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

C/S T.021

Issue 1 – Revision 5

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Until the Cospas-Sarsat Council has declared that SGBs can reliably be used in the System, the Programme will only issue type-approval certificates valid for test protocols.

Beacon manufacturers and test facilities shall ensure that all the protocols subsequently expected to be type approved for a beacon, including the related test protocols, are tested.

The Cospas-Sarsat Secretariat will re-issue type-approval certificates to manufacturers of such beacons, to be valid for all protocols which had been previously type-approval tested, once the Council has declared that SGBs can be successfully used in the System.

This procedure was approved by Council and communicated to all interested parties, by way of Council letter CS18/151/F400/F500 dated 10 August 2018.

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

HISTORY

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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).

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.

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 Brand Variant: A beacon brand 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 brand 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.

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[*] 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.

For reports published on the web, Cospas-Sarsat will assign a unique TAC number to each approved beacon model which for SGBs will have a “1” as a dash number suffix, and a decimal suffix number to identify the Cospas-Sarsat approved modification state of that beacon model design. Thus, the unique representation of the beacon model would be provided in the form:

TAC NNNNN-M.m

Where:

NNNNN is a five-digit TAC number (9,999 to 65,535),
M equals “1” for SGBs, and
m is an integer number indicating a Cospas-Sarsat approved modification (0, 1, 2, …)

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.

[*] 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 9,997	Reserved for FGB beacons: to ensure no duplicate TAC numbers are assigned to SGBs.
9,998 and 9,999	Allocated for SGB Type Approval Testing
10,000 to 11,999	Allocated to PLB Design Certification TACs and Production Extension TACs, with 11,700 to 11,999 allocated to PLB LoCs
12,000 to 13,999	Allocated to EPIRB Design Certification TACs and Production Extension TACs, with 13,700 to 13,999 allocated to EPIRB LoCs
14,000 to 15,999	Allocated to ELT Design Certification TACs and Production Extension TACs, with 15,700 to 15,999 allocated to ELT LoCs
16,000 to 17,999	Allocated to ELT(DT) Design Certification TACs and Production Extension TACs, with 17,700 to 17,999 allocated to ELT(DT) LoCs
18,000 to 65,520	Reserved for future use
65,521 to 65,535	Reserved for System beacons (see document C/S T.022)

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* 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† 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 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.

* Or a Letter of Compatibility, as described in section 2.2.2.
† These beacons are described in section 4.3.

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 G, Part G.6.

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 39,999 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 40,000 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 G.4) of any modifications to the design or changes during production of the beacon, power source, or external devices specific to beacon operation forming part of the nominal system configuration (e.g., remote control panel, programming adaptors, etc.), as described in this section and/or in Annex J. All tests for demonstrating the performance of modified beacons shall be conducted at a Cospas-Sarsat accepted test facility except as provided for in this document.

2.4.1 Defined Changes

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

The beacon manufacturer may consult with the Secretariat through a pre-consultation application to review the scope of defined changes, if desired.

2.4.2 Undefined Changes

If a modification is not covered by ANNEX J, then it shall be considered an undefined change, and the process described in this section applies.

The beacon manufacturer may choose to perform a complete re-test and submit a full type-approval application to support any modification(s). If the undefined change includes non-standard functionality, then section 5 of this document would also apply.

Alternatively, a pre-application consultation may be conducted to bound the required scope necessary to support the approval of the change. This pre-application submission must include a description of the change and may also include a proposed test scope and compliance validation procedures.

The Secretariat will review the pre-application submission and determine the particulars of data items to support the application, test scope and compliance validation procedures in consultation with the beacon manufacturer, the test facility, and Parties, as appropriate.

2.4.3 Minor Changes

Minor changes or modifications to an approved beacon are defined as those changes that do not require notification to the Cospas-Sarsat Programme, as determined by the beacon manufacturer, according to the criteria defined in this section and/or as described in ANNEX J.9.

