ANNEX A BEACON CODING

A1 GENERAL

A1.1 Summary

This annex defines the 406 MHz beacon digital message coding. The digital message is divided into various bit fields as follows:

Short Message Format (see Figure A1)

Bit Field Name	Bit Field Location
1. Bit synchronization	bit 1 through bit 15
2. Frame synchronization	bit 16 through bit 24
3. First protected data field (PDF-1)	bit 25 through bit 85
4. First BCH error correcting field (BCH-1)	bit 86 through bit 106
5. Non-protected data field	bit 107 through bit 112

Long Message Format (see Figure A2)

Bit Field Name	Bit Field Location
1. Bit synchronization	bit 1 through bit 15
2. Frame synchronization	bit 16 through bit 24
3. First protected data field (PDF-1)	bit 25 through bit 85
4. First BCH error correcting field (BCH-1)	bit 86 through bit 106
5. Second protected data field (PDF-2)	bit 107 through bit 132
6. Second BCH error correcting field (BCH-2)	bit 133 through bit 144

The bit synchronization and frame synchronization fields are defined in sections 2.2.4.1 and 2.2.4.2, respectively.

The first protected data field (PDF-1) and the non-protected data field of the short message are defined in section 3.1 and section A2 of this Annex, and shown in Figures A1, A3 and A4.

The first protected data field (PDF-1) and the second protected data field (PDF-2) of the long message are defined in section 3.1 and section A3 of this Annex, and shown in Figures A2, A5, A6, A7, A8, A9, A10 and A11.

The BCH error correcting fields BCH-1 and BCH-2 fields are defined in section 3.1 and the corresponding 21 bit BCH error-correcting code and 12 bit BCH error-correcting code are described at Annex B.

A1.2 Message Format Flag, Protocol Flag, and Country Code

The bit allocations for the message format flag, protocol flag and country code are identical in all beacon protocols. They are assigned in PDF-1 of the short and the long messages as follows:

Bits	Usage
25	format flag (F)
26	protocol flag (P)
27-36	country code

A1.2.1 Format Flag

The format flag (bit 25) shows whether the message is short or long using the following code:

F=0	short format
F=1	long format

A1.2.2 Protocol Flag

The protocol flag (bit 26) indicates which type of protocol is used to define the structure of encoded data, according to the following code:

P=0	standard location protocols or national location protocol
P=1	user protocols or user-location protocols.

The various protocols are identified by a specific protocol code, as described in section A1.3.

A1.2.3 Country Code

Bits 27-36 designate a three-digit decimal country code number expressed in binary notation. Country codes are based on the International Telecommunication Union (ITU) Maritime Identification Digit (MID) country code available on the ITU website (http://www.itu.int/en/ITU-R/terrestrial/fmd/Pages/mid.aspx). National administrations which were allocated more than one MID code may opt to use only one of these codes. However, when the 6 trailing digits of a MMSI are used to form the unique beacon identification, the country code shall always correspond to the first 3 digits of the MMSI code. 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.

For all types of protocols, except the test protocols, the country code designates the country of beacon registration, where additional information can be obtained from a database.

A1.3 Protocol Codes

Each coding protocol is identified by a unique protocol code defined as follows:

- 3-bit code in bits 37 to 39 for user and user-location protocols;

- 4-bit code in bits 37 to 40 for standard location and national location protocols, RLS Location Protocol and ELT(DT) Location Protocol.

Table A1 shows the combinations of the format flag and the protocol flag which identify each category of coding protocols. The protocol codes assignments are summarized in Table A2.

Table A1: Format Flag and Protocol Flag Combinations

Format Flag (bit 25) → **Protocol Flag (bit 26) ↓**	**0** **(short)**	**1** **(long)**
0 **(protocol code: bits 37-40)**	Not Used	Standard Location Protocols National Location Protocol RLS Location Protocols ELT(DT) Location Protocol
1 **(protocol code: bits 37-39)**	User Protocols	User Protocols (*) User-Location Protocols

Figure A1: Data 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 Data	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

Figure A2: Data 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

* Only Orbitography and National User protocols (see section A2.7 and document C/S T.006, and section A2.8, respectively).

Table A2: Protocol Codes Assignments

A2-A: User and User-Location Protocols **(F=0, P=1) short message**
(F=1, P=1) long message

		Protocol Codes (Bits 37 - 39)
1. EPIRB - Maritime User Protocol:	(MMSI, 6 digits)	010
	(radio call sign, 6 characters)	010
2. EPIRB - Radio Call Sign User Protocol		110
3. ELT - Aviation User Protocol	(aircraft registration markings)	001
4. Serial User Protocol:		011

bits 40, 41, 42 used to identify beacon type:
- 000 ELTs with serial identification number;
- 001 ELTs with aircraft operator designator & serial number;
- 010 float free EPIRBs with serial identification number;
- 100 non float free EPIRBs with serial identification number;
- 110 PLBs with serial identification number;
- 011 ELTs with aircraft 24-bit address;
- 101 & 111 spares.

bit 43 = 0: serial identification number is assigned nationally; or
bit 43 = 1: identification data include the C/S type approval certificate number.

5. Test User Protocol		111
6. Orbitography Protocol		000
7. National User Protocol*		100
8. Not to be used (allocated to Second Generation Beacons)		101

A2-B: Standard National, RLS and ELT(DT) Location Protocols **(F=1, P=0) long message**

		Protocol Codes (Bits 37 - 40)
Standard Location Protocols		
1. EPIRB - MMSI/Location Protocol		0010
2. ELT - 24-bit Address/Location Protocol		0011
3. Serial Location Protocols	a) ELT - serial	0100
	b) ELT - aircraft operator designator	0101
	c) EPIRB-serial	0110
	d) PLB-serial	0111
4. Ship Security		1100
5. National Location Protocol		
	a) ELT	1000
	b) EPIRB	1010
	c) PLB	1011

* The National User Protocol has certain bits which are nationally defined, as described in section A2.8.

6. Test location Protocols		
	a) Standard Test Location Protocol	1110
	b) National Test Location Protocol	1111
7. RLS Location Protocol		1101
8. ELT(DT) Location Protocol		1001
9. Spare		0000, 0001

A2 USER PROTOCOLS

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

A2.1 Structure of User Protocols

The user protocols have the following structure:

bits	usage
25	format flag (short message=0, long message =1)
26	protocol flag (=1)
27-36	country code
37-39	protocol code
40-83	identification data
84-85	auxiliary radio-locating device type(s)

Bits 37-39 in the protocol code field designate one of the user protocol codes as listed in Table A2-A, and indicate how the remaining bits of identification data are encoded/decoded.

Bits 40-83 are used to encode the identification data of the beacon and, together with the protocol flag, the country code, the protocol code, and bits 84-85, shall form a unique identification for each beacon, i.e. the beacon 15 Hex ID. They will be discussed separately for each user protocol.

Bits 84-85 are used to indicate for all user protocols excluding the orbitography protocol, the type of auxiliary radio-locating device(s) forming part of the particular beacon. The assignment of bits is as follows:

bits 84-85	auxiliary radio-locating device type
00	no auxiliary radio-locating device
01	121.5 MHz
10	maritime 9 GHz Search and Rescue Radar Transponder (SART)
11	other auxiliary radio-locating device(s)

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.

The bit assignments for user protocols, in PDF-1 of the 406 MHz beacon digital message, are summarized in Figure A3.

Figure A3: Bit Assignment for the First Protected Data Field (PDF-1) of User Protocols

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 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 0	R L

3. SERIAL USER PROTOCOL

Bits	25	26	27 36	37 39	40 42	43	44 73	74 83	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	R L

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)

8. SGB PROTOCOL (Reserved for SGB – but not transmitted)

Bits	25	26	27 36	37 39	40 85
......	…	1	Country Code	1 0 1	As Defined in C/S T.018 (46 bits)

<u>Notes</u>:

RL = Auxiliary radio-locating device (see section A2.1)

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

C = C/S Type Approval Certificate Flag:
"1" = C/S Type Approval Certificate number encoded in bits 74 to 83
"0" = other national use

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

EN = Specific ELT number on designated aircraft (see section A2.4) *

* Effective as of 1 November 2011.

Table A3: 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 EPIRB messages containing MMSI or radio call sign identification, and in ELTs containing the aircraft registration marking or the 3-letter aircraft operator designator.

A2.2 Maritime User Protocol

The maritime user protocol has the following structure:

Bits	Usage
25	format flag (=0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=010)
40-75	radio call sign or trailing 6 digits of MMSI
76-81	specific beacon number
82-83	spare (=00)
84-85	auxiliary radio-locating device type(s)

Bits 40-75 designate the radio call sign or the last 6 digits of the 9 digit maritime mobile service identity (MMSI) using the modified-Baudot code shown in Table A3.

This code enables 6 characters to be encoded using 36 bits (6x6 = 36). This data will be right justified with a modified-Baudot space (100100) being used where no character exists. If all characters are digits, the entry is interpreted as the trailing 6 digits of the MMSI. 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.

Bits 76 to 81 are used to identify specific beacons on the same vessel (the first or only float free beacon shall 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).

