

**SafetyNET™**  
**AN INMARSAT SERVICE FOR THE**  
**GLOBAL PROMULGATION**  
**OF MARITIME SAFETY INFORMATION**

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**INTRODUCTION**

The development of the INMARSAT Enhanced Group Call (EGC) System and specifically the SafetyNET™ Service offers those responsible for providing Maritime Safety Information (MSI) a uniquely reliable and cost effective means of ensuring that all types and sizes of vessels anywhere in the world can receive such messages automatically, efficiently and in a timely manner.

Maritime Safety Information is currently transmitted by VHF in harbour and coastal areas, by MF in the offshore areas and by HF Morse code and, in some instances, HF telex in the high seas areas. Messages originate from numerous sources including hydrographers for NAVAREA warnings, meteorologists for weather and storm warnings and Rescue Co-ordination Centres (RCC) for shore-to-ship distress alerts and other urgent information.

A major revolution of the world's maritime communications will start when implementation of the International Maritime Organization's (IMO) Global Maritime Distress and Safety System (GMDSS) begins in 1992.

This new system, which will be embodied in a new Chapter 4 of the Safety of Life at Sea (SOLAS) Convention, will make extensive use of automated communication facilities ashore and on board vessels. In particular, Satellite Services will for the first time assume a prominent role in maritime safety.

An issue of particular importance to all mariners is the need to receive pertinent Maritime Safety Information in a timely manner. To achieve this, INMARSAT's Enhanced Group Call (EGC) SafetyNET™ service will provide the primary means of ensuring the efficient promulgation of such information throughout the world.

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## BACKGROUND

The GMDSS differs from the existing SOLAS requirements in a number of significant areas. The new rules will apply to all vessels of 300 gross tonnes and over engaged in international voyages, although it is anticipated that many administrations will make them applicable to all their domestic shipping in order to standardize rules, and thereby minimize the terrestrial infrastructure cost of providing safety services.

The new rules eliminate the requirement and use of morse telegraphy and place emphasis on a vessel in distress alerting a Rescue Co-ordination Centre (RCC), which in turn will alert appropriate vessels and aircraft to provide assistance. Ships in the immediate vicinity may still be directly alerted by the vessel in distress, but this is likely to occur only in high density shipping areas.

The carriage requirements for radio equipment by SOLAS vessels will now depend on their sea areas of operation. Sea Area A 1 is in VHF coverage, A 2 is within MF Digital Selective Calling (DSC) range as defined by national administrations, A 3 is within the coverage of geostationary satellites (INMARSAT coverage), and A 4 denotes those areas not covered by A 1, A 2 and A 3 (i.e. the extreme polar areas not served by satellite, MF or VHF coverage). The few vessels operating in A 4 areas will be required to fit an HF radio installation with DSC.

For ships operating in Sea Area A 3, the owner can choose to install HF DSC, an INMARSAT Standard-A or Standard-C ship earth station for the vessel's primary communications.

To receive Maritime Safety Information (MSI), all ships will be required to install a NAVTEX receiver when sailing in sea areas provided with such service and an INMARSAT Enhanced Group Call (EGC) receiver to receive SafetyNET™ messages when sailing in sea areas not served by NAVTEX.

NAVTEX service is being established in coastal waters with a high density of shipping and ensures that mariners receive messages relevant to their area of operation in a timely manner. The use of a single medium frequency (518 kHz) simplifies the receiver design, while the inherent range limitation of the frequency means that messages are received only from appropriate stations in the area in which the vessel is operating. In those areas where messages originate from numerous sources, however, transmitters are allocated specific time slots within which to make their transmission and so avoid mutual interference.

This still leaves extensive coastal areas and the existing NAVAREAS and ocean weather forecast areas which will need to be served by the EGC SafetyNET™ service. It should be noted that administrations additionally may also provide MSI to vessels operating in their areas by HF means. However, this optional capability aboard ships is in addition to the EGC SafetyNET™ requirement, unless the ships are engaged exclusively on voyages in areas where a relevant HF narrow-band direct-printing MSI service is provided.

For the maritime community, a major benefit of the SafetyNET™ service is that messages may be sent by administrations as soon as the facts are known and subsequently received and printed out on vessels automatically. This will ensure that all MSI, including shore-to-ship distress alerts, are quickly brought to the attention of the officer of the watch for appropriate action.

## THE INMARSAT SYSTEM

There are three essential components of the INMARSAT system:

- the INMARSAT space segment — the satellites and ground support facilities — planned by INMARSAT and funded by Signatories;
- the Coast Earth Stations (CES) which are generally funded and operated by Signatories and which provide an interface between the space segment and the national and international fixed telecommunications networks;
- the Ship Earth Stations (SES) — the satellite communications terminals which are purchased or leased by individual ship owners/operators from manufacturers or their agents.

Shore-to-ship communications are in the 6 GHz band from the CES to the satellite and in the 1.5 GHz band (L-band) from satellite to ship. Ship-to-shore communications are in the 1.6 GHz band from the ship to the satellite and in the 4 GHz band from satellite to CES.

### The Space Segment

To provide its space segment for global coverage, INMARSAT employs satellite capacity leased under contract from three organizations:

- The European Space Agency (ESA) for the lease of two MARECS spacecraft;
- The International Telecommunications Satellite Organization (INTELSAT) for Maritime Communications Sub-systems (MCS) on three INTELSAT V satellites, and
- The COMSAT General Corporation for the lease of the three original MARISAT satellites in the three ocean regions for contingency back-up purposes.

This space segment provides one operational and spare satellites over each of the three main ocean regions, with the exception of the polar regions (above 75° latitude), which cannot be seen by geostationary satellites.

The INMARSAT Operations Control Centre (OCC) at the London Headquarters functions around-the-clock co-ordinating activities of the satellite technical control centres, operated by the three space segment suppliers, and the coast earth stations. The OCC also commissions ship earth stations wishing to

operate within the INMARSAT system.

INMARSAT entered into contract with a consortium of companies headed by British Aerospace Dynamics Group for the purchase of four new satellites with an option for a further five. The first INMARSAT-2 satellite is expected to be delivered in late 1989 with the additional satellites following close behind.

A total of six launchers have been booked (two Ariane, two Delta and two shuttle) to ensure the timely availability of these satellites in orbit.

These new satellites will have over three times the capacity of the existing satellites and will, in addition to covering the whole of the maritime L-band allocation, also cover 3 MHz of the aeronautical mobile-satellite 'R' band.

### Coast Earth Stations (CES)

The INMARSAT system is connected into the worldwide telecommunications networks via Signatory-owned coast earth stations, of which there are twenty currently in operation (Fig. 1).

Atlantic Ocean Region (AOR)	Indian Ocean Region (IOR)	Pacific Ocean Region (POR)
Southbury — USA Goonhilly — UK Tangua — Brazil Umm-al-Aish — Kuwait Odessa — USSR Fucino — Italy Pleumeur Bodou — France Psary — Poland Maadi — Egypt	Yamaguchi — Japan Eik — Norway (for the Nordic countries) Odessa — USSR Thermopylae — Greece Nakhodka — USSR Jeddah — S. Arabia Psary — Poland	Ibaraki — Japan Santa Paula — USA Singapore Nakhodka — USSR

Additional coast earth stations are also planned in Denmark, Federal Republic of Germany, Australia, Turkey, China, Korea, Canada, India, Argentina, Cuba, Spain and Bulgaria. The wider spread of coast earth stations around the world offers the prospect of reduced land-line and hence end-user charges.

