>
<tr>
<td>Capacity</td>
<td>10</td>
<td>90</td>
</tr>
</tbody>
</table>

Beacon Detection Probability:
It is the probability of a local user terminal receiving at least one beacon message with a correct code-protected section from the first tracked satellite for 406 MHz frequency.
Beacon Location Probability:
For 406 MHz frequency, it is defined as the probability of detection and decoding of at least four individual message bursts during a single satellite pass so that the doppler curve-set estimate can be generated by local user terminal. For 121.5 MHz beacons it is the probability of location during a satellite pass above 10 degree elevation with respect to the beacon. It relates to two solutions ("true" and "mirror") not a single unambiguous result.

Beacon Location Accuracy:
It is the difference between the calculated location and actual location using the doppler shift.

Ambiguity Resolution Probability:
It is the ability of the system to select the true location rather than the mirror location.

Capacity:
It is the number of beacons in common view of the spacecraft which the system can process simultaneously.

Coverage:
The real time coverage of Local User Terminals operational in 1986 is shown in Fig. 22. The 121.5 MHz system operates in real time only, while the 406 MHz system works in both real time and stored data mode. The overall coverage provided by COSPAS-SARSAT system in real time mode is determined by the number and location of Local User Terminal, each covering an area of approximately 2500 Km in radius. At present there are 15 Local User Terminals situated in 7 countries. (Canada = 4, USSR = 4, USA = 3, France = 1, Norway = 1, UK = 1, Brazil = 1)
Notification Time:
It depends upon the following parameters:

- Satellite Constellation
- LUT Configuration
- Beacon Location Relative to a LUT
- Beacon Latitude
- Ground Communication Network

The detailed evaluation of the notification time has to be done with a full constellation of four satellites are available and the ground communication network is fully developed, however, the tests carried out so far indicate a mean time of approximately one and a half hour for the real time mode, and one hour in stored data mode.

5.13 RESCUE CO-ORDINATION CENTRE:

In order to take the full advantage of global maritime distress and safety system it is necessary that an efficient rescue co-ordination centre be established according to the needs of the country. This centre or centres should be able to utilize the integrated satellite and terrestrial communications in rescue co-ordination work as well as interconnecting links between various rescue co-ordination centres, associated coast stations, INMARSAT coast earth stations and COSPAS-SARSAT ground stations. (Table 4)

The interconnecting links between rescue co-ordination centres is normally provided through public switched networks or dedicated circuits. If sufficient access is not available through public switched network, the rescue co-ordination centre should be equipped with an INMARSAT ship earth station.
### Table 4: Action of the “First RCC”

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert/call received in RCC</td>
<td>Where practicable communicate with ship in distress</td>
</tr>
<tr>
<td>NO</td>
<td>Advise ships in vicinity by broadcasts</td>
</tr>
<tr>
<td>YES</td>
<td>Co-ordinate assistance to ship in distress</td>
</tr>
<tr>
<td>NO</td>
<td>Continue to communicate with ship in distress until other RCC in direct touch</td>
</tr>
<tr>
<td>YES</td>
<td>If incident in own SRR?</td>
</tr>
<tr>
<td>NO</td>
<td>Is there an RCC in a better position to assist?</td>
</tr>
<tr>
<td>NO</td>
<td>Is incident in another SRR?</td>
</tr>
<tr>
<td>YES</td>
<td>Is the other RCC prepared to accept responsibility for the incident?</td>
</tr>
<tr>
<td>YES</td>
<td>Transfer co-ordination responsibilities to other RCC</td>
</tr>
</tbody>
</table>

Source: IMO Publication No. ISBN 92-801-1216-3
CHAPTER VI

THE ROLE OF RADIO OFFICER IN FUTURE
6.1 GENERAL:

The use of satellite communications to improve maritime safety is much discussed subject and is particularly important to the marine radio officer, whose role will be radically changed by the introduction of a Global Maritime Distress and Safety System.

Present maritime communications rely heavily on the use of Morse telegraphy and although this is supplemented by Telex-over Radio the system remains labour intensive, mainly due to the watchkeeping requirements which occupy eight hours per day. These arrangements have evolved over a number of years and take account of propagation problems, commercial requirements and safety. Ships sailing the oceans need to communicate directly with company head office and the radio station must therefore be manned to accommodate time differences, at the same time taking account of permitted work hours, generally accepted as eight hours per day.

