
COSPAS-SARSAT GUIDELINES ON 406 MHz BEACON CODING, REGISTRATION AND TYPE APPROVAL

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COSPAS-SARSAT GUIDELINES ON 406 MHz
BEACON CODING, REGISTRATION AND TYPE APPROVAL

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1. INTRODUCTION

1.1 Overview

This document describes the various methods of coding 406 MHz distress beacons for maritime, aviation or personal applications and provides guidelines for setting up a 406 MHz beacon registration database. The procedure to be followed by manufacturers to obtain a Cospas-Sarsat type approval certificate is also described, together with recommendations for administrations regarding national type approval of 406 MHz beacons.

1.2 Scope

The purpose of this document is to inform administrations, Cospas-Sarsat equipment manufacturers and users on practical matters concerning the coding, registration and type approval of 406 MHz beacons. It is not intended to replace the current System documents which provide the specification for 406 MHz beacons, including all the technical details and options for applicable coding protocols (C/S T.001), or the procedure for Cospas-Sarsat type approval testing (C/S T.007).

Some background information on the Cospas-Sarsat 406 MHz System is given in section 2 of these guidelines. The basic information required for coding and registering 406 MHz beacons is presented in sections 3 and 4, and a guide for manufacturers requesting Cospas-Sarsat type approval testing is provided in section 5. General guidelines to administrations, manufacturers and distributors are included in section 6.

1.3 Reference Documents

The following documents contain more detailed information on 406 MHz beacons and should be used for reference, as necessary, on specific matters not fully covered by these guidelines:

- a) C/S T.001, Specification for Cospas-Sarsat 406 MHz Distress Beacons;
- b) C/S T.007, Cospas-Sarsat 406 MHz Distress Beacon Type Approval Standard;
- c) C/S G.003, Introduction to the Cospas-Sarsat System;
- d) C/S G.004, Cospas-Sarsat Glossary; and
- e) C/S S.007, Handbook of Beacon Regulations*.

These documents may be obtained from the Cospas-Sarsat Secretariat or downloaded from the Cospas-Sarsat web site: **www.cospas-sarsat.org** (except item (d)).

Note: * Document updated annually.

1.4 Summary of the Cospas-Sarsat Guidelines on Beacon Coding, Registration and Type Approval

National authorities are responsible for all regulatory matters concerning the use of 406 MHz beacons. This includes:

- a) issuing equipment specifications and carriage requirements;
- b) testing and type approving beacon models in accordance with Cospas-Sarsat, IMO, ICAO, ITU and/or their own national performance requirements;
- c) defining which coding protocols (see section 3) are applicable;
- d) allocating identification codes (see sections 3.3 and 3.4) as appropriate; and
- e) defining and implementing registration procedures (see section 4).

When developing national regulations, administrations are invited to consider the guidelines provided herein and other information available from the Cospas-Sarsat Secretariat, concerning type approved beacons, applicable coding protocols and registration procedures recommended by the relevant international organizations.

The Cospas-Sarsat Secretariat maintains a list of points of contact of a number of administrations responsible for 406 MHz beacon matters*. All countries adopting the use of 406 MHz beacons are invited to inform the Cospas-Sarsat Secretariat of their point(s) of contact for 406 MHz beacon matters, for inclusion in this list.

In summary, administrations are invited to:

- a) test beacons for type approval according to the Cospas-Sarsat specification and type approval standard (C/S T.001 and C/S T.007), or authorise the use of only those 406 MHz beacons which have received a Cospas-Sarsat type approval certificate, as recorded in the Cospas-Sarsat System Data document issued from time to time by the Cospas-Sarsat Secretariat;
- b) perform additional tests, as appropriate, to ensure that the beacons comply with their specific requirements for the corresponding application, and/or consider whether the same beacon model has already been tested and approved by other administrations for that application;
- c) select the beacon coding protocols they wish to use in their country;
- d) establish and maintain a beacon register or co-ordinate with other administrations for the establishment and maintenance of a "regional" registration database; and
- e) provide the Cospas-Sarsat Secretariat with the address(es) of their point(s) of contact for 406 MHz beacon matters (i.e. type approval, coding and registration).

Note: * See "Handbook of Beacon Regulations", C/S S.007.

2. BACKGROUND INFORMATION ON THE 406 MHz SYSTEM

2.1 406 MHz Beacons

The use of the 406 MHz system shall be in accordance with the appropriate provisions of the ITU Radio Regulations, and the alerting signals shall be in accordance with relevant ITU-R Recommendations.

406 MHz distress beacons are normally designed and constructed either as Emergency Position-Indicating Radio Beacons (EPIRBs) for maritime applications, as Emergency Locator Transmitters (ELTs) for aviation applications, or as Personal Locator Beacons (PLBs) for personal use.

A 406 MHz distress beacon transmits, every 50 seconds, a half-second burst of data. The Cospas-Sarsat satellites relay this data, referred to as the beacon message, to Cospas-Sarsat earth receiving stations called Local User Terminals (LUTs) which automatically examine the beacon message and determine the geographical location of the distress beacon. To ensure that the System performance requirements are met and to maintain the quality of alert and location data forwarded to search and rescue (SAR) services, it is essential that only beacons which satisfy Cospas-Sarsat specification and type approval requirements are used in the System. The list of Cospas-Sarsat type approved beacons is provided in the Cospas-Sarsat System Data document issued by the Cospas-Sarsat Secretariat, and is also published to the Cospas-Sarsat website at www.cospas-sarsat.org.

2.2 Beacon Identification

Each message transmitted by a 406 MHz beacon must uniquely identify the beacon. The complete beacon identification code includes the: protocol flag, protocol code, country code, and other identification data, all of which are encoded in the first protected data field (PDF-1) of the 406 MHz message (see section 3.2.3).

Identification data can be provided in various alphanumeric formats, depending on the coding protocol required by the responsible administration (see section 3). It is encoded together with the country code and other information in the beacon message in binary format. However, for the purpose of transmission to SAR services in the alert message produced by Cospas-Sarsat, the unique identification of a 406 MHz beacon encoded in bits 26-85 of the beacon message is provided as a 15 hexadecimal character string, referred to as the beacon 15 Hex Identification, or beacon 15 Hex ID (see also item 3.2.3.4).

The beacon 15 Hex ID is used:

- a) to correlate all the messages transmitted by a particular beacon;
- b) to provide SAR services with information on the ship, the aircraft or the beacon owner in case of beacon alert (see section 2.3); and
- c) to retrieve information from the beacon registration databases.

2.3 Operational Use of Beacon Registration Databases

It is crucial that 406 MHz distress beacons are registered in recognized beacon registration databases that are accessible to search and rescue authorities 24 hours per day. The information contained in these databases concerning the beacon, its owner, and the vehicle/vessel on which the beacon is mounted is vital for the effective use of Search and Rescue resources. The unique information encoded in the Cospas-Sarsat 406 MHz beacon message provides the information necessary to identify the register that should hold the registration information for that beacon, and it is also the unique key used for retrieving the registration details.

Both the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO) require administrations authorising the use of 406 MHz beacons to make provisions for registering 406 MHz beacons that are under their jurisdiction. For beacon owners in countries that do not operate national registers, Cospas-Sarsat has implemented an International 406 MHz Beacon Registration Database (IBRD). A more detailed description of the registration process, requirements for 406 MHz beacon registers, and an introduction to the IBRD is provided at section 4.

As mentioned above, because a beacon may be transmitting from anywhere on the globe, access to beacon registration databases must be provided to SAR services world-wide, 24 hours per day and with minimum delay. In order to achieve this objective, the following requirements should be met by all countries which authorise the use of 406 MHz distress beacons:

- a) all beacons should be coded in accordance with the Cospas-Sarsat specification (C/S T.001) and national requirements, and include the country code assigned to the country of beacon registration (see section 3.2.3.2) and additional identification data, which together forms a unique beacon 15 Hex ID (see section 3.2.3.4);
- b) all beacons should be registered with the appropriate administration, or in the International Beacon Registration Database (IBRD) if the administration has chosen to use the IBRD for beacons with their country code(s) (see section 4);
- c) appropriate points of contact should be designated, and identified to the Cospas-Sarsat Secretariat¹, for providing guidance to beacon owners in respect of national registration and coding; and
- d) procedures should be defined for communicating beacon registration database information to SAR services upon request; details of the registry's point of contact should be provided to the Cospas-Sarsat Secretariat for the information of SPOCs and Cospas-Sarsat MCCs.

The accuracy of information contained in the registration databases should also be checked periodically, possibly as part of any mandatory periodic beacon testing.

2.4 Encoded Position Data

Beacon messages encoded with the location protocols include position data in addition to the beacon identification data. Such position data can be derived from a satellite navigation system,

¹ For inclusion in "Handbook of Beacon Regulations", C/S S.007.

such as GPS or GLONASS, using either a receiver integrated into the beacon, or an external navigation receiver connected to the beacon.

The incorporation of the position data into the beacon message provides locating capability for 406 MHz alerts received through geostationary satellites in the 406 MHz GEOSAR system.

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3. 406 MHz BEACON CODING

3.1 Beacon Types

Cospas-Sarsat 406 MHz beacons can be used in different environments and for a variety of applications such as EPIRBs and Ship Security Alert System (SSAS) beacons that service the maritime environment, ELTs (aviation) or PLBs (personal use). The specification of the distress signal characteristics (document C/S T.001), which ensures that all 406 MHz beacons are compatible with the Cospas-Sarsat Space Segment, is applicable to all types of beacons. However, different user groups have different needs; hence the need for various coding protocols. To satisfy these requirements, the Cospas-Sarsat specification provides for various coding options which are divided in two groups of coding protocols:

User Protocols, described in section 3.3; and

Location Protocols, described in section 3.4.

The user protocols can be used for encoding the beacon identification and other data in the digital message transmitted by a 406 MHz distress beacon, but do not allow for encoding beacon position data. The coding options for user protocols are listed in Table 3.1 and further described in section 3.3.

The location protocols can be used for encoding beacon position data, in addition to the beacon identification data, in the digital message transmitted by a 406 MHz distress beacon. The coding options for location protocols are listed in Table 3.2 and further described in section 3.4.

Protocols in both groups (i.e. user protocols and location protocols) can be implemented using either the short message format or the long message format, as described in Figure 3.1.

All protocols have the general structure of the 406 MHz digital message described in section 3.2 of this document.

The choice of the protocol option to be used in a particular beacon type depends on:

- a) the user category (maritime, aviation, or personal);
- b) the method used to provide beacon identification data as required by the responsible administration; and
- c) the required resolution of encoded position data (only for location protocols).

Administrations will normally specify which coding protocols can be used for the applications that they authorise. Manufacturers of 406 MHz beacons should contact the appropriate national authorities to determine how beacons should be coded for each country. The document C/S S.007 “Handbook of Beacon Regulations”, which is annually updated by the Cospas-Sarsat Secretariat, provides a list of points of contact (including addresses and telephone numbers) for beacon matters in a number of countries.

Administrations should not authorise coding options which are not currently allocated or permitted by the Cospas-Sarsat specification for 406 MHz beacons (C/S T.001).

Figure 3.1: General Format of the 406 MHz Beacon Message

3.1.a: Fields of the Short Message Format

	Bit Synchronization	Frame Synchronization	First Protected Data Field (PDF-1)				BCH-1	Non-Protected Data Field
Unmodulated Carrier (160 ms)	Bit Synchronization Pattern	Frame Synchronization Pattern	Format Flag	Protocol Flag	Country Code	Identification or Identification plus Position	21-Bit BCH code	Emergency Code/ National Use or Supplement. Data
Bit No.	1-15	16-24	25	26	27-36	37-85	86-106	107-112
	15 bits	9 bits	1 bit	1 bit	10 bits	49 bits	21 bits	6 bits

3.1.b: Fields of the Long Message Format

	Bit Synchronization	Frame Synchronization	First Protected Data Field (PDF-1)				BCH-1	Second Protected Data Field (PDF-2)	BCH-2
Unmodulated Carrier (160 ms)	Bit Synchronization Pattern	Frame Synchronization Pattern	Format Flag	Protocol Flag	Country Code	Identification or Identification plus Position	21-Bit BCH code	Supplementary and Position or National Use Data	12-Bit BCH code
Bit No.	1-15	16-24	25	26	27-36	37-85	86-106	107-132	133-144
	15 bits	9 bits	1 bit	1 bit	10 bits	49 bits	21 bits	26 bits	12 bits

In addition to the available coding options listed in Table 3.1 and Table 3.2, a "national" user protocol and a specific "orbitography" protocol have been defined.

The national user protocol allows for coding data which is defined and controlled by national administrations. It is described further in section 3.3.6.

The orbitography protocol is not described in this document as its use is restricted to a small number of orbitography beacons under the control of Cospas-Sarsat System operators.

Table 3.1: List of Available Coding Options for User Protocols			
Application	Identification Data	Protocols	Figure No.
EPIRBs (Maritime)	MMSI	Maritime User	F 3.6
	Unique EPIRB Serial Number*	Serial User	F 3.7
	Radio Call Sign	a. Maritime User b. Radio Call Sign	F 3.8 F 3.9
ELTs (Aviation)	Unique ELT Serial Number*	Serial User	F 3.10
	Aircraft Operator Designator & Serial Number*	Serial User	F 3.11
	Aircraft 24-bit Address	Serial User	F 3.12
	Aircraft Registration Marking	Aviation User	F 3.13
PLBs (Personal)	Unique PLB Serial Number*	Serial User	F 3.14
Test**	Any Unique Combination	All	F 3.15

Note:

(*) Serial number means a unique number assigned by an administration or a beacon manufacturer. Administrations must ensure that the assigned serial numbers provide a unique beacon identification when used with the country code. Serial numbers assigned by a manufacturer must provide a unique beacon identification when used with the Cospas-Sarsat type approval certificate number assigned to that beacon model.

(**) The test protocol is used in trials (to be co-ordinated with the appropriate MCC) which involve live transmissions to satellites. It is described further in section 3.3.5.

