
**COSPAS-SARSAT
406 MHz DISTRESS BEACON
TYPE APPROVAL STANDARD**

C/S T.007
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COSPAS-SARSAT 406 MHz DISTRESS BEACON
TYPE APPROVAL STANDARD

History

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1. INTRODUCTION

1.1 Scope

This document defines the Cospas-Sarsat policy on type approval of 406 MHz distress beacons and describes:

- a. the procedure to apply for Cospas-Sarsat type approval of a 406 MHz distress beacon; and
- b. the type approval test methods.

1.2 Reference Documents

- a. Cospas-Sarsat Document C/S T.001, "Specification for Cospas-Sarsat 406 MHz Distress Beacons".
- b. Cospas-Sarsat Document C/S T.008, "Cospas-Sarsat Acceptance of 406 MHz Beacon Type Approval Test Facilities".
- c. Cospas-Sarsat Document C/S T.012, "Cospas-Sarsat 406 MHz Frequency Management Plan".
- d. ITU-R M.633, "Transmission characteristics of a satellite emergency position-indicating radio beacon (satellite EPIRB) system operating through a satellite system in the 406 MHz band".

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2. COSPAS-SARSAT TYPE APPROVAL

2.1 Policy

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

However, to ensure beacon compatibility with Cospas-Sarsat receiving and processing 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. A 406 MHz beacon with an integrated navigation system will be considered as a single integral unit for type approval testing.

Therefore, it is recommended that national authorities and search and rescue agencies require manufacturers to comply with the provisions of this document.

2.2 Testing

The Cospas-Sarsat tests described in this document are limited to ensure that:

- a. beacon signals are compatible with System receiving and processing equipment;
- b. beacons to be deployed do not degrade nominal System performance; and
- c. beacons encoded position data is correct.

These tests will determine if beacons comply with this document, with the "Specification for Cospas-Sarsat 406 MHz Distress Beacons" (C/S T.001), and with the document "Cospas-Sarsat 406 MHz Frequency Management Plan" (C/S T.012).

Tests conducted in beacon manufacturing facilities during development of new beacon models or production unit testing must not cause harmful interference to the operational Cospas-Sarsat system. The level of 406 MHz emissions from beacon manufacturing facilities should be less than -51 dBW in an area immediately external to the manufacturers' facility. The -51 dBW is equivalent to a power flux density of -37.4 dB (W/m²) or a field intensity of -11.6 dB (V/m).

2.3 Type Approval Certificate

A Cospas-Sarsat Type Approval Certificate (see sample in Annex M) will be issued by the Cospas-Sarsat Secretariat, on behalf of the Cospas-Sarsat Council (CSC), to the manufacturer of each 406 MHz distress beacon model that is successfully tested at an accepted Cospas-Sarsat test facility. All manufacturers are encouraged to obtain a Cospas-Sarsat Type Approval Certificate for each of their beacon models. The Secretariat will treat manufacturer's proprietary information in confidence.

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.

The Cospas-Sarsat Type Approval Certificate itself does not authorize the operation or sale of 406 MHz beacons. National type acceptance and/or authorization may be required in countries where the manufacturer intends to distribute beacons.

The Certificate is subject to revocation by the Cospas-Sarsat Council should the beacon type for which it was issued cease to meet the Cospas-Sarsat specification.

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3. TESTING LABORATORIES

3.1 Testing

The tests described in this document consist of a series of laboratory technical tests and an outdoor functional test of the beacon transmitting to the satellite. Manufacturers are encouraged to conduct preliminary laboratory tests on their beacons, but are cautioned not to radiate signals to the satellite. If open air radiation of 406 MHz signals should be necessary, the manufacturer must coordinate and receive approval for the test from the appropriate national or regional MCC. Any such radiation must use the test protocol of the appropriate type and format. For example, test user-location protocol shall be used for testing of beacons intended to be encoded with user-location protocol.

All type approval tests shall be conducted by an accepted test facility unless specifically stated otherwise in this document.

3.2 Cospas-Sarsat Accepted Test Facilities

Certain test facilities are accepted by Cospas-Sarsat to perform Cospas-Sarsat type approval tests, as described in document C/S T.008. Accepted test facilities are entitled to perform tests on any 406 MHz distress beacon for the purpose of having a Cospas-Sarsat Type Approval Certificate issued by the Secretariat. A list of Cospas-Sarsat accepted test facilities is maintained by the Cospas-Sarsat Secretariat.

Following successful testing of a beacon, the technical information listed in section 5 of this document should be submitted to the Cospas-Sarsat Secretariat, so that a Cospas-Sarsat Type Approval Certificate can be issued to the beacon manufacturer.

3.3 Testing of ELT Antennas Separated from Beacons

Although the Cospas-Sarsat type approval policy is to consider only the complete beacon with its antenna (i.e. Cospas-Sarsat does not type approve specific beacon components), this policy is not strictly applicable to ELTs which can be approved for use with different aircraft antennas.

In respect of antenna testing requirements provided in Annex B to this document, testing ELT antenna at a reputable and independent test facility specialised in antenna measurements is acceptable subject to prior agreement by Cospas-Sarsat and provided that the test facility is accredited by recognised standardisation bodies responsible for type approval of electronic and electrical equipment.

In such case, the testing application package shall also include:

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- a. written confirmation by the Cospas-Sarsat Representative of the country where the facility is located (see Annex J) of the independence of the antenna testing facility from the beacon manufacturer;
- b. a letter from the test facility briefly describing their capability in respect of ELT antenna testing to the requirements specified in applicable Cospas-Sarsat documents; and
- c. the reference of the test facility accreditation by recognised standardisation bodies responsible for type approval of electronic and electrical equipment in the facility's country.

In all cases, the testing of the aircraft antenna, as described above, shall be completed with:

- i. VSWR measurement as described at Annex B;
- ii. the calculated EIRP values in the format provided at Tables F-B.1 and F-B.2;
- iii. the calculations for EIRP minimum and maximum at beacon end of operational life ($EIRP_{minEOL}$ and $EIRP_{maxEOL}$) in the format provided at Table F-B.1; and
- iv. satellite qualitative tests using a type approved ELT or the ELT submitted for type approval as described at Annex A and reported as per Appendix A to Annex F.

- END OF SECTION 3 -

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4. COSPAS-SARSAT TESTING PROCEDURE

4.1 Sequence of Events

Typical steps to obtain a Cospas-Sarsat Type Approval Certificate for a new beacon are:

- a. manufacturer develops a beacon;
- b. manufacturer conducts preliminary testing in his laboratory;
- c. manufacturer schedules testing at a Cospas-Sarsat accepted test facility;
- d. test facility conducts¹ type approval tests;
- e. manufacturer and/or test facility (as coordinated by the manufacturer) submits to the Cospas-Sarsat Secretariat the information listed in section 5 of this document;
- f. Secretariat and Cospas-Sarsat Parties review the test results and technical data; and
- g. Cospas-Sarsat Secretariat provides results of review to the manufacturer within approximately 30 days, and if approved, a Cospas-Sarsat Type Approval Certificate is subsequently issued.

4.2 Initial Request

An initial request to a test facility might need to be made several weeks prior to the desired testing date. Since the manufacturer may wish to send a representative to witness the tests and provide assistance in operating the beacon, proper clearances should be made with the test facility well in advance. The manufacturer should be prepared to provide the test facility with:

- a. two beacons for testing purposes;
- b. replacement batteries.

The power output of the test beacons when measured relative to 50 Ohm impedance shall have identical factory settings (aligned to 0.3 dB).

¹ The cost of the testing is to be borne by the manufacturer.

4.3 Test Units

If the beacon has a 121.5 MHz homer, the homer transmitter of the test beacon shall be set to the output power declared by the beacon manufacturer in the application form and tuned to the frequency nearest to 121.5 MHz allowed by the national administration for type approval testing, but under no circumstances should this frequency be greater than 121.65 MHz.

One test unit shall be a fully packaged beacon, similar to the proposed production beacons, operating on its normal power source and equipped with its proper antenna.

The second beacon shall be configured such that the antenna port can be connected to the test equipment by a coaxial cable terminated by a 50-Ohm load. All necessary signal or control devices shall be provided by the beacon manufacturer to simulate nominal operation of all ancillary devices of the beacon, such as external navigation input signals and manual control, in accordance with A.3.7, while in an environmental test chamber. The means to operate these devices in an automated and programmable way shall be also provided by the manufacturer.

The test units shall be coded with the test protocol of appropriate type and format and shall meet the requirements of C/S T.001. It should be noted that:

- a. The test unit subjected to the Cospas-Sarsat tests remains the property of the manufacturer. All information marked as proprietary shall be treated as such.
- b. The organization performing the Cospas-Sarsat tests bears no responsibility for either the manufacturer's personnel or equipment.
- c. The manufacturer shall certify that the units submitted for test contain no hazardous components. The testing organization may choose not to test units that it regards as hazardous.
- d. Test units shall normally stay at the test facility for the full duration of type approval testing, however in situations when modification or repair of the test units is required at the manufacturer's facility, this shall be properly documented by the test facility and reflected in the test report.

If a beacon is to receive certification for several protocol types, means of changing message coding shall be provided by the beacon manufacturer. Alternatively, this can be satisfied with additional test units.

If a beacon is to receive certification for location protocols and non-location protocols, the unit used for the tests listed in section A.2 shall be coded with one of the location protocols.

4.4 Test Conditions

Tests shall be conducted by facilities accepted by Cospas-Sarsat. It is advisable that the manufacturer, or his representative, witness the tests.

The tests shall be carried out on the test beacon with its own power source. Test results shall be presented on the forms shown in Annex F of this document, along with additional graphs as necessary. Tests shall demonstrate compliance with C/S T.001 and comprise the following elements:

- a. operating life and performance measurements at the beacon's minimum specified operating temperature;
- b. performance measurements at room ambient temperature;
- c. performance measurements at the beacon's maximum specified operating temperature;
- d. performance measurements during the thermal gradient;
- e. performance measurements beginning 15 minutes after thermal shock and activation;
- f. antenna measurements; and
- g. a qualitative performance test through the satellite.

At the discretion of the test authority, the manufacturer may be required to replace the batteries between these phases. However, no other modifications to the beacon will be allowed during the test period without a full re-test.

Beacons with multiple operator selectable and / or automatic modes of operation (e.g. voice transceivers, internal GNSS receivers, homers, etc.) shall undergo testing by the manufacturer to determine:

- i. the mode that draws maximum battery energy;
- ii. the modes that exhibit pulse loads greater than in (i) above.

The results of the manufacturer testing shall be included in the technical data submitted to the Cospas-Sarsat Secretariat.

The mode that draws the maximum battery energy shall be tested to the full range of the test requirements by the test laboratory. Operating modes that exhibit a pulse load greater than the mode that draws maximum battery energy shall undergo the operating lifetime at minimum temperature test.

Approved measurement methods are described in Annexes A, B, C, D and E of this document, although other appropriate methods may be used by the testing authority to perform the measurements. These shall be fully documented in a technical report along with the test results.

4.5 Test Configuration

The type approval tests required by Cospas-Sarsat are identical for all types of 406 MHz beacons, with the exception of the tests identified below:

- a. satellite qualitative test (Annex A section A.2.5);
- b. antenna characteristics (Annex A section A.2.6); and
- c. position acquisition time and position accuracy (Annex A section A.3.8.2).

The test configurations for these tests are a function of the beacon type and the operational environments supported by the beacon, as declared by the manufacturer in Annex G. The applicable test configurations for the beacon antenna testing are summarised below in Figure 4.1, while the applicable test configurations for the satellite qualitative test and the position acquisition time and position accuracy test are summarised in Figure 4.2.

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Operational Environment: Beacon used while:		Configuration 1 (Fig: B.4) "Water" ground plane	Configuration 2 (Fig: B.3) Antenna fixed to ground plane	Configuration 3 (Fig: B.2) Beacon sitting on ground plane	Configuration 4 (Fig: B.5) Beacon above ground plane
EPIRB (*)	Floating in water, in safety raft or on deck of vessel	X			X
PLB	On ground and above ground			X	X
PLB	As above plus floating in water	X			X
ELT Survival	On ground and above ground			X	X
ELT Survival	As above plus floating in water	X			X
ELT Auto. Fixed	Fixed ELT with external antenna		X		
ELT	On aircraft with external antenna		X		
Auto. Portable	Outside of aircraft with own antenna attached			X	X
ELT Auto. Deployable	Released with attached antenna, assumed to be self righting in water	X		X (**)	X

* As configurations 1 and 4 cover the two extremes, configuration 3 is not required.

** For possible landing configuration not covered in Test Configuration 1, i.e. upside down.

Figure 4.1: Antenna Test Configuration Requirements

	Operational Environment Bacon Used While	Configuration 5 (see below) Water ground plane	Configuration 6 (see below) Antenna fixed to ground plane	Configuration 7 (see below) Beacon on ground plane*	Configuration 8 (see below) Beacon above ground plane**
EPIRB	Floating in water or on deck or in a safety raft	X		X	X
PLB	On ground and above ground			X	X
PLB	On ground and above ground and floating in water	X		X	X
ELT Survival	On ground and above ground			X	X
ELT Survival	On ground and above ground and floating in water	X		X	X
ELT Auto. Fixed	Fixed ELT with aircraft external antenna			X	
ELT Auto. Portable	In aircraft with an external antenna		X		
	On ground, above ground, or in a safety raft with an integral antenna			X	X
ELT Auto. Deployable	Deployable ELT with attached antenna	X		X	X
Other	As defined in Annex G.1	To be determined by C/S Secretariat	To be determined by C/S Secretariat	To be determined by C/S Secretariat	To be determined by C/S Secretariat

* Configuration 7 is used to represent a beacon; On Ground, On the Deck of a Metal Vessel and on the Floor of a Safety Raft

** Configuration 8 is used to represent a beacon; Above Ground (e.g. Held in the Hand), On the Deck of a Fibreglass or Wooden Vessel and being Held in a Safety Raft

Figure 4.2: Satellite Qualitative Test & Position Acquisition Time and Position Accuracy Test Configuration Requirements

When performing the Satellite Qualitative Test (Annex A section A.2.5) and Position Acquisition Time and Position Accuracy test (Annex A section A.3.8.2), each of the applicable test configurations in figure 4.2 shall be applied, even if the manufacturer states that this beacon will only be used in one configuration. PLB's used near water but not designed to be used in the water shall not be subjected to the Water Ground Plane Test. The test requirements for each configuration are as follows:

Configuration 5 – Water ground plane: The beacon shall be completely submerged in salt water [composition 5% salt solution by weight], activated while submerged, and allowed to float to the surface under its own buoyancy. The beacon shall be maintained at or near the centre of the container for the duration of the test. The container holding the salt water shall be placed on a flat surface in an area with a good all round view of the sky. The container shall be made from a non-conductive material (e.g. plastic) and there shall be at least 10cm of salt water under the base of the beacon when it is floating in the container and at least 10cm of salt water between the beacon and the sides of the container.

Configuration 6 – Antenna fixed to ground plane: The base of the antenna shall be placed in the centre of a thin 50cm ± 2 cm diameter conductive metal disc (made of aluminium or copper) which shall be placed directly on level dry ground (ideally cement, tarmacadam or dirt) in an area with a good all round view of the sky. The beacon itself shall either be placed in a hole under the conductive metal disc or shall be run off at least 3m (from the antenna) to one side of the disc using a coaxial cable.

Configuration 7 – Beacon on ground plane: The beacon shall be placed in the centre of a thin 27cm ± 1 cm diameter conductive metal disc (made of aluminium or copper) which shall be placed directly on level dry ground (ideally cement, tarmacadam or dirt) in an area with a good all round view of the sky, in the orientation described in the manufacturer's instructions.

Configuration 8 – Beacon above ground plane: The beacon shall be placed on an electrically insulating support so that its base is 0.45m ± 5 cm above level dry ground (ideally cement, tarmacadam or dirt) in an area with a good all round view of the sky, in the orientation described in the manufacturer's instructions. The conductive metal disc used in Configuration 7 above shall be removed for this test.

4.6 Test Procedure for Beacon with Operator Controlled Ancillary Devices

A unique test procedure may need to be defined for beacons with operator controlled ancillary devices to characterise the possible impact of these devices on the beacon performance. Such test procedure shall follow the guidelines provided at section A.3.7.2. A typical procedure for a beacon with a voice transceiver is provided at Annex E as an example of the guidelines implementation.

Unique test procedures for beacons with operator controlled ancillary device shall be:

- a. coordinated between the beacon manufacturer and a Cospas-Sarsat type approval facility;
- b. submitted to the Cospas-Sarsat Secretariat for review prior to type approval testing at the Cospas-Sarsat type approval facility; and
- c. approved by the Cospas-Sarsat Parties as appropriate.

- END OF SECTION 4 -

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5. TECHNICAL DATA

Beacon manufacturers are required to provide technical data indicated below as part of their type approval application. This technical data is used to determine the appropriate test configurations and procedures. It is therefore expected that the technical data will be provided to the accepted test facility prior to type approval testing to ensure that appropriate test procedures are used.

The technical data submitted to the Cospas-Sarsat Secretariat shall include the following:

- a. an application form (Annex G) for a Cospas-Sarsat Type Approval Certificate, signed by the Cospas-Sarsat accepted test facility confirming that the beacon was tested in accordance with C/S T.007 and complies with C/S T.001, and signed by the manufacturer to confirm the technical details of the beacon, including:
 - i. the list of operational configurations supported,
 - ii. details of the beacon battery cells and battery pack,
 - iii. details on the special features of the beacon (e.g. homer, strobe light, etc),
 - iv. information on the beacon navigation system where appropriate (i.e. navigation device manufacturer, navigation interface specifications, etc.),
 - v. a description of the beacon self-test characteristics and if applicable, the description of the GNSS Self Test mode and characteristics;
- b. a summary of the beacon and antenna test results, with supporting test data, graphs and tables, as designated in Annexes A, B and F, including:
 - i. satellite qualitative test results as per Appendix A to Annex F,
 - ii. beacon antenna test results as per Appendix B to Annex F,
 - iii. navigation system test results as per Appendix C to Annex F,
 - iv. sample messages generated by the beacon coding software for each coding option applicable to the beacon model as per Appendix D to Annex F;
- c. analysis and calculations from the beacon manufacturer that support the pre-test battery discharge figures required for the operating lifetime at minimum temperature test, as per Table F-E.2;

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- d. for beacons with multiple operator selectable and / or automatic modes of operation (e.g. voice transceivers, internal GNSS receivers, homers, etc.), analysis supported by test results that identifies:
 - i. the operating mode that draws the maximum battery energy,
 - ii. operating modes that have pulse loads greater than in i. above;
- e. beacon operating instructions and a technical data sheet;
- f. brochure and photographs of the beacon, with its antenna deployed whilst in all manufacturer declared configurations (e.g. floating in water, resting on ground, held by operator, etc.);
- g. the technical data sheet for the battery cells used in the beacon and the electric diagram of the beacon's battery pack;
- h. a copy of the beacon label;
- i. the technical data sheet of the reference oscillator, including oscillator type and specifications;
- j. statements and descriptions, complete with diagrams as necessary, to demonstrate that the design:
 - i. provides protection against continuous transmission (see section A.3.4),
 - ii. meets the frequency stability requirements over 5 years (see section A.3.5),
 - iii. provides protection from repetitive self-test mode transmissions (see section A.3.6),
 - iv. ensures that the self-test messages (except for GNSS self-test) have default values encoded in position fields, at all times and irrespectively of the navigation data input, and
 - v. provides protection against erroneous position encoding into the beacon message (see section 4.5.5 of C/S T.001);
- k. a technical description and analysis of the matching network supplied for testing purposes per section A.1, or for cases where a matching network is not required, information shall be provided that confirms that the nominal output impedance of the beacon power amplifier is 50 Ohms and the beacon antenna VSWR measured relative to 50 Ohms is within a ratio of 1.5:1;
- l. for ELT separated antennas, a statement of the beacon manufacturer if they do not want to have their own antenna included on the Secretariat-maintained list of accepted ELT antennas (for antennas of their own design and having their own part number, see Annex K);

- m. the beacon quality assurance plan (see Annex L);
- n. for beacons with an internal GNSS receiver, description of the GNSS receiver operation cycle and its phases, including duration and average battery current measured for each phase;
- o. list and description of all automatic and manually selectable operation modes;
- p. technical data sheets for all external ancillary devices (e.g. external G-switch and other activation devices, remote control panel, audio- and light-indicator, S-VDR memory module etc.), supported with schematic diagrams, indicating electrical connections to the beacon and providing details of power supply; and
- q. for beacon models with several variants, a comprehensive description of differences between these variants.

For separated ELT antennas, the antenna test results requested under (b) above may be replaced by a reference to the proper entry in the Secretariat-maintained list of accepted antennas¹, along with:

- test laboratory VSWR measurements conducted in the appropriate configuration(s), as per Annex B; and
- a completed Table F-B.1 that includes the calculated EIRP levels for each azimuth and elevation, and the calculated maximum and minimum EIRP levels at the end of life taking into account the beacon power and EIRP_{LOSS} figure measured by the test laboratory.

- END OF SECTION 5 -

¹ The measurement of parameters for antennas included in the Secretariat list are kept on file at the Cospas-Sarsat Secretariat and are available upon request.

