

# CHAPTER 28

## MARITIME SAFETY SYSTEMS

### MARITIME SAFETY AND THE NAVIGATOR

#### 2800. Introduction

The navigator's chief responsibility is the safety of the vessel and its crew. Fulfilling this duty consists mostly of ascertaining the ship's position and directing its course so as to avoid dangers. But accidents can happen to the most cautious, and the most prudent of navigators may experience an emergency which requires outside assistance. Distress incidents at sea are more likely to be resolved without loss of vessel and life if they are reported immediately. The more information that rescue authorities have, and the sooner they have it, the more likely it is that the outcome of a distress at sea will be favorable.

Global distress communication systems, ship reporting systems, emergency radiobeacons, and other technologies have greatly enhanced mariners' safety. Therefore, it is critical that mariners understand the purpose, functions, and

limitations of maritime safety systems.

The mariner's direct high-seas link to shoreside rescue authorities is the Global Maritime Distress and Safety System (GMDSS), which was developed to both simplify and improve the dependability of communications for all ships at sea. GMDSS nicely complements the operation of the U.S. Coast Guard's Amver system, which tracks participating ships worldwide and directs them as needed to distress incidents. GMDSS and Amver rely on radiotelephone or satellite communications for passing information. But even with normal communications disabled, a properly equipped vessel has every prospect of rapid rescue or aid if it carries a SOLAS-required Emergency Position Indicating Radiobeacon (EPIRB) and a Search and Rescue radar Transponder (SART). These systems are the subject of this chapter.

### GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM

#### 2801. Introduction and Background

The **Global Maritime Distress and Safety System (GMDSS)** represents a significant improvement in maritime safety over the previous system of short range and high seas radio transmissions. Its many parts include satellite as well as advanced terrestrial communications systems. Operational service of the GMDSS began on February 1, 1992, with full implementation accomplished by February 1, 1999.

GMDSS was adopted in 1988 by amendments to the Conference of Contracting Governments to the International Convention for the Safety of Life at Sea (SOLAS), 1974. This was the culmination of more than a decade of work by the International Maritime Organization (IMO) in conjunction with the International Telecommunications Union (ITU), International Hydrographic Organization (IHO), World Meteorological Organization (WMO), Inmarsat (International Maritime Satellite Organization), and others.

GMDSS offers the greatest advancement in maritime safety since the enactment of regulations following the Titanic disaster in 1912. It is an automated ship-to-ship, shore-to-ship and ship-to-shore communications system covering distress alerting and relay, the provision of **mari-**

**time safety information (MSI)**, and routine communications. Satellite and advanced terrestrial systems are incorporated into a communications network to promote and improve safety of life and property at sea throughout the world. The equipment required on board ships depends not on their tonnage, but rather on the area in which the vessel operates. This is fundamentally different from the previous system, which based requirements on vessel size alone. The greatest benefit of the GMDSS is that it vastly reduces the chances of ships sinking without a trace, and enables search and rescue (SAR) operations to be launched without delay and directed to the exact site of a maritime disaster.

#### 2802. Ship Carriage Requirements

By the terms of the SOLAS Convention, the GMDSS provisions apply to cargo ships of 300 gross tons and over and ships carrying more than 12 passengers on international voyages. Unlike previous shipboard carriage regulations that specified equipment according to size of vessel, the GMDSS carriage requirements stipulate equipment according to the area in which the vessel operates. These sea areas are designated as follows:

**Sea Area A1** An area within the radiotelephone coverage of at least one VHF coast station in which continuous Digital Selective Calling is available, as may be defined by a Contracting Government to the 1974 SOLAS Convention. This area extends from the coast to about 20 miles offshore.

**Sea Area A2** An area, excluding sea area A1, within the radiotelephone coverage of at least one MF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government. The general area is from the A1 limit out to about 100 miles offshore.

**Sea Area A3** An area, excluding sea areas A1 and A2, within the coverage of an Inmarsat geostationary satellite in which continuous alerting is available. This area is from about 70°N to 70°S.

**Sea Area A4** All areas outside of sea areas A1, A2 and A3. This area includes the polar regions, where geostationary satellite coverage is not available.

Ships at sea must be capable of the following functional GMDSS requirements:

1. Ship-to-shore distress alerting
2. Shore-to-ship distress alerting
3. Ship-to-ship distress alerting
4. SAR coordination
5. On-scene communications
6. Transmission and receipt of emergency locating signals
7. Transmission and receipt of MSI
8. General radio communications
9. Bridge-to-bridge communications

To meet the requirements of the functional areas above the following is a list of the minimum communications equipment needed for all ships:

1. VHF radio capable of transmitting and receiving DSC on channel 70, and radio telephony on channels 6, 13 and 16
2. Radio receiver capable of maintaining a continuous Digital Selective Calling (DSC) watch on channel 70 VHF
3. Search and rescue transponders (SART), a minimum of two, operating in the 9 GHz band

4. Receiver capable of receiving NAVTEX broadcasts anywhere within NAVTEX range
5. Receiver capable of receiving SafetyNET anywhere NAVTEX is not available
6. Satellite emergency position indicating radiobeacon (EPIRB), manually activated and float-free self-activated
7. Two-way handheld VHF radios (two sets minimum on 300-500 gross tons cargo vessels and three sets minimum on cargo vessels of 500 gross tons and upward and on all passenger ships)

Additionally, each sea area has its own requirements under GMDSS which are as follows:

#### **Sea Area A1**

1. General VHF radio telephone capability
2. Free-floating satellite EPIRB
3. Capability of initiating a distress alert from a navigational position using DSC on either VHF, HF or MF; manually activated EPIRB; or Ship Earth Station (SES)

#### **Sea Areas A1 and A2**

1. Radio telephone MF radiotelephony or direct printing 2182 kHz, and DSC on 2187.5 kHz
2. Equipment capable of maintaining a continuous DSC watch on 2187.5 kHz
3. General working radio communications in the MF band (1605-4000 kHz), or Inmarsat SES
4. Capability of initiating a distress alert by HF (using DSC), manual activation of an EPIRB, or Inmarsat SES

#### **Sea Areas A1, A2 and A3**

1. Radio telephone MF 2182 kHz and DSC 2187.5 kHz.
2. Equipment capable of maintaining a continuous DSC watch on 2187.5 kHz
3. Inmarsat-A, -B or -C (class 2) or Fleet 77 SES Enhanced Group Call (EGC), or HF as required for sea area A4
4. Capability of initiating a distress alert by two of the following:
  - a. Inmarsat-A, -B or -C (class 2) or Fleet 77 SES
  - b. Manually activated EPIRB
  - c. HF/DSC radio communication

#### **Sea Area A4**

1. HF/MF receiving and transmitting equipment for band 1605-27500 kHz using DSC, radiotelephone and direct printing
2. Equipment capable of selecting any safety and

distress DSC frequency for band 4000-27500 kHz, maintaining DSC watch on 2187.5, 8414.5 kHz and at least one additional safety and distress DSC frequency in the band

3. Capability of initiating a distress alert from a navigational position via the Polar Orbiting System on 406 MHz (manual activation of 406 MHz satellite EPIRB)

### 2803. The Inmarsat System

**Inmarsat (International Maritime Satellite Organization)**, a key player within GMDSS, is an international corporation comprising over 75 international partners providing maritime safety communications for ships at sea. Inmarsat provides the space segment necessary for improving distress communications, efficiency and management of ships, as well as public correspondence services.