The radio watch is governed by International Law in the interest of safety, since the present distress system depends on self help. Ships in distress transmit a general alarm, alerting other ship and shore stations who can then render assistance. The greater the number of ships physically monitoring the international distress frequency the greater the likelihood of a week distress signals being received. Certainly this was true when Morse telegraphy was the only means of communication and the 500 kHz callband was crowded and noisy.

Introduction of new services such as RT and HF did not significantly help to relieve congestion in the MF Band which remains the principal means of establishing short and medium range communication. Following the inquiry into the loss of the Titanic, a Convention was signed in 1914 which made fitting of radio mandatory on board all passenger ships and cargo ships
above 1600 grt and this Convention became Law in 1919.

Shipowners did not readily accept this additional cost to their operations and reached in different ways, depending on the trade in which their ships were engaged. Those owners who saw no commercial advantage in radio tried to make the service as cheap as possible, while others used it as management tool to increase operating efficiency. This diverse opinion still exists despite major technological change and is reflected in the approach some shipowners and ship managers have to the development of technology in the shipping industry.

Since the mid-1960's there has been an increase in automation on board ship, resulting in such concepts as unmanned machinery space and remote control cargo-handling. Developments in navaids such as radar have been rapid and today's micro technology has provided the means to simplify the operation of long-range communication equipment. During this time British marine radio officers have taken advantage of educational and training facilities to extend their knowledge and ability in order to become competent technicians, capable of maintaining a variety of shipboard electronic systems. The question today is what role the radio officer should play.

To remain competitive, western shipping needs automation and the resulting reduction in operating costs. The question remains whether duplication and triplication of automatic systems is cost effective. Recent studies have indicated that it may not be the case, since the failure of one system can often adversely affect another. Ships also spend more time on sea passage than in port and this trend is becoming increasingly prevalent as more and more cargoes become "boxed".

It is essential, therefore, that electronic diagnostic ability be present on board ship in order to ensure effective repair during limited time in port and to provide efficient system
management. The radio officer has accumulated a high level of skill which, if properly harnessed, can lend itself productively to the shipping industry. That can be achieved by making use of satcoms and GMDSS principles.

6.2 SATELLITE COMMUNICATIONS:

The satellite communications system is free of the propagation problems associated with conventional communications and can provide a means of instantaneous alert. Satellite Epirbs will soon become available and this will further enhance maritime safety. The system is, however, still young and many problems are yet to be overcome, not the least of which is setting up global search and rescue facilities in order to expedite rescue. The satellite Epirb is still being developed and tested voluntary fitting has started and the minimum acceptable performance standards for ship-to-satellite alerting under adverse conditions associated with distress situations are still to be set. A combination of geostationary and polar orbiting satellites for Epirb operation will provide the means of full global coverage for distress alerting.

Satellite communications often depends for safety and distress signalling on the vagaries of the international and national terrestrial telecommunications system, since presently there are few coasts earth stations (CES) and selection for routing purposes is therefore limited at present. Some CESs however, are now connected directly to the nearest available RCC and this reduces the potential for any disruption. In addition, rescue centres could be fitted with ship earth stations, such as the Argentine RCC at Puerto Belgrano. The INMARSAT system also provides for ship-to-ship direct working in the satellite system, again reducing the potential for delay.

The present 500 kHz altering system will remain prominent for some considerable time in the interest of global maritime
safety, since it is possible that shipowners will fit satcoms largely on new tonnage or sophisticated existing specialist tonnage such as gas/oil tankers, quick turn-round container ships and passenger vessels. Many smaller vessels, however, have already fitted INMARSAT ship earth stations.

Coincident with the development of maritime satcoms has been the introduction and forthcoming mandatory carriage requirement of automatic radar plotting aids (ARPA) on board ship, which will come into force on 1st September 1987, for non-tankers constructed before 1st September 1984 of 20000 - 40000 tons gross, as per SOLAS amendment of Chapter V. Both depends to some extent on microprocessor technology, digital/analogue techniques and gyro compass input. While the long communication system has been simplified operationally, it become technically more complex, as have navaids. Both systems, being automatic, must be properly and carefully maintained if they are always to be available and, to ensure this, international standards are being set. The microprocessors circuitry and technology used on satcoms and ARPA is, in fact, similar to those used in other automated shipboard electronic systems.

