COSPAS-SARSAT SPECIFICATION AND TYPE APPROVAL STANDARD FOR 406 MHz SHIP SECURITY ALERT (SSAS) BEACONS

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COSPAS-SARSAT SPECIFICATION AND TYPE APPROVAL STANDARD FOR 406 MHz SHIP SECURITY (SSAS) BEACONS

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1. INTRODUCTION

1.1 Purpose

This document defines:

a. the minimum requirements to be used for the development and manufacture of 406 MHz ship security alert system (SSAS) beacons, provided at section 2; and

b. the policies, procedures and type approval test methods for obtaining Cospas-Sarsat type approval of 406 MHz SSAS beacons, provided at section 3.

1.2 Background

As a result of increased concern about maritime security world-wide, the Safety Of Life At Sea (SOLAS) Conference in December 2002 adopted amendments to the SOLAS convention for a “Ship Security Alert System” (SSAS).

At the open meeting of the Cospas-Sarsat Thirty-First Session, the Cospas-Sarsat Council decided to allow the Cospas-Sarsat System to be used in support of the above mentioned SSAS requirement. The Council also decided that to the extent practical the specification and type approval requirements for 406 MHz SSAS beacons should be as close as possible to those established for 406 MHz distress beacons.

To the extent practical the specification and type approval requirements defined in this document refer to the corresponding requirement in documents C/S T.001 (Cospas-Sarsat specification for 406 MHz distress beacons) and C/S T.007 (Cospas-Sarsat type approval standard for 406 MHz distress beacons).

It should be noted that this document does not provide guidance for SSAS beacon installation, as this is a matter that falls under the jurisdiction of national administrations. Beacon manufacturers are responsible for ensuring that installation guidelines conform to the appropriate national regulations, and that installation instructions are provided to SSAS beacon installers. Failure to provide a satisfactory beacon and antenna installation may result in the ship security alert not being received by the Cospas-Sarsat System.

1.3 Reference Documents

a. C/S T.001: Specification for Cospas-Sarsat 406 MHz Distress Beacons; and

b. C/S T.007: Cospas-Sarsat 406 MHz Distress Beacon Type Approval Standard.

- END OF SECTION 1 -

2. SPECIFICATION FOR COSPAS-SARSAT 406 MHz SSAS BEACON

Cospas-Sarsat 406 MHz SSAS beacons shall conform to all specifications defined for Cospas-Sarsat 406 MHz distress beacons (document C/S T.001) except for the items specifically identified otherwise in the paragraphs below.

2.1 Message Content

406 MHz SSAS beacons shall use a long format message, comprising 144 bits, coded as follows:

a) bits 1 to 15: bit-synchronisation as defined in document C/S T.001;

b) bits 16 to 24: frame-synchronisation as defined in document C/S T.001;

c) bit 25 and 26: set to "10";

d) bits 27 to 36: country code as defined in document C/S T.001;

e) bits 37 to 40: set to "1100";

f) bits 41 to 60: the last six digits of the vessel MMSI expressed as a binary number;

g) bits 61 to 64: set to "0000"; and

h) bits 65 to 144: set as per the Standard Location protocol as defined in document C/S T.001.

2.2 Transmitter Power Output

The transmitter power output shall be within the limits of 6W ± 1dB (37 to 39 dBm) measured into a 50-Ohm load. This power output shall be maintained during 24-hour operation at any temperature throughout the specified operating temperature range. Power output rise time shall be less than 5 ms measured between the 10% and 90% power points. The power output is assumed to rise linearly from zero and therefore must be zero prior to about 0.6 ms before the beginning of the rise time measurement; if it is not zero, the maximum acceptable level is -10 dBm.

2.3 Antenna Characteristics

The SSAS beacon antenna shall satisfy the following requirements for elevation angles between 5º and 90º:

a) polarisation: right hand circular (RHCP) or linear;

b) RHCP antenna gain: between -3 dBi and 4 dBi over 90% of all measurement points;

c) linear antenna gain: between -5 dBi and 4 dBi (elevation less or equal to 70 degrees), between –10 dBi and 4 dBi (80 degree elevation only) and between -15 dBi and 4 dBi (90 degree elevation only) over 90% of all measurement points; and

d) antenna VSWR: not greater than 1.5:1.

2.4 Encoded Position Data

The SSAS beacon shall provide encoded position data, either from an internal or external navigation device. The beacon shall process location data provided by the navigation device in accordance with the procedures described in document C/S T.001.

2.4.1 Internal Navigation Device Performance

If the beacon includes an internal navigation device, the navigation device shall satisfy the requirements for internal navigation devices provided in document C/S T.001. The distance between the position provided by the navigation device at the time of position update and the true beacon position shall not exceed 500 metres.

2.4.2 External Navigation Device Performance

If the beacon receives position data from an external navigation device, the beacon and the navigation device shall satisfy the requirements for "external navigation device input" provided in document C/S T.001.

If the beacon is designed to accept position data from an external navigation device prior to beacon activation, the navigation input shall be provided at intervals not longer than 20 minutes.

2.5 Auxiliary Radio-Locating Device

The SSAS beacon shall NOT incorporate an auxiliary radio-locating device (e.g. 121.5 MHz or 243 MHz homing devices shall not be included in SSAS beacons).

2.6 Compatibility with GEOSAR System

The SSAS beacon shall provide a transmit signal that enables Cospas-Sarsat GEOLUTs to receive, process and provide the complete transmitted beacon message within 10 minutes of beacon activation.

- END OF SECTION 2 -

3. 406 MHz SSAS BEACON TYPE APPROVAL REQUIREMENTS

3.1 Policy

The issuing of performance requirements, carriage regulations, testing and type approval requirements for 406 MHz SSAS beacons are responsibilities of national authorities. However, to ensure 406 MHz SSAS 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 is compatible with, and will not degrade, the Cospas-Sarsat System.