The maritime user and the radio call sign user protocols may be used for beacons that require coding with a radio call sign. The maritime user protocol may be used for radio call signs of 6 or fewer characters. Radio call signs of 7 characters must be encoded using the radio call sign user protocol.

A2.3 Radio Call Sign User Protocol

The radio call sign user protocol is intended to accommodate a vessel's radio call sign of up to seven characters, where letters may be used only in the first four characters, thereby complying with the ITU practice on formation of radio call signs.

The radio call sign user protocol has the following structure:

Bits	Usage
25	format flag (=0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=110)
40-75	radio call sign
40-63	first 4 characters (modified-Baudot)
64-75	last 3 characters (binary-coded decimal)
76-81	specific beacon number
82-83	spare (=00)
84-85	auxiliary radio-locating device type(s)

Bits 40 to 75 contain the radio call sign of up to 7 characters. Radio call signs of fewer than 7 characters should be left justified in the radio call sign field (bits 40-75) and padded with "space" (1010) characters in the binary-coded decimal field (bits 64-75).

Bits 76 to 81 are used to identify specific beacons on the same vessel (the first or only float free beacon shall 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).

A2.4 Aviation User Protocol

The aviation user protocol has the following structure:

Bits	Usage
25	format flag (=0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=001)
40-81	aircraft registration marking
82-83	specific ELT number [1]
84-85	auxiliary radio-locating device type(s)

Bits 40-81 designate the aircraft registration marking which is encoded using the modified-Baudot code shown in Table A3. This code enables 7 characters to be encoded using 42 bits (6x7=42). This data will be right justified with a modified-Baudot space (100100) being used where no character exists.

Bits 82-83 are used to create a unique ELT identification when several ELTs coded with the Aviation User protocol are installed on the same aircraft. "00" indicates the first ELT on the aircraft coded with this protocol and "01", "10" and "11" identify additional ELTs, all coded with the Aviation User protocol.[*]

A2.5 Serial User Protocol

The serial user protocol is intended to permit the manufacture of beacons whose 15 Hex ID will be identified in a data base giving specifics about the unit. The following types of serial identification data can be encoded in the beacon:

- serial number
- 24-bit aircraft address number
- aircraft operator designator and a serial number.

Bits 40-42 indicate the beacon type with serial identification data encoded, as follows:

000	indicates an aviation ELT serial number is encoded in bits 44-63
010	indicates a maritime float free EPIRB serial number is encoded in bits 44-63
100	indicates a maritime non float free EPIRB serial number is encoded in bits 44-63
110	indicates a personal locator beacon (PLB) serial number is encoded in bits 44-63
011	indicates the aircraft 24-bit address is encoded in bits 44-67 and specific ELT number in bits 68-73 if several ELTs, encoded with the same 24-bit address, are carried in the same aircraft

[*] Effective as of 1 November 2011.

001 indicates an aircraft operator designator and a serial number are encoded in bits 44-61 and 62-73, respectively.

Bit 43 is a flag bit to indicate that the Cospas-Sarsat type approval certificate number is encoded. If bit 43 is set to 1:

- bits 64-73 should either be set to all 0s or allocated for national use and control (and will be made public when assigned by the responsible administration) or used as defined for coding the aircraft 24-bit address or aircraft operator designator;
- bits 74-83 should be encoded with the Cospas-Sarsat type approval certificate number which is assigned by the Cospas-Sarsat Secretariat for each beacon model approved according to the type approval procedure of document C/S T.007. The certificate number is to be encoded in binary notation with the least significant bit on the right.

If bit 43 is set to 0:

- bits 64-83 are for national use and control (and will be made public when assigned by the responsible administration) or used as defined for coding the aircraft 24-bit address or aircraft operator designator.

Details of each type of serial identification data are given hereunder.

A2.5.1 Serial Number

The serial user protocol using a serial number encoded in the beacon message has the following structure:

```
Bits  25 26 27          36 37    40      44              63 64         73 74          83  85
  ---+--+--+------------+-----+-----+-+-----------------+-------------+-------------+---+-
     ¦  ¦  ¦ Country    ¦     ¦     ¦ ¦   (20 bits)     ¦  All "0" or ¦ C/S cert. No.   ¦
     ¦0 ¦1 ¦ Code       ¦0 1 1¦T T T¦C¦  Serial Number  ¦  Nat. Use   ¦ or Nat. Use ¦R L¦
    ------------------------------------------------------------------------------------------
```

Bits	Usage
25	format flag (= 0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=011)
40-42	beacon type (=000, 010, 100 or 110)
43	flag bit for Cospas-Sarsat type approval certificate number
44-63	serial number
64-73	all 0s or national use
74-83	C/S type approval certificate number or national use
84-85	auxiliary radio-locating device type(s)

Bits 44-63 designate a serial identification code number ranging from 0 to 1,048,575 (i.e., 2^{20}-1) expressed in binary notation, with the least significant bit on the right.

This serial number encoded in the beacon message is not necessarily the same as the production serial number of the beacon.

A2.5.2 Aircraft 24-bit Address

The serial user protocol using the aircraft 24-bit address has the following structure:

```
Bits  25 26 27        36 37    40      44             67 68         73 74         83  85
  ---+--+--+------------+-----+-----+-+-----------------+-------------+-------------+---+-
     ¦  ¦  ¦ Country    ¦     ¦     ¦ ¦   Aircraft      ¦ Additional  ¦ C/S Cert.No.¦   ¦
     ¦0 ¦1 ¦ Code       ¦0 1 1¦0 1 1¦C¦  24-bit Address ¦  ELT No.s   ¦ or Nat. Use ¦R L¦
   ------------------------------------------------------------------------------------
```

<u>Bits</u>	<u>Usage</u>
25	format flag (= 0)
26	protocol flag (=1)
27-36	country code
37-39	user protocol code (=011)
40-42	beacon type (=011)
43	flag bit for Cospas-Sarsat type approval certificate number
44-67	aircraft 24-bit address
68-73	specific ELT number, if several ELTs encoded with the same 24-bit address are carried in the same aircraft
74-83	C/S type approval certificate number or national use
84-85	auxiliary radio-locating device type(s)

Bits 44-67 are a 24-bit binary number assigned to the aircraft. Bits 68-73 contain the 6-bit specific ELT number, in binary notation with the least significant bit on the right, which is an order number of the ELT in the aircraft, where “000000” indicates the first ELT on the aircraft coded with this protocol and “000001”, “000010”, “000011”, etc., identify additional ELTs, all coded with the Aircraft 24-bit Address User protocol. The purpose of this specific number is to produce different 15 Hex numbers containing the same 24-bit address.

A2.5.3 Aircraft Operator Designator and Serial Number

The serial user protocol using the aircraft operator designator and serial number has the following structure:

```
Bits  25 26 27        36 37    40      44                 61 62       73 74         83  85
  ---+--+--+------------+-----+-----+-+--------------------+-----------+-------------+---+-
     ¦  ¦  ¦ Country    ¦     ¦     ¦ ¦ Operator 3-letter ¦  Serial   ¦ C/S Cert. No.   ¦
     ¦0 ¦1 ¦ Code       ¦0 1 1¦0 0 1¦C¦    Designator     ¦  Number   ¦ or Nat. Use ¦R L¦
   ------------------------------------------------------------------------------------
```

<u>Bits</u>	<u>Usage</u>
25	format flag (=0)
27-36	country code
37-39	user protocol code (=011)
40-42	beacon type (=001)
43	flag bit for Cospas-Sarsat type approval certificate number
44-61	aircraft operator designator

62-73	serial number assigned by operator
74-83	C/S type approval certificate number or national use
84-85	auxiliary radio-locating device type(s)

Bits 44-61 are a 3-letter aircraft operator designator from the list* of "Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services" published by the International Civil Aviation Organization (ICAO). The 3 letters are encoded using the modified-Baudot code of Table A3.

Bits 62 to 73 are a serial number (in the range of 1 up to 4095) as designated by the aircraft operator, encoded in binary notation, with the least significant bit on the right.

A2.6 Test User Protocol

The test user protocol will be used for demonstrations, type approval, national tests, training exercises, etc. Mission Control Centres (MCCs) will not forward messages coded with this protocol unless requested by the authority conducting the test.

The test user protocol has the following structure:

Bits	Usage
25	format flag (short message = 0, long message = 1)
26	protocol flag (=1)
27-36	country code
37-39	test user protocol code (=111)
40-85	national use

A2.7 Orbitography Protocol

The orbitography protocol is for use by special system calibration transmitters and is intended for use only by operators of the Local User Terminals. Therefore, it is not further described in this document.

A2.8 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 coded into the country code field.

* The list of designators, comprising about 3000 operating agencies, authorities or services world-wide, is published by ICAO in document 8585, and can be purchased from ICAO in printed and electronic form.

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 has the following structure:

```
Bits  25 26 27       36¦37    ¦40                           85 86         106 107        132¦133  144¦
  ---+--+--+----------+-----+---------------------------+-------------+-------------¦--------¦
     ¦  ¦  ¦ Country  ¦     ¦       National Use         ¦    BCH Code ¦National Use  BCH Code¦
     ¦F ¦1 ¦ Code     ¦1 0 0¦        (46 bits)           ¦   (21 bits) ¦  (26 bits)  ¦(12 bits)
   ---------------------------------------------------------------------------------¦--------¦
```

Bits	Usage
25	format flag (short message =0, long message =1)
26	protocol flag (=1)
27-36	country code
37-39	national user protocol code (=100)
40-85	national use
86-106	21-bit BCH code
107-112	national use
113-132	national use (if long message)
133-144	12-bit BCH code (if long message)

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 recomputed and that such changes do not occur more frequently than once every 20 minutes.

