COSPAS-SARSAT SECOND-GENERATION
406-MHz DISTRESS BEACON
TYPE APPROVAL STANDARD

C/S T.021
Preliminary Issue A
June 2018

Document C/S T.021, Preliminary Issue A is not sufficiently mature to allow the type approval of beacons given the uncertainty about the maturity of the test procedures. However, if the Parties deem testing results, technical review, and testing procedures to be sufficiently compelling as to performance, they may decide to type approve a beacon that has been tested using the procedures of document C/S T.021, Preliminary Issue A.

COSPAS SARSAT

COSPAS-SARSAT SECOND GENERATION 406-MHz BEACON TYPE APPROVAL STANDARD

HISTORY

Issue	Revision	Date	Comments
Preliminary A		June 2018	Approved by CSC-60

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1. INTRODUCTION

1.1 Scope

This document defines the Cospas-Sarsat policy and process for type approval of 406-MHz distress beacons as specified by document C/S T.018 and describes:

a) the procedure to apply for a Cospas-Sarsat type approval of a 406-MHz distress beacon designed to the specifications of Cospas-Sarsat document C/S T.018;

b) the type approval procedures, tests, and validation methods to verify compliance of 406-MHz distress beacons designed to the specifications of Cospas-Sarsat document C/S T.018;

c) the reporting requirements that must be satisfied by beacon manufacturers and approved Cospas-Sarsat test facilities for the completion of a type approval application for Second Generation 406-MHz distress beacons requirements, and

d) the procedures to apply for modifications to Cospas-Sarsat type approved models.

1.2 Reference Documents

a) Cospas-Sarsat Document C/S T.018, "Specification for Second-Generation 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) Cospas-Sarsat Document C/S G.004, "Cospas-Sarsat Glossary".

1.3 Terms, Abbreviations, and Definitions

This section is reserved for the inclusion of any specific terms, abbreviations, and definitions which are not included in the glossary of acronyms and terminology on the Cospas-Sarsat website, as Reference Document d), and also currently located at:

http://www.cospas-sarsat.int/en/documents-pro/acronyms-and-terminology

In the event of a conflict between any item defined herein and the online version, this document will take precedent for the purposes of this document.

Beacon Model Definitions

The definition of beacon models, variants, and changes is integral to the assignment and maintenance of the type approval certificates and letters of compatibility that are assigned by the Cospas-Sarsat Secretariat.

Beacon Model: A beacon model is a specific version of a beacon design that has been defined by the beacon manufacturer and results in specific configuration(s) of the deployed beacon with a known feature set that is covered by the type approval for that beacon. (e.g., Model X1-G is an EPIRB, with a 121.5 MHz homer, including a GNSS capability, Model X1 is an EPIRB, with a 121.5 MHz homer but does not include a GNSS capability). Each beacon model design will be assigned a unique design certification TAC number.

Beacon Model Family: A beacon family is a series of beacon models which have similar design origins for which all beacon model features can be evaluated by the testing of a subset of the beacon models. (i.e., testing a beacon model with 121.5 MHz and 243 MHz homer would be sufficient to also accept (with supporting documentation) a model that only had a 121.5 MHz homer enabled). The relationship between these beacon models will be documented by the Cospas-Sarsat Secretariat and each model will be assigned a unique TAC.

Approved Configuration: A single beacon model may have several approved configurations which were included in the original type approval or change application (e.g., an ELT may be approved for use with several different antennas, or various remote-control panels, a military PLB may be approved with different antennas).

Beacon Variant: A beacon variant is a beacon model that is identical to an approved beacon design in electrical design and Cospas-Sarsat certified performance. This may include labels and product branding and/or variations in product features that are outside the Cospas-Sarsat certification, such as hydro-static release mechanisms, mounting brackets, case colour or features etc. Beacon variants will be treated as a single beacon model, but will be listed separately on the TAC for that model.

Beacon Modifications: A beacon modification is any change to the beacon design, as previously approved by Cospas-Sarsat, which results in a change in the electrical performance of production beacons.

Only a significant or major beacon modification as defined in section 2.4 will result in the issuing of a new design TAC. These may not include changes or additions to Approved Configurations which are also managed by the Secretariat.

1.4 Relationship to C/S T.018 and Other Cospas-Sarsat Documents

This document:

a) defines the policies and processes which are intended to be applied to ensure that a 406-MHz distress beacon designed to the C/S T.018 Standard, is compliant with the programme requirements for type approval of the product;

b) maps the requirements from document C/S T.018 to this document including the validation methods which are intended to be applied to perform the type approval evaluation as described in ANNEX L: COMPLIANCE VERIFICATION MATRIX;

c) provides the test procedures to ensure SGBs are compatible with the frequency management requirements in document *C/S T.012*; and

d) contains the test procedures and methods to ensure compliance with C/S T.018 by the C/S T.008 compliant Cospas-Sarsat Test Facilities.

- END OF SECTION 1 -

2. COSPAS-SARSAT TYPE APPROVAL PROCESS

2.1 Type Approval Policy

Cospas-Sarsat beacon type approval, through the policies and process of this document, is intended to ensure beacon-model compatibility with Cospas-Sarsat receiving and processing equipment, and minimum performance standards that have been agreed among the Cospas-Sarsat participating governments and agencies. Compliance with these requirements provides assurance that the tested beacon performance is compatible with, and will not degrade, the Cospas-Sarsat system, and meets other Cospas-Sarsat standards approved by participating governments and agencies.

All optional / additional features defined in document C/S T.018 will be validated as a part of the beacon type approval process. Any other features or functionality of the beacon design must also be included in the certification testing to the extent that they affect the 406-MHz distress-signal performance as specified in document C/S T.018.

During the type-approval evaluation, beacon models that are equipped for transmitting a 406-MHz homing signal must be tested to ensure that the homing signals will not negatively impact the System performance. The suitability of any 406-MHz signals for homing purposes is the prerogative of national administrations, however, unlike out-of-band homing signals, the emission of any homing signals in the 406.0 to 406.1 MHz band is a beacon-model characteristic to be evaluated during the type-approval process to determine whether there is any System performance degradation not permitted by Cospas-Sarsat specifications.

Within Cospas-Sarsat specifications, GNSS receivers are an optional feature for most beacon models. (National governments or other agencies may separately mandate GNSS receivers.) Beacon models which include the optional GNSS functionality will be subjected to a basic set of GNSS performance tests primarily intended to ensure that the position data can be correctly encoded into the beacon message. Beacon models which incorporate a mandatory GNSS functionality in response to a specific Cospas-Sarsat GNSS-based performance requirement, (e.g., ELT(DT)s and RLS-equipped models), will be subjected to an extended set of validation tests in order to verify the specified performance.

During the type-approval evaluation, Cospas-Sarsat will verify the Return Link Service (RLS) functionality, if applicable, (specified in Cospas-Sarsat documents and as specified by recognized regional standards-setting bodies) for any beacon model that incorporates this feature into its design.

Cospas-Sarsat does not typically specify the environmental requirements for the certification of the overall beacon product. The definition of environmental requirements and their verification are the prerogative of the national authorities to define. However, it is recognized that many national and international standards for beacon products make reference to the Cospas-Sarsat Standards for

406-MHz performance and in many cases require environmental testing to be carried out on the beacon design prior to obtaining the Cospas-Sarsat certification.

It is generally acknowledged that environmental testing (e.g., shock and vibration testing) should be carried out prior to the confirmation of the electrical performance of the design, when required.

National authorities retain the right to issue additional beacon carriage regulations, performance requirements, and any required testing and type approval of 406-MHz distress beacons that they may deem necessary.

National authorities and agencies should require manufacturers to comply with the provisions of this document to ensure compliance with the International Telecommunication Union Radio Regulations and to ensure compatibility with the global Cospas-Sarsat System, for which allocations have been made through the Radio Regulations.

2.2 Cospas-Sarsat Certification

2.2.1 Type Approval Certificate

A Cospas-Sarsat Type Approval Certificate, TAC (see TAC sample in ANNEX I), is issued by the Cospas-Sarsat Secretariat, on behalf of the Cospas-Sarsat Council, to the manufacturer for each 406-MHz distress beacon model that has been successfully tested[1] at an accepted Cospas-Sarsat test facility and type-approved by Cospas-Sarsat. The beacon TAC numbers will be assigned in the ranges described in Table 2.1.

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 will issue a unique TAC number to each beacon model, however this does not preclude a family of similar beacons from being submitted under one type approval application. The relationship to other beacon models in a beacon family will be retained by the Secretariat and identified on the Cospas-Sarsat web-site.

[1] A complete type approval test for an initial application, which may include a partial test of related model designs with reduced feature sets (i.e., Full GNSS versus a Non-GNSS model, etc.)

Table 2.1: Type Approval Certificate Range

TAC Range	Description
1 to 9,999	Reserved for FGB beacons: to ensure no duplicate TAC numbers are assigned to SGBs.
10,000 to 69,999	SGB Model Design Certification TACs: design approval TACs for SGBs for use in product certification and to capture future major beacon modifications.
70,000 to 99,999	SGB Model Letter of Compatibility TACs: design approval TACs for SGBs for use in product certification and to capture future major beacon modifications of beacons which are approved under a Letter of Compatibility in lieu of a full type approval.
100,000 to 1,048,575	SGB Production Extension TACs: TACs or blocks of TACs which are assigned solely to facilitate continued serial number allocation to an already approved production beacon design.
999,999	Allocated for SGB Type Approval Testing

Cospas-Sarsat design certification TAC numbers will be assigned in the following cases:

- type approval of new beacon models, and
- significant or major changes to an approved beacon model, as defined in section 2.4 of this document.

Cospas-Sarsat production extension TAC numbers will be assigned in the following cases:

- the need for additional serial numbers to encode a unique identification of the beacon, provided that the capacity of all possible serial numbers associated with previously assigned TAC number(s) are fully used (See section 2.4.4).

Except as authorized by a national administration, a Cospas-Sarsat Type Approval Certificate itself is not sufficient to 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 place beacons on the market.

The Type-Approval Certificate is subject to revocation or suspension by the Cospas-Sarsat Council should the beacon model for which it was issued cease to meet the Cospas-Sarsat specification, or the Council determine that there are irregularities in beacon production or marketing that are inconsistent with the terms of the Type Approval Certificate.

2.2.2 Letter of Compatibility

At times, with the support of a Cospas-Sarsat Participant, beacons are designed to meet specific user requirements but do not meet some of the Cospas-Sarsat requirements. If such beacon models satisfy all other requirements of document C/S T.018, as verified in accordance with this type approval standard, document C/S T.021, the Cospas-Sarsat Parties may consider approval of such beacon models and authorizing the Secretariat to issue a letter of compatibility in lieu of a Cospas-Sarsat Type Approval Certificate.

The Cospas-Sarsat Parties will decide on a case-by-case basis which performance requirements may be waived when deciding on approval and authorizing the Secretariat to issue a letter of compatibility (See Sample LOC in Annex I.2). Requirements which affect the compatibility of the beacon signal with satellite and ground segment processing, including the reliability or the quality of alert data, will not be waived.

2.3 Sequence of Events

Typical steps to obtain a Cospas-Sarsat Type Approval Certificate[2] for a new beacon model are as follows:

a) development by a manufacturer of a beacon design considered suitable for production and sale;

b) manufacturer conducts preliminary testing of the beacon;

c) manufacturer schedules testing of a beacon representative of the production design[3] at a Cospas-Sarsat accepted test facility;

d) test facility conducts type approval tests;

e) manufacturer and/or test facility (as coordinated by the manufacturer) submits to the Cospas-Sarsat Secretariat a report (per *ANNEX F*) on type approval testing, and technical data described in *ANNEX H* of this document;

f) Cospas-Sarsat Secretariat reviews the application package, test results and technical data, and informs the manufacturer and the test facility about the type-approval review outcome within approximately 30 calendar days;

g) once all type-approval review issues are resolved with the manufacturer and the test facility, or the beacon manufacture requests that the remaining issues be raised to the attention of the Parties, the Cospas-Sarsat Secretariat informs the beacon manufacturer and the test facility and produces a summary report with a recommendation and distributes this to the

[2] Or a Letter of Compatibility, as described in section 2.2.2.
[3] These beacons are described in section 4.3.

Cospas-Sarsat Parties for their review and decision regarding type approval of that beacon model;

h) the Cospas-Sarsat Parties review the summary report and make a decision regarding the type approval and advise the Secretariat within approximately 14 calendar days;

i) the Cospas-Sarsat Secretariat informs the manufacturer of the Parties decision, and, if approved, assigns a type-approval certificate number and issues a Cospas-Sarsat Type Approval Certificate.

2.3.1 Beacon Development

It is important that beacon manufacturers are aware that a Cospas-Sarsat type approval alone is not necessarily sufficient to allow the sale and use of their products. In many cases, the beacon models are required to be evaluated against other national or international standards (e.g., ETSI, EUROCAE, RTCA, RTCM, etc.) before the product can be authorized for sale into national markets. These other standards should be considered by the manufacturer, if necessary, during the beacon development, but they are outside the scope of this document.

Within the purview of Cospas-Sarsat are the mandatory data items and testing that are defined in this document. Manufacturers should ensure that during their beacon-development process that they are designing for compliance with the latest, in-effect Cospas-Sarsat standards, and that consideration is made to ensuring the availability of the required data items defined in ANNEX H when submitting their type-approval application, as the failure to provide these items may result in delays to the type approval of the beacon. A checklist of required data items is provided in ANNEX E, Part E.8.

2.3.2 Beacon Design and Development Testing

Upon completion of a beacon development, the manufacturer should perform preliminary beacon design and development testing. The purpose of this testing is to provide confidence that the developed beacon is compliant with the requirements of document C/S T.018 and ready for type-approval testing at an accepted test facility.

Any unresolved issues, such as non-compliances (whether planned or not) to the specifications, or deviations from standard test procedures, at this stage, could be discussed with the Cospas-Sarsat Secretariat for resolution or future consideration during the type approval review.

Tests conducted at beacon manufacturing facilities during the development of a new beacon model or during beacon production must not cause harmful interference to the operational Cospas-Sarsat System particularly, to prevent false alerts and the generation of excessive traffic into the System).

2.3.3 Type Approval Compliance Verification at Accepted Test Facilities

After completion of the beacon development and preliminary testing, the manufacturer approaches a Cospas-Sarsat accepted test facility and schedules type-approval compliance verification testing.

Note: the cost of the type-approval testing at the accepted test facility is borne by the beacon manufacturer.

The type-approval testing/verifications conducted by an accepted test facility are designed to demonstrate that the beacon model is compliant with the requirements of document C/S T.018 and that the facility performed type approval verification in accordance with document C/S T.021.

As described in document C/S T.008, certain test facilities are recognised by Cospas-Sarsat as "accepted" test facilities and these are the only facilities that are recognized to perform Cospas-Sarsat type approval tests on 406-MHz distress beacons for the purpose of being granted a Cospas-Sarsat Type Approval Certificate (TAC). A list of Cospas-Sarsat accepted test facilities is maintained by the Cospas-Sarsat Secretariat.

The detailed requirements of type-approval testing/compliance validation are provided in ANNEX L of this document.

2.3.4 Submission of Application Package

Following the completion of type-approval testing of a beacon model at a Cospas-Sarsat accepted test facility, the test facility generates a report on type-approval testing. The manufacturer and/or the test facility (as coordinated by the manufacturer) submit the type-approval application package, comprising a report on type-approval testing (*ANNEX F*) and all the required technical data described in *ANNEX H* of this document, to the Cospas-Sarsat Secretariat for review.

2.3.5 Review of Type Approval Application

On behalf of the Parties, the Secretariat reviews the completed type-approval application package to verify and establish that:

- technical data and documentation submitted in the application package are complete and allow the compliance to the requirements of this document to be verified;
- the scope of type-approval testing and the applied test procedures and compliance validation methodologies correspond to the methods as described in document C/S T.018 and this document; and
- the results of type-approval testing provide sufficient evidence that the beacon model complies with the requirements of document C/S T.018 and other applicable Cospas-Sarsat standards.

Upon completion of the type-approval application review, approximately within 30 calendar days of the type-approval application package submission, the Secretariat informs the beacon manufacturer and the accepted test facility of the type-approval review outcome.

If during the review of the type-approval application, issues are identified with the type-approval application, documentation, or test report, the Secretariat informs the beacon manufacturer and the accepted test facility about this, provides questions and comments, and recommends actions for resolution of the issues.

2.3.6 Cospas-Sarsat Type Approval

2.3.6.1 Final Approval

Once all issues with the type-approval application package are successfully resolved, or the beacon manufacture requests that the unresolved issues be raised to the attention of the Parties, the Cospas-Sarsat Secretariat prepares a report comprising details of the type-approval application, a summary of test results, description of any non-compliances observed and deviations from standard test procedures and unresolved issues, if any, and makes a recommendation regarding type-approval that may also include describing any unresolved issues. This report is distributed by the Secretariat to the Cospas-Sarsat Parties for their review and decision on type-approval.

The Parties review the report and, typically within 14 calendar days, inform the Secretariat about their decision on the beacon-model type-approval, or, if needed, request clarifications and additional information, which are relayed by the Secretariat to the test facility or beacon manufacture, as applicable.

When the review by the Cospas-Sarsat Parties is completed, the Secretariat notifies the beacon manufacturer about the Parties decision.

If the type approval is not granted, the Secretariat will also provide a description of the reasons for that decision. The manufacturer would then be able to amend their application or modify the beacon design, if desired. The manufacturer may change their submission and seek a letter of compatibility, or pursue other options, as applicable.

2.3.6.2 Issuance of Type Approval Certificates

Upon Cospas-Sarsat type approval of beacon models the Secretariat assigns Type Approval Certificate (TAC) number(s) from the 10,000 to 69,999 series, and, subsequently issues the Cospas-Sarsat Type Approval Certificate(s).

The details of type-approval application, technical data, test results and type approval will be kept on file at the Secretariat. A selected subset of technical data associated with the beacon model will be published on the Cospas-Sarsat webpage.

Type Approval Certificates may also be issued under the conditions outlined in sections 2.4.

2.3.6.3 Issuance of Letters of Compatibility

If the Parties, on behalf of the Council, decide to approve the beacon model(s) with a Letter of Compatibility, the Secretariat assigns Type Approval Certificate (TAC) number(s) from the 70,000 series and, subsequently issues a Letter of Compatibility.

The details of type-approval application, technical data, test results and type approval will be kept on file at the Secretariat. A selected subset of technical data associated with the beacon model will be published on the Cospas-Sarsat webpage.

2.4 Changes to Approved Beacons

[*The manufacturer must advise the Cospas-Sarsat Secretariat (see ANNEX J) 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 of the change 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. The results of factory tests 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. Test results shall be submitted as described in ANNEX F].

2.4.1 Typical Changes

[*ANNEX J of this document provides details of typical changes to type-approved beacon models, including a description of standard modifications, the required test scope, and technical data submission requirements for each of these typical change cases.*

If a modification is not covered by ANNEX J then it shall be considered a non-typical change and the process described in the following section applies.]

2.4.2 Minor Changes

[*Minor changes or modifications (as defined in this document[4], section [TBD]) to an approved beacon that were not accounted for in the original design and manufacturing documentation (e.g., the use of select-on-test components for tuning), must be declared to Cospas-Sarsat for the validity of the type approval to remain in effect. Cospas-Sarsat reserves the right to review such declared changes or modifications and may require additional compliance verification to be made in cases when changes/modifications might affect beacon performance.*]

2.4.3 Non-Typical Changes

[*For the non-typical changes, particulars of the application, test scope and compliance validation procedures are to be defined by the Secretariat in consultation with the beacon manufacturer and the test facility.*

In some cases, the development of a case-specific test set-up and test configuration might be required. It is, therefore, expected that the appropriate consultations with the Secretariat be conducted well before the type-approval testing commences. However, if a manufacturer prefers to submit a complete type-approval application package including all required technical and test data, no consultation with the Secretariat is necessary.]

2.4.4 Additional Type Approval Certificate Numbers

Cospas-Sarsat production extension TAC numbers are TAC numbers in the range of greater than 100,000 that are assigned (individually or in blocks) to manufacturers to allow continued production (of the approved design) by providing additional serial numbers to encode unique identification of the beacon. Assignment of TACs in this range is an administrative process and does not indicate a change in the beacon design. The process for requesting these additional TAC numbers is detailed in ANNEX K.

- END OF SECTION 2 -

[4] At this time there are no changes which have been defined as minor by Cospas-Sarsat.

3. TESTING OVERVIEW

3.1 Type Approval Testing

The validation of a beacon model design to verify compliance with Cospas-Sarsat standards comprises a series of laboratory tests and “qualitative” testing of the beacon’s transmissions over a Cospas-Sarsat satellite.

Developmental testing of a beacon design may be undertaken by a beacon manufacturer, or by a third party at the discretion of the manufacturer, at any suitable facility provided that such testing does not interfere with the operational Cospas-Sarsat system. Certain other testing may be undertaken by the manufacturer as specifically allowed within this document. All other type approval testing must be conducted by a Cospas-Sarsat accepted test facility (approved for type-approval testing of document C/S T.018-compatible beacons), unless specifically stated otherwise in this document.

3.1.1 Sequence of Testing

The type approval testing of beacons at an approved test facility should be performed using the guidelines provided in Annex A, section A.1.2. This sequence includes a series of conducted testing and a number of on-air tests.

3.1.2 General Guidance for Conductive Testing

All type approval conductive testing shall be performed at an accepted Cospas-Sarsat test facility, unless stated otherwise in this document. Typically, conductive tests are performed indoors, and they do not require on-air transmissions.

The requirements for the radiation levels of 406-MHz emissions provided in section 3.3.1 for beacon manufacturers’ facilities are fully applicable to test facilities.

A test sample designated for conductive tests 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. If necessary, the test beacon shall be modified to include a robust and electrically-equivalent impedance matching network to allow connection of the measurement equipment[5]. If applicable, the antenna-matching

[5] For type-approval testing of beacon models with detachable, remote or external antennas, the submittal of a single test beacon to a type approval test facility is acceptable, provided that either such beacon has a 50-Ohm antenna cable port or a robust electrically equivalent impedance matching network as described in the application package submitted in the manufacturers ANNEX H submission.

network shall stay connected for all conducted tests, unless it is otherwise specified in this document (e.g. 406-MHz VSWR test (see section B.9)). The beacon, or its battery pack shall be modified to allow access for the measurement equipment to perform battery current measurements.

The test beacon shall be configured for the purpose of the test. If applicable, all additional devices that form part of the nominal beacon system configuration shall be included, and be operated normally throughout the test program.

Test facilities shall perform analysis of the beacon design and modes of operation to ensure that measurement intervals, defined in Annex A for use in conductive tests encompass all normal operating modes for the beacon and any additional devices or features, and include this information in the test report. The requirements for the measurement interval are described in section 0.

For conductive tests, the test beacons shall be encoded with a variant of an appropriate message protocol types, declared in Annex G.1 in accordance with Annex C.

Other requirements for test beacons to be used during conductive tests, their configuration and modes of operation are further described in sections 4.3 and 4.6. The test setup and test conditions are further described in section 4.7.

3.1.3 General Guidance for On-Air Testing

On-air tests are conducted in open-air conditions and include EIRP measurements (section B.11), Satellite Qualitative test (section A.2.5), on-air navigation system (section B.14) and RLS tests (section B.19.2). During on-air tests, test beacons emit signals in the 406-MHz and other frequency bands, which might interfere with emergency and other operational radio-communication. For this reason, the test facility (or beacon manufacturer, if an on-air test takes place at the manufacturer's facility) should coordinate such testing with the local MCCs and obtain an approval from the national authority regulating the radio-frequency matters in that region.

If the beacon includes a homing transmitter operating on a distress frequency (e.g., 121.5 MHz or 243 MHz), this homer-transmitter may need to be disabled or offset from the distress frequency for this test, as required by the national authorities responsible for the region around a test facility.

For all on-air tests, test beacons shall be encoded with test variants of the appropriate message protocols (see section 3.3.2 and Annex C), unless otherwise specified in this document.

The use of operational message protocols for the on-air type-approval testing is strictly prohibited, since it might cause disruption to SAR services and distract valuable SAR assets from saving lives.

If applicable, all additional devices that form part of the nominal beacon system configuration shall be included, and be operated normally throughout the test program.

3.2 Cospas-Sarsat Accepted Test Facilities

As described in document C/S T.008, certain test facilities are recognised by Cospas-Sarsat as Cospas-Sarsat accepted test facilities, and they are entitled to perform Cospas-Sarsat type-approval tests on 406-MHz distress beacons for the purpose of obtaining Cospas-Sarsat type approval and a Cospas-Sarsat type-approval certificate.

A list of Cospas-Sarsat accepted test facilities is maintained by the Cospas-Sarsat Secretariat and is available publicly on the Cospas-Sarsat website.

3.3 Testing of Beacons at Manufacturers' Facilities

3.3.1 Radiation Requirements

Tests conducted in beacon manufacturing facilities must not cause harmful interference to the operational Cospas-Sarsat System. In an area immediately external to the manufacturers' facility, the level of 406-MHz emissions from beacon manufacturing facilities shall comply with relevant national test and development and international emission limits for the 406.0 MHz to 406.1 MHz band, these are typically less than -51 dBW, which corresponds to a power flux density of -37.4 dB (W/m^2) or a field intensity of -11.6 dB (V/m).

3.3.2 Message Encoding of Test Beacons for On-Air Testing

Manufacturers are encouraged to conduct preliminary laboratory tests on their beacons, but are cautioned not to radiate signals to the satellite, as this could interfere with successful reception of a real distress signal. If an open-air radiation of 406-MHz signals should be necessary, the manufacturer must coordinate and receive an approval for the test from the appropriate national or regional mission control center (MCC), contacts for which are available on the Cospas-Sarsat website. For any open-air test, the test beacons must be encoded with the test protocol of the appropriate type and format, and have message structure and modulation characteristics as specified in document C/S T.018.

3.3.3 Reporting of the Test Results

The results of type-approval tests performed by beacon manufacturers shall be submitted as described in section 4.10 in the format of the test report template (ANNEX F) and contain the information specified in ANNEX E.

- END OF SECTION 3 -

4. STANDARD TYPE APPROVAL PROCEDURE

Section 2.3 of this document provides a list and description of typical steps required to obtain a Cospas-Sarsat type approval, and a type-approval certificate (TAC), together with a certificate number, for a new beacon model.

4.1 Scheduling of Type-Approval Testing at an Accepted Test Facility

A beacon manufacturer request to a Cospas-Sarsat accepted test facility (approved for type-approval testing of document C/S T.018-compatible beacons) for beacon-model testing might need to be made several weeks in advance of the desired testing date. At the time of the initial request to the test facility, the manufacturer must submit a fully-compiled data package comprising technical data items listed in ANNEX H of this document. This documentation is required for the test facility to understand the beacon design and operational particulars, to determine the appropriate test configuration and procedures, to develop a test programme and schedule, and to allocate resources for type-approval testing.

Since the manufacturer may wish to send a representative to witness the tests and provide assistance in operating the beacon, proper travel and any other regulatory clearances should be made with the test facility well in advance.

For the type-approval testing, the manufacturer shall provide the test facility with:

a. all technical data items, listed in ANNEX H of this document;

b. one or more test beacons for testing purposes; and

c. replacement batteries.

4.2 Technical Data

The technical data items that shall be submitted with the type approval application, in order to allow the verification of the beacon design against the requirements of document C/S T.018, are defined in ANNEX E, Part E.8.

These data items include but are not limited to, application forms, manuals, descriptions, etc.

4.3 Test Beacons

For the type-approval testing, the manufacturer shall provide the test facility with one or more beacons representative of the production design.

A beacon representative of production design is a unit that accurately represents the production configuration for both hardware and software. Both electrical and mechanical parts of the unit should be from production tooling. This includes design, components, batteries, casing, paint (as this may affect radiation characteristics), connectors, switches, indicators, antenna(s), etc. While highly desirable, the item does not have to be manufactured on a formal production line to be considered production representative.

One test unit shall be a fully packaged and unmodified beacon, operating on its nominal power source and equipped with antenna(s).

The second beacon[6] 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 functions of the beacon system, such as external navigation input signals and remote control units, in accordance with section 5, while the test beacon is placed 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 power output of the test beacons when measured relative to 50-ohm impedance shall be aligned to within 0.3 dB of the intended production design power output.

The test units shall be coded with the test protocol of appropriate type and format.

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 the beacon model features a 121.5-MHz homing transmitter or transmits another radio signal for homing purposes, the homer transmitter(s) of the test beacons shall be set for the maximum output power declared by the beacon manufacturer in the application form (consistent within 0.3 dB).

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[6] For type-approval testing of beacon models with detachable, remote or external antennas, it is allowed to submit a single prototype test beacon to an accepted test facility, provided that such beacon either has a 50-ohm antenna cable port or a robust electrically-equivalent impedance matching network as described in section 5(k) and A.1.a. which can allow connection of the test equipment.

For a test beacon being tested in a transmitting (radiating) configuration (e.g., for antenna radiation pattern and satellite qualitative tests), the 121.5 MHz homer-transmitter may be off-tuned to a frequency adjacent to 121.5 MHz as allowed by the administration responsible for the territory where the testing is being conducted (to avoid a false distress signal on 121.5 MHz), but under no circumstances should this frequency be greater than 121.65 MHz. During satellite qualification and navigation tests of beacon models equipped with an internal navigation device, the nominal 121.5 MHz homer-transmitter frequency shall be set in the range from 121.35 to 121.5 MHz. If such frequency offset is not possible due to national restrictions or design limitations of the beacon model, the 121.5 MHz homer-transmitter shall be tuned to a frequency above 121.5 MHz, but no higher than 121.65 MHz.

Other homing frequencies may be offset or configured in a test mode, as allowed by appropriate applicable standards which define their signal characteristics and use.

If an application is for a beacon model to receive a type approval for operation with several protocol types or several message-programing options, means of changing the message coding and programming options of the prototype test beacon shall be provided by the beacon manufacturer. Alternatively, this can be satisfied with additional test units that utilize one of every protocol type and programming option.

4.4 Methods of Compliance Validation

For evaluation of the test beacon performance compliance with document C/S T.018 requirements, one or more of the following methods (See Annex L.1 for definitions) shall be used:

1) Test – Measurement,
2) Test – Observation,
3) Inspection of Evidence,
4) Analytical Evaluation.
5) Design Similarity (within beacon model families only)

The methods to be applied to each individual requirement from document C/S T.018 are defined in the compliance verification matrix as presented in Annex L.2 of this document.

4.5 Test Configurations for On-Air Tests

The type approval testing of beacons at an approved test facility involves on-air testing which should be performed in the test configurations described in Annex A, section A.1.4.

4.6 Configurations and Modes of Test Beacon

During type-approval testing, test beacons shall be operating in a standard operating mode and configuration appropriate to the test being conducted. For example, during Self-test mode test, the test beacon shall be activated in the self-test mode.

For the test beacons with multiple operator-selectable and/or automatic modes of operation, test facilities shall perform battery current measurements to determine the mode that draws maximum battery energy.

If a beacon model has several options of beacon external devices forming part of the nominal system configuration (e.g., remote-control panels and switches, external sound and light indicators, message programming devices/dongles, G-switches and other beacon activators, etc.), battery current measurements shall be conducted by the test facility to determine a beacon system configuration that draws maximum battery energy.

The beacon system configuration and operational mode that draw the maximum battery energy shall be used throughout all tests.

A need for and scope of testing for beacons with non-standard features, beacon system configurations, and modes of operation, appropriate to the type approval, should be defined through consultation with the Secretariat on a case-by-case basis.

4.7 Test Setup and Test Conditions

Tests shall be conducted by test facilities accepted by Cospas-Sarsat, unless allowed otherwise herein. It is advisable that the manufacturer, or its representative, witness the tests.

The tests shall be carried out on the test beacon with its own power source and without any additional thermal shielding around the beacon that might prevent it from being exposed to the specified test temperature. However, shields or deflectors inside the chamber designed to prevent the beacon from being exposed to temperatures lower or higher than the specified test temperature are permitted. In cases, when such additional shields and deflectors are used in thermal chambers, this shall be documented with photographs and reflected in the test reports.

Test results shall be presented on the forms shown in ANNEX E of this document, along with additional graphs as necessary. Test results shall demonstrate compliance with C/S T.018.

At the discretion of the accepted test facility, the manufacturer may be required to replace the batteries between tests.

For beacon models with multiple automatic and/or operator-selectable features or modes of operation (e.g. internal GNSS receivers, homers, voice transceivers, etc.) the application must specify which features consume energy from the same battery that supplies the 406-MHz distress signal.

The test beacon shall undergo testing by the manufacturer to determine:

a. the feature/mode combination that draws maximum battery energy from the battery that supplies the 406-MHz distress signal (note that this test is intended to also determine additional current draw by the 406-MHz-related circuitry because of a feature activation, even if that feature is powered by a source other than the 406-MHz battery);

b. the feature/mode combinations that exhibit pulse loads greater than in (a) 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 energy from the 406-MHz-circuitry battery shall be tested to the full range of the test requirements by the accepted test facility.

All functions intended for use as part of the beacon system and specific to beacon operation, designed principally for use with the beacon model and forming part of the nominal system configuration, such as remote control panels and switches, sound and light indicators, external navigation interface units, beacon message programmers (dongles), remote activators, etc., during all tests shall be connected, powered, operated in nominal mode and placed in the same environmental conditions as the beacon under test. If necessary, it is permissible to shield selected components of the beacon system from the effects of humidity and moisture during environmental tests (e.g. by enclosing them in a plastic bag).

Approved compliance validation methods are described in ANNEX L of this document, although other appropriate methods may be used by the accepted test facility to perform the measurements. These shall be fully documented in a technical report along with the test results.

4.8 Measurement Interval

In certain cases during type-approval testing, the beacon characteristics are measured and test parameters are evaluated over a series of bursts (e.g., section A.2.1.2) and successive measurements of the 406-MHz signal during this period.

The measurement interval and the number of measurements shall, if necessary, be extended to cover all phases of the beacon-model working cycle and the beacon-model additional-device operating conditions (e.g. homing transmitter(s) turning on and off, internal GNSS receiver operating in search and tracking modes, voice-transceiver in receive and transmit mode etc.).

4.9 Test Report

Type approval test reports shall provide a summary of the beacon and antenna test results, with supporting test data, graphs and tables, as described in ANNEX E.

The test reports should be prepared using the test report template provided in ANNEX F. The test reports shall contain information required in ANNEX G.

4.10 Type Approval Application Package

This section provides guidance for compiling a type-approval application package comprising:

- report on type approval testing performed at an accepted test facility;
- report on factory testing performed by beacon manufacturer;
- technical data package as per [*ANNEX H – TBC*];
- letter from beacon manufacturer introducing new beacon model or describing modifications;
- Accepted formats, etc.
- Submission Options – Electronic submission is the preferred option

- END OF SECTION 4 -

5. PROCEDURES FOR BEACONS WITH ADDITIONAL FEATURES

5.1 Type-Approval Test Procedure for Non-Typical Beacon Models

Beacons with novel or non-standard design features or operational configurations, which are not described in the current standards should be discussed with the Secretariat prior to commencement of testing at an approved test facility. Depending on the nature of the design features, the beacon manufacturer may need to pursue certification through a modified test sequence and/or procedure(s) or via the letter of compatibility process.