The basic components of the Inmarsat system include the Inmarsat **space segment**, **Land Earth Stations (LES)**, also referred to as **Coast Earth Stations (CES)**, and mobile **Ship Earth Stations (SES)**.

The Inmarsat space segment consists of 11 geostationary satellites. Four operational Inmarsat satellites provide primary coverage, four additional satellites (including satellites leased from the European Space Agency (ESA) and the International Telecommunications

Satellite Organization (INTELSAT)) serve as spares and three remaining leased satellites serve as back-ups.

The polar regions are not visible to the operational satellites but coverage is available from about 75°N to 75°S. Satellite coverage (Figure 2803) is divided into four overlapping regions:

1. Atlantic Ocean - East (AOR-E)
2. Atlantic Ocean - West (AOR-W)
3. Pacific Ocean (POR)
4. Indian Ocean (IOR)

The LES's provide the link between the Space Segment and the land-based national/international fixed communications networks. These communications networks are funded and operated by the authorized communications authorities of a participating nation. This network links registered information providers to the LES. The data then travels from the LES to the Inmarsat **Network Coordination Station (NCS)** and then down to the SES's on ships at sea. The SES's provide two-way communications between ship and shore. **Inmarsat-A**, the original Inmarsat system, operates at a transfer rate of up to 64k bits per second and is telephone, telex and facsimile (fax) capable. The similarly sized **Inmarsat-B** system uses digital technology, also at rates to 64kbps. Fleet 77 service is also digital and operates at up to 64kbps.

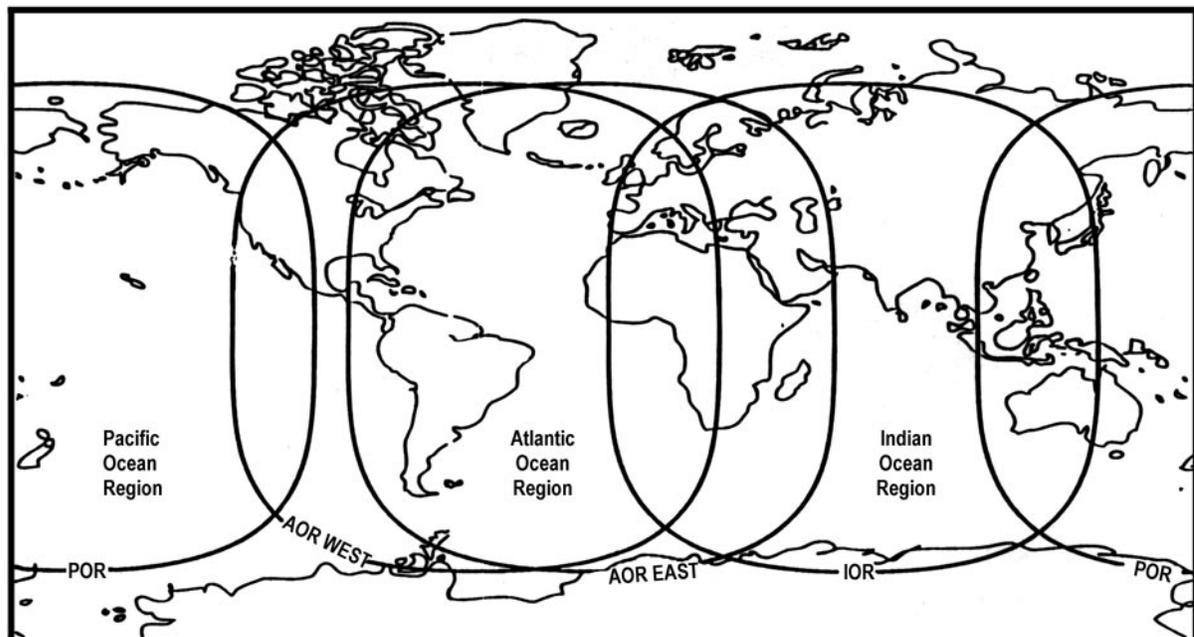


Figure 2803. The four regions of Inmarsat coverage.

**Inmarsat-C** provides a **store and forward** data messaging capability (but no voice) at 600 bits per second and was designed specifically to meet the GMDSS requirements for receiving MSI data on board ship. These units are small, lightweight and use an omni-directional antenna.

#### 2804. Maritime Safety Information (MSI)

Major categories of MSI for both NAVTEX and SafetyNET are:

1. Navigational warnings
2. Meteorological warnings
3. Ice reports
4. Search and rescue information
5. Meteorological forecasts
6. Pilot service messages (not in the U.S.)
7. Electronic navigation system messages (i.e., LORAN, GPS, DGPS, etc.)

Broadcasts of MSI in NAVTEX international service are in English, but may be in languages other than English to meet requirements of the host government.

#### 2805. SafetyNET

**SafetyNET** is a broadcast service of Inmarsat-C's **Enhanced Group Call (EGC)** system. The EGC system (Figure 2805) is a method used to specifically address particular regions or groups of ships. Its unique addressing capabilities allow messages to be sent to all vessels in both fixed geographical areas or to predetermined groups of ships. SafetyNET is a service designated by the IMO through which ships receive maritime safety information. The other service under the EGC system, called **FleetNET**, is used by commercial companies to communicate directly and privately with their individual fleets.

SafetyNET is an international shore to ship satellite-based service for the promulgation of distress alerts, navigational warnings, meteorological warnings and forecasts, and other safety messages. It fulfills an integral role in GMDSS as developed by the IMO. The ability to receive SafetyNET messages is required for all SOLAS ships that sail beyond coverage of NAVTEX (approximately 200 miles from shore).

SafetyNET can direct a message to a given geographic area based on EGC addressing. The area may be fixed, as in the case of a NAVAREA or weather forecast area, or it may be uniquely defined by the originator. This is particularly useful for messages such as local storm warnings or focussed shore to ship distress alerts.

SafetyNET messages can be originated by a **Registered Information Provider** anywhere in the world and broadcast to the appropriate ocean area through an Inmarsat-C LES. Messages are broadcast according to their

priority (i.e. Distress, Urgent, Safety, and Routine).

Virtually all navigable waters of the world are covered by the operational satellites in the Inmarsat system. Each satellite broadcasts EGC traffic on a designated channel. Any ship sailing within the coverage area of an Inmarsat satellite will be able to receive all the SafetyNET messages broadcast over this channel. The EGC channel is optimized to enable the signal to be monitored by SES's dedicated to the reception of EGC messages. This capability can be built into other standard SES's. It is a feature of satellite communications that reception is not generally affected by the position of the ship within the ocean region, atmospheric conditions, or time of day.