It should be noted that distress alert messages encoded with the national user protocol can be passed within the Cospas-Sarsat System only as hexadecimal data, and the content of the message can only be interpreted by the appropriate national administration.

A2.9 Non-Protected Data Field

The non-protected data field consists of bits 107 to 112, which can be encoded with emergency code / national use data as described below. However, when neither the emergency code nor the national use data have been implemented, nor such data entered, the following default coding should be used for bits 107 to 112:

000000: for beacons that can be activated only manually, i.e.
bit 108 = 0 (see below)

010000: for beacons that can be activated both manually and automatically, i.e., bit 108 = 1 (see below).

Bit 107 is a flag bit that should be automatically set to (=1) if emergency code data has been entered in bits 109 to 112, as defined below.

Bit 108 indicates the method of activation (the switching mechanism) that has been built into the beacon:

bit 108 set to (=0) indicates that a switch must be manually set to “on” after the time of the distress to activate the beacon;
bit 108 set to (=1) indicates that the beacon can be activated either manually or automatically.

A float-free beacon shall have bit 108 set to 1.

A2.9.1 Maritime Emergency code

The emergency code is an optional feature that may be incorporated in a beacon to permit the user to enter data in the emergency code field (bits 109-112) after beacon activation of any maritime protocol (i.e. maritime user protocol, maritime serial user protocols, and radio call sign user protocol). If data is entered in bits 109 to 112 after activation, then bit 107 should be automatically set to (=1) and bits 109 to 112 should be set to an appropriate maritime emergency code shown in Table A4. If a beacon is pre-programmed, bits 109 to 112 should be coded as "unspecified distress" (i.e. 0000).

A2.9.2 Non-Maritime Emergency code

The emergency code is an optional feature that may be incorporated in a beacon to permit the user to enter data in the emergency code field (bits 109-112) of any non-maritime protocol (i.e. aviation user protocol, serial user aviation and personal protocols, or other spare protocols). If data is entered in bits 109 to 112, then bit 107 should be automatically set to (=1) and bits 109 to 112 should be set to an appropriate non-maritime emergency code shown in Table A5.

Table A4: Maritime Emergency Codes in Accordance with the Modified (1) IMO Nature of Distress Indication

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 for assistance desired or other information to facilitate the rescue if necessary)

(1) Modification applies only to code "1111", which is used as a "spare" instead of as the "test" code.
(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 A5: 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)

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

A2.9.3 National Use

When bit 107 is set to (=0), codes (0001) through (1111) for bits 109 to 112 may be used for national use and should be set in accordance with the protocol of an appropriate national authority.

Figure A4: Summary of User Protocols Coding Options

<table>
<tr><td colspan="5">b 25: Message format flag: 0 = short message, 1 = long message</td></tr>
<tr><td colspan="5">b 26: Protocol flag: 1 = User protocols</td></tr>
<tr><td colspan="5">b 27 - b 36: Country code number: 3 digits, as listed in Appendix 43 of the ITU Radio Regulations</td></tr>
<tr><td colspan="5">b 37 - b 39: User protocol code: 000 = Orbitography
001 = Aviation
010 = Maritime
011 = Serial
110 = Radio call sign
111 = Test
100 = National
101 = Spare</td></tr>
<tr><td>b 37 - b 39: 010 = Maritime user</td><td>110 = Radio call sign user</td><td>011 = Serial user</td><td>001 = Aviation user</td><td>100 = National User</td></tr>
<tr><td>b 40 - b 75: Trailing 6 digits of MMSI or radio call sign (modified-Baudot)

b 76 - b 81: Specific beacon (modified-Baudot)
b 82 - b 83: 00 = Spare</td><td>b 40 - b 63: First four characters (modified-Baudot)

b 64 - b 75: Last three characters (binary coded decimal)

b 76 - b 81: Specific beacon (modified-Baudot)
b 82 - b 83: 00 = Spare</td><td>b 40 - 42: Beacon type
000 = Aviation
001 = Aircraft Operator
011 = Aircraft Address
010 = Maritime (float free)
100 = Maritime (non float free)
110 = Personal

b 43: C/S Certificate flag
b 44 - b 73: Serial No. and other data

b 74 - b 83: C/S Cert. No. or National use</td><td>b 40 - b 81: Aircraft Registration Marking (modified - Baudot)

b 82 - b 83: Specific ELT number*</td><td rowspan="2">b 40 - 85:
National use</td></tr>
<tr><td colspan="4">b 84 - 85: Auxiliary radio-locating device type(s): 00 = No Auxiliary radio-locating device
01 = 121.5 MHz
10 = Maritime locating: 9 GHz SART
11 = Other auxiliary radio-locating device(s)</td></tr>
<tr><td colspan="5">b 86 - b 106: BCH code: 21-bit error-correcting code for bits 25 to 85</td></tr>
<tr><td colspan="4">b 107: Emergency code use of b 109 - b 112: 0 = National use, undefined (default = 0)
1 = Emergency code flag</td><td rowspan="4">b 107 - 112:
National use</td></tr>
<tr><td colspan="4">b 108: Activation type: 0 = Manual activation only
1 = Automatic and manual activation</td></tr>
<tr><td colspan="4">b 109 - b 112: Nature of distress: Maritime emergency codes (see Table A.4) (default = 0000)
Non-maritime emergency codes (see Table A5) (default = 0000)</td></tr>
<tr><td colspan="4"></td></tr>
</table>

* Effective as of 1 November 2011.

A3 LOCATION PROTOCOLS

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

A3.1 Summary

Five types of location protocols are defined for use with the long message*, as shown in Figure A5.

User-Location Protocols. These location protocols are for use with the long message format. The beacon identification data is provided in PDF-1 by one of the user protocols defined in section A2 (see Figure A3). Position data is provided as latitude and longitude, to 4-minute resolution, encoded into PDF-2.

Standard Location Protocols. These location protocols are for use with the long message format. The beacon identification data is provided in a standardized format in 24 bits of PDF-1. Position data to 15-minute resolution is also given in PDF-1, with position offsets to 4-second resolution in PDF-2.

National Location Protocol. This location protocol is for use with the long message format. The beacon identification data is provided in a nationally-defined format in 18 bits of PDF-1. Position data, to 2-minute resolution, is given in PDF-1, with position offsets to 4-second resolution in PDF-2.

Return Link Service (RLS) Location Protocol†. This location protocol is for use with the long message format. The beacon identification data is provided in 26 bits of PDF-1 where the first two bits define the beacon type and the remaining 24 bits define the RLS truncated TAC number and serial number. Position data, to 30-minute resolution, is given in PDF-1, with position offsets to 4-second resolution in PDF-2. PDF-2 also contains six supplementary data bits which contain RLS data.

ELT(DT) Location Protocol‡. This location protocol is for use with the long message format. The beacon identification data is provided in 26 bits of PDF-1 where the first two bits define the type of beacon identity and the remaining 24 bits provide that identity. Position data to 30-minute resolution is also given in PDF-1, with position offsets to 4-second resolution in PDF-2. PDF-2 also contains six supplementary data bits which contain altitude and other ELT(DT) data.

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* Cospas-Sarsat no longer permits the use of short format location protocols. Information on these protocols is available in C/S T.001, Issue 3- Revision 7.

† By decision of the Cospas-Sarsat Council at its Fifty-Seventh Session, this protocol will be effective as of 1 January 2018, as a target, subject to further review and consideration.

‡ By decision of the Cospas-Sarsat Council at its Fifty-Seventh Session, this protocol will be effective as of 1 January 2018, as a target, subject to further review and consideration.

A3.2 Default Values in Position Data

The following default values shall be used in all encoded position data fields of the location protocols, when no valid data is available:

a) all bits in degrees fields set to "1", with N/S, E/W flags set to "0";

b) all bits in the minutes fields set to "0", with Δ signs set to "1"; and

c) all bits in the seconds fields set to "1" (the value "1111" = 60 sec is out of range).

This pattern shall also be transmitted if the beacon radiates a 406 MHz message in the self-test mode. Additionally, if a location protocol beacon includes an optional GNSS self-test and this fails to provide a valid location to encode into the transmitted self-test message, then the beacon may radiate a single self-test message with the above default data. However if a location protocol beacon with optional GNSS self-test obtains a location, then the beacon may radiate a single self-test message with encoded position.

Figure A5: 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	Posit. 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

ELT(DT) and RLS Location Protocol							
bit 26	bits 27-40	bits 41-66	bits 67-85	bits 86-106	bits 107-114	bits 115-132	bits 133-144
0	....	Identification Data (26 bits)	Position Data to 30 min Resolution (19 bits)	21-Bit BCH code	Supplementary Data (8 bits)	Position Data to 4 sec Resolution (18 bits)	12-Bit BCH code

A3.3 Definition of Location Protocols

The general structure of location protocols is illustrated in Figure A6.

