VMS MB 101 - EPIRBs

VMS MB 101, May 1991By Dr James CowleyAn EPIRB is an Emergency Position Indicating Radio Beacon. These devices were
originally installed aboard some ocean going vessels in the early 1 970's to assist in the search and rescue efforts should seamen find themselves in a potential loss situation requiring abandonment of the vessel. Under the 1983 Amendments to the SOLAS Convention of 1974, EPIRBs transmitting on 121.5 MHz are mandatory equipment for all vessels from July 1, 1991. Two units are required, fitted one on each side of the vessel so as to be readily available to be carried to the nearest lifeboat or life raft.

Today more sophisticated satellite EPIRBs are available.
These units are specifically designed for satellite detection and Doppler location and they transmit on 406 MHz to a low-altitude, near-polar orbiting satellite to provide: a reliable means of distress alert; determination of location within one or two miles; and identification of the vessel in distress. In addition, they are normally provided with transmission capability on 121.5 MHz to enable search and rescue units to "home in" on them. Under IMO recommended equivalent arrangements as an alternative to the two 121.5 MHz EPIRBs, only one satellite EPIRB, having a float free capability, is required along with two Search and Rescue Transponders (SARTs). These transponders generate a series of response signals when interrogated by any ordinary 9 GHz radar. These response signals produce a line of 20 blips on the radar screen of the rescue ship or aircraft.

This bulletin discusses the basic concept of the system, and highlights some of the technical details such as coding. It provides an overview only. Detailed electronics questions should be addressed to your local supplier.

- Introduction

- Overview

- Communication systems

- Operation

- Doppler effect

- Blinker Light Question

- Digital Message Encoding

- Message format

- Bits

- Other protocols

- Future developments

- A view from the Registry

Overview

The International
Maritime Organization, recognizing the need for maritime satellite communications, worked with a number of organizations to develop the Global Maritime Distress and Safety System. This system will be complemented by a coordinated effort on the part of coastal states to provide a Maritime Search and Rescue Service under the provisions of the International Convention on Maritime Search and Rescue (SAR) 1979. EPIRBs are a major first link in the chain between GMDSS and SAR.

Communication Systems

The COSPAS-SARSAT and
INMARSAT communication systems are the two basic systems through which the EPIRB signal is relayed to ground and sea stations. COSPAS-SARSAT is a joint International Satellite Aided Search and Rescue System established and currently operated by organizations in Canada, France, the United States and the USSR. COSPAS- SARSAT provides a system of polar orbiting satellites which receive and relay distress signals of EPIRBs and determines their position.

IN MARSAT is an organization composed of a number of countries (some 64 as of May 1991)

dedicated to improving maritime communications via the use of satellites. INMARSAT provides a satellite communications system which makes available to ships a full range of distress alerting and other communications capabilities including voice, telex, data and telefacsimile.

Operation

If an EPIRB is activated, COSPAS-SARSAT picks up the signal, locates the vessel, passes the information to a land station where the information is then relayed, either via coast radio or satellite, to rescue coordination centers, to other interested parties such as rescue vessels, nearby vessels, even back to the vessel in distress if still manned, etc.

The COSPAS-SARSAT System is really a one way only communications system, from the EPIRB via the satellite to the rescuers.

The INMARSAT System allows two way communications to/from earth stations, ship stations, etc. via voice, telex, data transmission or fax. In other words the EPIRBs transmission and nothing else is passed via COSPAS-SARSAT. All other satellite traffic is via INMARSAT.

Doppler Effect

The COSPAS-SARSAT system employs five low-altitude, near-polar orbiting satellites and by utilizing the Doppler principle, permits location of a transmitting EPIRB within one or two miles. As a satellite approaches a transmitting EPIRB, the frequency of the signals it receives is higher than that being transmitted; when it is directly overhead the received and transmitted frequencies are identical; and when the satellite has passed the EPIRB the received frequency is lower than that being transmitted. There is a significant Doppler shift and calculations taking into account the earth's rotation and other relevant factors provide the location of the EPIRB.

The 121.5 MHz units, designed for detection by over flying aircraft, have been in production for several years. Their transmitting frequency is that of the International Aeronautical Emergency Frequency. The 406 MHz units are more sophisticated because of the inclusion of identification coding capability. The COSPAS-SARSAT System provides two coverage modes, real-time and global. The 121.5 MHz operates only in real-time, therefore the short range homing capability. The 406 MHz operates in both modes. To quote IMO's GMDSS publication "once the satellite receives the 406 MHz beacon signals, the Doppler shift is measured and the beacon digital data recovered from the

beacon signal. This information is time-tagged, formatted as digital data, and transferred to the repeater downlink for real-time transmission to any LUT [a LUT is a Local User Terminal] in view." With the 406 MHz unit the information is also stored for sending to other LUTS, thus the global aspect The 121.5 MHz units are only real-time, the satellite relays the signal directly to the ground. If both LUT and EPIRB are in view of the satellite, the signal can be received.