Messages can be transmitted either to geographic areas (area calls) or to groups of ships (group calls):

1. **Area calls** can be to a fixed area such as one of the 16 NAVAREA's or to a temporary geographic area selected by the originator. Area calls will be received automatically by any ship whose receiver has been set to one or more fixed areas.
2. **Group calls** will be received automatically by any ship whose receiver acknowledges the unique group identity associated with a particular message.

Reliable delivery of messages is ensured by forward error correction techniques. Experience has demonstrated that the transmission link is generally error-free and low error reception is achieved under normal circumstances.

Given the vast ocean coverage by satellite, some form of discrimination and selectivity in printing the various messages is required. Area calls are received by all ships within the ocean region coverage of the satellite; however, they will be printed only by those receivers that recognize the fixed area or the geographic position in the message. The message format includes a **preamble** that enables the microprocessor in a ship's receiver to decide to print those MSI messages that relate to the present position, intended route or a fixed area programmed by the operator. This preamble also allows suppression of certain types of MSI that are not relevant to a particular ship. As each message will also have a unique identity, the reprinting of messages already received correctly is automatically suppressed.

MSI is promulgated by various information providers around the world. Messages for transmission through the SafetyNET service will, in many cases, be the result of coordination between authorities. Information providers will be authorized by IMO to broadcast via SafetyNET. Authorized information providers are:

1. National hydrographic offices for navigational warnings
2. National weather services for meteorological warnings and forecasts

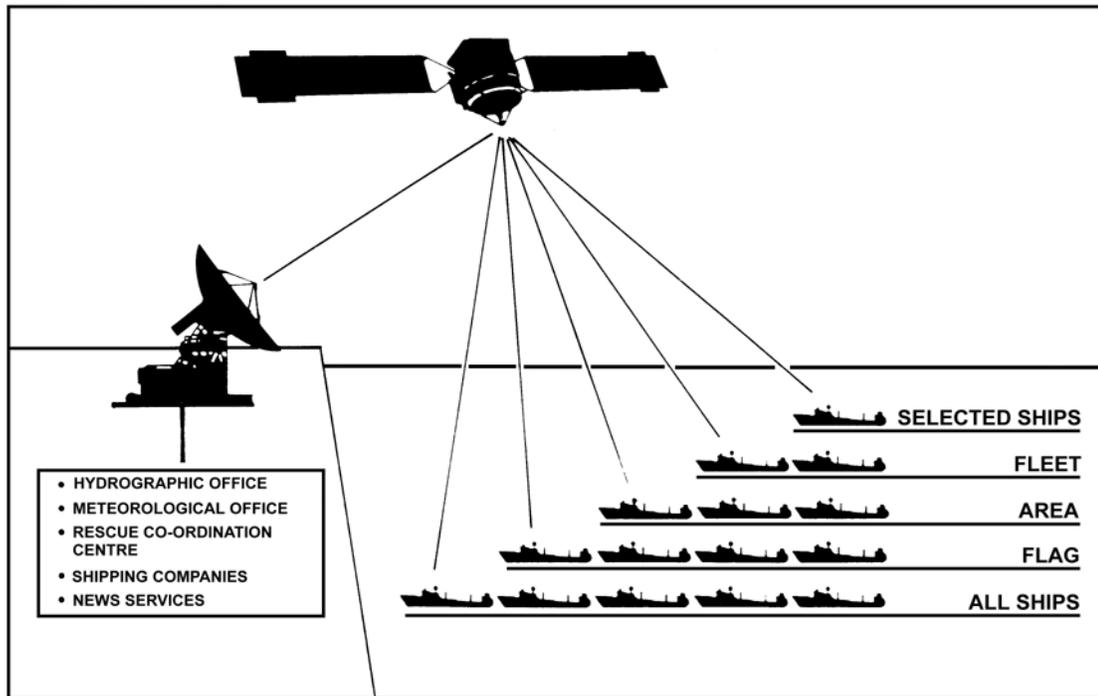


Figure 2805. SafetyNET EGC concept.

3. Rescue Coordination Centers (RCC's) for ship-to-shore distress alerts and other urgent information
4. In the U.S., the International Ice Patrol (IIP) for North Atlantic ice hazards

Each information provider prepares their SafetyNET messages with certain characteristics recognized by the EGC service. These characteristics, known as "C" codes are combined into a generalized message header format as follows: C1:C2:C3:C4:C5. Each "C" code controls a different broadcast criterion and is assigned a numerical value according to available options. A sixth "C" code, "C0" may be used to indicate the ocean region (i.e., AOR-E, AOR-W, POR, IOR) when sending a message to an LES which operates in more than one ocean region. Because errors in the header format of a message may prevent its being broadcast, MSI providers must install an Inmarsat SafetyNET receiver to monitor the broadcasts it originates. This also ensures quality control.

The "C" codes are transparent to the mariner, but are used by information providers to identify various transmitting parameters. C1 designates the message priority, either distress to urgent, safety, or routine. MSI messages will always be at least at the safety level. C2 is the service code or type of message (for example, long range NAVAREA warning or coastal NAVTEX warning). It also tells the receiver the length of the address (the C3 code) it will need to decode. C3 is the address code. It can be the

two digit code for the NAVAREA number for instance, or a 10 digit number to indicate a circular area for a meteorological warning. C4 is the repetition code which instructs the LES when to send the message to the NCS for actual broadcast. A six minute echo (repeat) may also be used to ensure that an urgent (unscheduled) message has been received by all ships affected. C5 is a constant and represents a presentation code, International Alphabet number 5, "00".

Broadcasts of MSI in the international SafetyNET service must be in English, but may be supplemented by other languages to meet requirements of the host government.

## 2806. NAVTEX

NAVTEX is a maritime radio warning system consisting of a series of coast stations transmitting radio teletype (standard narrow-band direct printing, called **Sitor** for Simplex Telex Over Radio) safety messages on the internationally standard medium frequency of 518 kHz. It is a GMDSS requirement for the reception of MSI in coastal and local waters. Coast stations transmit during previously arranged time slots to minimize mutual interference. Routine messages are normally broadcast four times daily. Urgent messages are broadcast upon receipt, provided that an adjacent station is not transmitting. Since the broadcast uses the medium frequency band, a typical station service

radius ranges from 100 to 500 NM day and night (although a 200 mile rule of thumb is applied in the U.S.). Interference from or receipt of stations further away occasionally occurs at night.

Each NAVTEX message broadcast contains a four-character header describing: identification of station (first character), message content or type (second character), and message serial number (third and fourth characters). This header allows the microprocessor in the shipboard receiver to screen messages from only those stations relevant to the user, messages of subject categories needed by the user and messages not previously received by the user. Messages so screened are printed as they are received, to be read by the mariner when convenient. All other messages are suppressed. Suppression of unwanted messages is becoming more and more a necessity to the mariner as the number of messages, including rebroadcast messages, increases yearly. With NAVTEX, a mariner will not find it necessary to listen to, or sift through, a large number of non-relevant data to obtain the information necessary for safe navigation.