The GMDSS was conceived in 1979 and planned to be in place by 1991. Almost certainly this target date will not be met on a global basis. During at least the next decade, therefore, the space and terrestrial distress and safety communications systems will co-exist.

The question remains, then as to how should the industry react. There are two possibilities. One is a unilateral declaration of intent to use the new system and abandon the old. The alternative is the introduction of a properly controlled transitional plan. Of these options, the first is totally contrary to IMO principles and is, therefore, unacceptable. The second, properly and sensibly managed, can provide for improved safety and increased efficiency and is, of
course, IMO’s preferred plan.

In order to develop a transitional plan effectively it is a prerequisite to establish that maritime electronic systems require to be properly maintained by a suitably qualified and competent engineer. Alternatively, all systems related to safety, which will include communications, navaids, alarms and surveillance equipment, must have adequate redundancy and isolation built in.

During the next decade, or until the GMDSS would be fully in process, the present distress system must be maintained to some extent if all ships are to be protected. The alerting facility provided by satcoms, however, can improve the ability of ships to respond and locate. The need for human monitoring of 500 kHz on vessels so fitted could therefore be modified, provided that the 500 kHz autoalarm remained in operation throughout the sea passage. The radio officer could then be released from statutory watch keeping.

Interestingly, it is already apparent that simplifying and improving long-range maritime communications has increased the volume of traffic. This can be further encouraged by introducing electronic office systems on board ship. To manage these systems requires new computer software skills.

\[ 6.3 \text{ MAINTENANCE COURSE:} \]

Already the UK administration has introduced an Electronic Navigation Equipment Maintenance (ENEM) Certificate which can be related to recognised industrial electronic engineering qualifications. Radio officers taking advantage of this training may gain new skills in microprocessor technology by virtue of involvement with ARPA and satcoms. Many radio officers during the past decade have retrained as electronics officers and already possess these skills. The prime objective
of this course is to impart the knowledge and skill, of software techniques, operational use and maintenance of electronic navigational equipment on board the modern vessels, to find the fault of the equipment to component or printed circuit board level, depending upon the design of the equipment and the resources available on the vessel.

The advantage to the shipping industry in considering the development of the radio officer during the next decade may be summarised as follows:-

a. Wireless telegraphy skill remains on board, thus satisfying global SOLAS and is a reserve back-up in event of failures.

b. The human watchkeeping arrangements may be modified where satcoms and Epirbs are provided.

c. The new and old systems are harmoniously maintained in old ships.

d. The ship's complement includes an electronic systems engineer.

e. The systems engineer has communications skills.

f. The communicator has administrative ability.

So, while recognising that the requirement for a full-time electronic maintenance engineer is unlikely, nevertheless the increased volume of communications will undoubtedly result in the need to dedicate a crew member partly to this function. Consider therefore, the general purpose electronics officer who will be:
a. electronic system engineer  
b. communications manager  
c. information technology manager  

The resulting productivity envisaged should not be overlooked when compared with built-in redundancy. The systems engineer will be responsible for maintenance of electronic systems and will provide technical support in all areas. The communications manager will ensure cost effective communications by selecting and advising the best circuits to suit specific needs and will be the dedicated communicator in emergencies.

The range of circuits will include:

- Morse Telegraph
- TOR
- Radiotelephone
- Satcoms
- NBDP

- HF & MF
- HF & MF
- VHF, HF & MF
- TLX & TFN
- Tlx (will eventually replace Morse telegraphy)

The application of information technology to areas such as compiling spare-parts lists, stores lists, mailing schedules, port papers, etc., will reduce time spend on administration. The data collected can be processed and stored before being forwarded saving time and reducing costs on communication circuits.

The short term cost of training should justify long-term productivity and in recognition of cash flow problems in some areas, training should be arranged in modular form which can be built up into a whole, rather than long, expansive residential courses. Comprehensive electronic knowledge is
available. All that is required is departure from traditional policy in order to stimulate the industry.

With the introduction of Global Maritime Distress and Safety System the reliance on Morse telegraphy will gradually disappear, the general purpose electronics officer will become integrated into ship operations and it may be that further productivity could be achieved by providing the facility to obtain a deck watch certificate. This suggests that, ultimately, the specialist shipboard disciplines and duties of existing ships officers will become part specialised and part inter-departmental, within a framework of flexibility and co-operation.