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Blinker Light Question

How does the system (COSPAS-SARSAT, INMARSAT, RCCS and SAR units) know whose EPIRB it is? In other words the old blinker light query "what ship? where bound?" still prevails.

Each 406 MHz EPIRB transmits a digital message, coded into its memory, which provides distress information to SAR authorities for more rapid and efficient rescue than was previously possible. This information includes an MID (see below) and either a Ship Station Identifier, a Ship Radio Call Sign or a Serial Number, to specifically identify the ship in distress.

The use of EPIRBs is controlled by national administrations and several coding schemes or

protocols have been developed. These add flexibility to satisfy unique requirements for various applications. Coding schemes or protocols include:

Maritime/Location

Maritime User

Radio Call Sign User

Serialized User

Currently, national authorities such as Vanuatu specify
which protocol or protocols can be used along with any optional or national use fields. If your vessel does not fly the Vanuatu flag, contact the appropriate authority to determine which protocol is to be used. Vanuatu is coding in accordance with the Maritime User Protocol which coding is consistent with that for Digital Selective Calling (DSC) used in an emergency.

Digital Message
Encoding

For the purposes of
this bulletin, interest primarily centers on the digital message encoded in the EPIRB. This message identifies the country through the Maritime Identification Digits (MID) and the specific ship by the Ship Station Identifier (thus uniquely defining the ship). The MID consists of a three digit number identifier provided by ITU to identify the country. Vanuatu's MID is 576. The SSI is a 6-digit number which is assigned to each individual ship. Apparently, an administration could have 999,999 vessels in its fleet without running into problems; but ships engaged in world-wide trading must have three trailing zeros in the SSI, thus leaving a possible 999 numbers for such ships. However, for technical reasons, twenty four numbers are forbidden. Therefore when the number of ships in the fleet approaches the maximum number of 975, the ITU will issue an additional MID to the country.

Message Format

The Maritime User
Protocol message format is detailed below for technically oriented readers. It will be noted that the message giving the nationality of the ship and the Ship Station Identifier (SSI) are included within the protected area (bits 25 to 85) of the coding and cannot be altered by the user.

Bit 1

Carrier

Bits 2 - 24

Bit and frame synchronization

Bit 25

Format flag

Bit 26

Protocol flag (maritime = 1)

Bits 27 - 36

MID (ours is 576)

Bits 37 - 39

0 1 0 (Protocol Identifier)

Bits 40 - 75

SSI (unique ship number)

Bits 76 - 81

Alphanumeric Multiple Beacon Identity

Bits 82 - 83

00

Bits 84 - 85

Homing or not and type of homing

Bits 86 - 106

Error Correcting Code

Bit 107

Emergency Code Flag

Bit 108

Type of Activation

Bits 109- 112

Nature of the Distress

Bits 113- 144

Optional messages area

Comment:

Bit 25- This determines
whether the EPIRB will transmit a long or short message. The long message specifies the position of the ship, i.e. latitude, longitude, etc. as coded by the ship's staff in the optional messages area (Bits 113 - 144). This procedure is not recommended as the EPIRB may well have drifted well away from the ship and the ship's staff may be totally incorrect in their estimate. Furthermore, their position is being determined by SAR from the EPIRB transmission. Consequently:

Bit 25 Format flag (short message = 0)

Bits

For those more technically inclined, or simply curious, Bits are short for Binary Digits and use 0 and 1 to represent pieces of information, for example YESNO, ON/OFF. It takes 10 Bits of Information to represent Vanuatu's Maritime identification Digits (MID), which is 576. In contrast it takes 1 bit to tell if the unit is a homing unit or not: 0 = no or 1 = yes. Let's convert Vanuatu's MID Number to binary.