Non-typical beacon models could include, but are not limited to, a beacon which includes features such as:

a) Cospas-Sarsat beacon functionality being embedded in a product with other non-Cospas-Sarsat defined functionality;

b) non-typical (autonomous or semi-autonomous) programming features;

c) operational scenarios or technical characteristics not defined in documents C/S T.018 or C/S T.021; and

d) intentional design limitation that does not fully comply with the document C/S T.018 requirements.

Through the consultation process, measures to provide a pathway to certification for the novel product will be explored and may include:

a) discussion of the proposed product design and features;

b) analysis of possible implications of the proposed design, including trade-offs and possible alternative design choices; and

c) definition of test scope and development of any required novel or design-specific test procedures.

5.2 Test of Beacon Models with Operator-Controlled Additional Devices

Type approval testing of beacons with additional devices under operator control shall be designed to confirm that these devices do not degrade 406-MHz beacon transmission characteristics, including frequency stability, timing, and modulation. This may be accomplished by requiring the additional devices that are under operator control to be activated periodically during the measurement of these characteristics.

The timing of the periodic activation of additional 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 also include the operating life tests with the additional devices set in the operating mode that draws maximum battery energy (See below for beacons with voice transceivers). During this test the activation deactivation regime shall be carried out at suitable intervals.

A typical procedure for a beacon model with a voice transceiver is provided at [Annex TBD] as an example of the guidelines for implementation.

A test procedure based on the guidelines above for beacon models with operator controlled devices shall be:

a. coordinated between the beacon manufacturer and the accepted test facility;

b. submitted to the Cospas-Sarsat Secretariat for review prior to type-approval testing at the accepted test facility; and

c. approved by the Cospas-Sarsat Parties as appropriate.

5.3 Testing of Beacon-Models with Automatically-Controlled Devices

Automatically controlled devices in the beacon (e.g. homing transmitter, Search and Rescue Radar Transponder (SART), strobe light, etc.) must operate for the duration of the tests conducted in the laboratory (unless they are specifically designed to cease operation at an earlier point in time) to ensure that they do not affect the 406-MHz signal and that the battery can support 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 in the region of the test facility.)

5.4 Testing of Beacon-Models Powered by External Power Supply

Beacons with the ability to be powered by an external power supply, which are not described in the current standards should be discussed with the Secretariat prior to commencement of testing at an approved test facility. Depending on the nature of the design features, the beacon manufacturer may need to pursue certification through a modified test sequence and/or procedure(s) or via the letter of compatibility process.

The supporting design documentation required to support the type approval application is described in [*Annex H.1.n*].

Under some conditions it is allowable to power some portion of the beacon from an external power supply, such as providing power to the ELT(DT) navigation system to keep it in a hot-stand-by state for the duration of the flight, or even after activation when aircraft power is still available to the beacon. These beacons must be designed to have a primary battery to support beacon operation should the external power supply source be unavailable. Beacons which are designed to include this type of feature might need to be subjected to a customized test procedure which takes into account:

a) the specifics of the power supply and switching circuitry included in the beacon design;
b) the beacon features which can be powered by the external power supply (e.g., GNSS system, complete beacon, etc.); and
c) all conditions which may result in depletion of the primary battery during the beacon life.

If an ELT(DT) has an external power source that is used to power it, or some parts of it, when it is in the ARMED mode of operation, as defined in section 4.5.6.1 of document C/S T.018, this external power source shall be set to the minimum voltage of the external power source specified by the beacon manufacturer.

5.5 Testing of Beacon Models Powered by Lithium-Ion Rechargeable Batteries

The testing of beacon models which contain lithium-ion rechargeable batteries (LIRB) can be done based on the interim procedure (C/S IP (LIRB)), however, this procedure was developed and is associated with document C/S T.007. Manufacturers who would like to utilize this procedure for SGB testing should contact the C/S Secretariat prior to testing to co-ordinate this activity.

- END OF SECTION 5 -

6. TEST ANOMALIES AND FAILURES

6.1 Anomalies and Test Beacon Failures During Type-Approval Testing

It is expected that test beacons submitted for type-approval testing are “representative” test samples that are fully-functional and fully-compliant with Cospas-Sarsat requirements. However, during type-approval testing, accepted test facilities might observe anomalies and test beacon failures. Generally, such anomalies include:

- deviation from standard test procedures,
- deviation from agreed non-standard test procedures,
- non-compliances of beacon characteristics with Cospas-Sarsat requirements,
- beacon malfunctioning,
- mechanical break-downs,
- failures of the beacon hardware, software, firmware, or electronic components.

All anomalies in the test beacon behaviour observed by a test facility during type-approval testing shall be properly documented in the test report, and reported to the Secretariat.

If deviations from standard or agreed test procedures take place during type-approval testing, these must be properly documented in the test report. These tests might need to be repeated, after review of the circumstances and supporting justification of the deviation are considered.

Marginal non-compliances, which are within the measurement uncertainty provisions of section A.1, must be properly documented in the test report, however these non-compliances are typically acceptable and do not require modification of the test beacon, so additional testing may not be required.

6.2 Modification of Test Beacons During Type Approval Testing

An observed anomaly might require repair of a test beacon and/or the replacement of faulty component(s) which may be accepted with suitable documentation and justification.

If an observed anomaly is a result of the design deficiency, this might require beacon re-design and modification.

The manufacturer and/or test facility shall, in a timely manner, advise the Cospas-Sarsat Secretariat of the problem or issue and their proposed process to investigate the root cause and potential solutions. The manufacturer shall indicate the necessity for any modification(s) to the beacon hardware, firmware or software, unless a complete retest is undertaken on the modified beacon. The Secretariat will in a timely manner review the information provided by the manufacturer and/or test facility and, in consultation with them, will provide clarifications and where necessary recommendations for additional, or regression testing.

6.3 Additional Testing

Circumstances which might result in a need for additional or further testing include, but are not limited to:

- beacons with novel or non-standard design features or operational configurations, which are not described in the current standards and for which test procedures have not been agreed with the Secretariat prior to testing,
- any modification of the test beacon during type approval testing,
- non-compliances with C/S T.018 performance requirements,
- deviations from standard and/or agreed test procedures,
- lack and / or omission of test results or technical data,
- inadequacy of testing to cover features, modes, related functions or intended operational scenarios, as declared by the manufacturer,
- as a means to verify the effectiveness of any corrective measures undertaken.

The scope of additional or regression testing will be defined and/or confirmed by the Cospas-Sarsat Secretariat following consultations with the beacon manufacturer and the test facility, as appropriate, and may range from only those tests relevant to the circumstances to a full beacon retest. In some cases, development of new test procedures may be required for beacons with non-standard or novel design and operational features.

- END OF SECTION 6 -

ANNEX A: COMPLIANCE VALIDATION METHODOLOGY

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.018, which must be measured during the tests.

A.1.1 Measurement Equipment

All measurements shall be performed with equipment and instrumentation which are 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 B of C/S T.008. These measurement accuracies (except for EIRP See Section B.11) may be added to the beacon specification limits of C/S T.018 (thereby allowing a slight extra margin) when considering test results which are near the specification limit.

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 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). 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;

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.11.

A.1.2 Recommended Test Sequence

A suggested sequence for performing the tests described herein is shown in section 0 below, 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 E and ANNEX F, with appropriate graphs attached as indicated.

A.1.3 Test Beacon Message Content

The beacon message content to be coded in the beacon for the tests described herein are described in Annex C.1. The main message fields are the same for all beacon types but the rotating field, or fields, to be coded is dependent on the type of beacon being tested as defined in C/S T.018. For beacons with encoded location capability, the GNSS signal should be denied to the beacon to ensure that default parameters are provided in the beacon in the message, for all tests in sections A.2.1.A.2.2, A.2.3, and A.2.4.

The following table identifies where the message field values are defined and where the results from the test are entered.

Table A.1-1: TBD

Item	Values to be coded into the Beacon Message	Expected and Recorded Results
Main Message Field	Table C.1-1	Table E.5-1
Rotating Field #0	Table C.1-2	Table E.5-2
Rotating Field #1	Table C.1-3	Table E.5-3
Rotating Field #2	Table C.1-4	Table E.5-4
Rotating Field #3	Table C.1-5	Table E.5-5
Rotating Field #15	Table C.1-6	Table E.5-6

A.1.4 Test Configurations

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) Beacon Antenna Test (Annex A section A.2.6); and

c) Navigation System Test, if Applicable (Annex A section A.2.7).

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.1. The applicable test configurations for the beacon antenna testing are summarised in section B.11.1.2.5

in Table B.11-2, while the applicable test configurations for the satellite qualitative test and the navigation system test are summarised in Table A-1.

In order to be representative the beacon (or remote antenna) must be provided with an RF ground situation that mimics the true usage scenario. The test configurations detailed in the following sections are representative approximations to those usage scenarios.

The table below shall be used to determine which test configurations need to be tested for each type of beacon in the satellite qualitative test or the navigation tests (where an open-air testing is required). In cases where the beacon is novel and the table seems inappropriate then the Cospas-Sarsat Secretariat should be consulted for advice before testing commences. Note that configuration names (e.g. SN-AG, SN-W) are explained in sections that follow.

Table A.1-2: Satellite Qualification and Navigation Test Configurations

PRODUCT	*VARIANT*	*CONFIGS REQUIRED*	
		Sat Qual (A.2.5)	*Navigation Tests (B.14)*
ELT-AF (auto fixed) or ELT(DT)		*SN-AV*	*SN-AV*
ELT-AP (auto portable)		*SN-AG*[7]*, SN-ON*[7]*, SN-AV*[8]	*SN-ON*
ELT-AD (auto deployable)		*SN-AG, SN-W, SN-ON*	*SN-ON*
ELT-S (survival) / PLB	*A) General (Land & Marine)*	*SN-AG, SN-ON*	*SN-ON*
PLB	*B) Designed to attach to a life preserver*	*SN-AG, SN-ON, SN-LP*	*SN-ON*
ELT-S / PLB	*C) Designed to operate while floating*	*SN-AG, SN-W, SN-ON*	*SN-ON*
EPIRB		*SN-AG, SN-ON, SN-W*	*SN-ON*

PLB and ELT-S beacons have variants which address different segments of the beacon market. The beacon manufacturer may opt to address more than one of these markets by declaring any combination of variants A, B, or C. The corresponding additional ground configurations are then appended to the test schedule.

A.1.4.1 Above-ground (SN-AG) configuration

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

[7] Configuration required for ELT(AP) with the portable antenna installed, as applicable.
[8] Configuration required for ELT(AP) with the fixed external antenna(s) attached, as applicable.

A.1.4.2 On-ground (SN-ON) configuration

The beacon shall be placed in the centre of a thin 27cm ±1cm diameter conductive metal disc (made of aluminium or copper) which shall be placed directly on level dry ground (ideally cement, tarmacadam, dirt, or chamber floor for Navigation Test) in an area with a good all-around view of the sky, in the orientation described in the manufacturer's instructions.

A.1.4.3 Water-ground plane (SN-W) configuration

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-around 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.

A.1.4.4 Antenna Fixed to Ground plane (SN-AV) configuration

The base of the antenna shall be placed in the centre of a thin 50cm ±2cm 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-around 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.

A.1.4.5 Beacon Attached to Life-Preserver (SN-LP) configuration

Configuration under development, anticipated to be available in 2019. Until this has been defined, testing may be conducted per section 5.1.

A.2 TESTS REQUIRED

A.2.1 Electrical and Functional Tests at Constant Temperature – Ambient, Minimum, Maximum Temperature

A.2.1.1 Requirement

T.018/S.4.2.1/R.0680

A.2.1.2 Method of Validation

During type-approval testing, certain beacon characteristics are measured and test parameters evaluated over a period of time while the beacon transmits multiple bursts in a defined sequence as follows.

Activate and deactivate the beacon in accordance with the manufacturer's instructions in order to create the following beacon burst sequences.

1. Activate for at least 115 bursts and then turn off (note that for ELT(AF) and ELT(DT) this will initiate the cancellation function)
2. Activate the self-test function per para. B.13

Note: Some B.16 tests in section A.2.9.2.c are also performed at the temperature extremes.

For each activation sequence defined above, the tests specified below 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. Measurements shall commence immediately after the beacon has been activated. The following parameters shall be measured at each of the three constant temperatures for each transmitted burst:

a) transmitter power output, per para. 0;

b) carrier frequency stability, per para B.2.2;

c) chip characteristics, per para B.3;

d) EVM, per para B.4;

e) spurious output, per para B.5;

f) first burst delay and repetition period, per para B.7 sub-sections, as appropriate (except self-test); and

g) message structure and content[9], per para B.6 and para B.8 sub-sections, as appropriate

[9] The message content is as defined in Annex C.

The VSWR test, per para 0[10] is performed once at each temperature plateau after the completion of all other tests at that temperature plateau.

A.2.1.3 Required Results

Populate the data tables as required in Annex E.1: Tabs:
Annex E.1-1 - A.2.1 - Seq 1,
Annex E.1-2 - A.2.1 - Seq 2,
Annex E.1-3 - A.2.1 - VSWR,
Annex E.1-13 - Tmin,
Annex E.1-14 - Tamb, and
Annex E.1-15 - Tmax
for each test parameter indicated in section A.2.1.2 using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

A.2.2 Thermal Shock Test

A.2.2.1 Requirement

T.018/S.4.2.1/R.0680
T.018/S.4.2.1/R.0700
T.018/S.4.2.1/R.0710

A.2.2.2 Method of Validation

The beacon under test, while turned off, is to stabilize for a minimum of 2 hours at a selected temperature in its operating range. The beacon is then, within one minute, simultaneously placed into an environment held at 50 degrees C offset (within the beacon operating temperature range) from the initial temperature and turned on. Measurements shall commence immediately[11] after the beacon activation to measure the following parameters:

a) transmitter power output, per para. 0;
b) carrier frequency stability, per para B.2.2;
c) chip characteristics, per para B.3;
d) EVM, per para B.4;
e) first burst delay and repetition period, per para B.7; and
f) message structure and content, per para B.6 and B.8.

[10] The message sequence in this section does not apply to this test. Testing is per the procedure in the section referenced.
[11] Measurements must start immediately, however the beacon performance is not required to meet specification as defined in document C/S T.018 under thermal shock until after 5 seconds from activation (8 seconds for EPIRBs).

The above measurements are made continually for two hours.

A.2.2.3 Required Results

Populate the data tables as required in Annex E.1: Tabs:
    Annex E.1-4 - A.2.2, and
    Annex E.1-16 - Thermal Shock
for each test parameter indicated in section A.2.2.2 using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

A.2.3 Operating Lifetime at Minimum Temperature

A.2.3.1 Requirement

T.018/S.4.2.1/R.0680
T.018/S.4.2.1/R.0740
T.018/S.4.2.1/R.0750
T.018/S.4.2.1/R.0760
T.018/S.2.5/R.0800
T.018/S.2.5/R.0810
T.018/S.2.5/R.0820
T.018/S.2.5/R.0830
T.018/S.4.5.6/R.1910
T.018/S.4.5.6/R.1930
T.018/S.4.5.6/R.1990
T.018/S.4.5.6/R.2025
T.018/S.4.5.14.4/R.2370
T.018/S.2.5/R.2380

A.2.3.2 Method of Validation

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) transmitter power output, per para. 0;
b) carrier frequency stability, per para B.2.2;
c) chip characteristics, per para B.3;
d) EVM, per para B.4;
e) first burst delay and repetition period, per para B.7; and
f) message structure and content, per para B.6 and B.8, (the fields Remaining Battery Capacity and Elapsed Time Since Activation (except for ELT(DT) shall be verified during this test).

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 date[12]. 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 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)),

iv. the worst case depletion in battery power due to current draw that cannot be replicated during the lifetime test, for example, to account for any difference between the actual output power setting of the test unit homer transmitter and the output power of the homer transmitter, as declared by the beacon manufacturer in Annex G.1, and

v. 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.

If applicable, at the beginning of the test it shall be ascertained that:

[12] 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 current measurement results reported in the format of [Table F E.1] and pre-test battery discharge calculations reported in the format of Table [F-E.2].

a) all radio locating signals do not begin transmitting for at least 30 seconds after beacon activation; and
b) that all radio locating signals shall commence transmitting within 5 minutes of beacon activation (except for AIS signals, which shall commence within 1 minute).

In addition, during the test the 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 noted in Annex E.1.

A.2.3.3 Required Results

Populate the data tables as required in Annex E: Tabs:
Annex E.1-5 - A.2.3,
Annex E.1-17 - Op Life,
Annex E.6-1 - Operating Current, and
Annex E.6-2 - Battery Discharge,
for each test parameter indicated in section A.2.3.2 using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

A.2.4 Frequency Stability Test with Temperature Gradient

A.2.4.1 Requirement

T.018/S.4.2.1/R.0680
T.018/S.4.2.1/R.0690

A.2.4.2 Method of Validation

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:

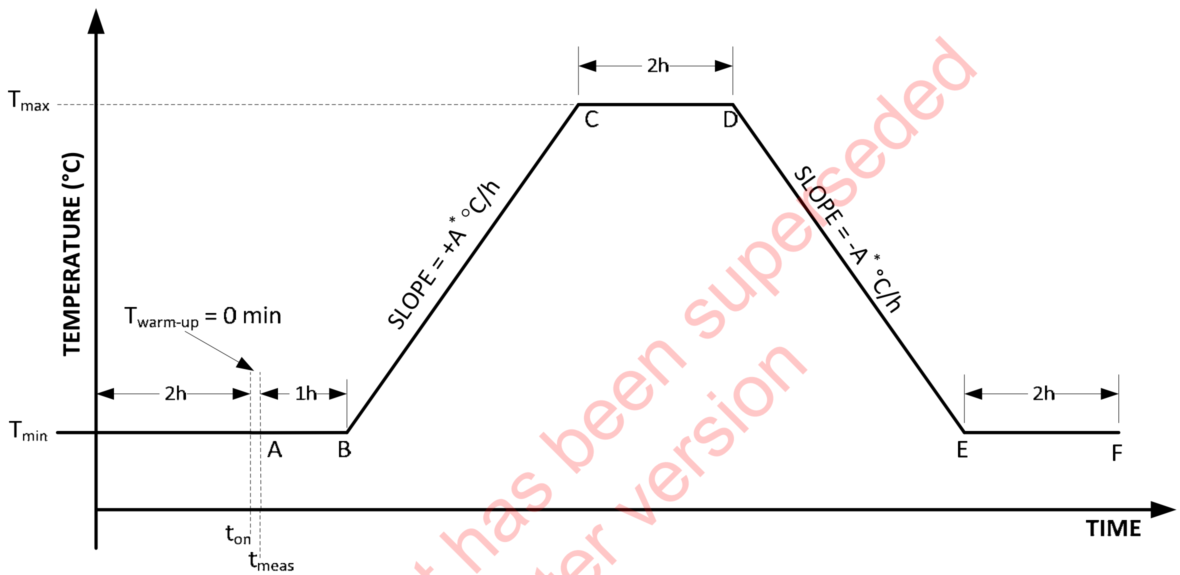
a) transmitter power output, per para. 0;
b) carrier frequency stability, per para B.2.2;
c) chip characteristics, per para B.3;
d) EVM, per para B.4;
e) first burst delay and repetition period, per para B.7 (except self-test);
f) message structure and content[13], per para B.6 and B.8; and

Measurements shall start immediately after beacon activation.

[13] The message content is as defined in ANNEX C.

When a battery replacement is required, two separate tests shall be performed. The up-ramp test is from Point A to point D (see Figure A.1) and the down-ramp test is from point C to Point F. Before point C of the down-ramp, the beacon under test, while turned off, is to stabilize for 2 hours at $+T_{max}$ °C and is then turned on.

Figure A.1: Temperature Profile for Frequency Stability[14]



NOTES:

T_{max} = + 70°C (Class 0 beacon)
T_{max} = + 55°C (Class 1 & 2 beacons)

T_{min} = - 55°C (Class 0 beacon)
T_{min} = - 40°C (Class 1 beacon)
T_{min} = - 20°C (Class 2 beacon)

t_{on} = beacon turn-on time after 2 hour "cold soak"
t_{meas} = start time of frequency stability measurement (t_{on} + 0 min)

A^* = 7°C/hour for Class 0
A^* = 5°C/hour for Class 1 and Class 2

A.2.4.3 Required Results

Populate the data tables as required in Annex E.1: Tabs:

Annex E.1-6 - A.2.4, and

Annex E.1-18 - Temp Gradient,

for each test parameter indicated in section A.2.4.2 using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

[14] Note: this diagram is not to scale.

A.2.5 Satellite Qualitative Test

A.2.5.1 Requirement

T.018/S.4.5.5.4/R.1750
T.018/S.4.5.5.4/R.1760
T.018/S.4.5.5.4/R.1770

[TBD]

A.2.5.2 Method of Validation

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 defined in section A.1.4 and are dependent on the manufacturer's declaration of Operational Configurations in Annex G.1.

The test beacon shall have its own antenna connected and shall be coded with a test protocol of appropriate type and format (see ANNEX C). Other parameters of the test beacon message coding including "Country Code" shall be set in coordination with the MCC.

For testing of beacons with external/remote antennas, the antenna cable assembly used in the test shall have at least the maximum declared insertion loss (see [*Annex H.1.n*]). For such beacons, the antenna cable assembly may be provided by a beacon manufacturer, in which case its loss at 406 MHz shall be verified by the test facility.

For beacons with the RLS function, within 15 minutes after activation of the beacon, the beacon shall indicate reception of the Type 1 acknowledgement as indicated in document C/S T.018, section 4.5.9.3.

The test data shall be obtained from MEOSAR satellites. The test shall be performed at a known location, that has a clear view of the sky in all directions down to 5 degrees elevation, 3 times for a period of between 15 to 20 minutes each time separated by a period of 5 to 7 hours between each test when there are at least 4 MEOSAR satellites in co-visibility with the beacon and MEOLUT capable of tracking the satellites in question (either L-or S-Band or a combination of these).

A.2.5.2.1 Criteria for All Beacon Tests (Except ELT(DT))

The pass/fail criteria for non – ELT(DT)s is as follows:

a) The probability that the MEOLUT produce an alert with a complete beacon message within 10 minutes from the first beacon message transmission shall be equal to or greater than 85%;
b) The probability that the MEOLUT produce an alert with a 2D location (Latitude/Longitude), independently of any encoded position data in the 406 MHz beacon message within 10 minutes from the first beacon message transmission shall be equal to or greater than 85%;
c) The location provided by the MEOLUT in b) above shall contain a location within 5 km from the actual beacon position, with a probability equal to or greater than 75%; and
d) If the beacon has encoded location capability then the following shall also be confirmed:

    i. message with encoded location is received by the MEOLUT from at least one MEOSAR satellite within 3 minutes;

    ii. that the 2D encoded location provided by the MEOLUT is within 30 m of actual location of the beacon within 5 minutes.

A.2.5.2.2 Criteria for ELT(DT) Test

The pass/fail criteria for ELT(DT)s is as follows:

a) The MEOLUT shall produce an alert with a complete correct beacon message, , at least once every minute for greater than 90% of the total test time;

b) The encoded location provided by the MEOLUT for each alert in a) above shall be accurate in the horizontal plane to within 30 metres for greater than 90% of the alerts; and

c) The encoded location provided by the MEOLUT for each alert in a) above shall be accurate in the vertical altitude to within 50 metres for greater than 90% of the alerts.

A.2.5.3 Required Results

Populate the data tables as required in Annex E.1: Tabs:
    Annex E.1-7 - A.2.5, and
    Annex E.2-1 - Sat Qual,
for each test parameter indicated in section A.2.5.2 using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

The test report shall indicate the time of the tests and tracking schedule of the MEOLUT supporting the tests (including starting and ending azimuth and elevation of each MEOSAR satellite tracked during the test).

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

A.2.6 Beacon Antenna Test

A.2.6.1 Requirement

The applicable requirements for each procedure are listed in the appropriate sections of Annex B.11.

A.2.6.2 Method of Validation

The beacon antenna test, described in Annex B.11, shall be performed at the ambient temperature of the test facility and a correction factor shall be applied to the data to calculate the worst case EIRP result. This test shall be performed in each configuration applicable to the type of beacon declared in the manufacturer's Annex G.1 application, 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.2.6.3 Required Results

Populate the data tables as required in Annex E.1: Tabs:
  Annex E.1-8 - A.2.6, and
  Annex E.3-1 - EL-EIRP,
for each test parameter indicated in section A.2.6.2 using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

A.2.7 Navigation System Test, if Applicable

A.2.7.1 Requirement

The applicable requirements for each procedure are listed in the appropriate sections of Annex B.14.

A.2.7.2 Method of Validation

For beacons incorporating the optional capability to transmit encoded position data (mandatory in ELT(DT)s), some additional tests, described in section 0, are required to verify the beacon output message, including the correct position data, BCH error-correcting code(s), default values, and update rates.

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.

A.2.7.3 Required Results

Populate the data tables as required in Annex E.1: Tabs:
Annex E.1-9 - A.2.7,
Annex E.4-1 - Navigation System, and
Annex E.4-2 - B.14,
for each test parameter indicated in B.14 using the data collected during the test sequence by calculating the statistics, as required in B.14, using data collected from each of the bursts.

A.2.8 Beacon Coding Software

A.2.8.1 Requirement

T.018/S.2.2.5/R.0260

A.2.8.2 Method of Validation

The Vessel ID portion of the Main Message Field shall be verified for each Vessel ID declared by the manufacturer in their C/S T.021 Annex G.1 application. This shall be achieved by encoding into the beacon in turn each declared Vessel ID, as defined in Annex C Table C.1-1, and then transmitting a signal from that beacon and decoding the received message and verifying that:

a) The decoded Vessel ID Field (Bits 91-93 of the Main Message Field) correctly identifies the encoded type of Vessel ID; and
b) The decoded Vessel ID (Bits 94-137 of the Main Message Field) correctly matches the encoded Vessel ID from Table C.1-1.

The content of Bits 138 to 140 in the Main Message Field shall be verified to ensure the following:

a) That the type of beacon, as declared by the manufacturer in their C/S T.021 Annex G.1 application, is correctly encoded in Bits 138 and 139 of the Main Message Field;
b) That for a beacon without RLS capability, as declared by the manufacturer in their C/S T.021 Annex G.1 application, that Bit 140 is always set to ‘0’; and
c) That for a beacon with RLS capability, as declared by the manufacturer in their C/S T.021 Annex G.1 application, that Bit 140 is set to ‘1’ when the RLS capability is enabled and the beacon is transmitting the RLS Rotating Field, and that Bit 140 is set to a ‘0’ when the RLS capability is not enabled and the beacon is not transmitting the RLS Rotating Field

These tests 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 the relevant sections of Annex E as appropriate.

A.2.8.3 Required Results

Populate the data tables as required in Annex E.1: Tabs:
Annex E.1-10 - A.2.8, and
Annex E.5: Tabs:
Annex E.5-1 - Main Field,
Annex E.5-2 - Rot Field #0,
Annex E.5-3 - Rot Field #1,
Annex E.5-4 - Rot Field #2,
Annex E.5-5 - Rot Field #3, and
Annex E.5-6 - Rot Field #15,
for each test parameter indicated in section A.2.8.2 using the data collected during the test sequence, as required in Annex E, using data collected from each of the bursts.

A.2.9 Other Tests

A.2.9.1 Requirement

The applicable requirements for each procedure are listed in the appropriate sections of Annex B.

A.2.9.2 Method of Validation

Unless specified otherwise in each detailed test procedure in Annex B the following tests and / or assessments shall be carried out just once at ambient temperature:

a) Maximum Continuous Transmission B.10;
b) Beacon Activation B.15;
c) Beacon Activation Cancellation Function B.16;
d) Operator Controls Tests B.18;
e) RLS Function B.19; and
f) Battery Status Indication B.20

A.2.9.3 Required Results

The required results for each test procedure are listed in the relevant part of Annex B, referenced in the method of validation above.

A.2.10 Documentation and Labelling

A.2.10.1 Requirement

The applicable requirements for each procedure are listed in the appropriate sections of Annex B.

A.2.10.2 Method of Validation

The following inspections of evidence, as described in Annex B, shall be performed:

a) Beacon Labelling B.21; and

b) Beacon Instruction Manual B.22

A.2.10.3 Required Results

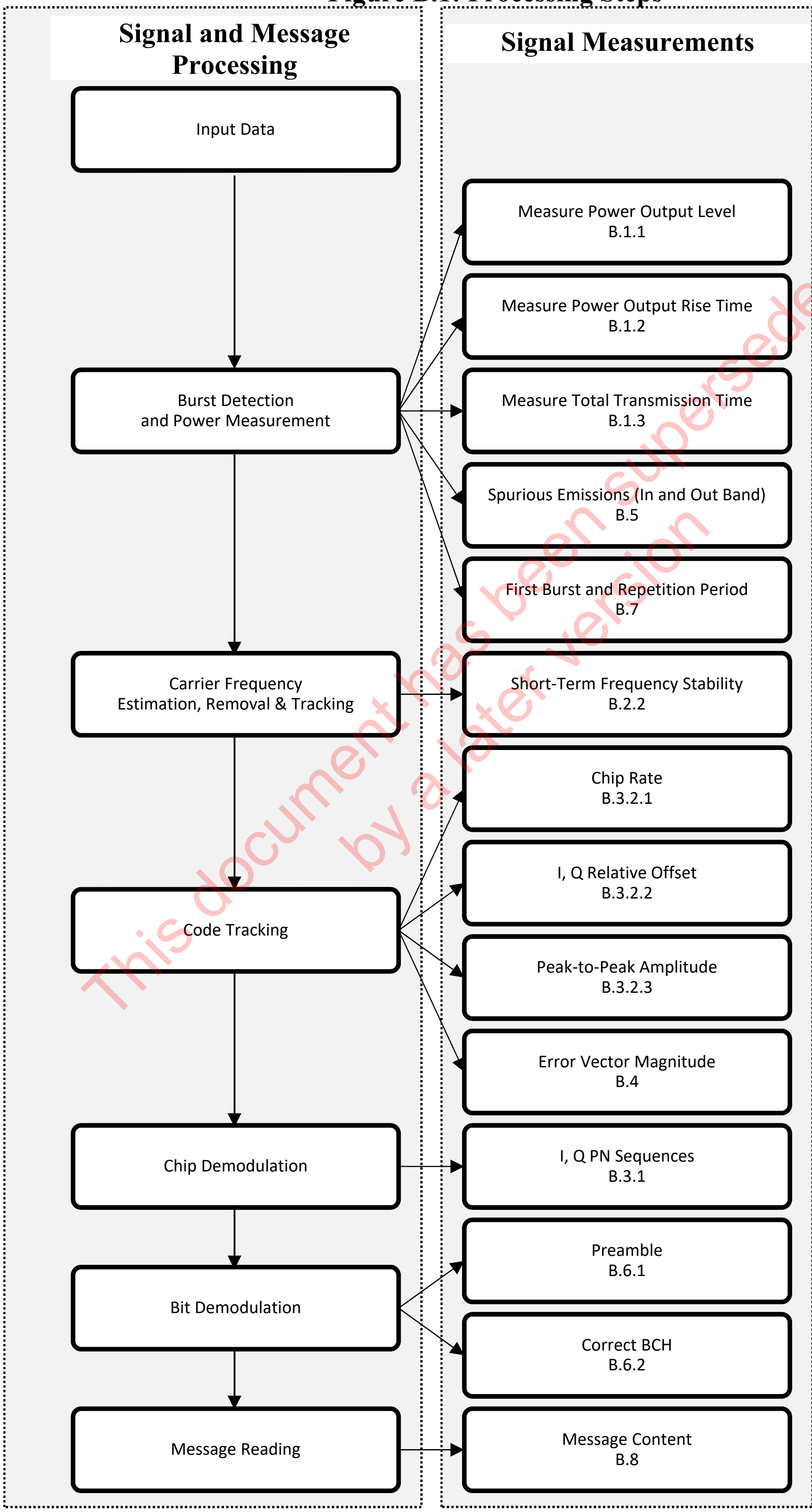
The required results for each procedure are listed in the appropriate sections of Annex B, referenced in the method of validation above.

- END OF ANNEX A -

ANNEX B: MEASUREMENT METHODS

Many of the tests in this section require the beacon signal to be processed in order to recover components of the signal that need to be measured to verify compliance to the requirements. The following is an example of the necessary signal processing steps with indications which steps of the processing provide signal components used in individual signal measurement test sections.

Figure B.1: Processing Steps



Input Data

The beacon signal is first frequency downconverted using a fixed local oscillator frequency to an intermediate frequency compatible with an analog to digital converter. The signal is then sampled by the converter to produce digital samples of the beacon burst. This can be accomplished using signal capturing hardware such as a digital spectrum analyzer or digital oscilloscope. The sampling requirements are:

(1) that the digital samples have sufficient amplitude resolution to produce accurate measurements;
(2) the sample rate be chosen by the Nyquist bandwidth of the signal with margin for carrier offset and unsuppressed out of band RF energy that would alias into the frequency band being analysed; and
(3) the sample clock is adequately stable and accurate to produce accurate measurements.

The input samples can be either real or complex data. The acquisition of the signal involves frequency downconversion of the signal to an intermediate frequency that may cause spectral inversion of the signal's in-phase (I) and quadrature-phase (Q) components.

Burst Detection and Power Measurement

The beginning of the burst can be detected using an energy detection approach that can find the rise of the signal envelope. The signal can be detected by comparing the input samples magnitude to a minimum threshold crossing. Figure B.2 illustrates the energy envelope of the signal power. The first instance of the power reaching a minimum threshold will provide a coarse detection time. A margin of time (Δt) is recommended to ensure that the beginning of the burst is captured (see Figure B.3). The transmitter output power measurements can be taken from this power envelope as described in Section B.1.1.
A spectral measurement of the detected signal is performed. The normalized power spectral density is then compared to the spurious emission mask and the out of band power is measured and compared to the 1% threshold as described in Section B.5.

Carrier Frequency Estimation, Removal & Tracking

In preparation for signal analysis, the remnants of the carrier frequency remaining in the input data must be removed. (Figure B.4 illustrates the signal in the frequency domain.) This can be accomplished in two steps.

As the signal is modulated with an OQPSK (Offset Quadrature Phase Shift Keying) modulation, a coarse estimation of the carrier frequency can be obtained by an FFT (Fast Fourier Transform) followed by a peak detection performed on the fourth power of the complex signal. The center frequency (a scalar quantity) can then be applied to a digital downconversion process producing a baseband complex signal. No filtering or filtering with bandwidth much higher than the SGB bandwidth should be applied so that the signal shape is retained.

After downconversion, the complex baseband signal should be analysed for residual carrier frequency offset. Any carrier frequency offset (Δf) that remains must be tracked and removed (for example, using a PLL (Phase Lock Loop)). Figure B.5 illustrates the presence of residual carrier offset. The tracking process will produce fine frequency measurements across the burst.

The two carrier measurements are combined together with the local oscillator frequency used in the input sampling process, into a composite frequency measurement that will be used to characterize the transmit frequency section B.2.2.

Code Tracking

Finally, a timing error detector will be used to provide chip symbol synchronization and demodulate the I and Q chip sequences. I and Q channel signal characteristics such as chip rate, chip rate variation, the relative offset and amplitude can then be measured as described in section B.3.2. Note that the time offset between I and Q channel measurement requires coherent processing (i.e. same time reference) on both I and Q channels.