From 1st July 1986, the Maritime Administration in Pakistan has stopped the entry of fresh Radio Officers in Pakistan flag vessels. Due to recent world wide slump in the shipping industry, which has resulted in large number of ships lying idle, a large number of Pakistani radio officers working in foreign flag vessels have become redundant.

With the introduction of Global Maritime Distress and Safety System which requires entirely different techniques for a radio officer in the field of satellite communications, electronic navigational aids, computer software and search and rescue operations.

In order to train the new generation radio officer for international market, a comprehensive program for their training should be worked out whereby they should be fully equipped with the knowledge of radio communication, electronics and computer software, to enable them to deal with the modern equipment maintenance and repairs. In addition to the watchkeeping duties required in the communication systems they could also act as co-ordinators as envisaged in the global maritime distress and safety system and INMARSAT requirements.
This type of arrangements could provide Pakistan with a corps of trained radio officers available for international market as well as for Pakistan flag vessels.
CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS
7.1 CONCLUSION:

Terrestrial radiocommunications have been an important ingredient in the maritime safety for three-quarters of a century. However, in order to take advantage of the capabilities offered by new technology to improve communications in all distress and safety situations, the Global Maritime Distress & Safety System is being developed by the International Maritime Organization under the INMARSAT convention the International Maritime Satellite Organization has an institutional obligation to cooperate closely with the IMO in the improvement of distress and safety of life at sea communications.

Where as the present system for maritime distress communication relies primarily on the capability of a ship in distress to alert another ship for assistance, the Global Maritime Distress and Safety System places primary emphasis on alerting shore search and rescue authorities for co-ordinated rescue operations. New technology has made it possible for satellite communication to play a major role in the safety of a mariner. A series of satellite communication tools is becoming available that will enable the master of a ship to perform all medium and long range communications functions which have been identified as requirements for improved safety of life at sea. (Touko Habio, 4th IMLA Conference on Maritime Education and Training, Kotka, Finland, September 1986)

In the light of the various factors analysed in this paper and the points enumerated above it is pertinent to draw the following conclusions:

1. The introduction of satellite communications has greatly enhanced the maritime search and rescue capabilities.

2. The traditional method of alerting vessels in distress
(ship to ship) in future will be changed and the responsibility will be shifted to shore authorities.

3. Navigational and Meteorological warning service, Navtex, Telex and Telephone service will eliminate the morse radio telegraphy, making the Radio Officer redundant.

4. Each State will have its own Search and Rescue Organization infrastructure and trained personnel for saving lives at sea or ashore.

5. All safety information to the vessels will be provided automatically.

6. Instead of Morse Code radiotelegraphy, digital selective calling and narrow band direct printing will be used.

7. Congestion and reception difficulties as well as the uncertainty of messages being received will be eliminated.

8. The equipment required under the Global Maritime Distress & Safety System are designed for simple operation and the equipment will be largely automated.

9. At present none of the Pakistani flag vessels is equipped with INMARSAT Ship Earth Station Standard-A or Standard-C.
7.2 RECOMMENDATIONS:

1. Pakistan should ratify the International Convention on Maritime Search and Rescue 1979, with arrangements of establishing a National Search and Rescue Agency. The organizational set up of the agency should be institutionalized after the ratification, convening in accordance with the policy of the Government of the Islamic Republic of Pakistan.

2. A maritime rescue co-ordination centre at Karachi should be established along with the maritime rescue sub-centres at Ormara, Pasni and Gwadar to safeguard the safety of life at sea of Pakistani fishermen and vessels sailing within the Exclusive Economic Zone of Pakistan.

3. The maritime rescue co-ordination centre should be equipped with the INMARSAT ship earth station to avoid delays with the public switch network and to help in the rapid exchange of distress and safety information between various RCC's.

4. A Local Users Terminal (LUT) in cooperation with the Space and Upper Atmospheric Research Corporation (SUPARCO) should be established to receive transmission from COSPAS-SARSAT satellites and to process the information for beacon positioning and passing it to RCC.

5. Joint exercises in co-operation with Pakistan Navy, Maritime Security Agency and Pakistan Coast Guard should be conducted regularly for search and rescue operations.