Cospas-Sarsat type approval procedures and requirements for 406 MHz SSAS beacons are identical to the type approval requirements for 406 MHz distress beacons C/S T.007, except for the items specifically identified in the paragraphs below.

3.2 Technical Data

The technical data to be submitted to the Cospas-Sarsat Secretariat is defined at section 5 of document C/S T.007, with the following clarifications and additions:

a) the application form for a Cospas-Sarsat Type Approval Certificate for a 406 MHz SSAS beacon is provided at Annex A to this document;

b) beacon and antenna installation instructions, supplemented with photographs of the beacon and antenna installed on a vessel shall be provided;

c) information from the beacon manufacturer confirming that no homer generator/transmitter is present (or has been removed/disabled) and that no homer signals will be either generated or radiated by the beacon; and

d) a summary of the test results shall be provided in the format identified at Annex D to this document.

3.3 Scope of Testing of SSAS Beacons Based on a New Design

All SSAS beacon models based on a new design (i.e. not based on the design of 406 MHz distress beacon already approved by Cospas-Sarsat) shall be tested to the full scope of document C/S T.007, with the exceptions / clarifications noted below:

a) “thermal shock test” is not required;

b) "additional types of protocol" testing is not applicable since beacons only use the SSAS beacon message protocol defined at section 2.1 of this document;

c) satellite qualitative testing and reporting shall be performed in accordance with section 3.5 to this document;

d) beacon antenna testing and reporting shall be performed in accordance with Annex B to this document; and

e) the beacon coding software testing and reporting shall be performed in accordance with section 3.6 to this document.

3.4 Scope of Testing of SSAS Beacons Based on Type Approved 406 MHz Distress Beacon

If the SSAS beacon design is based on a 406 MHz distress beacon that was previously approved by Cospas-Sarsat the guidance provided at Annex C applies.

3.5 SSAS Beacon Satellite Qualitative Test

The SSAS beacon shall undergo the satellite qualitative test described in document C/S T.007, supplemented by tests that demonstrate beacon compatibility with the Cospas-Sarsat GEOSAR system.

The GEOSAR portion of the satellite qualitative test is performed by activating the beacon in a configuration that simulates the manufacturer installation guidelines. The time from beacon activation to when a Cospas-Sarsat GEOLUT provides a complete correct beacon message shall be reported.

3.6 Beacon Coding Software

This test can be performed either by an accepted test laboratory or by the manufacturer.

The beacon coding software test demonstrates the reliability of the processes and procedures used by the manufacturer to code beacon messages. The beacon shall be coded with the ship security alert protocol, using country code: 201 and a vessel MMSI: 999 999.

Examples of the following three complete beacon messages shall be provided:

a) a self-test transmission;

b) a real transmission with encoded location information; and

c) a second real transmission with encoded location information 500 metres from the location in b) above.

The beacon messages shall be obtained by activating the beacon in the appropriate mode (i.e. self-test mode or real transmission) and monitoring and demodulating the transmitted signal using a receiver external to the beacon.

The beacon messages shall be reported in hexadecimal format, comprising 36 characters. The first six characters representing the bit and frame synchronisation transmitted by the beacon in bits 1 through 24.

3.7 Alternative Power Source

SSAS 406 MHz beacons and / or their external components (e.g. remote activation points, GNSS receiver) might be powered by multiple alternative sources of energy, such as the ship main AC power and the beacon battery. Each shall be considered a different mode of beacon operation, and shall be tested as follows.

The beacon shall undergo complete testing in the battery mode.

The beacon shall undergo the following tests in the AC mode:

a) power output test (as per C/S T.007, Table C2, reference 1);

b) digital message test (as per C/S T.007, Table C2, reference 2);

c) digital message generator test (as per C/S T.007, Table C2, reference 3);

d) modulation test (as per C/S T.007, Table C2, reference 4);

e) 406 MHz transmitted frequency test (as per C/S T.007, Table C2, reference 5);

f) spurious emissions test (as per C/S T.007, Table C2, reference 6);

g) 406 MHz VSWR check (as per C/S T.007, Table C2, reference 7);

h) temperature gradient test (as per C/S T.007, Table C2, reference 11); and

i) satellite qualitative tests (as per section 3.5 of this document).

- END OF SECTION 3 -

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ANNEXES TO THE COSPAS-SARSAT SPECIFICATION AND TYPE APPROVAL STANDARD FOR 406 MHz SHIP SECURITY ALERT (SSAS) BEACONS

ANNEX A

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

A.1 INFORMATION PROVIDED BY THE BEACON MANUFACTURER

Beacon Manufacturer and Beacon Model

Beacon Manufacturer	
Beacon Model	

Beacon Characteristics

Characteristic	**Specification**
Operating temperature range	Tmin =______ Tmax=______
Operating lifetime	_______hours
Power source (beacon battery, ship main AC power, combined power source or other – please indicate)	
Battery chemistry	
Battery cell size and number of cells	
Battery manufacturer	
Battery pack manufacturer and part number	
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 (Integrated or External)	
Antenna manufacturer	
Antenna part name and number	

Characteristic	**Specification**
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	
- Geodetic reference system	
- GNSS receiver cold start forced at every beacon activation (Yes or No)	
- Navigation device manufacturer	
- Navigation device model name and part Number	
- 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	
- Navigation device model and manufacturer (if beacon designed to use specific devices)	
Self-Test Mode Characteristics	
- 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)	

Characteristic	**Specification**
- 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.)	
- Self-test can be activated from beacon remote activation points (Yes or No)	
- Self-test performs an internal check and indicates that RF power is emitted at 406 MHz (Yes or No)	
- 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")	
Beacon includes a homer transmitter (Yes or No)	
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)	
Does the beacon provide any features in addition to SSAS 406 MHz transmissions? If so identify.	

