



Focus on IMO



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Shipping Emergencies - Search and Rescue and the GMDSS

When maritime nations gathered together in 1914 to develop the first international shipping safety convention, following the loss of the **Titanic** two years earlier, the focus was not just on preventing shipping accidents but also improving the chances of survival if one should occur. That conference resulted in the adoption of the International Convention for the Safety of Life at Sea (SOLAS), which included regulations on provision of life-saving equipment and the safety of navigation.

SOLAS, which has since been revised and updated many times, later came under the auspices of the United Nations International Maritime Organization (IMO), which assumed global responsibility for shipping when it came into being in 1959. While accident prevention is a major goal of the Organization, IMO has also concentrated efforts on developing world-wide, integrated systems to respond to shipping emergencies. The most significant of these are the **International Convention on Maritime Search and Rescue (SAR)** and the **Global Maritime Distress and Safety System (GMDSS)**.

The GMDSS - which became fully effective from 1 February 1999 - is essentially a worldwide network of automated emergency communications for ships at sea. It means that all ocean-going passenger ships and cargo ships of 300 gross tonnage and upwards must be equipped with radio equipment that conforms to international standards as set out in the system. The basic concept is that search and rescue authorities ashore, as well as shipping in the immediate vicinity of the ship in distress, can be rapidly alerted through satellite and terrestrial communication techniques to a distress incident so that they can assist in a coordinated SAR operation with the minimum of delay.

The 1979 SAR Convention was designed to provide a global system for responding to emergencies and the GMDSS was established to provide it with the efficient communication support it needs. Both the GMDSS and SAR are crucial to maritime safety and they are designed to ensure that any emergency at sea will result in a distress call and the response to that call will be immediate and effective. The days when a ship could vanish without trace should then be ended.

This paper includes the following sections:

- **Maritime Search and Rescue (SAR)**
- **The GMDSS**
- **The future - problems to be solved**
- **SAR/GMDSS - the achievements**

- **Main components of the GMDSS**

Maritime Search and Rescue (SAR)

Although the obligation of ships to go to the assistance of vessels in distress was enshrined both in tradition and in international treaties (such as SOLAS), there was, until the adoption in 1979 of the International Convention on Maritime Search and Rescue (SAR), no international system covering search and rescue operations. In some areas there was a well-established organization able to provide assistance promptly and efficiently, in others there was nothing at all.

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

IMO was charged with improving this situation and, 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. It was adopted by the IMO Assembly in 1971 under the title of the Merchant Ship Search and Rescue Manual (MERSAR). It was updated several times with the latest amendments being adopted in 1992 - they entered into force in 1993.

MERSAR provided guidance for those who, during emergencies at sea, may require assistance from others or who may be able to provide assistance themselves. In particular, it was designed to aid the master of any vessel who might be called upon to conduct SAR operations at sea for persons in distress.

In 1978, the Maritime Safety Committee (MSC), IMO's senior technical body, adopted a second manual called the IMO Search and Rescue Manual (IMOSAR) to help Governments to implement the International Convention on Maritime Search and Rescue. The manual provided 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. It was also updated in 1992, with the amendments entering into force in 1993.

The manual was 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. MERSAR was also aligned, where appropriate, with IMOSAR.

The MERSAR and IMOSAR manuals have now been replaced with a combined manual, published in three volumes, called the International Aeronautical and Maritime Search and Rescue (IAMSAR) manual.

SAR Convention

In 1979, a conference convened by IMO in Hamburg adopted the **International Convention on Maritime Search and Rescue** (SAR Convention), which entered into force in 1985. The aim was to develop an international SAR plan, so that, no matter where an accident occurs, the rescue of persons in distress at sea will be co-ordinated by a SAR organization and, when necessary, by co-operation between neighbouring SAR organizations.

Co-operation of this type is encouraged by SOLAS 1974, Parties to which undertake "to ensure that any necessary arrangements are made for coast watching and for the rescue of persons in distress round its coasts. These arrangements should include the establishment, operation and maintenance of such maritime safety facilities as are deemed practicable and necessary".

The SAR convention contains six chapters:

- Chapter 1 - Terms and Definitions.
- Chapter 2 - Organization - dealing with the basic structure of a search and rescue organization.
- Chapter 3 - Co-operation - dealing with co-operation between States in carrying out SAR operations and co-ordination with aeronautical services.
- Chapter 4 - Preparatory Measures - dealing with preparatory measures to be taken by RCCs (Rescue Co-ordination Centres) and RSCs (Rescue Sub-Centres) and the state of preparedness of rescue units.
- Chapter 5 - Operating Procedures - Parties are required to maintain continuous watch on international distress frequencies and detailed requirements are given concerning the action to be taken by coast radio stations which receive distress messages. Detailed procedures for RCCs and RSCs are given.
- Chapter 6 - Ship reporting systems - contains recommendations on establishing ship reporting systems for search and rescue purposes.

The technical requirements of the SAR Convention are contained in an Annex. Parties to the Convention are required to ensure that arrangements are made for the provision of adequate SAR services in their coastal waters.

Parties are encouraged to enter into SAR agreements with neighbouring States involving the establishment of SAR regions, the pooling of facilities, establishment of common procedures, training and liaison visits. The Convention states that Parties should take measures to expedite entry into its territorial waters of rescue units from other Parties.

The Convention then goes on to establish preparatory measures which should be taken, including the establishment of rescue co-ordination centres and sub-centres. It outlines operating procedures to be followed in the event of emergencies or alerts and during SAR operations. This includes the designation of an on-scene commander and his duties.

Parties to the Convention are encouraged to establish ship reporting systems, where these are deemed necessary, under which ships report their position to a coast radio station. This enables the interval between the loss of contact with a vessel and the initiation of search operations to be reduced. It also helps to permit the rapid determination of vessels which may be called upon to provide assistance including medical help when required.

Under the Convention, the world's oceans have been divided into 13 areas for search and rescue purposes.

Implementation of the SAR Convention

The SAR Convention was designed to provide the framework for search and rescue operations. It and the two associated manuals, together with other resolutions and recommendations adopted at the 1979 Conference, should ensure that such operations are conducted with maximum speed and efficiency, no matter where the distress incident occurs. But its effectiveness depends almost entirely on how well it is implemented and this depends in turn on the action taken by Parties to the Convention.

Because the Convention imposes considerable obligations on Parties - such as setting up the shore installations required - the Convention has not been ratified by as many countries as some other treaties. By the end of 1997, for example, the SAR Convention had been ratified by only 56 countries, whose combined merchant fleets represented less than 50% of world tonnage. Equally important, many of the world's coastal States had not accepted the Convention and the obligations it imposes.

As a result, the development of SAR plans in the 13 areas has been relatively slow and by 1995 - ten years after the Convention entered into force - provisional SAR plans had only been drawn up for nine regions.