### Network Co-ordination Stations (NCS)

In each ocean region, an NCS provides the system management function. SESs monitor the appropriate assignment channel, when not engaged in traffic, for call announcements which automatically switch them to the appropriate CES and working channel.



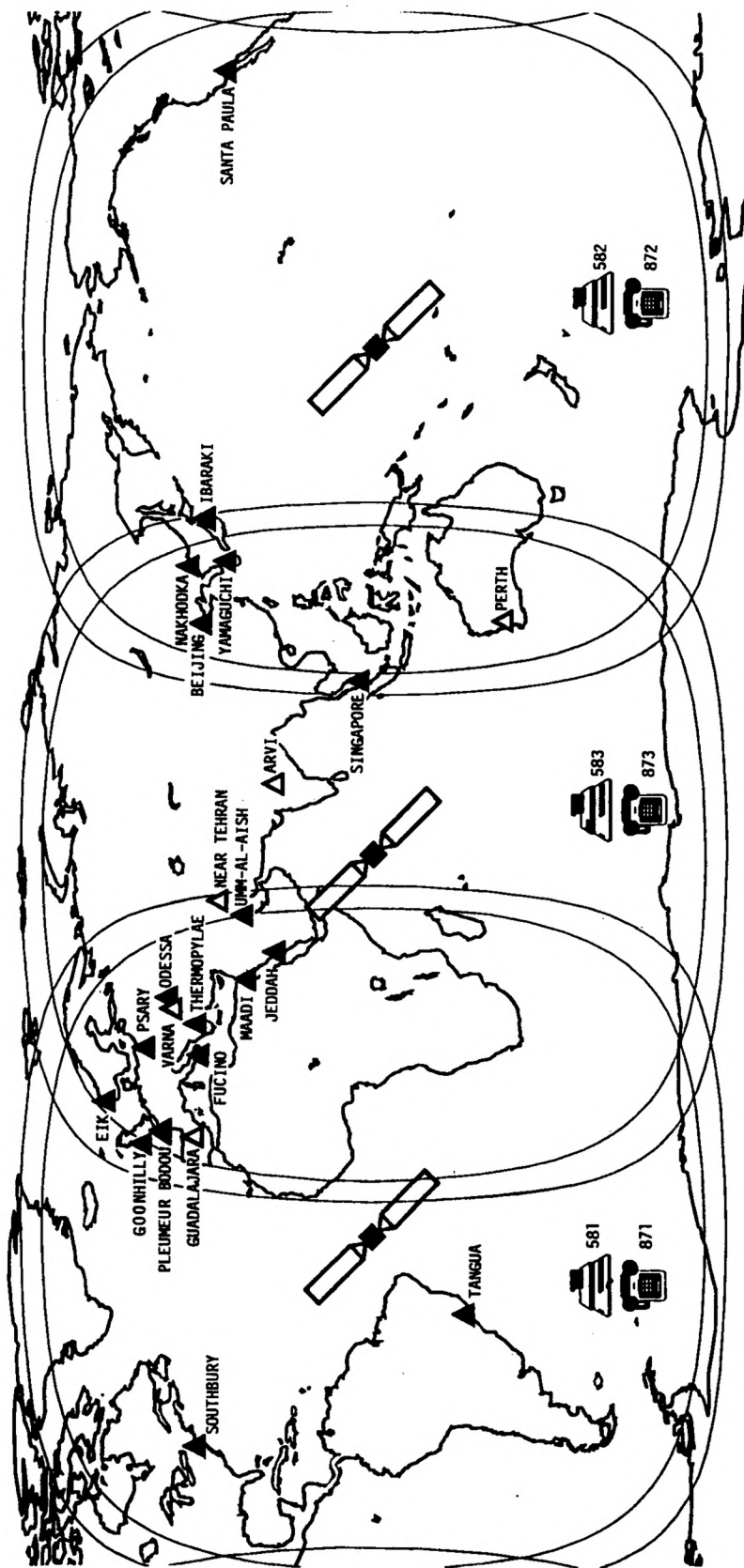


Fig. 1. — INMARSAT Coverage and Coast Earth Stations.

### **Ship Earth Stations (SES)**

More than 7000 vessels are now equipped with a Standard-A SES. The above-deck equipment includes a steerable antenna mounted on a stabilized platform to keep the antenna pointed towards the satellite. It is enclosed within a protective radome. Below-deck equipment consists of a telephone, teleprinter and associated electronics. Each new SES design is tested (type-approved) by INMARSAT to ensure that it meets the standards necessary for operation in the INMARSAT system and to ensure it will not cause harm to other users.

To augment the present Standard-A SES, INMARSAT is now introducing the new Standard-C system (Fig. 2).

### **STANDARD-C SYSTEM**

The Standard-C SES is small, lightweight and low in power consumption. The Standard-C System provides store and forward message and data transfer services and includes connections with the international telex network. Most CES operators are also likely to provide access to electronic mail services, data networks and other message/data services. They will also provide a connection to an associated maritime RCC to handle distress and other urgent traffic. The receiver of the new Standard-C SES is identical, electronically, to the Enhanced Group Call receiver. This will greatly enhance its utility and cost effectiveness, as when not engaged in traffic it will monitor the NCS common channel which carries the call assignments and EGC messages.

Three NCS stations for controlling the Standard-C network have been ordered and will be available for service in each ocean region from the second half of 1989. Starting in November 1988, INMARSAT will be providing a pre-operational service in the Atlantic Ocean region and has plans for providing similar capabilities in the Pacific and Indian Oceans by the middle of 1989. These facilities will enable shipowners, administrations and message originators to gain experience prior to the availability of full service through commercial CES's from late 1989. This pre-operational phase will be of considerable benefit to MSI providers, as it will enable them to develop new operational scenarios for the SafetyNET™ service in the period leading to full service.

### **THE ENHANCED GROUP CALL SYSTEM**

Technically related to Standard-C, the Enhanced Group Call (EGC) system (Fig. 3) is available exclusively in the shore-to-ship direction and will enable ships to receive Maritime Safety Information (MSI) addressed to designated geographical areas and commercial calls to selected groups of ships.