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

(Continued on Next Page)

A.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[1]		
C/S T.007[1]		
C/S T.015		

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 amended by the Cospas-Sarsat Specification and Type Approval Standard for 406 MHz Ship Security Alert Beacons (C/S T.015), and demonstrated in the attached report.[2]

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

(Name, Position and Signature of Beacon Manufacturer Representative)

- END OF ANNEX A -

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1 For requirements that are defined in documents C/S T.001 and C/S T.007 by reference, identify the issue and revision of documents C/S T.001 and C/S T.007 that were applied.

2 If the test results do not support full compliance to the above standards, 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.

ANNEX B

ANTENNA CHARACTERISTIC TEST PROCEDURE AND REPORTING REQUIREMENTS

B.1 SCOPE

B.1.1 This Annex describes the measurement procedure to verify the antenna characteristics of 406 MHz SSAS beacons defined in document C/S T.015, and the associated reporting requirements. The beacon antenna characteristics are determined by measuring the beacon Equivalent Isotropically Radiated Power (EIRP) performance throughout its specified coverage region. Alternative procedures including the use of a shielded anechoic room are acceptable if they provide equivalent information, provided they have minimal impact on Cospas-Sarsat operations.

B.1.2 This antenna test requires data to be measured at 77 antenna positions. If the antenna can be set to its new position during the 50-second interval between beacon transmissions, the entire test could be performed in about 2.5 hours (1.25 hour for each polarization), thereby minimizing the impact on the Cospas-Sarsat System if tests are performed outside.

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. The BUT shall be tested on ground plane configurations that simulate manufacturer authorised installations and conditions in which the beacon might be expected to operate, including:

- a configuration that shall be used for beacons that use antennas mounted directly on a flat reflective horizontal surface that extend a minimum of one metre from the antenna in all directions (Figure B.1 and B.2); and

- a configuration that shall be used for beacons that do not require a ground plane or whose ground plane is part of the beacon or antenna (Figure B.3 and B.4).

If the beacon is intended to support both installations, then antenna testing in both configurations shall be conducted. The applicable ground plane configurations, as described above, will be decided by the Cospas-Sarsat Secretariat on the basis of technical considerations relevant to the manufacturer antenna description and installation guidelines.

B.2.2 A measuring antenna located at a distance a minimum of 3 metres from the BUT shall be used to measure the emitted field strength. The test facility shall move the measuring antenna as required to evaluate the 77 different antenna positions (ideally the measuring antenna shall be raised vertically for measurements between 10 degrees and 50 degrees and shall then be moved horizontally towards the BUT to make the 60 degrees to 90 degrees measurements). The BUT shall be equipped with a fresh battery and the test performed at ambient temperature.

B.2.3 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, antenna tests shall be conducted using a beacon operating at its nominal repetition rate and coded with a long message test protocol. 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 sort.

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 required. This ground is referred to as “Ground Plane A” in figures B.2 and B.3. All electrical wires and cables should 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 above ground shall be within 6 metres of the BUT during actual measurements. Test reports shall include a detailed description of the test environment. They 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.

B.3.5 Beacon antennas designed to be mounted directly on a flat reflective horizontal surface that extend a minimum of one metre from the antenna in all directions, shall be tested in the configuration depicted in Figure B.2. The raised ground plane depicted on Figure B.2 as “ground plan A”, shall have a minimum radius of 125 cm and be made of highly conductive material (aluminium or copper). It shall be positioned 0.75 +/- 0.10 metres above ground plane A.

B.4 MEASURING ANTENNA

B.4.1 The radiated field of the BUT antenna shall be detected and measured using a tuned dipole or an RHCP antenna. The measurement antenna shall be positioned at a minimal distance of 3 metres from the BUT antenna and mounted on a non-conducting structure.

B.4.2 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.4.3 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. If the measuring antenna cannot be maintained perpendicular to the direction of propagation a correction factor must be considered due to the gain variation pattern of the measuring antenna.

B.5 RADIATED POWER MEASUREMENTS

B.5.1 Prior to each open field test site transmission, the appropriate national authorities responsible for Cospas-Sarsat and radio emissions shall be notified.

B.5.2 The radiated power measurement procedure provides data which can be used to calculate the beacon EIRP by measuring the vertically and horizontally polarised waves. Conversely, direct EIRP measurements can be performed using a RHCP measuring antenna with a known antenna factor at 406 MHz.

B.5.2.1 Measurement Requirements

The BUT shall be transmitting normally with a fresh battery. The signal received by the measuring antenna should be coupled to a spectrum analyzer or a field strength meter and the radiated power output should be measured during the beacon transmission. The receiver should be calibrated according to the range of level expected, as described in section B.6.

Measurements shall be taken for the azimuths and elevations identified at Table B.1. The induced voltages for both polarizations are measured for each position. Conversely, a single induced voltage measurement at each position will be provided if a RHCP measuring antenna is used.