Table 3.2: List of Available Coding Options for the Location Protocols (1/3)				
Application	Identification Data	Location Data	Protocols	Figure No.
EPIRBs (Maritime)	MMSI	4 minute resolution encoded in PDF-2	User-location	F 3.6 F 3.18
		position offset to 4 second resolution encoded in PDF-2 in addition to 15 minute resolution encoded in PDF-1	Standard Location	F 3.19 F 3.24
	Unique EPIRB Serial Number*	4 minute resolution encoded in PDF-2	User-location	F 3.7 F 3.18
		position offset to 4 second resolution encoded in PDF-2 in addition to 15 minute resolution encoded in PDF-1	Standard Location	F 3.23 F 3.24
	Radio Call Sign	4 minute resolution encoded in PDF-2	User-location	F 3.8 F 3.9 F 3.18
	Serial Number* Assigned by Administration	position offset to 4 second resolution encoded in PDF-2 in addition to 2 minute resolution encoded in PDF-1	National Location	F 3.25
SSAS (Maritime)	MMSI	position to 15 minute resolution encoded in PDF-1 and offset to 4 second resolution encoded in PDF-2	Standard Location	F 3.20

(…/…)

Table 3.2: List of Available Coding Options for the Location Protocols (2/3)				
Application	Identification Data	Location Data	Protocols	Figure No.
ELTs (Aviation)	Unique ELT Serial Number*	4 minute resolution encoded in PDF-2	User-location	F 3.10 F 3.18
		position offset to 4 second resolution encoded in PDF-2 in addition to 15 minute resolution encoded in PDF-1	Standard Location	F 3.23 F 3.24
	Aircraft Operator Designator & Serial Number*	4 minute resolution encoded in PDF-2	User-location	F 3.11 F 3.18
		position offset to 4 second resolution encoded in PDF-2 in addition to 15 minute resolution encoded in PDF-1	Standard Location	F 3.22 F 3.24
	Aircraft 24-bit Address	4 minute resolution encoded in PDF-2	User-location	F 3.12 F 3.18
		position offset to 4 second resolution encoded in PDF-2 in addition to 15 minute resolution encoded in PDF-1	Standard Location	F 3.21 F 3.24
	Aircraft Registration Marking	4 minute resolution encoded in PDF-2	User-location	F 3.13 F 3.18
	Serial Number* Assigned by Administration	position offset to 4 second resolution encoded in PDF-2 in addition to 2 minute resolution encoded in PDF-1	National Location	F 3.25

(…/…)

Table 3.2: List of Available Coding Options for the Location Protocols (3/3)				
Application	Identification Data	Location Data	Protocols	Figure No
PLBs (Personal)	Unique PLB Serial Number*	4 minute resolution encoded in PDF-2	User-location	F 3.14 F 3.18
		position offset to 4 second resolution encoded in PDF-2 in addition to 15 minute resolution encoded in PDF-1	Standard Location	F 3.23 F 3.24
	Serial Number* Assigned by Administration	position offset to 4 second resolution encoded in PDF-2 in addition to 2 minute resolution encoded in PDF-1	National Location	F 3.25
Test**	Any Unique Combination		All	

Note: (*) Serial number means a unique number assigned by an administration or a beacon manufacturer. Administrations must ensure that the assigned serial numbers provide a unique beacon identification when used with the country code. Serial numbers assigned by a manufacturer must provide a unique beacon identification when used with the Cospas-Sarsat type approval certificate number assigned to that beacon model.

(**) The test protocol is used in trials (to be co-ordinated with the appropriate MCC) which involve live transmissions to satellites. It is described further in section 3.3.5.

3.2 General Coding Requirements

3.2.1 General Format and Field Definition of the 406 MHz Beacon Message

The message transmitted by a Cospas-Sarsat 406 MHz beacon can be encoded either in a short message format or a long message format, as shown in Figure 3.1.

3.2.1.1 The short message format consists of:

- unmodulated carrier signal (160 ms), bit synchronization pattern (bits 1 to 15) and frame synchronization pattern (bits 16 to 24), often referred to as the preamble;
- the first protected data field (PDF-1) which includes the format and protocol flags, the country code, and beacon identification data or beacon identification and position data (bits 25 to 85);

- c) the first BCH error correcting field (BCH-1) associated with the PDF-1 (encoded in bits 86 to 106); and
- d) the non-protected data field (variable / optional or supplementary data contained in bits 107 to 112).

3.2.1.2 The long message format consists of:

- a) the preamble;
- b) the first protected data field (PDF-1);
- c) the first BCH error correcting field (BCH-1);
- d) the second protected data field (PDF-2) which includes supplementary and position data of the location protocols, or information defined in national requirements (encoded in bits 107 - 132); and
- e) the second BCH error correcting field BCH-2 associated with the PDF-2 (encoded in bits 133 to 144).

The 82 bits of the combined PDF-1 and BCH-1 are also referred to as the first protected field. The 38 bits of the combined PDF-2 and BCH-2 are also referred to as the second protected field.

3.2.2 Preamble

3.2.2.1 Standard Preamble

The preamble of the 406 MHz digital message allows the receiver-processor to:

- a) detect the incoming signal and lock on its frequency, using the unmodulated carrier transmission;
- b) lock on the phase and bit timing of the modulation using the bit synchronization pattern; and
- c) identify the first data bit of the message using the frame synchronization pattern.

Therefore, this preamble must be fixed and identical for all Cospas-Sarsat 406 MHz beacons, and encoded according to the format of Figure 3.2.

Figure 3.2: Standard Preamble Coding

160 ms	Bits 1-15	Bits 16-24
Unmodulated Carrier	Bit Synchronization Pattern	Frame Synchronization Pattern
- unmodulated carrier: 160 ms; - bits 1 to 15: all set to "1"; - bits 16 to 24: set to the pattern "000101111" (except in self-test mode *).		

Note: (*) The self-test mode described in section 3.2.2.2 should not be confused with the "test" protocols described in sections 3.3.5 and 3.4.5 which are processed by Cospas-Sarsat satellites.

3.2.2.2 Self-Test Mode Preamble

A 406 MHz beacon should be designed to perform a short self-test. The self-test transmission may consist of a short duration emission of a single burst. If the beacon transmits in the self-test mode, the signal must have a frame synchronization pattern of 011010000 to ensure that the satellite or ground equipment will not process this test transmission. This eliminates the risk of a false alert being generated by the self-test burst. Unless prior co-ordination has been accomplished in accordance with Cospas-Sarsat document C/S A.004 "Cospas-Sarsat System Exercising", no other test transmissions are permitted when using a beacon coded with an "operational" protocol (see the "test" protocol coding in sections 3.3.5 and 3.4.7), as any such test could generate a false alert. In addition, self-test transmissions must be kept to a minimum as they interfere with "real" 406 MHz distress alerts.

In the self-test transmission mode the complete test transmission must be limited to one burst only of a maximum duration of 440 ms (+1%) for a short message or 520 ms (+1%) for a long message. If a 440 ms transmission is used for a beacon encoded with the long format message, the message should be truncated without changing the format flag bit. For location protocols, the default bits should replace the position data in encoded position data fields of the self-test mode messages. Therefore, the content of the self-test message shall always provide the beacon 15 Hex ID.

3.2.3 First Protected Data Field (PDF-1)

3.2.3.1 General Structure of the First Protected Data Field (PDF-1)

The first protected data field (PDF-1) (bits 25 to 85) includes (see Figure 3.1):

- a) the format flag (bit 25) which indicates the use of the short message or long message formats as described in Table 3.3;
- b) the protocol flag (bit 26) which is set to "1" for all user protocols and user-location protocols, and to "0" for all other location protocols (i.e. standard location protocols and national location protocol);
- c) the country code which is a three-digit decimal number (see section 3.2.3.2) encoded in bits 27 to 36 in binary notation;
- d) identification data: a number of bits (different for each protocol, depending on the method used to encode the beacon 15 Hex ID: see Figures 3.5 and 3.17) which must remain fixed as this information will:
 - provide, with the preceding flags and country code, a unique identification of each beacon transmission and of the corresponding Doppler measurements used by LUTs to compute the beacon location,
 - permit a fast and reliable identification of the vehicle / user in distress, in order to obtain all information required to assist search and rescue operations,
 - permit a fast identification of the transmitter in case of false alert, allowing its cancellation at minimum cost to SAR services; and

- e) position data: a number of bits (different for each protocol, depending on the method used to encode the beacon 15 Hex ID: see Figure 3.17) which will be used in standard location protocols and national location protocols to encode beacon position data.

In the case of user and user-location protocols, the PDF-1 may also include information which is specific to an application or a beacon type (e.g. information on auxiliary radio-locating devices available in that beacon).

3.2.3.2 Format Flag, Protocol Flag and Country Code

The bit allocations for the format flag, protocol flag and country code are identical in all beacon protocols. The possible combinations of format flag and protocol flag values are summarised in Table 3.3.

Table 3.3: Format Flag and Protocol Flag Combinations

Format Flag (bit 25) → Protocol Flag (bit 26) ↓	0 (short)	1 (long)
0 (protocol code: bits 37-40)	No longer allowed	Standard Location Protocols National Location Protocol
1 (protocol code: bits 37-39)	User Protocols	User-Location Protocols National and Test User Protocols

The country code is part of every beacon identification data. This code is the 3-digit decimal number allocated to each country/territory by the International Telecommunication Union (ITU) and listed as Maritime Identification Digits (MID) in Appendix 43 of the ITU Radio Regulations. The up-to-date list of MIDs is available from the ITU web site at:

http://www.itu.int/cgi-bin/htsh/glad/cga_mids.sh

The country code is encoded in binary notation in bits 27 to 36 of the message, with the least significant bit on the right. The country code indicates the administration maintaining the beacon registration data base (see section 4). If the appropriate registration database exists, the country code should always match the flag of the vessel or aircraft.

The example presented in Figure 3.3 shows the country code for the United Kingdom, where: MID=232 (i.e. decimal number "232" coded "0011101000" in binary notation).

Figure 3.3: Example of Country Code

Bits	27									36
	0	0	1	1	1	0	1	0	0	0

3.2.3.3 Identification Data and Position Data

The unique Beacon Identification consists of the protocol flag, country code and the fixed (non-variable) bits of identification data specific for each protocol. In some location protocols, PDF-1 also includes variable bits which provide for the encoding of beacon position (see Figure 3.17). Therefore, the interpretation of data contained in the PDF-1 requires determining which protocol is being used, as indicated by the setting of the protocol flag (bit 26) and the protocol code (bits 37 to 40 for standard and national location protocols (short and long formats), and bits 37 to 39 for all user protocols, including user-location protocols).

The bit settings for the protocol code and the bit assignments for identification data and position data are described in sections 3.3 and 3.4.

Some user protocols (i.e. the serial user protocol and the national user protocol) have, as part of the identification data, data fields that may be defined by administrations to fulfil specific identification requirements. Administrations should inform the Cospas-Sarsat Secretariat of their national identification coding schemes to ensure that these schemes remain compatible with the general Cospas-Sarsat coding requirements.

3.2.3.4 Fifteen Hexadecimal Character Beacon Identification

The fifteen hexadecimal character representation of PDF-1 excluding bit 25 (message format flag) is used for the purpose of distribution of distress alerts over Cospas-Sarsat ground communication network. It is referred to as the beacon **15 Hex ID**. The beacon 15 Hex ID must uniquely identify each 406 MHz beacon. The beacon 15 Hex ID is derived from a 406 MHz message by presenting every 4 bits of a beacon message, starting from bit 26 to bit 85, as a hexadecimal character: "0000" = Hex 0 up to "1111" = Hex F. The beacon 15 Hex ID is, therefore, represented as a string of fifteen characters, for example: **ADCD0228C500401** for the bit sequence: 1010 1101 1100 1101 0000 0010 0010 1000 1100 0101 0000 0000 0100 0000 0001.

In the case of location protocol, bits 26 to 85 include variable position data. The position data in PDF-1 must be set to specified default values to create the fixed unique 15 Hex ID of the beacon.

3.2.4 21-bit First BCH Error Correcting Field (BCH-1)

The 61 bits forming the first protected data field (PDF-1, bits 25 to 85) are followed by a 21-bit Bose-Chaudhuri-Hocquenghem (BCH) error-correcting code (bits 86 to 106), in a field defined as the first BCH error correcting field (BCH-1). This code can detect and correct up to three bit errors in the 82 bits of the first protected field (PDF-1 and BCH-1). The error-correcting code is generated from the content of PDF-1 as described in Annex B of C/S T.001. Therefore, it must be computed and encoded together with the PDF-1. When updates to the PDF-1 are required for encoding position data, the error-correcting code must be regenerated after each update.

3.2.5 Non-Protected Data Field of the Short Message Format

The data field (bits 107 to 112) following the BCH-1 in the short message format is not error protected. It can be used to transmit supplementary data indicating the distress situation (emergency code) or specific features of the beacon (radio-locating device, source of encoded position data). The bits of the non-protected data field have different assignments in the user protocols group or the location protocols group, which are described in Figure 3.4.

Figure 3.4: Short Message Non-Protected Data Field**Figure 3.4.a: Emergency Code/National Use Data (*) for Short Format User Protocols**

Bits	107	108	109	112
Content	Emergency Code Flag	Activation Code	Emergency Code or National Use Data	
<p>- bit 107: flag bit set to "1" means that bits 109 to 112 contain one of the agreed emergency codes (Table 3.4 and Table 3.5);</p> <p>flag bit set to "0" means that bits 109 to 112 contain data defined by the administration designated in the country code;</p> <p>default coding for bit 107 is "0";</p> <p>- bit 108: the activation code is set to "1" if beacon is designed for both automatic and manual activation; it is set to "0" if beacon can be activated manually only;</p> <p>- bits 109 to 112: encoded with one of the agreed emergency codes (Table 3.4 and Table 3.5) or with data defined according to national requirements;</p> <p>default coding for bits 109 to 112 is "0000".</p>				

Note: (*) For national user protocols, the content of bits 107 to 112 of the non-protected field may be reassigned and controlled by national administrations (see section 3.3.6).

Figure 3.4.b: Short Format Location Protocols () Supplementary Data**

Bits	107	108	109	110	111	112
Content	1	1	0	1	Source of Position Data Flag	121.5 MHz Radio-locating Device
<p>- bit 107-110: "1101" (fixed);</p> <p>- bit 111: position data source flag set to "0" means that the position data encoded in PDF-1 is provided by an external navigation device;</p> <p>position data source flag set to "1" means that the position data encoded in PDF-1 is provided by an internal navigation device;</p> <p>- bit 112: 121.5 MHz radio-locating device flag set to "0" means that there is no 121.5 MHz auxiliary radio-locating transmitter in the beacon;</p> <p>121.5 MHz radio-locating device flag set to "1" means that the beacon is equipped with a 121.5 MHz auxiliary radio-locating transmitter.</p>						

Note: (**) Not applicable to the User-location Protocol

Table 3.4: Maritime Emergency Codes ⁽¹⁾		
IMO Indication⁽²⁾	Binary Code	Usage
1	0001	Fire/explosion
2	0010	Flooding
3	0011	Collision
4	0100	Grounding
5	0101	Listing, in danger of capsizing
6	0110	Sinking
7	0111	Disabled and adrift
8	0000	Unspecified distress ⁽³⁾
9	1000	Abandoning ship
	1001 to 1111	Spare (could be used in future as necessary)

- Note:** (1) The maritime emergency codes are in accordance with the list of IMO Nature of Distress Indications, except for code "1111" which, for 406 MHz beacons, is defined as "spare" instead of "test" code in the IMO list (see also the test protocol in section 3.3.5).
- (2) IMO indication is an emergency code number, it is different from the binary encoded number.
- (3) If no emergency code data has been entered, bit 107 remains set to (=0).