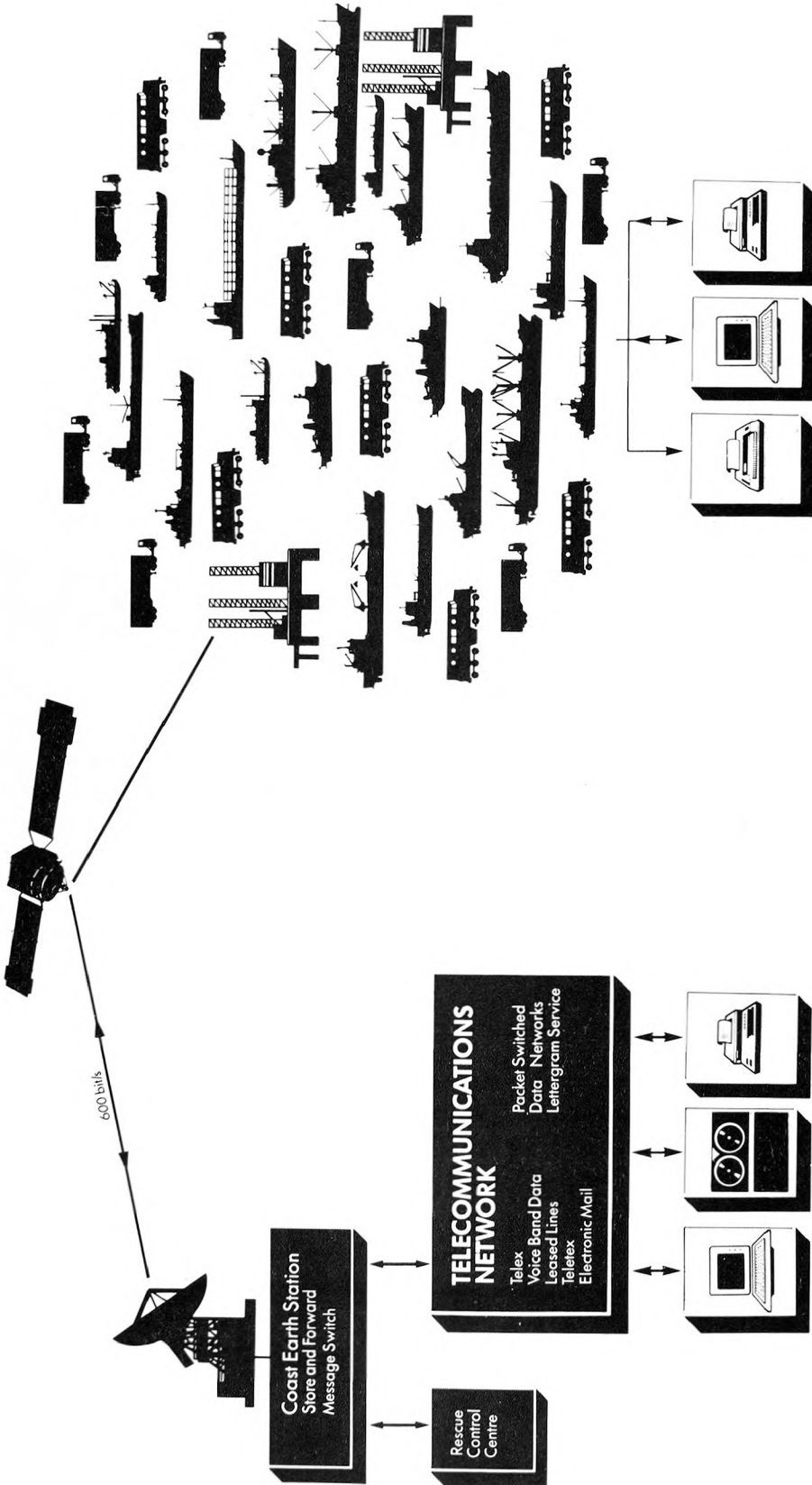


FIG. 2. — Standard-C System.

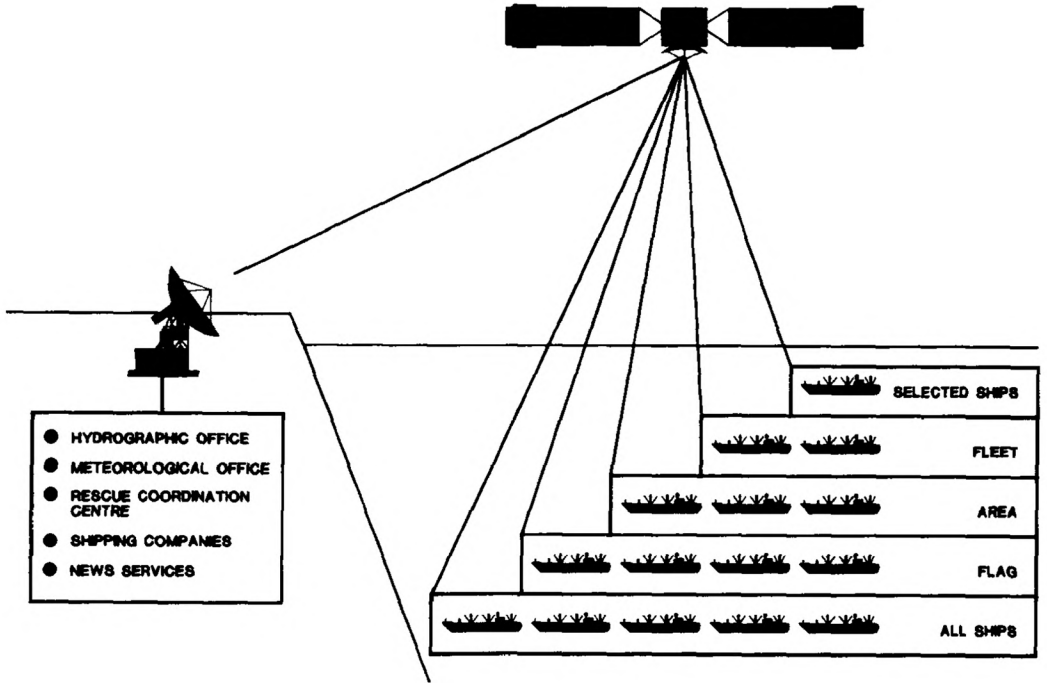


FIG. 3. — The Enhanced Group Call System.

The EGC system has been under active development for a number of years and, during this period, meetings and trials have taken place with organizations who originate MSI to ensure that the SafetyNET™ service will meet existing and future requirements of the entire maritime community. In developing a totally new system, INMARSAT has not been constrained by existing arrangements but has instead sought to satisfy the real requirements of the many users. Included in this work has been the future needs for transmitting corrections for on-board data bases such as for sailing directions, light lists and the emerging electronic charts.

The complete commonality between an EGC receiver and a Standard-C SES ensures the lowest possible cost which, together with its small size, low weight, power consumption and cost, make it ideal for installation on any size or type of ship. A major feature of the Standard-C/EGC equipment is the small and simple, unstabilized, omnidirectional antenna which is no more difficult to install than a VHF antenna. For ships not requiring telephony service, a low cost Standard-C/EGC installation could well be the primary radio equipment serving the GMDSS carriage requirements for distress alerting, receipt of MSI via the SafetyNET™ service and the vessels general communications requirements. However, for those requiring voice communications, Standard-A will still be necessary, although a Standard-C/EGC combination might well be fitted as back-up and used primarily as an EGC receiver for SafetyNET™ and FleetNET™ messages.