It was generally agreed that one reason for the small number of acceptances and the slow pace of implementation was due to problems with the SAR Convention itself and that these could best be overcome by amending the Convention. A meeting was held in October 1995 in Hamburg, Germany to consider the problem and it was agreed that there were a number of substantial concerns that needed to be taken into account, including:

- lessons learned from SAR operations;
- experiences of States which have implemented the Convention;
- questions and concerns posed especially by developing States which are not yet Party to the Convention;
- needed improvements to the two IMO SAR Manuals which are prevented by the present wording of the Convention;
- need to further harmonize the IMO and ICAO SAR provisions;
- difficulties in finalizing the IMO SAR Plan which result from present provisions of the Convention; and
- inconsistent use of Convention terminology and phraseology.

The Sub-Committee on Radio-Communications and Search and Rescue (COMSAR) was requested to revise the Convention. A draft text was prepared and was approved by the 68th session of the MSC in May 1997, and was then adopted by the 69th MSC session in May 1998. The revised Convention is due to enter into force on 1 January 2000.

Revised SAR Convention

The revised SAR Convention clarifies the responsibilities of Governments and puts greater emphasis on the regional approach and co-ordination between maritime and aeronautical SAR operations.

It is hoped the revised Convention will be more acceptable to those States which have not yet ratified the 1979 SAR Convention - as of 1 February 1999, the SAR Convention had been ratified by only 60 countries, whose combined merchant fleets represent less than 50% of world tonnage.

The revision applies to the main body of the Convention, contained in the Annex.

The terms and definitions contained in Chapter 1 have been updated and Chapter 2, which deals with Organization and Co-ordination, has been re-drafted to make the responsibilities of Governments clearer. The new text requires Parties, either individually or in co-operation with other States, to establish basic elements of a search and rescue service, which are defined as:

- a legal framework;
- assignment of a responsible authority;
- organization of available resources;
- communication facilities;
- co-ordination and operational functions; and
- processes to improve the service, including planning, domestic and international co-operative relationships and training.

Parties are required to establish rescue co-ordination centres and to operate them on a 24-hour basis with trained staff having a working knowledge of English.

Under the revised Chapter 2, Parties are required to "ensure the closest practicable co-ordination between maritime and aeronautical services".

IMO and the International Civil Aviation Organization (ICAO) have established a Joint Working Group on the harmonization of aeronautical and maritime SAR operations, which has prepared the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual to replace the earlier Merchant Ship Search and Rescue Manual (MERSAR) and the IMO Search and Rescue Manual (IMOSAR).

- The IAMSAR Manual is being published in three volumes, dealing with Organization and management, Mission co-ordination and Mobile Facilities.

Other Chapters in the revised SAR Convention deal with Co-operation between States (Chapter 3) and Operating Procedures (Chapter 4), which incorporates the previous Chapters 4 (Preparatory Measures) and 5 (Operating Procedures).

Chapter 4 gives procedures to be followed, such as during initial action, emergency phases, initiation of search and rescue operations when the position of the search object is unknown and co-ordination of SAR activities. The revised Chapter 4 says that "Search and rescue operations shall continue, when practicable, until all reasonable hope of rescuing survivors has passed".

The original Chapter 6 (Ship Reporting Systems) has been updated and renumbered as Chapter 5.

It says that ship reporting systems should provide up-to-date information on the movements of vessels in the event of a distress incident to help the SAR activities.

Developing the global SAR plan

During the last few years, a major effort has been made to improve the implementation of the SAR Convention, particularly in facilitating the preparation of a global search and rescue plan, which is the ultimate objective of the Convention.

Starting in 1981, IMO organized a series of seminars and conferences in order to prepare and agree SAR plans for the oceans' 13 search and rescue areas, including the delimitation of individual countries' search and rescue regions for which they are responsible.

This process was concluded in September 1998 when an integrated SAR plan for the Indian Ocean was agreed at a conference held in Fremantle, Western Australia, based on regional plans adopted earlier at conferences in Tokyo and Cape Town.

The conferences and seminars have also provided the countries concerned with the opportunity to address training needs for SAR as well as the adequacy of shore-based facilities in the particular region for implementation of the GMDSS.

The table below shows the seminars and conferences that have been held.

SAR and the GMDSS - seminars and conferences organized by IMO			
Venue and Year	SAR Area	Type of Meeting	Result
Barbados 1981 Caracas 1984	Caribbean Sea Ditto	Seminar Conference	Preparation of provisional SAR plan Agreement on a provisional SAR plan
Jakarta 1984 Tokyo 1986	Asia and Pacific Ditto	Seminar Conference	Preparation of provisional SAR plan Agreement on a provisional SAR plan
Lagos 1984 Lagos 1991	Eastern South Atlantic Ditto	Seminar Conference	Preparation of provisional SAR plan Agreement on a provisional SAR plan
Sharjah 1992 Mombasa 1992 Cape Town 1996	North West Indian Ocean South West Indian Ocean West Indian Ocean	Seminar Seminar Conference	Preparation of provisional SAR plan Preparation of provisional SAR plan Agreement on a provisional SAR plan
Lisbon 1994	Atlantic Ocean	Conference	Agreement on an integrated provisional SAR plan
Varna 1994 Istanbul 1996 Valencia 1997 Ankara 1998	Black Sea Ditto Ditto Ditto	Seminar Conference Conference Conference	Preparation of provisional SAR plan Preparation of provisional SAR plan General agreement on a provisional SAR plan Signing of an Agreement on co-operation regarding maritime SAR services
Toulon 1995 Valencia 1997	Mediterranean Sea Ditto	Seminar Conference	Preparation of provisional SAR plan General agreement on a provisional SAR plan
Seoul 1997	Pacific Ocean	Conference	Agreement on an integrated provisional SAR plan
Fremantle 1998	Indian Ocean	Conference	Agreement on an integrated provisional SAR plan

The Global Maritime Distress and Safety System (GMDSS)

The SAR Convention has provided a global plan for carrying out SAR operations. What it cannot do is to improve the communications which are so important in search and rescue operations. That is where the **GMDSS** comes in.

The GMDSS was introduced by means of amendments to SOLAS which were adopted in 1988 and entered into force on 1 February 1992. It became fully operational on 1 February 1999.-On that date, the Morse Code was phased out and all passenger ships and all cargo ships of 300 gross tonnage and upwards on

international voyages are now required to carry equipment designed to improve the chances of rescue following an accident, including satellite emergency position indicating radio beacons (EPIRBs) and search and rescue transponders (SARTs) for the location of the ship or survival craft.