The NAVTEX receiver is a small unit with an internal printer, which takes a minimum of room on the bridge. Its antenna is also of modest size, needing only a receive capability.

### 2807. Digital Selective Calling (DSC)

**Digital Selective Calling (DSC)** is a system of digitized radio communications which allows messages to be targeted to all stations or to specific stations, allows for unattended and automated receipt and storage of messages for later retrieval, and permits the printing of messages in hardcopy form. All DCS calls automatically include error-checking signals and the identity of the calling unit. Digital codes allow DSC stations to transmit and receive distress messages, transmit and receive acknowledgments of distress messages, relay distress messages, make urgent and safety calls, and initiate routine message traffic.

Each unit has a MAYDAY button which allows the instant transmittal of a distress message to all nearby ships and shore stations. The location of the distress will be automatically indicated if the unit is connected to a GPS or Loran C receiver. Each unit must be registered with the Coast Guard and have unique identifier programmed into it. Distress alerts can be sent on only one or as many as six channels consecutively on some units.

Listening watch on 2182 kHz ended with implementation of GMDSS in 1999. When DSC has been implemented worldwide, the traditional listening watch on Channel 16 VHF will no longer be necessary. The introduction of DSC throughout the world is expected to take to take a number of years.

There are four basic types of DSC calls:

- Distress

- Urgent
- Safety
- Routine

Distress calls are immediately received by rescue authorities for action, and all vessels receiving a distress call are alerted by an audible signal.

Each DSC unit has a unique Maritime Mobile Service Identity (MMSI) code number, which is attached to all outgoing messages. The MMSI number is a nine-digit number to identify individual vessels, groups of vessels, and coast stations. Ship stations will have a leading number consisting of 3 digits which identify the country in which the ship is registered, followed by a unique identifying number for the vessel. A group of vessels will have a leading zero, followed by a unique number for that group. A coast station will have 2 leading zeros followed by a code number. Other codes may identify all stations, or all stations in a particular geographic area.

DSC frequencies are found in the VHF, MF and HF bands. Within each band except VHF, one frequency is allocated for distress, urgent, and safety messages. Other frequencies are reserved for routine calls. In the VHF band, only one channel is available, Channel 70 (156.525 MHz), which is used for all calls. In the MF band, 2187.5 kHz and 2189.5 kHz are reserved for distress/safety, and 2177 kHz for ship to ship and ship to shore calls.

### 2808. Using DSC

A distress call consists of a Format Specifier--Distress; the MMSI code; the nature of the distress (selected from a list: fire/explosion, flooding, collision, grounding, listing, sinking, disabled/adrift, or abandoning ship; defaults to Undesignated); the time of the call, and the format for subsequent communications (radiotelephone or NDBP). Once activated, a distress signal is repeated automatically every few minutes until an acknowledgment is received or the function is switched off. As soon as an acknowledgment is received by the vessel in distress, it must commence communications with appropriate an message by radiotelephone or NDBP according to the format:

“MAYDAY”  
 MMSI CODE NUMBER AND CALL SIGN  
 NAME OF VESSEL  
 POSITION  
 NATURE OF DISTRESS  
 TYPE OF ASSISTANCE NEEDED  
 OTHER INFORMATION

Routine calls should be made on a channel reserved for non-distress traffic. Once made, a call should not be repeated, since the receiving station either received the call and stored it, or did not receive it because it was not in service. At least 5 minutes should elapse between calls by vessels on

the first attempt, then at 15 minute minimum intervals.

To initiate a routine ship to shore or ship to ship call to a specific station, the following procedures are typical (consult the operator's manual for the equipment for specific directions):

- Select the appropriate frequency
- Select or enter the MMSI number of the station to be called
- Select the category of the call
- Select subsequent communications method (R/T, NDBP)
- Select proposed working channel (coast stations will indicate vacant channel in acknowledgment)

- Select end-of-message signal (RQ for acknowledgment required)
- Press <CALL>

The digital code is broadcast. The receiving station may acknowledge receipt either manually or automatically, at which point the working channel can be agreed on and communications begin.

Watchkeeping using DSC consists of keeping the unit ON while in the appropriate Sea Area. DSC watch frequencies are VHF Channel 70, 2187.5 kHz, 8414.5 kHz, and one HF frequency selected according to the time of day and season. Coast stations maintaining a watch on DCS channels are listed in NIMA *Pub. 117* and other lists of radio stations.

## AMVER

### 2809. The Automated Mutual-Assistance Vessel Rescue System (Amver)

The purpose of ship reporting systems is to monitor vessels' positions at sea so that a response to any high-seas emergency can be coordinated among those nearest and best able to help. It is important that complete information be made available to search and rescue (SAR) coordinators immediately so that the right type of assistance can be sent to the scene with the least possible delay.

For example, a medical emergency at sea might require a doctor; a ship reporting system can find the nearest vessel with a doctor aboard. A sinking craft might require a vessel to rescue the crew, and perhaps another to provide a lee. A ship reporting system allows SAR coordinators to quickly assemble the required assets to complete the rescue.

The International Convention for the Safety of Life at Sea (SOLAS) obligates the master of any vessel who becomes aware of a distress incident to proceed to the emergency and assist until other aid is at hand or until released by the distressed vessel. Other international treaties and conventions impose the same requirement.

By maintaining a database of information as to the particulars of each participating vessel, and monitoring their positions as their voyages proceed, the Amver coordinator can quickly ascertain which vessels are closest and best able to respond to any maritime distress incident. They can also release vessels that might feel obligated to respond from their legal obligation to do so, allowing them to proceed on their way without incurring liability for not responding. International agreements ensure that no costs are incurred by a participating vessel.

Several ship reporting systems are in operation throughout the world. The particulars of each system are given in publications of the International Maritime Organization (IMO). Masters of vessels making offshore passages are requested to always participate these systems when in the areas covered by them. The only worldwide system in operation is the U.S. Coast Guard's Amver system.

Amver is an international maritime mutual assistance program that coordinates search and rescue efforts around the world. It is voluntary, free of charge, and endorsed by the IMO. Merchant ships of all nations are encouraged to file a sailing plan, periodic position reports, and a final report at the end of each voyage, to the Amver Center located in the U.S. Coast Guard Operations Systems Center in Martinsburg, WV. Reports can be sent via e-mail, Inmarsat-C, Amver/SEAS "compressed message" format, Sat-C format, HF radiotelex, HF radio or telefax message. Most reports can be sent at little or no cost to the ship.

Data from these reports is protected as "commercial proprietary" business information, and is released by U.S. Coast Guard only to recognized national SAR authorities and only for the purposes of SAR in an actual distress. Information concerning the predicted location and SAR characteristics of each vessel is available upon request to recognized SAR agencies of any nation or to vessels needing assistance. Predicted locations are disclosed only for reasons related to marine safety.

The Amver computer uses a dead reckoning system to predict the positions of participating ships at any time during their voyage. Benefits to participating vessels and companies include:

- Improved chances of timely assistance in an emergency.
- Reduced number of calls for ships not favorably located.
- Reduced lost time for vessels responding.
- Added safety for crews in the event of an overdue vessel.