Chip Demodulation

After the known data information is removed from the I and Q chip sequences, the I and Q PN sequences can be verified to be correct.

Bit Demodulation

A complex reference waveform made up of unmodulated PN sequences properly offset to form the OQPSK waveform should be generated. The beacon signal's input data samples can then be multiplied and accumulated, or integrated, with the complex reference waveform and its conjugate in segments of 256 symbols. The obtained complex symbols are used to compute the EVM as described per section B.4.

This integration process de-spreads the underlying data. The complex values of the resulting integrations are generated across the burst creating a matrix of 150 complex pairs. The complex pairs are analyzed to resolve the 300 message bits. The bits are then inspected for message structure and content in sections B.6 and B.8

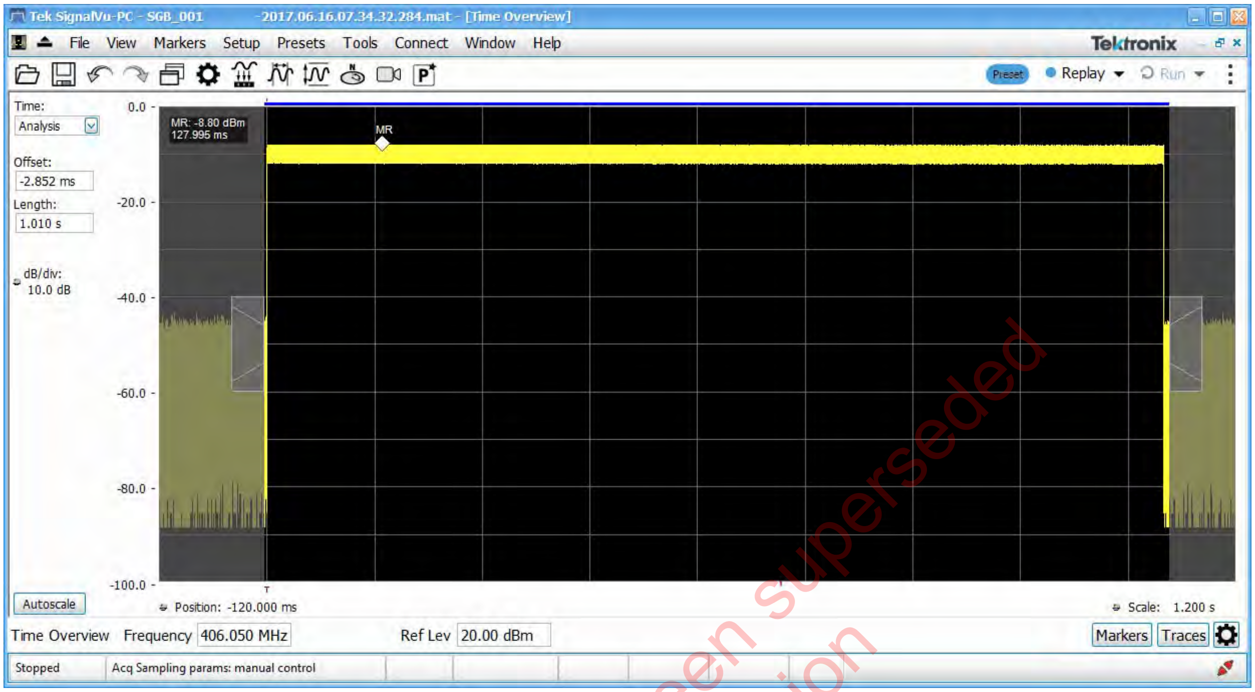


Figure B.2: Burst Energy Detection

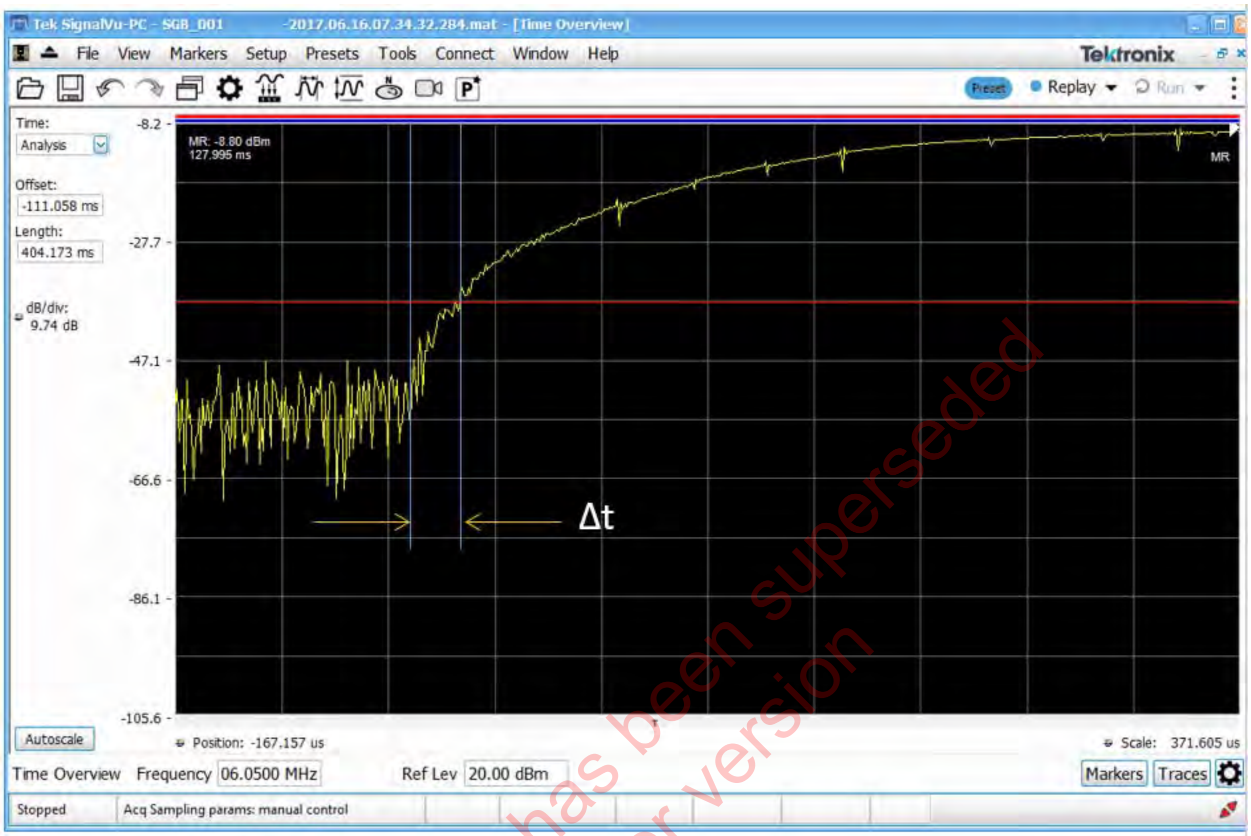


Figure B.3: Burst Detection Threshold and Margin

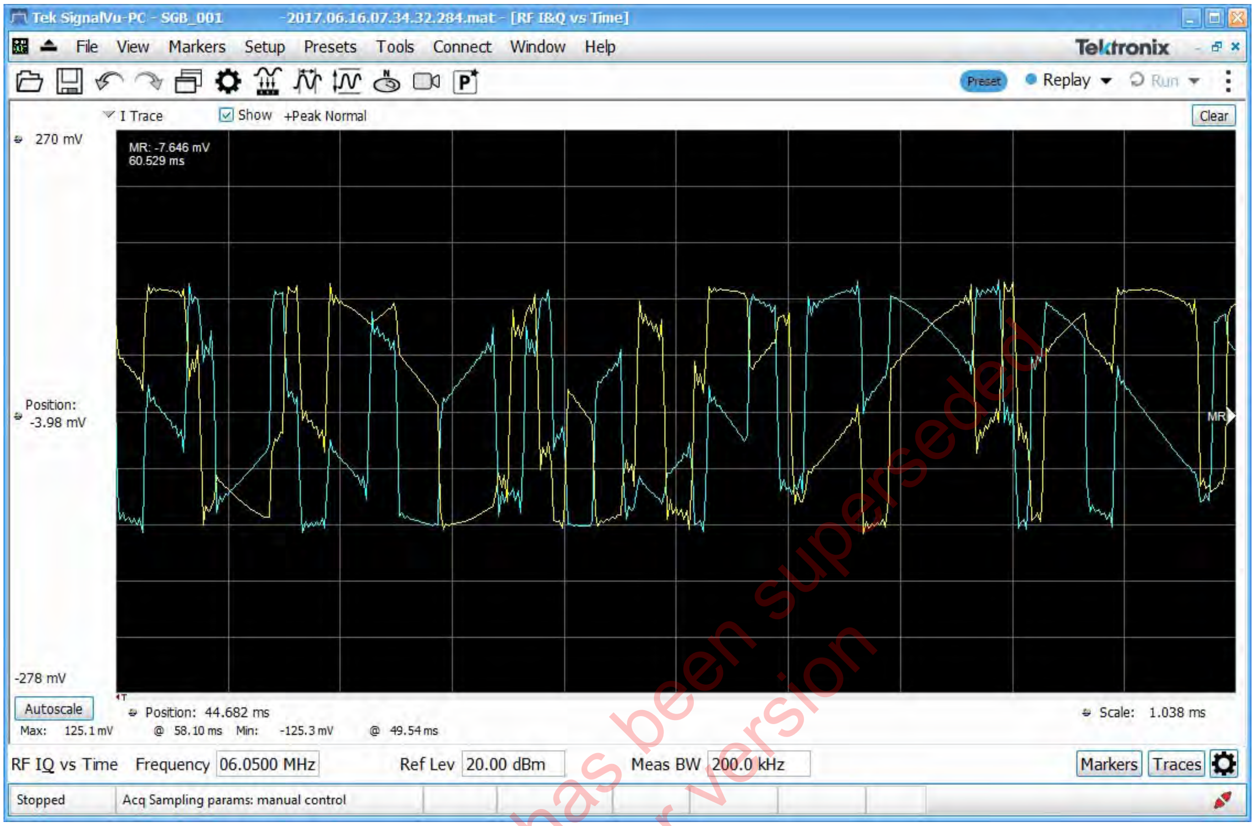


Figure B.4: Complex Signal with Carrier Frequency Offset

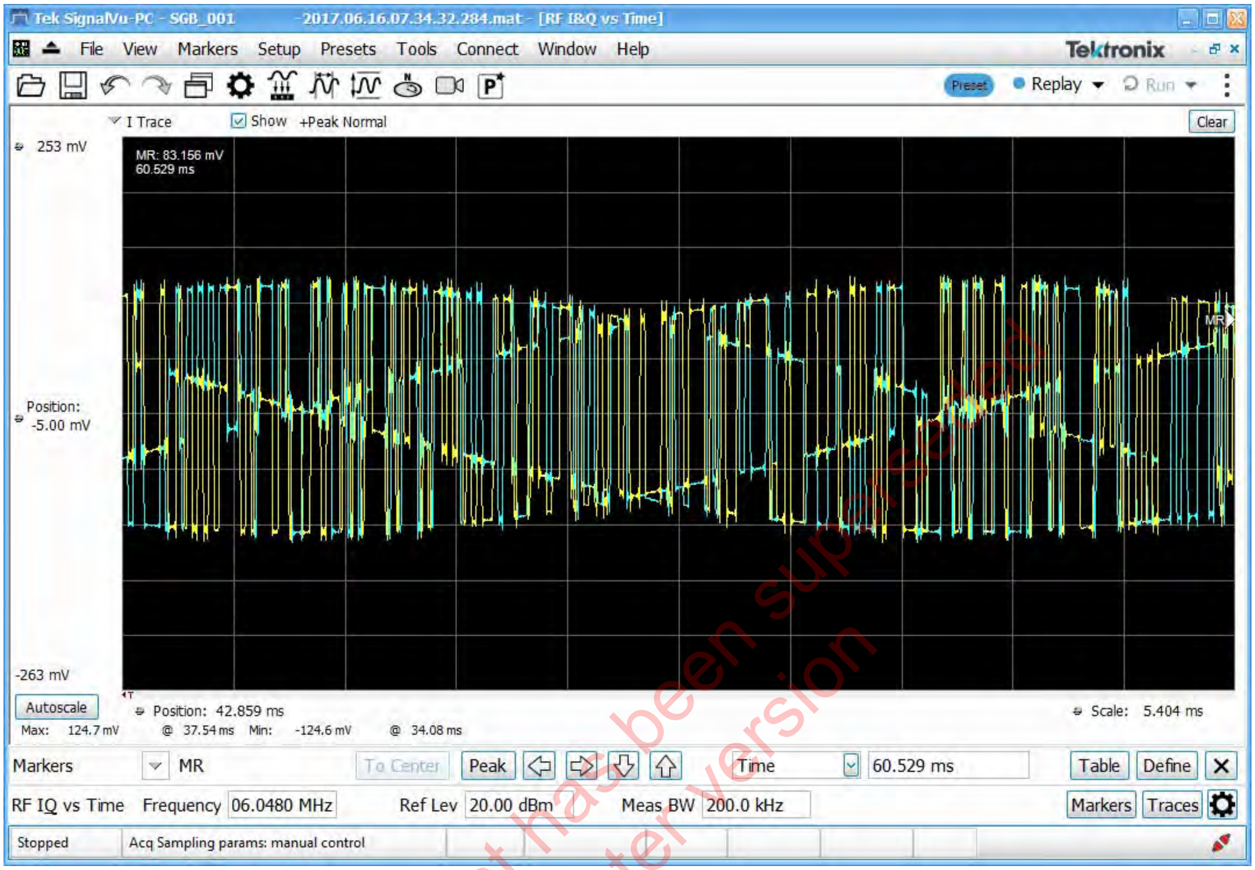


Figure B.5: Sampled Complex Baseband Data with residual carrier frequency offset

B.1 TRANSMITTER OUTPUT POWER

B.1.1 Measure Power Output Level

B.1.1.1 Requirement

The measurement of this value is required to provide an input into other required verifications defined in this section.

B.1.1.2 Method of Validation

The transmitter power output level shall be measured at the transmitter output. During output power measurement, the antenna shall be replaced by an impedance matching unit 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.

For each transmitted burst, the instantaneous power shall be averaged over 800 ±5 milliseconds of signal centred at the middle of the burst to estimate a nominal* power level.

B.1.1.3 Required Results

The nominal, minimum and maximum values of transmitter output power measured over the full test interval shall be reported. For the purposes of EIRP calculations in B.11, the nominal value shall be used.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.1.2 Measure Power Output Rise Time

B.1.2.1 Requirement

T.018/S.2.4.1/R.0440
T.018/S.2.4.1/R.0430

B.1.2.2 Method of Validation

This nominal power level (P_n) as determined in B.1.1 is used as the reference to estimate the 10% and 90% signal levels.

* Nominal power is the mean value calculated over the measurement period.

The 10% and 90% rising and decreasing power points (tagged as $t_{r,10\%}$ and $t_{r,90\%}$ for the rising points and $t_{d,10\%}$ and $t_{d,90\%}$ for the decreasing points) can be obtained at the intersection of the instantaneous power with the 10% and 90% signal levels.

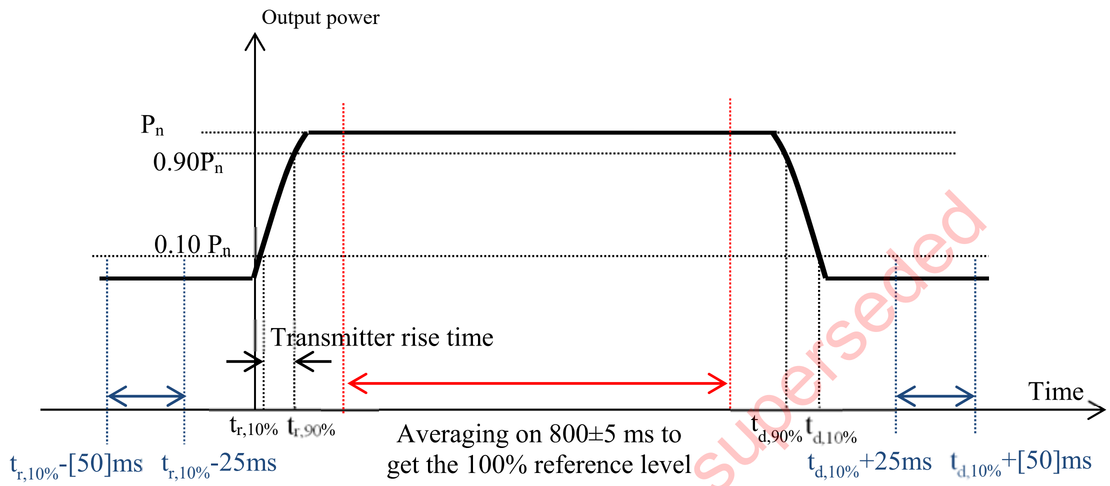


Figure B.6: TBD

Then the transmitter rise time can be computed as the difference in time between the two rising power points ($t_{r,90\%}$- $t_{r,10\%}$).

The maximum value of the output power over the time interval {$t_{r,10\%}$ - 50 ms ; $t_{r,10\%}$ - 25 ms} is compared to the maximum required value of -10 dBm. Note that the RF losses of any impedance connected to the beacon only for test purposes shall be accounted for in this comparison.
The same comparison is done over the time interval {$t_{d,10\%}$ + 25 ms ; $t_{d,10\%}$ + 50 ms}.

B.1.2.3 Required Results

The transmitter rise time shall be measured for each burst.

The maximum values of the transmitter RF output power prior to 25 ms before the commencement and 25 ms after the end of each burst shall be measured.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.1.3 Measure Power Output Total Transmission Time

B.1.3.1 Requirement

T.018/S.2.2.2/R.0110

B.1.3.2 Method of Validation

This nominal power level (P_n) as determined in B.1.1 is used as the reference to estimate the 90% signal levels.

The 90% rising power point (tagged as $t_{r,90\%}$) and the 90% decreasing power point (tagged as $t_{d,90\%}$) can be obtained at the intersection of the instantaneous power with this 90% signal level.

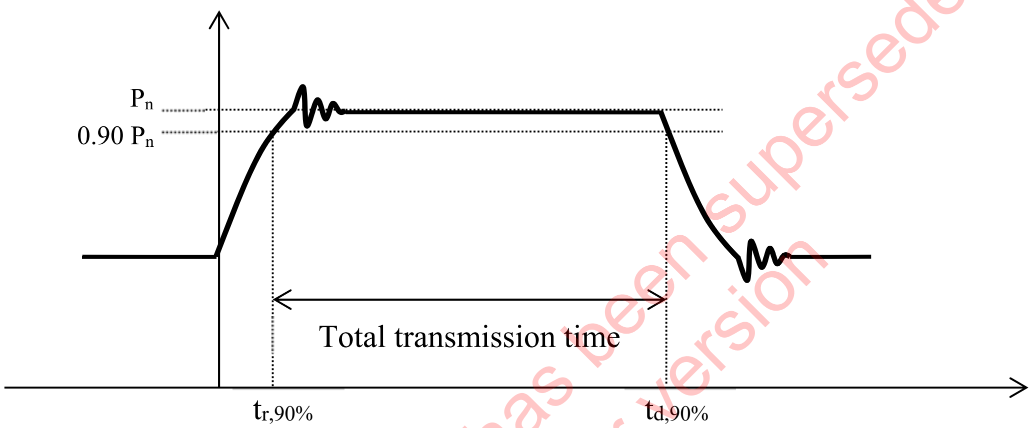


Figure B.7: TBD

Then the total transmission time can be estimated as the difference in time between these two points ($t_{d,90\%}$- $t_{r,90\%}$).

B.1.3.3 Required Results

The value of the total transmission time shall be measured by the test facility for each burst.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.2 CARRIER FREQUENCY STABILITY

B.2.1 Long Term

B.2.1.1 Requirement

T.018/S.2.3.1.1/R.0310

B.2.1.2 Method of Validation

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. The data shall include an analysis of the allowances for each contribution in the beacon design that impacts long term frequency stability. The result of which will be a frequency tolerance on the nominal beacon frequency of 406.050 MHz at beginning of beacon life that will guarantee compliance to the long-term frequency stability requirement. The beacon shall be verified to be within this frequency tolerance using the average of the frequency measurements obtained in section B.2.2.2.

This procedure shall follow the steps below:

a) Analysis from beacon manufacturer (including data from oscillator manufacturer related to ageing performance)

Determination of the maximum frequency variation range over 5 years: Δ_f^{5y}

Determination of the maximum frequency range allowed at the beginning of beacon life $\Delta_f^{begin} = 2400\ Hz - \Delta_f^{5y}$

Verification that the measured averaged frequency, as per section B.2.2.2 step 9, is within the maximum frequency range of 406.050 +/- (Δ_f^{begin}/2).

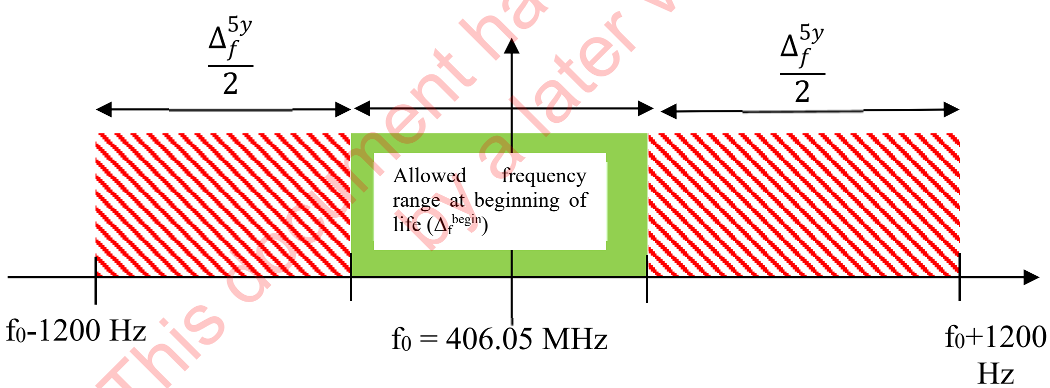


Figure B.8: TBD

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 long-term stability (LTS) would remain within the specification of ± 3.0ppm for 5 years or the manufacturers declared period. The proportion of the 3 ppm total allowance left for aging shall be determined by deducting all other frequency stability factors except for time.

For example, initial calibration error 0.5ppm, allowance for reflow and mounting on beacon manufactures board 0.6ppm, frequency vs temperature 0.2ppm, frequency vs supply and load 0.2 ppm, etc. Therefore, deducting these from the total allowance leaves ±1.5ppm for aging. The sum of all of these values represent the oscillator contribution to the value required in b) above.

The requirement can be addressed for new oscillator qualifications by the following means:

Selecting a Sample size of a minimum of 22 pcs and subjecting them to an accelerated LTS temperature of +85C for a monitoring period of 90 days under a conditionally biased state at a nominal Vcc and output load, then measuring the Frequency at a minimum of 6 times per day. The frequency measurements taken are to be mathematically fitted to the prediction equation per MIL-PRF-55310E to determine the coefficients A & B for each device as follows:

- $f(t) = k_{12} A \log_{10}(1 + Bt) + k_{12} C$
- $k_{12} C$ is removed when the aging prediction is zeroed to day 1
- k_{12} = Thermal acceleration factor and t = time.

The thermal acceleration factor is to be determined by the oscillator supplier. The predicted long term stability is then calculated using the beacon manufacturers declared period of use at an average storage temperature of +20C and applying the above equation for all samples.

The applicable LTS qualification report for that model / variant of TCXO along with the data for the actual oscillators used shall be supplied to the beacon manufacturer.

The requirement can be addressed for ongoing production oscillators by the following means:

LTS 100% Testing with the test method as follows:

All oscillators will be serialized and subjected to the LTS qualification process above for a monitoring period of a minimum of 21 days.

Traceable data from the individual production test data for all serialized oscillator units shall be provided to the Beacon manufacturer. This data will be submitted to the Secretariat and the test facilities for all beacons submitted for type approval testing.

B.2.1.3 Required Results

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

The data items required in ANNEX H.1 are required.

B.2.2 Short Term

B.2.2.1 Requirement

T.018/S.2.3.1.1/R.0310
T.018/S.2.3.1.1/R.0320

B.2.2.2 Method of Validation

1) Starting at the beginning of the one second burst, take a single frequency measurement over a period of 20 ms or greater within the first 41.666 ms period of the burst.
2) Repeat 1) above every 41.666 ms over the entire duration of the burst (i.e. take 24 frequency measurements per burst).
3) Compute the maximum difference in frequency between measurements 1 to 5 above.
4) Repeat 3) above for measurements 2 to 6, 3 to 7, 4 to 8 etc. up to 20 to 24 and compute the maximum difference in frequency for each set of 5 measurements.
5) This will give you a total of 20 results for each burst.
6) Review all 20 results and record the worst one of these (the one with the largest difference).
7) Ensure that the maximum difference in frequency for the worst case result from the 20 sets of 5 measurements is less than 7.4 ppb (3.005 Hz).
8) Repeat for remaining bursts as required by document C/S T.021 Annex A.2.
9) Ensure the average frequency over the measurements in steps 1 and 2 are within 406.050 MHz +/- 1200 Hz.
10) the allowable beginning of life frequency range as calculated in Section B.2.1.

B.2.2.3 Required Results

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.3 CHIP CHARACTERISTICS

B.3.1 I,Q PN sequences (Normal or Self-Test)

B.3.1.1 Requirement

T.018/S.2.2.3/R.0120
T.018/S.2.2.3/R.0130
T.018/S.2.2.3/R.0140
T.018/S.2.2.3/R.0150
T.018/S.2.2.3/R.0160
T.018/S.2.2.3/R.0170

T.018/S.2.2.3/R.0180
T.018/S.2.2.3/R.0190
T.018/S.2.2.3/R.0200
T.018/S.2.2.3/R.0210
T.018/S.2.2.3/R.0211
T.018/S.2.2.3/R.0215

B.3.1.2 Method of Validation

The validation of the spreading sequences used to generate the I and Q components of the signal can be achieved separately using the same method.

The I and Q channels have to be extracted from the processed burst. Because these sequences are modulated by the data bits, these data bits have to be compensated to retrieve the non-modulated spread sequences (I & Q).

The extracted spreading sequences (for both normal and self-test transmissions) shall be then compared to the spread sequences defined in document C/S T.018 for the I and Q channels.

B.3.1.3 Required Results

The number of erroneous chips shall be recorded by the test facility for each I and Q channels of each burst. The reported value for each channel of each burst shall be 2 or less.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.3.2 I,Q Chip Characteristics

B.3.2.1 Chip Rate

B.3.2.1.1 Requirement

T.018/S.2.3.1.2/330
T.018/S.2.3.1.2/340
T.018/S.2.3.1.2/350

B.3.2.1.2 Method of Validation

The chip rate shall be evaluated on time windows of 10ms (for example, using a tracking loop).

The average value of the chip rate shall be computed from the obtained successive measurement (both over the preamble and on the entire burst).

The variation of the chip rate is obtained by using a linear interpolation, which slope gives directly the average frequency variation (both over the preamble and on the entire burst).

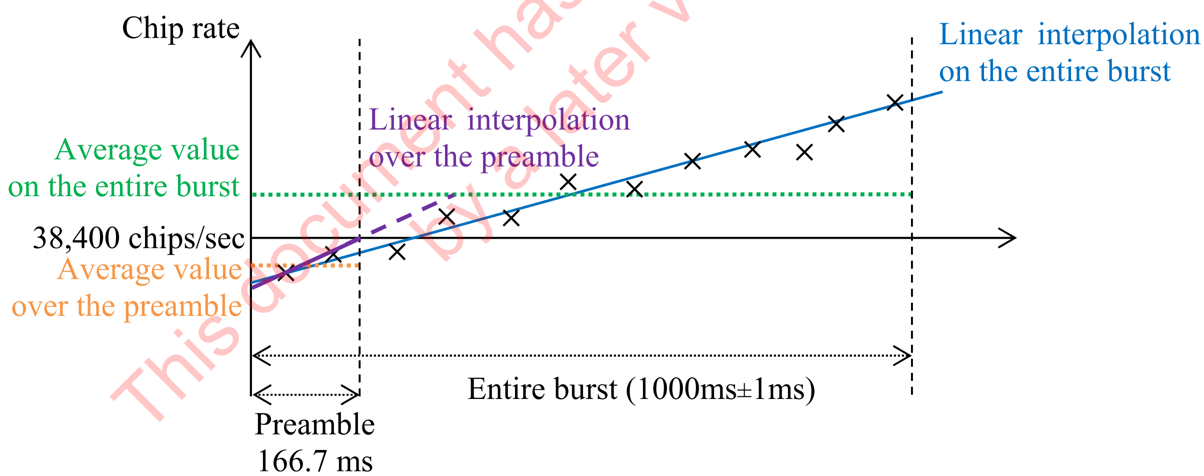


Figure B.9: TBD

B.3.2.1.3 Required Results

The average chip rate and the variation of the chip rate shall be compliant with the requirement over the preamble and on the entire burst.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.3.2.2 Offset

B.3.2.2.1 Requirement

T.018/S.2.3.3/R.0145
T.018/S.2.3.3/R.0380

B.3.2.2.2 Method of Validation

The I and Q channels have to be compared in order to estimate the average relative time offset between these two channels. In order to accurately estimate this time offset, a unique time scale shall be used for both I and Q channel analysis.

Different methods can be used to measure the IQ time offset, as long as they result in sufficient accuracy. However, two general methods have been identified:

a) Direct comparison between I and Q channel

A "master" channel (for example, the I channel) is processed so that timing properties are estimated (typically, the code phase evolution over time). These timing properties are then applied to the "slave" channel (for example, the Q channel) so that the relative time delay between I and Q channels can be estimated. This measurement can be performed by tracking the "master" channel at the chip level (with DLL/PLL) and applying the tracking output to the "slave" channel (with addition of half-chip delay and 90° phase rotation to take into account the OQPSK modulation).

b) Timing measurement of I and Q channel by correlating with known PN sequences

The timing properties of the I and Q channels are first measured separately (with the same timing reference). This measurement is typically performed by estimating the TOA of the I and Q channels. An accurate TOA can be obtained by correlating the received signal after carrier removal, with a local replica. The local replica is a noiseless copy of the expected received signal generated by combining the known PRN sequences defined in document C/S T.018 with the message data recovered from the beacon burst. The TOA is then the delay that offers a maximum of correlation (eventually, using interpolation) between the received signal and the local replica. The time offset between I and Q channels can then be obtained by comparing the two TOAs (taking into account the half-chip delay to take into account the OQPSK modulation).

B.3.2.2.3 Required Results

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted,for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.3.2.3 Peak to Peak Amplitude

B.3.2.3.1 Requirement

T.018/S.2.3.3/R.0385

B.3.2.3.2 Method of Verification

On each channel, the peak to peak amplitude can be estimated as the difference of the mean value of the positive integrated chips (derived from a chip integration for each of the 38,400 chips of the burst on both I & Q channels) and the mean value of the negative integrated chips as follows:

$$\text{Peak to peak amplitude} = \text{mean}(\text{integrated chips} > 0) - \text{mean}(\text{integrated chips} < 0)$$

Then the relative peak to peak amplitude can be evaluated as the ratio of the peak to peak amplitude on the I channel and that computed on the Q channel as follows:

$$100 * \left(\frac{\text{Peak to peak amplitude on the I channel}}{\text{Peak to peak amplitude on the Q channel}} - 1\right)$$

Note that the chip integration can be represented as follows:

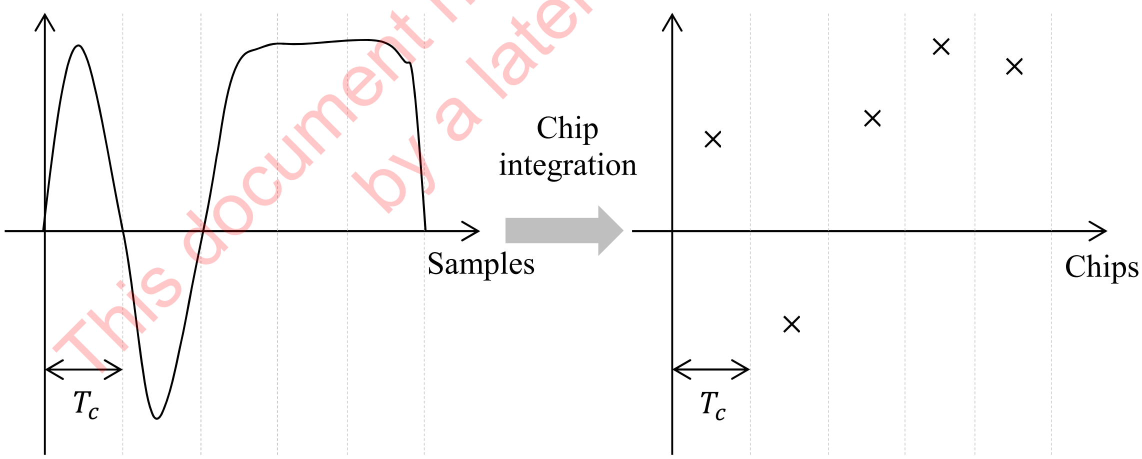


Figure B.10: TBD

B.3.2.3.3 Required Results

The peak to peak amplitude shall be reported for each burst. It shall be less than 15%.

Populate the data tables as required in for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.4 ERROR VECTOR MAGNITUDE (EVM)

B.4.1 Requirement

T.018/S.2.3.3/R.0390

B.4.2 Method of Verification

The Error Vector Magnitude (EVM) can be computed on sliding windows of 150 ms according the following equation:

$$EVM_{\%} = 100 \cdot \frac{\sqrt{\frac{1}{N} \cdot \sum_{n=0}^{N-1} \left(\left(I_{ref} - I_{meas} \right)^2 + \left(Q_{ref} - Q_{meas} \right)^2 \right)}}{\sqrt{\frac{1}{N} \cdot \sum_{n=0}^{N-1} \left(I_{ref}^2 + Q_{ref}^2 \right)}}$$

where:

- I_{meas} and Q_{meas} design the I and Q components of the measured signal (derived from a chip integration for each of the 38,400 chips of the burst of the burst)
- I_{ref} and Q_{ref} design the I and Q components of the theoretical signal (aligned on the four phase references 45°, 135°, 225° and 315° of an OQPSK modulation)
- N refers to the number of integrated chips in a 150ms period, that is N=5760.

EVM values are computed on each 150 ms time windows of the 1s burst duration. The overlap between successive EVM measurements is 140 ms. Only the maximum value of the EVM measurements for each burst is required to be retained.

Figure B.11 illustrates the mapping from I/Q vs time to the constellation plane. The I/Q offset is removed so that each of the corresponding ideal demodulation sample points are aligned. The ideal samples at each symbol period are used as a complex number in order to map into the complex plane. The angle is computed as the four-quadrant arc tangent of the Q/I. The magnitude of the vector is the normalized square root of the sum of the squares of the I and Q components.