GMDSS Countdown
Between 1 February 1992 and 1 February 1999 existing ships can comply with the Chapter IV of SOLAS in force prior to 1 1992 or the GMDSS.
All ships have been required to carry a NAVTEX (transmission of maritime safety information) receiver and satellite EPIRBs (emergency position-indicating radio beacons) since 1 April 1993
Ships built on or after 1 February 1995 must comply with all applicable GMDSS requirements
On 1 February 1999 all passenger ships and all cargo ships of 300 gross tonnage and upwards on international voyages must comply with the GMDSS

The GMDSS was designed to have a major impact on safety at sea and has already saved many lives. The different systems involved offer great flexibility and will certainly develop in the future as new technology is introduced. But it is based on an invention made just over a hundred years ago and which was first used for a rescue at sea in 1899 - **radio**.

The development of radio

Until the invention of radio, there was little a ship could do if it was in trouble on the high seas, except set off flares and hope a ship in the vicinity would see and come to the rescue. The invention of radio by Guglielmo Marconi in 1895, and the subsequent development of the technology of radiocommunication through the efforts of several other scientists, created a revolution in maritime communications.

The importance of radio to maritime safety can hardly be exaggerated. The introduction of telephony and telegraphy was of little use at sea, since they both depended upon cables and once a ship was out of sight of land it was effectively cut off from all contact with other persons, except for the chance sighting of another vessel.

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.

In 1903, a radio conference met in Berlin to consider preliminary studies for the international regulation of radio-communications. One of the main decisions made was to require coast radio stations 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. 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.

Titanic disaster

This 1906 conference laid the basis for the development of radiocommunications at sea. The increasing number of accidents at sea showed the importance of radiocommunications in saving lives. The most famous of these occurred in 1912 when the **Titanic** sank with the loss of more than 1,500 lives. Although 700 lives were saved when the liner **Carpathia** picked up the **Titanic**'s distress message, the death toll may have been reduced had the **Californian**, which was a relatively short distance from the scene, done the same. Unfortunately her radio officer was off duty.

Three months after the **Titanic** disaster, another international radio conference met, this time in London. 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.

At the 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 (for "*Save Our Souls*") 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 "m'aider" which simply means "help me".)

1914 SOLAS Convention

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.

By the autumn of 1914 Europe was at war, and as a result the convention did not enter into force. In 1929, the second SOLAS conference was held, again in London, and it adopted a convention that entered into force in 1933. Although the convention followed the same pattern as the 1914 version, 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 radiotelegraph automatic alarm and the 1929 convention allowed some exceptions regarding watchkeeping for ships fitted with such a device. Another regulation required larger passenger ships to have some lifeboats equipped with radio equipment.

By 1948, however, the SOLAS Convention was becoming outdated and so a new conference was called to adopt a third version. Unlike its predecessor, it made the carriage of a radio installation a requirement for all passenger ships and for cargo ships of 500 gross tonnage and above. The new convention also took into account other developments in radiocommunications, including **radio-telephony** on ships of 500-1,600 gross tonnage and radio direction finding.

The **radiotelephone** was already decades old. 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 and it became the only means of communication between all ships, radiotelegraphy being generally restricted to the larger ships.

Another major advance in radio-communications 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.

IMO revises SOLAS Chapter IV

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 radiocommunications were concerned but the regulations of chapter IV, entirely dedicated to communications at sea for distress and safety purposes, 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), another specialized agency of the United Nations system. In SOLAS 1960, a radiotelephone station was made mandatory on all ships of 300-1,600 gross tonnage, unless fitted with a radiotelegraph station.

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 1 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, as necessary, and adopting various recommendations, IMO has been able to keep pace with most of the developments taking place in maritime radiocommunications. The carriage of VHF radiotelephony (which had been recommended by IMO since 1975) was made mandatory on all ships of 300 gross tonnage and above by the 1981 amendments to SOLAS 1974.

The trouble with radio

Radio has helped to save the lives of tens of thousands of people involved in maritime disasters, but conventional terrestrial radio does have a number of serious drawbacks that had become more apparent when IMO met for the first time in 1959. They included the following:

- Reception difficulties: the quality of some messages can be adversely affected by changes in propagation conditions.
- Uncertainty of the message being received: the maximum range of the mandatory telegraphy and telephony equipment is only about 250 kilometres. A message transmitted from a ship in mid-ocean is therefore unlikely to be received on shore. The service is primarily a ship-to-ship service and depends on another ship being within range.¹
- The need for specialization: Morse telegraphy, the basis of the radio service, required many years of training and practice. If something happened to the radio operator, it was unlikely that anyone else on board would be able to use the telegraphy equipment.
- Congestion: the development of radio on land meant that competition for frequencies became fierce. There was little chance of the frequencies allocated for maritime purposes being increased.

It would have been difficult if not impossible to solve these problems using technology in existence in the 1950s, but, within a few years of IMO's first meeting, the solution suddenly appeared: in 1962 when the world's first telecommunications satellite, Telstar, was launched.

The introduction of satellite communications

Satellites offered a number of advantages over conventional radio systems. One of the most important is the fact that they offer a solution to the problem that radio messages travel in straight lines. Because they do not follow the curve of the Earth's surface eventually they disappear into space (except on HF). Radio messages sent via a satellite also travel in straight lines - but they can immediately be re-directed from the satellite back to Earth, greatly extending the range of communications. Instead of a ship sending out a distress alert and hoping that another ship is near enough to hear, satellites enable the message to be sent to a satellite and then back to a dedicated station on land that is designed and equipped to deal with such emergencies.

In February 1966, the MSC 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 (ITU) invited IMO to continue this work.

By 1971, IMO's studies had advanced sufficiently for it to submit two recommendations to the ITU conference on space telecommunications. They specified, among other things, that maritime satellite

¹Using High Frequency (HF) equipment solves the problem of range, but HF equipment was not a mandatory requirement before the GMDSS. With HF, the ionospheres of the earth act as a "mirror", reflecting radio waves back to earth.

communications could be used for the exchange of information by telephony and telegraphy, including data transmissions, direct printing and facsimile.

In particular, it was already recognised that satellites offered great advantages in alerting and locating ships in cases of distress or emergency; facilitating search and rescue operations; issuing safety and urgency messages, and a number of other functions such as automatic reporting of ships' positions, 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.

New maritime satellite system

IMO decided to start work on the establishment of a new maritime satellite communications system and in 1973, the IMO Assembly adopted two resolutions which were to form the basis of the Organization's future work in this area - one authorizing the MSC to develop a distress system; and one calling a conference to establish a maritime satellite organization.

The conference first met in 1975 and held three sessions, the last of which, in 1976, resulted in the adoption of the Convention on the Establishment of the International Maritime Satellite Organization (Inmarsat).

The Convention entered into force in 1979 and Inmarsat became operational in February 1982, when it took over the system operated by the MARISAT Joint Venture, an American company which had pioneered the use of satellites for merchant shipping.

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. The Inmarsat system offered advantages which could not be provided by terrestrial radiocommunications.

The present Inmarsat system utilizes geostationary satellites, two positioned above the Atlantic Ocean, and one each over the Indian Ocean and the Pacific Ocean. From these four positions, satellites virtually cover the globe as far north and south as 75 degrees. Only the Polar regions, where shipping is infrequent, are excluded.