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6. COSPAS-SARSAT CERTIFICATION

6.1 Approval of Results

To receive a Cospas-Sarsat Type Approval Certificate, a beacon shall have been demonstrated to meet the requirements of C/S T.001. The technical data and test results will be reviewed by the Cospas-Sarsat Secretariat and then, if found satisfactory, submitted to the Cospas-Sarsat Parties for approval. The results of this process will be conveyed to the manufacturer within approximately 30 days.

If the unit is deemed to have passed the tests, the Secretariat will subsequently issue a Cospas-Sarsat Type Approval Certificate on behalf of the Cospas-Sarsat Council. The technical data and test results will be retained on file at the Secretariat.

6.2 Changes to Type Approved Beacons

The manufacturer must advise the Cospas-Sarsat Secretariat (see Annex H) of any changes to the design or production of the beacon or power source, which might affect beacon electrical performance. All tests for demonstrating the performance of modified beacons shall be conducted at a Cospas-Sarsat accepted test facility unless specifically stated otherwise in this document.

The manufacturer shall provide a statement clarifying whether the modification changed the beacon physical characteristics (e.g. weight, dimensions, centre of gravity, floatation characteristics, etc.). If the physical characteristics of the beacon have changed, the manufacturer shall provide photographs of the beacon in its operational configurations and submit an analysis regarding the possible impact on beacon electrical performance.

For minor modifications to the beacon, factory test results provided to the Secretariat by the manufacturer can be considered on a case-by-case basis. These test results will be reviewed by the Secretariat, in consultation with the test facility which conducted the original type approval tests on the beacon, and the manufacturer will be advised if there is a need for further testing.

6.3 Alternative Batteries

Once a beacon incorporating a particular type of battery has been successfully tested at a Cospas-Sarsat test facility and type approved by Cospas-Sarsat, subsequent upgrades to that battery are permitted without further type approval testing at a Cospas-Sarsat test facility, provided the beacon manufacturer demonstrates that the changes do not degrade the performance of the 406 MHz beacon, as described below.

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If a beacon manufacturer wishes to make changes to the type of battery after the beacon has been Cospas-Sarsat type approved, the change notice form in Annex H shall be completed and submitted to the Secretariat, together with factory test data confirming that the substitute battery is at least technically equivalent to that used when the beacon was type approved, and a summary of the required test results provided as per Table F.1.

The Cospas-Sarsat type approval certificate will not be amended to include the alternative battery in such cases, unless the beacon was partially retested at a Cospas-Sarsat type approval test facility.

6.3.1 Batteries Not Used in Beacons Tested at an Approved Facility

The factory tests to be performed on the 406 MHz beacon with a type of battery that has not been used in previous models tested at a Cospas-Sarsat type approval facility shall include:

- a. electrical tests at the three constant temperatures (maximum, minimum and ambient), excluding spurious output, VSWR and self-test (section A.2.1);
- b. thermal shock test (section A.2.2);
- c. operating lifetime at minimum temperature (section A.2.3); and
- d. satellite qualitative test (section A.2.5), in a single configuration only.

The beacon manufacturer shall also submit technical data sheets describing the new battery.

6.3.2 Batteries Used in Two Beacons Tested at an Approved Facility

If the alternative battery has been previously used in at least two beacon models for testing at a Cospas-Sarsat type approval test facility, the factory tests to be performed on the 406 MHz beacon with the alternative batteries shall include:

- a. electrical tests at ambient temperature excluding digital message, digital message generator, modulation, spurious output, VSWR check, self-test mode (section A.2.1);
- b. operating lifetime at minimum temperature, excluding digital message (section A.2.3); and
- c. satellite qualitative test (section A.2.5), in a single configuration only.

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6.4 Internal Navigation Device

6.4.1 Inclusion or Removal of an Internal Navigation Device

A type approved beacon modified to include an internal navigation device shall be completely retested at a facility accepted by Cospas-Sarsat.

In cases of a type approved beacon modified to remove an internal navigation device or new beacon models that have variants both with and without an internal navigation device, the variant with the internal navigation device shall be completely tested at a facility accepted by Cospas-Sarsat. The variant without an internal navigation device shall undergo at a Cospas-Sarsat accepted facility the following testing:

- a. electrical and functional tests at ambient temperatures (section A.2.1), excluding Transmitter Power Output and Transmitted Frequency tests;
- b. the satellite qualitative test, in a single configuration only; and
- c. beacon coding software test, which may also be performed by the beacon manufacturer.

6.4.2 Change to Internal Navigation Device

For changes to the internal navigation device of a type approved beacon which might affect the beacon electrical performance, the tests identified below shall be conducted at a Cospas-Sarsat accepted facility:

- a. position acquisition time and position accuracy (section A.3.8.2); and
- b. satellite qualitative test (section A.2.5).

In addition, the manufacturer shall provide the results and analysis of tests conducted at the manufacturer's facilities that demonstrate that the load on the beacon battery is not greater than the load measured for the approved beacon model prior to the change of the internal navigation device.

If the change of internal navigation device results in higher battery loads, or might affect aspects of the beacon performance other than the position acquisition time and position accuracy, the scope of testing shall be determined by Cospas-Sarsat after reviewing a description of the proposed change provided by the manufacturer.

6.5 Interface to External Navigation Device

6.5.1 Modifications to Include Encoded Position Data from an External Navigation Device

A type approved beacon modified to accept position data from an external navigation device shall be tested with the test protocol of appropriate type and format at a Cospas-Sarsat type approval facility. The tests to be performed shall consist of:

- a. electrical tests at ambient and maximum temperatures but excluding modulation, spurious output, and VSWR check (section A.2.1);
- b. operating lifetime at minimum temperature (section A.2.3);
- c. navigation system test (section A.2.7);
- d. beacon coding software (section A.2.8); and
- e. satellite qualitative test (section A.2.5).

In addition, the beacon manufacturer shall also provide technical data sheets describing the navigation interface unit.

6.5.2 Modifications to Interface to External Navigation Device

For a subsequent change to the beacon navigation interface unit that might affect the beacon electrical performance, the tests identified below shall be conducted at a Cospas-Sarsat accepted facility:

- a. navigation system tests (section A.2.7); and
- b. satellite qualitative tests (section A.2.5).

In addition, the manufacturer shall provide the results and analysis of tests conducted at the manufacturer's facilities that demonstrate that the load on the beacon battery is not greater than the load measured for the approved beacon model prior to the change of the external navigation device.

For a change to the navigation interface that might affect aspects of beacon performance beyond the processing of encoded location information from the external navigation device, the scope of testing will be determined by Cospas-Sarsat after reviewing a description of the proposed changes provided by the manufacturer.

6.6 Changes to Frequency Generation

6.6.1 Minor Changes to Frequency Generation

In the case of oscillator replacement by an identical oscillator (on the basis of oscillator manufacturer data and written assurance) and when no other changes are required to beacon electronics or firmware, or in the case of a change of frequency of the beacon when this is achieved by modification of the oscillator (tuning or replacement of the oscillator crystal by a crystal of the same type) which does not involve significant changes to the oscillator performance, or in the case of a type approved beacon using a frequency synthesiser, the modification of the beacon can be considered as minor.

Factory tests verifying the beacon performance can be accepted after consideration by the Secretariat on a case-by-case basis.

6.6.1.1 In the case of a change of frequency, if the modification of the oscillator is limited to the replacement of the crystal by a crystal of the same type, or tuning the oscillator by the oscillator manufacturer or reprogramming of the frequency synthesiser, the factory testing shall include:

- a. measurement of absolute value of the beacon 406 MHz transmitted carrier frequency at ambient temperature; and
- b. satellite qualitative test (section A.2.5).

6.6.1.2 In the case of oscillator replacement with an identical oscillator¹ and no other changes are required to the beacon electronics, or in the case of a change of frequency if the modification includes changes to circuits external to the frequency oscillator/synthesiser (e.g., an external trimmer), the factory tests shall include:

- a. transmitted frequency (section A.3.2.1) at minimum, ambient and maximum temperature;
- b. thermal shock (section A.2.2) excluding transmitted power and digital message;
- c. frequency stability with temperature gradient (section A.2.4) excluding transmitted power and digital message;
- d. oscillator ageing and MTS analysis (section A.3.5); and
- e. satellite qualitative test (section A.2.5).

¹ For the purpose of the Cospas-Sarsat type approval a replacement oscillator can be considered to be identical to the original oscillator if they have the same circuitry, packaging, physical dimensions and firmware (as applicable) and the replacement reference oscillator has electrical and mechanical parameters that are equal to, or better than, those of the original oscillator.

6.6.1.3 In both cases (6.6.1.1 and 6.6.1.2 above) the technical file shall be submitted to the Secretariat including at least the following:

- a. a change notice form (Annex H) specifying the details of frequency generation change;
- b. the measurement results of required tests; and
- c. a technical data sheet describing the oscillator, including:
 - i. oscillator type,
 - ii. oscillator specifications,
 - iii. assurance of oscillator manufacturer that the specification of the old and new oscillators are identical, except for the frequency, as appropriate, in the form of a detailed statement.

6.6.2 Changes to Frequency Generation which Might Affect Beacon Performance

If the alternative oscillator has different parameters, or alternative technology is used to generate the RF frequency (e.g. frequency synthesis), or additional changes are required to the beacon electronics or firmware, the modified beacon shall be re-tested at a Cospas-Sarsat accepted facility.

The testing shall include:

- a. transmitted frequency (section A.3.2.1) at minimum, ambient and maximum temperature;
- b. thermal shock (section A.2.2);
- c. operating lifetime at minimum temperature (section A.2.3);
- d. frequency stability with temperature gradient (section A.2.4) excluding transmitted power and digital message;
- e. oscillator ageing and MTS analysis (section A.3.5);
- f. recalculation of $EIRP_{EOL\ min/max}$; and
- g. satellite qualitative test (section A.2.5).

The technical data submitted to the Cospas-Sarsat Secretariat shall include at least the following:

- i. a change notice form (Annex H) specifying the details of frequency generation change;
- ii. beacon technical data sheet;

- iii. statement of the specified operating temperature range of the beacon (maximum and minimum temperatures);
- iv. descriptions, complete with diagrams as necessary, to demonstrate that the design meets the long term frequency stability requirement;
- v. the measurement results as specified above; and
- vi. technical data sheet describing the oscillator, including
 - oscillator type,
 - oscillator specifications.

6.7 Alternative Names for a Type Approved Beacon

If a beacon manufacturer wishes to have the type approved beacon designated under alternative names (e.g., agent/distributor's name and model number), Annex I of this document shall be completed and sent to the Secretariat.

6.8 Beacon Hardware or Software Modifications

Any change to the beacon hardware or software which might affect the beacon electrical performance not specifically addressed above shall also be supported by a change notice form (Annex H) and testing as appropriate. The scope of the testing and reporting requirements will be determined by Cospas-Sarsat after a review of the modifications.

In the case of beacon changes that affect the software used to encode the position received from the navigation device into transmitted message, these beacons shall be updated to use the latest location protocol rules and be retested in accordance with A.3.8.

As a minimum all changes must be supported by satellite qualitative tests (A.2.5).

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ANNEXES
TO THE COSPAS-SARSAT
406 MHz DISTRESS BEACON
TYPE APPROVAL STANDARD

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ANNEX A**BEACON MEASUREMENT SPECIFICATIONS****A.1 GENERAL**

The tests required by Cospas-Sarsat for 406 MHz beacon type approval are described in this Annex and Annexes B, C, D and E, giving details on the parameters, defined in C/S T.001, which must be measured during the tests.

All measurements shall be performed with equipment and instrumentation which is in a known state of calibration, and with measurement traceability to National Standards. The measurement accuracy requirements for Cospas-Sarsat accepted test facilities are given in Annex A of C/S T.008. These measurement accuracies may be added to the beacon specification limits of C/S T.001 (thereby allowing a slight extra margin) when considering test results which are near the specification limit.

All measurement methods used by Cospas-Sarsat accepted test facilities (as defined in C/S T.007) must be approved by Cospas-Sarsat to ensure the validity and repeatability of test data.

In general, the test equipment used shall be capable of

- a. measuring the power that would be accepted by the antenna while the power is directed to a 50 Ohm load. An impedance matching network is to be provided for the test period by the beacon manufacturer. The matching network shall present a 50 Ohm impedance to the dummy load and shall present to the beacon power amplifier output the same impedance as would be present if the antenna were in place (the matching network is not required if the beacon power amplifier nominal output impedance is 50 Ohm and the beacon antenna VSWR measured relative to 50 Ohm is within the 1.5:1 ratio);
- b. determining the instantaneous phase of the output signal and making amplitude and timing measurements of the phase waveform;
- c. interpreting the phase modulation to determine the value of the encoded data bits;
- d. measuring the frequency of the output signal;
- e. producing gating signals synchronized with various features of the signal modulation;
- f. maintaining the beacon under test at specified temperatures and temperature gradients while performing all other functions stated;
- g. providing appropriate navigation input signals, if applicable; and
- h. measuring the radiated power level, as described in Annex B.

A suggested sequence for performing the tests described herein is shown in Table F.1 of Annex F, but the tests may be performed in any other convenient sequence. However, it is highly recommended that, when applicable, the tests requiring open air radiation be performed only after successful completion of conductive, non-radiation tests. The test results are to be summarized and reported as shown in Annex F, with appropriate graphs attached as indicated.

A.2 TESTS REQUIRED

A.2.1 Electrical and Functional Tests at Constant Temperature (test no. 1 to 8 in Table F.1)

The tests specified in para. A.3.1 through para. A.3.3 (except A.3.2.2.3, antenna tests) are performed after the beacon under test, while turned off, has stabilized for a minimum of 2 hours at laboratory ambient temperature, at the specified minimum operating temperature, and at the maximum operating temperature. Except for testing in the self-test mode (per paragraph A.3.6), the beacon is then allowed to operate for 15 minutes before measurements are started. The following parameters shall be measured at each of the three constant temperatures:

- a. transmitter power output, per para. A.3.2.2 (except A.3.2.2.3 antenna tests);
- b. digital message, per para. A.3.1.4;
- c. digital message generator, per para. A.3.1.1, A.3.1.2 and A.3.1.3;
- d. modulation, per para. A.3.2.3;
- e. transmitted frequency, per para. A.3.2.1;
- f. spurious output, per para. A.3.2.2.4;
- g. VSWR check, per para. A.3.3; and
- h. self-test mode and GNSS self-test mode (if applicable), per para. A.3.6.

A.2.2 Thermal Shock Test (test no. 9 in Table F.1)

The beacon under test, while turned off, is to stabilize at a selected temperature in its operating range. The beacon is then simultaneously placed into an environment held at 30 degrees C offset from the initial temperature and turned on. The beacon is then allowed to operate for 15 minutes before measurements are started to measure the following parameters:

- a. transmitted frequency, per para. A.3.2.1;
- b. transmitter power output, per para. A.3.2.2.1; and
- c. digital message, per para. A.3.1.4.

Frequency measurements are made continually for two hours. Stability analysis is performed for these frequency samples as in para. A.3.2.1. The 18-sample analysis window of the stability calculations is advanced in time through the period such that each succeeding data set includes the latest frequency sample and drops the earliest one. Power output per para. A.3.2.2.1 and digital message checks per paragraph A.3.1.4 shall also be made continually throughout the two-hour period.

A.2.3 Operating Lifetime at Minimum Temperature (test no. 10 in Table F.1)

The beacon under test is operated at its minimum operating temperature for its rated life. During this period, the following parameters are measured on each transmission:

- a. transmitted frequency, per para. A.3.2.1;
- b. transmitter power output, per para. A.3.2.2.1; and
- c. digital message, per para. A.3.1.4.

The 18-sample analysis window of the stability calculations is advanced in time through the period such that each succeeding data set includes the latest frequency sample and drops the earliest one.

If beacon is intended to be encoded with short or long format messages, this test shall be performed with a long format message. If the beacon includes an internal GNSS receiver, this test shall be performed in an environment that ensures that the GNSS receiver draws the maximum energy from the battery (e.g. ensuring that any GNSS receiver sleep time is minimised over the test duration).

The operational lifetime test is intended to establish, with reasonable confidence, that the beacon will function at its minimum operating temperature for its rated life using a battery that has reached its expiration date¹. To accomplish this, the lifetime test of a beacon with its circuits powered from the beacon battery prior to beacon activation shall be performed with a fresh battery pack which has been discharged to take into account:

- i. the depletion in battery power resulting from normal battery loss of energy due to battery ageing over the rated life of the battery pack;
- ii. the average current drain resulting from constant operation of the circuits powered from the beacon battery prior to beacon activation over the rated life of the battery pack;
- iii. the number of self-tests, as recommended by the beacon manufacturer and, when the function is included, the maximum number and maximum duration of GNSS self test

¹ The beacon manufacturer shall provide data necessary to discharge a fresh battery pack at room temperature to account for current drain over the battery pack rated life time. The battery discharge figures provided by the beacon manufacturer shall be verified by the testing laboratory with measurement results reported in Table F-E.1.

transmissions, over the rated life of the battery pack (the beacon manufacturer shall substantiate the method(s) used to determine the corresponding current drain(s)); and

- iv. a correction coefficient of 1.65 applied to item (ii) and item (iii) to account for differences between battery to battery, beacon to beacon and the possibility of exceeding the battery replacement time.

After the battery pack has been appropriately discharged, the beacon is tested at its minimum operating temperature for its rated life as indicated above. Discharge of the battery may be replaced by the equivalent extension of the operating lifetime test.

Measurements shall start after soaking of beacon at minimum temperature for 2 hours, upon beacon activation, without allowing a beacon warm-up. However, compliance to medium-term frequency stability requirements is applicable only for measurements taken 15 minutes after beacon activation, in accordance with C/S T.001 section 2.3.1.

If applicable, homer transmitter characteristics, including homer frequency, peak power level and transmitter duty cycle shall be measured during the lifetime test at least in the beginning and at the end of the test and the results recorded in Table F.1.

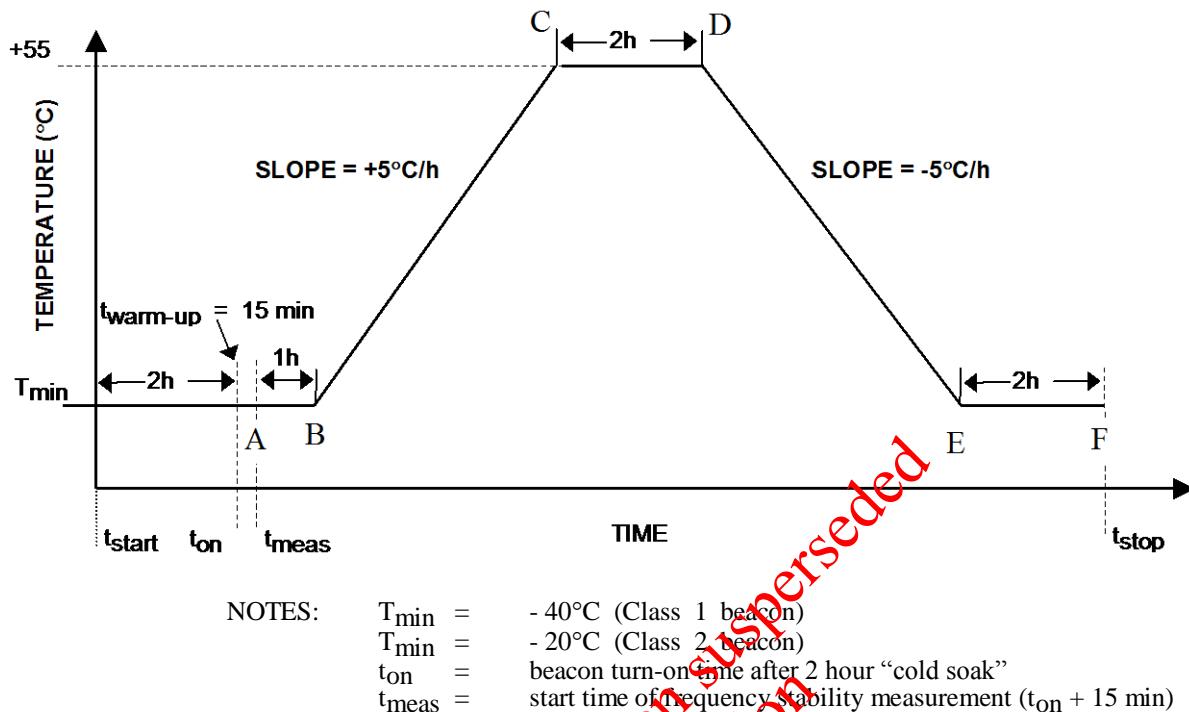
A.2.4 Frequency Stability Test with Temperature Gradient (test no. 11 in Table F.1)

The beacon under test, while turned off, is to stabilize for 2 hours at the minimum specified operating temperature. It is then turned on and subjected to temperature gradient specified in Figure A.1, during which time the following tests are performed continually on each burst:

- a. transmitted frequency, per para. A.3.2.1;
- b. transmitter power output, per para. A.3.2.2.1; and
- c. digital message, per para. A.3.1.4.

The 18-sample analysis window of the stability calculations is advanced in time through the period such that each succeeding data set includes the latest frequency sample and drops the earliest one. A 15-minute warm-up is allowed at the beginning of the test, after which measurements shall start.