Amver participants can also act as the eyes and ears of SAR authorities to verify the authenticity of reports, reducing the strain on SAR personnel and facilities. Amver is designed to compliment computer and communications technologies, including GMDSS systems that provide distress alerting, and GPS positioning systems. These technologies can reduce or entirely eliminate the search aspect of search and rescue (since the precise location of the distress can be known), allowing SAR authorities to concentrate immediately on the response.

The Amver Sailing Plan provides information on the port of departure, destination, course, speed, navigational method,

waypoints, communications capabilities, and the presence of onboard medical personnel. The database contains information on the ship's official name and registry, call sign, type of ship, tonnage, propulsion, maximum speed, and ownership. Changes in any of this data should be reported to Amver at the earliest opportunity.

Amver participants bound for U.S. ports enjoy an additional benefit: Amver messages which include the necessary information are considered to meet the requirements of 33 CFR 161 (Notice of Arrival).

### 2810. The Amver Communications Network

The following methods are recommended for ships to transmit information to Amver:

1. **Electronic mail** (e-mail) via the Internet: The Amver internet e-mail address is [amvermsg@amver.com](mailto:amvermsg@amver.com). If a ship already has an inexpensive means of sending e-mail to an internet address, this is the preferred method. The land-based portion of an e-mail message is free, but there may be a charge for any ship-to-shore portion. Reports should be sent in the body of the message, not as attachments.

2. **Amver/SEAS Compressed Message** via Inmarsat-C through certain Land Earth Stations (LES's): Ships equipped with an Inmarsat-C transceiver with floppy drive and capability to transmit a binary file (The ship's GMDSS Inmarsat-C transceiver can be used); and ships equipped with an IBM-compatible computer with hard drive, 286 or better processor, VGA graphics interface, and Amver/SEAS software; may send combined Amver/Weather Observation messages free of charge via TELENOR-USA Land Earth Stations at:

001 Atlantic Ocean Region-West (AOR-W)-Southbury  
101 Atlantic Ocean Region East (AOR-E)-Southbury  
201 Pacific Ocean Region (POR)-Santa Paula  
321 Indian Ocean Region (IOR)-Assaguel

Amver/SEAS software can be downloaded free of charge from <http://dbcp.nos.noaa.gov/seas.html>.

3. **HF Radiotelex Service** of the U.S. Coast Guard Communication Stations; see full instructions at:

<http://www.navcen.uscg.mil/marcomms/cgcomms/call.htm>

4. **HF Radio** at no cost via Coast Guard contractual agreements with Globe Wireless Super Station Network, or Mobile Marine Radio (WLO) (under Telaurus Communications Inc.).

5. **Telex**: Amver Address (0) 230 127594 AMVERNYK

6. **Telefax**: To the USCG Operations Systems Center at: +1 304 264 2505. Telefax should be used only if other means are unavailable.

The **Amver Bulletin** provides information on the operation of the Amver System of general interest to the mariner and up-to-date information on the Amver communications network.

### 2811. Amver Participation

Instructions guiding participation in the Amver System are available from the Amver User's Manual published in the following languages: Chinese, Danish, Dutch, English, French, German, Greek, Italian, Japanese, Korean, Norwegian, Polish, Portuguese, Russian, Spanish and Swedish. This manual is available free from:

Amver Maritime Relations Office  
USCG Battery Park Building  
1 South Street  
New York, NY, USA, 10004-1499  
Telephone: (212) 668-7764  
Fax: (212) 668-7684

or from:

Commander, Pacific Area  
United States Coast Guard  
Government Island  
Alameda, CA 94501

The manual may also be obtained from Coast Guard District Offices, Marine Safety Offices, and Captain of the Port Offices in all major U.S. ports. Requests should indicate the language desired if other than English.

SAR operational procedures are contained in the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual published jointly by the IMO and the ICAO. Volume III of this manual is required aboard SOLAS vessels.

To enroll in Amver, a ship must first complete a SAR Questionnaire (SAR-Q). Participation involves filing four types of reports:

1. Sailing Plan
2. Position Report
3. Deviation Report
4. Final Report

The **Sailing Plan** is sent before leaving port, and indicates the departure time and date, destination, route and waypoints, speed, and navigational method.

The **Position Report** is sent after the first 24 hours to confirm departure as planned and conformance with the reported Sailing Plan. An additional report is requested every 48 hours to verify the DR plot being kept in the Amver computer.

A **Deviation Report** should be sent whenever a change of route is made, or a change to course or speed due to weath-

er, heavy seas, casualty, or any other action that would render the computerized DR inaccurate.

A **Final Report** should be sent at the destination port. The system then removes the vessel from the DR plot and logs the total time the ship was participating.

Vessels that travel certain routes on a recurring basis may be automatically tracked for successive voyages as long as delays in regular departures are reported. The system may also be used to track vessels sailing under special circumstances such as tall ships, large ocean tows, research vessel operations, factory fishing vessels, etc. At any given time nearly 3,000 vessels worldwide are being plotted by Amver, and the number of persons rescued as a direct result of Amver operations is in the hundreds each year.

**2812. Amver Reporting Requirements**

The U.S. Maritime Administration (MARAD) regulations state that certain U.S. flag vessels and foreign flag “War Risk” vessels must report and regularly update their voyages to the Amver Center. This reporting is required of the following: (a) U.S. flag vessels of 1,000 tons or greater, operating in foreign commerce; (b) foreign flag vessels of 1,000 gross tons or greater, for which an Interim War Risk Insurance Binder has been issued under the provisions of Title XII, Merchant Marine Act, 1936.

**2813. The Surface Picture (SURPIC)**

When a maritime distress is reported to SAR authorities, the Amver computer is queried to produce a Surface Picture (SURPIC) in the vicinity of the distress. Several different types of SURPIC are available, and they can be generated for any specified time. The SURPIC output is a text file containing the names of all vessels meeting the criteria requested, plus a subset of the

information recorded in the database about each vessel. See Figure 2813. A graphic display can be brought up for RCC use, and the data can be sent immediately to other SAR authorities worldwide. The information provided by the SURPIC includes the position of all vessels in the requested area, their courses, speeds, estimated time to reach the scene of the distress, and the amount of deviation from its course required for each vessel if it were to divert. RCC staff can then direct the best-placed, best-equipped vessel to respond.

Four types of SURPIC can be generated:

A **Radius SURPIC** may be requested for any radius from 50 to 500 miles. A sample request might read:

“REQUEST 062100Z RADIUS SURPIC OF DOCTOR-SHIPS WITHIN 800 MILES OF 43.6N 030.2W FOR MEDICAL EVALUATION M/V SEVEN SEAS.”

The **Rectangular SURPIC** is obtained by specifying the date, time, and two latitudes and two longitudes. As with the Radius SURPIC, the controller can limit the types of ships to be listed. There is no maximum or minimum size limitation on a Rectangular SURPIC.