Table 3.5: Non-Maritime Emergency Codes	
Bits	Usage ⁽¹⁾
109	No fire (=0); fire (=1)
110	No medical help (=0); medical help required (=1)
111	Not disabled (=0); disabled (=1)
112	Spare (=0)

- Note:** (1) If no emergency code data has been entered, bit 107 remains set to (=0).

3.2.6 Second Protected Data Field (PDF-2)

The twenty-six bits (bits 107 to 132) following the BCH-1 in the long message format form the second protected data field (PDF-2). The PDF-2 is available only in the long message format.

The second protected data field (PDF-2) is used for encoding supplementary data and position data as defined for the various location protocols described in section 3.4. However, administrations can also define their own bit assignments for this field to satisfy specific national requirements, as provided for in the national user protocol (see section 3.3.6).

3.2.7 Second BCH Error Correcting Field (BCH-2)

The twenty-six bits forming the PDF-2 (bits 107 to 132) of the beacon message are followed by a 12-bit BCH error-correcting code (bits 133 to 144) in a field defined as the second BCH error correcting field (BCH-2), which can detect and correct up to 2 bit errors in the 38 bits of the second protected field (PDF-2 plus BCH-2). The error-correcting code is generated from the content of PDF-2 as described in Annex B of C/S T.001. Therefore, it must be computed and encoded together with the PDF-2. When updates to the PDF-2 are required, the error-correcting code must be regenerated after each update.

The 12-bit BCH error-correcting code must be computed and encoded in the second BCH error correcting field (BCH-2) of all protocols using the long message format (with the exception of orbitography protocol which is intended for use only by the Cospas-Sarsat System operators).

3.3 Coding User Protocols

This section defines the user protocol message formats which can be used to encode the beacon identification data and other data in the message transmitted by a 406 MHz distress beacon.

3.3.1 General Requirements for User Protocols

There are 6 different options for coding user protocols, which are described in Figure 3.5. The applicable user protocol type is selected by setting bits 37 to 39 according to the appropriate pattern. Most of the user protocols are available only in the short message format, selected by setting bit 25 (format flag) to "0". The coding of the user protocols is described with further details in section 3.3.2 to 3.3.6.

The national user protocol and the test user protocol can be coded either with the short or the long message format, as indicated by the format flag: "0" (short message), or "1" (long message). The national user protocol which can be used to meet specific national requirements must be defined in accordance with section 3.3.6.

The user-location protocol, described in section 3.4 as part of the location protocol group, uses the long message format, but has the same definition as the user protocols for the first protected data field (PDF-1).

1. MARITIME USER PROTOCOL												
Bits	25	26	27	36	37	39	40	81	82	83	84	85
.....	0	1	Country Code		0	1	0	MMSI or Radio Call Sign (42 bits)			0	R L
2. RADIO CALL SIGN USER PROTOCOL												
Bits	25	26	27	36	37	39	40	81	82	83	84	85
.....	0	1	Country Code		1	1	0	Radio Call Sign (42 bits)			0	R L
3. SERIAL USER PROTOCOL												
Bits	25	26	27	36	37	39	40	42	43	44	73	84 85
.....	0	1	Country Code		0	1	1	T	T	T	C	Serial Number and other Data C/S Cert. No or National Use
4. AVIATION USER PROTOCOL												
Bits	25	26	27	36	37	39	40	81	82	83	84	85
.....	0	1	Country Code		0	0	1	Aircraft Registration Marking (42 bits)			E N ¹	R L
5. NATIONAL USER PROTOCOL												
Bits	25	26	27	36	37	39	40	85				
.....	F	1	Country Code		1	0	0	National Use (46 bits)				
6. TEST USER PROTOCOL												
Bits	25	26	27	36	37	39	40	85				
.....	F	1	Country Code		1	1	1	Test Beacon Data (46 bits)				
7. ORBITOGRAPHY PROTOCOL												
Bits	25	26	27	36	37	39	40	85				
.....	F	1	Country Code		0	0	0	Orbitography Data (46 bits)				

TTT =	000 - ELT with serial number	010 - float free EPIRB with serial number
	011 - ELT with 24-bit aircraft address	100 - non float free EPIRB with serial number
	001 - ELT with aircraft operator designator and serial number	110 - personal locator beacon (PLB) with serial number

F = Format Flag ("0" = short message, "1" = long message)

EN = Specific ELT number on designated aircraft (see Figure 3.13) ¹

Radio call sign of six or fewer alphanumeric characters can be encoded in Maritime User Protocol.
Radio call sign of up to seven characters (four alphanumeric and three digits) can be encoded in Radio Call Sign User Protocol.

¹Effective as of 1 November 2011.

Table 3.6: Auxiliary Radio-locating Device Code	
00	- No Auxiliary Radio-locating Device
01	- 121.5 MHz Auxiliary Radio-locating Device
10	- 9 GHz SART Locating Device
11	- Other Auxiliary Radio-locating Device(s)

Note: If other auxiliary radio-locating device(s) is (are) used in addition to 121.5 MHz, the code for 121.5 MHz (i.e. 01) should be used.

3.3.2 Coding Maritime Protocols

Resolution A.810(19) of the International Maritime Organization (IMO) 19th Assembly meeting states that:

"A unique beacon identification code shall be made part of all messages.

This identification code shall include a 3-digit code for the country in which the beacon is registered, followed by either:

- .1 the trailing 6 digits of the ship station identity in accordance with Appendix 43 of ITU Radio Regulations; or
- .2 a unique serial number; or
- .3 a radio call sign.

Preference is given to method .1."

Note: For the purpose of this document the Maritime Mobile Service Identity (MMSI) and the Ship Station Identity are equivalent and are defined as a 9-digit number consisting of the MID (country code) followed by six digits.

Coding of beacons with the identification codes recommended by IMO is detailed in the following sections:

- 3.3.2.1 Coding the Maritime User Protocol with MMSI;
- 3.3.2.2 Coding EPIRBs with a Unique Serial Number; and
- 3.3.2.3 Coding EPIRBs with the Radio Call Sign Identification.

3.3.2.1 Coding the Maritime User Protocol with MMSI*

The maritime user protocol can be used to encode the Maritime Mobile Service Identity (MMSI) in EPIRBs as shown in Figure 3.6.

Figure 3.6: Coding the Maritime User Protocol with MMSI

Bits	25	26	27	36	37 ..	39	40	75	76	81	82	83	84	85
	0	1	Country Code		0	1	0	(36 bits) Trailing 6 digits of MMSI	Beacon Number		0	0	R	L

- bit 25: format flag set to "0" (short message)
- bit 26: protocol flag set to "1";
- bits 27 to 36: country code = 3 digit, decimal number encoded in binary notation (see section 3.2.3.2);
- bits 37 to 39: protocol code, set to "010" (maritime user protocol);
- bits 40 to 75: contain the trailing 6 digits of MMSI number encoded using the modified-Baudot code (i.e. 6 bits per digit, see Table C.1 of Annex C);
- bits 76 to 81: a consecutive decimal number for each beacon on that vessel, encoded using the modified-Baudot code (see Table C.1 of Annex C), where the first or only float free beacon is to be coded with a modified-Baudot zero: "001101"; additional beacons shall be numbered consecutively using modified-Baudot characters 1 to 9 and A to Z;
- bits 82 and 83: spare, set to "00";
- bits 84 and 85: (RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices).

*Note: This coding method should be used only if the first 3 digits (MID) forming part of a unique 9-digit code of ship station identity correspond to the 3 digit country code encoded in bits 27 to 36.

3.3.2.2 Coding EPIRBs with a Unique Serial Number

Protocol code bits 37 to 39 for this method of encoding identification data are set to "011" (i.e. the serial user protocol) to indicate that a beacon serial number is contained in the message as described in Figure 3.7, unless the beacon serial identity number is defined otherwise by the national regulation. Bits 40 to 42 are used to identify the beacon type, as the same serial protocol is used in several applications.

Figure 3.7: Coding the EPIRB Serial Identification

Bits	25	26	27 36	37 .. 39	40 .. 42	43	44 63	64 73	74 83	84 85
	0	1	Country Code	0 1 1	T T T	C	(20 bits) Serial Number	All '0' or National Use	C/S Cert. No or National Use	R L
<ul style="list-style-type: none"> - bit 25: format flag set to "0" (short message); - bit 26: protocol flag set to "1"; - bits 27 to 36: country code = 3 digit decimal number encoded in binary notation (see section 3.2.3.2); - bits 37 to 39: protocol code set to "011" (serial user protocol); - bits 40 to 42: (TTT) beacon-type code set to "010" for EPIRBs which can be automatically released and activated, (float free type) or to "100" for EPIRBs which can be manually activated only (survival type); - bit 43: (C) set to "1" to indicate that the Cospas-Sarsat type approval certificate number is encoded in bits 74 to 83, or set to "0" otherwise *; - bits 44 to 63: sequential number, allocated by the manufacturer *, encoded in binary notation with the least significant bit on the right; - bits 64 to 73: all "0", unless designated otherwise by the responsible administration *; - bits 74 to 83: if bit 43 is set to "1", these bits contain the Cospas-Sarsat type approval certificate number for that beacon model (i.e. a unique number assigned by Cospas-Sarsat for each beacon model), encoded in binary notation with the least significant bit on the right; if bit 43 is set to "0", these bits are designated by the responsible administration *; - bits 84 and 85: (RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices). 										

Note: (*) Alternative means of allocating and controlling serial numbers on a national basis may be adopted by administrations, but they must be compatible with the serial user protocol defined in document C/S T.001, and provide a unique beacon 15 Hex ID.

The serial identification coding format described in Figure 3.7, which uses the Cospas-Sarsat type approval certificate (TAC) number, is compatible with other existing serial formats defined by administrations (as notified to the Cospas-Sarsat Secretariat).

The Cospas-Sarsat TAC number is a unique number assigned by the Cospas-Sarsat Secretariat to each beacon model which has been successfully tested in accordance with the Cospas-Sarsat Type Approval Standard (C/S T.007). The list of Cospas-Sarsat TAC numbers of type approved beacon models is published by the Cospas-Sarsat Secretariat in the document "Cospas-Sarsat System Data". Using the Cospas-Sarsat TAC number ensures that the serial production number assigned by a

3.3.2.3 Coding EPIRBs with the Radio Call Sign Identification

3.3.2.3.1 Coding the Maritime User Protocol with the Radio Call Sign

Radio call signs consisting of six or fewer alphanumeric characters can be encoded using the maritime user protocol as shown in Figure 3.8. Although the same protocol is used for both MMSI and Radio Call Signs of 6 or fewer characters, the use of letters in Radio Call Signs ensures that the Radio Call Sign will not be confused with MMSI composed of only digits.

Figure 3.8: Coding the Maritime User Protocol with the Radio Call Sign

Bits	25	26	27	36	37 ..	39	40	75	76	81	82 83	84 85	
	0	1	Country Code		0	1	0	(6 alphanumeric characters = 36 bits) Radio Call Sign	Beacon Number		0	0	R L

- bit 25: format flag set to "0" (short message);
 - bit 26: protocol flag set to "1";
 - bits 27 to 36: country code = 3 digit, decimal number encoded in binary notation (see section 3.2.3.2);
 - bits 37 to 39: protocol code, set to "010" (maritime user protocol);
 - bits 40 to 75: up to 6 alphanumeric characters encoded using the modified-Baudot code (see Table C.1 of Annex C); if the radio call sign has fewer than six characters, blank spaces should be encoded to the left of the characters using the modified-Baudot space symbol: "100100"; if the radio call sign has seven characters it can only be encoded with the Radio Call Sign User Protocol (see item 3.3.2.3.2);
 - bits 76 to 81: a consecutive serial number for each beacon on that vessel, encoded using the modified-Baudot code, where the first or only float free beacon is to be coded with a modified-Baudot zero "001101"; additional beacons shall be numbered consecutively using modified-Baudot characters 1 to 9 and A to Z;
 - bits 82 and 83: set to "00";
 - bits 84 and 85: (RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices).

3.3.2.3.2 Coding the Radio Call Sign User Protocol with the Radio Call Sign

Radio call signs of up to seven characters can be encoded according to Figure 3.9 if they comply with the ITU Radio Regulations on the formation of call signs (Article 25 of the Radio Regulations) whereby alphabetic characters are allowed only in the first four characters of the sequence. These first four characters are coded with the modified-Baudot code in bits 40 to 63 (see Table C.1 of Annex C) and the final three digits are coded in binary-coded decimal form in bits 64 to 75. Characters coded with the modified-Baudot code can be either alphabetic or numeric; characters coded in binary-coded decimal (BCD) must be numeric.

If the radio call sign protocol is used for a call sign of less than seven characters, the radio call sign should be left justified (i.e. data on the left) in the data field (bits 40 to 75) and padded to the right of the last character with BCD "space" characters (see Annex D) in the binary-coded decimal field (bits 64-75).

Figure 3.9: Coding the Radio Call Sign User Protocol

Bits	25	26	27	36	37 ..	39	40	63	64 ..	75	76	81	82	83	84	85				
	0	1	Country Code			1	1	0	(4 alphanumeric char. of Radio Call Sign)			(3 last digits)			Beacon Number		0	0	R	L
<div><div>This document has been replaced by a later version</div><div><div>- bit 25:</div><div>format flag set to "0" (short message);</div></div><div><div>- bit 26:</div><div>protocol flag set to "1";</div></div><div><div>- bits 27 to 36:</div><div>country code = 3 digit, decimal number encoded in binary notation (see section 3.2.3.2);</div></div><div><div>- bits 37 to 39:</div><div>protocol code, set to "110" (radio call sign user protocol);</div></div><div><div>- bits 40 to 63:</div><div>first 4 characters of the radio call sign (letters or digits) encoded using the modified-Baudot code (see Table C.1 of Annex C);</div></div><div><div>- bits 64 to 75:</div><div>last BCD characters (see Annex D) of the radio call sign (3 digits or less), and padded with "space" ("1010") to the right of the last digit, if less than 3 digits (see example hereunder);</div></div><div><div>- bits 76 to 81:</div><div>a consecutive number for each beacon on the same vessel, encoded using the modified-Baudot code, where the first or only float free beacon is to be coded with a modified-Baudot zero "001101"; additional beacons shall be numbered consecutively using modified-Baudot characters 1 to 9 and A to Z;</div></div><div><div>- bits 82 and 83:</div><div>set to "00";</div></div><div><div>- bits 84 and 85:</div><div>(RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices).</div></div></div>																				

Example of radio call sign coding: "ABC123" will be coded:

" 111000 110011 101110 011101 0010 0011 1010 "

A B C 1 2 3 ()

3.3.3 Coding Aviation Protocols

The International Civil Aviation Organization (ICAO) has defined four coding methods which can be used to identify 406 MHz Emergency Locator Transmitters (ELTs) (Convention on International Civil Aviation, Annex 10, Appendix D to Part I - Emergency Locator Transmitter Coding).