A3.3.1 Position Data*

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. All rounding shall follow normal rounding conventions, for example with a resolution of 4, 0.000 to 1.999 shall be rounded down to 0 and 2.000 to 3.999 shall be rounded up to 4. In each location field the Most Significant Bit (MSB) is the lowest numbered bit in the message which is not a N/S, E/W or Δ sign flag bit.

For User Location Protocols, the position encoded in PDF-2 shall be as close as possible to the actual position.

For Standard Location, National Location, RLS Location, and ELT(DT) Location Protocols the position is encoded as follows. The coarse position encoded in PDF-1 is selected to be as close as possible to the actual position. The actual position is then rounded following the above rules to the nearest 4 seconds. The offset to be encoded in PDF-2 is then calculated by subtracting the coarse position encoded in PDF-1 from the rounded position, ensuring that the sign of the offset is included in PDF-2†. If there is no offset in either latitude or longitude (or both) in PDF-2 (i.e. the offset minutes and seconds are all zeroes) then the appropriate offset data flag shall be set to its default value (i.e., 1).

When a position is encoded in PDF-1, the higher resolution information given in PDF-2 is an offset (Δ latitude and Δ longitude) relative to position provided in PDF-1.

The latitude and longitude values contained in 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:

$$
\begin{aligned}
&100^\circ\ \text{E. longitude} + 30'\ \text{offset} = 100^\circ\ 30'\text{E. longitude}\\
&100^\circ\ \text{W.longitude} + 30'\ \text{offset} = 100^\circ\ 30'\text{W. longitude (not } 99^\circ\ 30'\ \text{W. longitude)}\\
&100^\circ\ \text{W.longitude} - 30'\ \text{offset} = 99^\circ\ 30'\text{W. longitude (not } 100^\circ\ 30'\ \text{W. longitude).}
\end{aligned}
$$

A3.3.2 Supplementary Data

The following supplementary data are provided in location protocols, in addition to the required identification data and available position data.

* Beacons submitted for type approval testing prior to 1 November 2010 may at manufacturers choice use the location protocol coding system defined in A3.3.1 or the previous system as defined in section A3.3.1 of document C/S T.001, Issue 3 - Revision 8. Manufacturers who choose to use the location encoding system defined in A3.3.1 may use the answer sheets in C/S T.007, Issue 3 - Revision 9. Manufacturers who submit for type approval testing after 1 November 2010 must use the answer sheets in C/S T.007, Issue 3 - Revision 10.

† Note that the encoded location in PDF-1 will be closest to the actual, but in some cases may not be the closest location to the rounded location.

A3.3.2.1 Source of Position Data

This information is encoded in bit 107 for the user-location protocol and RLS location protocol or bit 111 for the standard and national location protocols with the following interpretation:

"0" = the encoded position data is provided by an external navigation device
"1" = the encoded position data is provided by an internal navigation device

A3.3.2.2 Auxiliary Radio Locating Device (homing transmitter) Code

The "121.5 MHz homing" data is encoded in bit 112 for the standard and national location protocols (short and long versions) and in bit 108 for the RLS location protocol where:

"1" = indicates a 121.5 MHz auxiliary radio locating device
"0" = indicates other or no auxiliary radio locating devices;

and in bits 84-85 for the user-location protocols as follows:

"00" = no auxiliary radio locating device
"01" = 121.5 MHz auxiliary radio locating device
"10" = maritime locating: 9 GHz Search and Rescue Radar Transponder (SART)
"11" = other auxiliary radio-locating device(s).

A3.3.2.3 ELT(DT) Activation mechanism

This information is encoded in bits 107 and 108 for the ELT(DT) Location Protocol as defined in section A3.3.8.3.

A3.3.2.4 ELT(DT) Altitude above sea level

This information is encoded in bits 109 to 112 for the ELT(DT) Location Protocol as defined in section A3.3.8.3.

A3.3.2.5 ELT(DT) Encoded Location Status and PDF-2 rotating field indicator

This information is encoded in bits 113 and 114 for the ELT(DT) Location Protocol with the following interpretation:

- “00”: PDF-2 rotating field indicator,
- “01”: encoded location in message is more than 60 seconds old, or the default encoded position is transmitted,
- “10”: encoded location in message is greater than 2 seconds and equal to or less than 60 seconds old,
- “11”: encoded location in message is current (i.e., the encoded location freshness is less or equal to 2 seconds).

A3.3.2.6 RLS Data

Bits 109 and 110 Return Link Message (RLM) Request
Bits 111 and 112 Beacon Feedback (on receipt of RLM)
Bits 113 and 114 Return Link Service (RLS) Provider

A3.3.3 Test Location Protocols

The test protocol for all coding methods (i.e. "user" and "location" protocols, except for the ELT(DT) and RLS 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").

The ELT(DT) and RLS location protocols both have their own test protocols build into their protocol.

Figure A6: General Format of Long Message for Location Protocols

←1 24→	25 26	←27 36→	←37 39 →	40	←41 83→	84 85	←86 106→	←107 112 →	←113 132→	←133 144→
	←------------ 61 BITS PDF-1 ----------→						BCH-1	←------- 26 BITS PDF-2 -------→		BCH-2
	2	10	4		45		21	6	20	12
BIT & FRAME SYNCHRONIZAT. PATTERNS	F O R M A T & P R O T O C O L F L A G S	C O U N T R Y C O D E	3 010 110 001 011 111		<u>USER-LOCATION PROTOCOLS</u> (P=1) Identification Data (same as User Protocols) See Figure A7	2	21-BIT BCH ERROR CORRECTING CODE	<u>USER-LOCATION PROTOCOLS</u> Latitude / Longitude Data (4 Minute Resolution) See Figure A7		12-BIT BCH ERROR CORRECTING CODE
			4 0010 0011 0100 0101 0110 0111 1100 1110		<u>STANDARD LOCATION PROTOCOLS</u> (P=0) Identification & Position Data (1/4 Degree Resolution) See Figure A8			<u>STANDARD LOCATION PROTOCOLS</u> Δ Latitude / Δ Longitude (4 Second Resolution) + Supplementary Data See Figure A8		
			4 1000 1010 1011 1111		<u>NATIONAL LOCATION PROTOCOLS</u> (P=0) Identification & Position Data (2 Minute Resolution) See Figure A9			<u>NATIONAL LOCATION PROTOCOLS</u> Δ Latitude / Δ Longitude (4 Second Resolution) + Supplementary Data See Figure A9		
			4 1101		<u>RLS LOCATION PROTOCOLS</u> <u>(P=0)</u> Identification & Position Data (30 Minute Resolution) See Figure A10			<u>RLS LOCATION PROTOCOLS</u> Δ Latitude / Δ Longitude (4 Second Resolution) + Supplementary Data See Figure A10		
			4 1001		<u>ELT(DT) LOCATION PROTOCOL</u> <u>(P=0)</u> Identification & Position Data (30 Minute Resolution) See Figure A11			<u>ELT(DT) LOCATION PROTOCOL</u> Δ Latitude / Δ Longitude (4 Second Resolution) + Supplementary Data or Aircraft Operator 3LD See Figure A11		
	↑ F= 1 P= 0 or 1		↑ PROTOCOL CODE See Table A2						LONG MESSAGE FORMAT - 144 BITS→	

A3.3.4 User-Location Protocols (See Figure A7)

A3.3.4.1 These protocols (identified by F=1, P=1) provide for encoding latitude / longitude data with resolution to 4 minutes in PDF-2. Beacon identification data shall be encoded in PDF-1 using any of the user protocols defined in section 2, except the orbitography protocol and the national user protocol which are specific to a particular application or a particular country.

A3.3.4.2 The protocol codes (bits 37 to 39) are defined in Table A2-A for user and user-location protocols.

A3.3.4.3 The 26 bits available in PDF-2 are defined as follows:

a) bit 107: encoded position data source

"0" = the encoded position data is provided by an external navigation device

"1" = the encoded position data is provided by an internal navigation device;