A sample Area SURPIC request is as follows:

“REQUEST 151300Z AREA SURPIC OF WESTBOUND SHIPS FROM 43N TO 31N LATITUDE AND FROM 130W TO 150W LONGITUDE FOR SHIP DISTRESS M/V EVENING SUN LOCATION 37N, 140W.”

The **Snapshot** or **Trackline SURPIC** is obtained by specifying the date and time, two points (P1 and P2), whether the trackline should be rhumb line or great circle, what the half-width (D) coverage should be (in nautical miles), and whether all ships are desired or only those meeting certain parameters (e.g. doctor on board).

<u>Name</u>	<u>Call sign</u>	<u>Position</u>	<u>Course</u>	<u>Speed</u>	<u>SAR data</u>	<u>Destination and ETA</u>
CHILE MARU CPA 258 DEG. 012 MI. 032000Z	JAYU	26.2 N 179.9E	C294	12.5K	H 1 6 R T X Z	KOBE 11
WILYAMA CPA 152 DEG. 092 MI. 032000Z	LKBD	24.8N 179.1W	C106	14.0K	H X R T V X Z	BALBOA 21
PRES CLEVELAND CPA 265 WILL PASS WITHIN 10 MI. 040430Z	WITM	25.5N 177.0W	C284	19.3K	H 2 4 R D T X Z S	YKHAMA 08
AENEAS CPA 265 DEG. 175 MI. 03200Z	GMRT	25.9N 176.9E	C285	16.0K	H 8 R N V X Z	YKHAMA 10

Figure 2813. Radius SURPIC as received by a rescue center.

A Snapshot Trackline SURPIC request might look like:

“REQUEST 310100Z GREAT CIRCLE TRACKLINE SURPIC OF ALL SHIPS WITHIN 50 MILES OF A LINE FROM 20.1N 150.2W TO 21.5N 158.0W FOR AIRCRAFT PRECAUTION.”

A **Moving Point SURPIC** is defined by the starting and ending points of a vessel’s trackline, the estimated departure time of the vessel, and the varying time of the SURPIC. This SURPIC is useful when a vessel is overdue at her destination. If the vessel’s trackline can be accurately estimated, a SURPIC can be generated for increments of time along the trackline, and a list can be generated of ships that might have sighted the missing ship.

#### 2814. Uses of Amver Information

After evaluating the circumstances of a reported distress, The RCC can select the best available vessel to divert to the scene. In many cases a participating ship will be asked only to change course for a few hours or take a slightly different route to their destination, in order to provide a lookout in a certain area. RCC coordinators strive to use participating ships efficiently, and release them as soon as possible.

An example of the use of a Radius SURPIC is depicted in Figure 2814. In this situation rescue authorities believe

that a ship in distress, or her survivors, might be found in the rectangular area. The RCC requests a SURPIC of all eastbound ships within 100 miles of a position well west of the rectangular area. With this list, the RCC staff prepares a modified route for each of four ships which will comprise a “search team” to cover the entire area, while adding only a few miles to each ship’s route. Messages to each ship specify the exact route to follow and what to look for enroute.

Each ship contacted may be asked to sail a rhumb line between two specified points, one at the beginning of the search area and one at the end. By carefully assigning ships to areas of needed coverage, very little time need be lost from the sailing schedule of each cooperating ship. Those ships joining the search would report their positions every few hours to the Rescue Coordination Center, together with weather data and any significant sightings. In order to achieve saturation coverage, a westbound SURPIC at the eastern end of the search area would also be used.

The Trackline SURPIC is most commonly used as a precautionary measure for aircraft. Occasionally a plane loses one or more of its engines. A Trackline SURPIC, provided from the point of difficulty to the destination, provides the pilot with the added assurance of knowing the positions of vessels beneath him and that they have been alerted. While the chance of an airliner experiencing such an emergency is extremely remote, SURPIC’s have been used successfully to save the lives of pilots of general aviation aircraft on oceanic flights.

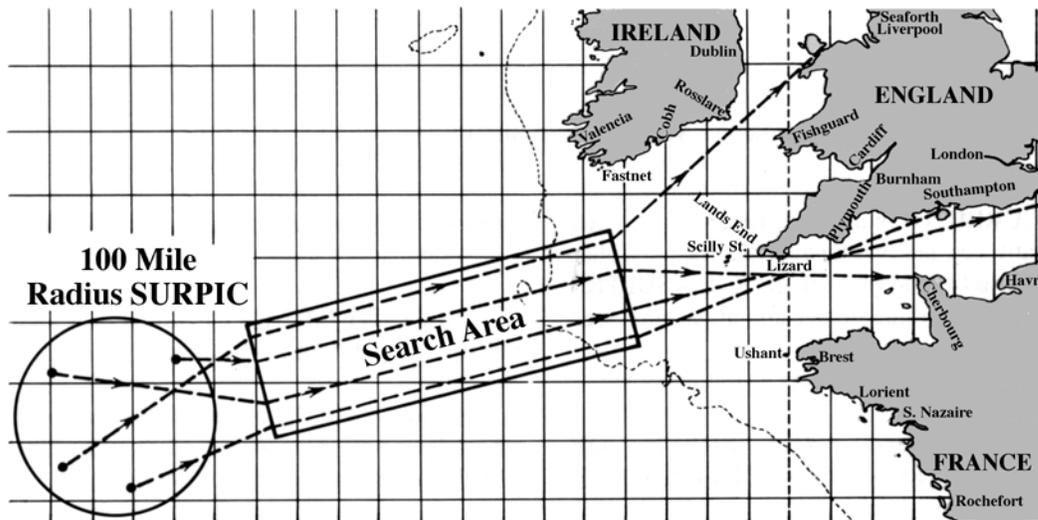


Figure 2814. Example of the use of a radius SURPIC to locate ships to search a rectangular area.

## EMERGENCY POSITION INDICATING RADIOBEACONS (EPIRB'S)

### 2815. Description And Capabilities

Emergency Position Indicating Radiobeacons (EPIRB's) are designed to save lives by automatically alerting rescue authorities and indicating the distress location. EPIRB types are described below (Figure 2815a):

**121.5/243 MHz EPIRB's (Class A, B, S):** These are the most common and least expensive type of EPIRB, designed to be detected by overflying commercial or military aircraft.

The IMO and the International Civil Aviation Organization (ICAO) have announced plans to eventually terminate the processing distress signals for 121.5/243 MHz EPIRBs. Support for Class A, B, and S EPIRB's will be discontinued at some unannounced time in the future due to the high number of false alarms and the superiority of other systems.

Satellites were designed to detect these EPIRB's, but are limited for the following reasons:

1. Satellite detection range is limited for these EPIRB's (satellites must be within line of sight of both the EPIRB and a ground terminal for detection to occur).
2. EPIRB design and frequency congestion cause a high false alarm rate (over 99%); consequently, confirmation is required before SAR forces deploy.
3. EPIRB's manufactured before October 1988 may have design or construction problems (e.g. some models will leak and cease operating when immersed in water) or may not be detectable by satellite.