Figure B.11: Demodulation: Mapping from I/Q to Constellation

B.4.3 Required Results

The maximum value of the EVM shall be determined for each burst.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.5 SPURIOUS EMISSIONS (IN AND OUT OF BAND)

B.5.1 Requirement

T.018/S.2.3.2/R.0360
T.018/S.2.3.2/R.0370

B.5.2 Method of Validation

The signal spectrum shall be computed and averaged on successive periods of time over the burst duration (for example, periods of 10 ms).

Then this spectrum shall be below the mask defined as follows:

- -20 dBc over the range of f_0-40 kHz to f_0+40kHz frequency band,
- -40 dBc for frequencies below f_0 -40 kHz and frequencies above f_0+40 kHz

where f_0 is 406.05 MHz.

The out of band emissions shall be computed with the ratio of the total power transmitted outside the 406.0 – 406.1 MHz frequency band to the total transmitted power.

The power spectral density shall be evaluated on a frequency band of at least B = 200 kHz. The equation is the following:

$$R_{OOB} = 100 \cdot \left(\frac{\int_{-\frac{B}{2}+406.05\,MHz}^{406.0\,MHz} PSD\,(f)df + \int_{406.1\,MHz}^{+\frac{B}{2}+406.05\,MHz} PSD\,(f)df}{\int_{-\frac{B}{2}+406.05\,MHz}^{+\frac{B}{2}+406.05\,MHz} PSD(f)df} \right)$$

B.5.3 Required Results

The signal spectrum for each burst shall be below the levels of the emission mask.

The transmitted power outside the 406.0 – 406.1 MHz shall comply with the requirement.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.6 MESSAGE STRUCTURE

B.6.1 Preamble

B.6.1.1 Requirement

T.018/S.2.2.4/R.0215
T.018/S.2.2.4/R.0220
T.018/S.2.2.4/R.0230
T.018/S.2.2.7/R.0290
T.018/S.2.2.7/R.0300
T.018/S.2.4.1/R.0450

B.6.1.2 Method of Validation

This procedure aims at verifying the modulation of the preamble (for both normal and self-test transmissions) on I & Q components (the preamble shall not be modulated, i.e. shall contain only 0's information bits).

If checked separately, the result of a correct preamble demodulation can lead to two different results:

- The preamble is "normal" (i.e. contains only 0's information bits)
- The preamble is "inverted" (i.e. contains only 1's information bits)

This is due to a possible phase ambiguity of 180° at the time of demodulation.

Then, the preamble shall be checked in consistence with the rest of the message (i.e. useful message) and the BCH. The test procedure shall be done according to the following steps:

- Assume that the preamble is correctly modulated (i.e. "normal" preamble on both I & Q components) and then read the useful message and check the BCH. If the BCH is correct (no error detected), then the preamble is correctly modulated. If, the BCH is not correct, then, this can be the result of a preamble inversion.
- Perform the same analysis, but assuming that the preamble is inverted (on both I & Q components) and then read the useful message and check the BCH. If, the BCH is correct (no error detected), then the preamble is not correctly modulated (i.e. it is completely inverted).

If, at the end of the second step, the BCH is still not correct, then it is not a matter of preamble but an issue with BCH computation by the beacon.

B.6.1.3 Required Results

The preamble on the I and Q components shall be compliant with the requirement (i.e. modulated with 0's information bits).

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.6.2 Correct BCH

B.6.2.1 Requirement

T.018/S.3.5/R.0670

B.6.2.2 Method of Validation

Using a method independent of the beacon and consistent with C/S T.018 Appendix B, calculate the BCH code from the information bits of the beacon message.
Compare the calculated BCH code with that transmitted in bit numbers 203 to 250 of the digital message burst.

B.6.2.3 Required Results

The independently calculated BCH code shall agree bit by bit with the BCH code transmitted in the message burst.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.7 FIRST BURST AND REPETITION PERIOD

For the tests described in this section, beacon burst time measurements are made at the beginning of the burst, defined as the time when the beacon transmitter reaches 90% of its nominal transmit power.

The repetition period (T_R) is the time interval between two successive beacon burst transmissions. The values of the statistics required to achieve the desired randomization assume a uniform distribution of the repetition period.

B.7.1 Standard Messages

B.7.1.1 Requirement

T.018/S.2.2.1/R.0030
T.018/S.2.2.1/R.0040
T.018/S.2.2.1/R.0050
T.018/S.2.2.1/R.0060
T.018/S.2.2.1/R.0070

B.7.1.2 Method of Validation

The first burst delay (FBD) is the time interval between the time of an action to activate the beacon and the time of the beginning of the first operational burst, defined as the time when the beacon transmitter reaches 90% of the nominal transmit power.

a) Activate the beacon, measure the first burst delay (FBD), and record the value.

b) For the first six bursts, measure the repetition period between successive bursts. Record the value of the repetition period between each successive burst.

c) For bursts 7 to 65, measure the repetition period between successive bursts. Record the value of the repetition period between each successive burst.

d) For bursts 66 to 115, measure the repetition period between successive bursts. Record the value of the repetition period between each successive burst.

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.

B.7.1.3 Required Result

a) Verify that the value of the FBD is no greater than 5 seconds, except for EPIRBs which is no greater than 8 seconds.

b) For burst 1 to 6: The average value for all burst repetition periods shall be 5.0 +/- 0.1 seconds.

c) For bursts 7 to 65: The difference between the maximum and minimum repetition periods shall be more than 4.6 seconds. The average repetition period shall be 30s ± 0.25s with a standard deviation between 1.34s and 1.57s.

d) For bursts 67 to 115: The difference between the maximum and minimum repetition periods shall be more than 4.8 seconds. The average repetition period shall be 120s ± 0.2s with a standard deviation between 1.34s and 1.57s.

e) Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.7.2 ELT(DT) Messages

B.7.2.1 Requirement

T.018/S.2.2.1/R.0030
T.018/S.2.2.1/R.0080
T.018/S.2.2.1/R.0087
T.018/S.2.2.1/R.0088
T.018/S.2.2.1/R.0089
T.018/S.2.2.1/R.0090
T.018/S.2.2.1/R.0100

B.7.2.2 Method of Validation

a) Activate the beacon and measure the repetition period between the first 24 bursts. Record the value of the repetition period between each successive burst.

b) For bursts 25 to 42, measure the repetition period between successive bursts. Record the value of the repetition period between each successive burst.

c) For bursts 43 to 115, measure the repetition period between successive bursts. Record the value of the repetition period between each successive burst.

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.

B.7.2.3 Required Result

a) Burst 1 to 24: The average value of bursts repetition period shall be between 4.8 seconds and 5.0 seconds.

b) Burst 25 to 42: The average value of bursts repetition period shall be between 9.8 seconds and 10.0 seconds.

c) Burst 43 to 75: The difference between the maximum and minimum repetition periods shall be more than 4.9 seconds. The average repetition period shall be 28.5s ± 0.25s with a standard deviation between 0.8s and 0.92s.

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.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.7.3 Cancellation Messages

B.7.3.1 Requirement

T.018/S.4.5.7/R.1990
T.018/S.4.5.7/R.2000
T.018/S.4.5.7/R.2010
T.018/S.4.5.7/R.2020
T.018/S.4.5.7/R.2030
T.018/S.4.5.7/R.2040
T.018/S.4.5.7/R.2050
T.018/S.4.5.7/R.2060
T.018/S.4.5.7/R.2070

B.7.3.2 Method of Validation

The first cancellation message delay is the time interval between the time of an action to deactivate the beacon and the time of the beginning of the first cancellation message burst, defined as the time when the beacon transmitter reaches 90% of the nominal transmit power.

a) Deactivate the beacon, measure the first cancellation message delay, and record the value.
b) Measure the repetition period between the 10 cancellation message bursts and record the value.

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.

B.7.3.3 Required Result

a) Verify that the value of the first cancellation message delay is no greater than 5 seconds.

b) For Burst 1-10: . The interval between each burst shall be 10.0 seconds ± 0.5 seconds.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.8 MESSAGE CONTENT (FIXED AND ROTATING FIELDS)

For beacons with encoded location capability, the GNSS signal should be denied to the beacon to ensure that default parameters are provided in the beacon in the message, for all tests in this section.

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 shall be verified.

The main message fields are the same for all beacon types but the rotating field, or fields, to be verified is dependent on the type of beacon being tested as defined in document C/S T.018.

The following table identifies where the message field values are defined and where the results from the test are entered. For values that are calculated by the beacon such as Elapsed Time, and Remaining Battery Capacity, the values generated by the beacon must be verified with values that are calculated independently.

Table B.8-1: TBD

Item	Values to be coded into the Beacon Message	Expected and Recorded Results
Main Message Field	Table C.1-1	Table E.5-1
Rotating Field #0	Table C.1-2	Table E.5-2
Rotating Field #1	Table C.**1-3**	Table E.5-3
Rotating Field #2	Table C.1-4	Table E.5-4
Rotating Field #3	Table C.1-5	Table E.5-5
Rotating Field #15	Table C.1-6	Table E.5-6

B.8.1 Main Field

B.8.1.1 Requirement

T.018/S.2.2.5/R.0260
T.018/S.2.2.5/R.0600

B.8.1.2 Method of Validation

1. Read the bit values in each field of the main portion of the beacon message and enter the values.

B.8.1.3 Required Results

1. The required results are given in Table E.5-1.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.8.2 Normal – Rotating Field #0

B.8.2.1 Requirement

T.018/S.2.2.5/R.0610

B.8.2.2 Method of Validation

1. Read the bit values in bit positions 155-202 of the beacon message and enter the values in Annex E Table E.5-2.

B.8.2.3 Required Results

The required results are contained in the tables in Annex E.5 Table E.5-2.

For the following subfields, the required results are as follows:

Elapsed Time: The binary field when converted to decimal equals the number of hours since activation. The result is truncated to the nearest hour.

Remaining Battery Capacity: The remaining battery capacity in the beacon compared to its initial capacity shall be verified as follows:

00 ≤ 9 hours remaining
01 > 9 hours and ≤ 18 hours remaining
10 > 18 hours remaining
11 Battery capacity not available

Populate the data tables as required in Annex E.5 Tab E.5-2 for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.8.3 ELT(DT) – Rotating Field #1

B.8.3.1 Requirement

T.018/S.2.2.5/R.0610

B.8.3.2 Method of Validation

1. Read the bit values in bit positions 155-202 of the beacon message and enter the values in Annex E.5 Table E.5-3.

B.8.3.3 Required Results

The required results are contained in the tables in Annex E.5 Table E.5-3.

For the following subfields, the required results are as follows:

Elapsed Time: The binary field when converted to decimal equals the number of hours since activation. The result is truncated to the nearest hour.

Remaining Battery Capacity: The remaining battery capacity in the beacon compared to its initial capacity shall be verified as follows:

00 ≤ 9 hours autonomy remaining
01 > 9 hours and ≤ 18 hours autonomy remaining
10 > 18 hours remaining
11 Battery capacity not available

Populate the data tables as required in Annex E.5: Tab E.5-3, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.8.4 RLS – Rotating Field #2

B.8.4.1 Requirement

T.018/S.2.2.5/R.0610

B.8.4.2 Method of Validation

1. Read the bit values in bit positions 155-202 of the beacon message and enter the values in Annex E.5 Table E.5-4.

B.8.4.3 Required Results

The required results are contained in the tables in Annex E.5 Table E.5-4.

Populate the data tables as required in Annex E.5 Tab E.5-4 for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.8.5 Beacon Message Content – Rotating Field#3

B.8.5.1 Requirement

T.018/S.2.2.5/R.0610

B.8.5.2 Method of Validation

1. Read the bit values in bit positions 155-202 of the beacon message and enter the values in Annex E.5 Table E.5-5.

B.8.5.3 Required Results

The required results are contained in the tables in Annex E.5 Table E.5-5.

Populate the data tables as required in Annex E.5 Tab E.5-5 for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.8.6 Cancellation – Rotating Field #15

B.8.6.1 Requirement

T.018/S.2.2.5/R.0610

B.8.6.2 Method of Validation

1. Read the bit values in bit positions 155-202 of the beacon message and enter the values in Annex E.5 Table E.5-6.

B.8.6.3 Required Results

The required results are contained in the tables in Annex E.5 Table E.5-6.

Populate the data tables as required in Annex E.5 Tab E.5-6 for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.9 VOLTAGE STANDING WAVE RATIO (VSWR)

B.9.1.1 Requirement

T.018/S.2.3.4/R.0400
T.018/S.2.3.4/R.0410

B.9.1.2 Method of Validation

With the matching network removed (if applicable), 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 over at least 10 bursts:

a) carrier frequency stability, per para B.2.2;
b) EVM, per para B.4;
c) message structure and content*, per para B.6 and para B.8 sub-sections, as appropriate.

B.9.1.3 Required Results

Populate the data tables as required in Annex E: Tab: Annex E.1-3 - A.2.1 - VSWR, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.10 MAXIMUM CONTINUOUS TRANSMISSION

B.10.1.1 Requirement

T.018/S.2.3.4/R.0420

B.10.1.2 Method of Validation

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.

B.10.1.3 Required Results

Populate the data tables as required in Annex E.5: Tab: Annex E.1-11 - A.2.9, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

* The message content is as defined in Annex C.

B.11 EIRP MEASUREMENTS

B.11.1 Equivalent Linear Effective Isotropic Radiated Power

This section provides a methodology to evaluate the Equivalent Linear Effective Isotropic Radiated Power (EL-EIRP) of the beacon to verify that it is capable of establishing a communications link to the satellite system as defined within the Cospas-Sarsat link budgets with sufficient quality in each of the required deployment scenarios.

B.11.1.1 Requirement

T.018/S.2.4.2/R.0460
T.018/S.2.4.2/R.0470
T.018/S.2.4.2/R.0480
T.018/S.2.4.2/R.0490
T.018/S.2.4.2/R.0500

Power output is defined in terms of EL-EIRP, not power into a 50-ohm load. Required EL-EIRP varies with elevation angle according to the table below. Greater than 65% of measured EL-EIRP values shall meet the limits shown (in Table B.11-3). In addition 90% of the measured EIRP values shall meet the limits shown at elevation angles below 55 degrees, except for ELT(DT)s, or ELTs used in combination with automatic deployable flight recorders.

B.11.1.2 Method of Validation

The sections below provide detail of the required test method, an overview of this follows:

The beacon with its antenna fitted (or a remote antenna) is positioned in an area that allows free space propagation with any unwanted reflections suppressed. The beacon (or remote antenna) is provided with an RF ground environment that approximates its true usage scenario.

EL-EIRP is determined by direct field strength measurement using a receive antenna with traceable gain calibration positioned at a known distance and aimed directly at the beacon. The receive antenna is stepped through an elevation arc from 10˚ to 85˚ in 5˚ steps. At each elevation the beacon is rotated to predetermined azimuth angles (see

Table B.11-1) and a measurement is taken when the beacon next transmits. The quantity of azimuth angles reduces as elevation increases to mimic reducing likelihood that a satellite will be present as elevation increases and to equally space points over the surface of the upper hemisphere.

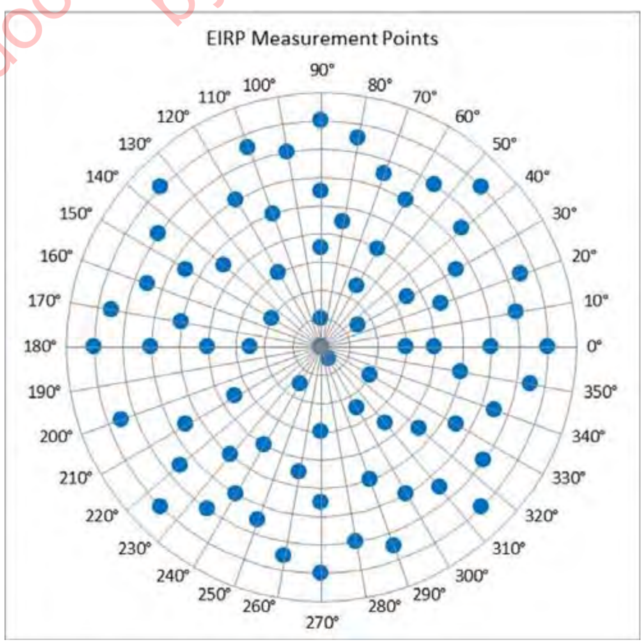
EL-EIRP results in dBm are tabulated and then the effects of temperature and operating lifetime are mathematically applied to the results. The beacon passes if a certain percentage of measured EL-EIRP values fall inside the upper/lower limits.

Table B.11-1: Table of Azimuth measurement positions

Elev	No Points	Azimuthal Antenna Measurement Points							
10	8	0	45	90	135	180	225	270	315
15	8	20	80	110	170	200	260	290	350
20	7	10	55	100	145	235	280	325	
25	7	40	70	160	220	250	310	340	
30	6	0	60	120	180	240	300		
35	6	30	90	150	210	270	330		
40	5	110	170	230	290	350			
45	5	20	80	140	260	320			
50	4	0	60	180	240				
55	4	30	90	210	310				
60	3	0	120	270					
65	3	60	180	300					
70	2	150	330						
75	2	30	240						
80	1	90							
85	1	300							

The following figure illustrates the distribution of the EL-EIRP measurement points over the upper hemisphere. While apparently random in nature the distribution has been selected to approximate the availability of satellites in the MEOSAR system and space the points approximately equidistance apart in azimuth.

Figure B.12: Distribution of EIRP Measurement Points



B.11.1.2.1 Beacon preparation

The test beacon shall be allowed to operate for at least 20 minutes in the test environment to allow thermal stabilisation and settling of any fresh battery. To confirm the transmitter has settled EL-EIRP readings shall be made at 25° elevation, at a random azimuth, to confirm less than 0.5 dB variation across 6 sequential bursts. If this criteria cannot be met wait for a further 20 minutes and repeat the test.

When different beacon samples are used for conducted and radiated tests then the output power setting of the radiated EL-EIRP test sample shall be within 0.5dB of the conducted sample. This shall be confirmed by the beacon manufacturer.

To avoid long waits between beacon transmissions manufacturers may provide an mode which transmits at approximately a 30 second repetition rate for an extended period after beacon activation. Where testing uses OATS, provision should also be made to avoid transmissions degrading traffic on the satellite system, for example by using a non-live PRN spreading code. If a live PRN code is used then advanced notification shall be given to SAR authorities to avoid a false alert. If required, homing signals in the beacon shall be offset to non-distress frequencies or signals unless an anechoic chamber is used.

Any beacon tested in configuration GP-IN (see later) needs to be RF coupled to the ground plane. Manufacturers may choose to provide coupling arrangements to suit the shape of their beacon, or a suitable container of salt water may be used as a coupling medium between the beacon and ground plane. The arrangement shall maintain the beacon antenna at the centre of the axis of rotation.

B.11.1.2.2 Test site layout

It is recommended that an Open Area Test Site (OATS) complying with the guidelines below is used. Alternative anechoic chamber test sites require test evidence to prove that the chamber can suppress unwanted wall reflections at 406 MHz and provide the required degree of site accuracy.

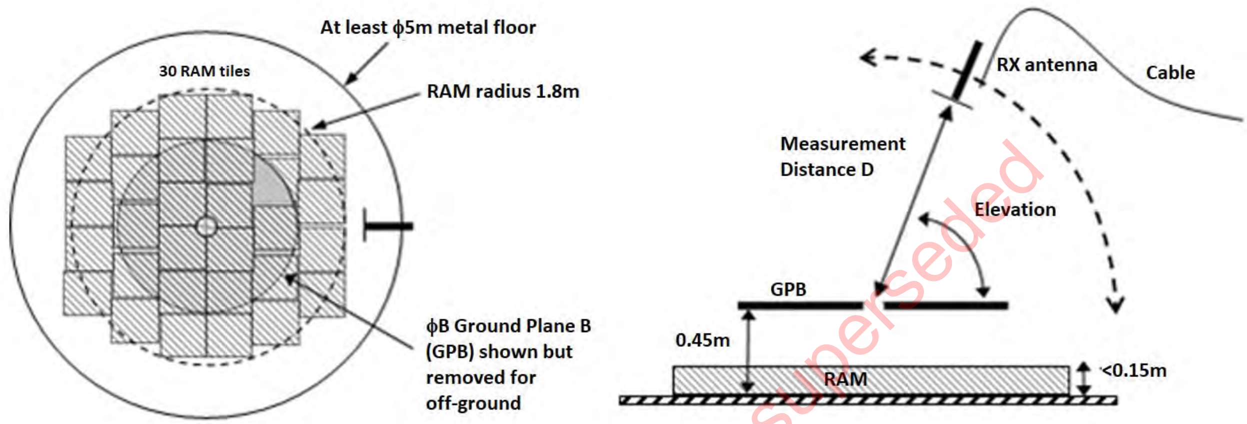
As a minimum OATS shall provide a level area with a central test zone having an electrically continuous metal floor at least 5m in diameter. The site should be clear of metal objects, overhead wires, etc. Distance from the test zone center to nearby reflecting objects or people should be at least 10m. If weather canopy is used it shall use non-conductive, non-reflective materials.

In all test cases the central circular test zone shall be covered in Radar Absorbing Material (RAM) to a minimum radius of 1.8m to counter floor reflections. Eccosorb AN79 layered loaded foam RAM is suggested but any equivalent may be used if it provides >18dB of attenuation at 406 MHz.

The central test zone could provide a turntable at floor level to allow rotation in azimuth. It is expected that the RAM layout shall provide equivalent results for all azimuth angles (for example by having the RAM rotate with the turntable). The beacon test position is 0.45m above floor level at the center of the test circle. Methods for supporting the beacon or antenna at this height are detailed in later sections.

The illustration below shows a raised ground plane (GPB) in place but this is removed for off ground testing.

Figure B.13: Illustration of RAM zone and RX antenna path



B.11.1.2.3 Receive Antenna Configuration

The beacon manufacturer in consultation with the test facility shall select* one of the two test configurations of the test set-up different by ground plane diameter (B) and measurement distance (D) to the receive (RX) antenna and defined as follows:

a) Configuration #1: B = 2.5 m and D = 2 m, or

b) Configuration #2: B = 2.25 m and D = 4 m.

The RX antenna shall follow a 10˚ to 90˚ elevation arc at a measurement distance of $D \pm 10cm$* from the central test/pivot position to the phase/calibration center of the RX antenna. A non-metallic support structure is required to allow this trajectory to be followed with minimal repeatability error and elevation angle accuracy better than 2˚. The arc pivot reference is 0.45m above floor level. Providing a 90° position allows site center calibration using a plumb-line.

The RX antenna shall always point directly at the central test/pivot position with less than 5˚ of misalignment. The RX antenna feed cable should be supported on axis for at least 1.5m behind the antenna, then supported so that it does not lie within a 5m radius of the test position. A lightweight feed cable is recommended.

The RX antenna shall be circular RHCP. This ensures that any arbitrary phase shift between vertical and horizontal field content is correctly taken into account in a manner that exactly mimics the real satellite antenna. Using RHCP confirms that the incoming signal is either linear or RHCP since any LHCP content will be attenuated and thus fail EL-EIRP limits.

* Until further notice, either of the two configurations are allowed to be used by test facilities pending the results of additional comparative evaluations.

The RHCP antenna should be small to allow minimise ambiguity over its phase/calibration center and lightweight to ease stress on its support structure. These criteria are best met by a single frequency 406 MHz antenna rather than a broadband device. Examples of suitable small RHCP antenna types include:

(a) cross-dipole (90˚ phasing either by $\lambda/4$ coax or by physical gap between V and H dipoles);
(b) cross-hair (90˚ phasing by stagger tuned short/long dipoles).

The RX antenna shall have an on-axis axial ratio better than 1.5dB and shall have a calibrated gain (ideally in dBi) traceable to a national standards institute.

B.11.1.2.4 EL-EIRP computation

The power in dBm for the burst shall be measured in accordance with B.1.1.

$$\text{EL-EIRP (dBm)} = Prx + Lc - Grx + Lp$$

Where

Prx = received power (dBm)
Lc = Cable loss at 406 MHz (dB)
Grx = RX antenna gain (dBi) where dBi implies Gain for Linear polarisation
Lp = Propagation loss (dB) = $20\log(4\pi D/\lambda)$ where D= Distance)

The actual test distance D at each elevation shall be measured for the installation and this value shall be used at each elevation to calculate Lp.

If the RX antenna calibration is quoted as Antenna Factor (AF) then this can be converted to Gain using the formula: Grx = 20log(F) -29.8 – AF (dB/m) where F=frequency (MHz).

Cospas-Sarsat sets EL-EIRP requirements assuming linear polarisation and link budgets allow for 3dB polarisation loss in the satellite RHCP antenna. To cater for this the gain of the RHCP receive antenna shall be expressed in dBi rather than dBic. If no specific dBi calibration is available then the following formula may be used: dBi = dBic -3dB. This has the effect of adding 3dB to the calculated EL-EIRP dBm values.

The use of dBi (or 3dB correction) remains unchanged if the beacon antenna uses circular polarisation. Since the RHCP satellite antenna gives 3dB more RX level for an RHCP signal, this means that a beacon transmitting RHCP is 3dB more effective (its EL-EIRP is larger if quoted in Equivalent Linear EL-EIRP terms) and retaining dBi correctly accounts for this.

B.11.1.2.5 Test Configurations

T.018/S.2.4.3/R.0510
T.018/S.2.4.3/R.0520
T.018/S.2.4.3/R.0530
T.018/S.2.4.3/R.0540
T.018/S.2.4.3/R.0550
T.018/S.2.4.3/R.0560
T.018/S.2.4.3/R.0570

T.018/S.2.4.3/R.0580
In order to be representative the beacon (or remote antenna) must be provided with an RF ground situation that mimics the true usage scenario. The test configurations detailed in the following sections are representative approximations to those usage scenarios.

The table below shall be used to determine which test configurations need to be tested for each type of beacon. In cases where the beacon is novel and the table seems inappropriate then the Cospas-Sarsat Secretariat should be consulted for advice before testing commences. Note that configuration names (e.g. AG, GP-XX) are explained in sections that follow.

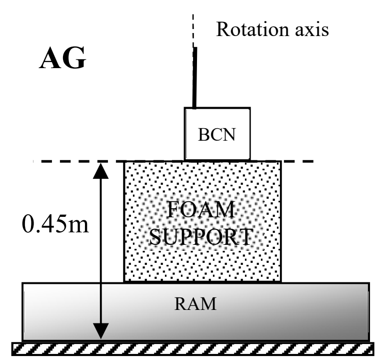
Table B.11-2: Test Configurations

PRODUCT	VARIANT	CONFIGS REQUIRED
ELT-AF (auto fixed)		GP-AV
ELT(DT)		GP-AV
ELT-AP (auto portable)		AG*, GP-ON†, GP-AV‡
ELT-AD (auto deployable)		AG, GP-IN, GP-ON
ELT-S (survival) / PLB	A) General (Land & Marine)	AG, GP-ON
PLB	B) Designed to attach to a life preserver	AG, GP-ON, GP-LP
ELT-S / PLB	C) Designed to operate while floating	AG, GP-IN
EPIRB		AG, GP-IN

PLB and ELT-S beacons have variants (A, B, C) which address different segments of the beacon market. The beacon manufacturer may opt to address more than one of these markets by declaring any combination of variants A, B, or C. The corresponding additional ground configurations are then appended to the test schedule.

B.11.1.2.6 Above-ground (AG) configurations

This ground configuration is appropriate for non-fixed beacons which may be deployed in situations where there is no obvious RF ground under the beacon. Examples for land based beacons might be with the beacon sat on a rock or tree stump. For marine usage examples might be with the beacon on a wooden boat deck or operated inside a safety raft.



For this configuration GPB is removed and the beacon is placed upright on an insulating support so that its base is 0.45m ± 3cm above the metal floor. The beacon antenna is positioned on the turntable axis such that test distance variation with rotation is minimised. The alignment of the beacon casing in relation to 0° rotation should be noted.

* Configuration required for ELT(AP) with the portable antenna installed, as applicable.
† Configuration required for ELT(AP) with the portable antenna installed, as applicable.
‡ Configuration required for ELT(AP) with the fixed external antenna(s)attached, as applicable.

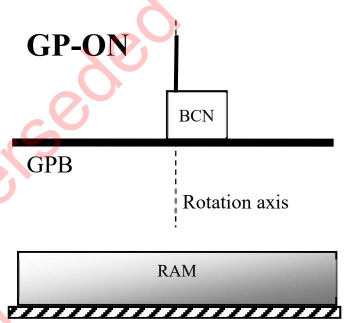
B.11.1.2.7 On-ground (GP-XX) configurations

These ground configurations are appropriate for beacons (or remote antennas) designed to operate in, on, or [*just above*] a large conductive RF ground.

For this configuration RF ground is approximated by a non-magnetic highly electrically conductive [*TBD value e.g. copper or aluminium*] disk B meters in diameter called Ground Plane B. This is raised 0.45m ± 3cm above floor level on non-conductive supports. A central hole in the disk caters for different beacon/antenna attachment methods as below:

a) Configuration GP-ON

This is appropriate where the beacon may be deployed directly on land based terrain.

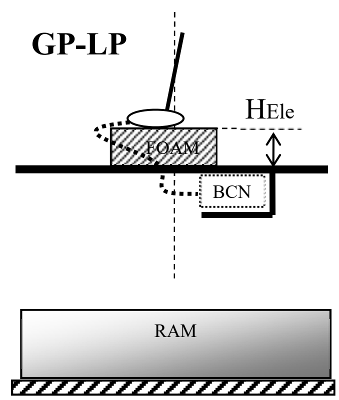


For this configuration GPB has a conductive metal sheet across its central hole and the beacon is stood in its intended operating manner on GPB so that its antenna is at the center of GPB.

b) Configuration GP-LP

Configuration under development, anticipated to be available in 2019. Until this has been defined, the configuration below cannot be used without prior consultation with the Secretariat per section 5.1.

This is appropriate for beacons (or remote antennas) where these are designed to be attached to a foam life preserver (LP) or a gas filled life jacket. These materials will not affect RF performance.
For this configuration GPB has a conductive metal sheet across its central hole and the beacon or remote antenna is supported at a height of 16 ± 3 cm to mimic an average life preserver.



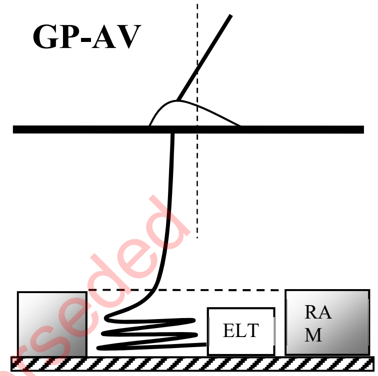
For LP remote antennas the beacon shall be attached to the underside of GPB in a manner that mimics water surrounding it and the portion of feed cable above GPB shall be arranged to reflect the intended arrangement on the life preserver. The cable shall be the correct type and maximum length as recommended by the manufacturer.

Beacons with no antenna cable shall be placed on the foam in a similar manner to the intended attachment method to the life preserver (e.g. on Velcro or a webbing strap etc.).

c) Configuration GP-AV

This is appropriate for remote antennas which are mounted directly into a large metal expanse, such as an aircraft fuselage.

For this configuration the antenna must be mounted into the center of GPB in its intended operational manner so that the electrical center of the antenna is central and variations in test distance with rotation are minimised. If the antenna tilts by design then the manufacturer should specify the electrical center. This may result in the feed connector being off-center.

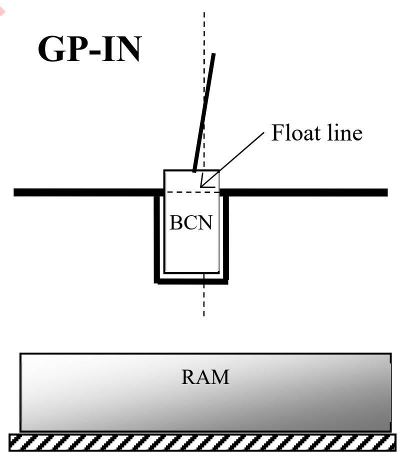


The remote antenna shall feed from the beacon via the maximum length and type of cable recommended by the manufacturer both of which are to be located directly under GPB as centrally as possible. To minimise cable radiation the beacon and cable shall be directly on the metal floor and a small (max 0.4m diameter) temporary hole may be cut into the RAM to allow this, which should be covered by additional RAM.

d) Configuration GP-IN

This configuration is appropriate for beacons designed to operate while floating in water.

For this configuration the beacon is first floated in 1.7% (by weight) salt water to confirm the manufactured-declared median (salt/fresh) water line and any antenna tilt that is evident (to be replicated in the test setup). The beacon is then sunk into the central GPB hole in a manner that allows the ground plane to wrap around the beacon and mimic water surrounding the beacon (e.g. by wrapping the beacon in metal foil or immersing it in salt water).



With the beacon supported so that its float line matches the GPB surface and with any antenna tilt correctly copied, the antenna is then centered on the turntable rotation axis to minimise any test distance variation with rotation.

B.11.1.3 Required Results

Measured EL-EIRP values shall be reported on the form given in Table E.3-1 which includes the following information:

a) Model of Beacon and/or Antenna under test
b) Name of test configuration
c) Photograph of the beacon in situ showing the overall test site and set up
d) Close-up photograph of the beacon in situ in its as tested configuration
e) Orientation of the beacon casing at 0° rotation (mark, illustration, photograph, etc.)

f) Worst case increase and decrease in dBm over the operating temperature range of the beacon, taking ambient with a new battery as the 0dB reference point.
g) Worst case increase and decrease in dBm over the operating lifetime test, taking ambient with a new battery as the 0dB reference point.

Analysis of the results table to determine pass/fail shall be as follows:
1) Any value failing the limits tabulated below shall be highlighted by strikeout (e.g. ~~29.7~~).

Table B.11-3: EL-EIRP pass limits vs. elevation angle

Elevation (°)	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85
Max dBm	45	45	45	45	45	45	45	45	45	44	44	44	44	44	44	44
Min dBm	34	34	34	34	34	34	34	34	34	34	34	33	33	33	33	33

2) For each result value in the table, without changing the value, highlight that value in red strikeout (e.g. ~~31.7~~) if the effects of temperature and operating life would cause that value to fail.

3) Where cable loss needs to be taken into account (see section B.11.2), for each table value, without changing the value, highlight any additional values in blue strikeout (e.g. ~~31.7~~) if the effects of minimum or maximum cable loss would cause that value to fail.

4) Measurement uncertainty of 1dB may now be applied to a maximum of 6 values in the results table that have failed to meet limits but would pass if measurement uncertainty were applied. Where the value is low a notional 1dB is added, where the value is high a notional 1dB is subtracted. Without changing any values, alter the value status to pass by removing the strikeout and changing the value colour to green (e.g. 31.7).

5) Count the number of values without any strikeout and express this count as a percentage of the total number of table values. If this is less than 65 % then the EL-EIRP test fails. In addition, if less than 90% for the measured EIRP values at elevation angles below 55 degrees then this test fails, except for ELT(DT)s, or ELTs used in combination with automatic deployable flight recorders.

6) From the values without any strikeout, locate the minimum and maximum values and declare these values on the results sheet.

B.11.2 Antenna Characteristics

This section gathers measurement data to confirm that all types of beacon antenna under approval will meet the EL-EIRP requirements of section B.11.1.3 even with worst case RF cable loss.

For remote antennas without an integrated cable, VSWR is checked to ensure that different cable lengths (signal phase) will not alter the EL-EIRP. Cable loss is dealt with separately.