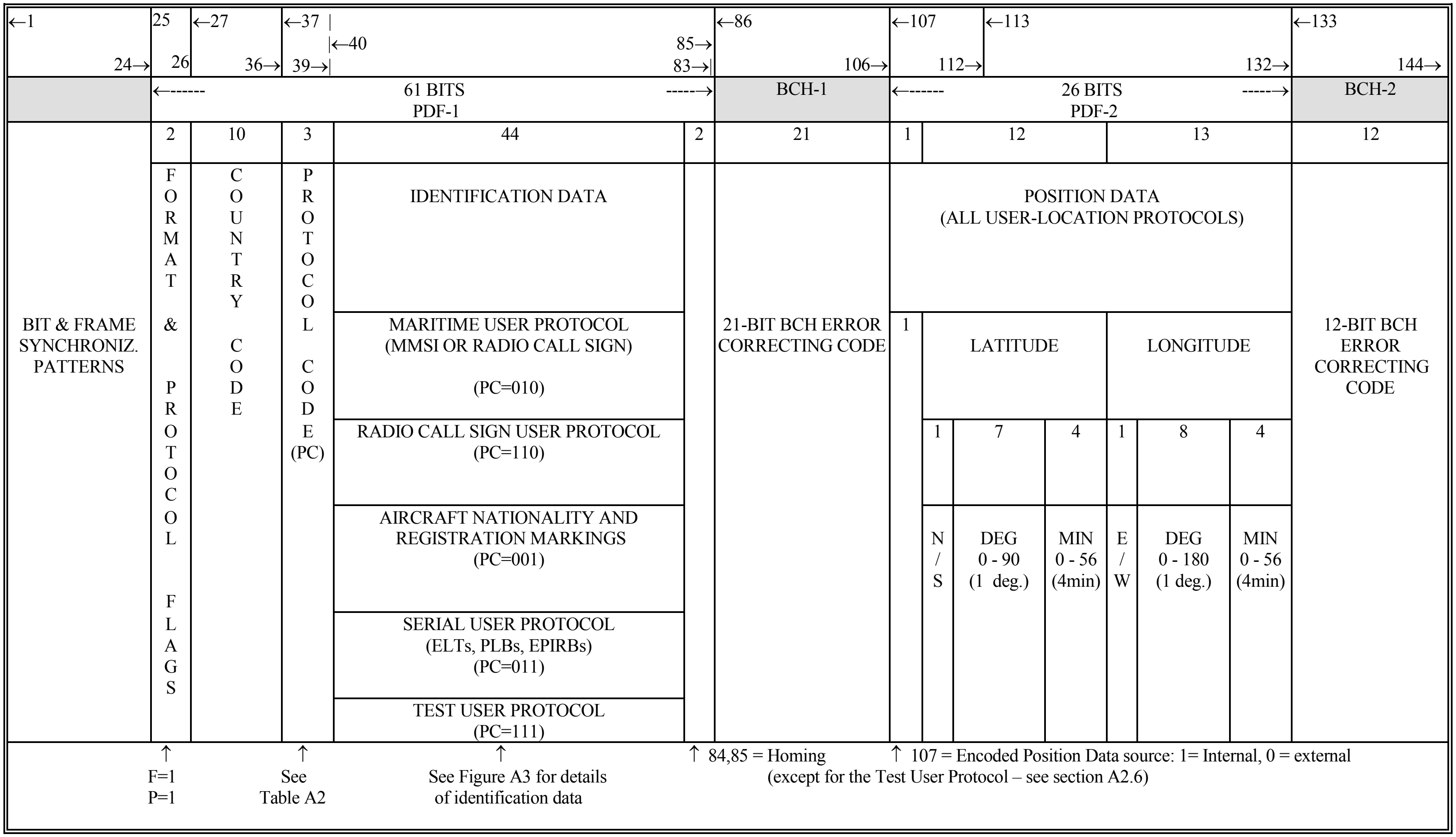
b) bits 108 to 119: latitude data (12 bits) with 4 minute resolution, including:

- bit 108: N/S flag (N=0, S=1)
- bits 109 to 115: degrees (0 to 90) in 1 degree increments
- bits 116 to 119: minutes (0 to 56) in 4 minute increments (default value of bits 108 to 119 = 0 1111111 0000); and

c) bits 120 to 132: longitude data (13 bits) with 4 minute resolution including:

- bit 120: E/W flag (E=0, W=1)
- bits 121 to 128: degrees (0 to 180) in 1 degree increments
- bits 129 to 132: minutes (0 to 56) in 4 minute increments (default value of bits 120 to 132 = 0 11111111 0000).

Figure A7: User-Location Protocol



A3.3.5 Standard Location Protocols (see Figure A8)

A3.3.5.1 The standard location protocols, identified by the flags F=1, P=0 and the protocol codes no. 1 to 4 of Table A2-B, have the following structure:

a) PDF-1:

bits 37 to 40:	4-bit protocol code as defined in Table A2-B
bits 41 to 64:	24 bits of identification data
bits 65 to 85:	21 bits of encoded position data to 15 minute resolution;

b) PDF-2:

bits 107 to 112:	4 fixed bits and 2 bits of supplementary data
bits 113 to 132	20-bit position offset (Δ latitude, Δ longitude), to 4 second resolution.

A3.3.5.2 The 24 bits of identification data (bits 41 to 64) can be used to encode:

a) (PC=0010) the last six digits of MMSI in binary form in bits 41 to 60 (20 bits), plus a 4-bit specific beacon number (0 to 15) in bits 61 to 64, to distinguish between several EPIRBs on the same ship;

b) (PC=0011) a 24-bit aircraft address (only one ELT per aircraft can be identified using this protocol); or

c) (PC=01xx, see Note 1) a 24-bit unique serial identification including:

(i) the 10-bit Cospas-Sarsat type approval certificate number of the beacon (1 to 1,023) in bits 41 to 50, and a 14 bit serial number (1 to 16,383) in bits 51 to 64; or

(ii) a 15-bit aircraft operator designator (see Notes 1 & 2) in bits 41 to 55, and a 9-bit serial number (1 to 511) assigned by the operator in bits 56 to 64.

d) (PC=1100) the last six digits of MMSI in binary form in bits 41 to 60 (20 bits), plus four spare fixed bits, 61 to 64, set to “0000”.

Notes: 1. The last two bits of the protocol code (bits 39-40) are used as follows (see also Table A2):

00	ELT-serial	10	EPIRB-serial
01	ELT-aircraft operator designator	11	PLB-serial

2. The aircraft operator designator (3 letters) can be encoded in 15 bits using a shortened form of the modified-Baudot code (i.e.: all letters in the modified-Baudot code are coded in 6 bits, with the first bit = "1". This first bit can, therefore, be deleted to form a 5-bit code)

A3.3.5.3 The 21 bits of position data in PDF-1 are encoded as follows:

a) bits 65 to 74: latitude data (10 bits) providing 15 minute resolution, including:
- bit 65: N/S flag (N=0, S=1)
- bits 66 to 74: degrees (0 to 90) in 1/4 degree increments
  (default value of bits 65 to 74 = 0 111111111); and

b) bits 75 to 85: longitude data (11 bits) providing 15 minute resolution, including:
- bit 75: E/W flag (E=0, W=1)
- bits 76 to 85: degrees (0 to 180) in 1/4 degree increments
  (default value of bits 75 to 85 = 0 1111111111).

A3.3.5.4 The 26 bits available in PDF-2 are defined as follows:

a) bits 107 to 109: ="110" (fixed);

b) bit 110: ="1" (fixed);

c) bit 111: encoded position data source

"0" = the encoded position data is provided by an external navigation device
"1" = the encoded position data is provided by an internal navigation device;

d) bit 112: 121.5 MHz auxiliary radio locating device included in beacon (1 = yes, 0 = no); 121.5 MHz auxiliary radio locating devices are not authorised for beacons coded with the ship security format
(i.e. when bits 37 – 40 = 1100);

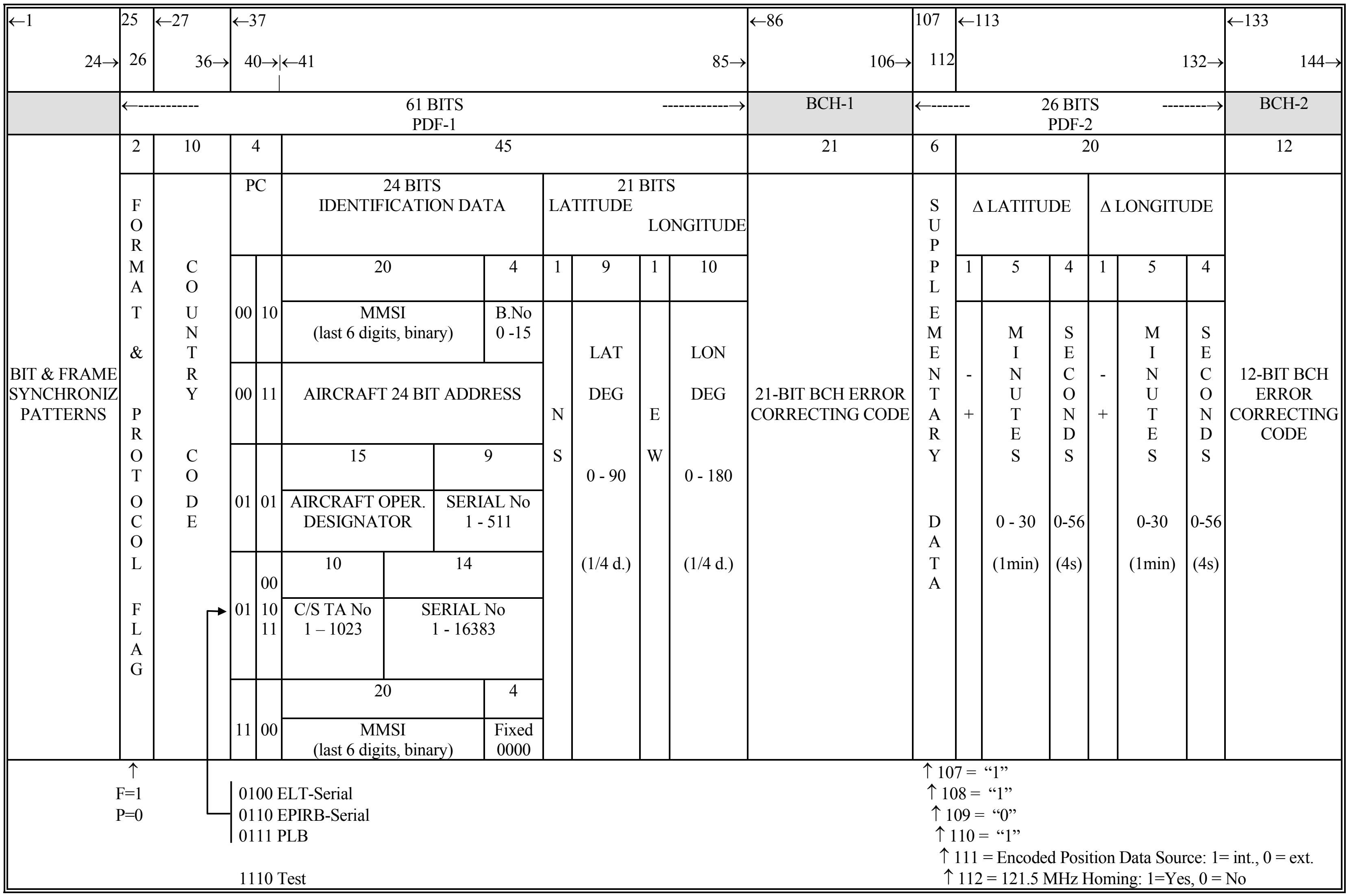
e) bits 113 to 122: Δ latitude with 4 second resolution:
- bit 113: Δ sign (0 = minus, 1 = plus)
- bits 114 to 118: Minutes (0 to 30) in 1 minute increments*
- bits 119 to 122: Seconds (0 to 56) in 4 second increments
  (default value of bits 113 to 122 = 1 00000 1111); and