Inmarsat advantages

One of the advantages of the Inmarsat system, from the shipowners' point of view, is the business opportunity it provides. Inmarsat not only provides good quality radiotelephone channels, it also provides a service for telex, facsimile and high-speed data transmission. Moreover, there is guaranteed privacy of communications between ship and owner - an important point in a commercial operation - whereas terrestrial radio messages can be overheard by anyone with the right receiver. Communications in either direction are simple and in many countries the ship can be contacted by merely dialling the appropriate telephone number.

The system also provides for reception of medical advice and assistance, meteorological reports and weather forecasts, navigational reports and warnings and ship position reports.

From IMO's point of view, Inmarsat's most important function is the provision of improved distress and safety communications. By using the Inmarsat system, a ship can send a distress message and know with certainty it will be received.

With Inmarsat established, it was possible to start work in earnest on the development of a future distress system. The IMO Sub-Committee on Radiocommunications began working on this proposed future global distress system in September 1978.

Much of the work was concerned with developing the necessary amendments to the International Convention for Safety of Life at Sea, 1974 (SOLAS), especially Chapter IV, which deals with radiocommunications.

New distress system policy

In 1979, resolution A.420(XI) was adopted by the IMO Assembly and established IMO policy for the new system. Its main recommendations were as follows:

- In order to provide an effective link between the international radiotelegraph distress frequency (500 kHz) and the radiotelephone distress frequency (2,182 kHz) all ships subject to the requirements for radiocommunications under the SOLAS Convention (basically this means cargo ships of 300 gross

tonnage and above and all passenger ships) should be fitted with radiotelephone equipment and be required to keep a continuous listening watch on 2,182 kHz.

- SOLAS Convention ships should be fitted with a maritime VHF installation and where practicable maintain watch on 156.8 MHz (Channel 16). This would also increase the possibility of distress messages transmitted by small craft equipped only with VHF equipment being received by larger ships. An amendment to the SOLAS Convention requiring VHF to be fitted on all passenger ships and on cargo ships of 300 gross tonnage and upwards and to require those ships to keep a continuous listening watch on Channel 16 entered into force in 1984.
- The carriage of emergency position- indicating radio beacons (EPIRBs) should be required. Float-free EPIRBs are designed to give an automatic distress signal when a ship sinks suddenly. They are also provided for use in some survival craft for manual operation by survivors.
- A selective calling system should be implemented. This is a system whereby individual ships or groups of ships can be automatically connected with a station that has a message for them and vice-versa.
- Narrow-band direct printing for the promulgation of navigational and meteorological warnings should be introduced.
- Equipment performance should be improved and training should be in compliance with the requirements of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978 (STCW).

These recommendations formed the basis for developing the distress system - by now known as the GMDSS.

The 1988 SOLAS amendments

In November 1988 a decade of work reached a successful conclusion when a conference held at IMO headquarters adopted amendments to the SOLAS Convention and the 1978 Protocol. The amendments were intended to introduce the GMDSS into the Convention. The date chosen for entry into force, under the SOLAS "tacit acceptance" provisions, was 1 February 1992, with a phase-in period to 1 February 1999.

The basic concept of the GMDSS is that search and rescue authorities ashore, as well as shipping in the immediate vicinity of the ship in distress, will be rapidly alerted to a distress incident so they can assist in a co-ordinated search and rescue operation with the minimum of delay.

The system also provides for urgency and safety communications and the dissemination of maritime safety information, including navigational and meteorological warnings. In other words, every ship will be able, irrespective of the area in which it operates, to perform those communication functions considered essential for the safety of the ship itself and of other ships operating in the same area.

Although satellites play an important part in the GMDSS, terrestrial radio is still important. The GMDSS combines various subsystems - which all have different limitations with respect to coverage - into one overall system, and the oceans are divided into four sea areas:

- **Area A1** Within range of VHF coast stations (about 20-30 miles)
- **Area A2** Beyond area A1, but within range of MF coastal stations (about 100 miles)
- **Area A3** Beyond the first two areas, but within coverage of geostationary maritime communication satellites (in practice this means Inmarsat). This covers the area between roughly 70 deg N and 70 deg S.
- **Area A4** The remaining sea areas. The most important of these is the sea around the North Pole (the area around the South Pole is mostly land). Geostationary satellites, which are positioned above the equator, cannot reach this far.

Equipment requirements vary according to the area (or areas) in which the ship operates. Coastal vessels, for example, only have to carry minimal equipment if they do not operate beyond the range of shore-based VHF radio stations. Ships which do go further from land have to carry MF equipment as well as VHF. Ships which operate beyond MF range have to carry HF or Inmarsat equipment in addition to VHF and MF. Ships which operate in area A4 have to carry HF, MF and VHF equipment.

In addition to radio equipment, the GMDSS introduced requirements for other equipment designed to improve the chances of survival, including float-free emergency position-indicating radio beacons (EPIRBs) and radar transponders for location of the ship or survival craft in distress.

How it works

The GMDSS enables a ship which is in distress to send a message in various ways and be virtually certain that it will be heard and acted upon. The distress or safety message is picked up by ships in the area and by shore stations within range if sent on MF and VHF or by shore stations if transmitted using HF, Inmarsat or COSPAS-SARSAT.

While ships can transmit an alert using any or all of the distress equipment available on board, ships transmit a ship-to-ship alert on MF or VHF and a ship-to-shore alert in areas A3 or A4, as appropriate, by a ship earth station, HF digital selective calling (DSC) communications or a satellite EPIRB as appropriate. Ships sailing in area A2 should at least be capable of transmitting a ship-to-shore alert on 2,187.5 kHz using DSC and satellite EPIRB and ships sailing in area A1 should at least be capable of transmitting a ship-to-shore alert on 156.525 MHz (Channel 70) using DSC.

The system means that distress messages are received much more reliably than before. And thanks to the SAR Convention of 1979, search and rescue operations are better co-ordinated.

In the event of an incident, the whole operation is co-ordinated by a designated rescue co-ordination centre (RCC) which is informed of the alert either through the Inmarsat or COSPAS-SARSAT systems or from coast radio stations participating in the GMDSS.

The search itself is conducted according to procedures laid down by the SAR Convention and amplified in the IAMSAR manual. The GMDSS, for its part, provides the means of communications regardless of the area in which the ship is located.

For ships equipped with an Inmarsat ship earth station (SES) sending a distress alert is both simple and certain. It only involves pressing a special distress button or using an abbreviated dialling code. This automatically gives priority access to the system and establishes contact with a coast earth station (CES) via the Inmarsat satellite. The message automatically gives the ship's name and position. The CES, being part of the international search and rescue system, will for its part immediately inform the rescue co-ordination centre (RCC) located nearest to the ship in distress and thereby initiate a search and rescue operation.