B.11.2.1 Requirement

T.018/S.2.4.3/R.0530
T.018/S.2.4.3/R.0540
T.018/S.2.4.3/R.0550
T.018/S.2.4.3/R.0560
T.018/S.2.4.3/R.0570
T.018/S.2.4.3/R.0580

B.11.2.2 Method of Validation

Antenna polarisation is measured as part of EL-EIRP testing under section B.11.1. There is no requirement to explicitly determine whether the beacon transmission falls into a linear or circular (RHCP) category. Instead by measuring EL-EIRP with a RHCP receive antenna the test method allows both linear and RHCP while eliminating LHCP.

Where more than one type of remote antenna is submitted for approval, EL-EIRP measurements as per B.11.1 shall be carried out and a results table generated for each antenna type submitted. For each remote antenna type section B.11.1.2.5 determines which deployment scenarios shall be tested.

Antennas will not be approved as stand-alone items, antennas must be tested with the type of beacon under approval. Remote antennas use an RF cable between the beacon the antenna and a representative cable must be used between the beacon and the antenna during EL-EIRP testing. If the cable is not integrated, then the cable used for testing shall be the maximum cable length specified by the beacon manufacturer. Where a specific cable assembly type is named then this specific cable assembly shall be tested.

Where the cable is not integrated, then for each remote antenna type the beacon manufacturer shall specify: (a) the cable characteristic impedance; (b) maximum cable loss permitted; (c) minimum cable loss permitted. The loss of the cable used during EL-EIRP testing shall be measured and detailed on the results sheet.

EL-EIRP results tables shall include post measurement analysis of the pass/fail impact of minimum and maximum cable loss on the EL-EIRP results. This is derived by adjusting for the min/max loss compared to the measured loss of the sample cable used during EL-EIRP testing.

For remote antennas without an integrated cable, measurement of antenna VSWR shall be carried out with a suitable network analyser or VSWR meter. Each type of remote antenna submitted shall have its VSWR (referenced to the specified cable impedance) measured directly at its antenna input connector. This measurement shall be made on the EL-EIRP test site and repeated for each ground configuration determined by section B.11.1.2.5.

B.11.2.3 Required Results

An EL-EIRP result table per Annex E.3: Tab: Annex E.3-1 - EL-EIRP, shall be completed for each antenna type, in each specified ground configuration.

For remote antennas the result sheet for each ground configuration shall include measured VSWR which shall not exceed 1.5:1.

Where applicable for a remote antenna the following shall be included on the results sheet:

a) Characteristic RF impedance of the cable
b) Measured cable loss of the EL-EIRP test cable (dB)
c) Minimum permitted cable loss, plus required EL-EIRP dB increase: (b) - (c)
d) Maximum permitted cable loss, plus required EL-EIRP dB decrease: (b) - (d)

The result table shall indicate the impact of min/max cable loss upon EL-EIRP results as per section B.11.2.3.

B.12 AUXILIARY RADIO LOCATING SIGNAL (RESERVED)

B.12.1 Requirement

T.018/S.2.5/R.0590
T.018/S.2.5/R.0780
T.018/S.2.5/R.0790

B.12.2 Method of Validation

Intentionally left blank.

B.12.3 Required Results

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B.13 BEACON SELF-TEST MODE

B.13.1 Requirement

T.018/S.4.5.4.1/R.0840
T.018/S.4.5.4.1/R.0850
T.018/S.4.5.4.1/R.0860
T.018/S.4.5.4.1/R.0870
T.018/S.4.5.4.1/R.0880
T.018/S.4.5.4.1/R.0890
T.018/S.4.5.4.1/R.0900
T.018/S.4.5.4.1/R.0910
T.018/S.4.5.4.1/R.0920
T.018/S.4.5.4.1/R.0930
T.018/S.4.5.4.1/R.0940

T.018/S.4.5.4.1/R.0950
T.018/S.4.5.4.1/R.0960
T.018/S.4.5.4.1/R.0970
T.018/S.4.5.4.1/R.0980
T.018/S.4.5.4.1/R.0990
T.018/S.4.5.4.1/R.1000
T.018/S.4.5.4.1/R.1010
T.018/S.4.5.4.1/R.1020
T.018/S.4.5.4.1/R.1030
T.018/S.4.5.4.1/R.1040
T.018/S.4.5.4.1/R.1050
T.018/S.4.5.4.1/R.1060
T.018/S.4.5.4.1/R.1070

B.13.2 Method of Validation

The manufacturer shall provide a list of the parameters that are monitored in the self-test mode (see Annex G.1). If a GNSS self-test is also provided for, this shall be noted and any additional parameters included.

The test shall verify that the self-test mode:

a) results in a single self-test burst transmission,
b) does not cause any operational mode transmissions,
c) terminates automatically immediately after completion of the self-test cycle and indication of the self-test results; and
d) has a duration that does not exceed the maximum value of 15 seconds or the value declared in Annex G.1 if it is shorter.

The test shall verify that activation of the Self-test Mode results in distinct indications that:

a) the self-test mode has been initiated within 2 seconds of activation;
b) RF-power is being emitted at the radio locating frequencies in the order of ascending frequencies, if applicable, followed by the 406 MHz burst;
c) within 15 seconds the Self-test has passed successfully, or has failed; and
d) the beacon battery status, if included in the self-test feature, is as described by the manufacturer and complies with B.20.

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.018 paragraph 4.5.5.2 or paragraph 4.5.5.3 for ELT(DT)s. The self-test mode(s) shall be tested to verify that any transmission shall not result in more than a single self-test burst regardless of the duration of activation of the GNSS self-test control. 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 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 for ELT(DT)s the beacon transmits a single self-test message with the correct encoded location; and

d) a separate distinct indication that the limited number of GNSS self-test attempts has been attained is provided immediately after GNSS self-test mode activation and without transmission of a test message or further GNSS receiver current drain.

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.

All beacons capable of transmitting encoded location data shall be subjected to the self-test navigation test scripts contained in ANNEX D.

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

B.13.3 Required Results

Populate the data tables as required in Annex E: Tab: Annex E.1-11 - A.2.9, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.14 ENCODED POSITION DATA

This section defines the test and inspection requirements for beacons with encoded location to ensure that the encoding of beacon position data in the digital message transmitted by a 406 MHz distress beacon complies with all the requirements in C/S T.018.

The following table provides a guide to the requirements and tests contained in this section.

Table B.14-1: TBD

T.021 Clause Number	Test Name	Requirements
B.14.1	**General**	
B.14.1.1	Encoded Location Data	R.1080 to R.1120
B.14.1.2	ELT(DT) Navigation Devices	R.1130 to R.1140
B.14.1.3	Navigation Device Failure	R.1150
B.14.2	**Internal Navigation Device**	
B.14.2.1	Capability and Standard	R.1160
B.14.2.2	Self-Check	R.1170 to R.1180
B.14.2.3	Cold Start	R.1190
B.14.2.4	Location Accuracy and Information	R.1200 to R.1270 R.1380 to R.1400
B.14.2.5	First Provision of Location and Dimensions	R.1280 to R.1300
B.14.2.6	Location Updates	R.1310 to R.1370
B.14.2.7	Operational Time of Navigation Device	R.1420 to R 1430
B.14.3	**ELT(DT) Internal Navigation Device**	
B.14.3.1	Capability and Standard	R.1440
B.14.3.2	Self-Check	R.1450 to R.1460
B.14.3.3	Cold Start	R.1470 to R.1480
B.14.3.4	Location Accuracy and Information	R.1490 to R.1540
B.14.3.5	First Provision of Location and Dimensions	R.1550 to R.1570
B.14.3.6	Location Updates	R.1490 and R.1500 R.1610 to R.1620
B.14.3.7	Operational Time of Navigation Device	R.1590 to R.1600
B.14.4	**External Navigation Device**	
B.14.4.1	Standards and Interfaces	R.1670 to R.1680
B.14.4.2	Location Accuracy and Information	R.1690 to R.1860

The following test procedures throughout this section make extensive use of GNSS simulators, unless otherwise stated, the simulator shall be configured to provide a nominal satellite constellation (or constellations) in accordance with the operating modes of the GNSS receiver in the beacon, as declared by the beacon manufacturer in their type approval application. The signal levels from the GNSS simulator shall be set up such that the GNSS antenna in the beacon under test experiences nominal signal levels (+/- 2dB) on the surface of the earth for the GNSS constellations in use. That is the signal levels at the site of the GNSS antenna in the beacon shall either be validated by measuring the signal strength or by calculation based upon the power output of the simulator, the gain of the radiating antenna attached to the simulator and the path loss between the simulator and the beacon.

B.14.1 General

B.14.1.1 Encoded Location Data

B.14.1.1.1 Requirement

T.018/S.4.5.5.1/R.1080
T.018/S.4.5.5.1/R.1090
T.018/S.4.5.5.1/R.1100
T.018/S.4.5.5.1/R.1110
T.018/S.4.5.5.1/R.1120

B.14.1.1.2 Method of Validation

The manufacturer's supplied documentation shall be inspected to see if the beacon complies with all the navigation provisions of C/S T.018 section 3 and section 4.5.5.

This test will check to see if the navigation related fields are correctly encoded. In order to do this, the navigation test scripts in Annex 0 will be run. The tests in C/S T.021 section B.6 use static values of parameters to check if those values appear in the proper location(s) in the digital message. This test check whether the navigation parameters of GNSS provided location, altitude, HDOP, VDOP and GNSS status are properly encoded into the beacon message.

This test shall be run for each provided method of navigation data input, that is for the internal navigation device if applicable and for the external navigation device input if applicable. In the case of the external navigation device input the test shall be run for each external interface data variant declared by the beacon manufacturer in their type approval application (e.g. IEC 61162-1 sentences, ARINC labels, proprietary sentences etc.). Only the highest data stream baud rate is required to be tested.

This test may be conducted by using a GNSS simulator (if a GNSS simulator is used the internal data line from the GNSS device to the beacon must be monitored to ensure the correct position information is being provided to the beacon), or by substituting the output of the internal navigation device with a data input into the beacon, or by injecting data into the external navigation input in a form which provides the location information required by the navigation test scripts in Annex D.4.

This test may be conducted either by the test laboratory or the manufacturer.

All types of beacons can be tested using this procedure.

1. Place the beacon inside a test chamber so that GNSS signals cannot be received by the beacon nor can the 406 transmissions reach any satellite.
2. Activate the beacon

3. Run navigation test script 1 in Annex D.4
4. Record the location, altitude, HDOP, VDOP and GNSS Status into the results page in Annex E.4
5. Run the remainder of the navigation test scripts as instructed in Annex D.4 and then deactivate the beacon.
6. Run the Self-Test navigation test scripts as instructed in Annex D.4.

B.14.1.1.3 Required Results

The manufacturers documentation shall provide evidence that the beacon complies with all navigation provisions of C/S T.018 section 3 and section 4.5.5.
For each navigation input method declared by the beacon manufacturer in their type approval application running the test scripts in Annex D.4 shall result in the beacon correctly encoding the location bits in the transmitted beacon message as defined in Annex D.4.

B.14.1.2 ELT(DT) Navigation Devices

B.14.1.2.1 Requirement

T.018/S.4.5.5.1/R.1130
T.018/S.4.5.5.1/R.1140

B.14.1.2.2 Method of Validation

1. The manufacturer's supplied documentation shall be inspected to see if the ELT(DT) has an internal navigation device.
2. The manufacturer's supplied documentation shall be inspected to see if the ELT(DT) has an interface to an external navigation device.

Test for ELT(DT)s with both an internal navigation device and external navigation device interface (this test does not apply if the ELT(DT) does not have an external interface)

1. Configure a device which will be able to send appropriate GNSS sentences to the internal GNSS device and the external interface location by Setting up location #1 that is destined for the internal GNSS device and a location #2, different from location #1 by at least 500 meters, that is destined for the external interface point for an external GNSS device.
2. Activate the ELT(DT) and record the locations of the first 5 transmissions then deactivate the ELT(DT).
3. Mask / remove the signal to the internal GNSS device and then activate the ELT(DT), after 3 transmissions unmask / reapply the signal to the internal GNSS device for a further 2 transmissions, then deactivate the ELT(DT).
4. Mask / remove the signal to both the internal GNSS device and the external navigation input and then activate the ELT(DT), after 3 transmissions unmask / reapply the signal to both the internal GNSS device and the external navigation input for a further 2 transmissions, then deactivate the ELT(DT)

B.14.1.2.3 Required Results

The required results are:
1. Internal navigation device: yes
2. Interface to external navigation device: optional

Results for ELT(DT)s with an external navigation device interface
First test:
1. The initial transmitted burst after activation shall contain either the internal or external navigation device position
2. All subsequent transmitted burst locations shall only contain the internal navigation device position.

Second test:
3. The first three transmissions after activation shall contain the external navigation device position and the subsequent two transmissions shall contain the internal navigation device position

Third test:

4. The first three transmissions after activation shall contain default position data and the subsequent two transmissions shall contain the internal navigation device position

B.14.1.3 Navigation Device Failure

B.14.1.3.1 Requirement

T.018/S.4.5.5.2/R.1150

B.14.1.3.2 Method of Validation

The manufacturer's supplied documentation shall be inspected to see if the beacon will continue to send transmitted bursts with default locations when the internal or external navigation device fails.

B.14.1.3.3 Required Results

The failure of a navigation receiver will not affect beacon operations except for having a default location.

B.14.2 Internal Navigation Device

B.14.2.1 Capability and Standard

B.14.2.1.1 Requirement

T.018/S.4.5.5.2/R.1160

B.14.2.1.2 Method of Validation

The manufacturer supplied documentation shall be inspected to verify that:

a) The internal GNSS receiver is capable of global operation, and
b) The internal GNSS receiver conforms to an applicable international standard.

B.14.2.1.3 Required Results

The beacon will support global operation and will conform to an applicable international standard.

B.14.2.2 Self-Check

B.14.2.2.1 Requirement

T.018/S.4.5.5.2/R.1170
T.018/S.4.5.5.2/R.1180

B.14.2.2.2 Method of Validation

The manufacturer's documentation shall be inspected to ensure that erroneous position data cannot be encoded into the beacon message.
The self-check features employed to prevent erroneous position data from being encoded into the beacon message unless minimum performance criteria are met shall be documented by the manufacturer and assessed to determine if they are adequate to comply with the requirement in C/S T.018.

B.14.2.2.3 Required Results

Erroneous position data cannot be encoded into the beacon message.
Position data is prevented from being encoded into the beacon message unless minimum performance criteria specified by the beacon manufacturer are met.

B.14.2.3 Cold Start

B.14.2.3.1 Requirement

T.018/S.4.5.5.2/R.1190

B.14.2.3.2 Method of Validation

The manufacturer's supplied documentation shall be inspected to see if a cold start is forced at every beacon activation

B.14.2.3.3 Required results

The manufacturers documentation provides sufficient evidence that a beacon cold start is forced at every activation.

B.14.2.4 Location Accuracy and Information

B.14.2.4.1 Requirement

T.018/S.4.5.5.2/R.1200
T.018/S.4.5.5.2/R.1210
T.018/S.4.5.5.2/R.1220
T.018/S.4.5.5.2/R.1230
T.018/S.4.5.5.2/R.1240
T.018/S.4.5.5.2/R.1250
T.018/S.4.5.5.2/R.1260
T.018/S.4.5.5.2/R.1270
T.018/S.4.5.5.2/R.1380
T.018/S.4.5.5.2/R.1390
T.018/S.4.5.5.2/R.1400

B.14.2.4.2 Method of Validation

There are two methods that can be used to test this requirement for a stationary beacon. The first method is an open air test and the second method is using a GNSS Simulator in a test chamber sending an RF signal into the beacons GNSS receive antenna. It cannot be done by inputting IEC sentences into the GNSS digital interface as there would be no location or altitude errors.

The test is repeated 3 times, each test generating 80 sets of results, making a total of 240 results to generate adequate statistics to address the 95% requirement. This is approximately ten times more trials than the minimum of having 19 of 20 trials correct to validate the 95% probability requirement. The reason is that the GNSS location determination process is probabilistic in nature and having many more trials improves the reliability of the location accuracy statistics. For example, having one run of 20 trials may result in a 90% compliance and having a second run of 20 trials could result in 100% compliance. By having many more trials means one could theoretically converge to the true compliance probability level. The final part of the test assesses various other parameters of the encoded navigation message including operating mode and time from last encoded location.

This test can either be performed outside using live signals from GNSS satellites or can be performed in an enclosed test chamber using a GNSS simulator at the discretion of the beacon manufacturer and test facility.

Open air method

1. Make sure there is a clear view to the sky down to 5 degrees elevation in all directions
2. Determine actual location and altitude of the stationary beacon to within 1 meter by another means
3. Coordinate with appropriate SAR authorities to get permission to transmit beacon signals
4. Activate the beacon for a period of one hour
5. After 20 to 25 minutes partially obscure the GNSS antenna on the beacon for a period of 200 seconds such that it can only see approximately 50% of the sky for that period of time.
6. Utilize some means of receiving the transmitted bursts and have an independent professional grade GNSS Receiver positioned close to the beacon under test that logs latitude, longitude, elevation, HDOP, VDOP and Time at least every 5 seconds for the duration of each of the three, one hour tests (note that the extended test 12 below is not required to be logged)
7. Read and decode the transmitted digital message and calculate the difference between the actual horizontal location and the encoded horizontal location as well as the actual altitude and encoded altitude
8. Record the HDOP and VDOP. This information appears in bits 32-39 of rotating field #0.
9. Record the fix type. This information appears in bits 45-46 of rotating filed #0
10. Deactivate the beacon and then wait for a period of 2 hours.
11. Repeat steps 4 through 10 a further two times to get a total of 240 sets of results.
12. Reactivate the beacon a fourth time and after 10 minutes has elapsed cover the GNSS antenna for a period of 18 minutes so that no GNSS signals are received and then uncover the GNSS antenna and leave the beacon running for a further 10 minutes, after this time again cover the GNSS antenna, this time for a period of 9 hours and then finally uncover the GNSS antenna for a further period of 2 hours and then deactivate the beacon.
13. Record all navigation data including the ‘time from last encoded location field’ for the entire duration of the test
14. Using the results from tests 4 to 11 calculate the probability of horizontal error for less than 30 meters by the following equation: P(30m)=(number of times horizontal location error is less than 30 meters)/(number of activations)
15. Using the results from tests 4 to 11 calculate the probability of altitude error for less than 50 meters by the following equation: A(50m)=(number of times altitude error is less than 50 meters)/(number of activations)
16. Note the Fix Type for each of the 240 sets of results (Note that again there are no pass / fail criteria for this data in C/S T.018).
17. Using the results from test 12 ensure that the ‘time from last encoded location field’ correctly reports increasing periods of time when no GNSS signals are available and that during these periods the reported position does not change and the Fix Type reports ‘No Fix’. Finally ensure that when GNSS signals are available again ensure that, the ‘time

from last encoded location field' resets to zero, the reported position starts updating again and the Fix Type changes to either 2D or 3D.

GNSS simulator/test chamber method

1. Install the beacon in a test chamber which has isolation of at least 80 dB at 406 MHz, 50 dB at 121.5 MHz and 40 dB at 1.5 GHz. This will prevent GNSS signals from on orbit satellite reaching the beacon and beacon signals reaching the satellites.
2. Program into the simulator the actual horizontal location and altitude of the test facility for a stationary beacon
3. Program into the simulator a realistic and full GNSS constellation with nominal parameters that is compatible with the GNSS Receiver in the beacon under test as declared by the manufacturer in their Annex G application.
4. Activate the GNSS simulator setting the simulator's date and start time to the present day and time of the test
5. Activate the beacon
6. After 20 to 25 minutes reduce the number of satellites being used by the GNSS simulator for a period of 200 seconds to mimic the situation where the GNSS antenna in the beacon can only see approximately 50% of the sky for that period of time.
7. After a period of one hour turn off the beacon, but leave the simulator running.
8. Utilize a means to receive and decode the transmitted burst and log the latitude, longitude, elevation, HDOP, VDOP and Time of the GNSS Simulator signals at least every 5 seconds for the duration of each of the three one hour tests (note that the extended test 14 below is not required to be logged).
9. Read and decode the transmitted digital message and calculate the difference between the actual horizontal location and the encoded horizontal location, and the actual altitude and the encoded altitude
10. Record the HDOP and VDOP. This information appears in bits 32-39 of rotating field #0.
11. Record the fix type. This information appears in bits 45-46 of rotating field #0.
12. Deactivate the beacon and wait for a period of 2 hours (note that the GNSS simulator remains running during this time).
13. Repeat steps 6 through 12 a further two times to get a total of 240 sets of results, noting that the simulator is not turned off or reset until after all three runs have been completed.
14. Restart the GNSS Simulator and then reactivate the beacon a fourth time and after 10 minutes has elapsed cover the GNSS antenna for a period of 18 minutes so that no GNSS signals are received and then uncover the GNSS antenna and leave the beacon running for a further 10 minutes, after this time again cover the GNSS antenna, this time for a period of 9 hours and then finally uncover the GNSS antenna for a further period of 2 hours and then deactivate the beacon and the simulator.
15. Record all navigation data including the 'time from last encoded location field' for the entire duration of the test.
16. Using the results from tests 6 to 13 calculate the probability of error less than 30 meters by the following equation: P(30m)=(number of times location error is less than 30 meters)/(number of activations)

17. Using the results from tests 6 to 13 calculate the probability of altitude error less than 50 meters by the following equation: A(50m)=(number of times altitude error is less than 50 meters)/(number of activations)
18. Note the Fix Type for each of the 240 sets of results (Note that again there are no pass / fail criteria for this data in C/S T.018).
19. Using the results from test 12 ensure that the 'time from last encoded location field' correctly reports increasing periods of time when no GNSS signals are available and that during these periods the reported position does not change and the Fix Type reports 'No Fix'. Finally ensure that when GNSS signals are available again ensure that, the 'time from last encoded location field' resets to zero, the reported position starts updating again and the Fix Type changes to either 2D or 3D

The manufacturer's documentation for the GNSS Receiver used in the beacon shall be inspected to determine compliance with a recognised ITRS system such as WGS 84 or GTRF etc and compliance with the accuracy requirements of such a reference system.

Count the number of trials where the Encoded locations within 30 meters of the actual location and the number of trials in which the encoded altitude is within 50 meters of the actual altitude. Use the following equations to calculate the respective percentages of location error <30 meters and altitude error < 50 meters.
Location Percentage = (number of locations within 30 meters of actual location)/ (number of trials)
Altitude Percentage = (number of altitudes within 50 meters of actual location)/ (number of trials)

B.14.2.4.3 Required Results

The location accuracy shall be 30 meters 95% of the time a beacon is activated.

The altitude accuracy shall be 50 meters 95% of the times a beacon is activated.

The utilized datum shall be compatible with the ITRS.

The difference between the utilized datum and the ITRS shall be less than 10cm.
There is an indication of the DOPs.

The HDOP information appears in bits 32-35 and the VDOP information appears in bits 36-39 of rotating field #0 in the digital message.

The fix type information is provided.

The fix type information is encoded into bits 45-46 of rotating field #0.

B.14.2.5 First Provision of Location and Dimensions

B.14.2.5.1 Requirement

T.018/S.4.5.5.2/R.1280
T.018/S.4.5.5.2/R.1290
T.018/S.4.5.5.2/R.1300

B.14.2.5.2 Method of Validation

2D and 3D TEST

1. Install the beacon in a test chamber which has isolation of at least 80 dB at 406 MHz, 50 dB at 121.5 MHz and 40 dB at 1.5 GHz. This will prevent GNSS signals from on orbit satellite reaching the beacon and beacon signals reaching the satellites.
2. Program into the simulator the actual horizontal location and altitude of the test facility for a stationary beacon
3. Program into the simulator a realistic and full GNSS constellation with nominal parameters that is compatible with the GNSS Receiver in the beacon under test as declared by the manufacturer in their Annex G application, but allow only four visible satellites transmitting to the beacon.
4. Activate the GNSS simulator setting the simulator's date and start time to the present day and time of the test and then activate the beacon.
5. Run the GNSS simulator for a period of 12 minutes.
6. Utilize a means to receive and decode the transmitted burst.
7. Read and decode the transmitted digital message and the fix type. This appears in bits 45-46 of rotating field #0.
8. Verify that the bits are "10" for a 3D fix.
9. Deactivate the Beacon and stop the GNSS simulator, deactivate one GNSS satellite in the simulator to make sure only three in view satellites are transmitting to the beacon
10. Reactivate the Simulator and then the beacon and run the GNSS simulator for a period of 12 minutes.
11. Read and decode the transmitted digital message and the fix type. This appears in bits 45-46 of rotating field #0.
12. Verify that the bits are"01" for 2D fix.
13. Stop the GNSS simulator and deactivate the beacon.

PROVISION OF FIRST LOCATION TEST;

1. This test can either be performed outside using live signals from GNSS satellites or can be performed in an enclosed test chamber using a GNSS simulator at the discretion of the beacon manufacturer and test facility.

2. Either run the procedure as defined in B.14.2.4.2 for the Open Air Test parts 1, 2, 3, 4 and 6 or the GNSS Simulator Test parts 1, 2, 3, 4, 5 and 8, but in each case deactivate the beacon after a period of 2 minutes and 40 seconds.

3. If applicable leave the GNSS Simulator running.

4. Leave the beacon turned off for a period of 1 minute, after which time the beacon should be turned on again for a further period of 2 minutes and 40 seconds.
5. Repeat test 4 above a further 100 times.

Tally up the number of trials that the first provision of location within the transmitted message occurred within 2 minutes and 5 seconds (to allow for randomisation of the transmitted messages) of beacon activation.
Calculate the probability of first provision of location within 2 minutes = (# times location provided within 2 minutes and 5 seconds / (total number of message bursts)

B.14.2.5.3 Required Results

With 4 satellites in view the beacon should indicate a 3D location. Bits 45-46 in rotating field #0 must be a value of "10".
With 3 satellites in view the beacon should indicate a 2D location. Bits 45-46 in rotating field 30 must be a value of "01".
First provision of encoded location shall occur within 2 minutes of activation with a probability of 95%

B.14.2.6 Location Updates

B.14.2.6.1 Requirement

T.018/S.4.5.5.2/R.1310
T.018/S.4.5.5.2/R.1320
T.018/S.4.5.5.2/R.1330
T.018/S.4.5.5.2/R.1340
T.018/S.4.5.5.2/R.1350
T.018/S.4.5.5.2/R.1360
T.018/S.4.5.5.2/R.1370

B.14.2.6.2 Method of Validation

The manufacturer shall supply documentation indicating the full operating regime of their internal GNSS Receiver over the operating lifetime of the beacon; this shall include any variations in the regime due to periods when a location is not obtained and indicate how this GNSS operating regime is aligned with the beacons transmissions.

TEST

1. This test can either be performed outside using live signals from GNSS satellites or can be performed in an enclosed test chamber using a GNSS simulator at the discretion of the beacon manufacturer and test facility.

2. Either run the procedure as defined in B.14.2.4.2 for the Open Air Test parts 1, 3, 4 and 6 or the GNSS Simulator Test parts 1, 3, 4, 5, 6 and 8, but in each case for a period of 100 minutes.

3. If using the open air test method then the beacon and all the logging equipment must be placed in a moving vehicle travelling at a rate such that over a 30 second period of time the position has changed by at least 70 metres from what it was 30 seconds previously (e.g.

travelling in a straight line at 8.4 kph (5.2 mph) would achieve this requirement). Note that the maximum change in location over any 30 second period should not exceed 500 metres every 30 seconds (i.e. 60 kph (37.3 mph)).

4. If using a GNSS Simulator for this test then configure the simulator to replicate a moving beacon travelling in a straight line at a constant speed of between 8.4 kph and 60 kph for the 100 minutes duration of the test.

5. Record the locations transmitted by the beacon in each burst for the duration of the test and ensure that the location changes in every burst for the first 30 minutes after beacon activation and in accordance with the manufacturers declared GNSS update rate for the remaining 70 minutes of the test.

B.14.2.6.3 Required Results

Internal navigation devices shall operate continuously during the initial 30 minutes period following beacon activation and then in accordance with the manufacturers declared update scheme**.**
During the first 30 minutes the beacon shall acquire fresh position information immediately prior to every transmission burst unless this becomes impractical due to navigation signal constraints.
During the first 30 minutes after beacon activation the location transmitted by the beacon shall always be with 1 second of the latest GNSS location generated by the GNSS receiver.

B.14.2.7 Operational Time of Navigation Device

B.14.2.7.1 Requirement

T.018/S.4.5.5.2/R.1420
T.018/S.4.5.5.2/R.1430

B.14.2.7.2 Method of Validation

The manufacturer supplied documentation shall be inspected to determine if the design of the beacon keeps the GNSS receiver on for up to 90 seconds prior to each transmitted burst.
The manufacturer supplied documentation shall be inspected to determine if the design of the beacon keeps the GNSS receiver on for at least 3 minutes when two burst have occurred without the receiver providing a location.

B.14.2.7.3 Required Results

The manufacturers documentation shall confirm that the internal navigation receiver shall be on for 90 seconds prior to the next transmission and that when the navigation device fails to provide a location, for two consecutive attempts the navigation receiver shall be on for 3 minutes prior to the next transmission.

B.14.3 ELT(DT) Internal Navigation Device

B.14.3.1 Capability and Standard

B.14.3.1.1 Requirement

T.018/S.4.5.5.3/R.1440

B.14.3.1.2 Method of Validation

The manufacturer supplied documentation shall be inspected to verify that:

a) The internal GNSS receiver is capable of global operation, and
b) The internal GNSS receiver conforms to an applicable international standard.

B.14.3.1.3 Required Results

The beacon will support global operation and will conform to an applicable international standard.

B.14.3.2 Self-Check

B.14.3.2.1 Requirement

T.018/S.4.5.5.3/R.1450
T.018/S.4.5.5.3/R.1460

B.14.3.2.2 Method of Validation

The manufacturer's documentation shall be inspected to ensure that erroneous position data cannot be encoded into the beacon message.
The self-check features employed to prevent erroneous position data from being encoded into the beacon message unless minimum performance criteria are met shall be documented by the manufacturer and assessed to determine if they are adequate to comply with the requirement in C/S T.018.

B.14.3.2.3 Required Results

Erroneous position data cannot be encoded into the beacon message.
Position data is prevented from being encoded into the beacon message unless minimum performance criteria specified by the beacon manufacturer are met.

B.14.3.3 Cold Start

B.14.3.3.1 Requirement

T.018/S.4.5.5.3/R.1470
T.018/S.4.5.5.3/R.1480

B.14.3.3.2 Method of Validation

The manufacturer's supplied documentation shall be inspected to see if a cold start is forced at initial power up of the ELT(DT) into the ARMED mode, but not subsequently when the ELT(DT) is activated or between transmissions.

B.14.3.3.3 Required results

The manufacturer's documentation provides sufficient evidence that a beacon cold start only occurs upon initial power up of the ELT(DT).

B.14.3.4 Location Accuracy and Information

B.14.3.4.1 Requirement

T.018/S.4.5.5.3/R.1490
T.018/S.4.5.5.3/R.1500
T.018/S.4.5.5.3/R.1510
T.018/S.4.5.5.3/R.1520
T.018/S.4.5.5.3/R.1530
T.018/S.4.5.5.3/R.1540

B.14.3.4.2 Method of Validation

There are two methods that can be used to test this requirement for a stationary beacon. The first method is an open air test and the second method is using a GNSS Simulator in a test chamber sending an RF signal into the beacons GNSS receive antenna. It cannot be done by inputting IEC sentences into the GNSS digital interface as there would be no location or altitude errors.

The test is repeated 3 times each test generating 80 sets of results, making a total of 240 results to generate adequate statistics to address the 95% requirement. This is approximately ten times more trials than the minimum of having 19 of 20 trials correct to validate the 95% probability requirement. The reason is that the GNSS location determination process is probabilistic in nature and having many more trials improves the reliability of the location accuracy statistics. For example, having one run of 20 trials may result in a 90% compliance and having a second run of 20 trials could result in 100% compliance. By having many more trials means one could theoretically converge to the true compliance probability level. The final part of the test assesses various other parameters of the encoded navigation message including operating mode and time from last encoded location.

This test can either be performed outside using live signals from GNSS satellites or can be performed in an enclosed test chamber using a GNSS simulator at the discretion of the beacon manufacturer and test facility.

Open air method

1. Make sure there is a clear view to the sky down to 5 degrees elevation in all directions
2. Determine actual location and altitude of the stationary beacon to within 1 meter by another means
3. Coordinate with appropriate SAR authorities to get permission to transmit beacon signals
4. Activate the beacon for a period of one hour
5. Utilize some means of receiving the transmitted bursts and have an independent professional grade GNSS Receiver positioned close to the beacon under test that logs latitude, longitude, elevation and Time at least every second for the duration of each of the three one hour tests (note that the extended test 10 below is not required to be logged)
6. Read and decode the transmitted digital message and calculate the difference between the actual horizontal location and the encoded horizontal location as well as the actual altitude and encoded altitude
7. Record the fix type. This information appears in bits 36-37 of rotating filed #1
8. Deactivate the beacon and then wait for a period of 2 hours.
9. Repeat steps 4 through 8 a further two times to get a total of 240 sets of results.
10. Reactivate the beacon a fourth time and after 10 minutes has elapsed cover the GNSS antenna for a period of 18 minutes so that no GNSS signals are received and then uncover the GNSS antenna and leave the beacon running for a further 10 minutes, after this time again cover the GNSS antenna, this time for a period of 9 hours and then finally uncover the GNSS antenna for a further period of 2 hours and then deactivate the beacon.
11. Record all navigation data including the 'time from last encoded location field' for the entire duration of the test
12. Using the results from tests 4 to 9 calculate the probability of horizontal error for less than 30 meters by the following equation: P(30m)=(number of times horizontal location error is less than 30 meters)/(number of activations)
13. Using the results from tests 4 to 9 calculate the probability of altitude error for less than 50 meters by the following equation: A(50m)=(number of times altitude error is less than 50 meters)/(number of activations)
14. Note the Fix Type for each of the 240 sets of results (Note that again there are no pass / fail criteria for this data in C/S T.018).
15. Using the results from test 12 ensure that the 'time from last encoded location field' correctly reports increasing periods of time when no GNSS signals are available and that during these periods the reported position does not change and the Fix Type reports 'No Fix'. Finally ensure that when GNSS signals are available again ensure that, the 'time from last encoded location field' resets to zero, the reported position starts updating again and the Fix Type changes to either 2D or 3D.