## FEATURES OF THE ENHANCED GROUP CALL SYSTEM

Two services will be provided through the EGC system. SafetyNET™ will be used by Administrations for the promulgation of Maritime Safety Information, such as NAVAREA and storm warnings, shore-to-ship distress alerts and routine weather forecasts to the high seas and those coastal waters not served by NAVTEX. FleetNET™ provides a commercial service for national and company fleet group calls, and provides the possibility of offering subscription services for news, sport results, stock exchange information, fish landing prices, commodity prices, etc.

Each Network Co-ordination Station (NCS) will transmit through the satellite a single carrier on a designated channel called the common channel. This will be monitored by every Standard-C SES when not sending or receiving traffic and also by a dedicated EGC receiver, which may be a stand-alone self-contained system or built into an existing or any future ship earth station. Spare NCS common channels are also available and may be used in the event of additional satellite regions being brought into service for operational reasons. In common with other INMARSAT services, and unlike any terrestrial radio system, reception of these satellite carriers will not be affected by the position of the ship within the ocean region, atmospheric conditions or time of day.

Calls can be directed to groups of ships or geographical areas. Group calls will be received automatically by any ship whose receiver acknowledges the unique group identity associated with a particular message. The geographical addressing facility is likely to be most widely used for the SafetyNET™ service.

Area calls can be to a fixed geographical zone, such as one of the 16 NAVAREAS, or to a temporary geographic area selected by the originator. A NAVAREA broadcast will be displayed on all ships within the specified area. Nonetheless, ships which may soon enter the area and wish to receive the message can do so (Fig. 4).

In practice, a ship can receive any NAVAREA message broadcast through the satellite it is monitoring. Looking into the future, other possible uses include corrections for onboard databases, including those associated with electronic charts and other nautical data such as the list of lights, tide tables, sailing directions, updates to the 'blue book' and other information presently carried in printed form aboard ships. For this purpose, a direct link between the EGC receiver and the database is desirable.

Given the whole ocean coverage by the EGC carrier, some form of discrimination and selectivity in printing the various messages is required. In the case of NAVAREA warnings, ships will select the area they are sailing in as well as those they will enter in the future. This will ensure they are aware of all warnings applicable to their intended passage. Reception of certain types of messages, such as distress alerts and storm warnings, will be mandatory and cannot be suppressed.

Temporary geographic areas may be circular or rectangular in shape.

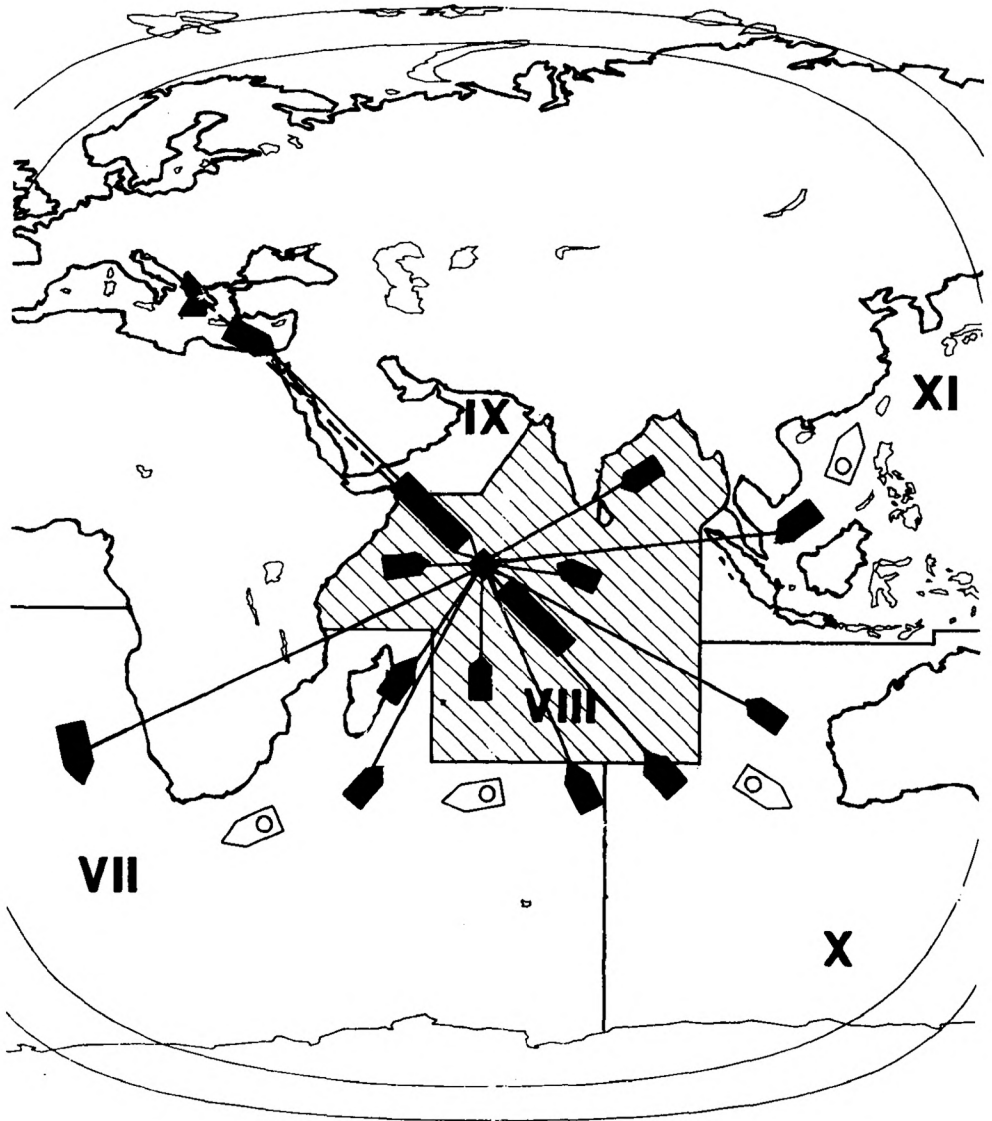


FIG. 4. — Reception of NAVAREA broadcast.

A circular area is described as a radius (in nautical miles) around a location specified in degrees and minutes of latitude and longitude. A rectangular area is described in northings and eastings from the Southwest corner of the rectangle and could be used by a national authority to issue a navigational warning for a coastal area not served by NAVTEX (Fig. 5).