B.5.2.2 EIRP and Antenna Gain Calculations

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

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

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

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

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

where:
V_{rec} is the calculated signal level from Step 1 (dBV)
AF_c is the corrected antenna factor as defined in paragraph B.4.2 and B.4.3
Lc is the receiver system attenuation and cable loss (dB)

Step 3: Calculate the EIRP and the G_i

Using the standard radio wave propagation equation:

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

and

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

we get the EIRP for each set of angular coordinates from

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

and the antenna gain from

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

where:

R is the distance between the BUT and the measuring dipole antenna
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.6 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) should be calibrated as follows:

a) Connect the equipment and install the BUT as shown in Figures B.1 and / or B.3, as appropriate.

b) Turn on the BUT for normal transmission. Set the receiver bandwidth to measure the power of the transmission. 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.7 ANTENNA POLARIZATION

B.7.1 If a RHCP measuring antenna is used for the antenna measurement no polarisation antenna polarisation measurements (table B.2) and analyses are required.

B.7.2 If a linearly polarized measuring antenna is used, an analysis of the raw data (V_v, V_h) obtained during the antenna test conducted with the beacon in configuration B.2 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.3.

B.7.3 If the induced voltage measurements V_v and V_h for at least 80% of all angular coordinates (elevation less or equal to 50 degrees) 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.7.4 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.7.5 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.8 shall be directly applied to the EIRP results. If the results are in accordance with C/S T.015 requirements, then the antenna should be accepted regardless of any circularly polarized component of the signal.

B.7.6 Report the measurement results in Table B.2.

B.8 ANALYSIS OF EIRP

B.8.1 Enter the type of antenna polarization determined per Section B.7 in Table B.1

B.8.2 Enter the EIRP levels in Table B.1. Verify that, for at least 90% of the measurement coordinates of the RHCP antenna and at least 80% of the measurement coordinates of the linear antenna, the BUT produces a field equivalent to an EIRP in the range of 34 dBm to 43 dBm for a RHCP antenna and of 32 dBm to 43 dBm for a Linear antenna. Specifically annotate Table B.1:

- with highlighted text, to indicate all the EIRP values that are not within the 34 dBm to 43 dBm or 32 dBm to 43 dBm range, as appropriate; and

- with stricken-out text, any EIRP levels that were removed from consideration for calculating the EIRP maximum and minimum values at the end of life.

B.8.3 For the set of measurements identified in Section B.8.2, the overall maximum ($EIRP_{max}$) and minimum ($EIRP_{min}$) EIRP values shall be identified in Table B.1.

B.8.4 A power loss factor ($EIRP_{LOSS}$) is determined to correct for what the power output would be after the beacon operated at minimum temperature for its operating lifetime.

The value of $EIRP_{LOSS}$ is calculated by subtracting the lowest beacon transmit power level observed during the lifetime at minimum temperature test from the transmit power measured at ambient temperature.

The value of $EIRP_{LOSS}$ is entered in Table B.1. $EIRP_{LOSS}$ is subtracted from the results in Section B.8.3 and entered in Table B.1 and item 14 of Table D.2 as $EIRP_{max\ EOL}$ and $EIRP_{min\ EOL}$.

B.9 ANTENNA VSWR MEASUREMENT

This section is not applicable to beacons with integral antennas.

B.9.1 The antenna VSWR of the BUT should 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.9.2 Numerous precautions are necessary in VSWR measurement to avoid errors due to the effect of nearby conducting objects on the antenna current distribution.

B.9.3 Consequently, the VSWR measurement should be done with the BUT mounted in the same configuration as used for the open field test site used for antenna test.

B.9.4 Report the measurement results in Table D.2. 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.