f) bits 123 to 132: Δ longitude with 4 second resolution:
- 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).

A3.3.5.5 The test protocol using the above format is encoded by setting bits 37-39 to "111" and bit 40 to "0".

* A3.3.5 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”.

Figure A8: Standard Location Protocols



A3.3.6 National Location Protocol (see Figure A9)

A3.3.6.1 The national location protocol, identified by the flags F=1, P=0 and the protocol codes in series no. 4 of Table A2-B, has the following structure:

a) PDF-1:

bits 37 to 40: 4-bit protocol code as defined in Table A2-B,

bits 41 to 58: 18-bit identification data consisting of a serial number assigned by the appropriate national authority,

bits 59 to 85: 27 bits of position data to 2 minute resolution;

b) PDF-2:

bits 107 to 112: 3 fixed bits set to "110", 1-bit additional data flag, describing the use of bits 113 to 132, and 2 bits of supplementary data,

bits 113 to 126: 14-bit position offset (Δ latitude, Δ longitude) to 4 second resolution, or alternate national use, and

bits 127 to 132: 6 bits reserved for national use (additional beacon type identification or other).

A3.3.6.2 The 27 bits of position data in PDF-1 are encoded as follows:

a) bits 59 to 71: latitude data (13 bits) with 2 minute resolution:
- 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); and

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

A3.3.6.3 The 38 bits available in PDF-2 are defined as follows:

a) bit 107 to 109: ="110" (fixed);

b) bit 110: additional data flag (1 = Δ position data as described below in bits 113 to 132; 0 = other to be defined nationally);

c) bits 111: encoded position data source

"0" = the encoded position data is provided by an external navigation device
"1" = the encoded position data is provided by an internal navigation device;

d) bit 112: 121.5 MHz auxiliary radio locating device included in beacon (1 = yes, 0 = no);

e) bits 113 to 119: if bit 110 = 1, Δ latitude with 4 second resolution:
- bit 113: Δ sign (0 = minus, 1 = plus)
- bits 114 to 115: minutes (0 to 3) in 1 minute increments*
- bits 116 to 119: seconds (0 to 56) in 4 second increments (default value of bits 113 to 119 = 1 00 1111);

bits 113 to 119: if bit 110 = 0, national use;

f) bits 120 to 126: if bit 110 = 1, Δ longitude with 4 second resolution:
- bit 120: Δ sign (0 = minus, 1 = plus)
- bits 121 to 122: minutes (0 to 3) in 1 minute increments*
- bits 123 to 126: seconds (0 to 56) in 4 second increments (default value of bits 120 to 126 = 1 00 1111);

bits 120 to 126: if bit 110 = 0, national use; and

g) bits 127 to 132: Additional beacon identification (national use) (default value of bits 127 to 132 = 000000).

A3.3.6.4 The test protocol using the above format is encoded by setting bits 37-39 to "111" and bit 40 to "1".

* A3.3.6 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”.

Figure A9: National Location Protocol

←1 24→	25 26	←27 36→	←37 40→	←41						85→	←86 106→	107 112	←113						132→	←133 144→
	←------ 61 BITS PDF-1 ------→										BCH-1	←------ 26 BITS PDF-2 ------→								BCH-2
	2	10	4	45							21	6	7			7			6	12
				18 BITS	27 BITS															
				IDENTI-FICATION	LATITUDE			LONGITUDE					Δ LATITUDE			Δ LONGITUDE				
				18	1	7	5	1	8	5			1	2	4	1	2	4		
BIT & FRAME SYNCHRONIZ. PATTERNS	FORMAT & PROTOCOL FLAG	COUNTRY CODE	PROTOCOL CODE	NATIONAL ID NUMBER	N S	DEGREES 0 - 90 (1 deg)	MINUTES 0 - 58 (2 m)	E W	DEGREES 0 - 180 (1 deg)	MINUTES 0 - 58 (2m)	21-BIT BCH ERROR CORRECTING CODE	SUPPLEMENTARY DATA	- +	MINUTES 0 - 3 (1m)	SECONDS 0 - 56 (4 s.)	- +	MINUTES 0 - 3 (1m)	SECONDS 0 - 56 (4 s.)	NATIONAL USE	12-BIT BCH ERROR CORRECTING CODE

↑ F=1 P=0

↑ See Table A2
1000 ELT
1010 EPIRB
1011 PLB
1111 Test

↑ 107 = "1"
↑ 108 = "1"
↑ 109 = "0"
↑ 110 = Additional Data Flag: 1 = Δ Position, 0 = Nat. Assignment
↑ 111 = Encoded Position Data Source: 1 = Internal, 0 = external
↑ 112 = 121.5 MHz Homing: 1= Yes, 0 = No

A3.3.7 RLS Location Protocol (see Figure A10)

A3.3.7.1 The RLS location protocol, identified by the flags F=1, P=0 and the protocol code in series no. 7 of Table A2-B, has the following structure:

a) PDF-1:

bits 37 to 40: 4-bit protocol code defined as 1101,

bits 41 to 42: 2-bit beacon type data set to "00" for ELT, "01" for EPIRB, "10" for PLB, and "11" for Location Test Protocol except when bits 43 to 46 have the value "1111" in which case these bits indicate the following; "00" First EPIRB on Vessel, "01" Second EPIRB on Vessel, "10" PLB and "11" Location Test Protocol.

bits 43 to 46: Set to "1111" indicate that this is an RLS Location Protocol coded with an MMSI, and bits 41 to 42 and bits 47 to 66 have a different use as defined above and below

bits 43 to 46: Set to any combination of bits other than "1111" indicate that the RLS Location Protocol is coded with either a TAC or National RLS and Serial Number

bits 43 to 52: 10 bit truncated[*†‡] C/S RLS TAC number or National RLS Number except when bits 43 to 46 are set to "1111",

[*] The 10-bit RLS truncated TAC or National RLS number is the last 3 decimal numbers in the TAC number data field, which allows a range of 1 to 948.
The RLS beacon TAC number 949 is reserved for type-approval testing.
The RLS beacon TAC number or National RLS number series are assigned as follows:
1000 series is reserved for EPIRBs (i.e. 1001 to 1948),
2000 series is reserved for ELTs (i.e. 2001 to 2948), and
3000 series is reserved for PLBs (i.e. 3001 to 3948).

These are represented in the RLS messages as bits 41 to 42 (except when bits 43 to 46 are set to "1111") indicating the beacon type series (EPIRB, ELT, or PLB) and a 10 bit (1-1024) TAC number which is added to the series to encode the full TAC number. (e.g., TAC 1042 would be encoded as "01" for EPIRB in bits 41 to 42 representing 1nnn, where "nnn" is "042" determined by "0000101010" in bits 43 to 52, and form a binary representation "00 0010 1010" of the decimal number "42".

[†] The numbers 920 to 948 (i.e., National RLS Numbers 920 to 948) are set aside for National Use by Competent Authorities. That is full National RLS Numbers 1920 to 1948 for EPIRBs, 2920 to 2948 for ELTs, and 3920 to 3948 for PLBs.