Minor changes or modifications to an approved beacon shall be assessed by the beacon manufacturer to determine their impact on the beacon performance as defined in document C/S T.018.

If the assessment indicates that beacon performance will be affected then the manufacturer shall carry out tests to determine the extent of the impact of the change.

The manufacturer shall establish a baseline for the performance of the beacon prior to implementation of the change. The manufacturer shall then compare the results of the modified beacon performance with the unmodified baseline performance and the previous testing at an Accepted Test Facility. If the performance of the baseline and modified beacon varies by more than the measurement uncertainty for any of the parameters defined in document C/S T.008, Table B-1, "Measurement Uncertainty Requirements for Type-Approval Testing of 406-MHz Beacons Compliant with Document C/S T.018", then the change is not considered minor and falls under section 2.4.2 of this document. If, however, the results are within the measurement uncertainty and do not exceed the limits specified in documents C/S T.018 and C/S T.021, then the change is considered minor and there is no requirement to notify the Programme. If there is a substantial difference between the most-recent applicable Type-Approval Test results and the unmodified baseline unit test results, further analysis and investigation is required to reconcile any differences. The manufacturer must retain records of assessment, analysis and testing for future review by the Programme, as required.

2.4.4 Additional Type Approval Certificate Numbers

Cospas-Sarsat production extension TAC numbers are TAC numbers in the ranges described in Table 2.1 (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 Extension TACs 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 -

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[*]. If applicable, the antenna-matching 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.

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[*] 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.

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 4.8.

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 centre (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 G, Part G.6.

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* 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).

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

* 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.

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*,
- 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 M* 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

Except for ELT(DT)s, 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.

* ANNEX M is still under development. It will be based upon document C/S T.007 Annex E and will be provided by JC-36. Beacon manufacturers wishing to obtain type approval for an SGB with a voice transceiver prior to the issue of Annex M shall consult the Secretariat for guidance, prior to commencing type approval tests.

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

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, as defined in section 4.5.14 of document C/S T.018, that is used to power the main beacon electronics when it is in the ON or ARMED mode of operation, as defined in section 4.5.6.1 of document C/S T.018, the beacon shall be tested as per section A.2.10.

For ELT(DT)s where tests refer to the beacon under test being ‘off’ or ‘deactivated’ or being ‘turned on for 15 minutes prior to the start of a test’, these conditions shall be taken to mean that the ELT(DT) is in its ARMED mode of operation.

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.

5.6 Testing of Beacon Models with Programming Adaptors

The Programming Adapter shall be submitted for type approval along with the Beacon Model and shall be tested in accordance with the requirements for Programming Adapters in C/S T.021. Upon successful completion of the type approval process, the Programming Adapter will be allocated its own unique TAC Number (for use when coupled with one beacon model) in accordance with C/S T.021.

- 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

Testing in section A.2 of this document may be performed in any convenient sequence. However, for ELT(DT)s test A.2.10 shall be performed prior to performing any other tests in section A.2. 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 - Message Content Values and Results Reference

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.11.1.2.6 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.1-2.

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). For navigation tests conducted with a GNSS simulator in a test chamber a test set up that approximates as closely as possible the SN-ON configuration should be used for all tests. 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*, SN-ON‡, SN-AV†	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-Dry	SN-ON and SN-LP-Wet‡
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 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.

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* 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.
‡ In the SN-LP-Wet configuration only test B.14.2.4 shall be performed using the Open-Air test method.

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

The beacon shall be placed in the centre of a thin 27cm diameter non-magnetic highly electrically conductive (i.e., with a conductivity of $>3 \times 10^7$ S/m) (e.g., copper or aluminium) metal disc 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 diameter non-magnetic highly electrically conductive (i.e., with a conductivity of $>3 \times 10^7$ S/m) (e.g., copper or aluminium metal disc 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

The SN-LP test configuration is exactly the same as the SN-ON configuration in A.1.4.2, apart from the inclusion of a thin plastic container which is placed directly on the 27cm diameter metal disc into which the PLB (or the PLB remote antenna) is placed (for further details on this test configuration see B.11.1.2.8 b)). This test configuration can be used both "dry" and "wet" as defined in Table A-1.2. When "wet" the PLB shall be sprayed with water as defined in B.11.1.2.8 b).