When a battery replacement is required, two separate tests shall be performed. The up-ramp test is from t_{start} to point D (see Figure A.1) and the down-ramp test is from point C to t_{stop} . Before point C of the down-ramp, the beacon under test, while turned off, is to stabilize for 2 hours at +55°C and is then turned on and allowed a 15 minute warm-up period.

Figure A.1: Temperature Gradient Test Profile**Table A.1: Medium-Term Frequency Stability Requirements During Temperature Gradient Test**

Points in Figure A.1	Requirements	
	Mean Slope, $\times 10^{-9}/\text{min}$	Residual frequency variation, $\times 10^{-9}$
During warm-up	No Requirement	No Requirements
A to B	-1.0 to +1.0	≤ 3.0
B to C+15 minutes	-2.0 to +2.0	
C+15 minutes to D	-1.0 to +1.0	
D to E+15 minutes	-2.0 to +2.0	
E+15 minutes to F	-1.0 to +1.0	

A.2.5 Satellite Qualitative Test (test no. 14 in Table F.1)

This test is to be performed only in coordination with the cognizant Cospas-Sarsat Mission Control Centre (MCC) and local authorities. The beacon should operate in its nominal configuration, if possible. However, if the beacon includes a homing transmitter operating on a distress frequency (e.g. 121.5 MHz or 243 MHz), this transmitter may need to be disabled or offset from the distress frequency for this test, as per the national requirements of the test facility.

This test shall be performed in environment(s) which approximate, as closely as practicable, the intended use of the beacon. Required test configurations are shown in Figure 4.2 and are dependant on the manufacturer's declaration of Operational Configurations in Annex G.

The test beacon shall have its own antenna connected and shall be coded with a test protocol of appropriate type and format (see sections 4.3 and A.3.1.4). The beacon shall be turned on for 15 minutes prior to the start of this test and then operated in the open for at least 5 LEOSAR satellite passes characterised by cross track angles between 1 and 21 degrees, and with bursts that bracket the satellite time of closest approach (TCA) to the beacon.

The pass/fail criteria are as follows:

- a. LEOLUT solutions producing the correct beacon 15 hexadecimal identification must be provided for all satellite passes with cross track angles between 1 and 21 degrees; and
- b. at least 80% of the LEOLUT Doppler locations, associated with satellite passes with cross track angles between 1 and 21 degrees and with bursts that bracket TCA, must be accurate to within 5 km.

Successful completion of this test shall be indicated by a “V” in Table F.1, and a “Satellite Qualitative Test Summary Report (Appendix A to Annex F) shall be provided for each operational configuration tested. The “Satellite Qualitative Test Summary Reports” shall indicate all LEOSAR satellite passes with cross track angles between 1 and 21 degrees for the period of the testing, even if a solution was not produced by the LEOLUT.

Photos of the beacon with the antenna deployed shall be included in the report for all tested configurations.

A.2.6 Beacon Antenna Test (test no. 15 in Table F.1)

The beacon antenna test, described in section A.3.2.2.3 and Annex B, shall be performed at the ambient temperature of the test facility and a correction factor shall be applied to the data to calculate the radiated power at minimum temperature at the end of the operating lifetime. This test shall be performed using the non-modified test beacon, including the navigation antenna, if applicable. For all tested configurations, photos of the test set-up shall be included in the report.

A.2.7 Navigation System Test, if Applicable (test no. 17 in Table F.1)

For beacons incorporating the optional capability to transmit encoded position data, some additional tests, described in section A.3.8, are required to verify the beacon output message, including the correct position data, BCH error-correcting code(s), default values, and update rates, if applicable. With the exception of the Position Data Encoding test (A.3.8.7) the navigation input system shall be operating for the duration of all tests to ensure that it does not affect the 406 MHz signal and that the beacon can operate for the required operating lifetime. The beacon output digital message shall be monitored during all tests, as described in section A.3.1.4.

If the beacon has a homer transmitter or ancillary devices, the transmitter shall be operated and all ancillary devices shall be active for all navigation system tests.

Please note:

- a. navigation tests shall be performed for one variant of each of the declared User-Location, Standard Location and National Location protocols;
- b. simulators shall not be used to replicate signals from GNSS satellites, unless stated otherwise;
- c. in the case of beacons that interface with external navigation devices, a simulated data stream provided in the format/protocol of the navigation interface may be used in lieu of an actual GNSS receiver; and
- d. when GNSS simulators are used, the peak level of a simulated navigation signal (per simulated satellite) shall be no higher than -123 dBm for all tests, except the Position Acquisition Time and Position Accuracy test, for which the peak level of a signal (per simulated satellite) shall be set to no higher than – 130 dBm.

A.2.8 Beacon Coding Software (test no. 16 in Table F.1)

The digital message for each beacon message protocol supported by the beacon shall be verified at ambient temperature according to A.3.1.4. This test shall evaluate both the real and self-test modes for each beacon message protocol. For the purpose of validating specific beacon message protocols, the beacon shall be programmed in accordance with the guidance provided at Annex C.

For location protocols, verification of 2 messages with encoded position data is required, the second message shall be provided with encoded position at least 500 metres from the first position for the National and Standard location protocols or 10 km for the User-Location protocol. The verification of the digital message does not require a change of location of the beacon.

The content of the complete digital message for both operational and self-test transmissions (including bits 1-24) shall be included in the test report as per Appendix D to Annex F.

This test can be conducted either by the test laboratory or by the beacon manufacturer. If performed by the beacon manufacturer, the manufacturer shall provide the test laboratory with the required test results for verification and inclusion in the test report. The test laboratory shall annotate Table F.1 with a “tick”, if all beacon messages for all protocols are compliant with Cospas-Sarsat requirements.

Type approval will not be granted to beacons using the short format variants of location protocols.

A.2.9 Testing Beacons Designed to Transmit Short or Long Format Messages

If a beacon is designed to allow encoding with either long format or short format messages, all tests shall be performed using long format message. In addition, beacon encoded with a short format message shall be subjected to:

- a. Electrical and Functional tests (as per A.2.1) at ambient temperature, excluding Transmitter Power Output, Spurious Output, VSWR check and Transmitted Frequency tests; and
- b. Beacon Coding Software test.

A.3 MEASUREMENT METHODS

A.3.1 Message Format and Structure

The repetition period T_R and the duration of the unmodulated carrier T_1 are illustrated in Figure A.2. (Note: many of the following measurements can be performed on the same set of 18 bursts).

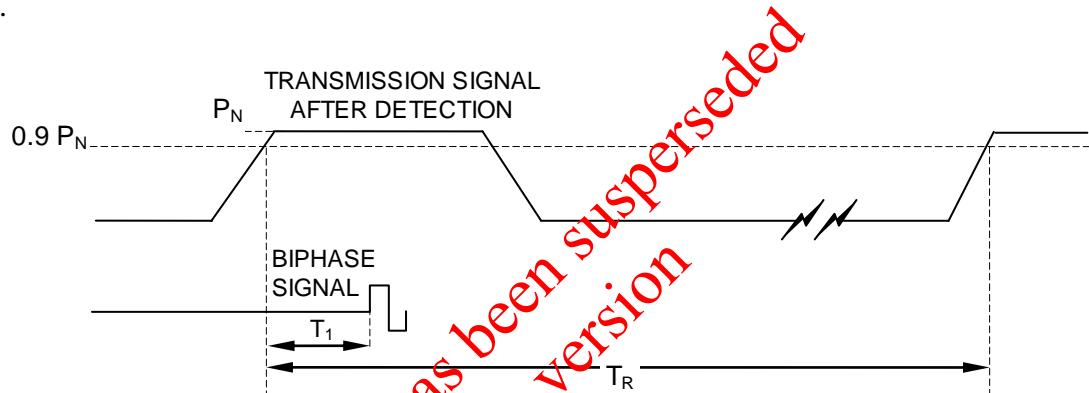


Figure A.2: Transmission Timing

A.3.1.1 Repetition Period

The repetition period, T_R , between the beginnings of two successive transmissions (see Figure A.2) shall be randomised over the range of 47.5 to 52.5 seconds. 18 successive measurements shall be made and the difference between the maximum and minimum repetition periods shall be more than 4 seconds. The average repetition period shall be $50\text{s} \pm 1.5\text{s}$. The standard deviation of the 18 values of T_R shall be between 0.5 and 2.0 seconds. The minimum value of T_R observed shall be between 47.5 and 48.0 seconds, the maximum value of T_R observed shall be between 52.0 and 52.5 seconds. The standard deviation, average, maximum and minimum values of T_R shall be recorded in Table F.1.

In the event that the testing does not demonstrate conformance to the minimum or maximum T_R requirements, the test may be repeated a maximum of three times. If the test is repeated, the results for each shall be recorded in Table F.1.

A.3.1.2 Duration of the Unmodulated Carrier

The unmodulated carrier duration, T_1 , between the beginning of a transmission and the beginning of the data modulation (see Figure A.2) shall satisfy the following requirement, where the values are derived from 18 successive measurements:

$$158.4 \text{ ms} \leq T_1 \leq 161.6 \text{ ms}$$

The maximum and minimum values of T_1 are to be recorded in Table F.1.

A.3.1.3 Bit Rate and Stability

The bit rate, f_b , in bits per second (bps) which is measured over at least the first 15 bits of one transmission, shall satisfy the following requirement, where the values of f_b are provided from 18 successive measurements:

$$396 \text{ bps} \leq f_b \leq 404 \text{ bps}$$

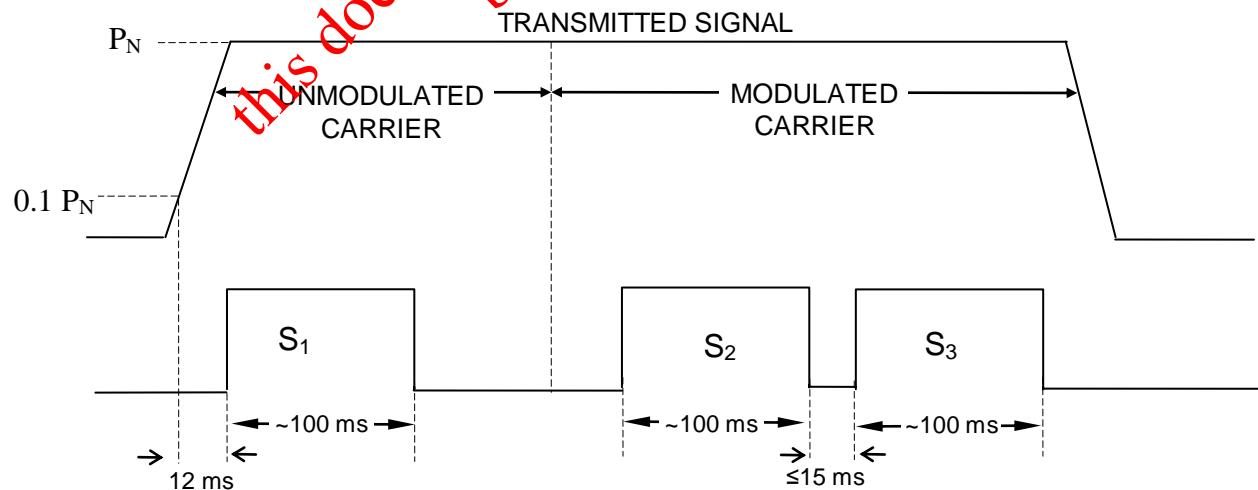
The maximum and minimum values of f_b are to be recorded in Table F.1.

A.3.1.4 Message Coding

The content of the demodulated digital message shall be checked for validity and compliance with the format for each data field, bit by bit, and the BCH error correcting code(s) shall be checked for correctness.

The content of the digital message shall be monitored during all tests. Note that protocols that support encoded location information (e.g. User-Location, Standard Location and National Location) shall only be used in beacons that are designed to accept location information from a navigation system.

A.3.2 Modulator and 406 MHz Transmitter



The S_1 pulse starts 12 ms after the beginning of the unmodulated carrier.

The S_2 pulse starts at the beginning of bit 23.

The S_3 pulse starts not later than 15 ms after the end of S_2 .

Figure A.3: Definition of Measurement Intervals

A.3.2.1 Transmitted Frequency

Frequency measurements shall be made during each transmission, either directly at 406 MHz or at a stable downconverted frequency, during various intervals of approximately 100 milliseconds, as shown in Figure A.3.

The various frequency and frequency stability computations defined hereunder can all be made using data collected from the same set of 18 transmissions.

A.3.2.1.1 Nominal Value

The mean transmission frequency, f_0 , shall be determined from 18 measurements of $f_i^{(1)}$ made during the interval S_1 during 18 successive transmissions, as follows:

$$f_0 = f^{(1)} = \frac{1}{n} \sum_{i=1}^n f_i^{(1)}$$

where $n=18$

A.3.2.1.2 Short-Term Stability

The short-term frequency stability shall be derived from measurements¹ of $f_i^{(2)}$ and $f_i^{(3)}$ made during the intervals S_2 and S_3 during 18 successive transmissions, as follows:

$$\sigma_{100ms} = \left\{ \frac{1}{2n} \sum_{i=1}^n \left(\frac{f_i^{(2)} - f_i^{(3)}}{f_i^{(2)}} \right)^2 \right\}^{1/2}$$

where $n=18$

The above relationship corresponds to the Allan variance. The measurement conditions used here are different (i.e. dead time between two measurements). Experience, however, has shown that the results obtained are very close to those achieved under the normal measurement conditions for the Allan variance.

A.3.2.1.3 Medium-Term Stability

The medium-term frequency stability shall be derived from measurements of $f_i^{(2)}$ made over 18 successive transmissions at instants t_i (see Figure A.4).

¹ To correctly measure the short-term frequency stability, it is essential that an equal number of positive and negative phase transitions are included in the gating intervals defined as S_2 and S_3 in Figure A.3, hence these intervals are only approximately 100 ms duration.

For a set of n measurements¹, the medium-term frequency stability is defined by the mean slope of the least-squares straight line and the residual frequency variation about that line.

The mean slope is given by:

$$A(t_n) = \frac{n \sum_{i=1}^n t_i f_i - \sum_{i=1}^n t_i \sum_{i=1}^n f_i}{n \sum_{i=1}^n t_i^2 - \left(\sum_{i=1}^n t_i \right)^2}$$

where n=18

The ordinate at the origin of the least-squares straight line is given by:

$$B = \frac{\sum_{i=1}^n f_i \sum_{i=1}^n t_i^2 - \sum_{i=1}^n t_i \sum_{i=1}^n f_i}{n \sum_{i=1}^n t_i^2 - \left(\sum_{i=1}^n t_i \right)^2}$$

where n=18

The residual frequency variation is given by:

$$\sigma(t_n) = \left\{ \frac{1}{n} \sum_{i=1}^n (f_i - At_i - B)^2 \right\}^{1/2}$$

where n=18

¹

With a transmission repetition period of approximately 50 seconds, there will be 18 measurements during an approximate 15 minute period (i.e. n=18). The time reference for this group of 18 measurements is to be taken as the time of the last measurement in the group, (i.e. t_n). When reporting results of the medium-term frequency stability, the values of calculated mean slope (A) and residual frequency variation (σ) shall be divided by the value of the mean transmission frequency (f_0), defined in section A.3.2.1.1.

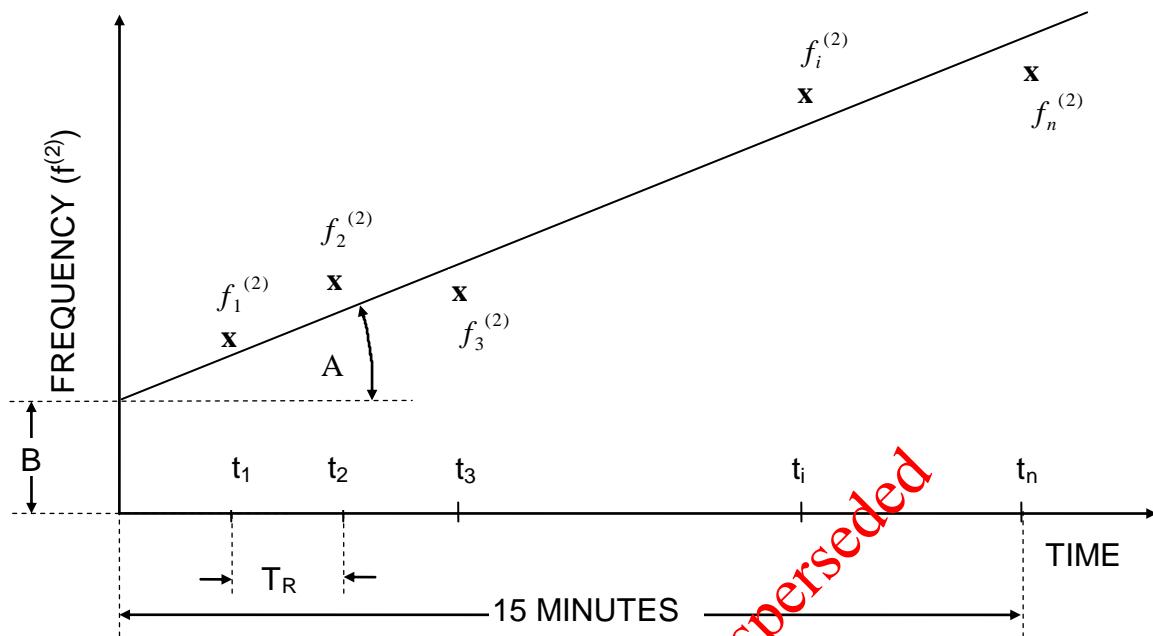


Figure A.4: Medium-Term Frequency Stability Measurement (not to scale)

A.3.2.2 Transmitter Power Output

A.3.2.2.1 Transmitter Power Output Level

The transmitter power output level shall be measured at the transmitter output. During output power measurement, the antenna shall be replaced by a dummy load that presents to the transmitter an impedance equal to that of the antenna under normal operation conditions. The RF losses of any impedance matching network which is connected to the beacon only for test purposes shall be accounted for in the power output measurement.

The minimum and maximum values of transmitter output power measured over the full test interval shall be reported in Table F.1.

A.3.2.2.2 Transmitter Power Output Rise Time

The transmitter power output rise time may be determined on an oscilloscope by measuring the rise time of the burst envelope from the 10% power point to the 90% power point.

The power output level, measured 1 millisecond before the 10% power point, shall be less than -10 dBm. (Note: this can be measured using a spectrum analyzer in its "zero span" mode, with a wide resolution bandwidth (e.g. ≥ 3 kHz), with the beacon output signal activating the video trigger to start a sweep).

A.3.2.2.3 Antenna Characteristics

The antenna characteristics test procedure is given in Annex B of this document. Successful completion of these tests is sufficient to show that the beacon meets the antenna and radiated output requirements for Cospas-Sarsat Type Approval. Alternative procedures may also be used to provide equivalent information, but these procedures must be agreed by the Cospas-Sarsat Secretariat in advance.

For antennas tested separately from beacons, either the procedures of Annex B (with “Beacon Under Test” replaced by “Antenna Under Test” where appropriate), or equivalent conventional antenna range test procedures may be used to demonstrate the antenna radiation pattern. In any case, the test results shall demonstrate that the antenna, when receiving an input power level of 37 dBm produces an EIRP within the limits 34 dBm to 41 dBm for at least 90 % of the measurement coordinates of Annex B, except for Figure B.5 configuration, in which it shall produce EIRP within the limits 32 dBm to 41 dBm for at least 80 % of the measurement coordinates.

A.3.2.2.4 Spurious Output

This measurement shall be performed with the beacon operating into 50 Ohms. The resolution bandwidth for the measurement of the spurious emission levels shall be 100 Hz or less. If this measurement is made on a spectrum analyzer, the spectrum analyzer display shall be used on a maximum hold for a period which is long enough to integrate the entire frequency spectral response. The 406 MHz beacon type approval test report shall include spectral plots depicting the complete 406.0 MHz to 406.1 MHz band.

A.3.2.3 Modulation

The modulation sense, the modulation index, the modulation rise and fall times, and the modulation symmetry of the bi-phase demodulated signal may be checked with an oscilloscope.

The modulation rise and fall times, t_R and t_F , and the modulation symmetry are defined in C/S T.001.

The modulation characteristics measurement¹ shall be performed during the first 15 bits of the modulated portion of the transmission and average values determined for the positive and negative phase deviations. It is recommended to display or monitor the complete demodulated transmission.

¹ Any overshoot observed in the modulation index (as illustrated in Figure 2.5 of C/S T.001) can be disregarded if its amplitude does not exceed 10% of the specification limit and its duration does not exceed 10% of a half-bit period.

This means that the overshoot can be ignored if the absolute value of the modulation index remains within these limits. That is, the modulation index may go out of the specification limits (1.0 to 1.2 radians) momentarily following the phase transition, provided the absolute value of the modulation index remains between 0.90 radians and 1.32 radians (1.0 - 10% and 1.2 + 10%), and returns to the normal specification in less than 0.125 ms (10% of the half-bit period of 1.25 ms) after it departed from those limits. Any overshoots shall be analysed by the test laboratory and a statement regarding whether they can be disregarded shall be provided as comments to items 4 or 7 of Table F.1.

The minimum and maximum values of the modulation index and modulation rise and fall times shall be reported in Table F.1.