In the case of a vessel in distress, a need exists to create a temporary geographic area around the casualty. This can be achieved by transmitting a shore-to-ship distress alert to an area defined by a radius about the casualty. This can be done so that only those ships likely to be in the vicinity and potentially

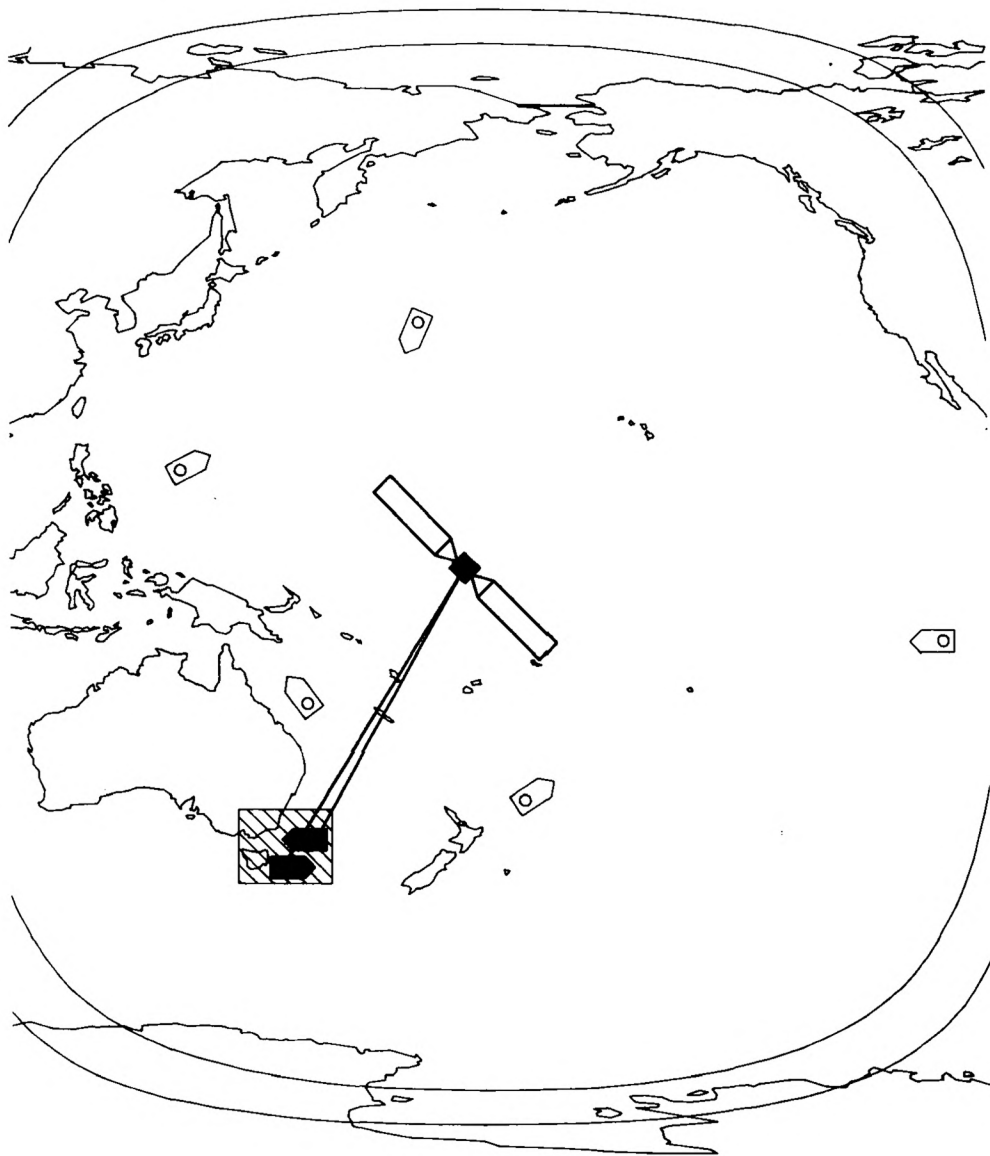


FIG. 5. — Local area warning using rectangular geographical address.

able to help, are alerted (Fig. 6).

If no response is received from any ship at the first call, the area can, if necessary, be broadened in steps until an acknowledgement by one or more vessels is received. Another typical application would be for issuing warnings about a storm whose centre may be moving rapidly.

The benefits of the selective area addressing approach is that ships operating outside the area of interest would not display the messages and, since only relevant messages are displayed, shipboard personnel are likely to give them



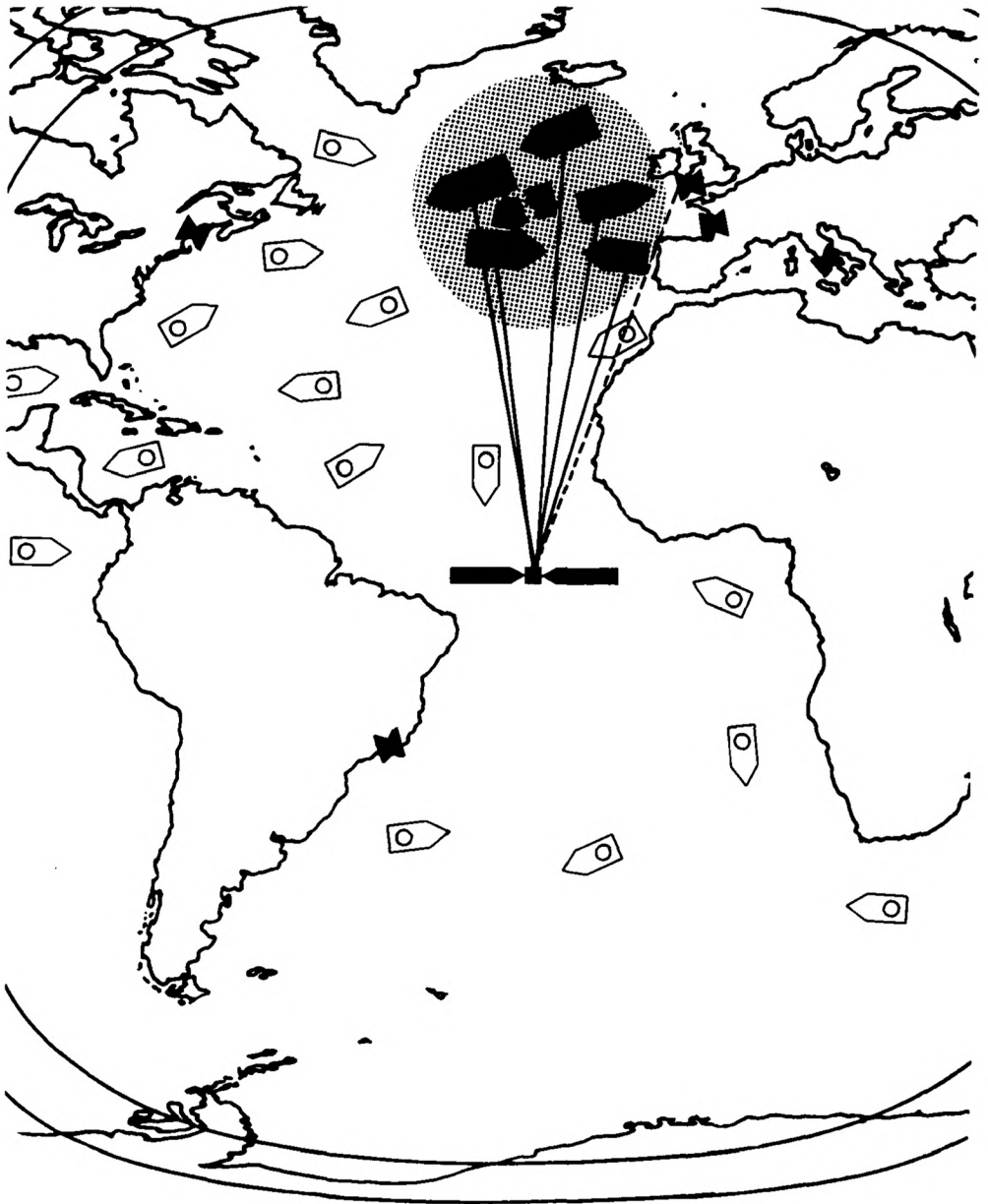


FIG. 6. — Shore-to-ship distress alert using circular geographic address.

greater attention.