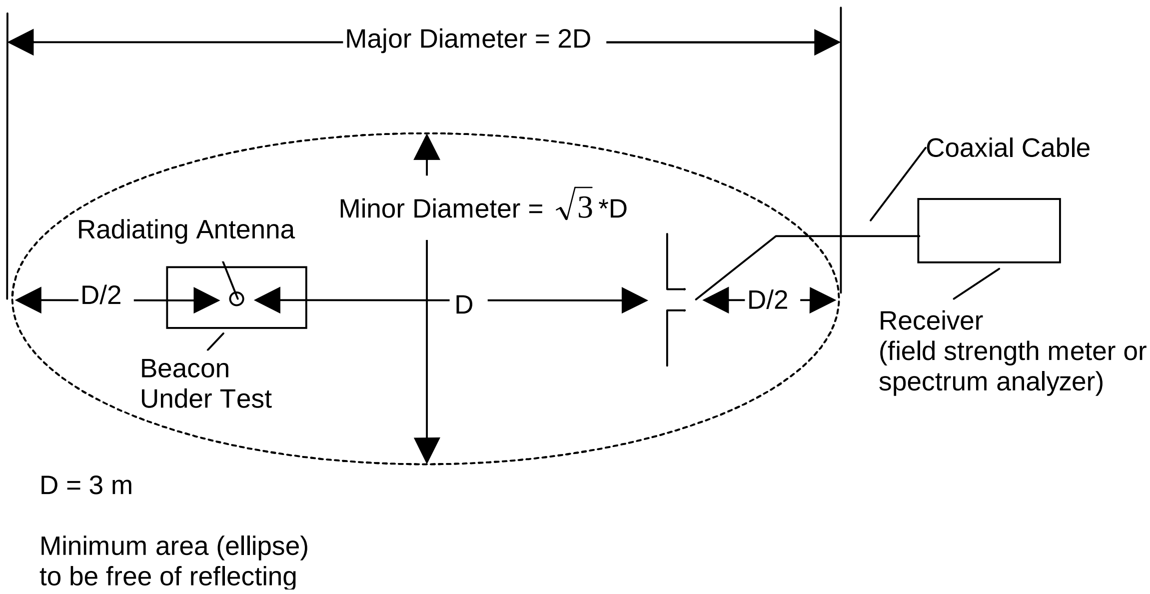

Figure B.1: Test Site Plan View

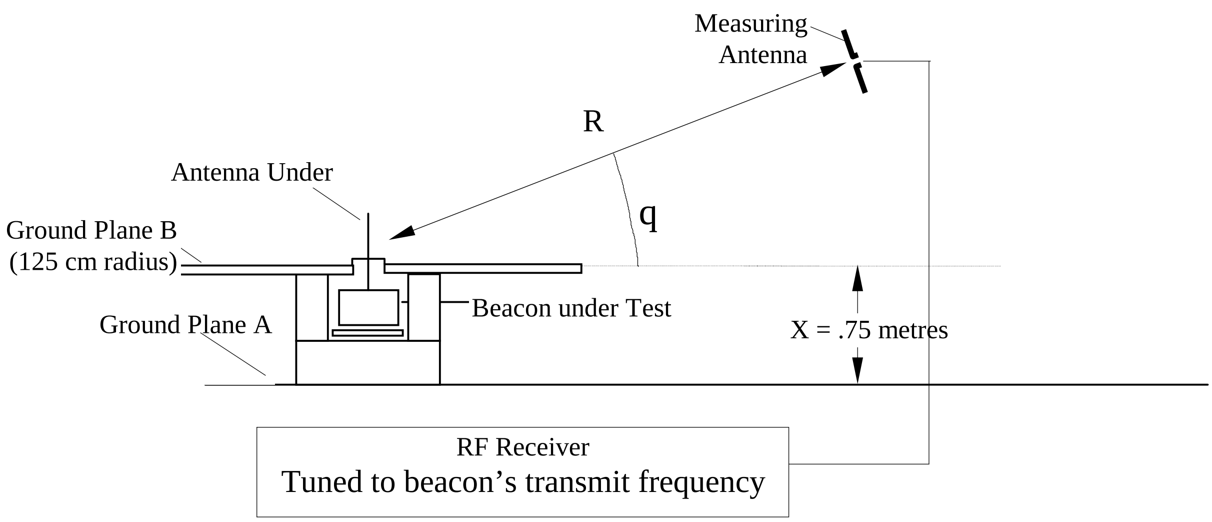

Figure B.2: Test Configuration for Antenna Mounted Directly on Large Ground Plane

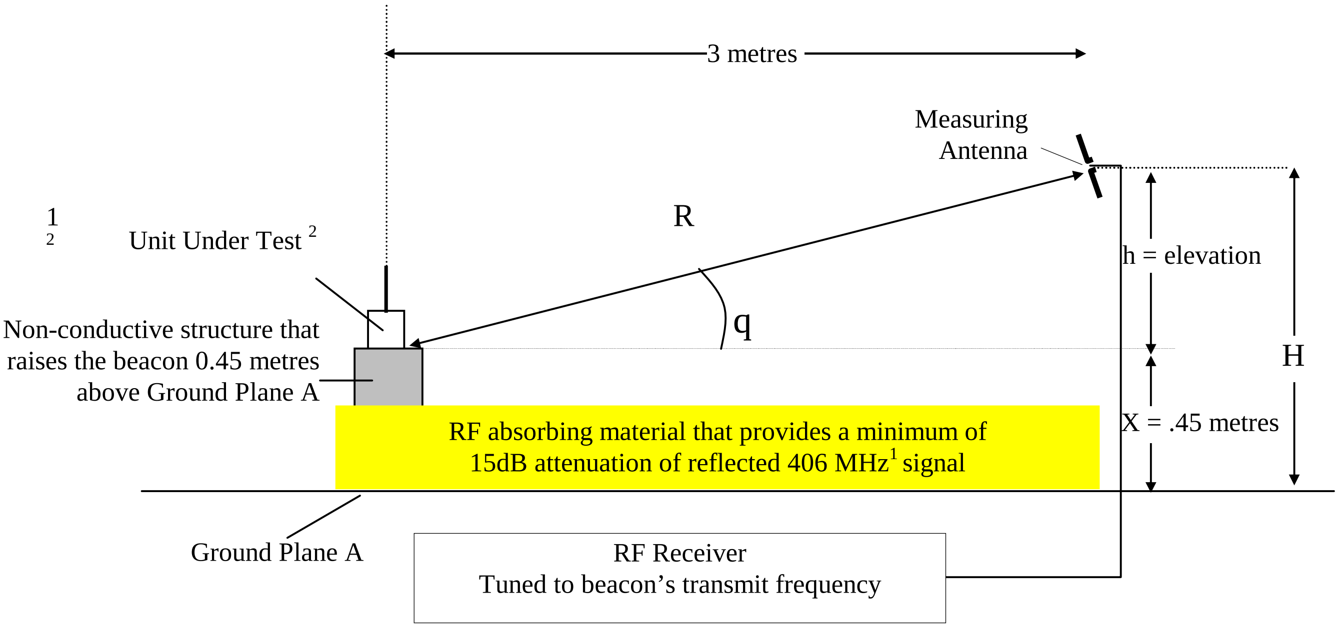

Figure B.3: Additional Test Configuration for all Devices that Might be Required to Operate Without a Ground Plane