GNSS simulator/test chamber method

1. Install the beacon in a test chamber which has isolation of at least 80 dB at 406 MHz, 50 dB at 121.5 MHz and 40 dB at 1.5 GHz. This will prevent GNSS signals from on orbit satellite reaching the beacon and beacon signals reaching the satellites.
2. Program into the simulator the actual horizontal location and altitude of the test facility for a stationary beacon
3. Program into the simulator a realistic and full GNSS constellation with nominal parameters that is compatible with the GNSS Receiver in the beacon under test as declared by the manufacturer in their Annex G application.
4. Activate the GNSS simulator setting the simulator's date and start time to the present day and time of the test
5. Activate the beacon
6. After a period of one hour turn off the beacon, but leave the simulator running.
7. Utilize a means to receive and decode the transmitted burst and log the latitude, longitude, elevation and Time of the GNSS Simulator signals at least every second for the duration of each of the three, one hour tests (note that the extended test 12 below is not required to be logged).
8. Read and decode the transmitted digital message and calculate the difference between the actual horizontal location and the encoded horizontal location, and the actual altitude and the encoded altitude
9. Record the fix type. This information appears in bits 36-37 of rotating field #1.
10. Deactivate the beacon and wait for a period of 2 hours (note that the GNSS simulator remains running during this time).
11. Repeat steps 5 through 10 a further two times to get a total of 240 sets of results, noting that the simulator is not turned off or reset until after all three runs have been completed.
12. Restart the GNSS Simulator and then reactivate the beacon a fourth time and after 10 minutes has elapsed cover the GNSS antenna for a period of 18 minutes so that no GNSS signals are received and then uncover the GNSS antenna and leave the beacon running for a further 10 minutes, after this time again cover the GNSS antenna, this time for a period of 9 hours and then finally uncover the GNSS antenna for a further period of 2 hours and then deactivate the beacon and the simulator.
13. Record all navigation data including the 'time from last encoded location field' for the entire duration of the test.
14. Using the results from tests 6 to 11 calculate the probability of error less than 30 meters by the following equation: P(30m)=(number of times location error is less than 30 meters)/(number of activations)
15. Using the results from tests 6 to 11 calculate the probability of altitude error less than 50 meters by the following equation: A(50m)=(number of times altitude error is less than 50 meters)/(number of activations)
16. Note the Fix Type for each of the 240 sets of results (Note that again there are no pass / fail criteria for this data in C/S T.018).
17. Using the results from test 12 ensure that the 'time from last encoded location field' correctly reports increasing periods of time when no GNSS signals are available and that during these periods the reported position does not change and the Fix Type reports 'No Fix'. Finally ensure that when GNSS signals are available again ensure that, the 'time

from last encoded location field' resets to zero, the reported position starts updating again and the Fix Type changes to either 2D or 3D.

The manufacturer's documentation for the GNSS Receiver used in the beacon shall be inspected to determine compliance with a recognised ITRS system such as WGS 84 or GTRF etc and compliance with the accuracy requirements of such a reference system.

Count the number of trials where the Encoded locations within 30 meters of the actual location and the number of trials in which the encoded altitude is within 50 meters of the actual altitude. Use the following equations to calculate the respective percentages of location error <30 meters and altitude error < 50 meters.
Location Percentage = (number of locations within 30 meters of actual location)/ (number of trials)
Altitude Percentage = (number of altitudes within 50 meters of actual location)/ (number of trials)

B.14.3.4.3 Required Results

The location accuracy shall be 30 meters 95% of the time a beacon is activated.

The altitude accuracy shall be 50 meters 95% of the times a beacon is activated.

The utilized datum shall be compatible with the ITRS.

The difference between the utilized datum and the ITRS shall be less than 10cm.

The fix type information is provided.

The fix type information is encoded into bits 36-37 of rotating field #1.

B.14.3.5 First Provision of Location and Dimensions

B.14.3.5.1 Requirement

T.018/S.4.5.5.3/R.1550
T.018/S.4.5.5.3/R.1560
T.018/S.4.5.5.3/R.1570

B.14.3.5.2 Method of Validation

2D and 3D TEST

1. Install the beacon in a test chamber which has isolation of at least 80 dB at 406 MHz, 50 dB at 121.5 MHz and 40 dB at 1.5 GHz. This will prevent GNSS signals from on orbit satellite reaching the beacon and beacon signals reaching the satellites.
2. Program into the simulator the actual horizontal location and altitude of the test facility for a stationary beacon
3. Program into the simulator a realistic and full GNSS constellation with nominal parameters that is compatible with the GNSS Receiver in the beacon under test as declared by the

manufacturer in their Annex G application, but allow only four visible satellites transmitting to the beacon.

4. Activate the GNSS simulator setting the simulator's date and start time to the present day and time of the test and then activate the beacon.
5. Run the GNSS simulator for a period of 12 minutes.
6. Utilize a means to receive and decode the transmitted burst.
7. Read and decode the transmitted digital message and the fix type. This appears in bits 36-37 of rotating field #1.
8. Verify that the bits are "10" for a 3D fix.
9. Deactivate the Beacon and stop the GNSS simulator, deactivate one GNSS satellite in the simulator to make sure only three in view satellites are transmitting to the beacon
10. Reactivate the Simulator and then the beacon and run the GNSS simulator for a period of 12 minutes.
11. Read and decode the transmitted digital message and the fix type. This appears in bits 36-37 of rotating field #1.
12. Verify that the bits are"01" for 2D fix.
13. Stop the GNSS simulator and deactivate the beacon.

PROVISION OF FIRST LOCATION TEST;

1. This test can either be performed outside using live signals from GNSS satellites or can be performed in an enclosed test chamber using a GNSS simulator at the discretion of the beacon manufacturer and test facility.

2. Either run the procedure as defined in B.14.3.4.2 for the Open Air Test parts 1, 2, 3, 4 and 5 or the GNSS Simulator Test parts 1, 2, 3, 4, 5 and 6, but in each case deactivate the beacon after a period of 15 seconds.

3. If applicable leave the GNSS Simulator running.

4. Leave the beacon turned off for a period of 1 minute, after which time the beacon should be turned on again for a further period of 15 seconds.

5. Repeat test 4 above a further 100 times.

Tally up the number of trials that the first provision of location within the transmitted message occurred within 5 seconds of beacon activation.

Calculate the probability of first provision of location within 5 seconds = (# times location provided within 5 seconds / (total number of message bursts)

B.14.3.5.3 Required Results

With 4 satellites in view the beacon should indicate a 3D location. Bits 36-37 in rotating field #1 must be a value of "10".
With 3 satellites in view the beacon should indicate a 2D location. Bits 36-37 in rotating field #1 must be a value of "01".
First provision of encoded location shall occur within 5 seconds of activation with a probability of 95%

B.14.3.6 Location Updates

B.14.3.6.1 Requirement

T.018/S.4.5.5.3/R.1490
T.018/S.4.5.5.3/R.1500
T.018/S.4.5.5.3/R.1610
T.018/S.4.5.5.3/R.1620

B.14.3.6.2 Method of Validation

This test uses a GNSS simulator to test the internal navigation device within the ELT(DT) under conditions similar to those that might be experienced during a distress situation to ensure that the location transmitted by the ELT(DT) under these conditions, is both up to date and remains accurate.

Activate the ELT(DT) in accordance with Annex D.5 and monitor the encoded 3D positions provided by the ELT(DT) while running the simulator scenario in Annex D.5, then deactivate the beacon. Accurately (to a resolution of better than 0.1 second) log the position provided to the beacon and the commencement of beacon transmissions vs time. For each burst from the ELT(DT) compute the 3D position provided by the signal to the beacon at the commencement of the burst (P(t0)) and at the point 1 second before the commencement of the burst (P(t0-1)). Check that for 95% of the results obtained the 3D encoded location transmitted by the ELT(DT) is within 30 metres in the horizontal plane and within 50 metres in altitude of at least one simulated location between the two above computed positions (i.e. (P(t0)) and (P(t0-1))), except during the final transition in the Annex D.5 scenario (which in effect simulates a rapid deceleration resulting from an impact). Also check that the time of the last encoded location in bits 159 to 175 of the beacon message (bits 5 to 21 of rotating field #1) are correct.

Note that this test is not concerned with validating other navigation message parameters such as HDOP, VDOP, 2D or 3D fix, which are validated by other tests in this section, however these parameters may be recorded and noted at the discretion of the beacon manufacturer and test facility if required. If recorded there are no pass or fail criteria for these parameters.
Count the number of positions where the Encoded locations are within 30 meters of the actual location and the number of positions in which the encoded altitude is within 50 meters of the actual altitude.

Use the following equations to calculate the respective percentages of location error <30 meters and altitude error < 50 meters.

Location Percentage = (number of locations within 30 meters of actual location)/ (number of locations)

Altitude Percentage = (number of altitudes within 50 meters of actual location)/ (number of locations)

If the ELT(DT) can accept navigation data from an external navigation device input as well as its own internal navigation device, then the external input shall not be connected for this test and there is no requirement to repeat this test using the external navigation device input as the interaction between these two inputs has already been tested in B.14.1.2.

B.14.3.6.3 Required Results

The location accuracy shall be 30 meters 95% of the time.

The altitude accuracy shall be 50 meters 95% of the time.

The location shall be encoded into the beacon message within 1 second prior to each burst.

B.14.3.7 Operational Time of Navigation Device

B.14.3.7.1 Requirement

T.018/S.4.5.5.3/R.1590
T.018/S.4.5.5.3/R.1600

B.14.3.7.2 Method of Validation

The manufacturer supplied documentation shall be inspected to determine if the design of the beacon keeps the GNSS receiver on for up to 90 seconds prior to each transmitted burst.
The manufacturer supplied documentation shall be inspected to determine if the design of the beacon keeps the GNSS receiver on for at least 3 minutes when two burst have occurred without the receiver providing a location.

B.14.3.7.3 Required Results

The manufacturer’s documentation shall confirm that the internal navigation receiver shall be on for 90 seconds prior to the next transmission and that when the navigation device fails to provide a location, for two consecutive attempts the navigation receiver shall be on for 3 minutes prior to the next transmission.

B.14.4 External Navigation Device

B.14.4.1 Standards and Interface

B.14.4.1.1 Requirement

T.018/S.4.5.5.4/R.1670
T.018/S.4.5.5.4/R.1680

B.14.4.1.2 Method of Validation

The beacon installation and user manual shall be reviewed to ensure that it provides a description of acceptable external navigation interfaces and the required features and functions of these that may be connected to the beacon, this should, if applicable, include warnings related to any interfaces that will not work with the beacon or which may damage the beacon.

B.14.4.1.3 Required Results

The beacon installation and user manual shall contain the necessary information to permit an end user to understand the external navigation interface requirements necessary for the beacon to provide encoded location information.

B.14.4.2 Location Accuracy and Information

B.14.4.2.1 Requirement

T.018/S.4.5.5.4/R.1690
T.018/S.4.5.5.4/R.1700
T.018/S.4.5.5.4/R.1710
T.018/S.4.5.5.4/R.1720
T.018/S.4.5.5.4/R.1730
T.018/S.4.5.5.4/R.1740
T.018/S.4.5.5.4/R.1750
T.018/S.4.5.5.4/R.1760
T.018/S.4.5.5.4/R.1770
T.018/S.4.5.5.4/R.1780
T.018/S.4.5.5.4/R.1790
T.018/S.4.5.5.4/R.1800
T.018/S.4.5.5.4/R.1810
T.018/S.4.5.5.4/R.1820
T.018/S.4.5.5.4/R.1830
T.018/S.4.5.5.4/R.1840
T.018/S.4.5.5.4/R.1850
T.018/S.4.5.5.4/R.1860

B.14.4.2.2 Method of Validation

For beacons using an external navigation device the accuracy and requirements of the device are outside of scope of Cospas-Sarsat testing, the only requirement is to ensure that navigation information provided at the input of the beacon is correctly and timely encoded into beacon transmitted messages. As such if this is being achieved once then by definition it will continue to be achieved for the duration of time that the beacon is active as there are no other variables to change the way in which the navigation data is encoded into the beacon message, thus testing requirements can be reduced accordingly.

The test defined herein is designed to cover all the external navigation device input testing in one combined test procedure.

This test is performed in an enclosed test chamber using a GNSS simulator or an NMEA data stream either of which are injected directly into the external navigation device input.

GNSS simulator/test chamber method

1. Install the beacon in a test chamber which has isolation of at least 80 dB at 406 MHz, 50 dB at 121.5 MHz and 40 dB at 1.5 GHz. This will prevent GNSS signals from on orbit satellite reaching the beacon and beacon signals reaching the satellites.
2. Program into the simulator the actual horizontal location and altitude of the test facility for a stationary beacon
3. Program into the simulator a realistic GNSS constellation with nominal parameters that is compatible with the GNSS Receiver in the beacon under test as declared by the manufacturer in their Annex G application.
4. Program the simulator to run a scenario in which the number of satellites in view, the latitude, longitude, elevation, HDOP and VDOP all change over time for a period of 60 minutes. The number of satellites in view should be nominal for most of the test but should be reduced to just 4 satellites for a period of 3 minutes and then just 3 satellites for a period of 3 minutes and then back to the nominal constellation for the remainder of the test. At the same time the location of the simulator should change to replicate a moving beacon travelling in a straight line at a constant speed of between 8.4 kph and 60 kph for the duration of the test.
5. Activate the GNSS simulator setting the simulator's date and start time to the present day and time of the test
6. Activate the beacon
7. After a period of one hour turn the simulation off but leave the beacon running for a further 5 minutes and then turn the beacon off. Finally turn the beacon back on for a period of 1 minute without the simulator connected to the external navigation input and then turn the beacon off.

8. Utilize a means to receive and decode the transmitted bursts from the beacon and log the latitude, longitude, elevation, HDOP, VDOP and Time from last encoded location transmitted by the beacon in every burst for the 60 minute duration of the test.
9. Using the data injected into the beacon external navigation device input calculate the difference between the actual horizontal location and the encoded horizontal location, and the actual altitude and the encoded altitude for each burst
10. Record the HDOP and VDOP for each burst.
11. Record the fix type for each burst. This information appears in bits 45-46 of rotating field #0.
12. Using the results from above calculate the probability of location error less than 30 meters by the following equation: P(30m)=(number of times location error is less than 30 meters)/(number of activations)
13. Using the results from above calculate the probability of altitude error less than 50 meters by the following equation: P(50m)=(number of times altitude error is less than 50 meters)/(number of activations)
14. Check that the HDOP and VDOP values encoded into each transmitted message match those injected into the beacon.
15. Check that the fix type correctly records 2D and 3D data for the number of satellites in view during the test.
16. At the end of the test when the simulator is turned off, ensure that transmissions from the beacon contain the last encoded location and that the time from last encoded location field in the message starts to increment.
17. When the beacon is turned back on for the last one minute ensure that the transmitted beacon message contains default navigation data.

Count the number of trials where the Encoded locations within 30 meters of the actual location and the number of trials in which the encoded altitude is within 50 meters of the actual altitude. Use the following equations to calculate the respective percentages of location error <30 meters and altitude error < 50 meters.
Location Percentage = (number of locations within 30 meters of actual location)/ (number of trials)
Altitude Percentage = (number of altitudes within 50 meters of actual location)/ (number of trials)

B.14.4.2.3 Required Results

The location accuracy shall be 30 meters 95% of the time a beacon is activated.

The altitude accuracy shall be 50 meters 95% of the times a beacon is activated.

The location is updated in each transmitted burst.

There is an indication of the DOPs.

The HDOP information appears in bits 32-35 and the VDOP information appears in bits 36-39 of rotating field #0 in the digital message.

The fix type information is provided.

The fix type information is encoded into bits 45-46 of rotating field #0.
Ensure that the last encoded location and default data are correctly handled by the beacon.

B.15 BEACON ACTIVATION

B.15.1 Regular Distress Beacons

B.15.1.1 Requirement

T.018/S.4.5.6/R.1870
T.018/S.4.5.6/R.1880
T.018/S.4.5.6/R.1890
T.018/S.4.5.6/R.1900

The beacon shall have a means of manual activation and deactivation and the beacon design shall prevent inadvertent activation. Note that the beacon may also optionally include means of remote manual activation and / or deactivation.

If the beacon also provides one or more optional means of automatic activation (e.g. water sensor, G-switch etc.), then these shall also be assessed, along with the associated means of deactivation.

Within 1 second of activation the beacon shall provide a visual indication that it has been activated and if the beacon can be remotely activated then there shall be an indicator on both the beacon and the remote activation device.

B.15.1.2 Method of Validation

a) The beacon shall be visually inspected and assessed to ensure that it has a manual means of activation (i.e. that there is a way to physically turn the beacon on actually on the beacon itself).

b) The beacon shall be visually inspected and assessed to ensure that it has a manual means of deactivation (i.e. that there is a way to physically turn the beacon off actually on the beacon itself).

c) Note that the means of activation and deactivation may be provided by separate functions or a combined function.

d) The beacon shall be visually inspected and assessed to ensure that its design will prevent inadvertent activation (it should be noted that the generally accepted means of achieving this requirement is by ensuring that at least two separate, simultaneous or sequential manual actions are required in order to activate the beacon and that neither one of these actions on its own will cause the beacon to activate. However, there may also be other equally valid ways of meeting this requirement and each beacon design should be assessed for compliance on its own merits).

e) If the beacon is also provided with one or more means of remote manual activation and / or deactivation then each of these shall also be visually inspected and assessed for compliance with a), b) and c) above, except that the functions shall be on the remote device rather than on the beacon itself.

f) If the beacon is equipped with one or more means of automatic activation then the beacon and its associated documentation shall be inspected to ensure that these modes are clearly identified where necessary (e.g. G-switch direction of activation) and are suitably described in the relevant documentation including any electrical interface criteria (if applicable) (note that testing of any means of automatic activation (e.g. water sensor, G-switch etc) is left to other national and international standards). The documentation shall also be inspected to ensure that the means of deactivating a beacon that has been automatically activated are clearly defined.

g) The following test shall be performed at ambient temperature and the minimum and maximum operating temperatures relevant to the Class of beacon under test. The following test may be performed at any time during the testing sequence and may be combined with other tests if appropriate. A means of accurately determining time related to the operation of the means of manual activation of the beacon shall be established (e.g. by using a stop-watch). The beacon itself shall then be activated manually and at the instant of performing the final step in the activation sequence the timing device shall be started. The beacon shall then be observed to ensure that there is a visual indication on the beacon that it has been activated. At the instant that the visual indicator is first observed the timing device shall be stopped and the time between activation and commencement of the visual indication shall be recorded. The beacon shall then be turned off. If necessary this test may be repeated multiple times in order to establish an accurate time of activation of the visual indicator.

h) If the beacon is equipped with one or more means of remote manual activation, then the test in f) above shall be repeated using the remote means of activation and the time to initiation of the indicator on the remote device shall also be recorded. Note that if there are multiple means of remote manual activation of the beacon, then only one of these needs to be tested for compliance with this clause.

B.15.1.3 Required Results

At the end of the inspection and analysis the following shall be evident:

a) There is a means to manually activate the beacon
b) There is a means to manually deactivate the beacon
c) If the beacon also includes means of activating and / or deactivating the beacon remotely that these have also been inspected and assessed
d) If the beacon also includes means of automatic activation that these have been adequately defined and described in the relevant documentation
e) That the beacon design prevents inadvertent activation by all manual means of activation
f) That there is a visual indicator on the beacon to show when it has been activated

g) If the beacon also includes means of remote activation, that there is also a visual indictor on the remote device to show when it has been activated
h) That the indicator on the beacon is visible within 1 second of the beacon being activated
i) If the beacon also includes means of remote activation, that the remote indicator is also visible within 1 second of the beacon being activated

In each case a positive result shall be indicated in the test report by a 'tick' a negative result shall be indicated by a 'cross' and any observed non-compliance(s) shall be stated in the comments.

B.15.2 ELT(DT)s

B.15.2.1 Requirement – ELT(DT)s only

T.018/S.4.5.6.1/R.1920
T.018/S.4.5.6.1/R.1930
T.018/S.4.5.6.1/R.1940
T.018/S.4.5.6.1/R.1950
T.018/S.4.5.6.1/R.1960
T.018/S.4.5.6.1/R.1970
T.018/S.4.5.6.1/R.1975
T.018/S.4.5.6.1/R.1980

The ELT(DT) shall as a minimum have the following modes of operation provided on the beacon:

- Off
- Armed
- On
- Reset

ELT(DT)s shall have both remote manual and automatic means of activation.

ELT(DT)s shall only be capable of being deactivated by the same means by which they are activated.

B.15.2.2 Method of Validation – ELT(DT)s only

a) The ELT(DT) shall be visually inspected to ensure that it has as a minimum the following modes of operation on the beacon itself:

    - Off
    - Armed
    - On
    - Reset

b) The ELT(DT) and its associated documentation shall be inspected to ensure that the remote manual and automatic means of activation are suitably described in the relevant documentation including any electrical interface criteria.

c) Activation and Deactivation Tests

The following tests are designed to check for correct activation and deactivation of the ELT(DT) coupled with the transmission of the Cancellation Message at the appropriate time.

All the tests specified below shall be performed at ambient temperature only.

The control lines into the ELT(DT) (or the means of beacon automatic activation – e.g. by G-switch) shall be activated in the sequences identified in the Table below and the correct bits in the beacon transmitted digital message shall be checked for each test. A check for valid BCH codes shall be performed throughout these tests.

Table B.15-1: TBD

Test No	Control Lines*			Message Bits Status	ELT(DT) Status†
	Auto Activation by beacon	Auto Activation by external means	Remote Manual Activation	Message Bits 186-189	
1	Disabled	Disabled	Disabled	N/A	ARMED
2	Disabled	Enabled	Disabled	1000	ON
3	Disabled	Enabled	Enabled	0001	ON
4	Disabled	Disabled	Enabled	0001	ON
5	Disabled	Disabled	Disabled	N/A	ARMED
6	Disabled	Enabled	Disabled	1000	ON
7	Disabled	Disabled	Disabled	N/A	ARMED
8	Disabled	Disabled	Enabled	0001	ON
9	Disabled	Enabled	Enabled	1000	ON
10	Disabled	Enabled	Disabled	1000	ON
11	Disabled	Disabled	Disabled	N/A	ARMED
12	Disabled	Disabled	Enabled	0001	ON
13	Disabled	Disabled	Disabled	N/A	ARMED
14	Enabled	Disabled	Disabled	0100	ON
15	Enabled	Disabled	Enabled	0001	ON

* The terms "Enabled" and "Disabled" as used for the ELT(DT) Control Lines are intended to be generic and apply to whatever means of ELT(DT) activation the beacon manufacturer has implemented e.g. hardwired control lines, logic levels, switches, data bits, ARINC labels etc.

† ARMED indicates that the ELT(DT) is not transmitting any 406 MHz signals. ON indicates that the ELT(DT) is transmitting 406 MHz distress signals.

Test No	Control Lines*			Message Bits Status	ELT(DT) Status†
	Auto Activation by beacon	Auto Activation by external means	Remote Manual Activation	Message Bits 186-189	
16	Enabled	Enabled	Enabled	1000	ON
17	Enabled	Disabled	Enabled	0001	ON
18a	Disabled *	Disabled	Disabled	N/A	ARMED
18b	Enabled †	Disabled	Disabled	0100	ON
19	Disabled	Disabled	Disabled	N/A	ARMED
20	Enabled	Disabled	Disabled	0100	ON
21	Enabled	Enabled	Disabled	1000	ON
22	Enabled	Enabled	Enabled	0001	ON
23	Enabled	Enabled	Disabled	1000	ON
24a	Disabled [3]	Disabled	Disabled	N/A	ARMED
24b	Enabled [4]	Disabled	Disabled	0100	ON
25	Disabled	Disabled	Disabled	N/A	ARMED

B.15.2.3 Required Results

a) Inspection of the ELT(DT) shall indicate as a minimum the following modes of operation:
- Off
- Armed
- On
- Reset

b) Inspection of the ELT(DT) and its documentation shall ensure that the remote manual and automatic means of activation have been adequately defined and described in the relevant documentation

c) The results of each of the activation and deactivation tests (Correct Message Bits, Correct BCH and Correct ELT(DT) status) shall be recorded in the results table.

In each case a positive result shall be indicated in the test report by a 'tick' a negative result shall be indicated by a 'cross' and any observed non-compliance(s) shall be stated in the comments.

* Manually deactivating the ELT(DT) is assumed to reset the "automatic activation by the beacon" (e.g. resetting the G-switch or means of deformation)

† If the ELT(DT) has a separate means of resetting the "automatic activation by the beacon" then this condition applies

B.16 BEACON ACTIVATION CANCELLATION FUNCTION

B.16.1 Requirement

T.018/S.4.5.7/R.1990
T.018/S.4.5.7/R.2000
T.018/S.4.5.7/R.2010
T.018/S.4.5.7/R.2020
T.018/S.4.5.7/R.2030
T.018/S.4.5.7/R.2040
T.018/S.4.5.7/R.2050
T.018/S.4.5.7/R.2060
T.018/S.4.5.7/R.2070

B.16.2 Method of Validation

B.16.2.1 Inspection – all beacons

The beacon shall be visually inspected and assessed to ensure the following:

a) That the manual cancellation function on the beacon is separate to the on/off function
b) That the manual cancellation function is protected from inadvertent activation and requires two simple and independent actions to initiate the cancellation function (e.g. by having a switch which is protected by a cover which has to be moved out of the way before the switch can be operated – note that other means that comply with the requirement are equally acceptable)

B.16.2.2 Cancellation Function – all beacons

The tests specified below 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 (Ref. A.2.1).

With the beacon activated and transmitting as normal initiate the cancellation function and check that the beacon meets the following requirements:

a. transmitter power output, per para. 0;
b. carrier frequency stability, per para B.2.2;
c. chip characteristics, per para B.3;
d. EVM, per para B.4;
e. spurious output, per para B.5;
f. first burst delay and repetition period, per para B.7 sub-sections, as appropriate (except self-test); and

g. message structure and content[*], per para B.6 and para B.8 sub-sections, as appropriate

h. after transmitting 10 cancellation messages the beacon ceases transmitting.

B.16.2.3 Cancellation Message – ELT(DT)s only

This test is in addition to the test in B.16.2.2. The test specified below shall be performed at ambient temperature only.

When performing the tests identified in section B.15.2.2 the transmissions from the ELT(DT) shall be monitored. The ELT(DT) shall transmit a Cancellation Message each time that it is deactivated (i.e. at the initiation of Tests 5, 7, 11, 13, 18a, 19, 24a and 25 in the Table in Section B.15.2.2). For each of the tests above verify g) and h) below and then during just one of these B.15.2.2 tests verify all of the parameters below:

a. transmitter power output, per para. 0;

b. carrier frequency stability, per para B.2.2;

c. chip characteristics, per para B.3;

d. EVM, per para B.4;

e. spurious output, per para B.5;

f. first burst delay and repetition period, per para B.7 sub-sections, as appropriate (except self-test); and

g. message structure and content[†], per para B.6 and para B.8 sub-sections, as appropriate

h. after transmitting 10 cancellation messages the beacon ceases transmitting.

B.16.2.4 Reactivation Test – all beacons

The tests specified below 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 (Ref. A.2.1).

With the beacon activated and transmitting as normal initiate the cancellation function. Approximately half way through the Cancellation Message sequence (i.e., approximately 50 seconds after initiating the cancellation function) the beacon shall be reactivated by turning it on.

[*] The message content is as defined in Annex C.
[†] The message content is as defined in Annex C.

The transmissions from the beacon shall be monitored to ensure that the ELT(DT) immediately ceases transmitting the Cancellation Message as soon as it is turned on and it then immediately reinitiates the alert sequence and transmits a valid alert message within 5 seconds after reactivation, or 8 seconds for EPIRBs. Verify the transition from cancellation message to distress message occurred by checking the message content per section B.8.

B.16.2.5 Reactivation Test – ELT(DT)s only

This test is in addition to the test in B.16.2.4. The test specified below shall be performed at ambient temperature only.

The ELT(DT) shall be activated by one of the means external to the ELT(DT) defined in the Table in section B.15.2.2 above and shall then be deactivated by the same means. Approximately half way through the Cancellation Message sequence (i.e., approximately 50 seconds after deactivating the ELT(DT)) the ELT(DT) shall be reactivated by one of the means defined in the Table in section B.15.2.2 above.

The transmissions from the ELT(DT) shall be monitored to ensure that the ELT(DT) immediately ceases transmitting the Cancellation Message as soon as it is reactivated and it then immediately reinitiates the alert sequence and transmits a valid alert message within 5 seconds after reactivation. Verify the transition from cancellation message to distress message occurred by checking the message content per section B.8

B.16.3 Required Results

a) Inspection of the beacon shall ensure that the manual cancellation function on the beacon is separate to the on/off function
b) Inspection of the beacon shall ensure that the manual cancellation function is protected from inadvertent activation and requires two simple and independent actions to initiate the cancellation function
c) The beacon shall be checked to ensure that it is reactivated and starts transmitting distress alerts within 5 seconds or 8 seconds for EPIRBs when the cancellation message is interrupted part way through by turning the beacon back on again.
d) On ELT(DT)s only the cancellation message shall be initiated by a means external to the ELT(DT) and part way through the cancellation sequence the ELT(DT) shall be reactivated and shall be checked to ensure that it starts transmitting distress alerts within 5 seconds.

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.17 VERIFICATION OF REGISTRATION (NOTE CURRENTLY NO REQUIREMENTS)

Note that there are currently no requirements for Verification of Registration within C/S T.018, until such time as these are introduced, there will be no corresponding test or evaluation requirements herein

B.18 OPERATOR CONTROLS TESTS

B.18.1 Self-Test Controls

The beacon shall be tested in the following way to determine if it malfunctions and begins to transmit more than one self-test transmission as required by C/S T.018 Section 4.5.4.

Notes

If the beacon has a common self-test and GNSS self-test control where the only differentiation between the two modes of operation is the amount of time that the control is operated then only test c) applies.

If the functioning of the either self-test mode is initiated by the release of the control, rather than the activation of the control then only test d) applies.

a) All self-test controls shall be operated and where possible maintained in the self-test activation mode (e.g. if the self-test is activated by a push button, then this shall be held down) for a period of at least 2 minutes longer than the specified maximum duration of the self-test. During this time it shall be ascertained that there is a single self-test transmission and that the beacon returns to its rest state on completion of the self-test cycle, even if the self-test control is still engaged.
b) If the beacon is equipped with a GNSS self-test mode then this mode shall be activated and where possible maintained in this condition for a period of at least 5 minutes longer than the maximum time duration of the GNSS self-test as defined by the manufacturer. During this time it shall be ascertained that there is no more than a single self-test transmission and that the beacon returns to its rest state on completion of the GNSS self-test cycle, even if the GNSS self-test control is still engaged.
c) For beacons that have a common self-test and GNSS self-test control, where the only differentiation between the two modes of operation is the amount of time that the control is operated, establish the minimum time interval from initial activation

of the control until the initiation of the GNSS self-test function 'X seconds'. Apply test a) above but only maintain the control in the self-test activation mode for X-1 seconds and then release it. Then apply test b) as detailed above.

d) For beacons where either self-test function is initiated by the release of the control, rather than by its activation, the above tests shall be applied as stated, except that there shall be no self-test transmissions from the beacon while the control is activated and no more than a single self-test transmission when the control is released.

B.18.2 Operational Controls

The beacon shall be tested in the following way to determine if it malfunctions and begins to transmit more frequently than is required by C/S T.018 Sections 2.2.1 and 4.5.6.

a) All manual operational controls designed to activate the beacon (e.g. On, Remote On etc.) shall be activated and where possible maintained in an operational mode (e.g. if the On function is activated by a push button, then this shall be held down) for a period of at least 3 minutes longer than the manufacturer declared time to transmit the first 406 MHz distress message.

b) Where possible both the self-test control(s) and the operational controls shall be activated together and be maintained in this condition for a period of at least 3 minutes longer than the manufacturer declared time to transmit the first 406 MHz distress message:

   i. by activating the self-test / GNSS self-test and after approximately 2seconds also activating the operational control(s)

   ii. by activating the operational control(s) and after approximately 5 seconds also activating the self-test / GNSS self-test

c) For beacons with an automatic means of beacon activation (e.g. water activation, g-switch etc.) tests a) and b) above shall be repeated once the beacon has first been activated by the automatic means.

The beacon shall be turned off between each test. In all conditions it shall be ascertained that the beacon does not transmit more than one self-test burst and does not transmit distress bursts more frequently than the repetition period defined in C/S T.018 Section 2.2.1. In addition during test b) ii) it shall be ascertained that the beacon continues to remain in the 'on' condition and instead does not activate the self-test function and transmit a self-test burst.

B.19 RLS GNSS RECEIVER OPERATION

B.19.1 Operation Cycle

B.19.1.1 Requirement

T.018/S.4.5.9.1/R.2100
T.018/S.4.5.9.3/R.2160
T.018/S.4.5.9.3/R.2170
T.018/S.4.5.9.3/R.2180
T.018/S.4.5.9.3/R.2190
T.018/S.4.5.9.3/R.2200
T.018/S.4.5.9.4/R.2255

T.018/S.4.5.9.2.1/R.2110
T.018/S.4.5.9.2.1/R.2120
T.018/S.4.5.9.3/R.2210
T.018/S.4.5.9.3/R.2220
T.018/S.4.5.9.3/R.2230
T.018/S.4.5.9.4/R.2240
T.018/S.4.5.9.4/R.2250
T.018/S.4.5.9.5/R.2260

B.19.1.2 Method of Validation

In all the manufacturer's declared operational configurations in Annex G.1, activate the beacon with the RLS Test Protocol (message bits 159 to 160 set to binary "11"). Check if the beacon indicates reception of the Test RLM message as indicated in document C/S T.018 sections 4.5.9.3 and 4.5.9.4.

B.19.1.3 Required Results

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.19.2 Derivation of M_{offset}

B.19.2.1 Requirement

T.018/S.4.5.9.2.1/R.2130
T.018/S.4.5.9.2.1/R.2140
T.018/S.4.5.9.2.2/R.2150

B.19.2.2 Method of Validation – M_{offset} Test

Set up the beacon under test such that it is possible to monitor when the GNSS Receiver in the beacon is active and inactive (i.e. powered up and providing position and related data) and it is possible to monitor the data output from the GNSS Receiver that is providing position and related data to the rest of the beacon electronics. A specially modified beacon (test unit) may be required for this test, thus this test may be performed using either the second beacon or another beacon as defined in section 4.3. This test may be performed by the beacon manufacturer or by the type approval test facility. This test may be carried out at any time during the testing sequence*.

Set up the beacon under test in an area where it can send 406-MHz signals and clearly receive navigation data to fully test the RLS closed-loop functionality, e.g., in an open area with a clear view of the sky.

Set up the necessary test equipment to enable the functioning of the GNSS Receiver and its data output to be monitored. It shall be possible to either store the information received at the GNSS Receiver data output for later analysis or to decode this data in real time such that the message stream provided can be correctly decoded and interpreted.

Ensure that the beacon is correctly coded with the RLS Test Protocol as per C/S T.021 Annex C.1. Carry out a self-test and ensure that:

a) the self-test message is transmitted with Rotating Field #2; and
b) the encoded 23 Hex ID is '9937D08FFE781E1E1E00001'.

Turn the beacon on at any time between 5 minutes and 20 minutes past any natural hour (e.g. between 09:05 and 09:20, between 15:05 and 15:20 etc.) and check the following:

a) that within 5 seconds of the beacon transmitting an initial RLS request through the transmission of Rotating Field #2 there is a visual indication of an RLS request;
b) that the first transmitted message is Rotating Field #2 and that subsequent [5] odd numbered burst are Rotating Field #2;
    - that bits 159-160 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '11' (RLS Test Protocol);
    - that bits 161-166 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '100000' (Beacon RLS Capability);
    - that bits 167-169 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '001' (RLS Provider Identification);

* Note it may be necessary to coordinate this test with both the relevant MCC and the Return Link Service Provider (RLSP) in order to ensure that test signals are correctly routed through the ground segment and the appropriate RLM is sent.