To enable the EGC receiver to recognize whether an area message is applicable, it is necessary to regularly input the vessels position. This can be done automatically by making a connection to an electronic position fixing system either by using an industry standard interface or manually on a periodic basis. Failure to update the receiver position either automatically or manually within

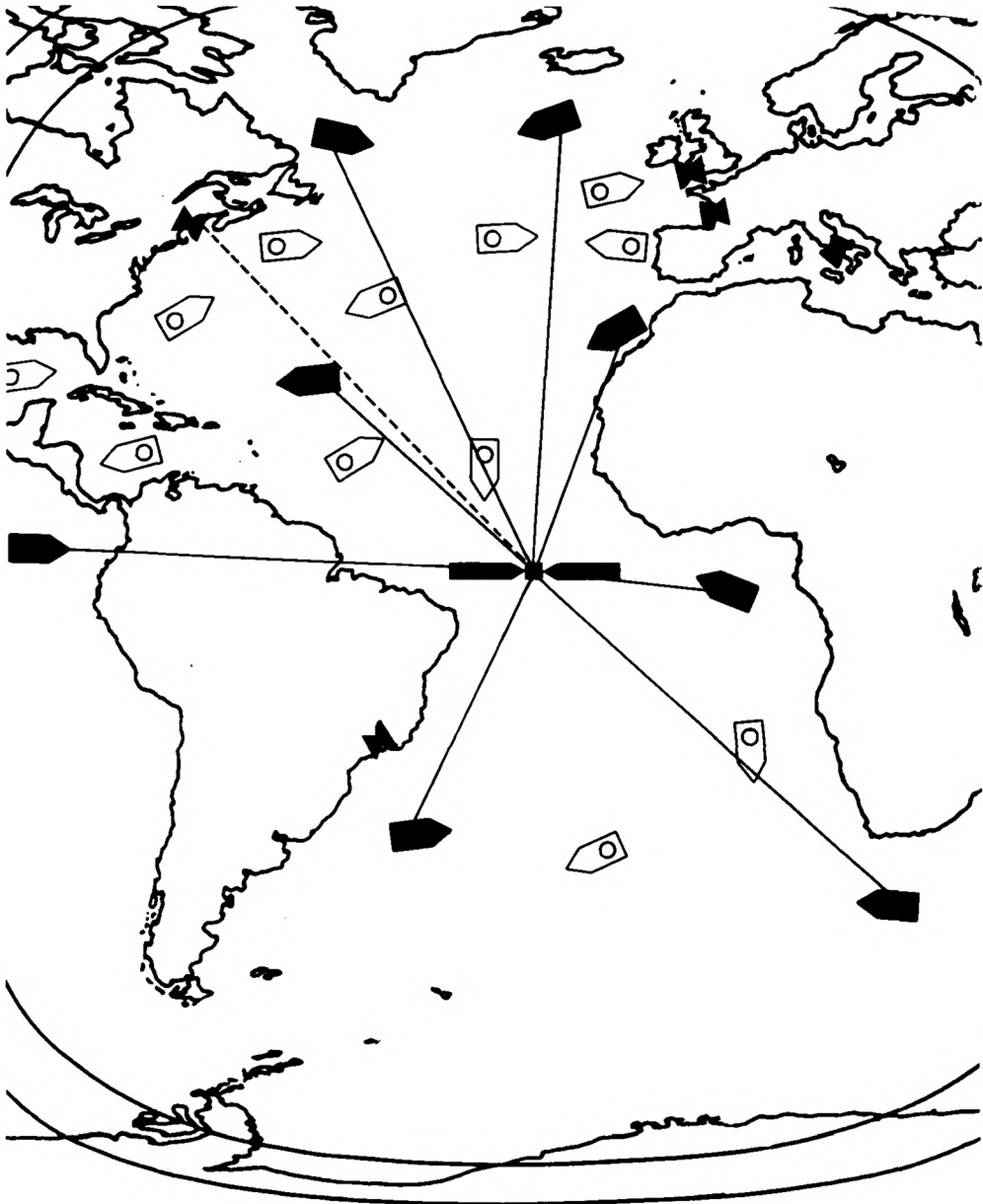


FIG. 7. — FleetNET call to a group of ships.

4 hours will cause an alarm to be sounded and displayed.

Group calls will also be received by all ships within the ocean region coverage of the satellite, but printed only by those receivers which recognize the unique group identity associated with the message (Fig. 7).

To ensure the confidentiality of EGC group messages, a capability has been built into the system to enable group identities to be downloaded through the

satellite to specific EGC receivers. If required, the capability also exists to unload a group identity from a particular ship's EGC receiver. These capabilities could be particularly valuable to those providing commercially valuable information or services. It is also feasible to add coding to the message.

All EGC messages will have a unique sequence number enabling the receiver to suppress previous copies of messages already received correctly. Error control techniques ensure that messages with garbled control headers are not printed; if the subsequent text has an unacceptable bit error rate, the message will not be printed. Each character received in error in the message will be printed as an underlined character. As the probability of a message character error rate being more than 4% in a satellite channel is virtually non-existent, the likelihood of a lost message can be based solely on the probability of a corrupted header. For a receiver working at the edge of satellite coverage, a conservative upper limit of 0.1% has been predicted. As errors induced in the EGC channel will tend to occur in bursts, the lost message probability for a given broadcast is ten or one hundred times less. In practical terms, system reliability approaches perfection. The EGC sea trials have confirmed these theoretical estimates.

### **PROMULGATION OF MARITIME SAFETY INFORMATION (MSI)**

With such a dependable satellite system, those responsible for promulgating maritime safety information will benefit by being able to significantly reduce the number of message repetitions. Each ocean region EGC carrier will have the capacity to transfer roughly 30,000 messages per day. Studies indicate that this will adequately handle all maritime safety information (SafetyNET™ service) and commercial messages (FleetNET™ service).

In addition to providing service to Convention ships operating in Sea Area A 3, the EGC SafetyNET™ service will also provide cost effective and efficient means of disseminating MSI to vessels in coastal waters not served by NAVTEX. EGC is also expected to benefit non-Convention ships, including fishing and pleasure craft, because of its inherent reliability, simplicity of operation and ability to cope with a wide range of national languages and alphabets.

Access to the EGC system will be granted to message originators authorized by the various CES operators and will include, typically, those responsible for promulgating Maritime Safety Information such as the search and rescue authorities, NAVAREA co-ordinators and meteorological forecasting centres. In addition, public subscribers, including shipping companies and subscription news services wishing to contact large numbers of vessels, will be able to gain access (Fig. 8).