Although satellite communications provide a primary means of sending distress messages for ships fitted with an Inmarsat SES, the latter can also use other features of the system if desired - for example they can establish direct contact with an RCC by telex or telephone.

The future - problems to be solved

GMDSS implementation

The full implementation of the GMDSS on 1 February 1999 marked the culmination of almost three decades of work by IMO and its Member States. It signified the realization of the vision and imagination of the pioneers who first saw the possibilities offered by satellite communications for saving lives and improving communications at sea.

The last pieces in the SAR jigsaw have also finally been put in place. The world's oceans are now divided into SAR areas using a standardized procedure for responding to emergencies which is being made even more effective by the GMDSS and the technological developments that have made it possible.

But even so, there are some aspects which have caused concern and need to be dealt with before the GMDSS and the SAR Convention fulfill their undoubted potential.

False alerts

False distress alerts are still a serious problem, causing unnecessary work and cost if search and rescue operations are initiated as a result of such a false alert. In 1996, it was estimated that more than 90 % of distress alerts through some sub-systems were false.

One of the main reasons for false distress alerts is improper use of GMDSS equipment by untrained personnel and the lack of practical experience on board ships by trained personnel. But another factor that has caused concern is the equipment itself, some of which has been criticized as "over complicated and un-user friendly."

IMO adopted a resolution to address the problem in 1995. *Guidelines for the avoidance of false distress alerts* (Resolution A.814(19)) provides guidance to Administrations, manufacturers, educators, users, communications and rescue service providers and all others concerned. It advised that testing procedures should be so designed that testing of the equipment will not result in false alerts; that supplier and installation personnel should have knowledge of the GMDSS and the consequences of transmitting a false alert; and that the activation of any distress alert must be indicated visually and/or acoustically until manually de-activated.

In May 1998, the Maritime Safety Committee (MSC) issued a Circular (MSC/Circ.861) which contains *Measures to reduce the number of false distress alerts*.

In February 1996, two IMO sub-committees were combined to form the Sub-Committee on Radiocommunications and Search and Rescue, to deal with all relevant issues. At its first meeting in 1996, the Sub-Committee took action to reduce the number of false alerts by deciding that automatic and, to a certain extent, semi-automatic relays of distress alerts by Digital Selective Calling (DSC) should not be permitted in the GMDSS. It prepared relevant modifications to the ITU recommendations. The Sub-Committee also issued circulars on the correct use of DSC.

Inmarsat-C/GMDSS installations reportedly also had a number of shortcomings which made them particularly vulnerable to issuing false alerts. As a result, IMO drew attention to the problems - notably that the systems often included commercial equipment that had not been designed for the maritime environment and that GMDSS equipment often incorporated a general purpose computer running non-GMDSS applications.

As a result, IMO has backed calls for existing Inmarsat C terminals to be modified to reduce the likelihood of false distress alerts - for example, making it possible to initiate distress alerts only through a dedicated distress button, which must be clearly marked.

One problem, which may contribute to the high proportion of false alerts recorded, is that manufacturers have adopted different solutions to providing GMDSS equipment. This means that an officer trained on one system may have difficulty transferring to another - where a similarly placed button may have a completely different function, of different keystrokes are used on each system to produce a distress call. IMO has introduced a standard button design, which means that the distress button has to be protected and must be held down for 3 seconds to be activated.

But information from manufacturers and coastal states indicate that, on average, there is only one false alert every 50 years from each of the alarms now available.

At the same time, the GMDSS system makes it possible for the ship in distress to be contacted, to check whether the alert is real or false, before search and rescue operations begin.

Human element

IMO has put increasing emphasis on the human factor in recent years, notably with the 1995 Amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), which entered into force in February 1997, and the International Safety Management Code, which came into force for certain ships on 1 July 1998 and will be extended to all ships in 2002. Both address key people involved in shipping - the seafarers and the people who manage ships.

The STCW revision makes it clear that seafarers must be competent in their area of operation, so this means that on a ship fitted with GMDSS equipment, the master and officers must be trained to use it and to use it properly.

A1 and A2 Sea Areas implementation

Inmarsat and COSPAS-SARSAT services were in place by the early 1990s and the implementation of NAVTEX and SafetyNET services was virtually completed by mid-1997.

However, the provision of GMDSS services in Sea Areas A1 and A2 in most parts of the world is still of concern.

Implementation in these areas is critical to provide an incentive to small ships (below 1600 gross tonnage) to fit GMDSS equipment early. Implementation of facilities in these areas is an obligation on Parties to SOLAS because it is enshrined in the 1988 SOLAS amendments which state that Parties will "make available" appropriate shore-based radio facilities.

As a result, IMO in 1996, invited the International Telecommunication Union (ITU) to urge all its member Administrations to assist in enhancing safety at sea by encouraging all ships and coast stations to use the frequencies and techniques prescribed for the GMDSS as soon as possible, so as to avoid operating the old maritime distress and safety system and the GMDSS in parallel for a long period. Operating two systems this way would create ever-increasing difficulties and incompatibilities between ships operating two different systems.

In some parts of the world Governments have re-defined coastal regions as A3 Sea Areas, but while this may be a solution in areas which have a sparse population and where shipping activity is light it is not possible in most parts of the world. A failure by SOLAS Parties to implement their treaty obligations inevitably puts lives at risk - and it hardly sets a good example to shipowners and the industry.

Non-SOLAS vessels

At the moment, most fishing vessels and recreational boaters are not required to participate in the GMDSS. But they will find many of the services available useful and may want to acquire equipment such as EPIRBs, which must be registered with the appropriate authorities.

Small vessels are also recommended to fit DSC equipment, since once the GMDSS is fully implemented, vessels without DSC will have difficulty contacting ships which are monitoring the DSC calling channel only.

However, in vessel traffic service zones, ships will still be required to maintain a listening watch on the appropriate frequency.

Most fishers and recreational boaters are already carrying VHF marine radios, which they have used to monitor and relay distress messages on the channel 16 distress frequency. However these radios are not generally DSC compatible.

Originally, it was foreseen that the Channel 16 distress frequency could be discontinued by 1 February 1999 as ships and pleasure boats became fitted with GMDSS equipment. However, IMO agreed in 1997 to extend the deadline for watchkeeping on the VHF Channel 16 distress frequency beyond 1 February 1999, as many IMO Member States felt that it was not feasible for the large numbers of non-SOLAS vessels to fit GMDSS equipment by the deadline. As a result, they would be unable to contact SOLAS ships when in distress if those SOLAS ships were no longer maintaining a watch on Channel 16.

The MSC in 1997 instructed the Sub-Committee on Radio-communications and Search and Rescue (COMSAR) to find a suitable date by which watchkeeping on Channel 16 could feasibly be phased out - and in 1998 agreed with the Sub-Committee's recommendation to continue monitoring of the Channel 16 distress frequency to 1 February 2005.