A.1.5 Test Results Pass / Fail Criteria

The tests defined in A.2.1, A.2.2, A.2.3, A.2.4 and A.2.10.2.1 and their related parts of Annex B will result in many thousands of individual test results for each of the main beacon electrical parameters being tested. It is generally expected that all of these results will be within specification, but there may be some exceptions. For results that are near the specification limit, measurement uncertainty may be applied, as specified in A.1.1. Results that are still outside specification shall be treated as follows:

1) For each individual test in Annex B (e.g., EVM at Constant Ambient Temperature), compute the number of results that are outside of specification, if these are less than 0.1% of the total, proceed to step 2 below, if they are more than 0.1% of the total then the

beacon is considered to have failed that test and the Secretariat and beacon manufacturer shall be consulted on how to move forward.

2) For results where less than 0.1% of the total are out of specification, the applicable test shall be repeated. If the results of the second test are:

   a. now all in specification then testing proceeds as normal,

   b. if more than 0.1% of the total are now out of specification then the beacon is considered to have failed that test and the Secretariat and beacon manufacturer shall be consulted on how to move forward,

   c. if less than 0.1% of the total are still out of specification then, the results that are out of specification from the first and second test shall be compared to see if they are random or repeatable (that is, did they occur on the same bursts and in the same places within a burst):

      i. if the out of specification results are not random (i.e. they repeatedly occur on the same burst and / or at the same point within a burst), then the beacon is considered to have failed that test and the Secretariat and beacon manufacturer shall be consulted on how to move forward,

      ii. if the out of specification results are random in nature (occurring infrequently on different bursts and / or at different points within a burst) then testing proceeds as normal.

If there are any concerns related to whether testing should continue or not then the test facility shall seek advice from the Secretariat and beacon manufacturer before proceeding.

All out-of-specification results shall be documented within the test report together with details of any repeated tests and a justification for continuing with type approval testing.

A.1.6 Repetitive Rapid Testing

It has been noted that the beacon under test may possibly overheat, if it is repeatedly activated in quick succession for short periods of time, such that it almost continuously produces bursts every 5 seconds. This could possibly occur during some tests, such as those in parts of B.11 and B.14. It is thus recommended that a cooling down period of 5 minutes should be allowed between any repetitive tests.

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. Normal Sequence: 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. Self-Test Sequences: 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. B.1;

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 burst transmission interval, 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.

The VSWR test, per para B-9[†] 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 - Normal Sequence,
Annex E.1-2 - A.2.1 - Self-Test Sequences,
Annex E.1-3 - A.2.1 - VSWR,
Annex E.2-1 – Constant Temperature Test Details (Normal Sequence)
Annex E.2-2 – Constant Temperature Test Details (Self-Test Sequence)

[*] The message content is as defined in Annex C.
[†] The message sequence in this section does not apply to this test. Testing is per the procedure in the section referenced.

Annex E.2-3 – Constant Temperature Test Details (VSWR)
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[*] after the beacon activation to measure the following parameters:

a) transmitter power output, per para. B.1;

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 burst transmission interval, per para B.7; and

f) message structure and content, per para B.6 and B.8.

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.3-1 - 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.4.5.1/R.0740
T.018/S.4.5.1.1/R.0750
T.018/S.4.5.1.1/R.0760

[*] 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).