All types of terrestrial interfaces may be supported at the coast earth stations, although telex is mandatory and is initially likely to be the most common method for delivery of traffic to the CESs. Data transmission from intelligent microcomputers is gaining rapid acceptance, since these devices make the preparation of messages much easier and more reliable. INMARSAT awarded a contract for simplifying the preparation of messages using a micro based telex

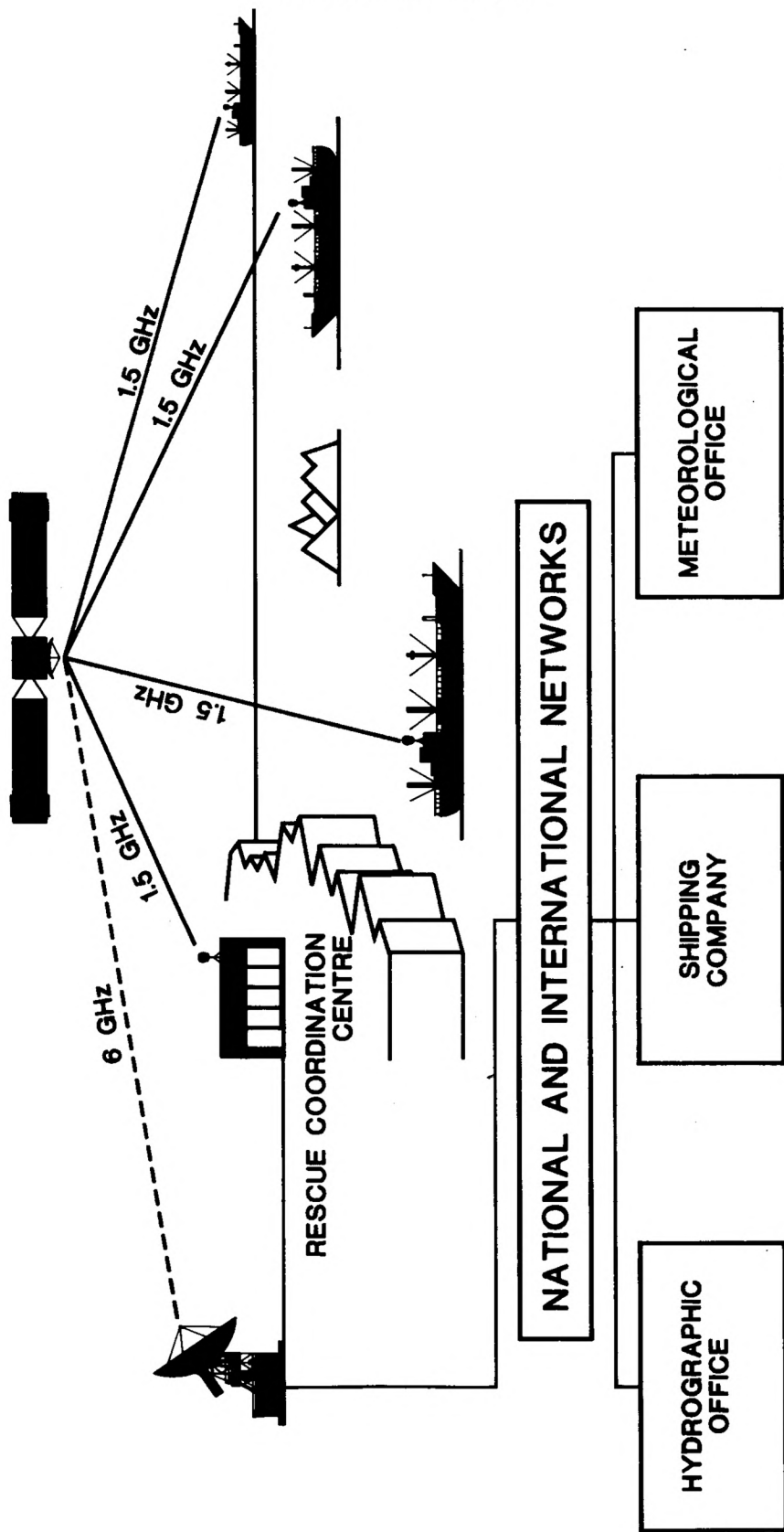


FIG. 8. — FleetNET or SafetyNET message placed through terrestrial landlines.

terminal and has taken delivery of sample units. A similar software package able to run on a PC has also been developed. These approaches will, after initial installation of the programme, dramatically simplify the preparation and transmittal of messages over telex, data or leased lines by the message originators.

Alternatively, a rescue co-ordination centre could, with the approval of the national licencing authorities, install an SES at their premises to transmit SafetyNET™ messages to an appropriate CES, which would then process them for transmission in the normal manner. This approach could prove particularly attractive to message originators who experience difficulties or delays in obtaining international terrestrial telecommunications circuits. Even in countries with good facilities, it could also serve as a back-up to normal terrestrial communications systems for transmitting urgent messages when unexpected delays or breakdowns occur (Fig. 9).

### COAST EARTH STATION FUNCTION

Messages to be transmitted over the EGC system are received and processed automatically. Participating coast earth stations forward EGC messages to the Network Co-ordination Station (NCS) for transmission over the common channel. Messages are scheduled for transmission according to their type and queued according to priority. This ensures that those messages with the highest priority are transmitted first. In practice, distress alerts are put at the top of the list followed by urgency, safety, routine and commercial correspondence. The message is stored at the NCS in non-volatile memory until it has been successfully transmitted the prescribed number of times. The originator of each message specifies, as part of the message, the desired number of repetitions and the interval between transmissions. It is also possible for the originator to cancel a message before the desired number of repetitions has been made. Arrangements can be made to enable messages destined for satellite coverage-overlap areas to be transmitted through the two satellites to ensure they are received by the intended ships, which may be working through either satellite.

### EGC CHANNEL CHARACTERISTICS

The modulation rate of the channel is 1200 bits per second. Forward error correction is applied to this, involving rate 1/2 convolutional coding with interleaving to disperse error bursts which arise when deep fades are present. This results in a message information rate of 600 bits per second and ensures a very high probability of receiving a message correctly at the first transmission, irrespective of the weather conditions or the ship's position within the satellite's coverage.