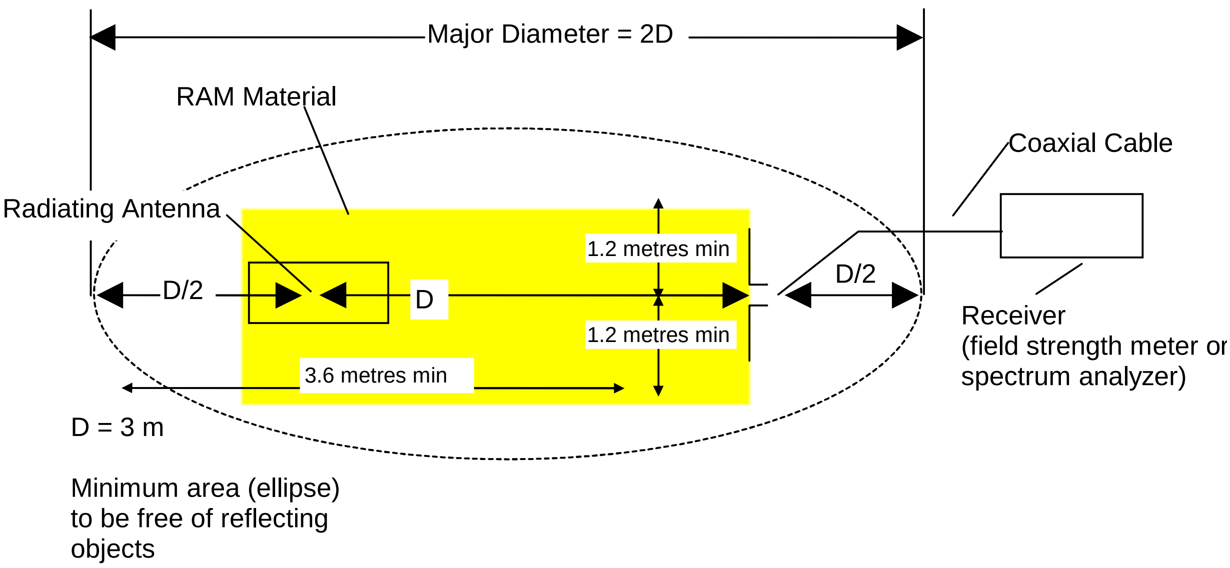

Figure B.4: Test Site Plan View with RAM Material

[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.3 and B.4), maximum height of 0.4 metres.

[2] Antenna may be mounted remotely from beacon for this test to simulate masthead mounting, etc.

Table B.1: Equivalent Isotropically Radiated Power (dBm) / Antenna Gain (dBi)

Azimuth Angle (Degrees)	Elevation Angle (Degrees)								
	10	20	30	40	50	60	70	80	90
0	/	/	/	/	/	/	/	/	/
30	/	/	/	/	/				
60	/	/	/	/	/	/	/		
90	/	/	/	/	/			/	
120	/	/	/	/	/	/	/		
150	/	/	/	/	/				
180	/	/	/	/	/	/	/	/	
210	/	/	/	/	/				
240	/	/	/	/	/	/	/		
270	/	/	/	/	/			/	
300	/	/	/	/	/	/	/		
330	/	/	/	/	/				

$EIRP_{LOSS} = Pt_{AMB} – Pt_{EOL}$ =___________dB

$EIRP_{max\ EOL}$ = **MAX [** $EIRP_{max}$ **,** ($EIRP_{max}$ - $EIRP_{LOSS}$) **]** = **MAX (** _____ **,** _____ **)** = ___________dBm

$EIRP_{min\ EOL}$ = **MIN [** $EIRP_{min}$ **,** ($EIRP_{min}$ - $EIRP_{LOSS}$) **]** = **MIN (** _____ **,** _____ **)** = ___________dBm

NOTE: for calculating $EIRP_{min\ EOL}$, use data from elevations 10 to 70 degrees.

Antenna Polarisation:________________________

Table B.2: Induced Voltage Measurements V_v/V_h (dBµV)[1]

Azimuth Angle (Degrees)	Elevation Angle (Degrees)								
	10	20	30	40	50	60	70	80	90
0	/	/	/	/	/	/	/	/	/
30	/	/	/	/	/				
60	/	/	/	/	/	/	/		
90	/	/	/	/	/			/	
120	/	/	/	/	/	/	/		
150	/	/	/	/	/				
180	/	/	/	/	/	/	/	/	
210	/	/	/	/	/				
240	/	/	/	/	/	/	/		
270	/	/	/	/	/			/	
300	/	/	/	/	/	/	/		
330	/	/	/	/	/				

- END OF ANNEX B -

[1] Induced voltage measurement results are not required if the beacon EIRP performance was measured using a RHCP receive antenna.

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ANNEX C

TYPE APPROVAL REQUIREMENTS FOR BEACONS BASED ON DESIGN OF A TYPE APPROVED 406 MHz DISTRESS BEACON

C.1 GENERAL

For SSAS beacons with a design based on a 406 MHz distress beacon that was previously type approved by Cospas-Sarsat, depending upon the scope of beacon design changes it might be possible to reduce the scope of testing required.

In all such cases the scope of testing will be based upon the Secretariat's evaluation of the modifications made to the distress beacon. The information provided below is for information purposes only. Beacon manufacturers should contact the Secretariat to confirm the scope of testing for their specific case prior to arranging and conducting tests at an accepted test facility.

C.2 DOCUMENTATION

The data submitted to the Secretariat shall comprise a complete type approval package as defined in section 3.2 of this document. In cases where tests from the original type approval testing is allowed in lieu of retesting, the original test report should be included in the type approval package submitted to the Secretariat.

C.3 SCOPE OF TESTING

The scope of testing will be determined by the Secretariat after reviewing a description of the modifications to the beacon provided by the manufacturer. For guidance purposes only, an indication of the scope of testing for specific changes can be estimated if the specific changes are addressed in either section 6.2 of document C/S T.007 and/or the information provided in this section. In all cases the manufacturer shall agree the scope of testing with the Secretariat prior to the start of testing since the culmination of several changes may require complete beacon retesting, rather than the individual testing identified below or in section 6.2 of C/S T.007.

C.3.1 Antenna Testing

All 406 MHz SSAS beacons shall undergo complete antenna testing as described at Annex B.