6. In the interest of safety of life at sea, safeguarding economic resources and prevention of marine pollution, Pakistan should built a centre for ship reporting system for vessels entering and leaving Pakistan's Exclusive Economic Zone. The centre should operate on the lines of
IMO assembly resolution A.531(13) adopted on 17th November 1983.

7. Due to the geographical location of Pakistan, considerable benefits could be gained by all the neighbouring countries in the region from co-operative agreements for Maritime Search and Rescue.

8. A comprehensive training programme for presently trained Radio Officers for their upgrading should be started in the operation, and maintenance of equipment and computer software techniques.

9. Future incumbent in the communication department of vessels should hold a B.E. (Electrical/Electronics). They should be trained in basic nautical knowledge for receiving and communicating in the distress and safety situation as well as acting as co-ordinator as envisaged in the International Convention on Maritime Search and Rescue.

10. Short courses for Masters and Officers at the Pakistan Marine Academy should be arranged in the operation and procedures of the Global Maritime Distress and Safety System.

11. Pakistani flag vessels should start amortizing the equipment and future ships should be equipped as per implementation schedule of the Global Maritime Distress and Safety System, in accordance with the anticipated time scale in Table 5 and cost estimates in Table 6.
## TABLE 5: ANTICIPATED TIME SCALE FOR INTRODUCTION OF THE GMDSS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EQUIPMENT AND SYSTEMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 <strong>Associated with satellite communications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) INMARSAT communication system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Ship earth stations, Standard-A</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>or as alternative</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Ship earth stations, Standard-C</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>(b) Satellite EPIRBs system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Polar orbiting system</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>2 Geostationary system*</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) INMARSAT enhanced group call system**</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>2.1 <strong>Associated with terrestrial communications systems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Digital selective calling (i) HF/MF (DSC) equipment</td>
<td>A/B</td>
<td>B</td>
<td>C</td>
<td>B/C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>(ii) VHF</td>
<td>A</td>
<td>A/B</td>
<td>A/B</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>(b) Survival craft equipment</td>
<td>I</td>
<td>I</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>(c) 9 GHz radar transponder</td>
<td>I</td>
<td>I</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>(d) Nav. &amp; met. warning system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) MF (NAVTEX)</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>(ii) HF</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 <strong>SHORE-BASED COMMUNICATIONS AND SAR ARRANGEMENTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Co-ordinated communications network</td>
<td>E</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>2.2 Development and implementation of international SAR plan</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
<td>E/F</td>
</tr>
<tr>
<td>2.3 Development and implementation of shore-based GMDSS equipment</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>C</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>3 <strong>INTERNATIONAL AGREEMENTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Revision of ITU Radio Regulations</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>MWIARC</td>
<td>H</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>3.2 Amendments to IMO Conventions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Amendments to the 1974 SOLAS Convention</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>expanded MSC</td>
<td>H</td>
<td>G/J</td>
<td>G/J</td>
</tr>
<tr>
<td>(b) Amendments to the 1978 STCW Convention</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>expanded MSC</td>
<td>H</td>
<td>G/J</td>
<td></td>
</tr>
<tr>
<td>3.3 IMO Assembly resolutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) On the introduction of the GMDSS</td>
<td>E</td>
<td>Assembly</td>
<td>G</td>
<td>G</td>
<td>G/J</td>
<td>G/J</td>
<td>G/J</td>
<td>G/J</td>
</tr>
<tr>
<td>(b) On GMDSS equipment performance standards</td>
<td>E</td>
<td>Assembly/</td>
<td>E/G</td>
<td>Assembly/</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
</tbody>
</table>

**KEY:**
- A - Research and development
- B - Development of performance standards and practical testing
- C - Voluntary fitting and use for distress purposes
- D - Installed in accordance with the revised provisions of the 1974 SOLAS Convention
- E - Preparation and development
- F - Implementation
- G - Provisions in force
- H - Period for entry into force
- I - Requirement under further consideration
- J - Amortization of old equipment begins

* Subject to consideration of results of tests and pre-operational demonstration.
** Subject to completion of tests and cost assessment of the service.