GMDSS training

Concern has also been expressed about training for the GMDSS. Chapter IV of SOLAS, as revised in 1988, requires every ship to "carry personnel qualified for distress and safety radiocommunications purposes to the satisfaction of the Administration". These persons should be issued with appropriate certificates and in passenger ships, during distress incidents "at least one person qualified...shall be assigned to perform only radiocommunication duties".

Some experts have pointed out that making another officer responsible for GMDSS communications - rather than carrying an officer primarily responsible for that function - could have safety implications in the event of a crisis. The officer concerned would have to leave his other duties to concentrate on GMDSS functions at a time when he or she could least be spared.

Evolving technology

The GMDSS and the implementation of the SAR Convention have both been made possible by advances in technology. But technology is continuing to evolve. Much of the work carried out by IMO to develop a global radio-communications system for shipping is based on a resolution adopted in 1979, which in turn took into account technology as it then existed.

Since then a great deal has changed. The invention of the cellular telephone means that

vessels operating in coastal waters can contact the shore by ordinary telephone rather than VHF. This has led to reduced usage of DSC for non-safety purposes, undermining the economics of the system.

However, larger vessels **must** have the radio equipment specified in the GMDSS regulations. For smaller vessels, not covered by the GMDSS, most coastal authorities do not recommend cellular telephones as a substitute for the marine radio distress and safety systems in the VHF maritime radio band.

A VHF radio is more advantageous in that it can also help ensure that storm warning and other urgent marine information broadcasts are received. Furthermore, VHF radio can be used worldwide.

Nonetheless, IMO, through its Maritime Safety Committee (MSC) and Sub-Committees, will continue to monitor new technology and assess how it should best be used in distress and safety situations - and make recommendations accordingly so there is a global, unified approach.

SAR/GMDSS - The achievements

Despite problems, the way the global SAR and maritime distress systems have developed represents a considerable achievement. In the 1950s, rescue at sea depended on methods that had changed very little since the days of the **Titanic**. The changes that have been introduced mean that the days when a ship could disappear without trace or when a distress alert could go unheard are almost at an end.

In the long run, the development of new communication systems will offer shipping great opportunities. The development of global satellite systems which can be used by anyone equipped with a hand-held mobile telephone, could be used by people at sea as well as those on land or in the air. The future, in fact, offers great possibilities for improving shipping safety - which is and will always remain IMO's greatest duty. The fact that the SAR and GMDSS are both in place means that these possibilities can be fully realized.

The GMDSS in operation

The equipment used in the GMDSS and the implementation of the SAR Convention have already proved their worth in a number of rescues at sea. Two examples serve to demonstrate how GMDSS, an integrated search and rescue plan and the right equipment can improve the chances of survival at sea when something goes wrong - whether it is on a pleasure craft or on a merchant ship.

The lone yachtsman

In January 1997, in the freezing waters between Australia and the Antarctic, a lone sailor was rescued after five days adrift when he crawled out from under his capsized yacht to board an inflatable raft dropped by a naval frigate.

Round-the-world yachtsman Tony Bullimore's rescue was not just a matter of luck and survival techniques - his yacht had been equipped with Argos beacons which transmitted his position via satellite to the French ground station then to race headquarters, so positions could be relayed to the maritime rescue co-ordination centre (MRCC) in Canberra, Australia. Bullimore also carried a 406 MHz EPIRB. This meant the yachtsman could be found and rescued, even though his vessel was some 2,600 kilometres (1,600 miles) from land.

The cruise ship

In December 1994, nearly 1,000 people were rescued from the cruise ship **Achille Lauro**, which caught fire as she sailed around the Horn of Africa en route to the Seychelles.

First news of the incident was received at the Norwegian maritime rescue co-ordination centre (MRCC) at Stavanger, when the Dutch livestock carrier **Corriedale Express** sent in an Inmarsat-A call, relaying information received from another ship via 500kHz, that the **Achille Lauro** was on fire and needing assistance. Stavanger MRCC notified all vessels in the area through broadcasts on the Inmarsat systems. Several ships responded and Stavanger appointed the Shell tanker **Lima** as surface search co-ordinator.

As there were no MRCC facilities on the east coast of Africa, Stavanger continued to co-ordinate the rescue from Norway, first plotting the positions and courses of ships in the area.

The first on the scene was the tanker **Hawaiian King**, which established VHF radio contact with the **Achille Lauro** and reported to Stavanger that all passengers and most crew had been evacuated into lifeboats or liferafts.

Hawaiian King took most of the people from the lifeboats and liferafts, while the bulk carrier **Bardu** took the rest from the ship. Stavanger meanwhile kept in contact with the rescue vessels via Inmarsat A and C. The only problem came as media and other authorities tried to get through to the rescue ships - occupying Inmarsat lines and causing Stavanger to lose contact for two hours.. Eventually, Stavanger set up an exclusive telex link with **Lima** and **Hawaiian King** through Telenor's Inmarsat coast earth station at Eik.

As a result of the rescue efforts, nearly 1,000 people were rescued from the burning ship. Two people lost their lives.

Survival at Sea

A Focus paper on **Survival at Sea**, covering the development of IMO regulations covering life-saving appliances and arrangements, is available separately.

The components of the GMDSS

This section includes descriptions of the following:

- **Inmarsat**
- **Enhanced Group Calling (EGC)**
- **Emergency position-indicating radio beacons (EPIRBs)**
- **High frequency (HF) service**
- **Digital Selective Calling (DSC)**
- **Medium-range service**
- **Short-range service**
- **Radar transponders**
- **NAVTEX**
- **Radio personnel**
- **World-Wide Navigational Warning Service (WWNWS)**

Inmarsat

The International Mobile Satellite Organization (Inmarsat) plays a crucial role in the GMDSS. Over the years, advances in technology have enabled the organization to offer various services to shipowners and other users. They include the following:

- **Inmarsat-A:** The Inmarsat-A ship earth station consists of a parabolic antenna (or dish) which is usually mounted on the ship's superstructure, while below deck there is telex and telephone equipment and associated hardware. Some ships may add computers and visual display units (VDUs) to the system.
- **Inmarsat-C:** Inmarsat-C does not provide for voice communications, but it does enable telex operations and distress messages to be relayed in the same way. Its omnidirectional antenna has the advantage of not having to be stabilized and its small size and low cost also makes Inmarsat-C ideal for small craft, such as yachts and fishing vessels. It has been accepted as an alternative to

Inmarsat-A or an HF radio installation for all SOLAS Convention ships operating in GMDSS sea area A3.

- **Inmarsat-E:** This was announced in January 1997 and is also fully compliant with the GMDSS. It combines the position determination of the Global Positioning System (GPS) with Inmarsat's own technology, thereby greatly increasing the speed at which a distress alert can be delivered, since no time is lost waiting for a satellite to appear over the horizon. The system includes float-free and hand-held EPIRBs.