- that bits 170-191 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘0000000000000000000000‘ (Beacon Feedback);

c) that the GNSS Receiver turns on (becomes active) within 5 seconds of the beacon transmitting its first message;

d) monitor the GNSS Receiver data output and determine how long it takes after becoming active before the Receiver starts to output UTC in whichever recognised IEC 61162-1 approved sentence (e.g. GNS, ZDA etc.) the manufacturer has defined for this purpose;

e) monitor the GNSS Receiver and ensure that it remains in active mode for a period of at least 30 minutes after beacon activation, or, for beacons only capable of processing Type-1 RLMs, until such time as the conditions in g) below are met, after which time it may turn off, or remain on, or turn on and off one or more times;

f) during the above 30 minute period monitor the RLS indicator and note at what time it changes state to indicate receipt of an RLS request acknowledgement (i.e. receipt of an RLM);

g) monitor bits 161 to 191 in the next 406 MHz transmitted message with Rotating Field #2 after the RLS indicator changes state and ensure:

  - that bits 161-166 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘100000’ (Beacon RLS Capability);
  - that bits 167-169 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘001‘ (RLS Provider Identification); and
  - that bits 170-191 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘1000011000000000000000‘ (Beacon Feedback).

h) After which time, for beacons only capable of processing Type-1 RLMs, the test may be stopped and the beacon turned off for a minimum period of 15 minutes before commencing the next test.

i) Note, that for beacons only capable of processing Type-1 RLMs tests j) to m) inclusive below do not apply,

j) monitor the GNSS Receiver and ensure that it turns on at 17 minutes +/- 5 seconds after the next natural hour (e.g. if the beacon was first activated at 10:11 check to ensure that it turns on again at 11:17 +/- 5 seconds). Note 17 minutes equates to the Moffset value for, the encoded 15 Hex ID subset of the 23 Hex ID;

k) monitor the GNSS Receiver and ensure that it remains in active mode for a minimum period of 15 minutes after which time it may turn off, or remain on, or turn on and off one or more times;

l) monitor the GNSS Receiver for a further hour and ensure that it turns on at 17 minutes +/- 5 seconds after the next natural hour (e.g. if the beacon was first activated at 10:11 check to ensure that it turns on again this time at 12:17 +/- 5 seconds); and

m) monitor the GNSS Receiver and ensure that it remains in active mode for a minimum period of 15 minutes, after which time the test may be stopped and the beacon turned off. Leave the beacon turned off for a minimum period of 15 minutes before commencing the next test.

B.19.2.3 Required Results

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.19.3 UTC Test

B.19.3.1 Requirement

T.018/S.4.5.9.2.1/R.2130
T.018/S.4.5.9.2.1/R.2140
T.018/S.4.5.9.2.2/R.2150

B.19.3.2 Method of Validation – UTC Test

With the equipment and beacon test set up as in B.19.2.2 above,

Turn the beacon on at any time between 5 minutes and 20 minutes past any natural hour (e.g. between 09:05 and 09:20, between 15:05 and 15:20 etc.) and check the following:

a) that within 5 seconds of the beacon transmitting an initial RLS request through the RLS Distress or RLS Test Protocol there is a visual indication of an RLS request;
b) that the first transmitted message is Rotating Field #2 and that subsequent 5 odd numbered burst are Rotating Field #2;
   - that bits 159-160 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘11’ (RLS Test Protocol);
   - that bits 161-166 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘100000’ (Beacon RLS Capability);
   - that bits 167-169 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘001‘ (RLS Provider Identification);
   - that bits 170-191 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘0000000000000000000000‘ (Beacon Feedback;
c) that the GNSS Receiver turns on (becomes active) within 5 seconds of the beacon transmitting its first RLS Location Protocol Test message;
d) monitor the GNSS Receiver data output and determine how long it takes after becoming active before the Receiver starts to output UTC in whichever recognised IEC 61162-1 approved sentence (e.g. GNS, ZDA etc.) the manufacturer has defined for this purpose;
e) monitor the GNSS Receiver data output to check for the presence of a valid position in whichever recognised IEC 61162-1 approved sentence (e.g. GNS, RMC etc.) the manufacturer has defined for this purpose. Between 15 seconds and 45 seconds after

first obtaining a position deny the beacon access to any satellite signals for the next portion of this test.

f) monitor the GNSS Receiver data output and ensure that no further time and / or position updates are received;

g) monitor the beacon transmitted signal and ensure:
   - that it contains the location of the beacon to within 500m accuracy;
   - that bits 161-166 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '100000' (Beacon RLS Capability);
   - that bits 167-169 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '001' (RLS Provider Identification); and
   - that bits 170-191 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '1000011000000000000000' (Beacon Feedback).

h) monitor the GNSS Receiver and ensure that it remains in active mode for a minimum period of 30 minutes after which time it may turn off, or remain on, or turn on and off one or more times;

i) monitor the GNSS Receiver and ensure that it turns on at 17 minutes +/- 5 seconds after the next natural hour (e.g. if the beacon was first activated at 10:11 check to ensure that it turns on again at 11:17 +/- 5 seconds). Note 17 minutes equates to the M_{offset} value for the encoded 15 Hex ID subset 23 Hex ID, while this test ensures that the internal clock within the beacon is functioning correctly in the absence of UTC;

j) monitor the GNSS Receiver and ensure that it remains in active mode for a minimum period of 15 minutes after which time it may turn off, or remain on, or turn on and off one or more times;

k) monitor the beacon transmitted signal and ensure:
   - that it still contains the location of the beacon to within 500 m accuracy;
   - that bits 161-166 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '100000' (Beacon RLS Capability);
   - that bits 167-169 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '001' (RLS Provider Identification); and
   - that bits 170-191 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '1000011000000000000000' (Beacon Feedback).

l) monitor the GNSS Receiver for a further hour and ensure that it turns on at 17 minutes +/- 5 seconds after the next natural hour (e.g. if the beacon was first activated at 10:11 check to ensure that it turns on again this time at 12:17 +/- 5 seconds);

m) within 10 seconds to 20 seconds of the GNSS Receiver turning back on again allow the beacon access to the satellite signals for the remaining portion of this test;

n) monitor the GNSS Receiver and ensure that it remains in active mode for a minimum period of 15 minutes. or, for beacons only capable of processing Type-1 RLMs , until such time as the conditions in test p) below are met, at which point the GNSS receiver may turn off;

o) during the above 15 minute period monitor the RLS indicator and note at what time it changes state to indicate receipt of an RLS request acknowledgement; and

p) monitor bits 161 to 114 in the next 406 MHz transmitted message after the RLS indicator changes state and ensure:

- that bits 161-166 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '100000' (Beacon RLS Capability);
- that bits 167-169 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '001' (RLS Provider Identification); and
- that bits 170-191 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '1000011000000000000000' (Beacon Feedback)

After which time the test may be stopped and the beacon turned off.

B.19.3.3 Required Results

Populate the data tables as required in Annex E.1: Tabs appropriate to the test being conducted, for each test parameter indicated above using the data collected during the test sequence by calculating the statistics, as required in Annex E, using data collected from each of the bursts.

B.20 BATTERY STATUS INDICATION

B.20.1 Requirement

T.018/S.4.5.10/R.2270
T.018/S.4.5.10/R.2280
T.018/S.4.5.10/R.2290
T.018/S.4.5.10/R.2300

B.20.2 Method of Validation

B.20.2.1 Testing Self-test Insufficient Battery Energy

The test is aimed to verify that the beacon, when activated in self-test mode, provides a distinct indication of Potentially Insufficient Battery Energy (PIE), i.e. that the remaining battery energy could be not sufficient to support the manufacturer declared minimum duration of continuous beacon operation.

B.20.2.1.1 Preparing for the Test

Prior to the test, the beacon manufacturer shall declare technical parameters (see ANNEX H.1).

B.20.2.1.2 PIE Indication Test Procedure

The test may be performed on a separate additional test unit and shall be conducted in two steps:

- on the first step, check the self-test indication when the beacon battery has sufficient energy to support beacon operation for the declared operating lifetime, and/or the PIE criteria is not met; and

- on the second step, check the self-test indication, when the test beacon battery capacity is not sufficient to support beacon operation for the declared minimum duration of continuous operation, and/or the PIE criteria is met.

Step-1: Verification of the Self-Test Indication of Sufficient Battery Energy

As applicable to the beacon design, discharge a fresh battery by operating a beacon in the worst-case operating mode at ambient temperature for the duration corresponding to $\mathbf{C_{PO}}$, or by the amount indicated by the beacon manufacturer, as their criteria for triggering PIE less 30 minutes, if this is different to $\mathbf{C_{PO}}$, and/or make sure that the criteria to generate the PIE indication is not yet met.

At ambient temperature, activate the test beacon in a self-test mode. Observe the beacon indication. The test is passed successfully, if during the self-test, the test beacon does not provide a distinct indication of insufficient battery energy (PIE indication), or (if this feature is supported by the beacon design) the test beacon provides a distinct indication of sufficient energy.

Note: If applicable to the beacon design and implementation of PIE indication, the sub-criteria for the absence of PIE indication can be achieved, e.g., by performing less than the maximum recommended number of self-tests, and/or less than the maximum number of GNSS self-tests, or by creating other PIE indication conditions declared by a beacon manufacturer (see ANNEX H.1).

Step-2: Verification of the Self-Test Indication of Insufficient Battery Energy

After completion of Step-1, further discharge the beacon battery, and/or make sure that, as applicable to the test beacon design, the criteria for the PIE indication is now fully met.

Note 1: The required battery discharge can be achieved by operating the test beacon in the worst-case operating mode at ambient temperature until the residual battery energy corresponds to $\mathbf{C_{CO}}$ **+ 30 minutes (**i.e., the total discharge of a fresh battery will correspond to the value of $\mathbf{C_{PO}}$ **+** $\mathbf{C_{SP\text{-}AMB}}$ **+ 30 minutes)**[*]**,** or until the amount of the residual battery energy indicated by the

[*] If $C_{SP\text{-}AMB}$ is not known and/or not declared, this value, for example, may be measured as follows:

1) Discharge the beacon battery by the value of $\mathbf{C_{PO}}$ at ambient temperature, and carry out the Operating Lifetime at Minimum Temperature test as defined in C/S T.021 0, by operating the beacon in the worst-case mode for the declared minimum duration of continuous operation, after which time, terminate the beacon operation.
2) Place the non-operating beacon in the ambient temperature conditions, allow at least 2 hours of soaking, activate the beacon and operate it in the worst-case mode until the beacon can no longer meet the performance requirements defined in document C/S T.018. The duration of the beacon fault-free operation is equivalent to $\mathbf{C_{SP\text{-}AMB}}$.

beacon manufacturer as their criteria for triggering PIE indication plus 30 minutes, if this amount is different from **C_{CO}.** Alternatively, if a different method of assessing PIE has been implemented by the manufacturer, the necessary conditions for PIE indication can be achieved in that way, for example, by performing the remaining number of self-tests and GNSS self-tests to reach the declared maximum numbers.

At ambient temperature, activate the beacon in the self-test mode. Observe test beacon indication. The test is passed successfully, if during the self-test the beacon provides a distinct indication of insufficient battery energy.

Note 2: The means to discharge the battery may be as defined by the manufacturer, this may, for example, be achieved by activating the beacon for the required period of time, or by running multiple self-tests, or by running GNSS self-tests, etc.

B.20.3 Required Results

Record the test results/observations of PIE indication in Annex E: Tab: Annex E.7-1 - PIE, and reflect the test results in Annex E: Tab: Annex E.1-11 - A.2.9.

B.21 BEACON LABELLING

B.21.1 Requirement

T.018/S.4.5.13/R.2310

Check the labelling on the beacon for compliance with the following requirements:

1) There is a clearly defined space for the recording of the beacons 23 Hex ID
2) The beacons operating temperature range (Class 0, 1 or 2 and the associated temperature range in degrees Celsius) is clearly marked
3) The beacons minimum duration of continuous operation is clearly marked
4) Any information displayed on the beacon label shall not contradict the information declared in the type approval application (See ANNEX H).

B.21.2 Method of Validation

The beacon labelling shall be Inspected to ensure compliance with the following:

1) That the space for the 23 Hex ID is adequate in size and is clearly marked with the text “23 Hex ID”. The space for the 23 Hex ID shall contain the 23 Hex ID programmed into the beacon for the purposes of type approval testing in legible roman characters that contrast with the background. There shall be provision for the 23 Hex ID to be easily changed in the event of the beacon being reprogrammed (e.g. to a different Country Code)

2) That the beacon class of operation (i.e. either Class 0, 1 or 2) and the corresponding operating temperature range in degrees Celsius are clearly marked on the exterior of the beacon in legible roman characters that contrast with the background. Optionally the temperature range in degrees Fahrenheit may also be provided
3) That the beacon minimum duration of continuous operation of the 406 MHz satellite signal (e.g. 24 hours, 48 hours) is clearly marked on the exterior of the beacon in legible roman characters that contrast with the background
4) An example of the minimum acceptable text for compliance with these requirements on small beacons with limited surface area is as follows, more descriptive text is encouraged but is not mandatory:
   a. 23 Hex ID: XXXXXXXXXXXXXXXXXXXXXXX
   b. Class 2: >24 hrs at –20C to +55C
5) All labelling shall be durably marked and shall not show any signs of smudging or fading after being subjected to the complete test program required by this document (e.g. temperature and handling).
6) The information included on the beacon label shall be checked for any inconsistency with the information provided in the type approval application (C/S T.021 ANNEX H) examples would include different beacon names or model numbers etc.

B.21.3 Required Results

At the end of the inspection all text shall be clearly visible and shall comply with the requirements. A positive result shall be indicated in the test report by a 'tick' a negative result shall be indicated by a 'cross' and the observed non-compliance(s) shall be stated in the comments.

Populate the data tables as required in Annex E.1: Tab: Annex E.1-12 - A.2.10, for each test parameter indicated above using the data collected during the test.

B.22 BEACON INSTRUCTION MANUAL

B.22.1 Requirement

T.018/S.4.5.14/R.2260
T.018/S.4.5.14/R.2320
T.018/S.4.5.14/R.2330
T.018/S.4.5.14/R.2340

Check that the End User instruction manual to be provided with the beacon contains the following information:

1) beacon type and designation (e.g. 406 MHz EPIRB, brand, model name or number etc.)

2) beacon specification;

3) typical operating scenarios and limitations with photos/drawings illustrating as a minimum all the operational configurations declared by the manufacturer in their application with antenna(s) deployed,

4) beacon system configuration, including connection of components and external devices and antennas, if applicable,

5) methods of beacon activation, deactivation and cancellation and related status indicators including as applicable beacon/antenna deployment,

6) as applicable the operation and function including any limitations of any additional beacon features (e.g. Encoded Position, RLS Capability, Homing Signals, Voice Transceivers etc.),

7) functioning of the battery status indicator and for beacons with rechargeable batteries details of how and when to charge the battery,

8) description of self-test mode and GNSS self-test mode (if applicable), including methods of self-test mode/GNSS self-test mode activation and indication of pass and fail,

9) battery replacement instructions and battery replacement period;

10) Information provided in the beacon manual shall be consistent with the information provided in the type approval application (See ANNEX H).

B.22.2 Method of Validation

The End User instruction manual shall be inspected to ensure that it contains the following information and where necessary an analysis shall be made to ensure that the manual correctly reflects the modes, methods and operational configurations of the beacon as declared by the beacon manufacturer in their type approval application and as observed by the test facility during type approval testing:

1) That the manual clearly defines the beacon type and designation that it applies to (e.g. 406 MHz EPIRB, brand, model name or number etc.). If the manual covers more than one type of beacon or different designations of beacon it shall be apparent what parts of the manual apply to which variant of beacon

2) That the manual contains a basic and brief specification for the beacon in question (e.g. Operating Frequency, Power Output, Modulation (of all transmitters), Class and Operating Temperature range, Size and weight, Battery Chemistry, Operating Lifetime, Replacement Battery Date, GNSS Receiver constellations and signals used (if applicable), External Encoded Location input signals (if applicable) and Standards complied with);

3) That the manual clearly illustrates typical operating scenarios and limitations with photos/drawings covering as a minimum all the operational configurations declared by the manufacturer in their application with antenna(s) deployed,

4) That the manual provides details of any necessary beacon system configuration (e.g. during installation), including connection of components and external devices and antennas, if applicable,

5) That the manual clearly addresses methods of beacon activation, deactivation and cancellation and related status indicators including as applicable beacon/antenna deployment,

6) As applicable the manual clearly addresses the operation and function (including any limitations) of any additional beacon features (e.g. Encoded Position, RLS Capability, Homing Signals, Voice Transceivers etc.),

7) That the manual provides details on the functioning of the battery status indicator and for beacons with rechargeable batteries details of how and when to charge the battery,

8) That the manual provides a description of the self-test mode and GNSS self-test mode (if applicable), including methods of self-test mode/GNSS self-test mode activation and indication of pass and fail,

9) That the manual provides battery replacement instructions and information as to when the battery should be replaced.

10) The beacon manual shall be examined for inconsistencies, beyond the specific items identified above, with the information provided in the type approval application package (section 4.10) with specific attention to:
    a. the information declared by the manufacturer in Form G.1,
    b. other critical information identified in ANNEX H.

The overall examination and any inconsistencies observed shall be limited to items that would mislead the end user or result in the incorrect installation, operation or maintenance of the beacon.

B.22.3 Required Results

At the end of the inspection and analysis it shall be evident that the End User instruction manual provides clear and unambiguous advice to end users on the correct installation, operation and maintenance (as applicable) of the beacon submitted for type approval. A positive result shall be indicated in the test report by a ‘tick’ a negative result shall be indicated by a ‘cross’ and the observed non-compliance(s) shall be stated in the comments.

Populate the data tables as required in Annex E.1: Tab: Annex E.1-12 - A.2.10, for each test parameter indicated above using the data collected during the test.

- END OF ANNEX B -

ANNEX C: BEACON CODING FOR EVALUATING MESSAGE CODING

C.1 BEACON CODING TO BE USED FOR EVALUATING MESSAGE CODING

The following tables contain values for the various fields to be used in evaluating message coding per Annex A.2.8, B.8, and B.19. GNSS defaults are not provided as GNSS verification is performed in Annex B.14.

Table C.1-1: Main Message Field

Field name (main field)	Bit positions	Value
TAC Number + Serial Number (30 bits)	1-30	999999 decimal for TAC, 999 decimal for serial number
Country Code (10 bits)	31-40	201 decimal
Status Of Homing Device (1 bit)	41	Set by the beacon
Self-Test function (1 bit)	42	Set by beacon depending on method of beacon activation
Test Protocol Message (1 bit)	43	1
Encoded GNSS Location (47 bits)	44-90	As provided by the GNSS receiver or for beacons that do not have GNSS capability (default Lat) Bits 44-66: 1 1111111 000001111100000 binary (default Long) Bits 67-90: 1 11111111 111110000011111 binary
Select from the following Vessel ID values depending on the Vessel ID type used by the beacon under test		
Vessel ID Field ID (3 bits)	91-93	000 binary
Vessel ID: no identity (44 bits)	94-137	0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
Vessel ID field ID: MMSI (3 bits)	91-93	001 binary
Vessel ID:MMSI (44 bits)	94-137	000111111 decimal, 10101010101010 binary
Vessel ID field ID: Radio call sign (3 bits)	91-93	010 binary
Vessel ID: Radio call sign (44 bits)	94-137	00 100100 100100 100100 100100 100100 100100 100100 binary
Vessel ID field ID – Aircraft registration Marking (3 bits)	91-93	011 binary

Field name (main field)	**Bit positions**	**Value**
Vessel ID – Aircraft Registration Marking (44 bits)	94-137	00 100100 100100 100100 100100 100100 100100 100100 binary
Vessel ID field ID: Aviation 24 bit address (3 bits)	91-93	100 binary
Vessel ID: Aviation 24 bit address (44 bits)	94-137	0000 1111 0000 1111 0000 1111 0000 0000 0000 0000 0000 binary
Vessel ID field ID: Aircraft operator and serial number (3 bits)	91-93	101 binary
Vessel ID: Aircraft operator and serial number (44 Bits)	94-137	100100 100100 100100 0000 0000 0001 1111 1111 1111 11 binary
Beacon Type (2 bits)	138-139	As appropriate to the beacon type (per document C/S T.018 Table 3.1)
RLS Function (1 bit)	140	As appropriate to the beacon (per document C/S T.018 Table 3.1)
Spare Bits (14 bits)	141-154	As appropriate to the beacon message type (per document C/S T.018 Table 3.1)

Table C.1-2: Table B.2 Rotating Field #0

Rotating Field name and number	**Bit Positions**	**Value**
Objective rotating Field (#0)		
Rotating field ID	155-158	0000 binary
Elapsed Time	159-164	Set by the beacon
Time from last encoded location	165-175	Set by the beacon
Altitude of encoded location	176-185	As provided by the GNSS receiver or beacon
Dilution of Precision	186-193	As provided by the GNSS receiver or beacon
Automated/Manual activation notification	194-195	Set by the beacon
Remaining battery capacity	196-198	Set by the beacon
GNSS status	199-200	As provided by the GNSS receiver or beacon
Spare	201-202	00 binary

Table C.1-3: Table B.3 Rotating Field #1

In Flight Emergency Rotating Field (#1)	Bit Positions	Value
Rotating field identifier	155-158	0001 binary
Time of last encoded location	159-175	Set by the beacon
Altitude of Encoded location	176-185	As provided by the GNSS receiver or beacon
Triggering Event	186-189	Set by the beacon
GNSS status	190-191	As provided by the GNSS receiver or beacon
Remaining Battery capacity	192-193	Set by the beacon
Spare	194-202	0 0000 0000 binary

Table C.1-4: Table B.4 Rotating Field #2

Rotating field (#2)	Bit Positions	Value
Rotating field ID (4 bits)	155-158	0010 binary
Beacon type (2 bits)	159-160	11 binary (RLS protocol)
Beacon RLS capability (6 bits)	161-166	100000 binary
RLS Provider ID (3 bits)	167-169	001 binary (Galileo)
Beacon Feedback (22 bits)	170-191	As set by the beacon
Unassigned (10 bits)	192-202	00 0000 0000 binary

Table C.1-5: Table B.5 Rotating Field #3

National Use Rotating Field (#3)	Bit Positions	Value
Rotating Field ID (4 bits)	155-158	0011 binary
National Use	159-202	1111 0000 1111 0000 1111 0000 1111 0000 1111 0000 1111 binary

Table C.1-6: Table B.7 Rotating Field #15

Cancellation Message Rotating field (#15)	Bit Positions	Value
Rotating Field ID	155-158	1111 binary
Fixed (42 bits)	159-200	10 1111 0000 1111 0000 1111 0000 1111 0000 1111 0000
Method of Deactivation	201-202	Set by the beacon

- END OF ANNEX C -

ANNEX D: NAVIGATION TEST SCRIPTS

D.1 TEST PROCEDURE

This set of test scripts have been developed for second generation beacons. There are 9 tests. No separate test for round-up or round-down was developed although it is a critical step. Round up/down is inherent in several of the test scripts. The reason is that if rounding is not correctly performed, wrong answers will be obtained in some of the test scripts.

An outline of the tests is provided below:

1. Default, no fix
2. Test at equator and prime meridian: mostly all zero's ("0"s) in encoded location field
3. Test at equator and prime meridian testing whether the flags can switch for the same location, 2D fix, low DOP's
4. Test at a location where the encoded location field is an alternating "10" pattern 3D fix, mid-range DOP's
5. Test where the encoded location field is almost all ones ("1"s). 2D fix, mid-range DOP's
6. Test near North pole and just east of international dateline 3D fix, very high DOP's
7. Test near South pole and just west of international dateline 2D fix, very high DOP's
8. Test at Dead Sea- -altitude much below sea level, no fix, very high HDOP, low VDOP
9. Self-test with no valid GNSS location very high DOP's
10. Optional self-test with valid GNSS location (per C/S T.018 section 4.5.5)

The method of verification is to monitor the beacon transmitted digital message as the test scripts are inputted and changed. Ensure that the beacon position data update interval is not modified/reduced during this test in order to reduce test time. The test scripts shall be implemented in the order indicated, and the beacon shall not be turned-off until after all the scenarios have been completed.

The test results shall be reported in the format provided at Table E.1-1.

D.2 TEST SCRIPTS

Second generation beacons use decimal degrees and decimal parts of degrees. This is more complicated than degrees, minutes and seconds of first generation beacons. In order to get the right answers, latitude and longitude needs to be specified with 5 or more digits to the right of the decimal point.

Table D.2-1: Location Test Scripts

Script	Value of Encoded Location Bits Transmitted by Beacon	Location Correct (√)	Required Value of Encoded Location Bits[29]
1. Turn on beacon ensuring that navigation data is not provided to the beacon. Record the value of encoded latitude and longitude location bits Default Lat: 127.03027 North Default Long: 255.96970 East Default altitude: altitude not available Fix: No Fix HDOP: Not available VDOP: Not available	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189 = VDOP bits 190-193; = GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191 =		Bits 44-66 = 3F83E0 Bits 67-90 = 7FFC1F Rotating field #0 Bits 176-185 = 3FF Bits 186-189 = F Bits 190-193 = F Bits 199-200 = 0 Rotating field #1 Bits 176-185 = 3FF Bits 190-191 = 0
2. Keeping the beacon active, apply the following navigation data to the beacon: 0° 0 min 0 sec South, in decimal degrees: 0.00000 S 0° 0 min 0 sec West, in decimal degrees: 0.00000 W Altitude: 0 meters Fix: 3D HDOP:4.2 VDOP:6.8 When the beacon transmitted message changes, record the new encoded location bits and the duration of time the beacon took to update.	Lat Bits 44-66 = Long Bits 67-90 = Number of seconds after providing navigation data that beacon transmitted the above encoded location information: ______ Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189: VDOP bits 190-193; GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 400000 Bits 67-90 = 800000 Response time for beacon to transmit correct encoded location must be less than 62.5 sec. Rotating field #0 Bits 176-185 = 01D Bits 186-189 = 4 Bits 190-193 = 6 Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 01D Bits 190-191 = 2

[29] 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. When there isn't sufficient number of bits to equal 4 bits for a Hex character, leading zeroes are used to fill in.

Script	Value of Encoded Location Bits Transmitted by Beacon	Location Correct (√)	Required Value of Encoded Location Bits[29]
3. Keeping the beacon active, change the navigation input to the beacon to: 0° 0 min 0 sec South, in decimal degrees 0.00000 W 0° 0 min 0 sec West, in decimal degrees 0.00000 W Altitude:4 meters Fix 2D HDOP: 2.0 VDOP: 5.0 When the beacon transmitted message changes, record the new encoded location bits.	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189 =: VDOP bits 190-193 = GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 000000 Bits 67-90 = 000000 Rotating field #0 Bits 176-185 = 01D Bits 186-189 = 1 Bits 190-193 = 4 Bits 199-200 = 1 Rotating field #1 Bits 176-185 = 01D Bits 190-191 = 1
4. Keeping the beacon active, change the navigation input to the beacon to: 42° 39 min, 59.96338 sec North, in decimal degrees, 42. 66667 N 170° 39 min,59.96338 sec East, in decimal degrees 170.66667 E Altitude: 322 meters Fix: 3D HDOP: 9 VDOP: 25 When the beacon transmitted message changes, record the new encoded location bits.	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189 =: VDOP bits 190-193 = GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 555555 Bits 67-90 = 555555 Rotating field #0 Bits 176-185 = 031 Bits 186-189 = 8 Bits 190-193 = C Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 031 Bits 190-191 = 2

Script	Value of Encoded Location Bits Transmitted by Beacon	Location Correct (√)	Required Value of Encoded Location Bits[29]
5. Keeping the beacon active, change the navigation input to the beacon to: 63° 59 min 59.963 sec South, in decimal degrees 63.99997 127 ° 59 min 59.963 sec East, in decimal degrees 127, 99997. Altitude: 334 meters Fix: 2DHDOP: 9 VDOP: 25 When the beacon transmitted message changes, record the new encoded location bits.	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189: = VDOP bits 190-193 =; GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 5FFFFF Bits 67-90 = BFFFFF Rotating field #0 Bits 176-185 = 032 Bits 186-189 = 8 Bits 190-193 = C Bits 199-200 = 1 Rotating field #1 Bits 176-185 = 032 Bits 190-191 = 1
6. Keeping the beacon active, change the navigation input to the beacon to: 89° 30 min 0 sec North, in decimal degrees 89.50000 N 179° 45 min 0 sec East, in decimal degrees. 179.75000 E Altitude:15848 meters Fix: 3DHDOP: 75 VDOP: 55 When the beacon transmitted message changes, record the new encoded location bits.	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189 = VDOP bits 190-193 = GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 2CC000 Bits 67-90 = 59E000 Rotating field #0 Bits 176-185 = 3FC Bits 186-189 = E Bits 190-193 = E Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 3FC Bits 190-191 = 2

Script	Value of Encoded Location Bits Transmitted by Beacon	Location Correct (√)	Required Value of Encoded Location Bits[29]
7. Keeping the beacon active, change the navigation input to the beacon to: 89° 30 min 0 sec South, in decimal degrees 89.50000 S 179° 45 min 0 sec West, in decimal degrees .179.75000 W Altitude: 15886m Fix: 2D HDOP: 75 VDOP: 55 When the beacon transmitted message changes, record the new encoded location bits.	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189 =: VDOP bits 190-193 =; GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 6CC000 Bits 67-90 = D9E000 Rotating field #0 Bits 176-185 = 3FE Bits 186-189 = E Bits 190-193 = E Bits 199-200 = 1 Rotating field #1 Bits 176-185 = 3FE Bits 190-191 = 1
8 Keeping the beacon active, change the navigation input to the beacon to: 31° 30 min 0 sec North, in decimal degrees 31.50000 N 35° 30 min 0 sec East, in decimal degrees 35.50000 E Altitude: -424 meters Fix: No Fix HDOP:75 VDOP:2 When the beacon transmitted message changes, record the new encoded location bits.	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189: VDOP bits 190-193; GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 0F4000 Bits 67-90 = 11C000 Rotating field #0 Bits 176-185 = 000 Bits 186-189 = E Bits 190-193 = 1 Bits 199-200 = 0 Rotating field #1 Bits 176-185 = 000 Bits 190-191 = 0

Self-Test Navigation Test Scripts

Script	Value of Encoded Location Bits Transmitted by Beacon	Location Correct (√)	Required Value of Encoded Location Bits[29]
9. For beacons without valid GNSS location data Turn the beacon off. Ensure that navigation data is not provided to the beacon then activate the Self-Test. Record the value of encoded location bits in the self-test message.	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189: VDOP bits 190-193; GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 3F83E0 Bits 67-90 = 7FFC1F Rotating field #0 Bits 176-185 = 3FF Bits 186-189 = F Bits 190-193 = F Bits 199-200 = 0 Rotating field #1 Bits 176-185 = 3FF Bits 190-191 = 0
10. For beacons with GNSS Self-Test Capability Continuously apply the following navigation data to the beacon: 0° 0 min 0 sec South, in decimal degrees 0.00000, 0° 0 min 0 sec West, in decimal l degrees 0.000000. Altitude: -10 m Fix: 3D HDOP: 2 VDOP: 2 Activate the Self-Test. Record the value of encoded location bits in the self-test message.	Lat Bits 44-66 = Long Bits 67-90 = Rotating field #0 Altitude bits 176-185 = HDOP bits 186-189: VDOP bits 190-193; GNSS status bits: 199-200 = Rotating Field #1 Altitude bits 176-185 = GNSS status bits 190-191		Bits 44-66 = 400000 Bits 67-90 = 800000 Rotating field #0 Bits 176-185 = 01C Bits 186-189 = 1 Bits 190-193 = 1 Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 01C Bits 190-191 = 2

D.3 ELT(DT) ENCODED POSITION DATA UPDATE INTERVAL GNSS SIMULATOR TEST PROCEDURE

D.3.1 INTRODUCTION

This procedure is intended to provide additional guidance on the testing of an ELT(DT) under typical conditions that may be found on an aircraft in order to ensure the correct operation of the GNSS Receiver within the ELT(DT) using a GNSS Simulator. This procedure is intended to supplement the basic test procedure outlined in C/S T.021 Annex B.14.3.6: it provides guidance to the test facility on setting up the GNSS Simulator and running the appropriate test(s). It is intended to be used in that light and alternative test methods that provide similar results may be used by a test facility in co-ordination with the ELT(DT) manufacturer and the Cospas-Sarsat Secretariat.

D.3.2 TEST CONDITIONS

D.3.2.1 GNSS Receiver

If the GNSS Receiver in the ELT(DT) is capable of being configured by the manufacturer or other entities, such that it can function differently either under different circumstances or in different parts of the world, then each of the different modes of operation of the GNSS Receiver shall be tested. For example if the GNSS Receiver can be configured to operate solely as a GPS Receiver for use in North America or solely as a Glonass Receiver for use in Asia then both of these modes must be tested, however if the GNSS Receiver has a single fixed mode of operation pre-set by the manufacturer (regardless of what this might be) then just a single test in this mode is required. Likewise, if the GNSS Receiver can handle multiple signals from one constellation (e.g. GPS L1 C/A, L2C or L5) and if these can be configured by the manufacturer or other entities under different circumstances, then each combination of signals shall be tested.

D.3.2.2 GNSS Constellations

The GNSS Simulator shall be configured to operate with the constellations declared by the ELT(DT) manufacturer that the GNSS Receiver is configured to accept (this could be a single constellation or multiple constellations). Each constellation shall be configured as an optimized constellation based upon the official published information on that constellation (e.g. GPS – 24 satellites in Orbital Planes A1-4, B1-4, C1-4, D1-4, E1-4 and F1-4, Glonass – 24 satellites in Orbital Planes 1 (Slots 1-8), 2 (Slots 9-16) and 3 (Slots 17-24) and Galileo – 24 satellites in Orbital Planes A (Slots 01-08), B (Slots 01-08) and C (Slots 01-08). Additional or spare satellites in any constellation shall not be included. Each constellation shall be configured to commence testing at 00:00 UTC on January 1, 2017 and the start position for each test shall be at Latitude 13.283 degrees North, Longitude 40.917 degrees East and Altitude -100 m. The simulator output shall be set such that the signal level received by the antenna of the GNSS Receiver under test is within +/- 2dB of the nominal signal level at the earth's surface for that constellation. No SBAS satellite augmentation such as WAAS or EGNOS shall be employed and no interference shall be superimposed on the GNSS signals.

D.3.2.3 ELT(DT)

The ELT(DT) under test, including its GNSS Receiver and related GNSS Antenna, shall be configured in a set up representative of a typical installation on board an aircraft. The GNSS Antenna shall be mounted in the centre of a superstructure of at least 1m2 representative of the aircraft fuselage. The ELT(DT) shall be mounted below the superstructure and the cabling between the GNSS/ELT Antenna(s) and the ELT(DT), if applicable, shall be the maximum length specified by the manufacturer. If the GNSS Receiver and/or the ELT(DT) is normally powered such that it is in the 'Armed' mode of operation prior to activation of the ELT(DT) then it shall be configured in this mode immediately after the commencement of the following test to ensure that it has initialised and has a valid location.