A.3.3 Voltage Standing-Wave Ratio

The transmitter shall be operated into an open circuit for a minimum period of 5 minutes, and then into a short circuit for a minimum period of 5 minutes. Afterwards, the transmitter shall be operated into a load having a VSWR of 3:1 (pure resistive load $R < 50$ Ohm i.e. $R=17$ Ohm), during which time the following parameters shall be measured:

- a. transmitter nominal frequency, as per para. A.3.2.1.1;
- b. digital message content, as per para. A.3.1.4; and
- c. the modulation parameters, as per para. A.3.2.3.

This sequence of transmitter loads and measurements shall be performed at maximum, minimum and ambient temperatures.

A.3.4 Protection against Continuous Transmission

If possible, the protection against continuous transmission shall be checked by inducing a continuous transmission from the beacon under test. However, if the beacon manufacturer has determined that this test is not feasible for his beacon, he must provide a technical explanation which demonstrates that his design complies with the specification.

A.3.5 Oscillator Aging

Long-term frequency stability shall be demonstrated by data (e.g. oscillator manufacturer's test data) provided by the beacon manufacturer to the test facility.

For oscillators which require compensation over the operating temperature range, measurement results and a technical analysis shall be provided to substantiate that the medium-term stability would remain within specification after five years ^{1,2}.

¹ The requirement can be addressed for example by measuring the medium-term stability on a batch of oscillators over a period of at least 6 months and extrapolating the results over 5 years. This can be achieved by testing a batch of at least 20 oscillators which should be measured every 4 to 6 weeks over a period of at least 6 months. The change in the medium-term slope and residual components should be calculated for each oscillator in a batch. The extrapolated results for at least 90% of the oscillators tested shall meet the performance requirements of the document C/S T.007. It is expected that any oscillator variants will be separately tested unless the manufacturer can demonstrate that they are technically equivalent to the tested oscillator.

² The test facility shall perform and report the results of the technical analysis to determine compliance of 406 MHz beacons equipped with a TCXO with Cospas-Sarsat type approval requirements, per C/S IP (TCXO).

A.3.6 Self-test Mode

The manufacturer shall provide a list of the parameters that are monitored in the self-test mode (see Annex G). If a GNSS self-test is also provided for, this shall be noted and any additional parameters included.

Self-test operation shall not cause any operational mode transmissions. The duration of the 406 MHz burst shall be measured, the frame synchronization pattern shall be checked and, if applicable, the encoded location checked for correct default code.

In addition, if a GNSS self-test mode is provided, the encoded location shall be checked against the known location to the accuracy defined in C/S T.001 paragraph 4.5.5.3 for the applicable protocols. The format flag bit shall be reported. The self-test mode(s) shall be tested to verify that any transmission is limited to one self-test burst only. If a GNSS self-test is provided for, it shall be verified that inadvertent activation of this mode is precluded.

The GNSS self-test mode shall be tested at ambient temperature to verify that:

- a. inadvertent activation of GNSS self-test mode is precluded;
- b. it is limited in duration (all location protocol beacons) and number of GNSS self-test transmissions (beacons with internal navigation devices powered by primary battery only),
- c. a distinct indication of successful completion or failure of the GNSS self-test is provided, and
- d. a separate distinct indication that the limited number of GNSS self-test attempts has been attained is provided.

For beacons with interface to external navigation device or for beacons that have an internal GNSS receiver that is capable for independent operation, the self-test mode test at ambient temperature shall be performed as follows. During the test, a navigation signal shall be provided and sufficient time shall be allowed for position acquisition to be obtained by an internal GNSS receiver or for position data to be acquired from the external navigation device, prior to initiating a self-test.

Design data shall be provided on protection against repetitive self-test mode transmissions.

A.3.7 Ancillary Electrical Devices in the Beacon

It is recommended that all graphs and tables which make reference to beacon burst characteristics be annotated in a manner that identifies the times at which ancillary devices are in operation, or when operating modes are changed.

A.3.7.1 Automatically Controlled Ancillary Devices

Automatically controlled ancillary devices in the beacon (e.g. homing transmitter, Search and Rescue Radar Transponder (SART), strobe light, etc.) must be operating for the duration of the tests in the laboratory to ensure that they do not affect the 406 MHz signal and that the battery can operate the full load for the required operating lifetime. (Note that

for beacon tests through the satellite, any homing transmitter may need to be turned off or offset from the distress frequency, as per the national requirements of the test facility.)

A.3.7.2 Operator Controlled Ancillary Devices

Type approval testing of beacons with ancillary devices under operator control shall be designed to confirm that the ancillary devices do not degrade beacon transmission characteristics, including frequency stability, timing, and modulation. This may be accomplished by causing the ancillary devices that are under operator control to be activated periodically during the measurement of these characteristics.

The timing of the periodic activation of ancillary devices shall be such that the instants of activation and deactivation occur over the full range of times relative to the beacon transmission burst, with the intent of detecting any effects of the activations or deactivations on the signal characteristics. The activation-deactivation regime shall be carried out for selected intervals spaced out over the duration of the long term tests (i.e. thermal shock, temperature gradient) to characterise the performance of the beacon over the entire range of operating conditions.

The test procedure shall include the operating life tests with the ancillary devices set in the operating mode that draws maximum battery energy. During this test the activation deactivation regime shall be carried out at suitable intervals. An example of test procedure for a beacon with an operator controlled voice transceiver function is provided at Annex E.

A.3.8 Navigation System (if applicable)

Except for the position data encoding test (section A.3.8.7), the navigation input system must be operating for the duration of all tests to ensure that it does not affect the 406 MHz signal and that the beacon can operate for the required operating lifetime. For a beacon operating with an external navigation device, navigation data input shall be provided in the same way as it would be by an operational navigation device.

All the tests specified below shall be performed at ambient temperature. A check for valid BCH code shall be performed throughout these tests, and any examples where the encoded BCH was not correct shall be specifically identified in the test report and an annotation provided at item 17 of Table F.1.

A.3.8.1 Position Data Default Values

If valid navigation data is not available in the beacon memory at the time the beacon transmits a 406 MHz message, the message shall contain default values for position data bits as specified in C/S T.001. To test this, ensure that no navigation input is present for at least 4 hours and 5 minutes (i.e. remove the appropriate navigation signal or navigation data input to the beacon), then activate and operate the test beacon for 30 minutes. Verify that the default values for position data are present in the digital message throughout this period. Deactivate the beacon. Record the results with a pass/fail indication at item 17 of Table F.1.

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A.3.8.2 Position Acquisition Time and Position Accuracy

A.3.8.2.1 At a known location, apply the appropriate navigation signal or navigation data input to the beacon. Activate the beacon and verify that the position is acquired and entered in the digital message within the specified time interval (1 min for external navigation device, 10 min for internal navigation device). Check that the encoded data is correct within 500 metres for beacons with Standard or National Location protocols or 5.25 km for beacons with User-Location protocols. Deactivate the beacon.

A.3.8.2.2 Change navigation data input or the navigation signal (by using GNSS RF simulator or by moving the beacon) by more than 5 km with respect to the position of A.3.8.2.1. Activate the beacon and verify that the new position is acquired and encoded into the digital message within the specified time interval (1 min for external navigation device, 10 min for internal navigation device). Check that the encoded data is correct within 500 metres for beacons with Standard or National Location protocols or 5.25 km for beacons with User-Location protocols. Deactivate the beacon.

Record the results to A.3.8.2.1 and A.3.8.2.2 with a pass/fail indication at item 17 of Table F.1, and the measured values in Table F-C.4 or Table F-C.5 as appropriate. If the test had to be repeated because initial test results failed to meet requirements, the failed tests shall also be reported and an explanation for the failure included in the report. In such circumstances the tests shall be repeated and reported at least 5 times in the configuration that failed.

In the case of beacons with internal navigation devices:

- a. test A.3.8.2.1 shall be conducted at a location where the beacon has clear visibility to the available GNSS satellites; and
- b. tests A.3.8.2.1 and A.3.8.2.2 shall be conducted with the beacon in all the configurations required by Figure 4.2 as applicable per the manufacturer's declaration of Operational Configurations in Annex G.

A.3.8.3 Encoded Position Data Update Interval

If the beacon is capable of updating the encoded position data, apply the appropriate navigation signal or navigation data input to the beacon which should cause the encoded position data to update and verify that the beacon does not update the digital message within 5 minutes after the time of the last update. For beacons with internal navigation devices, the test can be performed either by changing the beacon position or with a GNSS RF simulator to emulate the GNSS satellite downlinks. Verify that the beacon updates the digital message in accordance with the manufacturer's design. If the beacon design does not allow encoded position data updates, verify that the encoded position data in the digital message does not change when the appropriate navigation signal, or navigation data input to the beacon, are applied. Record the first measured position data update interval at item 17 of Table F.1.

This test can be conducted in a configuration determined between the beacon manufacturer and the test laboratory. Unlike A.3.8.2.1 and A.3.8.2.2 this test does not have to be repeated for each operational configuration.

A.3.8.4 Position Clearance after Deactivation

After the test A.3.8.3 deactivate and reactivate the beacon, with no navigation signal or navigation data input to the beacon, to verify that the previous position data has been cleared and that the correct default values are encoded in the message. Record the results with a pass/fail indication at item 17 of Table F.1.

A.3.8.5 Position Data Input Update Interval

If a beacon is designed to accept position data from an external navigation device prior to beacon activation, navigation data input should be provided and stored in the beacon memory at intervals not longer than 20 minutes for EPIRBs and PLBs, or 1 minute for ELTs. To test this:

- a. Deactivate the beacon, change the initial position data, allow for the appropriate time interval (between 20 min and 30 min for EPIRBs and PLBs or between 1 min and 1.5 min for ELTs) for the changed position to be accepted. Remove the navigation data input to the beacon and allow the stored position to be kept in the beacon memory for between 19 min 50 sec and 20 minutes (for EPIRBs or PLBs), or for between 50 sec and 1 minute (for ELTs). Activate the beacon. Verify that the encoded position data is correct and corresponds to the changed position.
- b. Deactivate the beacon, change the initial position data and remove the navigation data input to the beacon. Allow for the appropriate time interval (between 20 and 30 min for EPIRBs and PLBs or between 1 and 1.5 min for ELTs) for the stored position to be cleared. Activate the beacon. Verify that the location fields of the message are encoded with default values.

For beacons with internal navigation devices, a GNSS RF simulator may be used to simulate the GNSS satellite downlinks. Identify in Table F.1 the applicable time intervals for this test, and record the results with a pass/fail indication at item 17 of Table F.1.

A.3.8.6 Last Valid Position

Remove the appropriate navigation signals or the navigation input and verify that the last valid position data before the loss of navigation signal is retained in the 406 MHz beacon digital message for 4 hours (± 5 min) from the last valid position data input. Check that position data has been cleared and that the correct default values are encoded in the message after 4 hours (± 5 min). Identify in Table F.1 the duration for which the last valid position data continued to be transmitted by the beacon, and also that the correct default values were transmitted afterwards.

A.3.8.7 Position Data Encoding¹

This test is conducted by substituting the output of the navigation device with test scripts which replicate the location information provided in Table D.1 for the User-Location protocol, Table D.2 for the Standard Location Protocol, and Table D.3 for the National Location protocol.

For beacons supporting multiple types of data interfaces with an external navigation device, this test shall be performed for each external interface variant. Only the highest data stream baud rate shall be tested.

This test may be conducted either by the test laboratory or the manufacturer. The results shall be provided in the formal report as per Appendix C to Annex F. The test laboratory shall annotate Table F.1 with “√” if the beacon performed as required for all the scripts tested.

- END OF ANNEX A

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¹

Beacons submitted for type approval testing prior to 1 November 2010 using the location protocol coding system as defined in A.3.3.1 of document T.001, Issue 3 Revision 8 (November 2007) are to use Annex D and Appendix C to Annex F of document T.007 Issue 4 Rev.2 (November 2007) for this test.

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ANNEX B

ANTENNA CHARACTERISTICS

B.1 SCOPE

This Annex describes the measurement procedure to verify the antenna characteristics of 406 MHz distress beacons defined in document C/S T.001. Alternative procedures, including the use of a shielded anechoic room, are acceptable if they provide equivalent information and have minimal impact on Cospas-Sarsat operations.

B.2 GENERAL TEST CONFIGURATION

B.2.1 The antenna characteristics of the Beacon Under Test (BUT) shall be measured in an open field test site or a shielded anechoic room. In accordance with the guidance provided at Section 4.5, the beacon shall be tested in configuration(s) that simulate the ground conditions in which the beacon might be expected to operate.

A measuring antenna located at a horizontal distance of 3 metres from the BUT shall be used to measure the emitted field strength. In order to make measurements at all the required azimuths the BUT will have to be rotated through 360°, and to make measurements at the required elevation angles the measuring antenna will have to be moved vertically. The BUT shall be equipped with a fresh battery and the test shall be performed at ambient temperature.

B.2.2 Prior to each open field test site transmission, the appropriate national authorities responsible for Cospas-Sarsat and radio emissions shall be notified.

In order to keep the potential disturbance to the Cospas-Sarsat System to a minimum, these antenna tests shall be conducted using a beacon operating at its nominal repetition rate and coded with the test protocol of the appropriate type and format. Transmission of any continuous wave (CW) signal from a signal generator in the 406.0 - 406.1 MHz band is strictly forbidden.

B.3 TEST SITE

B.3.1 The test site shall be an area clear of any obstruction such as trees, bushes or metal fences within an elliptical boundary of dimensions shown in Figure B.1. Objects outside this boundary may still affect the measurements and care shall be taken to choose a site as far as possible from large objects or metallic objects of any kind.

B.3.2 The terrain at an outdoor test site shall be flat. Any conducting object inside the area of the ellipse shall be limited to dimensions less than 7 cm. A metal ground plane or wire mesh enclosing at least the area of the ellipse and keeping the same major and minor axis as indicated in Figure B.1 is preferred (indicated as ground plane "A" in figures B.2 through B.5). If this is not practical then a surface of homogeneous good soil (not

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sand or rock) is satisfactory. All electrical wires and cables shall be run underground or under the ground plane. The antenna cable shall be extended behind the measuring antenna along the major axis of the test site for a distance of at least 1.5 metres from the dipole elements before being routed down to ground level.

B.3.3 All precautions shall be taken to ensure that reflections from surrounding structures are minimized. No personnel shall be within 6 metres of the BUT during actual measurements. Test reports shall include a detailed description of the test environment. Reports shall specifically indicate what precautions were taken to minimize reflections.

B.3.4 Weather protection enclosures may be constructed either partially or entirely over the site. Fibreglass, plastics, treated wood or fabric are suitable materials for construction of an enclosure. Alternatively, the use of an anechoic enclosure is acceptable.

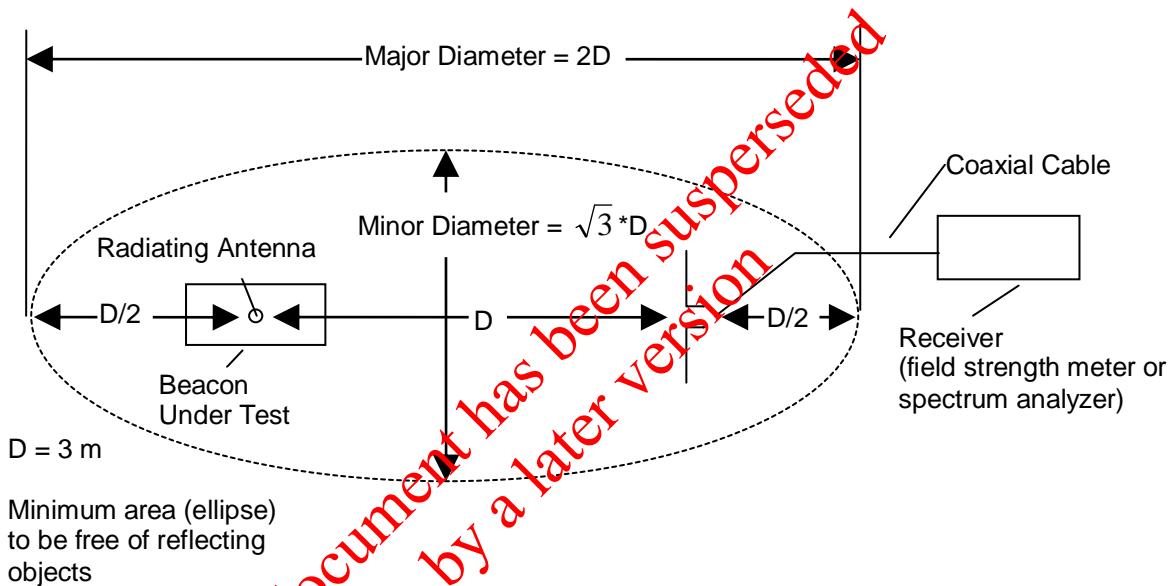


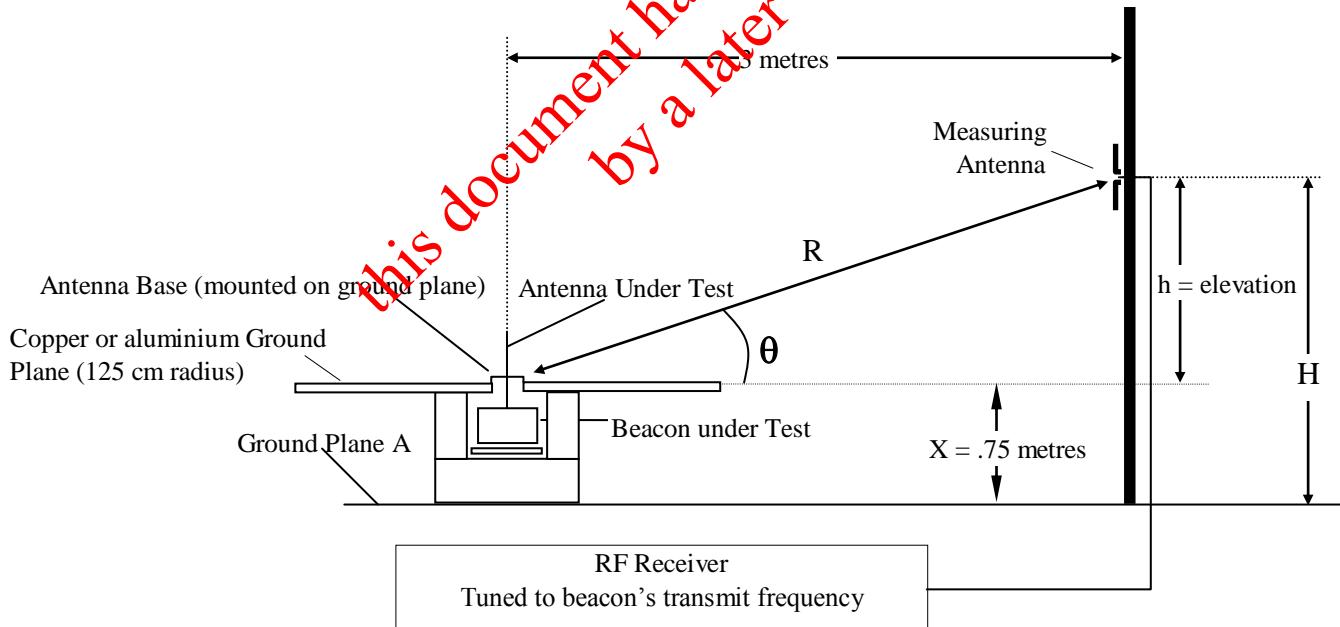
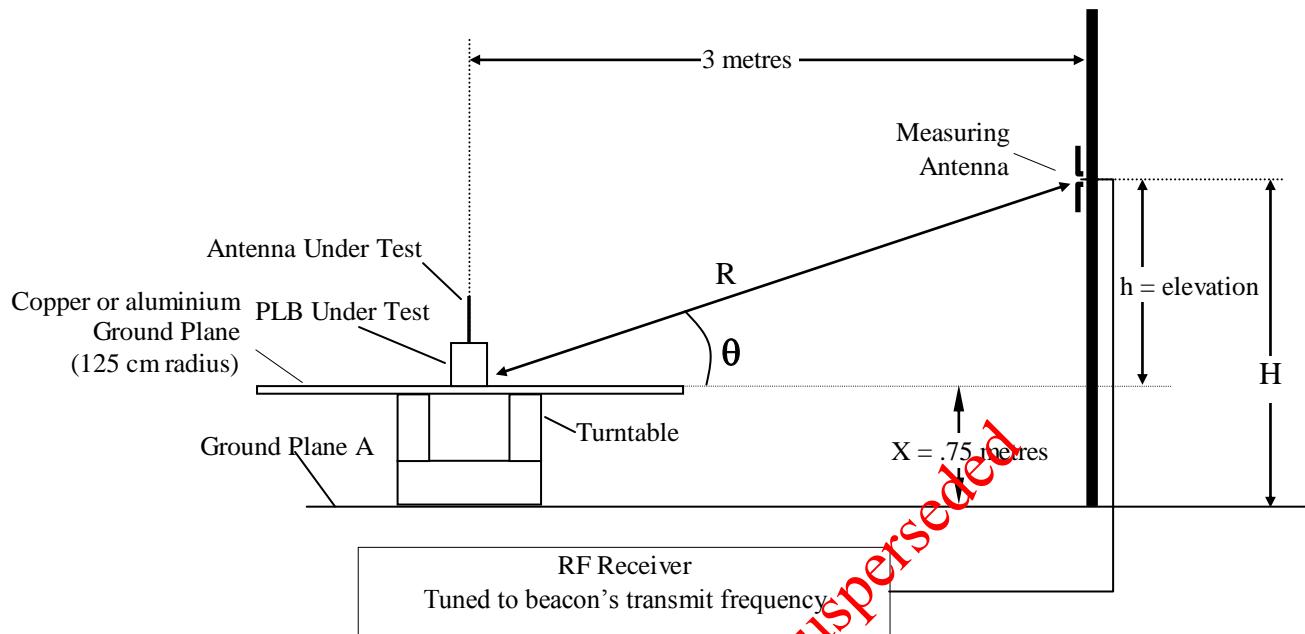
Figure B.1: Test Site Plan View

B.4 GROUND PLANE AND BEACON INSTALLATION

B.4.1 In accordance with the guidance provided at Section 4.5 the beacon shall be tested in the configurations that simulate the ground conditions in which the beacon might be expected to operate (see Figure 4.1). Descriptions of the test configurations are provided at Figures B.2 through B.5.