Enhanced group calling (EGC)

Inmarsat offers enhanced group calling (EGC). The dedicated message processor and printer required can be added to a Inmarsat-A or -C receiver or can stand alone, with a separate antenna.

EGC enables messages to be sent to a group of ships, rather than to all ships within range. Messages can be sent, for example, to ships flying a particular flag, or ships in a given geographical area. They may be sent to one ship - or all ships.

An EGC receiver is small and relatively inexpensive and it is also simple to operate. It has a keypad like a push-button telephone and a printer. The message format is similar to that used for NAVTEX.

The ability of EGC to be selective has considerable advantages as far as safety is concerned. For example, it enables messages to be sent to ships in the area nearest to a ship in distress or can enable the RCC to select the fastest (or nearest) ships to respond to a distress call. No other ships would have to be inconvenienced.

Inmarsat have developed two EGC services. The first, called FleetNET, is a commercial service and enables shipowners and others to send information to specific ships. This is done by preceding the message by a special calling code and for additional commercial security the message itself can be encoded.

The second service, called **SafetyNET**, is the one that is of interest to the GMDSS. It enables ships on the high seas in areas not covered by NAVTEX (which has a maximum range of about 500 nautical miles) to receive NAVTEX-type information. It can also be used selectively, so that safety information can be sent to ships in a particular area, rather than all ships. SafetyNET EGC broadcasts are only used by authorized services such as NAVAREA co-ordinators, meteorological offices, rescue co-ordination centres and so on.

Trials of the EGC system in 1987 proved highly successful, with an error rate of close to zero. The trials also showed that receivers and antennas can be produced that are cheap and small enough to be used on small craft of below 300 gross tonnage, such as fishing boats.

EGC is attractive as a means of distributing maritime safety information. NAVTEX may never be provided in some coastal areas where broadcasts of MSI are too few to justify the cost and is not able to serve ocean areas which are out of range. SafetyNET fills in these "blanks" in the NAVTEX system.

Emergency position-indicating radio beacons (EPIRBs)

These devices have been available for many years. They are designed to provide an alert in the event of a sudden disaster: they can be fully automatic so that if a ship sinks, the EPIRB will float free and automatically transmit a distress message. Others are designed to be activated manually and, except when they are used as a second means of alerting, are usually located in or close to survival craft. They will continue to transmit a signal for at least 48 hours after the accident to enable search and rescue units to home in on the signal.

Under the GMDSS, satellite EPIRBs operate either on 1.6 GHz (the Inmarsat frequency) or the 406 MHz frequency used by the COSPAS -SARSAT system, which was established in 1982 and consists of a number of polar-orbiting satellites which provide world-wide coverage. The system, whose Secretariat is based at Inmarsat's London headquarters, enables distress messages transmitted by EPIRBs carried by ships or aircraft to be positioned with a degree of accuracy which enables SAR units to find the persons in distress as quickly as possible.

In 1996, there were more than 125,000 beacons operating at 406 MHz (mostly EPIRBs) as well as 550,000 beacons operating at 121.5 MHz (mostly aircraft ELTs or earth to land transponders). Both together contributed in saving more than 5,000 lives.

The satellite system involves a minimum of four polar orbiting satellites in low altitude polar orbit and there are currently 33 LUTs (local user terminals) or monitoring stations and 19 MCCs (mission control centres) which ensure processing of distress alerts from 406 MHz beacons anywhere in the world.

Because the system's satellites are in a low polar orbit, there may be a delay in receiving the distress message, unless the footprint² of the satellite is simultaneously in view of a monitoring station (LUT). World-wide coverage is only possible with satellite EPIRBs operating on 406 MHz as those operating on the aeronautical emergency frequency 121.5 MHz or 243 MHz can only be received when an LUT is within the satellite's footprint. Signals on 406 MHz are recorded on the satellite and transmitted to an LUT as it comes within the satellite footprint*.

Ships which do not operate in area A4 may be equipped with EPIRBs operating at 1.6 GHz (the L-band). The advantage of L-band satellite EPIRBs is that they provide an instantaneous alert. The disadvantage is that without additional circuitry they do not provide for position updating.

High frequency (HF) service

Not all ships operating in area A3 are equipped with Inmarsat ship earth stations. Those that are not can use HF radiocommunications as an alternative, and even Inmarsat equipped ships need HF radio when out of Inmarsat range (COSPAS-SARSAT is designed purely for EPIRB distress alerts, not two-way communications).

Digital selective calling (DSC)

Distress alerting and safety calling on terrestrial frequencies (HF, MF and VHF) is carried out by means of digital selective calling (DSC).

For distress and safety purposes a number of frequencies have been assigned. They are 2,187.5 kHz in the MF band; 4,207.5 kHz, 6,312 kHz, 8,414.5 kHz, 12,577 kHz and 16,804.5 kHz in the HF bands; and 156.525 MHz (Channel 70) in the VHF band.

The reason for the large number of frequencies in the HF band is that propagation characteristics vary according to the geographical position and time of day and the choice of a frequency will therefore depend on where and when the incident occurs. HF ships keep watch on at least 8,414.5 kHz and also on the HF frequency most suited to the area in which they are sailing. Watch may also be kept on all frequencies by means of a scanning receiver.

DSC distress messages include such information as the identity of the caller (automatically), the nature of the distress (it provides for nine different indicators ranging from fire or explosion to abandoning ship); and the position of the ship and the time, both of which may be automatically included in the message if the ship has position-fixing equipment and a navigation interface.

After the initial distress alert and acknowledgement, subsequent communications are made by radiotelephony or narrow-band direct printing (NBDP) as indicated in the distress message.

Medium-range service

A medium-range service is provided using 2,187.5 kHz for DSC and 2,182 kHz for radiotelephony (the current radiotelephone distress and calling frequency). This is used for SAR co-ordinating functions and on-scene communications, while 2,174.5 kHz is used for distress and safety traffic by NBDP. The 518 kHz frequency is used for NAVTEX messages.

Short-range service

Ships operating within VHF range can use the DSC calling frequency, 156.525 MHz (Channel 70) for distress alerts and safety calls, and 156.8 MHz (Channel 16) for radiotelephone distress and safety traffic.

Survival craft radio equipment - Radar transponders

The GMDSS is designed to ensure that help arrives with the minimum of delay. But in some cases it will be impossible to reach the scene of an accident before the ship involved sinks. In such cases, the distress alert will have been sent by the ship or automatically by the satellite EPIRB, and the survivors will have embarked into survival craft. The main difficulty facing rescuers is simply finding them.

² Footprint means the line of sight from the LUT to the satellite as it rises above the horizon at the time when it has received sufficient information to enable the position of the EPIRB to be calculated until it sets.