T.018/S.4.5.3/R.0800
T.018/S.4.5.3/R.0810
T.018/S.4.5.3/R.0820
T.018/S.4.5.3/R.0830
T.018/S.4.5.6/R.1910
T.018/S.4.5.6.1/R.1930
T.018/S.4.5.7/R.1990
T.018/S.4.5.7.1/R.2025
T.018/S.4.5.15.5/R.2370
T.018/S.4.5.15.6/R.2380
T.018/S.4.5.16.8/R.2570
T.018/S.4.5.16.9/R.2590
T.018/S.4.5.16.9/R.2600

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. B.1;

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 burst transmission interval, 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 Elapsed Time Since Activation for ELT(DT)s) 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[*]. 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,

[*] 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 Annex E.6-1 and pre-test battery discharge calculations reported in the format of Annex E.6-2.

ii. the average current drain resulting from 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:

1. all radio locating signals do not begin transmitting for at least 30 seconds after beacon activation; and
2. 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.

For an ELT(DT) not designed to withstand a crash or not combined with an Automatic ELT (i.e., an ELT(DT) that is only required to have a minimum duration of continuous operation of 370 minutes) the Operating Lifetime at Minimum Temperature test shall continue beyond the minimum duration of 370 minutes until the ELT(DT) no longer meets specification as defined in this section (A.2.3.2 parts a), b), c), and d)) in accordance with the requirements of C/S T.018 section 4.5.1.

For an ELT(DT) specifically designed to withstand a crash, the test facility shall review the justification provided by the beacon manufacturer related to which period of time prior and after crash sensor activation shall be applied in order to maximize the battery energy consumption during the test. In any case, duration of the worst-case (in-flight distress tracking mode) beacon operation prior to the crash sensor activation shall be at least 10 minutes and a maximum of 370 minutes. The justification for the selected testing configuration shall be included in the test report.

For an ELT(DT) combined with an Automatic ELT, the test facility shall operate the beacon in the worst-case ELT(DT) mode for 370 minutes and in the worst-case Automatic ELT mode for the remainder of the test (at least an additional 24 hours).

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.4-1 - Op Life,
Annex E.4-2 - Operating Current, and
Annex E.4-3 - 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.4.2.2/R.0690
T.018/S.4.5.16.4/R.0745
T.018/S.4.5.15.3/R.2362
T.018/S.4.5.15.3/R.2462
T.018/S.4.5.16.4/R.2470
T.018/S.4.5.16.4/R.2490

For ELT(DT)s combined with Automatic ELTs, this test shall be carried out twice, once using the relevant ELT(DT) test conditions and then using the relevant Automatic ELT test conditions (both temperature class and ramp rate).

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. B.1;

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

c) chip characteristics, per para B.3;

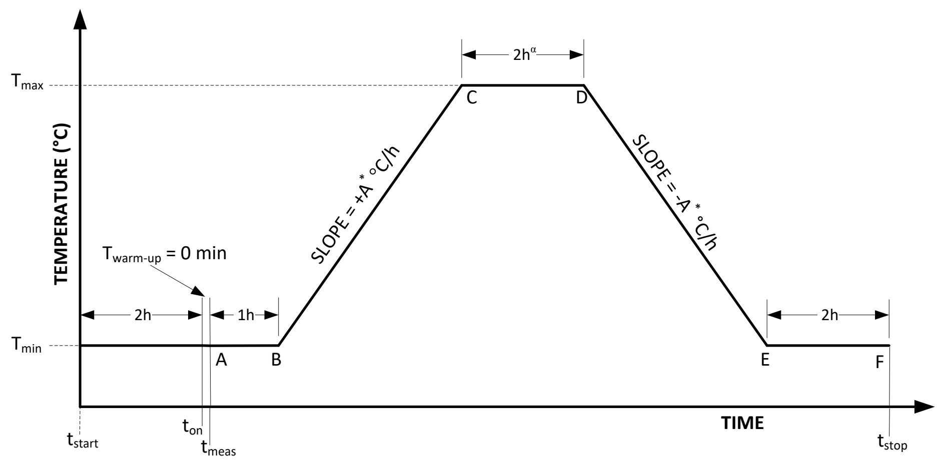
d) EVM, per para B.4;

e) first burst delay and burst transmission interval, per para B.7 (except self-test);

f) message structure and content*, per para B.6 and B.8; and

* The message content is as defined in ANNEX C.