The identification codes recommended by ICAO are in accordance with the general structure of Cospas-Sarsat user protocols shown in Figure 3.5 and described in the following sections:

- 3.3.3.1 Coding ELTs with the Beacon Serial Number;
- 3.3.3.2 Coding ELTs with the Aircraft Operator Designator and a Serial Number;
- 3.3.3.3 Coding ELTs with the Aircraft 24-bit Address; and
- 3.3.3.4 Coding ELTs with the Aircraft Nationality and Registration Marking.

All aviation coding methods include a country code based on ITU Radio Regulation Appendix 43 (see section 3.3.1). ICAO also recommends that "each beacon shall be assigned a unique coding and shall be registered" with the appropriate authority (Convention on International Civil Aviation, Annex 10, Volume I, Part I, Chapter 5. Emergency Locator Transmitter (ELT) for Search and Rescue).

3.3.3.1 Coding ELTs with the Beacon Serial Number

Protocol code bits 37 to 39 for this method of encoding identification data are set to "011" to designate the serial user protocol. Bits 40 to 42 are used to identify the beacon type and coding method (i.e. "000" to indicate an ELT serial number) since the same serial user protocol is used for several applications. If bit 43 is set to "1", the Cospas-Sarsat type approval certificate number is encoded in bits 74 to 83, as shown in Figure 3.10. This will help ensure that the serial identity of the beacon is unique (see also item 3.3.2.2).

Figure 3.10: Coding ELTs with the Beacon Serial Number

Bits	25	26	27	36	37 ..	39	40 ..	42	43	44	63	64	73	74	83	84	85			
	0	1	Country Code			0	1	1	0	0	0	C	(20 bits) Serial Number			All "0" or Nation. Use		C/S Cert.No or National Use	R	L
<div><div>- bit 25:</div><div>format flag set to "0" (short message);</div></div> <div><div>- bit 26:</div><div>protocol flag set to "1";</div></div> <div><div>- bits 27 to 36:</div><div>country code = 3 digit decimal number encoded in binary notation (see section 3.2.3.2);</div></div> <div><div>- bits 37 to 39:</div><div>protocol code, set to "011" (serial user protocol);</div></div> <div><div>- bits 40 to 42:</div><div>beacon type set to "000" for ELTs with serial identification;</div></div> <div><div>- bit 43:</div><div>(C) set to "1" to indicate that the Cospas-Sarsat type approval certificate number is encoded in bits 74 to 83, set to "0" otherwise;</div></div> <div><div>- bits 44 to 63:</div><div>sequential number, allocated by manufacturers*, encoded in binary notation with the least significant bit on the right;</div></div> <div><div>- bits 64 to 73:</div><div>all "0", unless designated otherwise by the responsible administration*;</div></div> <div><div>- bits 74 to 83:</div><div>if bit 43 is set to "1", these bits contain the Cospas-Sarsat type approval certificate number for that beacon model (i.e. a unique number assigned by Cospas-Sarsat for each beacon model), encoded in binary notation with the least significant bit on the right;</div><div>if bit 43 is set to "0", these bits are designated by the responsible administration *;</div></div> <div><div>- bits 84 and 85:</div><div>(RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices).</div></div>																				

Note: (*) Alternative means of allocating and controlling serial numbers on a national basis may be adopted by administrations, but they must be compatible with the serial user protocol defined in document C/S T.001, and provide a unique beacon 15 Hex ID.

3.3.3.2 Coding ELTs with the Aircraft Operator Designator and a Serial Number

The 3-letter Aircraft Operator Designator (AOD), defined in ICAO DOC 8585, is a unique identification of Aircraft Operators. The AOD can be coded in the serial user protocol as shown in Figure 3.11.

Figure 3.11: Coding ELTs with the Aircraft Operator Designator and Serial Number

Bits	25	26	27 36	37 .. 39	40 .. 42	43	44 61	62 73	74 83	84 85
	0	1	Country Code	0 1 1	0 0 1	C	Operator 3-letter Designator	Serial Number	C/S Cert.No or National Use	R L
<ul style="list-style-type: none"> - bit 25: format flag set to "0" (short message); - bit 26: protocol flag set to "1"; - bits 27 to 36: country code = 3 digit decimal number encoded in binary notation (see section 3.2.3.2); - bits 37 to 39: protocol code, set to "011" (serial protocol); - bits 40 to 42: beacon type set to "001" for ELTs identified with the 3-letter aircraft operator designator and a serial number; - bit 43: (C) set to "1" to indicate that the Cospas-Sarsat type approval certificate number is encoded in bits 74 to 83, set to "0" otherwise*; - bits 44 to 61: 3-letter aircraft operator designator, encoded using the Modified-Baudot code (see Table C.1 of Annex C); - bits 62 to 73: serial number, as designated by the operator, is encoded in binary notation with the least significant bit to the right (No. 0001 up to 4096); - bits 74 to 83: if bit 43 is set to "1", these bits contain the Cospas-Sarsat type approval certificate number for that beacon model (i.e. a unique number assigned by Cospas-Sarsat for each beacon model), encoded in binary notation with the least significant bit on the right; if bit 43 is set to "0", these bits are designated by the responsible administrations ; - bits 84 and 85: (RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices). 										

3.3.3.3 Coding ELTs with the Aircraft 24-bit Address

The Aircraft 24-bit Address is a unique 24-bit binary code assigned to the aircraft by national administrations in accordance with Annex 10 to the Convention on International Aviation. The Aircraft 24-bit Address is coded in the serial user protocol as shown in Figure 3.12.

Figure 3.12: Coding ELTs with the Aircraft 24-bit Address

Bits	25	26	27 36	37 .. 39	40 .. 42	43	44 67	68 73	74 83	84 85
	0	1	Country Code	0 1 1	0 1 1	C	24-bit Aircraft Address	Specific ELT number	C/S Cert. No or National Use	R L
<p>- bit 25: format flag set to "0" (short message);</p> <p>- bit 26: protocol flag set to "1";</p> <p>- bits 27 to 36: country code = 3 digit decimal number encoded in binary notation (see section 3.2.3.2);</p> <p>- bits 37 to 39: protocol code, set to "011"(serial protocol);</p> <p>- bits 40 to 42: beacon type set to "011" for ELTs identified with aircraft 24-bit address;</p> <p>- bit 43: (C) set to "1" to indicate that the Cospas-Sarsat type approval certificate number is encoded in bits 74 to 83, set to "0" otherwise;</p> <p>- bits 44 to 67: 24-bit aircraft address;</p> <p>- bits 68 to 73: 6 bit specific ELT number, in binary notation with the least significant bit on the right, if several ELTs are carried in the same aircraft and encoded with the same 24 bit address, or default to 0's when only one ELT is carried, see Notes (1) and (2) below;</p> <p>- bits 74 to 83: if bit 43 is set to "1", these bits contain the Cospas-Sarsat type approval certificate number for that beacon model (i.e. a unique number assigned by Cospas-Sarsat for each beacon model), encoded in binary notation with the least significant bit on the right;</p> <p>if bit 43 is set to "0", these bits are designated by the responsible administrations;</p> <p>- bits 84 and 85: (RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices).</p>										

Notes: (1) Before attempting to encode an ELT with the serial user protocol using the aircraft 24-bit address, to avoid repeating an existing 15 Hex ID, manufacturers / programming facilities should request the inquirer / user to provide appropriate information on the specific number to be encoded in bits 68 to 73.

(2) Administrations should advise users to inform manufacturers / programming facilities on the number to be encoded in bits 68 to 73 each time they request the coding of an ELT with a specific aircraft 24-bit address.

3.3.3.4 Coding ELTs with the Aircraft Nationality and Registration Marking

The aircraft nationality and registration marking is a unique alphanumeric number assigned by national administrations in accordance with Annex 10 to the Convention on International Civil Aviation. This is coded in the aviation user protocol as shown in Figure 3.13.

Figure 3.13: Coding ELTs with the Aircraft Nationality and Registration Marking

Bits	25	26	27	36	37 ..	39	40	81	82 83	84	85	
	0	1	Country Code			0 0 1	Aircraft Registration Marking (42 bits = up to 7 alphanumeric charact.)			ELT number	R	L
<ul style="list-style-type: none">- bit 25: format flag set to "0" (short message);- bit 26: protocol flag set to "1";- bits 27 to 36: country code = 3 digit decimal number encoded in binary notation (see section 3.2.3.2);- bits 37 to 39: protocol code, set to "001" (aviation user protocol);- bits 40 to 81: aircraft nationality and registration marking, containing up to 7 alphanumeric characters, is encoded using the modified-Baudot code (see Table C.1 of Annex C); if the aircraft nationality and registration marking include less than 7 characters, blank spaces should be encoded to the left of the characters using the modified-Baudot space symbol: "100100";- bits 82 and 83: Specific ELT number where "00" indicates the first ELT on the aircraft coded with this protocol and "01", "10" and "11" identify additional ELTs on the same aircraft, all coded with the Aviation User protocol ¹;- bits 84 and 85: (RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices).												

3.3.4 Coding PLBs with the Serial User Protocol

The serial user protocol is used to code beacons that have been designed as Personal Locator Beacons (PLB). These PLBs are coded as shown in Figure 3.14 using the serial user protocol with protocol code bits (40 - 42) set to "110".

¹ Effective as of 1 November 2011.

Figure 3.14: Coding PLBs with the Serial User Protocol

Bits	25	26	27 36	37 .. 39	40 .. 42	43	44 63	64 73	74 83	84 85
	0	1	Country Code	0 1 1	1 1 0	C	(20 bits) Serial Number	All "0" or Nation. Use	C/S Cert.No or National Use	R L
<p>- bit 25: format flag set to "0" (short message);</p> <p>- bit 26: protocol flag set to "1";</p> <p>- bits 27 - 36: country code = 3 digit decimal number encoded in binary notation (see section 3.2.3.2);</p> <p>- bits 37 - 39: protocol code set to "011" (serial user protocol);</p> <p>- bits 40 - 42: beacon-type code set to "110" (personal);</p> <p>- bit 43: (C) set to "1" to indicate that the Cospas-Sarsat type approval certificate number is encoded in bits 74 to 83, or set to "0" otherwise *;</p> <p>- bits 44 - 63: sequential number, allocated by the manufacturer *, encoded in binary notation with the least significant bit on the right;</p> <p>- bits 64 - 73: all "0", unless designated otherwise by the responsible administration *;</p> <p>- bits 74 - 83: if bit 43 is set to "1", contain the Cospas-Sarsat type approval certificate number for that beacon model (i.e., a unique number assigned by Cospas-Sarsat for each beacon model), encoded in binary notation with the least significant bit on the right; if bit 43 is set to "0", these bits are designated by the responsible administration *;</p> <p>- bits 84 - 85: (RL) set to "01" if a 121.5 MHz radio-locating transmitter is included in the beacon (see Table 3.6 to indicate other radio-locating devices).</p>										

Note: (*) Alternative means of allocating and controlling serial numbers on a national basis may be adopted by administrations, but they must be compatible with the serial user protocol defined in document C/S T.001, be made known to the Cospas-Sarsat Secretariat, and provide a unique beacon 15 Hex ID.

3.3.5 Coding the Test User Protocol

The test protocols are used when conducting any tests of beacons (e.g. demonstrations, type approval tests, training exercises, etc.) whenever the emitted signals might be detected by the satellites. The test user protocol can be formed from any of the other user protocols by setting bits 37 - 39 to "111". When using the test protocol, bits 40 to 85 and 107 to 112 may be set to any bit pattern (even random) provided that the error-correcting code is set accordingly.

Cospas-Sarsat MCCs will neither respond to, nor forward alert messages corresponding to beacons coded with the test user protocol, unless requested by the appropriate authority of the country conducting the test (e.g. the SPOC in that country) and co-ordinated with the appropriate MCC (i.e. the MCC in which service area the test is being conducted). Details of the procedure to co-ordinate tests are provided in the System document C/S A.001 (DDP).

The test user protocol is different than the beacon "self-test" mode described in section 3.2.2.2, which transmits a single burst having a modified frame synchronization bit pattern. The self-test mode transmission of the beacon is not processed by the Cospas-Sarsat satellite equipment.

Figure 3.15: Coding the Test User Protocol

Bits	25	26	27 36	37 .. 39	40..... 85
	F	1	Country Code	1 1 1	Any combination of bits allowed in the user protocol format
<ul style="list-style-type: none"> - bit 25: (F) format flag set to "0" (short message) or "1" (long message); - bit 26: protocol flag set to "1"; - bits 27 - 36: country code = 3 digit, decimal number encoded in binary notation (see section 3.2.3.2); - bits 37 - 39: protocol code set to "111" (test user protocol); - bits 40 - 85: any combination of bits (with the proper error-correcting code). 					

3.3.6 Coding the National User Protocol

The national user protocol is a special coding format having certain data fields, indicated as "national use", which are defined and controlled by the national administration of the particular country which is identified by the country code field.

The national user protocol may be either a short or a long message, as indicated by the format flag (bit 25). The correct BCH code(s) must be encoded in bits 86-106, and in bits 133-144 if a long message is transmitted.

The national user protocol coding format is described in Figure 3.16:

Figure 3.16: Coding the National User Protocol

Bits	25	26	27 36	37	38	39	40.....85	86.....106	107.....132	133....144
	F	1	Country Code	1	0	0	National Use (46 bits)	BCH Code (21 bits)	National Use (26 bits)	BCH Code (12 bits)
<p>- bit 25: (F) format flag set to "0" (short message) or "1" (long message);</p> <p>- bit 26: protocol flag set to "1";</p> <p>- bits 27 - 36: country code = 3 digit decimal number encoded in binary notation (see section 3.2.3.2);</p> <p>- bits 37 - 39: protocol code set to "100" (national user protocol);</p> <p>- bits 40 - 85: national use;</p> <p>- bits 86-106: 21-bit BCH code;</p> <p>- bits 107 - 112: national use;</p> <p>- bits 113 - 132: national use (if long message);</p> <p>- bits 133 - 144: 12-bit BCH code (if long message).</p>										

Once the beacon has been activated, the content of the message in bits 1 to 106 must remain fixed, but bits 107 onwards are permitted to be changed periodically, provided the correct 12-bit BCH code is also re-computed and that such changes do not occur more frequently than once every 5 minutes.