Source: IMO Publication No. ISBN 92-801-1216-3
### Table 6: Provisional Cost Estimates for GMDSS Equipment

<table>
<thead>
<tr>
<th>No.</th>
<th>Equipment</th>
<th>Equipment</th>
<th>Estimated cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VHF radiostation capable of voice and digital selective calling (DSC) communications</td>
<td>VHF DSC</td>
<td>5500</td>
</tr>
<tr>
<td>2</td>
<td>MF radiostation capable of voice and DSC communications</td>
<td>MF DSC</td>
<td>7400</td>
</tr>
<tr>
<td>3</td>
<td>MF/HF radiostation capable of voice, DSC and direct printing communications</td>
<td>HF DSC + radiotelex</td>
<td>11,100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NBDP</td>
<td>150,000</td>
</tr>
<tr>
<td>4</td>
<td>NAVTEX receiver</td>
<td>NAVTEX</td>
<td>1,000</td>
</tr>
<tr>
<td>5</td>
<td>INMARSAT ship earth station (SES)</td>
<td>INMARSAT coast earth station</td>
<td>30,000</td>
</tr>
<tr>
<td></td>
<td>Standard-A</td>
<td>Standard-C</td>
<td>30,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5,000</td>
</tr>
<tr>
<td>6</td>
<td>Satellite EPIRB (406 MHz)</td>
<td>COSPAS-SARSAT local user terminal</td>
<td>500-1,000</td>
</tr>
<tr>
<td>7</td>
<td>VHF EPIRB</td>
<td>INMARSAT satellite CES</td>
<td>2,000</td>
</tr>
<tr>
<td></td>
<td>Survival craft equipment</td>
<td>EPIRB processing equipment</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SAR transponder</td>
<td>Ship earth station</td>
<td>500-1,000</td>
</tr>
<tr>
<td></td>
<td>Portable VHF equipment (two sets)</td>
<td>for use at RCC</td>
<td>2,000</td>
</tr>
</tbody>
</table>

1 Cost estimates are considered accurate within ± 30% and include 15% installation costs.

2 The estimated total cost of equipment for ships depends on carriage requirements which are defined in accordance with each ship's area of operation. The estimated total cost of equipment for ships sailing in GMDSS areas will be:

<table>
<thead>
<tr>
<th>Area</th>
<th>Cost range (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>9,100 - 10,100</td>
</tr>
<tr>
<td>A1 + A2</td>
<td>16,500 - 17,500</td>
</tr>
<tr>
<td>A1 + A2 + A3</td>
<td>27,600 - 28,600</td>
</tr>
<tr>
<td>A1 + A2 + A3 + A4 without SES</td>
<td>46,500 - 47,500</td>
</tr>
<tr>
<td>A1 + A2 + A3 + A4 with SES Standard-A</td>
<td>21,500 - 22,500</td>
</tr>
<tr>
<td>A1 + A2 + A3 + A4 with SES Standard-C</td>
<td>27,600 - 28,600</td>
</tr>
<tr>
<td>A1 + A2 + A3 + A4 without SES</td>
<td>32,600 - 33,600</td>
</tr>
<tr>
<td>A1 + A2 + A3 + A4 with SES Standard-A</td>
<td>57,600 - 58,600</td>
</tr>
<tr>
<td>A1 + A2 + A3 + A4 with SES Standard-C</td>
<td>6,600 - 6,600</td>
</tr>
</tbody>
</table>

For comparison, the cost of providing a radiotelegraph station meeting the minimum requirements of the 1974 SOLAS Convention, as amended, is in the order of $25,000 for the equipment. However, in most cases extra equipment is also provided and the average cost of equipment fitted is $35,000. The cost of providing equipment for ships obliged to carry only a radiotelephone installation to the minimum requirements of the SOLAS 1974 Convention, as amended, are in the order of $36,000 for the equipment and, if HF RT is included, $13,000.

3 It has yet to be decided whether these costs should be included in estimates since “regional use” can be made of existing coast earth stations which also provide non-distress communications and COSPAS-SARSAT local user terminals will be used on shared basis with other services. The same could apply to HF DSC.