B.4.2 The applicable ground plane configurations, as described in Figures B.2 through B.5, will be decided by Cospas-Sarsat on the basis of technical considerations relevant to the beacon operation and information provided by the manufacturer. If there is any doubt in respect of the test configurations that must be tested, the beacon manufacturer and the type approval facility shall contact the Cospas-Sarsat Secretariat prior to the start of testing.

**Figure B.2: Test Configuration for “PLB-like” Devices
(e.g. PLB, survival ELT, automatic portable ELT)**



**Figure B.3: Test Configuration for “Fixed ELT-like” Devices
(i.e. beacon with an antenna designed to be mounted on a metal surface)**

**Figure B.4: Test Configuration for “EPIRB-like” Devices
(i.e. beacons designed to operate while floating in water)**

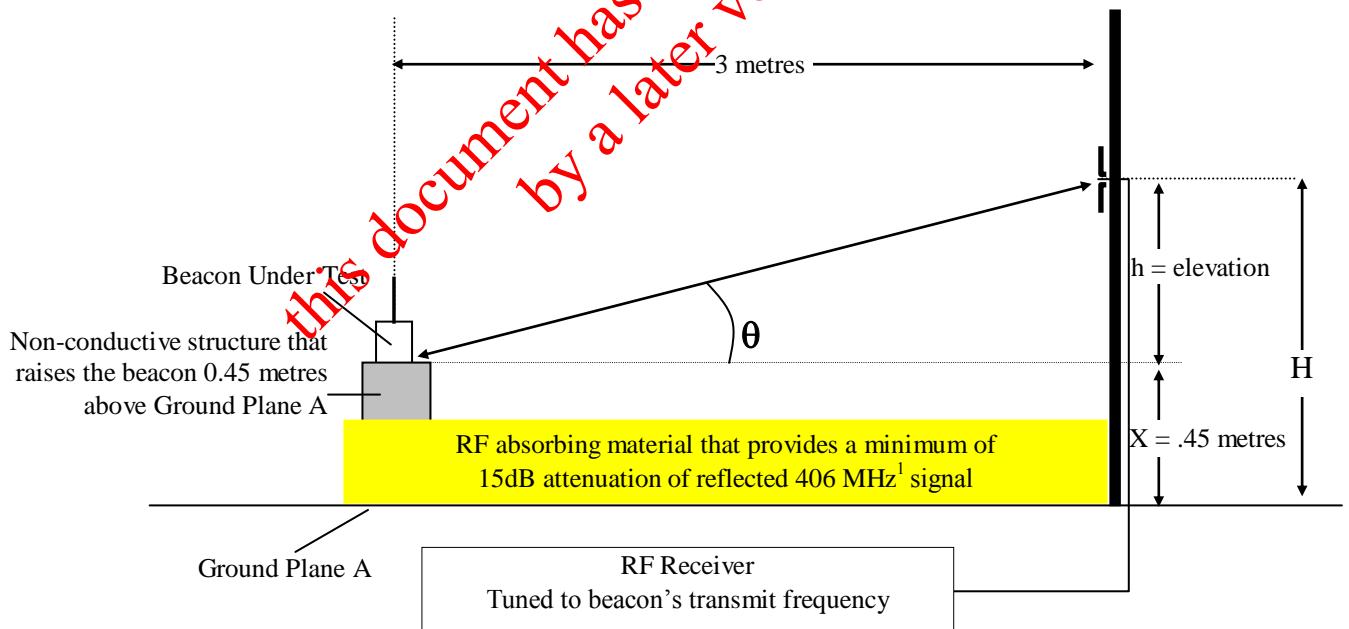
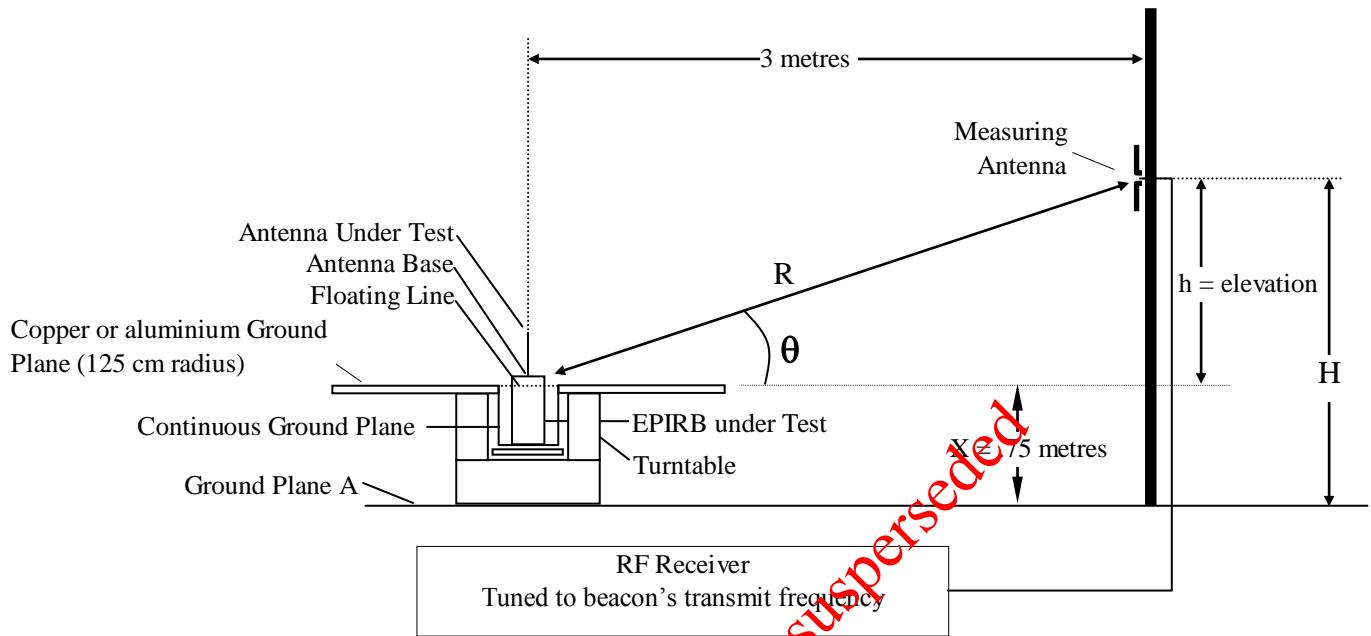
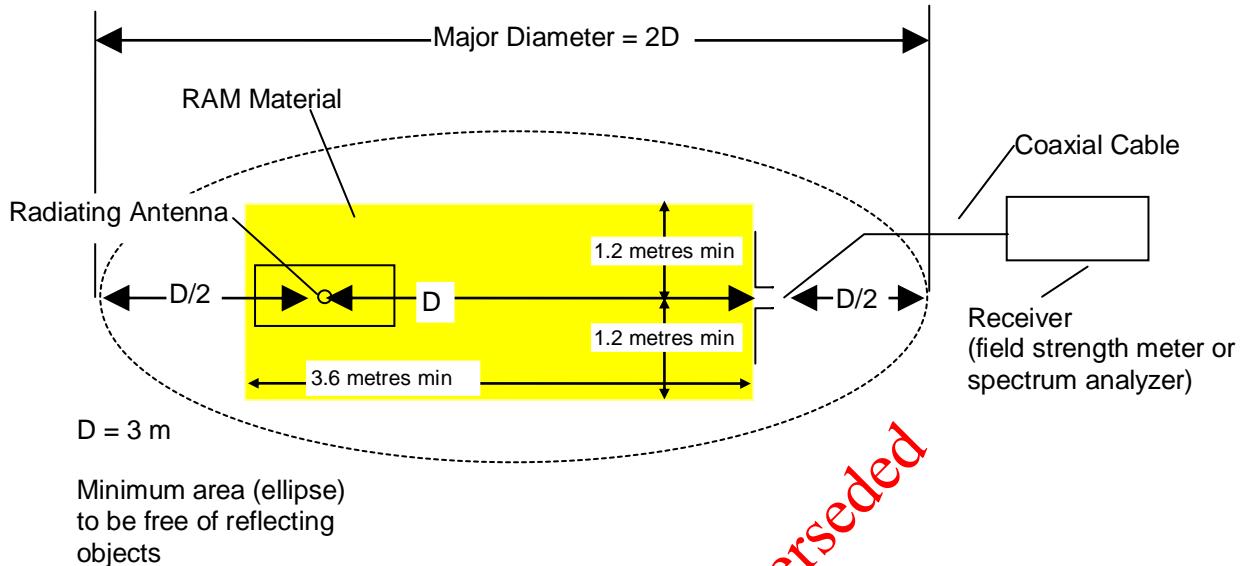


Figure B.5: Additional Test Configuration for all Devices that Might be Required to Operate Without a Ground Plane

¹ The dimensions of the RF absorbing material: minimum length of 3.6 metres, minimum width of 2.4 metres and equally spaced either side of the major axis “D” (see Figures B.1 and B.6), maximum height of 0.4 metres.

Figure B.6: Test Site Plan View with RAM Material

B.5 MEASURING ANTENNA

B.5.1 The radiated field of the BUT antenna shall be detected and measured using a tuned dipole. This dipole antenna shall be positioned at a horizontal distance of 3 metres from the BUT antenna and mounted on a non-conducting vertical mast that permits the height of the measuring antenna to be varied sufficiently to measure the beacon EIRP at elevation angles ranging from 10 to 50 degrees.

Referring to Figures B.2 through B.5, the height at which the measuring antenna must be elevated on the supporting mast for a specific elevation angle θ is calculated as follows:

$$h = 3 (\tan \theta) \text{ metres}$$

and

$$H = h + X$$

where,

X is the reference height (0.45 metres or 0.75 metres depending upon the test configuration)

h^1 is the height of the measuring antenna relative to the reference height X ,

θ is the desired angle of elevation as indicated on Figures B.2 through B.5 (at reference height X),

H is the height of the measuring antenna above the ground plane A.

¹ The centre of the measuring dipole antenna is used as the reference to determine its height.

B.5.2 As the measuring antenna is vertically elevated, the distance (R) between the BUT antenna and the measuring antenna increases. The distance (R) is a function of the elevation angle (θ) and it is calculated as follows:

$$R = \frac{3}{\cos \theta} \text{ metres}$$

B.5.3 The antenna factor (AF) of the measuring antenna at 406 MHz must be known. This factor is normally provided by the manufacturer of the dipole antenna or from the latest antenna calibration data. It is used to convert the induced voltage measurement into electric field strength.

B.5.4 Since the value of AF depends on the direction of propagation of the received wave relative to the orientation of the receiving antenna, the measuring dipole should be maintained perpendicular to the direction of propagation. In order to minimize errors during measurement, it is recommended to adopt this practice (Figure B.7). If the measuring antenna cannot be maintained perpendicular to the direction of propagation (Figure B.8), a correction factor must be considered due to the gain variation pattern of the measuring antenna. For a dipole, the corrected antenna factor (AF_c) is calculated as follows:

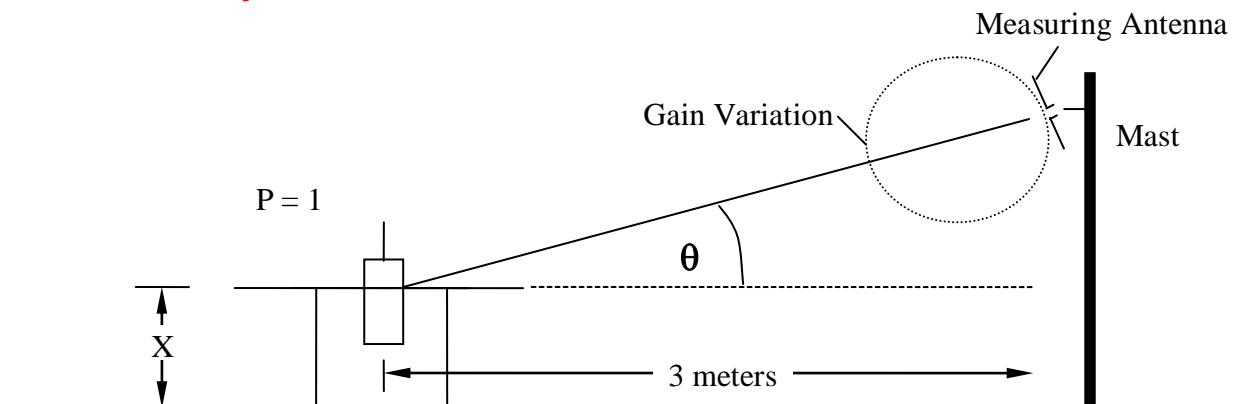
$$AF_c = \frac{AF}{P}$$

and

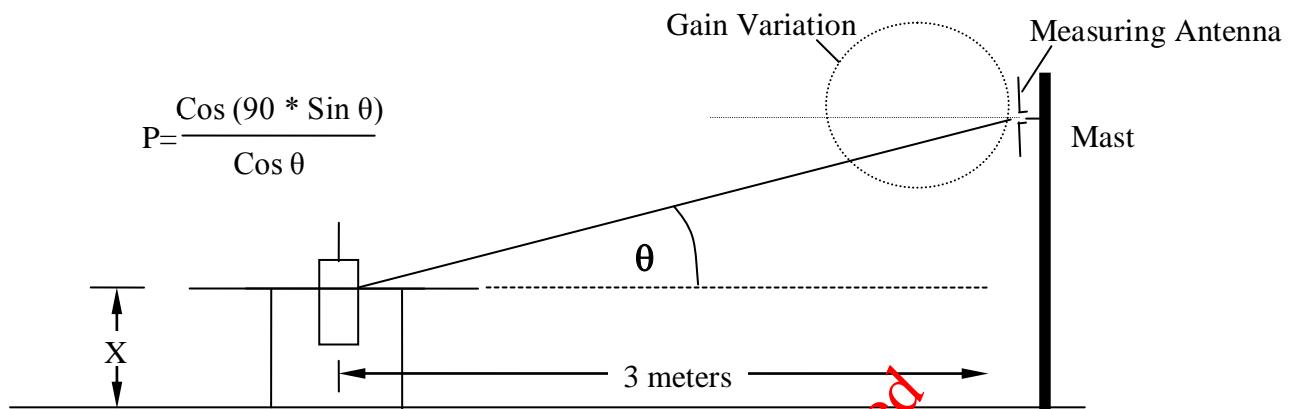
$$P = \frac{\cos (90^\circ - \sin \theta)}{\cos \theta}$$

where: AF is the antenna factor from paragraph B.5.3,
 θ is the elevation angle,
 P^1 is the correction factor for the dipole antenna pattern.

Figure B.7: Measuring Antenna Perpendicular to the Direction of Propagation



¹ The correction factor (P) is equal to 1 when the measuring antenna elements are maintained perpendicular to the direction of propagation. P is therefore equal to 1 when the measuring antenna is horizontally polarized at any elevation angle. The correction factor applies only to vertically polarized measurements.

Figure B.8: Measuring Antenna NOT Perpendicular to the Direction of Propagation**B.6 BEACON TRANSMITTING ANTENNA**

The BUT antenna may have been designed to transmit signals in the 406.0 – 406.1 MHz frequency band, and also at 243 MHz and 121.5 MHz, and also to conduct power to a strobe light mounted above the antenna. It is possible that the radiated signal will be composed of an unknown ratio of vertically and horizontally polarized waves. For this reason, consideration shall be given to the type of antenna and its radiated field. The results shall encompass all wave polarizations. The antenna pattern and field strength measurements should provide sufficient data to evaluate the antenna characteristics.

B.7 RADIATED POWER MEASUREMENTS

B.7.1 Prior to each open field test site transmission, the appropriate national authorities responsible for Cospas-Sarsat and radio emissions shall be notified.

B.7.2 The test provides data which characterises the antenna by measuring the vertically and horizontally polarised waves.

B.7.2.1 Measurement Requirements

The BUT shall be transmitting normally with a fresh battery. The signal received by the measuring antenna shall be coupled to a spectrum analyzer or a field strength meter and the radiated power output shall be measured during the beacon transmission. An example of a power measurement made with a spectrum analyzer during the unmodulated portion of a beacon transmission is illustrated in Figure B.9. The receiver shall be calibrated according to the range of levels expected, as described in Section B.8.

Measurements¹ shall be made at the azimuth and elevation angles indicated in the table below.

Test Configurations	Azimuth Angle in Degrees Rotated about the Antenna Axis ($\pm 3^\circ$)	Elevation Angle in Degrees ($\pm 3^\circ$)
Figures B.2, B.3 and B.4	0, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300 and 330	10, 20, 30, 40, 50
Figure B.5	0, 90, 180, 270	10, 20, 30, 40, 50

B.7.2.2 EIRP and Antenna Gain Calculations

The following steps shall be performed for each set of measured voltages and the results recorded:

Step 1: Calculate the total induced voltage V_{rec} in dBV using

$$V_{rec} (\text{dBV}) = 20 \log \sqrt{V_v^2 + V_h^2}$$

where:

V_v and V_h are the induced voltage measurements (in volts) when the measuring antenna is oriented in the vertical and the horizontal plane respectively.

Step 2: Calculate the field strength E in dBV/m at the measuring antenna using

$$E (\text{dBV/m}) = V_{rec} + 20 \log AF_c + L_c$$

where:

V_{rec} is the calculated signal level from Step 1 (dBV)

AF_c is the corrected antenna factor as defined in paragraph B.5.4

L_c is the receiver system² attenuation and cable loss (dB)

Step 3: Calculate the EIRP and the G_i

Using the standard radio wave propagation equation:

$$E (\text{Volts/metre}) = \frac{\sqrt{(30 \times Pt(\text{Watts}) \times Gi)}}{R (\text{metres})}$$

¹ The measuring antenna should be linearly polarized and positioned twice to align with both the vertical and horizontal components of the radiated signal in order to measure the total EIRP as described in section B.7.2.2.

² The receiver system attenuation is compensated for when performing the calibration procedure (section B.8). Otherwise, it shall be calculated separately.

and

$$Pt(\text{Watts}) \times Gi = \text{EIRP}$$

the EIRP for each set of angular coordinates is obtained from

$$\text{EIRP (Watts)} = \frac{E^2 \times R^2}{30}$$

and the antenna gain from

$$Gi = \frac{E^2 \times R^2}{30 \times Pt}$$

where:

R is the distance between the BUT and the measuring dipole antenna calculated in section B.5.2

Pt is the power transmitted into the BUT antenna

Gi is the BUT antenna numerical gain relative to an isotropic antenna

E is the field strength converted from Step 2 into volts/metre

B.8 TEST RECEIVER CALIBRATION

In order to minimize measurement errors due to frequency response, receiver linearity and cable loss, the test receiver (which may be a field strength meter or a spectrum analyzer) shall be calibrated as follows:

- a. Connect the equipment as shown in Figures B.2 through B.5, as appropriate. Install the BUT as described in Section B.4.
- b. Turn on the BUT for normal transmission. Set the receiver bandwidth to measure the power of the transmission. An example using a spectrum analyzer to measure the unmodulated portion of the transmission is illustrated in Figure B.9. The same receiver bandwidth shall be used during the antenna measurement process. Tune the receiver for maximum received signal. Position the measuring antenna in the plane (horizontal or vertical) that gives the greatest received signal. Rotate the BUT antenna and determine an orientation which is representative of the average radiation field strength (not a peak or a null). Record the receiver level.
- c. Disconnect the measuring antenna and feed the calibrated RF source to the receiver through the measuring antenna cable. Adjust the signal source to give the same receiver level recorded in (b) above.
- d. Disconnect the calibrated RF source from the measuring antenna cable and measure its RF output with a power meter.
- e. Reconnect the calibrated RF source to the measuring antenna cable and adjust the gain calibration of the receiver for a reading which is equal to the power.

B.9 ANTENNA POLARIZATION MEASUREMENT

B.9.1 Provide the measured induced voltage in Table F-B.2 (for configurations described in Figures B.2 through B.4) and annotate the results as described in section B.10.2 below. An analysis of the raw data (V_v , V_h) obtained during the antenna test conducted with the beacon in configurations B.2 through B.4 should be sufficient to determine if the polarization of the BUT antenna is linear or circular. There is no requirement to evaluate the sense of polarization for Figure B.5.

B.9.2 If the induced voltage measurements V_v and V_h for at least 80% of all angular coordinates (azimuth, elevation) differ by at least 10 dB, the polarization is deemed to be linear. The polarization shall be declared as vertical or horizontal depending upon whether V_v or V_h is greater.