It should be noted that the content of distress alert messages encoded with the national user protocol cannot be interpreted by Cospas-Sarsat MCCs and will be forwarded to SAR services only as hexadecimal data.

3.4 Coding Location Protocols

This section defines the protocols which can be used for encoding beacon position data, as well as the beacon identification data, in the digital message transmitted by a 406 MHz distress beacon.

Five types of location protocols are defined for use either with the long message format or with the short message format, as illustrated in Figure 3.17. The three protocol types available are:

- User-location Protocol;
- Standard Location Protocol;
- National Location Protocol.

Figure 3.17: Outline of Location Protocols

User - Location Protocols							
bit 26	bits 27-39	bits 40-83	bits 84-85	bits 86-106	bit 107	bits 108-132	bits 133-144
1	Identification Data (44 bits)	Radio-locating Device	21-Bit BCH code	Position. Data Source	Position Data to 4 min Resolution (25 bits)	12-Bit BCH code

Standard Location Protocols							
bit 26	bits 27-40	bits 41-64	bits 65-85	bits 86-106	bits 107-112	bits 113-132	bits 133-144
0	Identification Data (24 bits)	Position Data to 15 min Resolution (21 bits)	21-Bit BCH code	Supplementary Data	Position Data to 4 sec Resolution (20 bits)	12-Bit BCH code

National Location Protocol								
bit 26	bits 27-40	bits 41-58	bits 59-85	bits 86-106	bits 107-112	bits 113-126	bits 127-132	bits 133-144
0	Identification Data (18 bits)	Position Data to 2 min Resolution (27 bits)	21-Bit BCH code	Supplementary Data	Position Data to 4 sec Resolution (14 bits)	National Use	12-Bit BCH code

3.4.1 Position Data Encoding

All position information is encoded as degrees, minutes and seconds of latitude or longitude, or as fractions of these units. Latitude and longitude data are rounded off (i.e. not truncated) to the available resolution. When a position is encoded in the PDF-1, the higher resolution information given in the PDF-2 is an offset (Δ latitude and Δ longitude) relative to the position provided in PDF-1.

The position is encoded as follows. The coarse position encoded in the PDF-1 is selected to be as close as possible to the actual position. Then the actual position is rounded off. The offset encoded in the PDF-2 is selected so that it may be summed with the coarse position to produce a finer position that equates to the rounded position. Subsequent position updates (if applicable) are encoded in exactly the same way. An example of encoding of position data for the standard location protocol is presented in Table 3.7. More examples of encoding of the position data with the Standard Location and National Location protocols are provided in Annex B.

Table 3.7: Encoding of Position Data			
Position data:			
actual latitude:			43° 43' 57" N
actual longitude:			0° 57' 51" E
actual latitude rounded to nearest 4" increment:			43° 43' 56"N
actual longitude rounded to nearest 4" increment:			000° 57' 52"E
coarse latitude:			43° 45' N
coarse longitude:			001° 0' E
latitude offset:			- 1' 4"
longitude offset:			- 2' 8"
Binary encoding:	position	bits	setting
Latitude Flag:	N	65	0
Latitude in Degrees			
(in 1/4 degree increment):	43 ³ / ₄	66-74	0101011 11
Longitude Flag:	E	75	0
Longitude in Degrees			
(in 1/4 degree increment):	1	76-85	00000001 00
Latitude offset sign:	-	113	0
Latitude offset in min:	1	114-118	00001
Latitude offset in sec:	4	119-122	0001
Longitude offset sign:	-	123	0
Longitude offset in min:	2	124-128	00010
Longitude offset in sec:	8	129-132	0010

The latitude and longitude values contained in the PDF-1 are positive numbers regardless of their directions. The offset is applied by adding or subtracting the offset value in accordance with the offset sign in PDF-2. For example:

100° E. longitude + 30' offset = 100° 30' E. longitude
 100° W. longitude + 30' offset = 100° 30' W. longitude (not 99° 30' W. longitude)
 100° W. longitude - 30' offset = 99° 30' W. longitude (not 100° 30' W. longitude).

3.4.2 Coding the User-location Protocols

The applicable user-location protocol is selected by setting bit 26 (protocol flag) to "1" and bits 37 to 39 as defined in section 3.3. The protocols are available only in long message format, with bit 25 (format flag) set to "1".

The beacon identification data is provided in the PDF-1 by any one of the user protocols defined in section 3.3, except the orbitography user protocol and the national user protocol.

Position data is provided as latitude and longitude, to 4-minute resolution, encoded in the PDF-2. The 26 bits available in the PDF-2 can be encoded as shown in Figure 3.18.

Figure 3.18: Coding the User-location Protocols' Second Protected Data Field (PDF-2)

Bits	107	108	109	119	120	121	132
	Position Data Source	Flag N/S	Latitude Data		Flag E/W	Longitude Data	
<div><div><div>- bit 107:</div><div>encoded position data source bit set to "0" means that the encoded position data is provided by an external navigation device,</div><div>encoded position data source bit set to "1" means that the encoded position data is provided by an internal navigation device;</div></div><div><div>- bits 108 to 119:</div><div>latitude data (12 bits) with 4 minute resolution, including:</div></div><div><div>- bit 108:</div><div>N/S flag (N=0, S=1),</div></div><div><div>- bits 109 to 115:</div><div>degrees (0 to 90) in 1 degree increments,</div></div><div><div>- bits 116 to 119:</div><div>minutes (0 to 56) in 4 minute increments,</div><div>(default value of bits 108 to 119= 0 1111111 0000);</div></div><div><div>- bits 120 to 132:</div><div>longitude data (13 bits) with 4 minute resolution including:</div></div><div><div>- bit 120:</div><div>E/W flag (E=0, W=1),</div></div><div><div>- bits 121 to 128:</div><div>degrees (0 to 180) in 1 degree increments,</div></div><div><div>- bits 129 to 132:</div><div>minutes (0 to 56) in 4 minute increments,</div><div>(default value of bits 120 to 132= 0 11111111 0000).</div></div></div>							

3.4.3 Coding the Standard Location Protocols

The applicable standard location protocol is selected by setting bit 26 (protocol flag) to "0" and bits 37 to 40 as defined below. The protocols are available in long message format with bit 25 (format flag) set to "1".

The beacon identification data is provided in a standardised format in 24 bits of the PDF-1 and can be encoded for different standard location protocols as shown in Figures 3.19 to 3.23*.

Position data to 15-minute resolution is also given in the PDF-1, with position offsets to 4-second resolution in the PDF-2. The coding of this data is the same for all types of standard location protocols and is described with further details in Figure 3.24.

Figure 3.19: Coding the Standard Location Protocol with MMSI

Bits	26	26	27	....	36	37	38	39	40	41	....	60	61	...	64
	1	0	Country Code			0	0	1	0	(20 bits) Last 6 Digits of MMSI			Specific Beacon Number		

- bit 25: format flag set to "1" (long message);
- bit 26: protocol flag set to "0";
- bits 27 to 36: country code = 3 digit , decimal number encoded in binary notation (see section 3.2.3.2);
- bits 37 to 40: protocol code, set to "0010" (EPIRB -MMSI Standard Location Protocol);
- bits 41 to 60: contain the last 6 digits of MMSI in binary form;
- bits 61 to 64: 4-bit specific EPIRB number (in binary notation with the least significant bit on the right) used if several EPIRBs are carried on same vessel and encoded with the same 20 bit MMSI address, all bits defaulted to "0" when only one EPIRB is carried.

Figure 3.20: Coding a Ship Security Alert System (SSAS) Beacon

Bits	26	26	27	....	36	37	38	39	40	41	....	60	61	...	64
	1	0	Country Code			0	0	1	0	(20 bits) Last 6 Digits of MMSI			Specific Beacon Number		

- bit 25: format flag set to "1" (long message);
- bit 26: protocol flag set to "0";
- bits 27 to 36: country code = 3 digit , decimal number encoded in binary notation (see section 3.2.3.2);
- bits 37 to 40: protocol code, set to "1100" (Ship Security Alert);
- bits 41 to 60: contain the last 6 digits of MMSI in binary form;
- bits 61 to 64: values set to "0000"

Figure 3.21: Coding the Standard Location Protocol with the 24-bit Aircraft Address

Bits	26	26	27 36	37 40	41 64
	1	0	Country Code	0 0 1 1	24 bit Aircraft Address

- bit 25: format flag set to "1" (long message);
 - bit 26: protocol flag set to "0";
 - bits 27 to 36: country code = 3 digit , decimal number encoded in binary notation (see section 3.2.3.2);
 - bits 37 to 40: protocol code, set to "0011" (ELT 24-bit Address Standard Location Protocol);
 - bits 41 to 64: contain the 24-bit aircraft address (only one ELT per aircraft can be identified using this protocol).

Note: * ELTs carried to satisfy the requirements of ICAO Annex 6, Parts I, II and III shall operate in accordance with ICAO Annex 10.

Figure 3.22: Coding the Standard Location Protocol with the Aircraft Operator Designator and Serial Number

Bits	26	26	27 36	37 40	41 55	56 64
	1	0	Country Code	0 1 0 1	(15 bits) 3-letter of AOD code	9 bit ELT Number

- bit 25: format flag set to "1" (long message);
 - bit 26: protocol flag set to "0";
 - bits 27 to 36: country code = 3 digit, decimal number encoded in binary notation (see section 3.2.3.2);
 - bits 37 to 40: protocol code, set to "0101" (ELT - Aircraft Operator Designator Standard Location Protocol);
 - bits 41 to 55: 3-letter aircraft operator designator, encoded using the Modified-Baudot code (see Table C.1 of Annex C) in shortened form: the first bit which is =1 for any letter is deleted to form a 5 bit code;
 - bits 56 to 64: 9-bit unique ELT number (1-511) in binary form assigned by operator.

Bits	26	26	27 36	37 40	41 50	51 64
	1	0	Country Code	X X X X	10 bit C-S type approval certificate Number	14 bit Serial Number

- bit 25: format flag set to "1" (long message);
 - bit 26: protocol flag set to "0";
 - bits 27 to 36: country code = 3 digit, decimal number encoded in binary notation (see section 3.2.3.2);
 - bits 37 to 40: standard location protocol code, set to: 0100 for ELT, 0110 for EPIRB, 0111 for PLB;
 - bits 41 to 50: contain the 10-bit Cospas-Sarsat type approval certificate number of the beacon (1 to 1,023);
 - bits 51 to 64: 14-bit serial number (1 to 16,383) in binary form.

Figure 3.24: Coding the Position Data in the Standard Location Protocols

Bits	65	66-74	75	76-85	86-106	107-112	113	114-118	119-122	123	124-128	129-132	133-144
	Flag Lat	Lat degr	Flag Long	Long degr	21-bit BCH code	Suppl. Data	Lat Δ Sign	Lat Δ min	Lat Δ sec	Long Δ sign	Long Δ min	Long Δ sec	12-bit BCH code
<p>- bits 65 to 74: latitude data (10 bits) with 15 minute resolution, including:</p> <ul style="list-style-type: none"> - bit 65: Latitude flag (N=0, S=1) - bits 66 to 74: degrees (0 to 90) in 0.25 degree increments (default value of bits 65 to 74 = 0 111111111); <p>- bits 75 to 85: longitude data (11 bits) with 15 minute resolution including:</p> <ul style="list-style-type: none"> - bit 75: Longitude flag (E=0, W=1) - bits 76 to 85: degrees (0 to 180) in 0.25 degree increments (default value of bits 75 to 85 = 0 1111111111); <p>- bits 86 to 106: 21-bit BCH code;</p> <p>- bit 107-110: "1101" (fixed);</p> <p>- bit 111: position data source flag set to "0" means that the position data encoded in PDF-1 is provided by an external navigation device; position data source flag set to "1" means that the position data encoded in PDF-1 is provided by an internal navigation device;</p> <p>- bit 112: 121.5 MHz radio-locating device flag set to "0" means that there is no 121.5 MHz auxiliary radio-locating transmitter in the beacon; 121.5 MHz radio-locating device flag set to "1" means that the beacon is equipped with a 121.5 MHz auxiliary radio-locating transmitter;</p> <p>- bits 113 to 122: offset (Δ) latitude data (10 bits) with 4 second resolution, including:</p> <ul style="list-style-type: none"> - bit 113: Δ sign (0=minus, 1=plus) - bits 114 to 118: minutes (0 to 30) in 1 minute increments - bits 119 to 122: seconds (0 to 56) in 4 second increments (default value of bits 113 to 122 = 1 00000 1111); <p>- bits 123 to 132: offset (Δ) longitude data (10 bits) with 4 second resolution, including:</p> <ul style="list-style-type: none"> - bit 123: Δ sign (0=minus, 1=plus) - bits 124 to 128: minutes (0 to 30) in 1 minute increments - bits 129 to 132: seconds (0 to 56) in 4 second increments (default value of bits 123 to 132 = 1 00000 1111); <p>- bits 133 to 144: 12-bit BCH code.</p>													

* Fig 3.24 defines the coding scheme for all Standard Location Protocols, some newer beacons where the coarse position in PDF-1 is always selected to be as close as possible to the actual position will have a maximum offset in PDF-2 of +/- 7 minutes 30 seconds, in which case bits 114, 115, 124 and 125 of the message will not be used and should be permanently set to "0".

The applicable national location protocol is selected by setting bit 26 (protocol flag) to “0” and bits 37 to 40 as defined below. The protocol is available in the long message format with bit 25 (format flag) set to “1”.

Figure 3.25: Coding the National Location Protocol

Bits	25	26	27-36	37-40	41-58	59	60-66	67-71	72	73-80	81....85	86-106
	Format Flag	Prot. Flag	MID	Prot. Code	Ser. Numb	Flag Lat	Lat degr	Lat min	Flag Long	Long degr	Long min	21-bit BCH code

- bit 25: format flag set to "1" (long message);

- bit 26: protocol flag set to "0";

- bits 27 to 36: country code = 3 digit, decimal number encoded in binary notation (see section 3.2.3.2);

- bits 37 to 40: National location protocol code set to: 1000 for ELT, 1010 for EPIRB, 1011 for PLB;

- bits 41 to 58: contain the 18-bit identification data consisting of a serial number assigned by the responsible administration;

- bits 59 to 71: latitude data (13 bits) with 2 minute resolution, including:

- bit 59: N/S flag (N=0, S=1)
- bits 60 to 66: degrees (0 to 90) in 1 degree increments
- bits 67 to 71: minutes (0 to 58) in 2 minute increments (default value of bits 59 to 71= 0 1111111 00000);

- bits 72 to 85: longitude data (14 bits) with 2 minute resolution including:

- bit 72: E/W flag (E=0, W=1)
- bits 73 to 80: degrees (0 to 180) in 1 degree increments
- bits 81 to 85: minutes (0 to 58) in 2 minute increments (default value of bits 72 to 85 = 0 11111111 00000);

- bits 86 to 106: 21-bit BCH code.