Source: IMO Publication No. ISBN 92-801-1216-3
BIBLIOGRAPHY

1. Focus on International Maritime Organization
   (IMO and Radio at Sea)
2. The Journal of Maritime Satellite Communication
   Ocean Voice
4. The Radio Officer in the Age of Satellite
   G.M. Mochrie
5. Radio Communication in the Global Distress and Safety System
   Touko Hahkio (Fourth IMLA-Conference on Maritime Educa­
   tion and Training in Kotka, Finland, 1986)
6. The International Maritime Organization News
   Issue No. 2 of 1986 (Radio Communications - 31st Session)
   Issue No. 1 of 1987 (Radio Communications - 32nd Session)
7. INMARSAT Role in the global Maritime Distress and Safety
   System, J.L. Fear
8. The Progress of Safety
   R.Y. Winkelman
9. WMU Lecture Notes on INMARSAT
10. Global Maritime Distress and Safety System
    IMO Publication
11. Introduction to GPS-NAVSTAR Position Accuracy
    M. Jurdzinski, Merchant Marine Academy, Gdynia, Poland
12. Starfix, an RDSS Satellite System
    J.H. Mulders, Maritime Teachers Training College,
    Amsterdam, Holland
13. WARC - MOB/87 Conference
<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Item</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Ships Carriage Requirements for the Present System (SOLAS 74)</td>
<td>4</td>
</tr>
<tr>
<td>02</td>
<td>Basic Ship Carriage Requirements for the System</td>
<td>8</td>
</tr>
<tr>
<td>03</td>
<td>Functions of MCC's</td>
<td>98</td>
</tr>
<tr>
<td>04</td>
<td>Action of First RCC</td>
<td>103</td>
</tr>
<tr>
<td>05</td>
<td>Anticipated Time Scale for the Introduction of GMDSS</td>
<td>119</td>
</tr>
<tr>
<td>06</td>
<td>Provisional Cost Estimates for GMDSS Equipment</td>
<td>120</td>
</tr>
</tbody>
</table>
LIST OF ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Serial No.</th>
<th>Title of Figures</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>General Concept of Global System</td>
<td>2</td>
</tr>
<tr>
<td>02</td>
<td>Geographical Areas for Co-ordinating and Promulgating Radio-Navigational Warning with Area Co-ordinators noted in Parenthesis</td>
<td>9</td>
</tr>
<tr>
<td>03</td>
<td>Example of MF/HF DSC Equipment</td>
<td>65</td>
</tr>
<tr>
<td>04</td>
<td>Example of Navtex Receivers</td>
<td>67</td>
</tr>
<tr>
<td>05</td>
<td>Structure of Navtex Service</td>
<td>68</td>
</tr>
<tr>
<td>06</td>
<td>Example of VHF/DSC Equipment</td>
<td>70</td>
</tr>
<tr>
<td>07</td>
<td>Example of INMARSAT Enhanced Group Call System</td>
<td>72</td>
</tr>
<tr>
<td>08</td>
<td>Basic Concept of INMARSAT Enhanced Group Call System</td>
<td>74</td>
</tr>
<tr>
<td>09</td>
<td>Coverage of INMARSAT Satellites (0 &amp; 5 Degree Elevation)</td>
<td>76</td>
</tr>
<tr>
<td>10</td>
<td>Area Group Call Adressing</td>
<td>77</td>
</tr>
<tr>
<td>11</td>
<td>Basic Concept of L-Band Satellite EPIRB System</td>
<td>79</td>
</tr>
<tr>
<td>12</td>
<td>Example of L-Band Satellite EPIRB</td>
<td>80</td>
</tr>
<tr>
<td>13</td>
<td>Basic Concept of COSPAS-SARSAT System</td>
<td>82</td>
</tr>
<tr>
<td>14</td>
<td>ELT/EPIRB Operating on 406 MHz in COSPAS-SARSAT System</td>
<td>83</td>
</tr>
<tr>
<td>15</td>
<td>Example of Survival Craft Radar Transponder</td>
<td>85</td>
</tr>
<tr>
<td>16</td>
<td>INMARSAT Standard-A Ship Earth Station</td>
<td>87</td>
</tr>
<tr>
<td>17</td>
<td>Prototype of INMARSAT Standard-C Ship Earth Station</td>
<td>89</td>
</tr>
<tr>
<td>18</td>
<td>INMARSAT Coast Earth Station</td>
<td>91</td>
</tr>
<tr>
<td>19</td>
<td>Example of Coast Earth Station Ground Facilities for Receiving and Processing EPIRB Signals</td>
<td>92</td>
</tr>
</tbody>
</table>