B.9.3 If more than 20% of the induced voltage measurements (V_v , V_h) are within 10 dB of each other, the BUT antenna is considered to be circularly polarized. Since the sense of the polarization must be right hand circular polarized (RHCP), determine the polarization using the following method and report the results.

Compare the signals received at an elevation angle of 40° for each specified azimuth angle using known right-hand circularly polarized (RHCP) and left-hand circularly-polarized (LHCP) antennas. The circularly polarized antenna that receives the maximum signal obtained from measurements at the required azimuth angles determines the sense of polarization.

B.9.4 In the case of inclined linear beacon antennas, EIRP measurements may be performed directly using a RHCP measuring antenna with known antenna factor at 406 MHz. In this case the requirements of section B.10 shall be directly applied to the EIRP results. If the results are in accordance with C/S T.007 requirements, then the antenna should be accepted regardless of any circularly polarized component of the signal.

B.9.5 Report the measurement results in Table F-B.2.

B.10 ANALYSIS OF RESULTS

B.10.1 Enter the sense of the antenna polarization, determined per Section B.9, into Table F.1.

B.10.2 Provide the measured EIRP levels in Table F-B.1 (for configurations described in Figures B.2 through B.4) and Table F-B.3 (for Figure B.5). Verify that the BUT produces a field equivalent to an EIRP in the ranges indicated in the table below.

Test Configurations	EIRP Required
Figures B.2, B.3, and B.4	32 dBm to 43 dBm ¹ for at least 90% of the measurement points
Figure B.5	30 dBm to 43 dBm for at least 80% of the measurement points

Specifically annotate Table F-B.1, F-B.2 and F-B.3:

- a. with highlighted text, to indicate all the EIRP values that are not within the ranges indicated above;
- b. with stricken-out text, to indicate any EIRP levels that were removed from consideration for calculating the EIRP maximum and minimum values at the end of life; and
- c. with highlighted text, to indicate all induced voltage measurements that are within 10 dB of each other, and with stricken-out text to indicate the measurements that were taken out of consideration.

B.10.3 For the set of measurements identified in Section B.10.2, the overall maximum (EIRP_{max}) and minimum (EIRP_{min}) EIRP values shall be determined.

B.10.4 A power loss factor (EIRP_{LOSS}) shall be determined² to correct for what the power output would be after the beacon had operated at minimum temperature for its operating lifetime. The value of EIRP_{LOSS} shall be entered in Table F.1 and also at Appendix B to Annex F. This value shall be subtracted from the results in Section B.10.3 and entered in Appendix B to Annex F and item 15 of Table F.1 as EIRP_{max EOL} and EIRP_{min EOL}.

B.11 ANTENNA VSWR MEASUREMENT

This section is not applicable to beacons with integral antennas, nor for tests conducted in the configuration described at Figure B.5.

- B.11.1** The antenna VSWR of the BUT shall be measured at the input of the antenna (or the matching network if applicable) using an acceptable VSWR measurement technique, to be described in the test report.
- B.11.2** Numerous precautions are necessary in VSWR measurement to avoid errors due to the effect of nearby conducting objects on the antenna current distribution.

¹ The 32 dBm to 43 dBm limit is calculated from the specifications of Transmitter Power Output (37 dBm \pm 2 dB) and Antenna Gain characteristics (-3 dBi to +4 dBi).

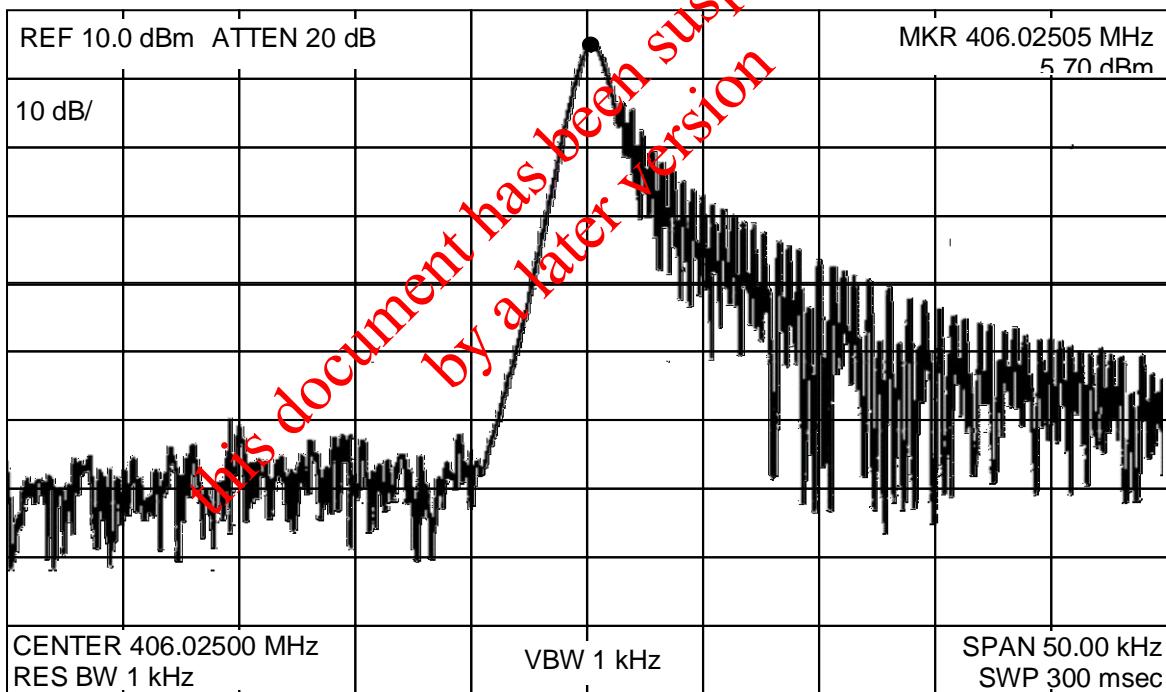
² The loss factor (EIRP_{LOSS}) is defined as the minimum transmitter power measured during the operating lifetime test (at minimum temperature) subtracted from the maximum transmitter power measured at ambient temperature during the transmitted power output test (i.e. EIRP_{LOSS} = Pt_{AMB} – Pt_{EOL}).

B.11.3 The VSWR measurement shall be performed with the BUT mounted in the configurations that were used for the previously described antenna test (i.e. configurations B.2 through B.4 as appropriate).

B.11.4 Report the measured results in Table F.1. The antenna VSWR at the nominal value of the transmitted frequency in the 406.0 – 406.1 MHz frequency band shall not exceed a 1.5:1 ratio.

B.11.5 If the antenna VSWR exceeds the 1.5:1 ratio but remains less than 1.8:1¹ at the nominal operational frequency, and if the antenna EIRP is evaluated by direct measurements² and is within the limits specified in section B.10, the beacon can still be considered as meeting the Cospas-Sarsat requirements. However, in this case, Cospas-Sarsat type approval will be deemed as valid only for the beacon-cable-antenna configuration tested (with specific cable type and length) and the antenna should not be used with any other beacon/cable³ without further type approval testing.

Figure B.9: RF Measurement During Preamble



¹ Provisions of section A.1 in respect of impedance matching network apply.

² In the case when the separated antenna was previously tested for type approval with an ELT, the direct EIRP measurement may be replaced with an analysis showing that the EIRP of the beacon-antenna combination would be within the limits specified in Section B.10.2 of Annex B. The analysis must address the actual measured beacon output power and the impedance mismatch between the beacon and the cable loaded with the ELT antenna.

³ A special tag should be provided on the antenna cable with a warning that the length of the cable should not be changed.

ANNEX C

BEACON CODING TO BE USED FOR EVALUATING BEACON MESSAGE CODING

If the beacon is designed to operate with a protocol that requires any of the following data elements, the values programmed into the beacon for evaluating beacon message coding (Table F.1 item 16) shall be in accordance with Table C.1. Examples of each requested beacon message protocol shall be included in the test report as per Tables F-D.1, F-D.2, and F-D.3.

Table C.1: CODING VALUES FOR BEACON MESSAGE CODING TESTING

Data Element	Value
Format Flag	As required by the specific protocol
Protocol Flag	As required by the specific protocol
Country Code	201
Protocol Code	As required by the specific protocol
MMSI	999999
Radio Call Sign	XPA02
Cospas-Sarsat Type Approval Certificate Number	999
Beacon Serialized Number	60
National 18 bits ID Number (binary)	011100000100011001
RLS 16 bits ID Number (binary) ²	1100000100011001
Any National Use Data Elements	Default values as specified in C/S T.001
Aircraft Registration Marking	C7518
Aircraft Operator Designator and a serial number	AAA500
Aircraft 24-bit Address	11472655 (Base 10 representation)
Specific Beacon	Assume only 1 beacon on vessel or aircraft
Non-Protected Data Field	Default values specified in C/S T.001
Auxiliary Radio Locating Device	As appropriate for the beacon design ¹
Manual / Automatic Activation	As appropriate for the beacon design ¹

- END OF ANNEX C -

¹ In cases where the beacon has several variants (i.e. with and without an automatic activation capability, with and without a 121.5 MHz homer), the report shall provide examples of the coding assuming automatic activation and the 121.5 MHz homer.

² RLS protocols will be effective as of 1 November 2013. The use of RLS-enabled beacons will be regulated by national administrations. Since the RLS functionality might affect the 406 MHz beacon performance, amendments to the type approval procedure for these beacons could be required. Beacon manufacturers should consult the Cospas-Sarsat Secretariat before undertaking the type approval of RLS-enabled beacon models.

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ANNEX D**NAVIGATION SYSTEM TEST SCRIPTS**

This test shall be conducted by inputting (e.g. in the form of NMEA sentences from a PC) the test scripts provided below¹ into the beacon and monitoring the beacon output digital message (ensure that the beacon position data update interval is not modified/reduced during this test in order to reduce test time). The test scenario shall be implemented in the order indicated, and the beacon shall not be turned-off until after all the scenarios have been completed. The procedure shall be completed for each location protocol type (i.e. Standard, National or User) for which type approval is being requested.

The test results shall be reported in the format provided at Tables F-C.1, F-C.2 and F-C.3.

Table D.1: User-Location Protocol Procedure

Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits ²
1. Turn on beacon ensuring that navigation is not provided to the beacon. Record the value of encoded location bits.	Bits 108-132=		Bits 108-132= 0FE0FF0
2. Keeping the beacon active, apply the following navigation data to the beacon: 0° 0 min 59 sec South, 0° 0 min 57 sec West. When the beacon transmitted message changes, record the new encoded location bits and the duration of time the beacon took to update.	Bits 108-132= _____ Number of seconds after providing navigation data that beacon transmitted the above encoded location information: _____		Bits 108-132= 1001000 Response time for beacon to transmit correct encoded location must be less than 52.5 sec.

Beacons submitted for type approval testing prior to 1 November 2010 using the location protocol coding system as defined in A.3.3.1 of document T.001, Issue 3 Revision 8 (November 2007) are to use Annex D and Appendix C to Annex F of document T.007 Issue 4 Rev.2 (November 2007) for this test.

² The hexadecimal values reported in this column are calculated by converting the binary value of the data required by column two into a hexadecimal value, apart from Bit 108 which remains a binary (0 or 1) character, leading zeros must not be suppressed. For example the following bits 0 1100 0011 0000 1111 0110 1001 would be expressed as 0C30F69.

Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits
3. Keeping the beacon active, change the navigation input to the beacon to: 0° 0min 53 sec North, 0° 0min 51 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 108-132=		Bits 108-132= 0000000
4. Keeping the beacon active, change the navigation input to the beacon to: 0° 11min 10 sec North, 179° 47min 7 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 108-132=		Bits 108-132= 0006B3C
5. Keeping the beacon active, change the navigation input to the beacon to: 0° 11min 3 sec South, 179° 46min 0 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 108-132=		Bits 108-132= 1007B3C
6. Keeping the beacon active, change the navigation input to the beacon to: 89° 15min 8 sec South, 89° 0min 1 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 108-132=		Bits 108-132= 1B28590
7. Keeping the beacon active, change the navigation input to the beacon to: 89° 16min 10 sec South, 89° 0min 1 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 108-132=		Bits 108-132= 1B29590

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Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits
8. Keeping the beacon active, change the navigation input to the beacon to: 89° 59min 4 sec North, 179° 59min 54 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 108-132=		Bits 108-132= 0B41B40
9. Keeping the beacon active, change the navigation input to the beacon to: 89° 57min 59 sec North, 179° 59min 24 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 108-132=		Bits 108-132= 0B3CB40
10. Keeping the beacon active, change the navigation input to the beacon to: 36° 30min 0 sec South, 138° 29min 59 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 108-132=		Bits 108-132= 14918A7

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Table D.2: Standard Location Protocol Procedure

Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits ³
1. Turn on beacon ensuring that navigation is not provided to the beacon. Record the value of encoded location bits.	Bits 65-85= _____ Bits 113-132= _____		Bits 65-85= 0FFBFF Bits 113-132= 83E0F
2. Keeping the beacon active, apply the following navigation data to the beacon: 0° 0 min 59 sec South, 0° 0 min 57 sec West. When the beacon transmitted message changes, record the new encoded location bits and the duration of time the beacon took to update.	Bits 65-85= _____ Bits 113-132= _____ Number of seconds after providing navigation data that beacon transmitted the above encoded location information: _____		Bits 65-85= 100400 Bits 113-132= 8420E Response time for beacon to transmit correct encoded location must be less than 52.5 Sec.
3. Keeping the beacon active, change the navigation input to the beacon to: 0° 0 min 53 sec North, 0° 0 min 51 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 65-85= _____ Bits 113-132= _____		Bits 65-85= 000000 Bits 113-132= 8360D
4. Keeping the beacon active, change the navigation input to the beacon to: 0° 11 min 10 sec North, 179° 47 min 7 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 65-85= _____ Bits 113-132= _____		Bits 65-85= 000ACF Bits 113-132= 0F222

³

The hexadecimal values reported in this column are calculated by converting the binary values of the data required by column two into hexadecimal values, as follows: Bits 65-85 hexadecimal apart from Bit 65 which remains a binary (0 or 1) character, leading zeros must not be suppressed. For example the following bits 1 0000 0111 1110 1111 0001 would be expressed as 107EF1. Bits 113-132 all hexadecimal, leading zeros must not be suppressed. For example the following bits 0000 1000 1011 1111 0010 would be expressed as 08BF2.

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Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits
5. Keeping the beacon active, change the navigation input to the beacon to: 0° 34 min 55 sec North, 179° 35 min 59 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 65-85= Bits 113-132=		Bits 65-85= 0012CE Bits 113-132= 93A60
6. Keeping the beacon active, change the navigation input to the beacon to: 0° 11 min 3 sec South, 179° 46 min 0 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 65-85= Bits 113-132=		Bits 65-85= 100ECF Bits 113-132= 0FA10
7. Keeping the beacon active, change the navigation input to the beacon to: 89° 15 min 8 sec South, 89° 0 min 1 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 65-85= Bits 113-132=		Bits 65-85= 1B2964 Bits 113-132= 80A00
8. Keeping the beacon active, change the navigation input to the beacon to: 89° 16 min 10 sec South, 89° 0 min 1 sec West. When the beacon transmitted message changes, record the encoded location bits.	Bits 65-85= Bits 113-132=		Bits 65-85= 1B2D64 Bits 113-132= 84E00

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Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits
9. Keeping the beacon active, change the navigation input to the beacon to: 89° 59 min 4 sec North, 179° 59 min 54 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 65-85= Bits 113-132=		Bits 65-85= 0B46D0 Bits 113-132= 03801
10. Keeping the beacon active, change the navigation input to the beacon to: 89° 57 min 59 sec North, 179° 59 min 24 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 65-85= Bits 113-132=		Bits 65-85= 0B42D0 Bits 113-132= 08009
11. Keeping the beacon active, change the navigation input to the beacon to: 36° 30 min 0 sec South, 138° 29 min 59 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 65-85= Bits 113-132=		Bits 65-85= 14962A Bits 113-132= 80200

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Table D.3: National Location Protocol Procedure

Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits ⁴
1. Turn on beacon ensuring that navigation is not provided to the beacon. Record the value of encoded location bits.	Bits 59-85= _____ Bits 113-126= _____		Bits 59-85= 3F81FE0 Bits 113-126= 27CF
2. Keeping the beacon active, apply the following navigation data to the beacon: 0° 0 min 59 sec South, 0° 0 min 57 sec West. When the beacon transmitted message changes, record the new encoded location bits and the duration of time the beacon took to update.	Bits 59-85= _____ Bits 113-126= _____ Number of seconds after providing navigation data that beacon transmitted the above encoded location information: _____		Bits 59-85= 4002000 Bits 113-126= 284E Response time for beacon to transmit correct encoded location must be less than 52.5 Sec.
3. Keeping the beacon active, change the navigation input to the beacon to: 0° 0 min 53 sec North, 0° 0 min 51 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= _____ Bits 113-126= _____		Bits 59-85= 0000000 Bits 113-126= 26CD
4. Keeping the beacon active, change the navigation input to the beacon to: 0° 11 min 10 sec North, 179° 47 min 7 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= _____ Bits 113-126= _____		Bits 59-85= 0019678 Bits 113-126= 060D

⁴ The hexadecimal values reported in this column are calculated by converting the binary values of the data required by column two into hexadecimal values, as follows: Bits 59-85 hexadecimal apart from Bits 59, 60 and 61 which form a decimal character (0 to 7), leading zeros must not be suppressed. For example the following bits 101 1000 0000 1100 1111 0101 0000 would be expressed as 580CF50. Bits 113-126 hexadecimal apart from Bits 113 and 114 which form a decimal character (0 to 3), leading zeros must not be suppressed. For example the following bits 10 1111 0000 1100 would be expressed as 2F0C.

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Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits
5. Keeping the beacon active, change the navigation input to the beacon to: 0° 10 min 55 sec North, 179° 51 min 1 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= Bits 113-126=		Bits 59-85= 001567A Bits 113-126= 2710
6. Keeping the beacon active, change the navigation input to the beacon to: 0° 11 min 3 sec South, 179° 46 min 0 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= Bits 113-126=		Bits 59-85= 401B677 Bits 113-126= 0740
7. Keeping the beacon active, change the navigation input to the beacon to: 89° 15 min 8 sec South, 89° 0 min 1 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= Bits 113-126=		Bits 59-85= 6CA0B20 Bits 113-126= 06C0
8. Keeping the beacon active, change the navigation input to the beacon to: 89° 16 min 10 sec South, 89° 0 min 1 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= Bits 113-126=		Bits 59-85= 6CA2B20 Bits 113-126= 21C0
9. Keeping the beacon active, change the navigation input to the beacon to: 89° 59 min 4 sec North, 179° 59 min 54 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= Bits 113-126=		Bits 59-85= 2D03680 Bits 113-126= 0701

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Script	Value of Encoded Location Bits Transmitted by Beacon	BCH Correct (✓)	Required Value of Encoded Location Bits
10. Keeping the beacon active, change the navigation input to the beacon to: 89° 57 min 59 sec North, 179° 59 min 24 sec East. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= Bits 113-126=		Bits 59-85= 2CF5680 Bits 113-126= 2009
11. Keeping the beacon active, change the navigation input to the beacon to: 36° 30 min 0 sec South, 138° 29 min 59 sec West. When the beacon transmitted message changes, record the new encoded location bits.	Bits 59-85= Bits 113-126=		Bits 59-85= 523F14F Bits 113-126= 2040

- END OF ANNEX D -

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ANNEX E

SAMPLE PROCEDURE FOR TYPE APPROVAL TESTING OF 406 MHz BEACONS WITH VOICE TRANSCEIVER

The following sample procedure illustrates the guidelines provided in section C/S T.007, section A.3.7.2, concerning the testing of beacons with operator controlled ancillary devices. It is applicable to beacons with operator controlled voice transceivers but may need to be adapted for specific beacon designs. All other aspects of the testing, as documented in C/S T.007 are unchanged.

E.1 Beacon Voice Transceiver Configuration

The following requirements pertain to the configuration of the beacon voice transceiver for the duration of all testing:

- a. if the beacon has a volume control setting, the beacon loudspeaker shall be set to maximum volume and a fully modulated voice carrier from an external RF-generator shall be transmitted in the operational frequency channel;
- b. if the beacon includes a manual squelch mode, this shall be selected, and it shall be set to its most sensitive level;
- c. if the beacon includes different transmitter power levels, the highest level shall be selected; and
- d. any other manual settings shall be set to the mode which creates the highest load on the beacon battery.

E.2 Thermal Shock Test (C/S T.007, section A.2.2)

The beacon transceiver shall be operated as described below for the duration of the thermal shock test:

- a. 5 Seconds (+/- 2.5 Seconds) before the first beacon burst to be measured, the voice transmitter shall transmit for 30 seconds, followed immediately by 30 seconds during which the beacon voice transmitter is not active; the receive mode shall be activated during the 30 seconds following the transmission cycle; this process shall be repeated for 15 minutes; and
- b. thereafter, the transceiver shall be configured to repeat the following cycle, 3 times in succession, once each hour;
 - i. transmit for 30 seconds,

- ii. followed by 30 seconds receiving.