Figure 3.25.b: Data of the PDF-2 and BCH-2 Fields of National Location Protocol

Bits	107-112	113	114-115	116-119	120	121-122	123-126	127.....132	133-144
	Supplem. Data	Lat Δ Sign	Lat min	Lat sec	long Δ sign	Long min	Long sec	National Use	12-bit BCH code
<p>- bit 107-109: "110" (fixed);</p> <p>- bit 110: additional data flag: set to "1" means that Δ position data encoded in PDF-2, set to "0" means that data in PDF-2 is defined nationally;</p> <p>- bit 111: position data source flag set to "0" means that the position data encoded in PDF-1 is provided by an external navigation device;</p> <p>position data source flag set to "1" means that the position data encoded in PDF-1 is provided by an internal navigation device;</p> <p>- bit 112: 121.5 MHz radio-locating device flag set to "0" means that there is no 121.5 MHz auxiliary radio-locating transmitter in the beacon;</p> <p>121.5 MHz radio-locating device flag set to "1" means that the beacon is equipped with a 121.5 MHz auxiliary radio-locating transmitter;</p> <p>- bits 113 to 119: offset (Δ) latitude data (7 bits) with 4 second resolution, including:</p> <p>- bit 113: Δ sign (0=minus,1=plus)</p> <p>- bits 114 to 115: minutes (0 to 3) in 1 minute increments</p> <p>- bits 116 to 119: seconds (0 to 56) in 4 second increments</p> <p>(default value of bits 113 to 119 = 1 00 1111);</p> <p>- bits 120 to 126: offset (Δ) longitude data (7 bits) with 4 second resolution, including:</p> <p>- bit 120: Δ sign (0=minus, 1=plus)</p> <p>- bits 121 to 122: minutes (0 to 3) in 1 minute increments</p> <p>- bits 123 to 126: seconds (0 to 56) in 4 second increments</p> <p>(default value of bits 120 to 126 = 1 00 1111);</p> <p>- bits 127 to 132: Additional beacon type identification (national use)</p> <p>(default value of bits 127 to 132= 000000);</p> <p>- bits 133 to 144: 12-bit BCH code.</p>									

* Fig 3.25.b defines the coding scheme for all National Location Protocols, some newer beacons where the coarse position in PDF-1 is always selected to be as close as possible to the actual position will have a maximum offset in PDF-2 of +/- 1 minute, in which case bits 114 and 121 of the message will not be used and should be permanently set to "0".

3.4.5 Coding the Test Location Protocols

The test protocol for all coding methods (i.e. "user" and "location" protocols) is encoded by setting bits 37-39 (protocol code) to "111". In addition, bit 40 is used to distinguish between the test format of the standard location protocols (bit 40 = "0") and national location protocols (bit 40 = "1"). With the above exception, the coding described in section 3.3.5 and Figure 3.15 (Test User Protocol) remain valid for the Test Location Protocol.

- END OF SECTION 3 -

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4. BEACON REGISTRATION

4.1 Purpose of Beacon Registration

One of the advantages of 406 MHz beacons is that each beacon is designed to transmit a unique message allowing its identification. However, to take advantage of this feature, a register is needed to relate each beacon to a particular ship, aircraft or individual user. Beacon registration is valuable for the resolution of SAR cases. Identification of the beacon user (ship, aircraft or individual user) helps SAR services to properly respond to a distress alert provided that the registration database contains the information listed below in section 4.2. This information provides important search planning data to allow the timely rescue of people in distress. Registration information also helps to resolve false alerts without diverting SAR resources.

All 406 MHz beacons (EPIRBs, ELTs or PLBs) should, therefore, be registered. Every administration requiring or allowing the use of 406 MHz beacons should make suitable arrangements for the registration of 406 MHz beacons, and enforce their registration.

4.2 General Principles for Registering 406 MHz Beacons

4.2.1 Where to Register 406 MHz Beacons

The International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO) require that administrations authorising the use of 406 MHz beacons make provisions for registering these beacons in a database register that is accessible by SAR services 24 hours a day. The administrative and operational contact details for national 406 MHz beacon registers that have been reported to Cospas-Sarsat are published respectively in the following Cospas-Sarsat documents, which can be downloaded free of charge from the Cospas-Sarsat website at www.cospas-sarsat.org:

- "Handbook of Beacon Regulations" (C/S S.007);
- "Cospas-Sarsat Data Distribution Plan" (C/S A.001).

Beacon owners should first consult these two documents to determine whether a national registration service exists in which they can register their beacons. For beacon owners in countries that do not operate national registers, Cospas-Sarsat has implemented an International 406 MHz Beacon Registration Database (IBRD).

The IBRD is provided solely for the purpose of assisting SAR Services in SAR operations and is not intended to fulfil the obligation of National Administrations, as required by IMO or ICAO. A more detailed description of the IBRD is provided at Section 4.3.

4.2.2 Country of Registration - Coding Procedure

As the administration authorising the use of the beacon does not always maintain a beacon registration database but could, alternatively, use the service of another administration or the IBRD, the country code in the 406 MHz beacon message (bits 27 - 36) must provide a link that identifies the operator of the database (i.e. the operator of the national database where the records are held).

The country code should always enable SAR services to retrieve pertinent registration data through the point of contact associated with that country code, either the IBRD (if the country has chosen to use the IBRD for registration of beacons with their country codes), or the national registration facility.

If a registration database is implemented and maintained regionally by agreement between several countries, the administration of the country of registration should arrange with Cospas-Sarsat and appropriate SAR authorities that its country code be recognised as one associated with that particular database, and provide information about such arrangements to the beacon owner.

4.2.3 Control and Updating of Registered Information

Administrations should provide the means for beacon owners to readily and expeditiously update information in the registration database. Owners of beacons are responsible for reporting any change in the registered information, including:

- de-registration of the beacon in the case of a change of ownership, or
- indicating if the beacon has been stolen or permanently removed from service.

Administrations should also regularly verify the accuracy of the database information by contacting the beacon owners. A census of registered 406 MHz beacons should be undertaken by administrations at least every two years. Administrations should also require a check of the beacon registration during mandatory periodic inspections of the beacon.

Authorities maintaining or using databases should ensure that information supplied for beacon registration is treated as proprietary, and ensure that it is used only by appropriate recognised authorities.

Specific guidance for updating registration information contained in the IBRD is provided at Section 4.3.2.

4.2.4 Access to Registration Databases

Administrations maintaining registration databases should provide the means for SAR services to obtain relevant information on a 24 hour, seven day per week basis. Beacon registration information contained in the IBRD can be accessed by SAR services on a 24 hour basis via the Internet. SAR services requiring a password to access the IBRD should submit requests to Cospas-Sarsat via their Representative to either IMO, ICAO or the Cospas-Sarsat Programme.

4.2.5 Content of National Registration Databases

It is desirable that the appropriate information from Tables 4.1, 4.2 and 4.3 be recorded in beacon registration databases or in other appropriate registers and be made available to SAR services in case of distress alerts. Examples of beacon registration cards are provided in the document C/S S.007 “Handbook of Beacon Regulations”, which is annually updated by the Cospas-Sarsat Secretariat.

4.2.6 Accuracy of Beacon Identification (15 Hex ID)

It is critical that the beacon’s 15 Hex ID is correctly entered in the registration database as any mismatch between the data encoded into the beacon and that in the database may delay a rescue or provide misleading information to SAR services. Before proceeding, Administration involved in

the registration, such as beacon maintenance facilities or beacon register operator, should be requested and recommended to check and verify the correct programming of the beacon. Errors may result in a mismatch in a number of ways, but the most common come from misreading the 15 Hex ID and entering an incorrect 15 Hex ID into the database, for example, entering a letter 'D' as an '0' or a letter 'B' as an '8'.

In order to reduce such data entry errors, a checksum has been implemented on the IBRD and some national registration databases, whereby the beacon manufacturer calculates and provides a 5 digit checksum, which is checked during registration data entry to identify possible input errors.

Guidelines on the use of the beacon registration checksum are provided in Annex E.

4.3 Cospas-Sarsat International 406 MHz Beacon Registration Database (IBRD) **(www.406registration.com)**

The IBRD is hosted on the Internet at www.406registration.com. It provides beacon owners who do not have access to national registration facilities the capability to register their beacons or have their beacons registered on their behalf. The IBRD has been configured as follows:

- a) registrations will not be accepted for beacons with country codes of countries that have advised Cospas-Sarsat that they operate national registers;
- b) registrations will be accepted only from the designated national representative (the National Data Provider) in countries that have informed Cospas-Sarsat that they will use the IBRD, but want to control the entry of registration data at a national level; and
- c) registrations will be accepted directly from beacon owners via the Internet, if neither a) nor b) apply.

For direct registration by the beacon owner (paragraph (c) above), the IBRD provides a web based user friendly interface in English, French, Russian and Spanish languages that makes registering new beacons and updating existing registration information both quick and easy. The application includes extensive online help features that answer most of the common questions that arise during the registration process. For issues not addressed in the online help, users can also send questions directly to the Database Administrator via Email.

4.3.1 IBRD Management Policy

Cospas-Sarsat policy regarding the operation and management of the IBRD is contained in the document C/S D.004, "Operations Plan for the Cospas-Sarsat International 406 MHz Beacon Registration Database", which is available at www.cospas-sarsat.org. Users of the IBRD are encouraged to read this document in its entirety. As a minimum IBRD users and potential users should be aware of the following:

- a) The content of registration information stored in the IBRD is the responsibility of the person, organisation, or Administration that provides the information. Cospas-Sarsat does not accept any responsibility or liability in respect of the accuracy of registration information submitted by users.

- b) Cospas-Sarsat will only accept beacon registrations submitted via the online facilities provided by the IBRD. Beacon registrations submitted in paper format or via other communication facilities will not be accepted.
- c) Cospas-Sarsat will not modify beacon registration information, unless absolutely essential to repair a problem that, if not corrected, could damage the system or corrupt the database.
- d) Cospas-Sarsat will implement procedures to avoid where possible the loss or corruption of beacon registration data in the IBRD. Nevertheless, Cospas-Sarsat will not accept responsibility for any loss or corruption of registration information that may occur.
- e) Cospas-Sarsat will not provide facilities in the IBRD to accommodate or enforce national requirements nor provide guidance on matters that fall within the jurisdiction of national administrations (e.g. will not limit the coding options accepted by the IBRD based on specific requirements established at the national level, will not recommend specific beacon models for use, will not identify which beacon models are authorised by specific national administrations, etc.).
- f) The IBRD was developed to improve the effectiveness of Cospas-Sarsat alert data, and is offered for use “as provided”. Cospas-Sarsat will support the operation of the IBRD on a best effort basis, but provides no guarantee in respect of its availability or performance.
- g) The IBRD includes security features that limit the release of registration data to SAR services. Nevertheless, Cospas-Sarsat will not be responsible for unauthorised access or unauthorised changes to registration data which may result from malicious activities.
- h) Cospas-Sarsat, on a best effort basis, will respond to requests for assistance by Administrations, SAR services and beacon owners. Support services provided by Cospas-Sarsat will only be offered during normal working hours, and subject to the availability and workload of the staff operating the database.

4.3.2 Updating Registration Information in IBRD

When a beacon is initially entered in the IBRD, a password is created that provides access to the person / organisation that entered the registration information. This password is needed for updating registration details as circumstances change. As a minimum, the registration data provider should update the beacon registration every two years.

If data registered in the IBRD with a particular country code is under the exclusive control of the Administration acting as the National Data Provider (section 4.3 (b)), then it is the sole responsibility of that Administration to update registration data for all beacons with its country code.

Registration reminder notices are automatically sent by Email to the Email address provided in the beacon's registration record. It is thus very important that this Email address be accurate and current.

Table 4.1: Example of Basic Information to be Recorded and Made Available through Beacon Registration		
PLB	ELT	EPIRB
<p>Beacon Identification (15 Hex ID*)</p> <p>Full length (22/30 Hex) message with default position bits</p> <p>Name of owner/ organization</p> <p>Name, address and phone number of emergency contact person</p> <p>Alternative 24-hour emergency phone number</p> <p>Town, city of residence or base</p> <p>Any critical personal information</p>	<p>Beacon Identification (15 Hex ID*)</p> <p>Full length (22/30 Hex) message with default position bits</p> <p>Aircraft registration number/ name of aircraft operator</p> <p>Name, address and phone number of emergency contact person</p> <p>Alternative 24-hour emergency phone number</p> <p>Type of aircraft, colour, aircraft marking</p> <p>Capacity for persons on board (passengers, crew)</p> <p>Home base</p> <p>Emergency equipment Navigation/communication equipment</p>	<p>Beacon Identification (15 Hex ID*)</p> <p>Full length (22/30 Hex) message with default position bits</p> <p>Name of vessel/ call sign/MMSI</p> <p>Name, address and phone number of emergency contact person</p> <p>Alternative 24-hour emergency phone number</p> <p>Brief vessel description **</p> <p>Capacity for persons on board (passengers, crew)</p> <p>Home port</p> <p>Ship radio installation (see Table 4-3)</p>

Notes: (*) Beacon Identification (Beacon 15 Hex ID) - the 15 hexadecimal characters that uniquely identify each 406 MHz beacon. This Beacon Identification is derived from bits 26 to 85 of the 406 MHz beacon message. For location protocols, the position data in the first protected data field (PDF-1) is set to specified default values to obtain the unique Beacon 15 Hex ID.

- (**) A brief vessel description may include:
- Length of vessel
 - Vessel type (see Table 4.2)
 - Hull colour
 - Hull type (see Table 4.2)
 - Superstructure colour
 - Propulsion (see Table 4.2).

Examples of ship descriptions are given hereunder:

- Example A Bulk carrier, 270 metres in length, black hull, white superstructure.
- Example B Stern trawler, 52 metres in length, green hull, grey superstructure.
- Example C Sail boat, 21 metres in length, double hull, single mast, white hull and superstructure.
- Example D Fishing vessel, 30 metres in length, superstructure aft, red hull and buff superstructure.