Measurements shall start immediately after beacon activation.
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. Prior to starting the down-ramp at 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. For ELT(DT)s the time between C and D on the down-ramp test is one hour.



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_{start}	=	test start time (overall and up-ramp tests)
t_{stop}	=	test stop time (down-ramp and overall tests)
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 (45°C/hour for ELT(DT))
A^*	=	5°C/hour for Class 1 and Class 2 (33°C/hour for ELT(DT))
α	=	For ELT(DT)s the time between points C and D is reduced on the down-ramp test to one (1) hour.

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

For ELT(DT) s designed to withstand a crash and ELT(DT)s combined with an Automatic ELT the Frequency Stability with Temperature Gradient Test shall be run as one continuous test from Point A to Point F in Figure A.1 (which will exceed 370 minutes by a minimum of 200 minutes).

During the Frequency Stability with Temperature Gradient Test the functioning of the ELT(DT) in the "in-flight" mode of operation shall be monitored to ensure that the ELT(DT) continues to

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

function in the same way after 370 minutes of operating time as it did before the 370-minute limit was reached (without activating the crash sensor).

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.5-1 - 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.

A.2.5 Satellite Qualitative Test

The purpose of the on-air Satellite Qualitative test (SQT) is to validate the compatibility of signals transmitted by a Cospas-Sarsat 406-MHz beacon and the transmitted message structure with the Cospas-Sarsat operational System Space- and Ground-segment elements (LUTs and MCCs).

Satellite Qualitative Tests are required as part of the type-approval testing at an accepted test facility, and, as part of type-approval testing associated with modification of an earlier type-approved beacon where required in Annex J.

A.2.5.1 Requirement

T.018/S.4.1/R.0682
T.018/S.4.1/R.0684
T.018/S.4.5.9.3/R.2170
T.018/S.4.5.9.3/R.2180

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.1.17). 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 RLS indication is readily and clearly visible to the user in direct sunlight, at a distance of 1 meter from the beacon, when the beacon is operated in all declared operational configurations.

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, with the beacon being placed in its normal armed state between each test period 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.

e) The RLS indication is readily and clearly visible to the user in direct sunlight, at a distance of 1 meter from the beacon, when the beacon is operated in all declared operational configurations.

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, including the correct beacon 23-Hex ID for greater than 90% of the bursts transmitted during the total test time;
b) The encoded location provided by the MEOLUT for each alert in a) above for which a complete beacon message was correctly decoded shall be accurate in the horizontal plane to within 30 metres for greater than 95% of the alerts; and
c) The encoded location provided by the MEOLUT for each alert in a) above for which a complete beacon message was correctly decoded shall be accurate in the vertical altitude to within 50 metres for greater than 95% 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.6-1 - 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.7-1 - 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.

This test shall be performed in the test configurations and environment(s) defined in section A.1.4. The actual test configuration depends on whether an Open Air test method or a GNSS Simulator / Test Chamber test method is being used.

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 B.14, 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.8-1 - Navigation System, and
Annex E.8-2 - 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
T.018/S.4.5.15.2/R.2350
T.018/S.4.5.16.2/R.2400
T.018/S.4.5.16.2/R.2410
T.018/S.4.5.16.2/R.2420
T.018/S.4.5.16.2/R.2425
T.018/S.4.5.16.2/R.2426
T.018/S.4.5.16.2/R.2430
T.018/S.4.5.16.2/R.2440

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 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 138-140 of the Main Message Field.