One device which assists rescue units to locate ships and survival craft by night or day in all weather conditions is the radar transponder, which is activated by receiving a radar pulse. It then automatically sends out a series of pulses which are displayed on the radar screen of the interrogating ship or aircraft. This clearly identifies the transponder's position, making it much easier for SAR units to reach the spot quickly.

Survival craft and ship transponders operating on 9 GHz are mandatory under the GMDSS.

NAVTEX

All ships of 300 gross tonnage and above are required to carry a receiver, capable of receiving international NAVTEX broadcasts in areas where these are provided. NAVTEX became mandatory for all cargo ships of 300 gross tonnage and above and all passenger ships under the GMDSS, on 1 August 1993.

NAVTEX, which operates on 518 kHz, is the chief means of transmitting short range maritime safety information (MSI) including navigational warnings, meteorological forecasts and warnings, ice reports, search and rescue information, pilot messages and details of changes to navigational aids.

NAVTEX messages are normally sent only in English using narrow-band direct printing (NBDP) and are received on board the ship on a special printer - a great improvement on information circulated in printed form, which can take days or even longer to reach ships. Many small ships do not carry radiotelegraph equipment and a dedicated radio officer, so at present, receive MSI by radiotelephone broadcasts on different frequencies at scheduled times. Broadcasts can often be missed when other duties have to take priority.

The NAVTEX system was first tried out in Sweden in 1977, the year when the IMO Assembly adopted the World-Wide Navigational Warning Service (WWNWS) as a means of promulgating navigational and meteorological information.

It was recognized at the start that NBDP offered an excellent means of sending out this information. The fact that the messages are in written form and can be studied at leisure is important, especially when the recipients are not fluent in English. Another advantage is that information which is required can be selected by the operator on the equipment, so that which is not needed, will not be printed. However, important information which should be received by all ships will always be printed.

Although the receiving ship can be selective to some extent, and the receiver is unattended, a ship cannot reject navigational and meteorological warnings and search and rescue information. However, NAVTEX is not regarded primarily as a means of transmitting distress information - under the GMDSS this is done on the distress and safety frequencies.

The early experiments with NAVTEX proved so successful that in 1979, countries bordering the Baltic Sea established the first NAVTEX network. This was then extended to NAVAREA I, which covers the sea areas off north western Europe. A resolution adopted by the IMO Assembly in the same year recommended Administrations to introduce NBDP broadcasts for promulgating navigational and meteorological warnings to shipping as part of the WWNWS (World-Wide Navigational Warning System).

Since then, NAVTEX has spread to many other NAVAREAS and in 1987, it was formally adopted as a component of the GMDSS by means of Assembly resolution A.617(15). This invites Governments to encourage the use of NAVTEX and provides information on how to commence NAVTEX services.

International NAVTEX messages are broadcast at fixed times on 518 kHz in English. But in many areas there is interest in transmitting similar information in a second language (for the benefit of local shipping, fishermen and so on). Messages with a high degree of urgency affecting safety in specific sea areas may also be transmitted in national languages on 518 kHz and in some areas messages are also sent out on the 4 MHz frequencies.

Although IMO's chief interest is the safety of ocean-going merchant shipping, NAVTEX can also be of great value to smaller craft, such as private yachts. The equipment required to receive NAVTEX messages is comparatively cheap - from about £500 upwards - and it does not have to be permanently attended.

Radio personnel

One important issue before IMO and ITU while developing GMDSS, concerned the role of the radio officer under the GMDSS. Before GMDSS, ships required to be fitted with radio-telegraphy equipment had to carry a radio officer trained in the use of Morse Code. The introduction of the GMDSS, however, meant the gradual phasing-out of Morse radiotelegraphy in favour of direct-printing telegraphy ("TELEX" by radio).

As a result, many Governments maintained that there was no need to have a radio officer on board, since it requires no special skills to use a radiotelephone or operate the other emergency equipment that is required by the system.

Other Governments insisted that although a radio officer may not be required, a radio specialist would still be needed to carry out on-board maintenance and emergency repairs.

A compromise between these two positions was successfully achieved and the 1988 SOLAS amendments state that ships operating in areas A1 and A2 must ensure the availability of equipment "by using such methods as duplication of equipment, shore-based maintenance or at-sea electronic maintenance capability, or a combination of these, as may be approved by the Administration". In areas A3 and A4 a combination of at least two of these methods must be used.

Regulation 16 of SOLAS Chapter IV deals with radio personnel. This states that "every ship shall carry personnel qualified for distress and safety radiocommunication purposes to the satisfaction of the Administration. The personnel shall be holders of certificates specified in the radio regulations as appropriate, any one of whom shall be designated to have primary responsibility for radio communications during distress incidents".

The World-Wide Navigational Warning Service (WWNWS)

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, buoys and other aids to navigation; the location of wrecks and other hazards and the establishment of offshore structures.

To ensure such information is received by all ships likely to be affected by it, IMO and the International Hydrographic Organization (IHO) established a World-Wide Navigational Warning Service (WWNWS). 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. The WWNWS now incorporates NAVTEX.

Publications from IMO

A number of publications relating to the SAR Convention and the GMDSS are available from IMO, including the following:

- * SOLAS (Consolidated edition, 1997)
- * Amendments to SOLAS 1974 concerning Radiocommunications for the Global Maritime Distress and Safety System (1989 edition)
- * Amendments to the Protocol of 1978 relating to SOLAS 1974 concerning Radiocommunications for the Global Maritime Distress and Safety System (1989 edition)
- * International Conference on the Establishment of An International Maritime Satellite System, 1975/76 (1976)
- * 1985 Amendments to the Convention and to the Operating Agreement on the International Maritime Satellite Organization
- * 1989 Amendments to the Convention and to the Operating Agreement on the International Maritime Satellite Organization
- * NAVTEX Manual (1994 edition)
- * International Conference on Maritime Search and Rescue 1979 (1979 edition)
- * International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual (1998/199 edition)
- * GMDSS Operating Guidance Card
- * GMDSS Handbook (1995)
- * The GMDSS Handbook on CD-ROM (Version 1.0)
- * International SafetyNET Manual (1994 edition)
- * Performance Standards for Shipborne Radiocommunications and Navigational Equipment (1997 edition)
- * International Life-Saving Appliance Code (LSA Code) (1997 edition)
- * Standard Marine Navigational Vocabulary (1985 edition)
- * International Code of Signals (1987 edition)

IMO Model courses:

- * General Operator's Certificate for the Global Maritime Distress and Safety System (Model Course 1.25 Course + Compendium, 132 hours)
- * Maritime Search and Rescue Co-ordinator Surface Search (Model Course 2.02 and Compendium; 27 hours)
- * Maritime Search and Rescue Administrator (Model Course 3.13 and Compendium; 40 hours)
- * Maritime Search and Rescue Mission Co-ordinator (Model Course 3.14 and Compendium; 92 hours)

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