**406 MHz EPIRB's (Category I, II):** The 406 MHz EPIRB was designed to operate with satellites. Its signal al-

lows authorities to locate the EPIRB much more accurately than 121.5/243 MHz devices and identify the individual vessel anywhere in the world. There is no range limitation. These devices also include a 121.5 MHz homing signal, allowing aircraft and rescue vessels to quickly locate the vessel in distress once underway. These are the only type of EPIRB which must be tested by Coast Guard-approved independent laboratories before they can be sold for use in the United States.

An automatically activated, float-free version of this EPIRB has been required on SOLAS vessels (cargo ships over 300 tons and passenger ships on international voyages) since August 1, 1993. The Coast Guard requires U.S. commercial fishing vessels to carry this device, and requires the same for other U.S. commercial uninspected vessels which travel more than 3 miles offshore.

**Inmarsat-E EPIRB's:** Inmarsat-E EPIRB's operate on 1.6 GHz (L-band) and transmit a distress signal to Inmarsat geostationary satellites, which includes a registered identity similar to that of the 406 MHz EPIRB, and a location derived from a GPS navigational satellite receiver inside the EPIRB. Inmarsat-E EPIRB's may be detected anywhere in the world between 70°N and 70°S. Since geostationary satellites are used, alerts are transmitted almost instantly to a RCC associated with the Inmarsat CES receiving the alert. The distress alert transmitted by an Inmarsat-E EPIRB is received by two CES's in each ocean region, giving 100 percent duplication for each ocean region in case of failures or outages associated with any of the CES's. Alerts received over the Inmarsat Atlantic Ocean Regions are routed to the U.S. Coast Guard Atlantic Area command center in Portsmouth, and alerts received over the Inmarsat Pacific Ocean Region are routed to the U.S. Coast Guard Pacific Area command center in Alameda. This type of EPIRB is designated for use in the GMDSS, but it is not sold in the United States or approved for use by U.S. flag vessels.

Type	Frequency	Description
Class A	121.5/243 MHz	Float-free, automatic activating, detectable by aircraft and satellite. Coverage limited (see Figure 2815b).
Class B	121.5/243 MHz	Manually activated version of Class A.
Class S	121.5/243 MHz	Similar to Class B, except that it floats, or is an integral part of a survival craft.
Category I	406 MHz	Float-free, automatically activated. Detectable by satellite anywhere in the world.
Category II	406 MHz	Similar to Category I, except manually activated.
Inmarsat-E	1646 MHz	Float-free, automatically activated EPIRB. Detectable by Inmarsat geostationary satellite.

Figure 2815a. EPIRB classifications.

<i>Feature</i>	<i>406 MHz EPIRB</i>	<i>121.5/243 MHz EPIRB</i>
Frequencies	406.025 MHz (locating) 121.500 MHz (homing)	243.000 MHz (military)
Primary Function	Satellite alerting, locating, identification of distressed vessels.	Transmission of distress signal to passing aircraft and ships.
Distress Confirmation	Positive identification of coded beacon; each beacon signal is a coded, unique signal with registration data (vessel name, description, and telephone number ashore, assisting in confirmation).	Virtually impossible; no coded information, beacons often incompatible with satellites; impossible to know if signals are from EPIRB, ELT, or non-beacon source.
Signal	Pulse digital, providing accurate beacon location and vital information on distressed vessel.	Continuous signal allows satellite locating at reduced accuracy; close range homing.
Signal Quality	Excellent; exclusive use of 406 MHz for distress beacons; no problems with false alerts from non-beacon sources.	Relatively poor; high number of false alarms caused by other transmitters in the 121.5 MHz band.
Satellite Coverage	Global coverage, worldwide detection; satellite retains beacon data until next Earth station comes into view.	Both beacon and LUT must be within coverage of satellite; detection limited to line of sight.
Operational Time	48 hrs. at -20°C.	48 hrs. at -20°C.
Output Power	5 watts at 406 MHz, 0.025 watts at 121.5 MHz.	0.1 watts average.
Strobe Light	High intensity strobe helps in visually locating search target.	None.
Location Accuracy (Search Area) and Time Required	1 to 3 miles (10.8 sq. miles); accurate position on first satellite overflight enables rapid SAR response, often within 30 min.	10 to 20 miles (486 sq. miles); SAR forces must wait for second system alert to determine final position before responding (1 to 3 hr. delay).

*Figure 2815b. Comparison of 121.5/406 MHz and 121.5/243 MHz EPIRB's.*

Mariners should be aware of the differences between capabilities of 121.5/243 MHz and 121.5/406 MHz EPIRB's, as they have implications for alerting and locating of distress sites, as well as response by SAR forces. See Figure 2815b. The advantages of 121.5/406 MHz devices are substantial, and are further enhanced by EPIRB-transmitted registration data on the carrying vessel. Owners of 121.5/406 MHz EPIRB's furnish registration information about their vessel, type of survival gear, and emergency points of contact ashore, all of which greatly enhance the quality of the response. The database for U.S. vessels is maintained by the National Oceanographic and Atmospheric Administration, and is accessed worldwide by SAR authorities to facilitate SAR response.

#### **2816. Testing EPIRB's**

EPIRB owners should periodically check for water tightness, battery expiration date, and signal presence. FCC

rules allow Class A, B, and S EPIRB's to be turned on briefly (for three audio sweeps, or 1 second only) during the first 5 minutes of any hour. Signal presence can be detected by an FM radio tuned to 99.5 MHz, or an AM radio tuned to any vacant frequency and located close to an EPIRB. All 121.5/406 MHz EPIRB's have a self-test function that should be used in accordance with manufacturers' instructions at least monthly.

#### **2817. The COSPAS/SARSAT System**

COSPAS is a Russian acronym for "Space System for Search of Distressed Vessels"; SARSAT signifies "Search And Rescue Satellite-Aided Tracking." COSPAS-SARSAT is an international satellite-based search and rescue system established by the U.S., Russia, Canada, and France to locate emergency radiobeacons transmitting on the frequencies 121.5, 243, and 406 MHz. Since its inception, the COSPAS-SARSAT system (SARSAT satellite only) has contributed to saving over 13,000 lives.

The USCG receives data from MRCC stations and SAR Points of Contact (SPOC). See Figure 2817.

Country	Location	Designator
Australia	Canberra	AUMCC
Brazil	San Paulo	BBMCC
Canada	Trenton	CMCC
Chile	Santiago	CHMCC
France	Toulouse	FMCC
Hong Kong	Hong Kong	HKMCC
India	Bangalore	INMCC
Indonesia	Jakarta	IONCC
ITDC	Taipei	TAMCC
Japan	Tokyo	JAMCC
Norway	Bodo	NMCC
Pakistan	Lahore	PAMCC*
Singapore	Singapore	SIMCC
Spain	Maspalomas	SPMCC
South Africa		SAMCC
Russian Federation	Moscow	CMC
United Kingdom	Plymouth	UKMCC
United States	Suitland	USMCC

\* Status Unknown

Figure 2817. Participants in COSPASS/SARSAT system.