The content of Bits 42 and 43 in the Main Message Field shall be verified to ensure the following:
a) that for a beacon without RLS capability, as declared by the manufacturer in their C/S T.021 Annex G.1 application, that Bit 42 is always set to ‘0’;
b) that for a beacon with RLS capability, as declared by the manufacturer in their C/S T.021 Annex G.1 application, that Bit 42 is set to ‘1’ when the RLS capability is enabled and the beacon is transmitting the RLS Rotating Field, and that Bit 42 is set to a ‘0’ when the RLS capability is not enabled and the beacon is not transmitting the RLS Rotating Field;
c) that for normal beacon operation in all beacons, that Bit 43 is always set to “0”[*]; and
d) that for non-operational uses in all beacons that Bit 43 is always set to “1”.

For ELT(DT)s combined with Automatic ELTs ensure that Rotating Field #1 continues to be transmitted when the device is activated as an Automatic ELT and does not change to Rotating Filed #0 and that Bits 138 to 140 in the message remain as “011”.

For ELT(DT)s designed to withstand a crash and for ELT(DT)s combined with Automatic ELTs ensure that the data in the main message field, other that the position data and status of homing device, does not change when the ELT(DT) changes state.

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

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.

[*] Care shall be taken to ensure that live distress alerts are not transmitted over the air during this testing.

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 (if applicable);
f) Battery Status Indication B.20; and
g) Programming Adaptor Tests B.23 (if applicable).

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 Testing ELT(DT)s Capable of Operating with External Power Source

A.2.10.1 Requirement

ELT(DT)s capable of operating (transmitting satellite distress alerts on 406 MHz) when powered from an external power source shall be subjected to a combined test which is a variation of the Electrical and Functional Tests at Constant Temperature and the Frequency Stability Test with Temperature Gradient, followed by a simplified Encoded Position Data Test, in order to demonstrate compliance with the requirement in document C/S T.018 section 4.5.14.

A.2.10.2 Method of Validation

A.2.10.2.1 Combined Constant Temperature and Frequency Stability Test

The ELT(DT), while turned off, is to stabilize for 2 hours at the maximum specified operating temperature for the ELT(DT) (either Class 0, 1 or 2) as declared by the beacon manufacturer in the technical details as per section 4.2, and Annex G. The ELT(DT) is to be denied a GNSS radiated signal, such that it cannot obtain a GNSS location for the duration of this test.

The ELT(DT) is then activated while being powered from the external power supply set to the maximum normal input voltage as declared by the beacon manufacturer in the technical details as per section 4.2, and Annex G and is maintained at its maximum specified operating temperature for a period of approximately 20 minutes, until data on the first 72 bursts has been obtained.

During this period the following tests are performed continually on each burst:

a) transmitter power output, per para. B.1;
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 burst transmission interval, per para B.7.2; and

g) message structure and content (as defined in Annex C), per para B.6, B.8.1 and B.8.3 (allowing for any prior periods of on time when calculating remaining battery capacity).

The ELT(DT) is then reset (i.e., deactivated) and left in that state for a period of between 3 and 5 minutes before starting the next part of this test.

The ELT(DT) is then activated again and subjected to the testing below, over the temperature gradient specified in Figure A.2,
During this period the following tests are performed continually on each burst:

a) transmitter power output, per para. B.1;

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 burst transmission interval, per para B.7.2 (first 115 bursts only); and

g) message structure and content (as defined in Annex C), per para B.6, B.8.1 and B.8.3(allowing for any prior periods of on time when calculating remaining battery capacity).

At the point at which the temperature reaches +20C +/- 5C the external power supply is then set to the minimum normal input voltage, as declared by the beacon manufacturer in the technical details as per section 4.2, and Annex G, for the remaining portion of the test.

After the test has commenced, the external power supply shall be turned off and on in the following sequence and then shall be left on until 15 minutes before the end of the gradient portion of the test.