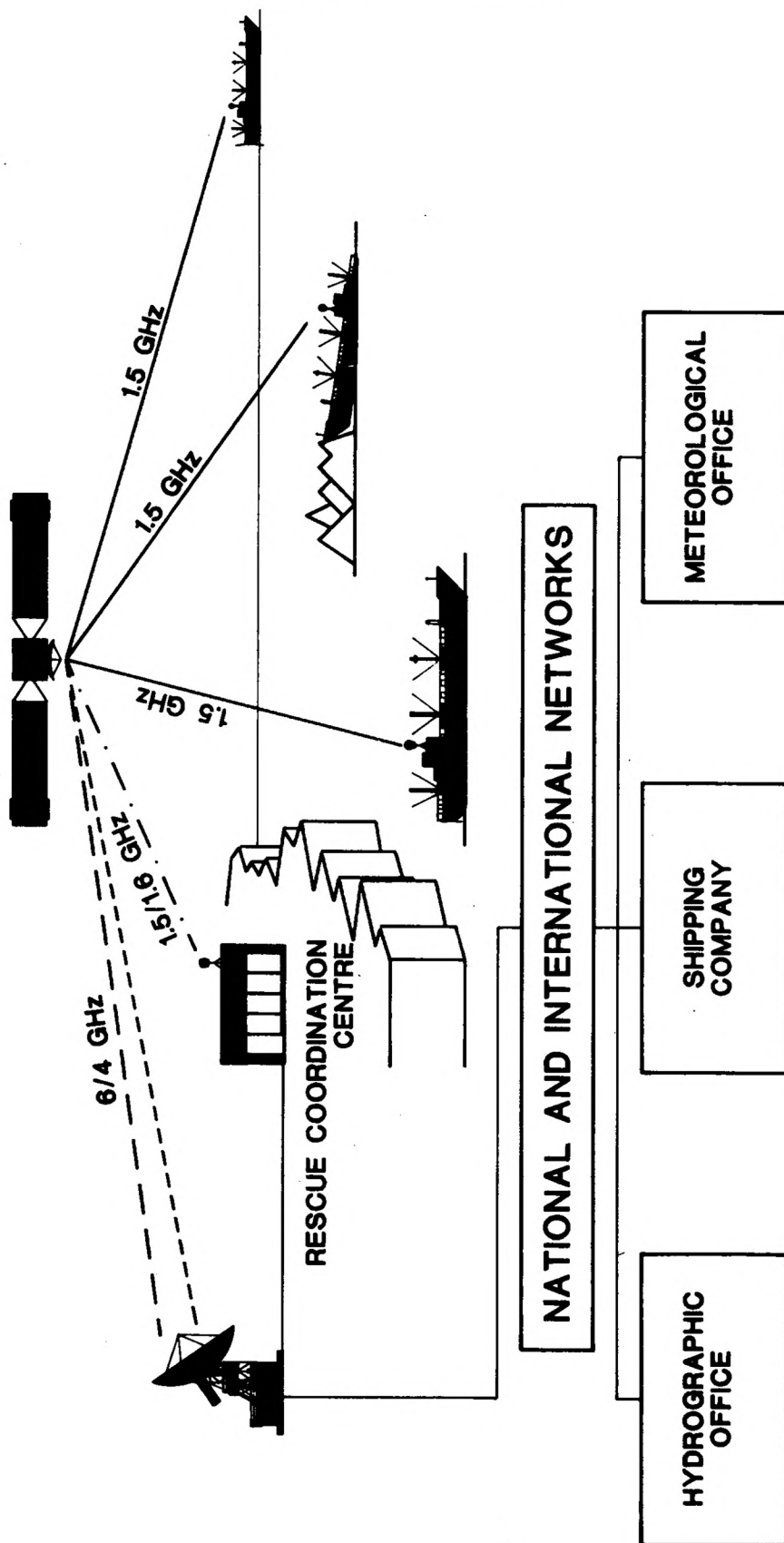


FIG. 9. — Distress alert placed through an RCC SES.

## RECEIVING EGC TRANSMISSIONS

Reception of EGC SafetyNET™ and FleetTM™ messages can be through a dedicated receive-only ship earth station or through a Standard-A or Standard-C ship earth station. For a Standard-A SES, the EGC receiver can either be built into the electronics or provided as a separate unit and connected through an I/F interface. In either case, use can be made of the existing antenna, low noise amplifier and diplexer. For a Standard-C SES, the EGC receive capability can simply be provided in the software or a dedicated EGC receiver and diplexer can be added to provide continuous monitoring for SafetyNET™ and FleetNET™ traffic, even when the ship earth station is transmitting or receiving other traffic. The Standard-C ship earth station can therefore provide a low cost solution for reliable communications plus reception of maritime safety information.

The basic requirement of the receiver is that it shall continuously receive the Standard-C NCS common channel and process the messages being transmitted. It will automatically recognize messages directed to groups to which a ship belongs and messages directed to geographic areas within which the ship is sailing or selected by the ship. It also inhibits the multiple printing of messages.



FIG. 10. — EGC Sea Trials receiver and antenna (T & T equipment photo).



Operation of the EGC receiver is extremely simple. Selection of the appropriate NCS common channel can be automatic or manual. Operator interface can be limited to a simple keypad. A prototype receiver is shown in Figure 10. Operator controls permit the selection of message types to be received, i.e. navigational, meteorological, groups, etc. It is not possible to inhibit *all ship* messages such as distress alerts. The controls can also be used to select languages, alphabets and geographic areas of interest for which the ship wishes to receive messages. When a distress alert is received, an audio alarm will sound, which can only be reset manually.

EGC receivers display at least 40 characters per line of text and, as a minimum, print the standard International Alphabet Number 5 character set (ASCII). Originators may also use other standard character sets as defined in ISO 2022 or CCITT Rec. T.61. The character set being transmitted will be indicated in the text parameter field of the message. For this reason, the use of a dot matrix printer is recommended which could also be used to display small graphics such as charts or diagrams.

## SEA TRIALS

INMARSAT convened an international meeting in February 1986 to start planning for sea trials which began in late 1987 in the North Atlantic area. This first and subsequent meetings were attended by representatives of the International Maritime Organization (IMO), the International Hydrographic Organization (IHO), and the World Meteorological Organization (WMO), together with representatives from Administrations and INMARSAT Signatories who were interested in participating in the trials. The outcome was to establish Terms of Reference for the trials steering committee which developed and co-ordinated the actual work programme of the trials. At the conclusion of the trials, the collected data was independently analysed and a final report prepared and distributed. This confirmed the suitability of the system and resulted in its adoption by IMO, together with an EGC equipment carriage requirement to meet the needs for a system able to automatically receive Marine Safety Information in Sea Area A 3 (the high seas) as well as A 1 and A 2 (coastal) waters not covered by NAVTEX.

## THE FUTURE

Since 1976, Maritime Satellite Communications have proven to be a highly reliable means of communicating in the hostile conditions in which mariners frequently find themselves. The introduction of the Standard-C and EGC system, which has already been adopted by IMO for inclusion in the GMDSS carriage requirements, will bring these benefits within the reach of all who sail the seas. The Enhanced Group Call System (which is based on Standard-C) and its SafetyNET™ service will provide the mariner and administrations with a reliable

simple and most cost effective means of globally promulgating maritime safety information to those areas not served by NAVTEX. The ability for the system to expand in this rapidly developing age of high technology is an important factor. It has already been determined that the EGC system can cope with the future requirements for automatically updating databases containing electronic charts, light lists, tide tables, hazardous cargo and other information currently carried in printed form.

## CONCLUSION

The INMARSAT EGC SafetyNET™ Service will fulfill a vital function in the GMDSS through its ability to promulgate maritime safety information reliably, quickly, efficiently and cost-effectively to ALL ships throughout the world. It is of vital importance for administrations to know that messages will, with a high degree of certainty, be automatically received, in a timely manner, by those aboard ships whose lives may well depend upon the receipt of such information.