First let's look at the decimal system:

Decimal Position Number:

10

9

8

7

6

5

4

3

2

1

Decimal Values for Positions:

10^4

10^3

10^2

10^1

10^0

Represented
As:

10000

1000

100

10

1

Values from Position
Only:

-

-

5

-

-

5X100=500

-

-

-

7

-

7X10=70

-

-

-

-

6

6X1=6

Cumulative
Total

5

7

6

576

Decimal Position
Number:

10

9

8

7

6

5

4

3

2

1

Decimal Values for Positions:

2^9

2^8

2^7

2^6

2^5

2^4

2^3

2^2

2^1

2^0

Represented As:

512

256

128

64

32

16

8

4

2

1

Values from Position Only:

1

-

-

-

-

-

-

-

-

-

1x512=512

-

0

-

-

-

-

-

-

-

-

-

0x256=0

-

-

0

-

-

-

-

-

-

-

0x128=0

-

-

-

1

-

-

-

-

-

-

-

1x64=64

-

-

-

-

0

-

-

-

-

-

0x32=0

-

-

-

-

-

-

0

-

-

-

-

0x16=0

-

-

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-

-

-

-

0

-

-

-

0x8=0

-

-

-

-

-

-

-

0

-

-

0x4=0

-

-

-

-

-

-

-

-

-

0

-

0x2=0

-

-

-

-

-

-

-

-

-

0

0x1=0

Cumulative
Total

5

7

6

576

Thus it takes 10 digits
to represent 576 in binary as 1001000000.

Other Protocols

Maritime/Location

This is intended for large
vessels where the national administration requires the vessels position to be
encoded in the protected field.

Radio Call Sign

This protocol is used for vessels
with radio call signs of up to seven characters.

Serialized User

This allows the manufacturer to
Install the complete code in the beacon at the time of its manufacture.

Future Developments

As mentioned above,
this bulletin deals primarily with the COSPAS-SARSAT 406 MHz EPIRBs. It should be noted that all ships to which Chapter IV of SOLAS, as amended in 1988, applies will be required to carry a float-free satellite EPIRB by August 1993. It should also be noted that Regulation IV/7.1.6 permits the carriage of a satellite EPIRB operating through the INMARSAT Geostationary-Satellite Service, subject to the availability of appropriate receiving and processing ground facilities for each ocean region covered by INMARSAT. Discussions at IMO on EPIRBs will no doubt continue for some time and further information on relevant developments will be issued as it becomes available.

A View From the
Registry

There is no doubt that
one of the banes of technology is all the numbers that you have to remember. There are numbers to pay taxes with, numbers to phone or fax with and numbers to get instant money with. Now there is a new number to remember, your EPIRB number. The best numbering system is one that is made up of logical unique components and is based on or is the same as already existing numbers.

There have been a number of proposals put forward on the
subject of EPIRB codes. An inherently simple and logical system has been derived with the understanding that eventually all the other systems will be discontinued. Yet this system, no matter how well thought out was not without a few hitches.

Vanuatu has been engaged in quite extensive correspondence
with INMARSAT and COSPAR-SARSAT Secretariats. Two main areas of concern were identified and one corrected. The first is that the format of INMARSAT Mobile Numbers (IMNs) did not always conform to the Maritime Mobile Service Identity (MMS*) as used for search and resuce purposes and DSC. INMARSAT has since issued instructions which correct this problem.

The other area of concern is the difference between the
numbering systems of the INMARSAT A and C Stations. For technical reasons the coding of the INMARSAT A Station cannot conform to the MMSI.

Vanuatu has used, and will continue to use, unique Marine
Mobile Service Identity (MMSI) recommended by the ITU for ship earth station identities for:

Coding the float free
satellite EPIRBs

DSC number

As the basis for
numbering INMARSAT Standard C stations, ie. the INMARSAT Mobile Number (IMN).

The interested reader is referenced to the diagram below
where it will be seen that the MMSI is formed from the country's Maritime

Identification Digits (MID) and the Ship Station Identity (SSI). The three squares of the SSI represent digits (between 1 and 999) allocated by Vanuatu to identify each ship on the register.

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The IMN is formed by inserting a "4" in front of the MMSI and dropping the final zero to retain 9 digits. The penultimate remaining zero must not be retained and is, for Vanuatu, changed to a "1" or "2" to represent the station number.

The use of the MID and SSI in the Maritime User Protocol for EPIRB coding adopted by Vanuatu is also indicated. All EPIRB coding systems include the MID in the protected field. Therefore, on change of registry recoding by the manufacturer will be necessary. The alternative codings for 84-85 show the provisions which have been made to indicate the type of homing device fitted to enable a searching vessel to "pin-point" the position of the EPIRB. The Search and Rescue organization thus knows the ship's identity and the position of the EPIRB (within a few miles) and the type of equipment to use when locating the vessel.

This is an introduction to the intricacies of EPIRB and SATC. If you wish more technical detail, look for our coming Technical Bulletin.