### 2818. Operation of The COSPAS/SARSAT System

If an EPIRB is activated, COSPAS/SARSAT picks up the signal, locates the source and passes the information to a land station. From there, the information is relayed to Rescue Coordination Centers, rescue vessels and nearby ships. This constitutes a one-way only communications system, from the EPIRB via the satellite to the rescuers. It employs low altitude, near polar orbiting satellites and by exploiting the Doppler principle, locates the 406 MHz EPIRB within about two miles. Due to the low polar orbit, there may be a delay in receiving the distress message unless the footprint of the satellite is simultaneously in view with a monitoring station. However, unlike SafetyNET, worldwide coverage is provided.

As a satellite approaches a transmitting EPIRB, the frequency of the signals it receives is higher than that being transmitted; when the satellite has passed the EPIRB, the received frequency is lower. This creates a notable Doppler shift. Calculations which take into account the Earth's rota-

tion and other factors then determine the location of the EPIRB.

Each 406 MHz EPIRB incorporates a unique identification code. Once the satellite receives the beacon's signals, the Doppler shift is measured and the beacon's digital data is recovered from the signal. The information is time-lagged, formatted as digital data and transferred to the repeater downlink for real time transmission to a local user terminal. The digital data coded into each 406 MHz EPIRB's memory indicates the identity of the vessel to SAR authorities. They can then refer to the EPIRB registration database for information about the type of vessel, survival gear carried aboard, whom to contact in an emergency, etc. The data includes a maritime identification digit (MID, a three digit number identifying the administrative country) and either a ship station identifier (SSI, a 6 digit number assigned to specific ships), a ship radio call sign or a serial number to identify the ship in distress.

With the Inmarsat-E satellite EPIRB's, coverage does not extend to very high latitudes, but within the coverage area the satellite connection is instantaneous. However, to establish the EPIRB's geographic position, an interface with a GPS receiver or other sensor is needed.

### 2819. Alarm, Warning, and Alerting Signals

For MF (i.e. 2182 kHz), the signal consists of either (1) a keyed emission modulated by a tone of 1280 Hz to 1320 Hz with alternating periods of emission and silence of 1 to 1.2 seconds each; or (2) the radiotelephone alarm signal followed by Morse code B (— •••) and/or the call sign of the transmitting ship, sent by keying a carrier modulated by a tone of 1300 Hz or 2200 Hz. For VHF (i.e. 121.5 MHz and 243 MHz), the signal characteristics are in accordance with the specifications of Appendix 37A of the ITU Radio Regulations. For 156.525 MHz and UHF (i.e. 406 MHz to 406.1 MHz and 1645.5 MHz to 1646.5 MHz), the signal characteristics are in accordance with CCIR recommendations.

The purpose of these signals is to help determine the position of survivors for SAR operations. They indicate that one or more persons are in distress, may no longer be aboard a ship or aircraft, and may not have a receiver available.

## SEARCH AND RESCUE RADAR TRANSPONDERS

### 2820. Operational Characteristics

Operating much like a RACON, the Search and Rescue Radar Transponder (SART) is a passive rescue device which, when it senses the pulse from a radar operating in the 9 GHz frequency band, emits a series of pulses in response, which alerts the radar operator that some sort of

maritime distress is in progress. Further, the SART signal allows the radar operator to home in on the exact location of the SART. The SART can be activated manually, or will activate automatically when placed in water.

The SART signal appears on the radar screen as a series of 12 blips, each 0.64 nautical miles apart. As the vessel or aircraft operating the radar approaches the SART loca-

tion, the blips change to concentric arcs, and within about a mile of the SART become concentric circles, centered on the SART.

Because the SART actively responds to radar pulses, it also informs its user, with an audible or visual signal, that it is being triggered. This alerts the user in distress that there is an operating radar in the vicinity, whereupon they may send up flares or initiate other actions to indicate their position.

Approved SART's operate in standby mode for at least 96 hours and actively for at least 8 hours. Because the SART signal is stronger than any surrounding radar returns, it will be easily sensed by any nearby radar. But because it is much weaker than the radar, its own range is the limiting factor in detection.

### 2821. Factors Affecting SART Range

SART range is affected by three main factors. First, The type of radar and how it is operated is most important. Larger vessels with powerful, high-gain antennae, set higher above sea level, will trigger and detect the SART signal sooner than low-powered radars set closer to sea level. The radar should be set to a range of 12 or 6 miles for best indication of a SART's signal, and should not have too narrow a receive bandwidth, which might reduce the strength of the received signal.

Second, weather is a factor in SART range. A flat calm might cause multipath propagation and distort the SART's signal. Heavy seas may cause the SART signal to be received intermittently as the transponder falls into the troughs of the seas. Careful adjustment of the sea and rain clutter controls will maximize the SART's received signal strength.

Third, the height of the SART will greatly affect the range, because the signal obeys the normal rules for radio waves in its spectrum and does not follow the curvature of the earth, except for a small amount of refraction. Tests indicate that a SART floating in the sea will have a range of about 2 nautical miles when triggered by a radar mounted 15 meters above sea level. At a height of 1 meter, range increases to about 5 miles. To an aircraft actively searching for a SART at an altitude of 3,000 feet, the range increases to about 40 miles.

### 2822. Operating the Radar for SART Detection

Only an X-band (3 cm) radar can trigger and sense a SART. An S-Band (10 cm) radar will neither trigger nor detect a SART. Normally, an X-band radar will sense a SART at about 8 nm. When triggered by an incoming radar signal, the SART will transmit a return signal across the entire 3 cm radar frequency band. The first signal is a rapid 0.4 microsecond sweep, followed by a 7.5 microsecond sweep, repeated 12 times. This will cause a series of 12 blips on the radar, spaced 0.64 nm apart. See Figure 2822a.



Figure 2822a. SART 12-dot blip code

For best reception, the radar should be set to medium bandwidth and to the 12 or 6 mile range. Too narrow a bandwidth will cause the SART signal to be weakened, as the radar is not sensing the entire SART pulse. The radar operator's manual should be consulted for these settings. Less expensive radars may not be able to change settings.

As the range to the SART decreases to about 1 nm, the initial 0.4 microsecond sweeps may become visible as weaker and smaller dots on the radar screen. When first sensed, the first blip will appear about 0.6 miles beyond the actual location of the SART. As range decreases, the blips will become centered on the SART.

As the SART is approached more closely, the blips ap-



Figure 2822b. SART arcs

pearing on the radar become concentric arcs centered on the SART itself. The arcs are actually caused by the radar return of side lobes associated with the radar signal. While use of the sea return or clutter control may decrease or eliminate these arcs, it is often best to retain them, as they indicate the proximity of the SART. See Figure 2822b. Eventually the arcs become rings centered on the SART, as in Figure 2822c.

On some radars it may be possible to detune the radar signal in situations where heavy clutter or sea return obscures the SART signal. With the Automatic Frequency Control (AFC) on, the SART signal may become more visible, but the radar should be returned to normal operation as soon as possible. The gain control should usually be set to normal level for best detection, with the sea clutter control at its minimum and rain clutter control in normal position for the ambient conditions.



*Figure 2822c. SART rings*