Table 4.2: Example of Ship Categories for Database Description

<u>Vessel Type</u>	<u>Hull</u>	<u>Propulsion</u>	
Tug	Single hull	Sail	Power
General cargo	Double hull		
Bulk carrier	Triple hull	Single mast	Inboard
Tanker		Two mast	Outboard
Container		Three mast	Inboard/Outboard
Passenger			
Fishing			
Ferry			
Pleasure craft			
Government			
Drilling platform			
Ro-ro			
Other			

Table 4.3: Example of Ship Radio Installation Description

Inmarsat - A / B / M
Inmarsat - C
VHF with DSC / UHF
HF
MF with DSC
9 GHz Radar Transponder

- END OF SECTION 4 -

5. 406 MHz BEACON TYPE APPROVAL

5.1 Objectives and Scope of Type Approval

The issuing of performance requirements, carriage regulations and the testing and type approving of 406 MHz distress beacons are the responsibilities of national authorities.

However, to ensure beacon compatibility with Cospas-Sarsat Space Segment and Ground Segment equipment, it is essential that beacons meet specified Cospas-Sarsat performance requirements. Compliance with these requirements provides assurance that the tested beacon performance is compatible with, and will not degrade, the Cospas-Sarsat System.

The Cospas-Sarsat type approval tests are designed to ensure that the signals transmitted by the beacons and their coding meet all applicable requirements of the Cospas-Sarsat specification for 406 MHz distress beacons (document C/S T.001). These tests primarily measure the electrical characteristics of beacon transmissions on 406 MHz and, with the exception of temperature, do not take into account environmental conditions the beacon may encounter during normal use.

In addition to the Cospas-Sarsat requirements, there might be other requirements (e.g., radio-locating, environmental, activation, etc.) that administrations and/or International Organizations may specify. Although a Cospas-Sarsat beacon must always be tested according to its normal operating mode (i.e. with auxiliary devices in operation), the control of the performance of these additional devices is not part of the Cospas-Sarsat testing requirements. Testing to ensure proper operation of such additional features, under the required environmental conditions, is the responsibility of the national authorities.

5.2 Cospas-Sarsat Type Approval Testing

In order to ensure that beacons do not degrade the System and to ensure uniformity of testing, Cospas-Sarsat has defined the necessary tests and overall procedure which a manufacturer must follow to receive Cospas-Sarsat type approval (document C/S T.007 "Cospas-Sarsat 406 MHz Distress Beacon Type Approval Standard"). The tests described in C/S T.007 consist of a series of indoor laboratory tests in which the beacon does not transmit to the satellite, and an outdoor functional test of the beacon transmitting to the satellite.

Cospas-Sarsat type approval testing must be performed by a Cospas-Sarsat accepted test facility. The Cospas-Sarsat Secretariat maintains a list of such test facilities.

The beacon manufacturers should submit for Cospas-Sarsat type approval testing beacons coded with a test protocol of appropriate type and format (user-short or long, user-location, standard location-short or long, national location-short or long). All protocol types intended for use with the beacon should be verified. The verification of the different coding options within each type is not required. However, sample messages should be provided for each applicable coding protocol as required by C/S T.007.

5.3 Cospas-Sarsat Type Approval Certificate

After successful completion of Cospas-Sarsat type approval testing, the test report and other technical documentation (as specified in C/S T.007) is submitted to the Secretariat. A Cospas-Sarsat type approval certificate (TAC) will be issued to the beacon manufacturer by the Cospas-Sarsat Secretariat, after review and approval of the test results by Cospas-Sarsat.

TAC numbers will be issued only in the following cases:

- type approval of new beacon models,
- significant changes to an approved beacon model that has been retested at an accepted test facility, and
- the need for additional serial numbers to encode a unique identification with the Standard Location Protocol, provided that the capacity of all possible serial numbers associated with previously assigned TAC numbers was fully used.

Should it be demonstrated subsequently that the production models do not meet the same standard as the type approved model, Cospas-Sarsat reserves the right to revoke the certificate.

406 MHz beacons that have received Cospas-Sarsat type approval are listed in the Cospas-Sarsat System Data which is published periodically by the Secretariat.

5.4 National Type Approval

Cospas-Sarsat encourages national administrations to adopt national requirements (e.g., radio-locating, environmental, activation, etc.) for 406 MHz beacons.

National administrations should also consider requirements which may contribute to reducing false alerts such as:

- visual/audio indicators;
- 2-step activation mechanism; and
- including a description of testing procedures in the beacon user manual.

Depending on the intended use of the beacon, administrations should also consider the recommendations of international organizations (e.g. IMO, ICAO, ITU, etc.). Administrations are urged to harmonise their requirements with those defined by other administrations or international organizations.

Administrations are urged to test beacons to the full requirements, or accept type approval results from other administrations, and to only approve beacons for use that have received Cospas-Sarsat type approval and passed all national type approval testing.

- END OF SECTION 5 -

6. GENERAL GUIDELINES TO ADMINISTRATIONS, MANUFACTURERS AND DISTRIBUTORS

6.1 Guidelines to Administrations

406 MHz beacon coding protocols have been developed to satisfy maritime (EPIRB), aeronautical (ELT) and personal (PLB) applications.

Regardless of the application or protocol used, the creation and maintenance of a registration database is very important. Administrations are responsible for the definition and control of beacon identifications registered in their national databases. All measures should be undertaken to avoid possible duplication of beacon identifications.

Using the Cospas-Sarsat type approval certificate number may help ensure that the serial number assigned by a manufacturer provides a unique beacon 15 Hex ID, independent of the country of registration indicated by the country code. When a beacon 15 Hex ID is assigned by the national administration of the country designated by the country code, bit 43 can be set to "0" and the content of bits 44 to 83 redefined as required. However, in that case, the national administration must ensure that the beacon 15 Hex ID is unique.

In selecting the best coding protocol, administrations should consider:

- whether harmony with beacon coding for other applications is desirable, where national SAR systems support other than just one user community (maritime/aviation/PLBs);
- what protocol is already in common use;
- availability of useful emergency information;
- timely availability of up-to-date registration data;
- ability to forward automatically to RCCs information from the database together with 406 MHz alerts;
- ease and timeliness of updating registration database information;
- beacon cost;
- ease of beacon replacement world-wide;
- ease of re-coding beacons, if required;
- availability of extra bits in the protocol for national use, if required; and
- that the location protocols which can be used for encoding beacon position data, as well as the beacon identification data, provide for 406 MHz GEOSAR alerts with beacon location information not otherwise available.

Having selected the appropriate protocol, administrations should:

- become well informed on the unique capabilities of the various 406 MHz beacon types and select those for use which best support their national requirements;
- promulgate clear and timely guidance to manufacturers and owners on coding and registration procedures;
- ensure that reliable means are provided for automatic or fast access to database information for SAR authorities;

- cooperate with other administrations, manufacturers, owners and organizations to help resolve any registration or information retrieval problems that may arise;
- disseminate procedures via ICAO, IMO, Cospas-Sarsat, Inmarsat and other service providers on how beacon registration database information can be obtained by SAR services, and inform the Cospas-Sarsat Secretariat of the details of their point of contact for 24 hour access to registered information (telephone, facsimile, telex numbers);
- encourage manufacturers and distributors to advise customers, upon purchase of properly coded beacons, about registration requirements, and refer unresolved coding and registration issues to proper national authorities for resolution; and
- encourage manufacturers and distributors to educate users about the maintenance of beacons.

In order to ensure that 406 MHz beacons are correctly coded and registered, administrations should make arrangements for periodic testing and on-board inspection of beacons. Periodic testing or inspection should include a check of the beacon coding and a verification of appropriate beacon registration.

6.2 Guidelines to Manufacturers and Distributors

Beacon manufacturers and distributors are an important part of the coding and registration process. They should ensure that a beacon is properly coded to meet the requirements of the administration authorising its use. In addition, they should inform the beacon owner of the requirements of the registering administration as a part of the instruction material provided with the beacon.

In order to facilitate the examination of beacon coding and registration during periodic beacon testing or inspections, beacon manufacturers should make provisions to ensure that the beacon 15 Hex ID, together with the hexadecimal presentation of the full length beacon message are adequately displayed on the exterior of the beacon. For location protocol beacons, the 15 Hex ID and full length beacon message displayed should correspond to position data set to default values.

Manufacturers/distributors should cooperate with administrations in all countries where their products are introduced to implement coding and registration procedures. Coding beacons for export is a particular concern. Improper coding and registration of beacons limit the effectiveness of the System.

On selling a beacon, manufacturers or distributors should:

- a) determine the identity of the administration authorising its use;
- b) provide the user with a beacon that meets the requirements of the authorising administration;
- c) provide beacon registration guidance to the owner;
- d) inform the owner of his responsibilities regarding registration;
- e) comply with administration registration requirements imposed upon the manufacturer; and
- f) provide beacon maintenance advice to the user.

Manufacturers/distributors should be aware that the use of some kinds of 406 MHz beacons are not authorised in a number of countries.

Manufacturers should refer unresolved beacon coding and registration issues to the proper national authorities for resolution.

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**ANNEXES TO THE
COSPAS-SARSAT GUIDELINES
ON 406 MHz BEACON
CODING, REGISTRATION
AND TYPE APPROVAL**

ANNEX A**LIST OF ACRONYMS**

AOD	aircraft operator designator
BCD	binary-coded decimal
BCH	Bose-Chaudhuri-Hocquenghem code
BCH-1	first BCH error correcting field
BCH-2	second BCH error correcting field
C/S	Cospas-Sarsat
DDP	Cospas-Sarsat Data Distribution Plan (C/S A.001)
DSC	digital selective calling
ELT	emergency locator transmitter
EPIRB	emergency position-indicating radio beacon
GHz	gigahertz
GEOSAR	Geostationary satellite system for SAR
GLONASS	Global Navigational Satellite System (Russia)
GPS	Global Positioning System (USA)
IBRD	International 406 MHz Beacon Registration Database
ICAO	International Civil Aviation Organization
ID	identification
IMO	International Maritime Organization
ITU	International Telecommunication Union
LAT	latitude
LEOSAR	Low-altitude satellite system for SAR
LONG	longitude
LSB	least significant bit
LUT	local user terminal
MCC	mission control centre
MF	medium frequency
MHz	megahertz
MID	maritime identification digits
MMSI	maritime mobile service identity
ms	millisecond
MSB	most significant bit
PDF-1	first protected data field
PDF-2	second protected data field
PLB	personal locator beacon
RCC	rescue co-ordination centre
SAR	search and rescue
SART	search and rescue radar transponder
SPOC	SAR point of contact
SSAS	Ship Security Alert System
TAC	type approval certificate
UHF	ultra high frequency
VHF	very high frequency

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ANNEX B**EXAMPLES OF 406 MHz BEACON CODES****1) Maritime User Protocol with MMSI**

<u>Bit Field Name</u>	<u>Content</u>	<u>Bit Field Location</u>	<u>Bits</u>
Message Format:	Short Message	25	0
Protocol Flag:	User Protocol	26	1
Country Code:	257 Norway	27-36	0100000001
User Protocol Type:	Maritime	37-39	010
Trailing 6 digits of the Ship Station Identity (modified-Baudot code):	743921	40-75	011100001010010000 000011011001011101
Specific EPIRB:	2	76-81	011001
Spare:	Not Used	82-83	00
Radio-locating:	121.5 MHz	84-85	01
BCH-1:	21-bit BCH Code	86-106	101001011011010101000
Emergency Code Flag:	Not Used	107	0
Beacon Activation:	Manual Only	108	0
Emergency/National Code or National use data:	Not used	109-112	0000

Beacon 15 Hex ID (bits 26 to 85): A029C 2900D 97591

406 MSG (Short) (bits 25 to 112): 5014E 14806 CBAC8 D2DAA 00

Bits	25	26	27	36	37	40	75	76	81	83	85
	0	1	0100000001	0	1	0	011100001010010000000011011001011101	011001	0	0	1
Bits	86	112									
	10100101101101010100000000										

2) Radio Call Sign User Protocol

(radio call sign includes 2 of maximum 3 last characters (digits))

Message Format:	Short Message
Protocol Flag:	User Protocol
Country Code:	219 Denmark
User Protocol Type:	Radio Call Sign
Radio Call Sign:	XPA02
Specific EPIRB:	1
Radio-locating:	121.5 MHz
Emergency/National Use:	Not Used
Beacon Activation:	Automatic or Manual

Beacon 15 Hex ID (bits 26 to 85): 9B7B7 B788C AA9D1
 406 MSG (Short) (bits 25 to 112): 4DBDB DBC46 554E8 C8BD7 10

Bits	25	26	27	36	37	40	63	64	75	76	81	83	85
	0	1	0011011011	1	1	0	110111101101111000100011	001010101010	011101	0	0	0	1

Bits	86	112
	100100010111101011100010000	

3) ELT Serial Identification

Message Format:	Short Message
Protocol Flag:	User Protocol
Country Code:	503 Australia
User Protocol Type:	Serial
Beacon Type:	Aviation
Serial Number:	0054839
National Use Bits:	00000000000000000000
Radio-locating:	121.5 MHz
Emergency/National Use:	Not Used
Beacon Activation:	Automatic or Manual

Beacon 15 Hex ID (bits 26 to 85): BEEC0 358DC 00001
 406 MSG (Short) (bits 25 to 112): 5F760 1AC6E 00000 E4A09 10

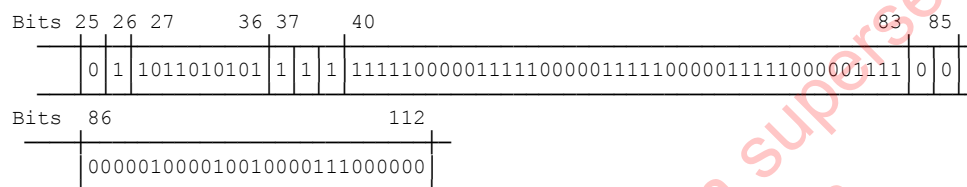
Bits	25	26	27	36	37	40	44	63	64	73	74	83	85		
	0	1	0111110111	0	1	1	0	0	0	0	00001101011000110111	0000000000	0000000000	0	1

Bits	86	112
	110010010100000100100010000	

¹ Effective as of 1 November 2011.