Start of Test (T)	External Power Supply	Comments
T = 0	Turn on	ELT(DT) runs on external power supply
T = 2 min 30 sec +/- 5 sec	Turn off	ELT(DT) runs on internal battery
T = 3 min 30 sec +/- 5 sec	Turn on	ELT(DT) runs on external power supply
T = 4 min 30 sec +/- 5 sec	Turn off	ELT(DT) runs on internal battery
T = 5 min 30 sec +/- 5 sec	Turn on	ELT(DT) runs on external power supply

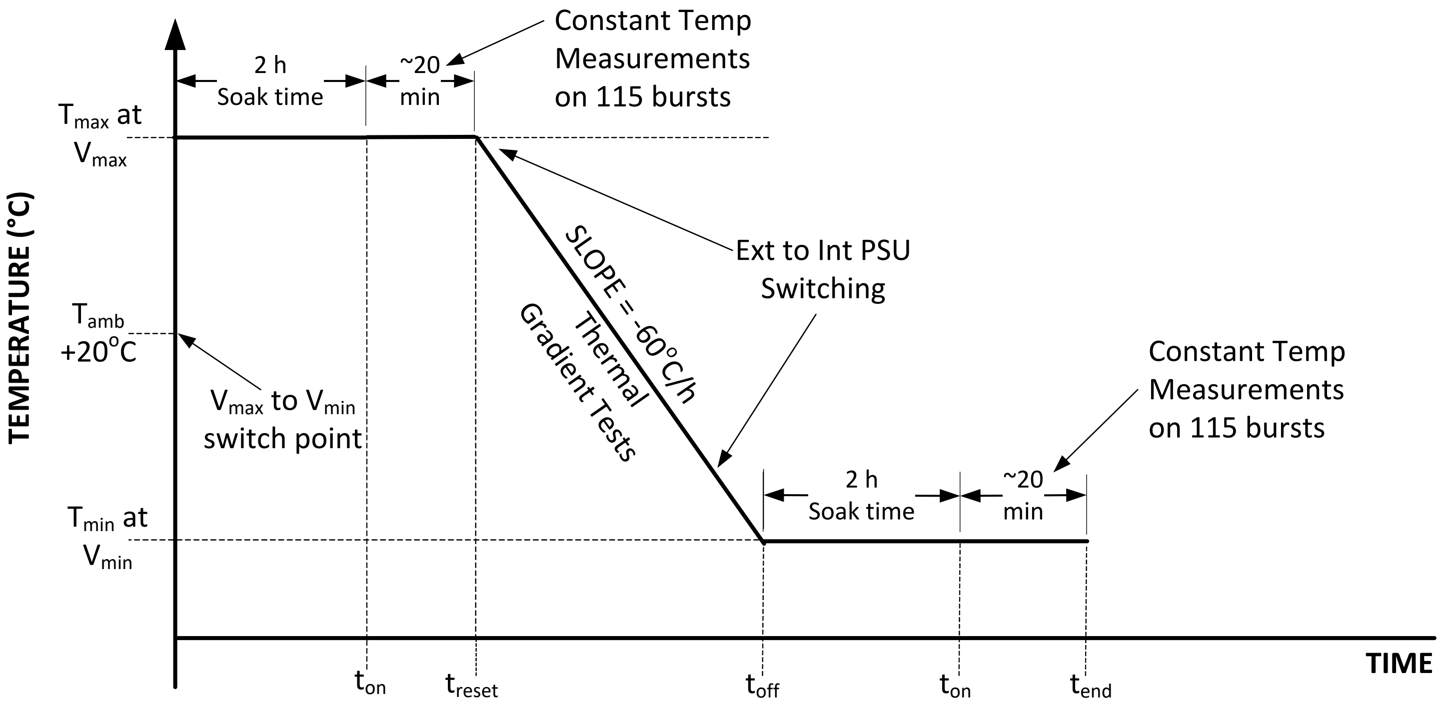
Note that when the ELT(DT) power supply is switched from the external power supply to the internal battery and back again the transmission repetition interval shall continue uninterrupted, i.e., it shall not reset and restart transmitting once every 5 seconds.