D.3.3 GNSS SIMULATOR SCENARIO

The GNSS Simulator shall be programmed to perform a flight pattern that complies with the one provided in the csv file in document C/S T.021 starting at a simulated time of 00:00 UTC on 01/01/2018, which could be summarized as follows;

a) five minutes of stationary (static position) with the beacon in "ARMED" mode and then approximately 15 seconds before the end of this time turn the ELT(DT) to the "ON" mode;

accelerate due North at a rate of 5.55 m/s2 for 60 seconds in a straight line, while climbing 5,000 m;

apply a constant horizontal speed of 333 m/s for 36 seconds in a straight line, while climbing a further 5,000 m;

level out and at a constant horizontal speed of 333 m/s simulate a bank of 45 degrees to the left and a turn of 6 degrees per second for one minute;

at the same horizontal speed remove the bank and turn and then simulate a bank of 45 degrees to the right and a turn of 6 degrees per second for one minute;

remove the bank and turn and then decelerate at a rate of 2.77 m/s2 for 120 seconds, while descending 5,000 m while performing a left turn of 12 degrees per second

level out, remove the turn and then accelerate at a rate of 2.77 m/s2 for 60 seconds in a straight line, while climbing 5,000 m;

level out and apply a constant horizontal speed of 166 m/s for 90 seconds, while descending 10,000 m; and

finally apply 60 seconds of stationary position again.

Note - the above trajectory and aircraft attitude shall be implemented such that:

b) The satellites used at the start of the simulation shall be those that are above 5 degrees elevation at the location of the simulation based upon its start time. As the aircraft direction and attitude changes during the simulation (i.e. climbs, banks, descends etc) the horizon shall be considered to change with the aircraft movement, such that the satellites in view change accordingly. For example, if the aircraft was heading due north and climbing at an angle of 30 degrees, then any satellites to the North below 35 degrees elevation would be excluded from the simulation, while satellites due South should take into account the earth's horizon, and satellites at other points around the compass would be included or excluded accordingly on the same basis.

discontinuities between the various phases of the trajectory are limited to a maximum acceleration of 100m/s2. Apart from the final transition phase, which in effect simulates the aircraft rapidly decelerating as the result of an impact, where the change in instantaneous acceleration shall be infinite.

The CSV file provided in document C/S T.021 containing the data for the above scenario shall be used to program the GNSS simulator and provide the navigation signals for these tests.

- END OF ANNEX D -

ANNEX E: REPORTING TYPE APPROVAL TEST RESULTS

The type-approval application form and other forms (e.g., Change-Notice form, Quality Assurance Plan, etc.), included in the electronic file:

"C-S_T.021_Annex_E-G_Preliminary_Issue_A_Rev_001.xlsx",

shall be completed, signed and submitted, or, alternatively, this information may be provided using the electronic format and procedures as available on the Cospas-Sarsat website.

Click the paper clip for the embedded Excel file:

E.1 TEST RESULTS SUMMARY

E.2 SATELLITE QUALITATIVE TEST SUMMARY REPORT

E.3 406 MHZ BEACON EL-EIRP / ANTENNA TEST RESULTS SHEET

E.4 NAVIGATION SYSTEM TEST RESULTS

E.5 BEACON CODING SOFTWARE RESULTS

E.6 BEACON OPERATING CURRENT AND PRE-TEST DISCHARGE CALCULATIONS

E.7 BATTERY STATUS INDICATION

E.8 DATA CHECKLIST

Table E.8-1: Check-List of Technical Data Provided by Beacon Manufacturer

Tick (√) to indicate submission of items	*Applicable C/S T.021 Annex H1 requirement*	*Description of technical information item*	*File name, title of document, page, section, where the item is located*
	(a-i)	*Application Form (Annex G.1)*	
	(a-ii)	*Test Facility Application Form (Annex G.2)*	
	(a-iii)	*Change Notice Form (Annex G.4)*	
	(a-iv)	*Quality Assurance Plan (Annex G.3)*	
	(b)	*Photos of the beacon in all operational configurations*	
	(c)	*Pre-test discharge data and analysis, [Table F-E.2]*	
	(d)	*List and analysis of operating modes, [Table F-E.1]*	
	(e)	*Beacon manuals*	
	(e)	*Beacon technical Data sheet*	
	(f)	*Marketing brochure*	
	(g)	*Battery cell technical data sheet*	
	(g)	*Electrical diagramme of the battery pack*	
	(h)	*Beacon labels and markings*	
	(i-i)	*Reference oscillator type and specification*	
	(i-ii)	*Long-term frequency stability (LTS)*	
	(i-iii)	*Technical data for TCXO/MCXOs*	
	(i-iv)	*Report on oscillator ageing*	
	(i-v)	*Serial Number and temperature gradient results (graph, summary and Excel file)*	
	(j-i)	*Design: protection against continuous transmission*	
	(j-ii)	*Design: frequency 5-year frequency stability*	
	(j-iii)	*Design: protection against repetitive self-test*	
	(j-iv)	*Design: self-test default values*	
	(j-v)	*Design: protection against GNSS receiver faulty operation*	
	(k)	*Matching network*	
	(l)	*Antenna cable type and maximum RF-losses*	
	(n)	*GNSS receiver operating cycle and battery current*	
	(n)	*Internal GNSS receiver and antenna data sheets*	
	(o)	*Interface with external navigation device*	
	(p-i)	*External ancillary devices: technical data sheets*	
	(p-ii)	*External ancillary devices: details of electrical connections*	
	(q)	*Description of differences between beacon model variants*	
	E-8	*Check-list*	
	(s)	*Statement on worst-case operating temperature*	
	(t)	*Statement on known non-compliances*	
		[Position Data Encoding:] [Tables F-C.1, F-C.2, F-C.3]	
		[Beacon Coding Software: Tables F-D.1 , F-D.2 and F-D.3]	
		Other	

(date)	*(beacon model)*	*(beacon manufacturer's point of contact for the type approval: name, job title, e-mail address)*	*(signature)*

- END OF ANNEX E -

ANNEX F: REPORTING TYPE APPROVAL TEST RESULTS

F.1 REPORT TEMPLATE

[Cospas-Sarsat Accepted Test Facility]

Report on

Cospas-Sarsat 406 MHz Emergency Beacon Testing of the [Beacon Manufacturer][Beacon type] model "[Beacon Model]" in accordance with C/S T.021

Report Nr. [Reference Nr] – Issue [Issue Nr] *[Date of Issue]*

[Test facility: [Test facility details, contact details, phone, email, www]
Accreditations: [List of National and International accreditations]

Report on: [Beacon type and beacon model number]

Prepared for: [Beacon manufacturer]
[Manufacturer representative (Name, Job title, Contact details)]

Prepared by: [TA specialist in charge of TA-testing: name, job title, contact details]
Approved by: [Test facility TA authority name, job title, signature]
Date of Issue: [Date of the Report Issue]

Dates of testing Submitted for testing:
Start of tests:
End of tests:

History of the report Issue/revisions:

Report Nr – Issue Nr. or Revision Nr.	*Date of Issue*	*Reasons for re-issue*

]

[1. Scope

2. Reference Documents

3. Details of Test samples

Model name
S/Ns of test beacons
P/Ns (Hardware, Firmware, Software)
Description of the test beacon and block diagramme of equipment under test (EUT)
List of ancillary devices: [antennas, remote switches, remote indicators, external buzzer, external navigation interface units, external activators, etc.]
List of test equipment, provided by beacon manufacturer for TA testing
Photos of the EUT with antennas and external ancillary devices subjected to TA-testing
Battery Pack details (composition, cell type, battery pack P/N)
Application details: ANNEX G – Part G.1

4. Type approval testing

Applicable standards and compliance statement: ANNEX G – Part G.2
Statement and details of non-compliances observed during TA testing
Statement and list and description of deviations from standard test procedures
EUT Modifications during TA testing:

Example:

Modification State (Mod State)	*Date of Implementation*	*Reasons for modification*	*Description of modification, HW/FW P/Ns, SW version/release after modification*
0	*20 June 2019*	*-*	*-*
1	*13 July 2019*	*Incorrect first burst delay*	*FW 1.001-02 SW 1.001-x1 HW (no change)*

Modes of EUT operation during TA testing, message encoding, EUT system configuration, Modes of operation of external ancillary devices]

[6. Photographs
Include photographs of:
EUT with antenna deployed
External components
EUT set for SQT (for all antennas in all test configurations)
EUT set for PAT-PAT (for all antennas in all test configurations)
EUT antenna set for Antenna tests (for all antennas in all test configurations)

7. Test Equipment
List of test equipment and calibration dates
Block diagrammes of test setup
Measurement accuracies
Description of measurement methods.

8. Other technical information, which is referred to in the test report
Technical data sheets for devices and components
Results of tests from beacon manufacturer
Other test reports, if applicable

9. Technical data submitted by Beacon manufacturer
Complete Check-List of Technical Data, as per Annex E.8.]

- END OF ANNEX F -

ANNEX G: TYPE APPROVAL APPLICATION FORMS

The type-approval application form and other forms (e.g., Change-Notice form, Quality Assurance Plan, etc.), included in the electronic file:

"C-S_T.021_Annex_E-G_Preliminary_Issue_A_Rev_001.xlsx",

shall be completed, signed and submitted, or, alternatively, this information may be provided using the electronic format and procedures as available on the Cospas-Sarsat website.

If the files are being submitted electronically, the sign-off sheet on page G-2 should accompany the submission.

Click the paper clip for the embedded Excel file:

G.1 INFORMATION PROVIDED BY THE BEACON MANUFACTURER

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

G.2 INFORMATION PROVIDED BY THE COSPAS-SARSAT ACCEPTED TEST FACILITY

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

G.3 BEACON QUALITY ASSURANCE PLAN

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

G.4 CHANGE NOTICE FORM

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

G.5 DESIGNATION OF ADDITIONAL NAME OF A TAC MODEL

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

- END OF ANNEX G -

ANNEX H: RESERVED FOR TECHNICAL DATA

H.1 OVERVIEW

[Proposed new Annex, the intent of which is to provide guidance similar to that provided in Section 5 of document C/S T.007 but be more extensive to include a description of all data items including a more detailed description where required for all data that will be required to be submitted as part of the type approval application. This data will need to be identified in the verification matrix. (An alternative proposal would be to reintroduce a section into the main document that provides this function).]

[This section is under development and it will provide:

- list and details of the documentation to be submitted as part of a type-approval application package;
- reference to section [section 2.4 or ANNEX H -TBC] for technical documentation to be submitted as part of Change Notice application]

[Beacon manufacturers shall 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 required that the technical data shall be provided to the accepted test facility prior to type-approval testing to ensure that appropriate test configurations and test procedures are used.

[The technical data submitted to the Cospas-Sarsat Secretariat shall include the following [this information should be reviewed to avoid duplication of information as the document is developed.]:

a. an application form (ANNEX G, section G.1) for a Cospas-Sarsat type approval, signed by the manufacturer attesting to the technical details of the beacon model as specified, and ANNEX G, section G.1, signed by the Cospas-Sarsat accepted test facility attesting that the beacon was tested in accordance with C/S T.021 and found in compliance with C/S T.018 and/or indicating the observed non-compliances and/or deviations from standard test procedures;

b. photographs of the beacon, with its antenna deployed whilst in all manufacturer- declared operational configurations (e.g., floating in water, resting on ground, placed above ground, held by operator, etc.) and the descriptions of operational configurations;

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-xxx];

d. a list and descriptions of all automatic and manually selectable operating modes, description of beacon working cycle phases and durations, and analysis supported by results of battery current measurements, provided as per [Table F-xxx], that identifies:

   i. the operating mode that draws the maximum battery energy,

   ii. operating modes that have pulse loads greater than in i. above,

   iii. the time interval covering one full beacon working cycle (measurement interval);

e. the beacon-model operating instructions and other owner manuals, if available, and a technical data sheet, describing the:

   i. beacon type and designation,

   ii. beacon model specification;

   iii. typical operating scenarios and limitations with photos/drawings illustrating all beacon operational configurations for all declared antenna(s) deployed,

   iv. beacon system configuration, including connection of [external] [TBD] devices and antennas, if applicable,

   v. methods of beacon activation and beacon/antenna deployment,

   vi. description of self-test mode and GNSS self-test mode, including methods of self-test mode/GNSS self-test mode activation and indication,

   vii. battery replacement instructions and battery replacement period;

f. beacon-model marketing brochure, if available;

g. the technical data sheet for the battery cells used in the beacon model indicating nominal cell capacity and self-discharge rate over the declared battery replacement period, and the electric diagram of the beacon model’s battery pack;

h. copy of the beacon-model markings and labels indicating, as per [C/S T.018 section x.x.x]:

i. beacon-model name, beacon-model manufacturer and the placement for the Cospas-Sarsat TAC number if/when it is issued;

ii. placement for the beacon [15-HEX] ID;

iii. operating temperature range (e.g., -20°C to +55°C);

iv. minimum duration of continuous operation (e.g., 24 hours);

i. the technical information on the reference oscillator and circuitry, including:

i. oscillator type and specifications,

ii. technical data on long-term frequency stability,

iii. technical data sheet for any temperature-compensated oscillator (e.g., TCXO, MCXO) that may be employed, indicating maximum MTS characteristics specified for the oscillator model,

iv. report on the oscillator ageing characteristics,

v. the serial number(s) of the temperature-compensated oscillator device(s) installed in the test beacon(s) that was subjected to conductive testing at a test facility, and MTS characteristics from the reference oscillator manufacturer, if applicable,

vi. a description of the beacon-model circuitry that converts the oscillator frequency to the transmitter output frequency;

j. statements and descriptions, complete with diagrams as necessary, to demonstrate that the beacon-model design:

i. provides protection against continuous 406-MHz transmission; i.e., transmission in excess of the schedule specified in document C/S T.018 (see section A.3.4),

ii. meets the frequency stability requirements over 5 years (see section A.3.5),

iii. provides protection from more than one self-test-mode cycle (and related transmissions) occurring from a single self-test activation by a user, including inadvertent continuous pressure on the self-test activation switch (see section A.3.6),

iv. ensures that self-test messages (except for GNSS self-test) have default values encoded in position fields, at all times and irrespective of the navigation data input (as a further indication to MCCs that the message is a test message and not a real alert message),

v. for location protocol beacon models, provides protection against degradation in beacon 406-MHz performance (including battery depletion) due to faulty operation or failure in operation of internal or external navigation devices and against invalid 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-model power amplifier is 50 ohms and the beacon-model antenna VSWR measured relative to 50 ohms is within a ratio of 1.5:1;
[Comment: Should be certain that this is not duplicative of other sections, and that the 50-ohm specification relates only to the test set-ups, and not a design specification?]

l. for beacon models with separated and/or remote antennas, technical data about the type of antenna cable and the allowed minimum and maximum losses at 406 MHz of the antenna cable assembly;

m. the beacon-model quality assurance plan (see [Annex J]);

n. for beacon models with an internal GNSS receiver, description of the GNSS receiver operation cycle and its functional phases (e.g., boot, status reporting, acquisition attempt, acquisition failure, acquisition re-attempt, acquisition success, data reporting, sleep, wake, position update), including duration and average battery current measured for each phase, and technical data sheet of the internal GNSS receiver and GNSS receiver antenna from the navigation-receiver and antenna manufacturers;

o. for beacon models capable of accepting position data from an external navigation device:

i. specification and description of the interface to the external navigation device,

ii. diagrams showing electrical connections to the beacon and providing details of the external power supply, if any required, for operation of the interface to the external navigation device;

p. for beacon models with [external] devices (e.g. external G-switchs and other activation devices, remote control panels, audio- and light-indicators, S-VDR memory module etc.), and/or when an external power supply is required for beacon operation:

i. technical data sheets, photographs and description for all the [external] [TBD] devices,

ii. schematic diagrams, indicating electrical connections to the beacon and providing details of external power supply;

q. for beacon models with several variants, a comprehensive description of differences between these variants;

r. a complete check-list of technical information provided in support of the type-approval or change-notice application, as per [section F to Annex F];

s. a statement indicating the temperature within the declared operating temperature range, at which the shortest duration of continuous beacon operation is expected and if this is not the minimum operating temperature, a detailed description of this beacon-model design feature; and

t. a statement and description of all known non-compliances.]

H.2 INSPECTION OF EVIDENCE

[Proposed T.021 Annex G additions- this is what the beacon manufacturer documentation will have to address for Inspection of Evidence to occur.

R. listing	*Manufacturer supplied Documentation Topics for C/S Inspection*
1080	*encoded locations from a GNSS receiver are encoded in the beacon message.*
1090	*indication that there is no encoded location in the beacon message.*
1100	*if default locations are encoded in the beacon message when there is no GNSS provided location.*
1110	*beacon complies with all provisions of T.018 section 4.5.5*
1120	*beacon complies with all provisions of T.021 section 3.*
1130	*ELT(DT) has an internal navigation device.*
1140	*ELT(DT) has an interface to an external navigation device.*
1150	*ELT(DT) will continue to send transmitted bursts with default locations when the internal or external navigation device fails.*
1160	*Check this matrix calls for IE*
1170	*Check this matrix calls for IE or AE*
1180	*Check this matrix calls for IE or AE*
1190	*a cold start at every beacon activation*
1200	*location accuracy requirement for horizontal location is addressed for a clear sky situation.*
1210	*accuracy requirement for altitude is addressed for a clear sky situation.*
1220	*compatibility with ITRS.*
1230	*difference between refence frame and ITRS*
1240	*indication of the potential error in location in terms of HDOP and VDOP*
1250	*DOP information message bit location*
1260	*indication of type of fix*
1270	*type of fix information bit location In the message*
1280	*none*
1290	*none*
1300	*provide the first appearance of an encoded location in the message within a set time period with a probability.*
1310	*none*
1320	*capability to acquire fresh position information prior to every 406 MHz transmission (unless this becomes impractical due to navigation signal constraints)*
1330	*check matrix calls for IE*
1340	*encodes the latest position obtained within less than 1 second prior to each burst into that transmission.*
1350	*none*
1360	

R. listing	*Manufacturer supplied Documentation Topics for C/S Inspection*
1370	
1380	
1390	*none*
1400	*check matrix calls for IE*
1410	*address if the GNSS receiver is enabled prior to each transmission (may be removed)*
1420	*design of the beacon keeps the GNSS receiver enablesd for up to 90 seconds prior to each transmitted burst.*
1430	*if the design of the beacon keeps the GNSS receiver on for at least 3 minutes when two burst have occurred without the receiver providing a location*
1440	*Global operation capability and et hdatum conforms to international standard the*
1450	*description of self test functionality that will prevent erroneous daat from being encoded into the message*
1460	*description of functionality to prevent locations from being encode unles minimum performance criteria are met*
1470	*provision for cold starts on initial activation.*
1480	*type of start in subsequent activstions or in between activations*
1490	*accuracy requirement for horizontal location is addressed for a clear sky situation.*
1500	*accuracy requirement for altitude is addressed for a clear sky situation.*
1510	*compatibility with ITRS.*
1520	*difference between the utilized format and the ITRS with its reference frames.*
1530	*beacon provides some indication of the potential error in location in terms of HDOP and VDOP*
1540	*provides the HDOP information in bits 32-35 and VDOP information in bits 36-39 of rotating field #0 in the digital message.*
1550	*whether the fix type information is provided.*
1560	*determine whether the fix type is encoded into the digital message in bits 45-46 of rotating field #0.*
1570	*none*
1580	*none*
1590	*design of the beacon keeps the GNSS receiver on for at least 90 seconds.*
1600	*the design of the beacon keeps the GNSS receiver on for at least 3 minutes when two burst have occurred without the receiver providing a location*
1610	*the beacon will acquire fresh position information prior to every 406 MHz transmission (unless this becomes impractical due to navigation signal constraints) for the entire operating lifetime of the ELT (DT)*
1620	*beacon encodes the latest position obtained within less than 1 second prior to each burst into that transmission*
1630	*check matrix has IE*

R. listing	*Manufacturer supplied Documentation Topics for C/S Inspection*
1640	*check matrix has IE*
1650	
1660	
1670	*check matrix has IE*
1680	
1690	*whether the beacon provides some indication of the potential error in location in terms of HDOP and VDOP*
1700	*whether the beacon provides the HDOP information in bits 32-35 and VDOP information in bits 36-39 of rotating field #0 in the digital message.*
1710	*whether the fix type information is provided.*
1720	*if the fix type and altitude information is in the proper bit locations.*
1730	*whether the altitude is transmitted in a 3D location.*
1740	*whether the fix type is encoded into the digital message in bits 45-46 of rotating field #0.*
1750	*the accuracy requirement for horizontal location from an external GNSS receiver is addressed for a clear sky situation.*
1760	*accuracy requirement for altitude is addressed for a clear sky situation.*
1770	*with a clear sky, the unit will transmit an encode location with 3 seconds.*
1780	*in the first 30 minutes after activation, the beacon will always transmit the latest horizontal location and altitude information.*
1790	*external navigation device shall provide an updated horizontal location and altitude at least every one second.*
1800	*update the horizontal location and altitude immediately prior to the next scheduled transmission burst shall be encoded and transmitted by the beacon within 1 second of receipt.*
1810	
1820	
1830	
1840	
1850	
1860	
1870	
1880	

- END OF ANNEX H -

ANNEX I: SAMPLE OF COSPAS-SARSAT TYPE-APPROVAL CERTIFICATE

TYPE APPROVAL CERTIFICATE

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

Certificate Number: …xxx

Manufacturer:	The ABC Beacon Company, Montreal, Canada
Beacon Type(s):	EPIRB
Beacon Model(s):	ABC-406
Test Laboratory:	*AnyLab*, Canada
Date of Test:	March 2019

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.018 Specification for Second-Generation Cospas-Sarsat 406-MHz Distress Beacon
Issue 1 – Rev. 2, February 2018

C/S T.021 Cospas-Sarsat Second-Generation 406-MHz Distress Beacon Type Approval Standard
Issue 1, *Dated TBD*

Date Originally Issued: 1 March 2019
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.
6. This certificate authorizes the use of the registered name mark "Cospas-Sarsat" and of registered trademarks for the Programme's logos, for labelling, instruction materials, and marketing of the 406-MHz beacon model identified, but not for other marketing or sales purposes (i.e., not for general uses beyond this specific beacon model).

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 Center Frequency: 406.050 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 1000 ms
- Optional GNSS Self-Test (limited to X times over the life of the battery)
- Cancellation Sequences (limited to Y times over the life of the battery)

Approved Beacon Message Parameters: Beacon is approved for encoding with the message parameters indicated with "Yes" and black text listed below:

BEACON TYPE		VESSEL IDs		ROTATING FIELDS	
No	ELT	**Yes**	**No Aircraft or Vessel ID**	**Yes**	**#0: C/S G.008 Objective Requirements**
Yes	**EPIRB**	**Yes**	**Maritime with MMSI**	No	#1: ELT(DT)
No	PLB	**Yes**	**Radio Call Sign**	No	#2: RLS
No	Spare	No	Aircraft Registration Marking (Tail Number)	No	#3: National Use
		No	Aircraft 24-bit Address	No	#4 to #14: Spare
		No	Aircraft Operator and Serial Number	**Yes**	**#15: Cancellation**
		No	Spare		
		No	Spare		

- END OF ANNEX I -

ANNEX J: CHANGES TO TYPE APPROVED BEACONS

The contents of this Annex have been cut and paste into this draft document from the corresponding section in document C/S T.007. The text has been made red, and will need to be reviewed and modified to align with this document.

J.1 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 of the change 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. The results of factory tests 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. Test results shall be submitted as described in section 4.7.]

J.2 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.

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 test data, as per section 4.7, confirming that the substitute battery is at least technically equivalent to that used when the beacon was type approved. The beacon manufacturer shall submit technical information per Section 5, items "a" (part G.1 only), "c", "d", "e " (item' vii' only), "g", "k", "m" and "r".

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.]

J.2.1 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);

d. re-calculations and analysis of EIRPEOLmin/max for all approved 406 MHz antenna models, based on results of the original type approval testing (sections B.10.3 and B.10.4) (only if beacon output power and / or EIRPLOSS have changed by more than 0.5dB compared to the original type approval test results); and

e. satellite qualitative test (section A.2.5), in a single configuration only.]

J.2.2 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 (section A.2.3); and

c. re-calculations and analysis of EIRPEOLmin/max for all approved 406 MHz antenna models, based on results of the original type approval testing (sections B.10.3 and B.10.4) (only if beacon output power and/or EIRPLOSS have changed by more than 0.5dB compared to the original type approval test results); and

d. satellite qualitative test (section A.2.5), in a single configuration only.]

J.3 INTERNAL NAVIGATION DEVICE

J.3.1 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 temperature (section A.2.1), excluding Transmitted Frequency tests;*

b. *operating current measurements and analysis demonstrating that the load on the battery of beacon without the internal navigation device is not greater than the load measured for the beacon model variant with the internal navigation device.*

c. *beacon coding software test, which may also be performed by the beacon manufacturer; and*

d. *the satellite qualitative test (section A.2.5), in a single configuration only.*

The beacon manufacturer shall provide detailed description of differences between variants with and without an internal navigation device.

For the variant without the internal navigation device, the beacon manufacturer shall submit technical information per Section 5, excluding items "a" (part G.2), "n" and "o".]

J.3.2 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.

Beacon manufacturer shall submit technical information per Section 5, excluding items "a" (part G.2), "i", "j (i-iii)", "n" and "o".]

J.4 INTERFACE TO EXTERNAL NAVIGATION DEVICE

J.4.1 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 and functional tests (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);*
- e. *re-calculations and analysis of EIRPEOLmin/max for all approved 406 MHz antenna models, based on results of the original type approval testing (sections B.10.3 and B.10.4) (only if beacon output power and / or EIRPLOSS have changed by more than 0.5dB compared to the original type approval test results); and*
- f. *satellite qualitative test (section A.2.5).*

In addition, the beacon manufacturer shall also provide technical data sheets describing the navigation interface unit and technical information as per Section 5, excluding items "a" (part G.2), "h", "i", "k", "l" and "n".]

J.4.2 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.

For the modified beacon, the beacon manufacturer shall submit technical information per Section 5, excluding items "a" (part G.2), "h", "i", "j (i-iii)", "k", "l", "n".]

J.5 CHANGES TO FREQUENCY GENERATION

J.5.1 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.

In both cases described in this section 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, in accordance with section 4.7; 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.]*

J.5.1.1 Oscillator Replacement (Oscillator Tuning)

[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).]*

J.5.1.2 Oscillator Replacement (Same Type)

[In the case of oscillator replacement with an identical oscillator[30] *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).]*

[30] 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.

J.5.2 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 synthesiser), 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);*

e. *oscillator ageing and MTS analysis (section A.3.5);*

f. *re-calculations and analysis of EIRPEOLmin/max for all approved 406 MHz antenna models, based on results of the original type approval testing (sections B.10.3 and B.10.4) (only if beacon output power and / or EIRPLOSS have changed by more than 0.5dB compared to the original type approval test results); and*

g. *satellite qualitative test (section A.2.5).*

The beacon manufacturer shall submit technical data per Section 5, indicated in items "a" (part G.1 only), "c", "d", "i", j(ii)," k"," m", "q" and "r".]

J.6 ALTERNATIVE MODEL NAMES FOR A TYPE APPROVED BEACON

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

The beacon manufacturer shall also submit technical data per Section 5, items "a" (part G.1 only), "e", "f", "h", "m" , "q" and "r".]

J.7 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 test results as appropriate. The scope of the testing and the required technical data will be determined by Cospas-Sarsat Secretariat, following consultation with the manufacturer and the test facility after a review of the proposed 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).]

J.8 CHANGE OF BEACON MANUFACTURER

[In case of a transfer of ownership / manufacturing rights for the type-approved beacon model to another organisation, or a change of beacon manufacturer's name, an official letter shall be submitted to the Secretariat indicating:

a. *nature of and date for the expected change;*

b. *the list of type-approved production and discontinued beacon models to be transferred (or rebranded);*

c. *indication of what organisation will be responsible for beacon production, maintenance of production standards, quality assurance, technical maintenance, repairs, battery replacement, customer support, and market distribution of the beacon model (not applicable for name change only);*

d. *whether a re-issue of type approval certificates in the name of new owner (or new company name) and changes to information published on Cospas-Sarsat website are required;*

e. *whether a revision of beacon manuals, marketing brochures and beacon labels is planned;*

f. *any new points of contact for beacon engineering, type approval and customer care.*

For each beacon model concerned, the new beacon manufacturer shall also complete and submit Annex H and technical data per Section 5, items "a" (part G.1 only), "e", "f", "h", "m" , "q" and "r".]

J.9 ADDITIONAL VARIANTS AND TYPES OF MESSAGE PROTOCOLS [31]

[In cases when an additional variant of an earlier type approved type of message protocol is added, beacon manufacturer or an accepted test facility shall perform and submit results of the beacon coding software test.

In cases when an additional, not earlier approved type of message protocol is added, the modified beacon encoded with a variant of a new protocol type shall undergo at a Cospas-Sarsat accepted facility the following testing:

a. navigation system tests (section A.3.8), if applicable;

b. operating current measurements and analysis demonstrating that none of the currents recorded in Table F-E.1 are more than 1% greater than those measured prior to making the modification (which may be performed by the beacon manufacturer);

c. the operating lifetime test at minimum temperature (or a calculation demonstrating that with the increased current the beacon will still meet the lifetime requirement), if the results of the measurements and analysis in b) show an increase in current;

d. beacon coding software test, which may be performed by the beacon manufacturer; and

e. the satellite qualitative test (section A.2.5), in a single configuration only.

Beacon manufacturer shall complete and submit Annex H and technical data per section 5, items "a" (part G.1 only), "d", "j(iv)", "j(v)" (if applicable), "m", "n", "o" (if applicable), and "r" and only if there are changes to the items "e" and "n".]

[31] Types of message protocol are defined as either User Protocol, User-Location Protocol, Standard Location Protocol, National Location Protocol or RLS Location Protocol and variants of a message protocol are additional protocols within one of the above types of message protocol.

J.10 ALTERNATIVE ANTENNAS

[In cases of beacon modification to include an alternative antenna, such beacon shall undergo at a Cospas-Sarsat accepted facility the following testing:

a. antenna tests (Annex B) in all declared configurations;

b. transmitter power output level at ambient temperature (section A.3.2.2.1);

c. satellite qualitative test (section A.2.5).

Beacon manufacturer shall complete and submit Annex H and technical data per Section 5, items "a" (part G.1 only), "b", "e", "f", "k", "l", "m", "q" (if applicable), and "r".]

- END OF ANNEX J -

ANNEX K: REQUEST FOR ADDITIONAL TYPE APPROVAL CERTIFICATE NUMBER(S)

K.1 REQUEST FOR ADDITIONAL TAC

In the case that additional serial numbers are required to encode a unique identification within the SGB message, the manufacture shall submit a request (by email to tasubmisssions@cospas-sarsat.int or through the website system) to the Cospas-Sarsat Secretariat that includes:

a) Manufacturer;

b) a request for an additional TAC number;

c) TAC number of the original type approval;

d) the TAC number(s) and associated model name(s) of beacons which are currently in production;

e) the date at which the depletion of the available serial numbers is anticipated;

f) declaration that the design is unchanged from the approved model(s) and that the Quality Assurance Plan remains valid for the beacon models to be manufactured under newly requested TAC(s), or, if modifications to the approved beacon model(s) has occurred, provide forms:

   i. G.1 Type Approval Application Form

   ii. G.3 Beacon Quality Assurance Plan,

   iii. G.4 Change Notice Form, or

   iv. Submit a full change application as described in ANNEX J

K.2 REQUEST FOR ADDITIONAL BLOCK OF TACS

In the case that an additional block of TACs are required to encode a unique identification within the SGB message, the manufacture shall submit a request (by email to tasubmisssions@cospas-sarsat.int or through the website system) to the Cospas-Sarsat Secretariat that includes:

a) Manufacturer;

b) a request for an additional block of TACs;

c) in the case of a block TAC request, the production rate of the associated beacons:

   i. over the previous six months (if available),

   ii. anticipated over the next three, six, and twelve months;

d) TAC number of the original type approval;

e) the TAC number(s) and associated model name(s) of beacons which are currently in production;

f) the date at which the depletion of the available serial numbers is anticipated;

g) declaration that the design is unchanged from the approved model(s) and that the Quality Assurance Plan remains valid for the beacon models to be manufactured under newly requested TAC(s), or, if modifications to the approved beacon model(s) has occurred, provide forms:

   i. G.1 Type Approval Application Form

   ii. G.3 Beacon Quality Assurance Plan,

   iii. G.4 Change Notice Form, or

   iv. Submit a full change application as described in ANNEX J

h) Blocks of TACs will be assigned by the Secretariat in an effort to accommodate between a three- and six-month supply of serial numbers based on actual production history and anticipated future production, as declared by the manufacturer.

- END OF ANNEX K -

ANNEX L: COMPLIANCE VERIFICATION MATRIX

L.1 COMPLIANCE MATRIX DEFINITIONS

This Compliance Matrix (Annex L.2) is intended to list each and every requirement within document C/S T.018 and map them to methods of compliance evaluation for inclusion within document C/S T.021 for each requirement.

There is a number of established methods of evaluation for demonstrating compliance with a range of requirements. In order alleviate any possible confusion, the definitions of each method as used herein are defined below. It should be noted that many requirements involve more than one method of evaluation being employed together (e.g. Test and Measurement).

L.1.1 Test

A procedure intended to establish the quality, performance, or reliability of the stated parameter of the beacon. Examples – Correct activation of the beacon self-test function, Assessment of the beacons output power under defined conditions.

L.1.1.1 Test – Measurement

During a 'Test' the action of ascertaining the size, amount, or degree of something by using an instrument or device marked in standard units. Example – Measurement of the output power of a beacon in dBm.

L.1.1.2 Test – Observation

The act of examining something aurally or visually to determine if said item meets certain criteria. Example – Did the light come on or not? (usually observation requires a simple Yes / No answer).

L.1.2 Inspection of Evidence

The act of examining relevant documents to determine if said items meet the defined requirements (this may include items such as user manuals, design justifications, manufacturers data sheets, schematic diagrams etc., as described in Annex G.1). Example – Does the content of the User Manual adequately describe the method of beacon operation?

L.1.3 Analytical Evaluation

The detailed examination and or analysis of something to ensure that it meets the stated criteria, this may for example involve a mathematical manipulation of various items of data or it may require the making of a judgment by a relevant expert about the usability or conformance of something that isn't defined by specific set limits. Examples – Calculation of battery pre-discharge criteria or assessment of a means to prevent inadvertent activation.

L.1.4 Similarity

Similarity may be used to demonstrate the compliance of Beacons within the same Beacon Model Family where the basic electrical and mechanical design and performance of the beacons is the same and the only differences are the additions or deletions of certain features or functionality of one beacon model compared to another. In such cases either a comparison of the two designs by a suitably qualified individual or a limited amount of retesting of the difference(s) between the designs is all that is required to demonstrate compliance of the similar beacon.

L.2 COMPLIANCE VERIFICATION MARTIX

[To be supplied based on the working excel file version of this matrix when deemed appropriate by the participants. Click the paper clip for the current version of the embedded Excel file.]

- END OF ANNEX L -

- END OF DOCUMENT -

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