[‡] The numbers in the ranges x700 to x799 in the 1000, 2000 and 3000 series have been set aside for allocation to special-use beacon models approved under letters of compatibility.

bits 53 to 66: 14-bit identification data consisting of a production serial number (1 to 16,383) assigned by the manufacturer associated with a C/S RLS TAC number (001 to 919), except when bits 43 to 46 are set to "1111",

or

bits 53 to 66: 14-bit identification data consisting of a Competent Authority assigned serial number (1 to 16,383), associated with a National RLS Number that has been allocated to an Administration by the Cospas-Sarsat Programme (920 to 949*), except when bits 43 to 46 are set to "1111",

bits 47 to 66: When bits 43 to 46 are set to "1111" then and only then, do these bits provide the last six digits of the MMSI in binary form†

bits 67 to 85: 19 bits of position data to 30 minute resolution;

b) PDF-2:

bits 107 & 108: 2 bits of supplementary data

bits 109 to 114: 6 bits reserved for RLS Data.

bits 115 to 132: 18-bit position offset (Δ latitude, Δ longitude) to 4 second resolution.

The 19 bits of position data in PDF-1 are encoded as follows:

a) bits 67 to 75: latitude data (9 bits) with 30 minute resolution, including:
- bit 67: N/S flag (N=0, S=1)
- bits 68 to 75: degrees (0 to 90) in 1/2 degree increments (default value of bits 67 to 75 = 0 11111111); and

b) bits 76 to 85: longitude data (10 bits) with 30 minute resolution, including:
- bit 76: E/W flag (E=0, W=1)
- bits 77 to 85: degrees (0 to 180) in 1/2 degree increments (default value of bits 76 to 85 = 0 111111111).

* TAC numbers 950 to 959 are currently unallocated.

† The full 9-digit MMSI is comprised of the Country Code in bits 27 to 36 providing the Flag State (MID) of the vessel and bits 47 to 66 providing the unique 6-digit identity for the vessel.

A3.3.7.2 The 26 bits available in PDF-2 are defined as follows:

a) bits 107 and 108 Supplementary Data

(1) bits 107: encoded position data source

"0" = the encoded position data is provided by an external navigation device
"1" = the encoded position data is provided by an internal navigation device;

(2) bit 108: 121.5 MHz auxiliary radio locating device included in beacon (1 = yes, 0 = no);

b) bits 109 to 114: RLS Data

(1) Bits 109-110: RLM Request

- bit 109: Capability to process RLM Type-1:
  "1": Acknowledgement Type-1 (automatic acknowledgement) accepted by this beacon,
  "0": Acknowledgement Type-1 not requested and not accepted by this beacon;
- bit 110: Capability to process manually generated RLM (e.g., Type-2)*:
  "1": Manually generated RLM (such as Acknowledgement Type-2) accepted by this beacon,
  "0": Manually generated RLM (such as Acknowledgement Type-2) not requested and not accepted by this beacon.

(2) Bits 111-112: Beacon feedback (acknowledging the reception of the RLM):

- bit 111: Feedback on RLM Type-1:
  "1": Acknowledgement Type-1 (automatic acknowledgement) received by this beacon,
  "0": Acknowledgement Type-1 not (yet) received by this beacon;

- bit 112: Feedback on RLM Type-2 (or any other manually generated RLM) :
  "1": RLM Type-2 received by this beacon,
  "0": RLM Type-2 not (yet) received by this beacon.

(3) Bits 113-114: RLS Provider Identification:

* The condition bit 109 = “0” and bit 110 = “0” is an invalid condition; at least one of these two bits must always be a “1”.

"01": GALILEO Return Link Service Provider
"10": GLONASS Return Link Service Provider*
“11”: BDS Return Link Service Provider*
"00": Spare (for other RLS providers)

c) bits 115 to 123: Δ latitude with 4 second resolution:
- bit 115: Δ sign (0 = minus, 1 = plus)
- bit 116 to 119: minutes (0 to 15) in 1 minute increments†
- bits 120 to 123: seconds (0 to 56) in 4 second increments (default value of bits 115 to 123 = 1 0000 1111);

d) bits 124 to 132: Δ longitude with 4 second resolution:
- bit 124: Δ sign (0 = minus, 1 = plus)
- bits 125 to 128: minutes (0 to 15) in 1 minute increments‡
- bits 129 to 132: seconds (0 to 56) in 4 second increments (default value of bits 124 to 132 = 1 0000 1111)

A3.3.7.3 Users should utilize the Return Link Service Location Test protocol identified with bits 41-42 set to “11” described in section A3.3.7.1 when testing an RLS-capable beacon.

* Beacons shall not be coded with these coding options (except for the RLS location test protocol) until the GLONASS or BDS RLS services are declared by the Cospas-Sarsat Council operational within the Cospas-Sarsat Programme. Type approval certificates allowing these versions of RLS Location protocols will not be issued until the RLS service provider has been approved for operational use in the System.

† Section A3.3.7 defines the coding scheme for the RLS Location Protocol. For these new beacons the coarse position in PDF-1 is always selected to be as close as possible to the actual position and will have a maximum offset in PDF-2 of +/- 15 minutes.

Figure A10: RLS Location Protocol

←1 … 24→	25 26	←27 … 36→	←37 40→|←41							… 85→	←86 … 106→	107 … 114	←115					… 132→	←133 … 144→
	←61 BITS→ PDF-1										BCH-1	←26 BITS→ PDF-2							BCH-2
BIT & FRAME SYNCHRONIZ. PATTERNS	2	10	4	45							21	8	9			9			12
				26 BITS IDENTIFICATION			19 BITS LATITUDE		LONGITUDE				Δ LATITUDE			Δ LONGITUDE			
				2	10	14	1	8	1	9			1	4	4	1	4	4	
	FORMAT & PROTOCOL FLAG	COUNTRY CODE	PROTOCOL CODE	BEACON TYPE	RLS TAC or NRN or	RLS ID SERIAL NUMBER or	N S	DEGREES 0 - 90 (1/2 deg)	E W	DEGREES 0 - 180 (1/2 deg)	21-BIT BCH ERROR CORRECTING CODE	SUPPLEMENTARY DATA	- +	MINUTES 0 - 15 (1m)	SECONDS 0 - 56 (4 s.)	- +	MINUTES 0 - 15 (1m)	SECONDS 0 - 56 (4 s.)	12-BIT BCH ERROR CORRECTING CODE
					Bits 43-46 ‘1111’ Bits 47-66 Last 6 digits of MMSI														

F=1
P=0

1101

If bits 43 to 46 = 1111
“00” =ELT “00” First EPIRB
“01”=EPIRB “01” Second EPIRB
“10”=PLB
“11”=RLS Location Test protocol

NRN – National RLS Number (see section A.3.3.7.1)

107 = Encoded Position Data Source: 1 = Internal, 0 = external
108 = 121.5 MHz Homing: 1= Yes, 0 = No
109 and 110 = Return Link Message (RLM) Request
111 and 112 = Beacon Feedback (on receipt of RLM)
113 and 114 = Return Link Service (RLS) Provider

A3.3.8 ELT(DT) Location Protocol (see Figure A11)

A3.3.8.1 The ELT(DT) location protocol, identified by the flags F=1, P=0 and the protocol code in series no. 8 of Table A2-B, has the following structure:

a) PDF-1:

bits 37 to 40: 4-bit protocol code defined as 1001;

bits 41 to 42: 2 bits for type of beacon identity set to "00" for Aircraft 24-bit address [*], "01" for Aircraft operators designator and serial number[†], "10" for TAC with serial number[†], and "11" reserved for future use;

bits 43 to 66: 24 bits of beacon identification data:

- (Bits 41 and 42 "00") a 24-bit aircraft address (only one ELT per aircraft can be identified using this protocol); or
- (Bits 41 and 42 "01") a 15-bit aircraft operator designator[‡] in bits 43 to 57, and a 9-bit serial number (1 to 511) assigned by the operator in bits 58 to 66; or
- (Bits 41 and 42 "10") a 10-bit Cospas-Sarsat type approval certificate number of the beacon (1 to 1,023) in bits 43 to 52, and a 14-bit serial number (1 to 16,383) in bits 53 to 66; or
- (Bits 41 and 42 "11") reserved for future use and shall not be used for beacon coding.

or ELT(DT) Location Test protocol when bits 43 to 66 are encoded with either all "0"s, or all "1"s;

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[*] This coding is compliant with the mandatory data elements defined in ICAO document 10150, "Manual on the Functional Specifications for the Location of an Aircraft in Distress Repository (LADR)" where bits 41 and 42 are set to "00" and the aircraft 24-bit address is provided in PDF-1, and the 3LD designator of the aircraft operator is provided in the rotating PDF-2 field (when bits 113 and 114 are set to "00" and bits 115 to 117 are set to "000" at the intervals described in section 2.2.1 of this document).

The LADR is a facility, that will be used by Cospas-Sarsat, to support ICAO requirements for autonomous location of an aircraft in distress contained in Annex 6, Part I, section 6.18 to the Convention on International Civil Aviation.

[†] **WARNING:** These coding options are NOT compliant with the mandatory data elements defined in ICAO document 10150 (no aircraft identifier is available) and the associated data cannot be stored in the LADR. Manufacturers wishing to comply with ICAO GADSS requirements and use these coding options should first consult the relevant Administration's aviation authorities for guidance, prior to encoding beacons with these protocols.