C.3.2 Removal or Disabling of a Homing Device

A type approved beacon modified to remove or disable a homing device shall undergo the following tests at an accepted Cospas-Sarsat type approval facility:

a) satellite qualitative tests (as per section 3.5 of this document); and

b) beacon coding software test (as per section 3.6 of this document).

C.3.3 Adding Remote Control Activation Capability

A type approved beacon modified to include a method for remotely activating the beacon shall undergo the following tests at an accepted Cospas-Sarsat type approval facility:

a) modulation test (as per C/S T.007, Table C2, reference 4);

b) VSWR tests (as per C/S T.007, Table C2, reference 7);

c) operating lifetime at minimum temperature test (as per C/S T.007, table C2, reference 10);

d) temperature gradient test (as per C/S T.007, Table C2, reference 11);

e) satellite qualitative tests (as per section 3.5 of this document); and

f) beacon coding software test (as per section 3.6 of this document).

C.3.4 Powered by External DC Supply

A type approved beacon modified to receive electrical power from an external DC power supply shall undergo the following tests at an accepted Cospas-Sarsat type approval facility:

a) satellite qualitative tests (as per section 3.5 of this document); and

b) beacon coding software test (as per section 3.6 of this document).

In addition the manufacturer shall provide technical analysis that demonstrates that the external battery is capable of powering the beacon for its rated lifetime, as well as all the other loads supported by the power source. This analysis should take into account all loads on the battery as required for the operational lifetime test at minimum temperature described in document C/S T.007.

- END OF ANNEX C -

ANNEX D

BEACON TYPE APPROVAL TEST RESULTS

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

Parameters to be Measured	Bits number	Range of Specification	Units	Test Results			Comments
				T_{min} (_____C)	T_{amb} (_____C)	T_{max} (_____C)	
1. Power Output							
- transmitter power output		37-39	dBm				
- power output rise time		<5	ms				
- power output 1 ms before burst		<-10 dBm	√[1]				
- information confirming that no homer generator/ transmitter is present (or was removed/ disabled)							
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	27-85	59 bit	√				
- BCH code	86-106	21 bits	√				
- emergency code /national use/ supplementary data	107-112	6 bits	bit value				
- additional data/BCH	113-144	32 bits	√				
- position error		<5	km				
3. Digital Message Generator							
- repetition rate T_R:							
• average T_R		48.5-51.5	sec				
• min T_R		$47.5 \leq T_R \leq 48.0$	sec				
• max T_R		$52.0 \leq T_R \leq 52.5$	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:							
• 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 D.1.

Parameters to be Measured	Range of Specification	Units	Test Results			Comments
			T_{min} (______C)	T_{amb} (______C)	T_{max} (______C)	
4. Modulation						
- biphase-L		√				
- rise time	50-250	μsec				
- fall time	50-250	μsec				
- phase deviation: positive	+(1.0 to 1.2)	radians				
- phase deviation: negative	-(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	$\leq 2 \times 10^{-9}$	/100 ms				
- medium-term stability slope	$(-1 \text{ to } +1) \times 10^{-9}$	/min				
- medium-term stability residual frequency variation	$\leq 3 \times 10^{-9}$					
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	50-250	μsec				
- modulation fall time	50-250	μsec				
- modulation phase deviation +ve	+(1.0 to 1.2)	radians				
- modulation phase deviation -ve	-(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
8. Self-test Mode				
- frame sync	"011010000"	√		
- format flag	1/0	bit value		
- single radiated burst	520 (±1%)	ms		
- default position data (if applicable)	must be correct	√		
- description provided		√		
- design data provided on protection against repetitive self-test mode transmissions		√		
- single burst verification	one burst	√		
- provides for 15 Hex ID	correct	√		
- 406 MHz RF power	self-test checks that RF power emitted	√		
9. Operating Lifetime at Minimum Temperature[1]				
- duration	>24		_____hours at T_{min}=_____	
- transmit frequency nominal value	C/S T.001	MHz		
- transmit frequency short-term stability	$\leq 2x10^{-9}$	/100ms		
- transmit frequency medium-term stability slope	$(-1 \text{ to } +1)x10^{-9}$	/min		
- transmit frequency medium-term stability residual frequency variation	$\leq 3x10^{-9}$			
- Pt_{EOL}=minimum transmitter power output observed during lifetime at minimum temperature	37-39	dBm		
- Digital message	correct	√		

[1] Attach graphs depicting test results.

Parameters to be Measured	Range of Specification	Units	Test Results	Comments
10. Temperature Gradient (5 C/hr)[1]				
- transmit frequency nominal value	C/S T.001	MHz		
- transmit frequency short-term stability	$\leq 2x10^{-9}$	/100ms		
- transmit frequency medium-term stability				
• slope (A to B, C+15 to D and E+15 to F)	$(-1 \text{ to } +1)x10^{-9}$	/min		
• slope (B to C+15 and D to E+15)	$(-2 \text{ to } +2)x10^{-9}$	/min		
• residual frequency variation	$\leq 3x10^{-9}$			
- transmitter power output	37-39	dBm		
- digital message	correct	√		
11. Oscillator Aging (data provided)	C/S T.001	MHz		
12. Protection Against Continuous Transmission description provided	<45	sec		Provide description.
13. Satellite Qualitative Test (results provided)[2]	As per section 3.5 of C/S T.015	√		
14. Antenna Characteristics				
- polarization	linear or RHCP			
- VSWR	≤1.5			
- $EIRP_{LOSS}$		dB		
- $EIRP_{max\ EOL}$	≤43	dBm		
- $EIRP_{min\ EOL}$	≥34 for RHCP antennas	dBm		
	≥32 for linear antennas	dBm		
- Antenna Gain				
for RHCP antennas	(-3 to 4)	dBi		
for linear antennas:				
- elevation angle (5° - 70°)	(-5 to 4)	dBi		
- elevation angle 80°	(-10 to 4)	dBi		
- elevation angle 90°	(-15 to 4)	dBi		

[1] Attach graphs depicting test results.