Message Format:	Short Message
Protocol Flag:	User Protocol
Country Code:	725 Chile
User Protocol Type:	Test
Binary Data Field:	11111000001111100000111110000011111000001111
Radio-locating:	None
Emergency/National Use:	Not Used
Beacon Activation:	Manual Only

```
Beacon 15 Hex ID (bits 26 to 85): DABFE 0F83E 0F83C
406 MSG (Short) (bits 25 to 112): 6D5FF 07C1F 07C1E 02121 00000
```



7) EPIRB Serial Identification User-location Protocol

(Encoded position = 43° 32' N, 1° 28' E)

<u>Bit Field Name</u>	<u>Content</u>	<u>Bit Field Location</u>	<u>Bits</u>
Message Format:	Long Message	25	1
Protocol Flag:	User Protocol	26	1
Country Code:	477 Hong Kong	27-36	01110111101
User Protocol Type:	Serial	37-39	011
Beacon type:	Maritime (float free)	40-42	010
C-S Type approval			
Certificate Indicator:	Type Approved	43	1
Serial Number:	0506153	44-63	01111011100100101001
National use:	Not used	64-73	0000000000
C/S Certificate No:	100	74-83	0001100100
Radio-locating:	121.5 MHz	84-85	01
BCH-1:	21-bit BCH Code	86-106	100001000110110110010
Position Data Source:	Internal	107	1
Latitude Flag:	N	108	0
Latitude in Degrees:	43	109-115	0101011
Latitude in Minutes:	32	116-119	1000
Longitude Flag:	E	120	0
Longitude in Degrees:	1	121-128	00000001
Longitude in Minutes:	28	129-132	0111
BCH-2:	12-bit BCH Code	133-144	000101010001

Beacon 15 Hex ID (bits 26 to 85): BBAD5 EE4A4 00191

406 MSG (Long) (bits 25 to 144): DDD6A F7252 000C8 C236C A5700 17151

Bits	25	26	27	36	37	40	44	63	64	73	74	83	85
	1	1	0111011101	0	1	1	0	1	0111011100100101001	0000000000	0001100100	0	1

Bits	86	106	109	119	121	132	133	144
	100001000110110110010	1	0	01010111000	0	000000010111	000101010001	

⁽¹⁾ This example uses the location protocol coding system defined in section A3.3.1 of document C/S T.001, Issue 3 - Revision 8 where the location encoded in PDF-1 may not be the closest to the actual location. This method of encoding will not be permitted after 1 November 2010, see Example 10 for an example of the current encoding method.

9) National Location Protocol(Encoded position = 43° 31' 56" N, 1° 25' 52" E)⁽¹⁾

Bit Field Name	Content	Bit Field Location	Bits
Message Format:	Long Message	25	1
Protocol Flag:	Location Prot.	26	0
Country Code:	257 Norway	27-36	0100000001
National Protocol Type:	EPIRB Serial	37-40	1010
Serial Number:	10753	41-58	000010101000000001
Latitude Flag:	N	59	0
Latitude in Degrees:	43	60-66	0101011
Latitude in Minutes:	32	67-71	10000
Longitude Flag:	E	72	0
Longitude in Degrees:	1	73-80	00000001
Longitude in Minutes:	28	81-85	01110
BCH-1:	21-bit BCH Code	86-106	110100110101100100110
Fixed bits:		107-109	110
additional data flag:	position data as defined by Cospas-Sarsat	110	1
Position data provided by:	external navig. device	111	0
121.5 auxiliary radio location device:	no	112	0
Latitude offset sign:	-	113	0
Latitude offset in min.:	0	114-115	00
Latitude offset in sec.:	4	116-119	0001
Longitude offset sign:	-	120	0
Longitude offset in min.:	2	121-122	10
Longitude offset in sec.:	8	123-126	0010
Additional Beacon type identification:	42	127-132	101010
BCH-2:	12-bit BCH Code	133-144	000101000000

Beacon 15 Hex ID (bits 26 to 85): 20341 500BF 81FE0*

406 MSG (Long) (bits 25 to 144): 901A0 A804A E0017 69AC9 B4028 AA140

Bits	25	26	27	36	37	41	58	60	66	67	71	73	80	81	85
	1	0	0100000001	1	0	1	0	000010101000000001	0	0101011	10000	0	00000001	01110	

Bits	86	106	109	116	123	127	133	144							
	110100110101100100110	1	1	0	1	00	0	00	0001	0	10	0010	101010	000101000000	

* With default values for position data.

⁽¹⁾ This example uses the location protocol coding system defined in section A3.3.1 of document C/S T.001, Issue 3 - Revision 8 where the location encoded in PDF-1 may not be the closest to the actual location. This method of encoding will not be permitted after 1 November 2010, see Example 11 for an example of the current encoding method.

(Actual Location = 43° 43' 56" N, 0° 11' 10" E)
(Encoded position = 43° 43' 56" N, 0° 11' 12" E)

<u>Bit Field Name</u>	<u>Content</u>	<u>Bit Field</u>	<u>Bits Location</u>
Message Format:	Long Message	25	1
Protocol Flag:	Location Prot.	26	0
Country Code:	257 Norway	27-36	0100000001
Standard Protocol Type:	EPIRB-MMSI	37-40	0010
Trailing 6 digits of the Ship Station Identity (in binary form):	506151	41-60	01111011100100100111
Specific EPIRB (in binary form):	2	61-64	0010
Latitude Flag:	N	65	0
Latitude in degrees:	43	66-72	0101011
Latitude in $\frac{1}{4}$ degree increment:	$\frac{3}{4}$	73-74	11
Longitude Flag:	E	75	0
Longitude in degrees:	0	76-83	00000000
Longitude in $\frac{1}{4}$ degree increment:	$\frac{1}{4}$	84-85	01
BCH-1:	21-bit BCH Code	86-106	111111101111011001110
Fixed bits:		107-110	1101
Position data provided by:	external navig. device	111	0
121.5 auxiliary radio location device:	yes	112	1
Latitude offset sign:	-		113
0			
Latitude offset in min.:	1	114-118	00001
Latitude offset in sec.:	4	119-122	0001
Longitude offset sign:	-	123	0
Longitude offset in min.:	3	124-128	00011
Longitude offset in sec.:	48	129-132	1100
BCH-2:	12-bit BCH Code	133-144	1010101111110

406 MSG (Long) (bits 25 to 144): 90127 B9272 2BC00 FF7B3 B5044 3CA54

Diagram illustrating the bit stream for the first two iterations of the SHA-256 algorithm:

Iteration 1: The input message block (bits 25 to 85) is processed by the SHA-256 function to produce a 256-bit hash value (bits 86 to 144).

Iteration 2: The 256-bit hash value from the first iteration is processed by the SHA-256 function to produce a 256-bit hash value (bits 145 to 210).

* With default values for position data.

11) National Location Protocol

(Actual Location = 43° 42' 58" N, 0° 0' 58" E)

(Encoded position = 43° 43' 0" N, 0° 1' 0" E)

Bit Field Name	Content	Bit Field Location	Bits
Message Format:	Long Message	25	1
Protocol Flag:	Location Prot.	26	0
Country Code:	257 Norway	27-36	0100000001
National Protocol Type:	EPIRB Serial	37-40	1010
Serial Number:	10753	41-58	000010101000000001
Latitude Flag:	N	59	0
Latitude in Degrees:	43	60-66	0101011
Latitude in Minutes:	42	67-71	10101
Longitude Flag:	E	72	0
Longitude in Degrees:	0	73-80	00000000
Longitude in Minutes:	0	81-85	00000
BCH-1:	21-bit BCH Code	86-106	010111100111011001111
Fixed bits:		107-109	110
additional data flag:	position data as defined by Cospas-Sarsat	110	1
Position data provided by:	external navig. device	111	0
121.5 auxiliary radio location device:	no	112	0
Latitude offset sign:	+	113	1
Latitude offset in min.:	1	114-115	01
Latitude offset in sec.:	0	116-119	0000
Longitude offset sign:	+	120	1
Longitude offset in min.:	1	121-122	01
Longitude offset in sec.:	0	123-126	0000
Additional Beacon type identification:	42	127-132	101010
BCH-2:	12-bit BCH Code	133-144	100001000011

Beacon 15 Hex ID (bits 26 to 85): 20341 500BF 81FE0*

406 MSG (Long) (bits 25 to 144): 901A0 A804A EA000 2F3B3 F4A14 2A843

Bits	25	26	27	36	37	41	58	60	66	67	71	73	80	81	85
	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0

Bits	86	106	109	116	123	127	133	144
	0	1	0	1	1	0	1	1

* With default values for position data.

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ANNEX C**MODIFIED-BAUDOT CODE**

Table C.1: Modified-Baudot Code					
Letter	Code MSB LSB	Letter	Code MSB LSB	Figure	Code MSB LSB
A	111000	N	100110	() *	100100
B	110011	O	100011	(-) **	011000
C	101110	P	101101	/	010111
D	110010	Q	111101	0	001101
E	110000	R	101010	1	011101
F	110110	S	110100	2	011001
G	101011	T	100001	3	010000
H	100101	U	111100	4	001010
I	101100	V	101111	5	000001
J	111010	W	111001	6	010101
K	111110	X	110111	7	011100
L	101001	Y	110101	8	001100
M	100111	Z	110001	9	000011

MSB: most significant bit
LSB: least significant bit

* Space
** Hyphen

Note: The modified-Baudot code is used to encode alphanumeric characters in beacon messages.

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ANNEX D**BINARY CODED DECIMAL**

To encode a decimal number in the Binary Coded Decimal (BCD) format, each digit of the decimal number is encoded using a four bit binary pattern as illustrated below:

For Example 127 is represented as:

1 2 7
0001 0010 0111

The following table represents the decimal numbers from 0 to 9 and the “space character” in BCD format authorized for use in the Radio Call Sign User protocol.

Decimal Number	BCD 8421
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
“space character”	1010

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ANNEX E

GUIDELINES ON THE USE OF THE BEACON REGISTRATION CHECKSUM

National Administrations wishing to implement a beacon registration checksum should note the following guidance.

- Beacon manufacturers should calculate the 5 character checksum based on the 15 hexadecimal Unique Identification Number (UIN) for serialized beacons.
- The beacon manufacturer should include the 5 character checksum on the registration documentation that it provides to the first buyer of the beacon. Note that some national administration registration documents may not contain space for the checksum. The beacon manufacturer should not provide a checksum when the beacon manufacturer cannot determine the beacon ID in their factory (e.g., for EPIRBs containing a Maritime User Protocol – MMSI, or ELTs containing an Aircraft 24-bit address), as the beacon coding details are not known until the beacon is about to be installed on a specific aircraft or vessel.
- The 5 character checksum should not be placed on the beacon itself only on the registration form provided with the beacon.
- The Five Character Checksum should be implemented using the algorithm provided in Appendix 1.
- Administrations that implement the checksum should ensure that the checksum is calculated correctly. Administrations may decide that checksums should only be generated by beacon manufacturers. If an Administration decides that the checksum should be implemented by distributors and service agents it should note that this may be difficult to achieve and regulate.
- Administrations should not require the checksum to be computed for beacons already on the market.

Appendix 1 to Annex E - Implementation of Five Character Checksum for UIN

The algorithm defined below produces a running sum using the ASCII decimal values for each character modified by arithmetic operations involving primary numbers. Intermediate results are directly truncated to avoid integer variable overflows, restricting all values within the positive range of values associated with standard 4 byte integers (0 to 2,147,483,647). The final result is also truncated to an integer of 20 bits or less, which yields the desired five hexadecimal characters. In the pseudo-code listing below the symbols (*, /, -, +) represent standard arithmetic operators of multiplication, division, subtraction and addition respectively, and inline comments follow the designator of //.

// Initializations:

```
ReturnLimit = 1048576    // used to limit the return value to a 20 bit result
RunningSumLimit = 538471 // large prime which will not cause an overflow
ConstPrimVal   = 3911    // small prime value, stays constant throughout
ModifierLimit   = 3847    // small prime which will not cause an overflow
Modifier        = 3803    // modifier, simply initialized to a prime value
RunningSum      = 0       // holds the running value of the checksum
```

// Main Computation:

```
Loop for first fourteen hexadecimal characters in UIN, 1 to 14:
    // incorporate a character into running checksum
    DecimalValue = ASCII decimal value of this character (See Table 1)
    TmpLongValue = (RunningSum * Modifier) + DecimalValue;
    TmpLongValue2 = TmpLongValue / RunningSumLimit; // whole number quotient
    RunningSum = TmpLongValue - (TmpLongValue2 * RunningSumLimit); // remainder
    // Compute next Modifier
    TmpLongValue = ConstPrimVal * Modifier;
    TmpLongValue2 = TmpLongValue / ModifierLimit; // whole number quotient
    Modifier = TmpLongValue - (TmpLongValue2 * ModifierLimit); // remainder
End Loop
```

// Process Final Character:

```
DecimalValue = ASCII decimal value of this character (See Table 1)
TmpLongValue = (RunningSum * Modifier) + DecimalValue;
```

// Truncation to 20 Bits for final checksum value:

```
TmpLongValue2 = TmpLongValue / ReturnLimit; // whole number quotient
ChecksumValue = TmpLongValue - (TmpLongValue2 * ReturnLimit); // remainder
```

The CheckSumValue, now 20 bits in length, is then translated to a five character hexadecimal representation by converting 4 bit blocks as per standard mechanisms (see Table E.2).

Table E.1 - Translation of characters to ASCII Decimal Values

Char	Dec	Char	Dec	Char	Dec	Char	Dec
0	48	4	52	8	56	C	67
1	49	5	53	9	57	D	68
2	50	6	54	A	65	E	69
3	51	7	55	B	66	F	70

Table E.2 - Standard Translation of 4 Bits Blocks to Hexadecimal Characters

Bits	Char	Bits	Char	Bits	Char	Bits	Char
0000	0	0100	4	1000	8	1100	C
0001	1	0101	5	1001	9	1101	D
0010	2	0110	6	1010	A	1110	E
0011	3	0111	7	1011	B	1111	F

Table E.3 - Example UIN Inputs and Resulting Checksums

#	UIN	Checksum
1	2DCC3FB834FFBFF	885BC
2	2DCC3FB858FFBFF	AE919
3	ADCE089F7C4106D	D31F8
4	ADCE08AA044006D	B3066
5	ADCE08ABE84106D	56B73
6	ADCE08BC004086D	97A1D
7	ADCE08BC744006D	96637
8	2DCC44328EFFBFF	93F7C
9	ADCE08958C4046D	3B7A0
10	ADCE0895A04046D	58C78
11	2DC8555076FFBFF	A8163
12	ADCE08969C4046D	0D618
13	ADCE089A1C4006D	EA65B
14	ADCE08B69C4106D	33ADA
15	ADCE08BB484106D	71DCF
16	2DCE4E1FE0FFBFF	9ADD3
17	2DCE4E17B8FFBFF	2DBC4
18	ADCC07FC0440401	F95BB
19	ADCC07FCB440401	F093A
20	ADCC07FCB840401	B539B
21	ADCE0884984046D	BA05E
22	2DCC3FC806FFBFF	AA605
23	2DCC445744FFBFF	3DA69
24	ADCD02355542801	2D88A
25	ADCD02354542801	7CC0C

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Cospas-Sarsat Secretariat
1250 Boul. René-Lévesque West, Suite 4215, Montreal (Quebec) H3B 4W8 Canada
Telephone: +1 514 500 7999 / Fax: +1 514 500 7996
Email: mail@cospas-sarsat.int
Website: www.cospas-sarsat.int