[‡] The aircraft operator designator (3 letters) can be encoded in 15 bits using a shortened form of the modified-Baudot code (i.e.: since all letters in the modified-Baudot code are coded in 6 bits, with the most significant bit = "1", this first (most significant) bit can be deleted to form a 5-bit code per letter).

bits 67 to 85: 19 bits of position data to 30 minute resolution;

b) PDF-2:

bits 107 & 108: means of activation

bits 109 to 112: encoded altitude

bits 113 & 114 encoded location freshness or PDF-2 rotating field indicator

bits 115 to 132: 18-bit position offset (Δ latitude, Δ longitude) to 4 second resolution or aircraft operator 3LD.

A3.3.8.2 The 19 bits of position data in PDF-1 are encoded as follows:

a) bits 67 to 75: latitude data (9 bits) with 30 minute resolution, including:
- bit 67: N/S flag (N=0, S=1)
- bits 68 to 75: degrees (0 to 90) in 1/2 degree increments
  (default value of bits 67 to 75 = 0 11111111); and

b) bits 76 to 85: longitude data (10 bits) with 30 minute resolution, including:
- bit 76: E/W flag (E=0, W=1)
- bits 77 to 85: degrees (0 to 180) in 1/2 degree increments
  (default value of bits 76 to 85 = 0 111111111).

A3.3.8.3 The 26 bits available in PDF-2 are defined as follows:

a) bits 107 and 108: means of activation
"00": manual activation by the user
"01": automatic activation by the beacon
"10": automatic activation by external means
"11": spare

If the beacon receives more than one triggering command, then the most recent triggering event is indicated in the bits 107-108.

b) bits 109 to 112: encoded altitude
"0000": altitude is less than or equal to 400 m (1312 ft)
"0001": altitude is greater than 400 m (1312 ft) up to and including 800 m (2625 ft)
"0010": altitude is greater than 800 m (2625 ft) up to and including 1200 m (3937 ft)
"0011": altitude is greater than 1200 m (3937 ft) up to and including 1600 m (5249 ft)
"0100": altitude is greater than 1600 m (5249 ft) up to and including 2200 m (7218 ft)

"0101": altitude is greater than 2200 m (7218 ft) up to and including 2800 m (9186 ft)
"0110": altitude is greater than 2800 m (9186 ft) up to and including 3400 m (11155 ft)
"0111": altitude is greater than 3400 m (11155 ft) up to and including 4000 m (13123 ft)
"1000": altitude is greater than 4000 m (13123 ft) up to and including 4800 m (15748 ft)
"1001": altitude is greater than 4800 m (15748 ft) up to and including 5600 m (18373 ft)
"1010": altitude is greater than 5600 m (18373 ft) up to and including 6600 m (21654 ft)
"1011": altitude is greater than 6600 m (21654 ft) up to and including 7600 m (24934 ft)
"1100": altitude is greater than 7600 m (24934 ft) up to and including 8800 m (28871 ft)
"1101": altitude is greater than 8800 m (28871 ft) up to and including 10000 m (32808 ft)
"1110": altitude is greater than 10000 m (32808 ft)
"1111": default value if altitude information is not available

c) bits 113 & 114: encoded location freshness or PDF-2 rotating field indicator:
- "00": PDF-2 rotating field indicator,
- "01": encoded location in message is more than 60 seconds old, or the default encoded position is transmitted,
- "10": encoded location in message is greater than 2 seconds and equal to or less than 60 seconds old,
- "11": encoded location in message is current (i.e., the encoded location freshness is less than or equal to 2 seconds);

d) bits 115 to 123: Δ latitude with 4 second resolution:
- bit 115: Δ sign (0 = minus, 1 = plus)
- bit 116 to 119: minutes (0 to 15) in 1 minute increments*
- bits 120 to 123: seconds (0 to 56) in 4 second increments
  (default value of bits 115 to 123 = 1 0000 1111);

e) bits 124 to 132: Δ longitude with 4 second resolution:
- bit 124: Δ sign (0 = minus, 1 = plus)
- bits 125 to 128: minutes (0 to 15) in 1 minute increments*

* Section A3.3.8 defines the coding scheme for the ELT(DT) Location Protocol. For these new beacons the coarse position in PDF-1 is always selected to be as close as possible to the actual position and will have a maximum offset in PDF-2 of +/- 15 minutes.

- bits 129 to 132: seconds (0 to 56) in 4 second increments
  (default value of bits 124 to 132 = 1 0000 1111)

OR when bits 113 and 114 are set to "00";

f) bits 115 to 117: PDF-2 rotating field type
   - 000: aircraft operator 3LD
   - other combinations: spare;

g) bits 118 to 132: when PDF-2 rotating field type is 000, then bits 118 to 132 indicate aircraft operator 3LD*, coded using the Modified Baudot Code in Table A3 (3 letters, each using 5 bits, omitting the most significant bit in Table A3; if there is no 3LD for the aircraft operator, then the 3LD is coded as "ZGA", i.e., bits 115 to 132 are set to 000 10001 01011 11000).

A3.3.8.4 Users should utilize the ELT(DT) Location Test protocol identified with bits 43-66 described in section A3.3.8.1 when testing an ELT(DT).

A3.3.8.5 Cancellation message

In case of alert cancellation, a specific message shall be sent with the following bit assignment:

bits 37 to 40:	4-bit protocol code as defined as 1001;
bits 41 to 42:	2-bits for type of beacon identity;
bits 43 to 66:	24 bits of beacon identification data, or ELT(DT) Location Test protocol;
bits 67 to 75:	fixed sequence "1 11111010";
bits 76 to 85:	fixed sequence "1 111111010";
bits 86 to 106:	BCH-1;
bits 107 to 114:	fixed sequence "00111100";
bits 115 to 123:	fixed sequence "0 1111 0000";
bits 124 to 132:	fixed sequence "0 1111 0000";
bits 133 to 144:	BCH-2.

*3LD is a 3-Letter aircraft operator Designator from the list of "Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services" published by the International Civil Aviation Organization (ICAO) as document 8585.

Figure A11: ELT(DT) Location Protocol

<table>
<tr><td>←1
24→</td><td>25
26</td><td>←27
36→</td><td colspan="2">←37
40→</td><td colspan="6">|←41
85→</td><td>←86
106→</td><td>107
114</td><td colspan="6">←115
132→</td><td>←133
144→</td></tr>
<tr><td></td><td colspan="10">←------------ 61 BITS PDF-1 -------------→</td><td>BCH-1</td><td colspan="7">←-------- 26 BITS PDF-2 --------→</td><td>BCH-2</td></tr>
<tr><td></td><td>2</td><td>10</td><td colspan="2">4</td><td colspan="6">45</td><td>21</td><td>8</td><td colspan="6">18</td><td>12</td></tr>
<tr><td rowspan="4">BIT & FRAME SYNCHRONIZ. PATTERNS</td><td rowspan="4">FORMAT & PROTOCOL FLAG</td><td rowspan="4">COUNTRY CODE</td><td colspan="2">PC</td><td colspan="2">26 BITS IDENTIFICATION DATA</td><td colspan="4">19 BITS
LATITUDE LONGITUDE</td><td rowspan="4">21-BIT BCH ERROR CORRECTING CODE</td><td rowspan="4">SUPPLEMENTARY DATA</td><td colspan="3">Δ LATITUDE</td><td colspan="3">Δ LONGITUDE</td><td rowspan="4">12-BIT BCH ERROR CORRECTING CODE</td></tr>
<tr><td rowspan="2">10</td><td rowspan="2">01</td><td>2</td><td>24</td><td>1</td><td>8</td><td>1</td><td>9</td><td>1</td><td>4</td><td>4</td><td>1</td><td>4</td><td>4</td></tr>
<tr><td>type of beacon identity</td><td>24-bit aircraft address or TAC & serial number or 15-bit aircraft operator designator or ELT(DT) Location Test protocol</td><td>N
S</td><td>DEGREES
0 - 90
(1/2 deg)</td><td>E
W</td><td>DEGREES
0 - 180
(1/2 deg)</td><td>-
+</td><td>MINUTES
0 - 15
(1min)</td><td>SECONDS
0-56
(4s)</td><td>-
+</td><td>MINUTES
0-15
(1min)</td><td>SECONDS
0-56
(4s)</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="4"></td><td colspan="6">or rotating field data (e.g., 3LD)</td></tr>
<tr><td colspan="20">↑ F=1 P=0
Bits 41 and 42 = indication of type of ELT(DT) beacon identity
↑ 107-108 = means of activation
↑ 109-112 = altitude
↑ 113-114 = encoded location freshness or PDF-2 rotating field indicator</td></tr>
<tr><td colspan="20">↓ CANCELLATION MESSAGE ↓</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td><td colspan="2">26 BITS IDENTIFICATION DATA</td><td colspan="4">FIXED SEQUENCE</td><td>BCH-1</td><td>FIXED</td><td colspan="6">FIXED SEQUENCE</td><td>BCH-2</td></tr>
<tr><td colspan="20">↑ F=1 P=0
↑ 67 - 75 = “1 1111 1010”
↑ 76 - 85 = “1 1111 1101 0”
↑ 107 - 114 = “0011 1100”
↑ 115 - 123 = “0 1111 0000”
↑ 124 - 132 = “0 1111 0000”</td></tr>
</table>