[2] Attach a satellite qualitative test summary report (Appendix A to Annex D).

Parameters to be Measured	Range of Specification	Units	Test Results	Comments
15. Beacon Coding Software[1]				
- sample messages provided for SSAS beacon coding as per section 3.6	correct	√		Per Table D-D.1
- sample self-test message provided for SSAS beacon coding	correct	√		Per Table D-D.1
16. Navigation System[2]				
- position data default values	correct	√		
- position acquisition time	<10/1	min		Per Table D-C.2 or D-C.3
- encoded position data update interval	>20	min		
- position clearance after deactivation	cleared	√		Test per A.3.8.4 of C/S T.007
- position data input update interval (as applicable)	20/1	min		
- position data encoding	correct	√		Results per tables D-C.1
- retained last valid position after navigation input lost	240(±5)	min		
- default position data transmitted after 240(±5) minutes without valid position data	cleared	√		Test per A.3.8.6 of C/S T.007
- information provided on protection against beacon degradation due to navigation device, interface or signal failure or malfunction		√		

[1] Attach examples of SSAS beacon coding as per Appendix D to Annex D.

[2] Attach navigation system test results as per Appendix C to Annex D.

APPENDIX A TO ANNEX D

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. provide description or refer to a photo of the test configuration):____

Table D-A.1: LEOSAR Results

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

$$\text{Ratio of successful solutions} = \frac{\text{number of Doppler solutions within 5 km with } 1° < CTA < 21°}{\text{number of satellite passes over test duration with } 1° < CTA < 21°} \times 100 = \_\_\_\_\%$$

Table D-A.2: GEOSAR Results

Satellite ID	Beacon Activation Date and Time	30 Hexadecimal Message Produced by GEOLUT	Date and Time Message Produced by GEOLUT

APPENDIX B TO ANNEX D

406 MHz BEACON ANTENNA TEST RESULTS

Table D-B.1: Equivalent Isotropically Radiated Power (dBm) / Antenna Gain (dBi)

Azimuth Angle (Degrees)	Elevation Angle (Degrees)								
	10	20	30	40	50	60	70	80	90
0	/	/	/	/	/	/	/	/	/
30	/	/	/	/	/				
60	/	/	/	/	/	/	/		
90	/	/	/	/	/			/	
120	/	/	/	/	/	/	/		
150	/	/	/	/	/				
180	/	/	/	/	/	/	/	/	
210	/	/	/	/	/				
240	/	/	/	/	/	/	/		
270	/	/	/	/	/			/	
300	/	/	/	/	/	/	/		
330	/	/	/	/	/				

$EIRP_{LOSS}$ = Pt_{AMB} – Pt_{EOL} =__________dB

$EIRP_{max\ EOL}$ = **M AX [** $EIRP_{max}$ **,** ($EIRP_{max}$ - $EIRP_{LOSS}$) **]** = **MAX (** _____ **,** _____ **)** = ___________dBm

$EIRP_{min\ EOL}$ = **MIN [** $EIRP_{min}$ **,** ($EIRP_{min}$ - $EIRP_{LOSS}$) **]** = **MIN (** _____ **,** _____ **)** = ___________dBm

<u>NOTE:</u> for calculating $EIRP_{min\ EOL}$, use data from elevations 10 to 70 degrees.

Table D-B.2: Induced Voltage Measurements V_v / V_h (dBuV) [1]

Azimuth Angle (Degrees)	Elevation Angle (Degrees)								
	10	20	30	40	50	60	70	80	90
0	/	/	/	/	/	/	/	/	/
30	/	/	/	/	/				
60	/	/	/	/	/	/	/		
90	/	/	/	/	/			/	
120	/	/	/	/	/	/	/		
150	/	/	/	/	/				
180	/	/	/	/	/	/	/	/	
210	/	/	/	/	/				
240	/	/	/	/	/	/	/		
270	/	/	/	/	/			/	
300	/	/	/	/	/	/	/		
330	/	/	/	/	/				

Antenna Polarisation:______________________

[1] Induced voltage measurement results are not required if the beacon EIRP performance was measured using a RHCP receive antenna.

APPENDIX C TO ANNEX D

NAVIGATION SYSTEM TEST RESULTS

Table D-C.1: Position Data Encoding Results

Script Reference (See Table D.2 of document C/S T.007)	Value of Encoded Location Bits Transmitted by Beacon (Hexadecimal)	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=	
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=	

Table D-C.2: Position Acquisition Time and Position Accuracy (Internal Navigation Devices)

C/S T.007 Section A3.8.2.1		C/S T.007 Section A3.8.2.2	
Time to Acquire Position (sec)	Location Error in metres	Time to Acquire Position (sec)	Location Error in metres

Table D-C.3: Position Acquisition Time and Position Accuracy (External Navigation Devices)

C/S T.007 Section A3.8.2.1		C/S T.007 Section A3.8.2.2	
Time to Acquire Position (sec)	Location Error in metres	Time to Acquire Position (sec)	Location Error in metres

APPENDIX D TO ANNEX D

BEACON CODING SOFTWARE RESULTS

Table D-D.1: Examples of Ship Security Alert Beacon Messages

Operational Message (in hexadecimal including bit and frame synchronisation bits)[14]		Self-Test Message (in hexadecimal including bit and frame synchronisation bits)
Location “A”	Location “B”	

- END OF ANNEX D -

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[14] Location “A” and location “B” must be separated by at least 500 metres

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