E.3 Operating Lifetime at Minimum Temperature (C/S T.007, section A.2.3)

The beacon transceiver shall be operated as described below, for the duration of this test:

- a. for the first 15 minutes of this test, the transceiver shall be operated as described at paragraph E.2.a above;
- b. 4 hours before the end of the test period the procedure described at paragraph E.2.a above shall be repeated for 15 minutes; and
- c. for the full duration of the test except the periods specified in paragraphs (a) and (b) above, the transceiver shall be operated to drain maximum energy from the battery.

E.4 Frequency Stability Test with Temperature Gradient (C/S T.007, section A.2.4)

The beacon transceiver shall be operated as described below, for the duration of this test:

- a. the transceiver shall be operated as described at paragraph E.2.b above for the duration of the test period; and
- b. in addition, the transceiver shall be operated as described at paragraph E.2.a above for one 15 minute period during which the temperature is rising, and for one 15 minute period during which the temperature is falling.

E.5 Satellite Qualitative Tests (C/S T.007, section A.2.5)

The beacon transceiver shall be operated as described at paragraph E.2.a above for the entire duration that the beacon is in view of the satellite.

E.6 All Other Tests

For all other tests, the beacon transceiver shall be operated as described at paragraph E.2.b above.

ANNEX F

BEACON TYPE APPROVAL TEST RESULTS

Table F.1: Overall Summary of 406 MHz Beacon Test Results

Parameters to be Measured	Range of Specification	Units	Test Results			Comments
			T _{min} (____ °C)	T _{amb} (____ °C)	T _{max} (____ °C)	
1. Transmitter Power Output						
- transmitter power output (min and max)	35-39	dBm				
- power output rise time	< 5	ms				
- power output 1 ms before burst	< -10 dBm	✓ ¹				
2. Digital Message	Bits number					
- bit sync	1-15	15 bits “1”	✓			
- frame sync	16-24	“000101111”	✓			
- format flag	25	1 bit	bit value			
- protocol flag	26	1 bit	bit value			
- Identification / position data	27-85	59 bits	✓			
- BCH code	86-106	21 bits	✓			
- emergency code / nation. use /suppl. data	107-112	6 bits	bit value			
- additional data /BCH (if applicable)		32 bits	✓			
- position error (if applicable)		< 5	km			
3. Digital Message Generator						
- repetition rate T _R :						
○ average T _R	48.5-51.5	sec				
○ min T _R	47.5≤T _R ≤48.0	sec				
○ max T _R	52.0≤T _R ≤52.5	sec				
○ standard deviation	0.5-2.0	sec				
- bit rate:						
○ min f _b	≥ 396	bit/sec				
○ max f _b	≤ 404	bit/sec				
- total transmission time:						
○ short message	435.6-444.4	ms				
○ long message	514.8-525.2	ms				
- unmodulated carrier:						
○ min T ₁	≥ 158.4	ms				
○ max T ₁	≤ 161.6	ms				
- first burst delay		≥ 47.5	sec			

¹ Indicate that testing demonstrated conformance to requirements by placing the ✓ symbol in Table F.1.

Parameters to be Measured	Range of Specification	Units	Test Results			Comments
			T _{min} (____°C)	T _{amb} (____°C)	T _{max} (____°C)	
4. Modulation						
- biphasic-L		✓				
- rise time (min and max)	50-250	μsec				
- fall time (min and max)	50-250	μsec				
- phase deviation: positive (min and max)	+(1.0 to 1.2)	radians				
- phase deviation: negative (min and max)	-(1.0 to 1.2)	radians				
- symmetry measurement	≤ 0.05	✓				
5. 406 MHz Transmitted Frequency						
- nominal value	C/S T.001	MHz				
- short-term stability	≤ 2x10 ⁻⁹	/100 ms				
- medium-term stability slope	(-1 to +1)x10 ⁻⁹	/min				
- medium-term stability residual frequency variation	≤ 3x10 ⁻⁹					
6. Spurious Emissions into 50 Ohms (406.0 – 406.1 MHz)¹	C/S T.001 mask	✓				
7. 406 MHz VSWR Check						
- nominal transmitted frequency	C/S T.001	MHz				
- modulation rise time (min and max)	50-250	μsec				
- modulation fall time (min and max)	50-250	μsec				
- phase deviation: positive (min and max)	+(1.0 to 1.2)	radians				
- phase deviation: negative (min and max)	-(1.0 to 1.2)	radians				
- modulation symmetry measurement	≤ 0.05	✓				
- digital message	correct	✓				

¹ Include spectral plots of the 406.0-406.1 MHz band, showing the transmit signal and the emission mask as defined in document C/S T.001.

Parameters to be Measured	Range of Specification	Units	Test Results	Comments
		T _{min} ($^{\circ}$ C)	T _{amb} ($^{\circ}$ C)	T _{max} ($^{\circ}$ C)
8 (a). Self-test Mode <ul style="list-style-type: none"> - frame sync - format flag - radiated burst - default position data (if applicable) - description provided - design data provided on protection against repetitive self-test mode transmissions - single burst verification - provides for 15 Hex ID - 121.5 MHz RF power (if applicable) - 406 MHz RF power 	“011010000” 1/0 $\leq 440/520 (+1\%)$ must be correct must be correct must be one burst must be correct verify that RF power is emitted verify that RF power is emitted	bit value ms 	\checkmark \checkmark \checkmark \checkmark \checkmark \checkmark \checkmark \checkmark \checkmark \checkmark	
8 (b). GNSS Self-Test Mode (if applicable) <ul style="list-style-type: none"> - frame sync - format flag - radiated burst duration - position data (if applicable) - design data showing how GNSS Self-Test is limited in number of transmissions and duration - single burst verification (if applicable) - 121.5 MHz RF power (if applicable) - 406 MHz RF power (if applicable) - Maximum duration of GNSS Self-Test - Actual duration of Self-Test with encoded location - Maximum number of GNSS Self-Tests (only beacons with internal navigation devices) - Distinct indication to register successful completion or failure of the GNSS self-test - Distinct indication that a maximum number of GNSS self-tests has been attained 	“011010000” 1 $\leq 520 (+1\%)$ must be within 500m (or 5.25km for User Location Protocol) of the actual position must be provided must be one burst verify that RF power is emitted verify that RF power is emitted Manufacturer to specify value Less than maximum duration Manufacturer to specify number must be provided must be provided	bit value ms \checkmark \checkmark \checkmark \checkmark sec sec number \checkmark \checkmark		

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Parameters to be Measured	Range of Specification	Units	Test Results	Comments
9. Thermal Shock¹ - soak temperature - measurement temperature - the following parameters are to be met within 15 minutes of beacon turn on and maintained for 2 hours: - transmit frequency nominal value - transmit frequency short-term stability - transmit frequency medium-term stability slope - transmit frequency medium-term stability residual frequency variation - transmitter power output (min and max) - digital message	C/S T.001 $\leq 2 \times 10^{-9}$ $(-2 \text{ to } +2) \times 10^{-9}$ $\leq 3 \times 10^{-9}$ 35-39 correct	MHz $/100 \text{ ms}$ $/\text{min}$ dBm \checkmark	$T_{\text{soak}} = \underline{\hspace{2cm}}^{\circ}\text{C}$ $T_{\text{meas}} = \underline{\hspace{2cm}}^{\circ}\text{C}$	
10. Operating Lifetime at Minimum Temperature² - duration - transmit frequency nominal value - transmit frequency short-term stability - transmit frequency medium-term stability slope - transmit frequency medium-term stability residual frequency variation - transmitter power output (min and max) - Pt _{EOL} =minimum transmitter power output observed during lifetime at minimum temperature - digital message - homer transmitter continuous operation during the lifetime test - homer frequency - homer peak power level - homer transmitter duty cycle	> 24 C/S T.001 $\leq 2 \times 10^{-9}$ $(-1 \text{ to } +1) \times 10^{-9}$ $\leq 3 \times 10^{-9}$ 35-39 35-39 correct	hrs MHz $/100\text{ms}$ $/\text{min}$ dBm dBm \checkmark hours MHz dBm $\%$	$\underline{\hspace{2cm}} \text{ hours at } T_{\text{min}} = \underline{\hspace{2cm}}^{\circ}\text{C}$	

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¹ Attach graphs depicting the test results.

² Attach graphs depicting test results.

Parameters to be Measured	Range of Specification	Units	Test Results	Comments
11. Temperature Gradient (5°C/hour)¹ - transmit frequency nominal value - transmit frequency short-term stability - transmit frequency medium-term stability o slope (A to B, C+15 to D and E+15 to F) o slope (B to C+15 and D to E+15) o residual frequency variation - transmitter power output (min and max) - digital message	C/S T.001 $\leq 2 \times 10^{-9}$ $(-1 \text{ to } +1) \times 10^{-9}$ $(-2 \text{ to } +2) \times 10^{-9}$ $\leq 3 \times 10^{-9}$ 35-39 Correct	MHz /100ms /min /min dBm ✓		
12. Oscillator Aging - 5-year carrier nominal frequency variation - MTS analysis (if applicable)	C/S T.001, section 2.3.1 Must demonstrate compliance	kHz ✓		
13. Protection against Continuous Transmission Description Provided	< 45	sec ✓		Provide description.
14. Satellite Qualitative Test (results provided)¹	15 Hex ID provided by LCN and position within 5 km 80% of time	✓		
15. Antenna Characteristics - polarization - VSWR - EIRP _{LOSS} - EIRP _{max EOL} - EIRP _{min EOL}	linear or RHCP ≤ 1.5 ≤ 43 $\geq 32 \text{ or } \geq 30$	dB dBm dBm		Report FF-each Antenna Configuration Tested $\geq 30 \text{ dBm}$ for antenna tested in Figure B.5 configuration

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¹ Attach a satellite qualitative test summary report (Appendix A to Annex F) for each test configuration.

Parameters to be Measured	Range of Specification	Units	Test Results	Comments
16. Beacon Coding Software³				
- sample message provided for each coding option of the applicable coding types	correct	✓		Per applicable F-D.1/F-D.2/F-D.3 Table.
- sample self-test message provided for each coding option of the applicable coding types	correct	✓		Per applicable F-D.1/F-D.2/F-D.3 Table.
17. Navigation System¹				Report the results for ULP, SLP and NLP, as appropriate
- position data default value	correct	✓		Results per Tables F-C.4 or F-C.5
- position acquisition time ²	< 10 (int.nav) < 1 (ext.nav)	min min		Results per Tables F-C.4 or F-C.5
- position accuracy ²	C/S T.001	m		Test per A.3.8.4
- encoded position data update interval	> 5	min		Test per A.3.8.5
- position clearance after deactivation	Correct			
- position data input update interval	<1.0 min (ELT) <20 min (EPIRB/PLB)	✓ ✓		
- stored position cleared within interval	1.0-1.5 min (ELT) 20-30 min EPIRB/PLB			
- position data encoding	Correct	✓		Results per Tables F-C.1, F-C.2 and F-C.3 as appropriate
- retained last valid position after navigation input lost	240(±5)	min		
- default position data transmitted after 240 (±5) minutes without valid position data	Correct	✓		Test per A.3.8.6
- information provided on protection against erroneous position encoding into the beacon message		✓		

¹ Attach navigation system test results as per Appendix C to Annex F.² Report the results of this test for all the declared beacon configurations.³ Attach examples of each requested coding option as per Appendix D to Annex F.

APPENDIX A TO ANNEX F**SATELLITE QUALITATIVE TEST SUMMARY REPORT**

Date of the Test: _____

Time of the Test: _____

Beacon Model: _____

Beacon 15 Hex ID: _____

Actual location of the test beacon: Latitude: _____; Longitude: _____

Beacon test configuration (e.g. on dry ground, floating in water, etc): _____

Satellite ID	Satellite Pass Number	Time of Closest Approach (TCA)	Cross Track Angle	15 Hex ID Provided by LUT	Doppler Location	Location Error (km)

Ratio of successful solutions = $\frac{\text{number of Doppler solutions within } 5 \text{ km with } 1^\circ < \text{CTA} < 21^\circ}{\text{number of satellite passes over test duration with } 1^\circ < \text{CTA} < 21^\circ} \times 100 = \underline{\hspace{2cm}}\%$

Note: A separate table shall be provided for each beacon configuration tested.

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APPENDIX B TO ANNEX F

406 MHz BEACON ANTENNA TEST RESULTS

Table F-B.1: Equivalent Isotropically Radiated Power (dBm) / Antenna Gain (dBi)
 (To be used for reporting the results of antenna testing in configurations B.2, B.3 and B.4)

Azimuth Angle (degrees)	Elevation Angle (degrees)				
	10	20	30	40	50
0	/	/	/	/	/
30	/	/	/	/	/
60	/	/	/	/	/
90	/	/		/	/
120	/	/	/	/	/
150	/	/		/	/
180	/		/	/	/
210	/	/	/	/	/
240	/	/	/	/	/
270		/	/	/	/
300	/	/	/	/	/
330	/	/	/	/	/

$$\text{EIRP}_{\text{LOSS}} = \text{Pt}_{\text{AMB}} - \text{Pt}_{\text{EOL}} = \text{_____} \text{ dB}$$

$$\text{EIRP}_{\text{max EOL}} = \text{MAX} [\text{EIRP}_{\text{max}}, (\text{EIRP}_{\text{max}} - \text{EIRP}_{\text{LOSS}})] = \text{MAX} (\text{_____}, \text{_____}) = \text{_____} \text{ dBm}$$

$$\text{EIRP}_{\text{min EOL}} = \text{MIN} [\text{EIRP}_{\text{min}}, (\text{EIRP}_{\text{min}} - \text{EIRP}_{\text{LOSS}})] = \text{MIN} (\text{_____}, \text{_____}) = \text{_____} \text{ dBm}$$

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Table F-B.2: Induced Voltage Measurements V_v / V_h (dBuV)

(To be used for reporting the results of antenna testing in configurations B.2, B.3 and B.4)

Azimuth Angle (degrees)	Elevation Angle (degrees)				
	10	20	30	40	50
0	/	/	/	/	/
30	/	/	/	/	/
60	/	/	/	/	/
90	/	/	/	/	/
120	/	/	/	/	/
150	/	/	/	/	/
180	/	/	/	/	/
210	/	/	/	/	/
240	/	/	/	/	/
270	/	/	/	/	/
300		/	/	/	/
330	/	/	/	/	/
Min($V_v - V_h$, dB)					

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Table F-B.3: Equivalent Isotropically Radiated Power (dBm) / Antenna Gain (dBi)
 (To be used for reporting the results of antenna testing in Figure B.5 configuration)

Azimuth Angle (degrees)	Elevation Angle (degrees)				
	10	20	30	40	50
0	/	/	/	/	/
90	/	/	/	/	/
180	/	/	/	/	/
270	/	/	/	/	/

$$\text{EIRP}_{\text{LOSS}} = \text{Pt}_{\text{AMB}} - \text{Pt}_{\text{EOL}} = \text{_____} \text{ dB}$$

$$\text{EIRP}_{\text{max EOL}} = \text{MAX} [\text{EIRP}_{\text{max}}, (\text{EIRP}_{\text{max}} - \text{EIRP}_{\text{LOSS}})] = \text{MAX} (\text{_____, _____}) = \text{_____} \text{ dBm}$$

$$\text{EIRP}_{\text{min EOL}} = \text{MIN} [\text{EIRP}_{\text{min}}, (\text{EIRP}_{\text{min}} - \text{EIRP}_{\text{LOSS}})] = \text{MIN} (\text{_____, _____}) = \text{_____} \text{ dBm}$$

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APPENDIX C TO ANNEX F**NAVIGATION SYSTEM TEST RESULTS****Table F-C.1: Position Data Encoding Results User-Location Protocol**

Script Reference (See Table D.1)	Value of Encoded Location Bits Transmitted by Beacon	Confirmation that BCH Correct (✓)
1	Bits 108-132=	
2	Bits 108 – 132=	
	Number of seconds after providing navigation data that beacon transmitted the above encoded location information: _____	
3	Bits 108-132=	
4	Bits 108-132=	
5	Bits 108-132=	
6	Bits 108-132=	
7	Bits 108-132=	
8	Bits 108-132=	
9	Bits 108-132=	
10	Bits 108-132=	

Table F-C.2: Position Data Encoding Results Standard Location Protocol

Script Reference (See Table D.2)	Value of Encoded Location Bits Transmitted by Beacon	Confirmation that BCH Correct (✓)
1	Bits 65-85=	
	Bits 113-132=	
2	Bits 65-85=	
	Bits 113-132=	
	Number of seconds after providing navigation data that beacon transmitted the above encoded location information: _____	
3	Bits 65-85=	
	Bits 113-132=	
4	Bits 65-85=	
	Bits 113-132=	
5	Bits 65-85=	
	Bits 113-132=	
6	Bits 65-85=	
	Bits 113-132=	

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Script Reference (See Table D.2)	Value of Encoded Location Bits Transmitted by Beacon	Confirmation that BCH Correct (✓)
7	Bits 65-85= Bits 113-132=	
8	Bits 65-85= Bits 113-132=	
9	Bits 65-85= Bits 113-132=	
10	Bits 65-85= Bits 113-132=	
11	Bits 65-85= Bits 113-132=	

Table F-C.3: Position Data Encoding Results National Location Protocol

Script Reference (See Table D.3)	Value of Encoded Location Bits Transmitted by Beacon	Confirmation that BCH Correct (✓)
1	Bits 59-85= Bits 113-126=	
2	Bits 59-85= Bits 113-126= Number of seconds after providing navigation data that beacon transmitted the above encoded location information: _____	
3	Bits 59-85= Bits 113-126=	
4	Bits 59-85= Bits 113-126=	
5	Bits 59-85= Bits 113-126=	
6	Bits 59-85= Bits 113-126=	
7	Bits 59-85= Bits 113-126=	
8	Bits 59-85= Bits 113-126=	
9	Bits 59-85= Bits 113-126=	
10	Bits 59-85= Bits 113-126=	
11	Bits 59-85= Bits 113-126=	

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**Table F-C.4:Position Acquisition Time and Position Accuracy
(Internal Navigation Devices)**

Operational Configuration	C/S T.007 Section A.3.8.2.1		C/S T.007 Section A.3.8.2.2	
	Time to Acquire Position (sec)	Location Error in metres	Time to Acquire Position (sec)	Location Error in metres
Water ground plane				
Antenna fixed to ground plane				
Antenna fixed to ground plane				
Beacon on ground plane				
Beacon above ground plane				
Other (specify)				

**Table F-C.5: Position Acquisition Time and Position Accuracy
(External Navigation Devices)**

C/S T.007 Section A.3.8.2.1		C/S T.007 Section A.3.8.2.2	
Time to Acquire Position (sec)	Location Error in metres	Time to Acquire Position (sec)	Location Error in metres

APPENDIX D TO ANNEX F**BEACON CODING SOFTWARE RESULTS****Table F-D.1: Examples of User Protocol Beacon Messages**

(Examples required for each protocol requested for inclusion on the type approval certificate)

Protocol	Operational Message (in hexadecimal including bit and frame synchronisation bits)	Self-Test Message (in hexadecimal including bit and frame synchronisation bits)
Maritime User Protocol with MMSI		
Maritime User Protocol with Radio Call Sign		
Radio Call Sign User Protocol		
Serial User: Float-Free EPIRB with Serial Number		
Serial User: Non Float-Free EPIRB with Serial Number		
Aviation User Protocol		
Serial User: ELT with Serial Number		
Serial User: ELT with Aircraft Operator Designator & Serial Number		
Serial User: ELT with Aircraft 24-bit address		
Serial User: PLB with Serial Number		
National User (Short)		
National User (Long)		
User Test		

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Table F-D.2: Examples of Standard and National Location Protocol Beacon Messages
 (Examples required for each protocol requested for inclusion on the type approval certificate)

Protocol	Operational Message (in hexadecimal including bit and frame synchronisation bits)		Self-Test Message (in hexadecimal including bit and frame synchronisation bits)	GNSS Self Test Message (if applicable, in hexadecimal, including bit and frame synchronisation bits)
	Location “A” ¹	Location “B” ¹		Location “A”
Standard Location: EPIRB with MMSI				
Standard Location: EPIRB with Serial Number				
Standard Location: ELT with 24-bit Address				
Standard Location: ELT with Serial Number				
Standard Location: ELT with Aircraft Operator Designator				
Standard Location: PLB with Serial Number				
Standard Location: Test				
National Location: EPIRB				
National Location: ELT				
National Location: PLB				
National Location: Test				
RLS Location: (ELT,EPIRB or PLB) ²				

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¹ Location “A” and location “B” must be separated by at least 500 meters for the Standard, National and RLS location protocols.

² RLS protocols will be effective as of 1 November 2013. The use of RLS-enabled beacons will be regulated by national administrations. Since the RLS functionality might affect the 406 MHz beacon performance, amendments to the type approval procedure for these beacons could be required. Beacon manufacturers should consult the Cospas-Sarsat Secretariat before undertaking the type approval of RLS-enabled beacon models.

Table F-D.3: Examples of User-Location Protocol Beacon Messages
 (Examples required for each protocol requested for inclusion on the type approval certificate)

Protocol	Operational Message (in hexadecimal including bit and frame synchronisation bits)		Self-Test Message (in hexadecimal including bit and frame synchronisation bits)	GNSS Self Test Message (if applicable, in hexadecimal, including bit and frame synchronisation bits)
	Location “A” ¹	Location “B” ¹		Location “A”
Maritime Protocol with MMSI				
Maritime Protocol with Radio Call Sign				
Radio Call Sign				
Serial User-Location: Float-Free EPIRB				
Serial User-Location: Non Float-Free EPIRB				
Aviation				
Serial User-Location: ELT				
Serial User-Location: ELT with Aircraft Operator Designator & Serial Number				
Serial User-Location: ELT with Aircraft 24-bit address				
Serial User-Location: PLB				
User-Location: Test				

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¹ Location “A” and location “B” must be separated by at least 10 km for the User-Location protocol.

APPENDIX E TO ANNEX F**BEACON OPERATING CURRENT AND
PRE-TEST DISCHARGE CALCULATIONS****Table F-E.1: Beacon Operating Current**

Beacon Operating Modes	Mode: Manually selectable or Automatic	Measurement interval, sec	Average Current, mA	Peak Current, mA

Table F-E.2: Pre-test Battery Discharge Calculations

Characteristic	Designation	Units	Value	Comments
Beacon battery replacement period (from date of cell manufacture)	T _{BR} or TBR	Number of years		
Battery pack electrical configuration				
Cell model and cell chemistry				
Nominal cell capacity		A-hrs		
Nominal battery pack capacity	C _{BN}	A-hrs		
Annual battery cell capacity loss (self-discharge) due to aging, as specified by cell manufacturer at ambient temperature	L _{SDC}	%		
Calculated battery pack capacity loss due to self-discharge: L _{CBN} = C _{BN} - [C _{BN} * (1 - L _{SDC} /100) ^{T_{BR}}]	L _{CBN}	A-hrs		
Number of self-tests per year	N _{ST}			
Average battery current during a self-test	I _{ST}	mA		
Maximum duration of a self-test	T _{ST}	sec		
Calculated battery pack capacity loss due to self-tests during battery replacement period: L _{ST} = I _{ST} *T _{ST} *T _{BR} *N _{ST} / 3600	L _{ST}	mA-hrs		
Maximum Number of GNSS self-tests between battery replacements	N _{GST}			
Average battery current during a GNSS self-test of maximum duration	I _{GST}	mA		
Maximum duration of a GNSS self-test	T _{GST}	sec		
Calculated battery pack capacity loss due to GNSS self-tests during battery replacement period: L _{GST} = I _{GST} *T _{GST} *N _{GST} / 3600	L _{GST}	mA-hrs		
Average stand-by battery pack current	I _{SB}	mA		
Battery pack capacity loss due to constant operation of circuitry prior to beacon activation: L _{ISB} = I _{SB} *T _{BR} *8760	L _{ISB}	mA-hrs		
Calculated value of the battery pack pre-test discharge L _{CDC} = L _{CBN} + 1.65*(L _{ST} + L _{GST} + L _{ISB})/1000	L _{CDC}	A-hrs		

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ANNEX G

APPLICATION FOR A COSPAS-SARSAT 406 MHz BEACON
TYPE APPROVAL CERTIFICATE

G.1 INFORMATION PROVIDED BY THE BEACON MANUFACTURER

Beacon Manufacturer and Beacon Model

Beacon Manufacturer	
Beacon Model	
Other Model Names	

Beacon Type and Operational Configurations

Beacon Type	Beacon used while:	Tick where appropriate
EPIRB	Floating in water or on deck or in a safety raft	
PLB	On ground and above ground	
	On ground and above ground and floating in water	
ELT Survival	On ground and above ground	
	On ground and above ground and floating in water	
ELT Auto Fixed	Fixed ELT with aircraft external antenna	
ELT Auto Portable	In aircraft with an external antenna	
	On ground, above ground, or in a safety raft with an integrated antenna	
ELT Auto Deployable	Deployable ELT with attached antenna	
Other (specify)		

Beacon Characteristics

Characteristic	Specification
Operating frequency	_____ MHz
Operating temperature range	Tmin = _____ Tmax = _____
Operating lifetime	_____ hours
Beacon power supply type (internal, external, combined, other)	

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Characteristic	Specification
External power supply parameters (AC/DC and nominal voltage)	
Is external power supply needed to energise the beacon or its ancillary devices in any of operational modes (N/A or Yes or No)	
Battery chemistry	
Battery cell model name, size and number of cells	
Battery cell manufacturer	
Battery pack manufacturer and part number	
Battery pack replacement period	years
Oscillator type (e.g. OCXO, MCXO, TCXO)	
Oscillator manufacturer	
Oscillator part name and number	
Oscillator satisfies long-term frequency stability requirements (Yes or No)	
Antenna type: Integral or Other (e.g. External, Detachable – specify type)	
Antenna manufacturer	
Antenna part name and number	
Navigation device type (Internal, External or None)	
Features in beacon that prevent degradation to 406 MHz signal or beacon lifetime resulting from a failure of navigation device or failure to acquire position data (Yes, No, or N/A)	
Features in beacon that ensures erroneous position data is not encoded into the beacon message (Yes, No or N/A)	
Navigation device capable of supporting global coverage (Yes, No or N/A)	
For Internal Navigation Devices	
<ul style="list-style-type: none"> <li data-bbox="235 1603 978 1641">– Geodetic reference system (WGS 84 or GTRF) 	
<ul style="list-style-type: none"> <li data-bbox="235 1664 978 1702">– GNSS receiver cold start forced at every beacon activation (Yes or No) 	

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Characteristic	Specification	
– Navigation device manufacturer		
– Navigation device model name and part Number		
– Internal navigation device antenna type(integrated, internal, external, passive/active) , manufacturer and model		
– GNSS system supported (e.g. GPS, GLONASS, Galileo)		
For External Navigation Devices		
– Data protocol for GNSS receiver to beacon interface		
– Physical interface for beacon to navigation device		
– Electrical interface for beacon to navigation device		
– Part number of the external navigation interface device (if applicable)		
– Navigation device model and manufacturer (if beacon designed to use specific devices)		
Self-Test Mode Characteristics:	Self-Test Mode	Optional GNSS Self-Test Mode
– Self-test has separate switch position (Yes or No)		
– Self-test switch automatically returns to normal position when released (Yes or No)		
– Self-test activation can cause an operational mode transmission (Yes or No)		
– Self-test causes a single beacon self-test message burst only regardless of how long the self-test activation mechanism applied (Yes or No)		
– Results of self-test indicated by (e.g. Pass / Fail Indicator Light, Strobe Light, etc.)		
– The content of the encoded position data fields of the self-test message has default values		N/A
– Self-test can be activated from beacon remote activation points (Yes or No)		
– Self-test performs an internal check and indicates that RF power emitted at 406 MHz and 121.5 MHz if beacon includes a 121.5 Hz homer (Yes or No)		

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Characteristic	Specification	
– Self-test transmits a signal(s) other than at 406 MHz (Yes & details or No)		
– Self-test can be activated directly at beacon (Yes or No)		
– List of Items checked by self-test		
– Self-test transmission burst duration (440 or 520 ms)		
– Self-test format bit (“0” or “1”)		
– Maximum duration of self-test		
– Maximum number of GNSS Self Tests (beacons with internal navigation devices only)	N/A	
– Self-test results in transmission of a single burst, irrespectively of the test result (Yes or No)	N/A	
– Maximum number of self-tests during battery pack replacement period		N/A
Message Coding Protocols:	(x) Tick the boxes below against the intended protocol options	
User Protocol (tick where appropriate)		<input type="checkbox"/> Maritime with MMSI <input type="checkbox"/> Maritime with Radio Call Sign <input type="checkbox"/> EPIRB Float Free with Serial Number <input type="checkbox"/> EPIRB Non Float Free with Serial Number <input type="checkbox"/> Radio Call Sign <input type="checkbox"/> Aviation <input type="checkbox"/> ELT with Serial Number <input type="checkbox"/> ELT with Aircraft Operator and Serial Number <input type="checkbox"/> ELT with Aircraft 24-bit Address <input type="checkbox"/> PLB with Serial Number <input type="checkbox"/> National (Short Message Format) <input type="checkbox"/> National (Long Message Format)
Standard Location Protocol (tick where appropriate)		<input type="checkbox"/> EPIRB with MMSI <input type="checkbox"/> EPIRB with Serial Number <input type="checkbox"/> ELT with 24-bit Address <input type="checkbox"/> ELT with Aircraft Operator Designator <input type="checkbox"/> ELT with Serial Number <input type="checkbox"/> PLB with Serial Number

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Characteristic	Specification
National Location Protocol (tick where appropriate)	National Location: EPIRB
	National Location: ELT
	National Location: PLB
RLS Location Protocol (tick where appropriate) ¹	EPIRB
	ELT
	PLB
User Location Protocol (tick where appropriate)	Maritime with MMSI
	Maritime with Radio Call Sign
	EPIRB Float Free with Serial Number
	EPIRB Non Float Free with Serial Number
	Radio Call Sign
	Aviation
	ELT with Serial Number
	ELT with Aircraft Operator and Serial Number
	ELT with Aircraft 24-bit Address
	PLB with Serial Number
Beacon includes a homer transmitter (if yes identify frequency of transmission)	_____ MHz
– Homer Transmit Power	_____ dBm
– Homer Transmitter Duty Cycle	_____ %
– Duty Cycle of Homer Swept Tone	_____ %
Beacon includes a strobe light (Yes or No)	
– Strobe light intensity	
– Strobe light flash rate	
Beacon transmission repetition period satisfies C/S T.001 requirement that two beacon's repetition periods are not synchronised closer than a few seconds over 5 minute period, and the time intervals between transmissions are randomly distributed on the interval 47.5 to 52.5 seconds (Yes or No)	
Other ancillary devices (e.g. voice transceiver, remote control, external audio and light indicators, external activation device). List details on a separate sheet if insufficient space to describe.	
Beacon includes automatic activation mechanism (Yes or No) Specify type of automatic beacon activation mechanism	

¹

RLS protocols will be effective as of 1 November 2013. The use of RLS-enabled beacons will be regulated by national administrations. Since the RLS functionality might affect the 406 MHz beacon performance, amendments to the type approval procedure for these beacons could be required. Beacon manufacturers should consult the Cospas-Sarsat Secretariat before undertaking the type approval of RLS-enabled beacon models.

Characteristic	Specification
Beacon includes software or hardware features and functions not listed above and non-related to 406 MHz (Yes or No)	
List features and use a separate sheet if insufficient space	
Beacon model hardware part number (P/N) and version	
Beacon model software/firmware P/N and version	
Beacon model printed circuit board P/N and version	

Dated:..... Signed:.....

(Name, Position and Signature of Beacon Manufacturer Representative)

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G.2 INFORMATION PROVIDED BY THE COSPAS-SARSAT ACCEPTED TEST FACILITY**Name and Location of Beacon Test Facility:** _____
_____**Date of Submission for Testing:** _____**Applicable C/S Standards:**

Document	Issue	Revision
C/S T.001		
C/S T.007		

I hereby confirm that the 406 MHz beacon described above has been successfully tested in accordance with the Cospas-Sarsat 406 MHz Beacon Type Approval Standard (C/S T.007) and complies with the Specification for Cospas-Sarsat 406 MHz Distress Beacons (C/S T.001) as demonstrated in the attached report.¹

Dated:..... Signed:.....
(Name, Position and Signature of Cospas-Sarsat Accepted Test Facility Representative)

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¹ If the test results do not support full compliance to the above standards, or deviations from the standard test procedures took place during type approval testing, the test laboratory shall modify this statement to identify discrepancies. A complete explanation of such discrepancies should be provided in the test report and the report references identified in this statement.

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ANNEX H
CHANGE NOTICE FORM

The Manufacturer of the Cospas-Sarsat Type Approved 406 MHz Distress Beacons:

Manufacturer: _____
(name and address) _____

406 MHz Beacon Model numbers: _____

Cospas-Sarsat Type Approval Certificate Numbers: _____

Proposed New Model Numbers Beacon: _____

hereby informs Cospas-Sarsat of the following changes to production beacons

planned date of change _____

Oscillator type: _____

Battery: _____ (specify): _____

Antenna type: _____

Homing transmitter: _____

Strobe light: _____

Size or shape of beacon package: _____

Other physical characteristics: _____ (specify): _____

Significant change to circuit design: _____

Internal navigation device: _____ (specify): _____

Operating frequency: _____ (specify): _____

External navigation data interface: _____ (specify): _____

Message protocol: _____ (specify): _____

Other: _____ (specify): _____

and substantiates these changes with the attached technical documentation and beacon test results (if applicable). I hereby confirm that with these changes the above 406 MHz beacon models are technically equivalent to the type approved beacon and continue to meet the Cospas-Sarsat requirements.

Dated:.....Signed:.....

(Name, Position and Signature of Beacon Manufacturer Representative)

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ANNEX I**DESIGNATION OF ADDITIONAL NAMES OF A
COSPAS-SARSAT TYPE APPROVED 406 MHz BEACON MODEL**

The Manufacturer of the following Cospas-Sarsat Type Approved 406 MHz Distress Beacon:

Beacon Manufacturer: _____
(name and address)

406 MHz Beacon model: _____

having Cospas-Sarsat Type Approval Certificate Number: _____

hereby informs Cospas-Sarsat that the above beacon will also be sold as:

Additional name and model number of beacon: _____
by Agent/Distributor: _____
(name and address)
telephone: _____
fax: _____
contact person/title: _____

I certify that we have an agreement with this agent/distributor to market the above-referenced 406 MHz beacon, which we will manufacture and which will be identical to the Cospas-Sarsat type approved beacon, except for labelling.

Dated:..... Signed:.....
(Name, Position and Signature of Beacon Manufacturer Representative)

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ANNEX J**APPLICATION FOR TESTING SEPARATED ELT ANTENNA(S)
AT AN INDEPENDENT ANTENNA TEST FACILITY**

The Manufacturer of the Cospas-Sarsat Type Approved 406 MHz Distress Beacons:

Manufacturer: _____

(name and address) _____

applies to test ELT antennas: _____

at antenna test facility: _____

located at: _____

Dated:..... Signed:.....

(Name, Position and Signature of ELT Manufacturer Representative)

**DECLARATION OF COSPAS-SARSAT REPRESENTATIVE FOR THE COUNTRY
WHERE THE ANTENNA TEST FACILITY IS LOCATED:**

I hereby confirm that the operation of the antenna test facility mentioned above is independent from the 406 MHz beacon manufacturer who is submitting this application.

Dated:..... Signed:.....

(Name and Signature of Cospas-Sarsat Representative)

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ANNEX K**REQUEST TO EXCLUDE ELT ANTENNA(S) FROM THE COSPAS-SARSAT
SECRETARIAT LIST OF ELT ACCEPTED ANTENNAS**

The Manufacturer of the Cospas-Sarsat 406 MHz ELT:

Manufacturer: _____

(name and address) _____

requests that the following ELT antenna(s), designed by us:

(model, part number)

used with the 406 MHz ELT: _____

not be included in the Cospas-Sarsat Secretariat list of accepted ELT antennas

Dated:..... Signed:.....
(Name, Position and Signature of ELT Manufacturer Representative)

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ANNEX L**BEACON QUALITY ASSURANCE PLAN**

We, manufacturer of Cospas-Sarsat 406 MHz beacons (Manufacturer name and address)

confirm that ALL PRODUCTION UNITS of the following beacon model(s),

(model, hardware part number, firmware part number, software version or part number)

will meet the Cospas-Sarsat specification and technical requirements in a similar manner to the units subjected for type approval testing. To this effect all production units will be subjected to following tests at ambient temperature:

- Digital message
- Bit rate
- Rise and fall times of the modulation waveform
- Modulation Index (positive/negative)
- Output power
- Frequency stability (short, medium)*

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Note*: Beacon manufacturer shall provide technical data on the beacon frequency generation to demonstrate that the frequency stability tests at ambient temperature are sufficient for ensuring that each production beacon will exhibit frequency stability performance similar to the beacon submitted for type approval over the complete operating temperature range. If such assurance of adequate performance over the complete operating temperature range cannot be deduced from the technical data provided and the frequency stability test results at ambient temperature, a thermal gradient test shall be performed on all production units.

- Other tests:

We confirm that the above tests will be performed as appropriate to ensure that the complete beacon satisfies Cospas-Sarsat requirements, as demonstrated by the test unit submitted for type approval.

We agree to keep the test result sheet of every production beacon for inspection by Cospas-Sarsat, if required, for a minimum of 10 years.

We confirm that Cospas-Sarsat representative(s) have the right to visit our premises to witness the production and testing process of the above-mentioned beacons. We understand that the cost related to the visit is to be borne by Cospas-Sarsat.

We also accept that, upon official notification of Cospas-Sarsat, we may be required to re-submit a unit of the above beacon model selected by Cospas-Sarsat for the testing of parameters chosen at Cospas-Sarsat discretion at a Cospas-Sarsat accepted test facility selected by the Cospas-Sarsat. We understand that the cost of the testing shall be borne by Cospas-Sarsat.

We understand that the Cospas-Sarsat Type Approval Certificate is subject to revocation should the beacon type for which it was issued, or its modifications, cease to meet the Cospas-Sarsat specifications, or Cospas-Sarsat has determined that this quality assurance plan is not implemented in a satisfactory manner.

Dated:..... Signed:.....
(Name, Position and Signature of Beacon Manufacturer Representative)

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ANNEX M

**COSPAS-SARSAT 406 MHZ BEACON TYPE APPROVAL CERTIFICATE
(SAMPLE)****TYPE APPROVAL CERTIFICATE**

For a 406 Megahertz Distress Beacon for use with the Cospas-Sarsat Satellite System

Certificate Number: ...xxx

Manufacturer: The ABC Beacon Company, London, UK
Beacon Type(s): EPIRB
Beacon Model(s): ABC-406
Test Laboratory: Intespace, Toulouse, France
Date of Test: January 2005

Details of the beacon features and battery type are provided overleaf.

The Cospas-Sarsat Council hereby certifies that the 406 MHz Distress Beacon Model identified above is compatible with the Cospas-Sarsat System as defined in documents:

C/S T.001 Specification for Cospas-Sarsat 406 MHz Distress Beacon
Issue 3 – Rev. 6, October 2004

C/S T.007 Cospas-Sarsat 406 MHz Distress Beacon Type Approval Standard
Issue 4, November 2005

Date Originally Issued: 10 March 2005

Date(s) Amended: _____

Head of Cospas-Sarsat Secretariat

NOTE, HOWEVER:

1. This certificate does not authorize the operation or sale of any 406 MHz distress beacon. Such authorization may require type acceptance by national administrations in countries where the beacon will be distributed, and may also be subject to national licensing requirements.
2. This certificate is intended only as a formal notification to the above identified manufacturer that the Cospas-Sarsat Council has determined, on the basis of test data of a beacon submitted by the manufacturer, that 406 MHz distress beacons of the type identified herein meet the standards for use with the Cospas-Sarsat System.
3. Although the manufacturer has formally stated that all beacons identified with the above model name(s) will meet the Cospas-Sarsat specification referenced above, this certificate is not a warranty and Cospas-Sarsat hereby expressly disclaims any and all liability arising out of or in connection with the issuance, use or misuse of the certificate.
4. This certificate is subject to revocation by the Cospas-Sarsat Council should the beacon type for which it is issued cease to meet the Cospas-Sarsat specification. A new certificate may be issued after satisfactory corrective action has been taken and correct performance demonstrated in accordance with the Cospas-Sarsat Type Approval Standard.
5. Cospas-Sarsat type approval testing requirements only address the electrical performance of the beacon at 406 MHz. Conformance of the beacon to operational and environmental requirements is the responsibility of national administrations.

Certificate Number: ...xxx

Dated: ...xxx

Operating temperature range: -20°C to +55°C

Battery Details: xxx Battery Company, type 123 (4 D-cells)
Battery chemistry**Operating Lifetime:** 48 hours**Transmit Frequency:** 406.028 MHz**Beacon Model Features:**

- 121.5 MHz auxiliary radio locating device (50 mW, continuous)
- Automatic activation mechanism
- Strobe light (0.75 cd, 20 flashes/min)
- Internal navigation device (GPS): manufacturer YYY, model ZZZ
- Self-test mode: one burst of 520 ms
- Optional GNSS Self Test (limited to X times over the life of the battery)

Approved Beacon Message Protocols

Beacon is approved for encoding with the message protocols indicated with "Yes" and black text below.

USER PROTOCOLS	USER-LOCATION PROTOCOLS	LOCATION PROTOCOLS
No Maritime with MMSI	No Maritime with MMSI	No Standard Location: EPIRB with MMSI
No Maritime with Radio Call Sign	No Maritime with Radio Call Sign	No Standard Location: EPIRB with Serial Number
No EPIRB Float Free with Serial Number	No EPIRB Float Free with Serial Number	No Standard Location: ELT with 24-bit Address
No EPIRB Non Float Free with Serial Number	No EPIRB Non Float Free with Serial Number	No Standard Location: ELT with Aircraft Operator Designator
No Radio Call Sign	No Radio Call Sign	No Standard Location: ELT with Serial Number
No Aviation	No Aviation	Yes Standard Location: PLB with Serial Number
No ELT with Serial Number	No ELT with Serial Number	No National Location: EPIRB
No ELT with Aircraft Operator and Serial Number	No ELT with Aircraft Operator and Serial Number	No National Location: ELT
No ELT with Aircraft 24-bit Address	No ELT with Aircraft 24-bit Address	Yes National Location: PLB
Yes PLB with Serial Number	Yes PLB with Serial Number	No RLS Location: EPIRB
Yes National (Short Format Message)		No RLS Location: ELT
No National (Long Format Message)		No RLS Location: PLB

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