At the point at which the temperature reaches +20^{o}C +/- 5^{o}C the external power supply is then set to the minimum normal external power supply voltage, as declared by the beacon manufacturer in the technical details as per section 4.2, and Annex G, for the remaining portion of the test.

Fifteen minutes before the end of the test, the external power supply shall be turned off and on in the following sequence and then shall be left on until the end of the test.

End of Test (EOT)	External Power Supply	Comments
EOT – 15 min +/- 10 sec	Turn off	ELT(DT) runs on internal battery
EOT – 12 min +/- 10 sec	Turn on	ELT(DT) runs on external power supply
EOT – 9 min +/- 10 sec	Turn off	ELT(DT) runs on internal battery
EOT – 6 min +/- 10 sec	Turn on	ELT(DT) runs on external power supply

Note that when the ELT(DT) power supply is switched from the external power supply to the internal battery and back again the transmission repetition interval shall continue uninterrupted, i.e., it shall not reset and restart transmitting once every 5 seconds.



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 "soak"
t_{reset} = beacon reset by turning off and then back on a few minutes later

Figure A.2: External Power Source Temperature Profile

The ELT(DT) is then powered off and left off to soak at minimum temperature for a period of two hours before starting the next part of this test.

The ELT(DT) is then powered on from the external power supply set to the minimum normal input voltage as declared by the beacon manufacturer in the technical details as per section 4.2, and Annex G and is maintained at its minimum specified operating temperature for a period of approximately 20 minutes, until data on the first 72 bursts has been obtained.

During this period the following tests are performed continually on each burst:

a) transmitter power output, per para. B.1;

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 burst transmission interval, per para B.7.2; and

g) message structure and content (as defined in Annex C), per para B.6, B.8.1 and B.8.3 (allowing for any prior periods of on time when calculating remaining battery capacity).

On completion of the above tests the ELT(DT) is powered off and returned to room temperature and is allowed to stabilise at room temperature for a minimum period of 2 hours before performing any further tests.

A.2.10.2.2 External Power Encoded Position Data Test

The ELT(DT) shall then be subjected to a variation of the ELT(DT) Location Accuracy and Information Test per para B.14.3.4.

Either method of validation (Open Air or GNSS Simulator) as defined in B.14.3.4.2 may be used for this test, however the test shall just be run twice generating two sets of 80 results as described below.

The ELT(DT) shall be activated while being powered from the external power supply set to the maximum external power supply voltage, as declared by the beacon manufacturer in the technical details as per section 4.2, and Annex G, and shall be maintained at ambient operating temperature for the duration of the test.

Then perform either the open-air test method steps 1 to 7 inclusive, or the GNSS Simulator / test chamber test method steps 1 to 9 inclusive as specified in B.14.3.4.2.

At the completion of the test turn the ELT(DT) off and wait for a period of 2 hours (if applicable the GNSS Simulator is left running during this time).

The ELT(DT) shall then be activated while being powered from the external power supply set to the minimum external power supply voltage, as declared by the beacon manufacturer in the technical details as per section 4.2, and Annex G, and shall be maintained at ambient operating temperature for the duration of the test.
The Test in B.14.3.4.2 is then repeated to obtain a second set of 80 results in either the open-air test method steps 1 to 7 inclusive, or the GNSS Simulator / test chamber test method steps 1 to 9 inclusive.

The data and results to be calculated from the above two sets of 80 results (160 results in total) are as defined in the relevant test method in B.14.3.4.2.

A.2.10.3 Required Results

Populate the data tables as required in Annex E Tabs E.1-12 and E.10-1.

For each data parameter indicated in section A.2.10.2 using the data collected during the test sequence calculate the statistics as required in Annex E. Transmitted bursts and their message content that occurred either during a switching interval or within 2 seconds following a switching interval shall be discarded.

A.2.11 Documentation and Labelling

A.2.11.1 Requirement

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

A.2.11.2 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.2.11.3 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.

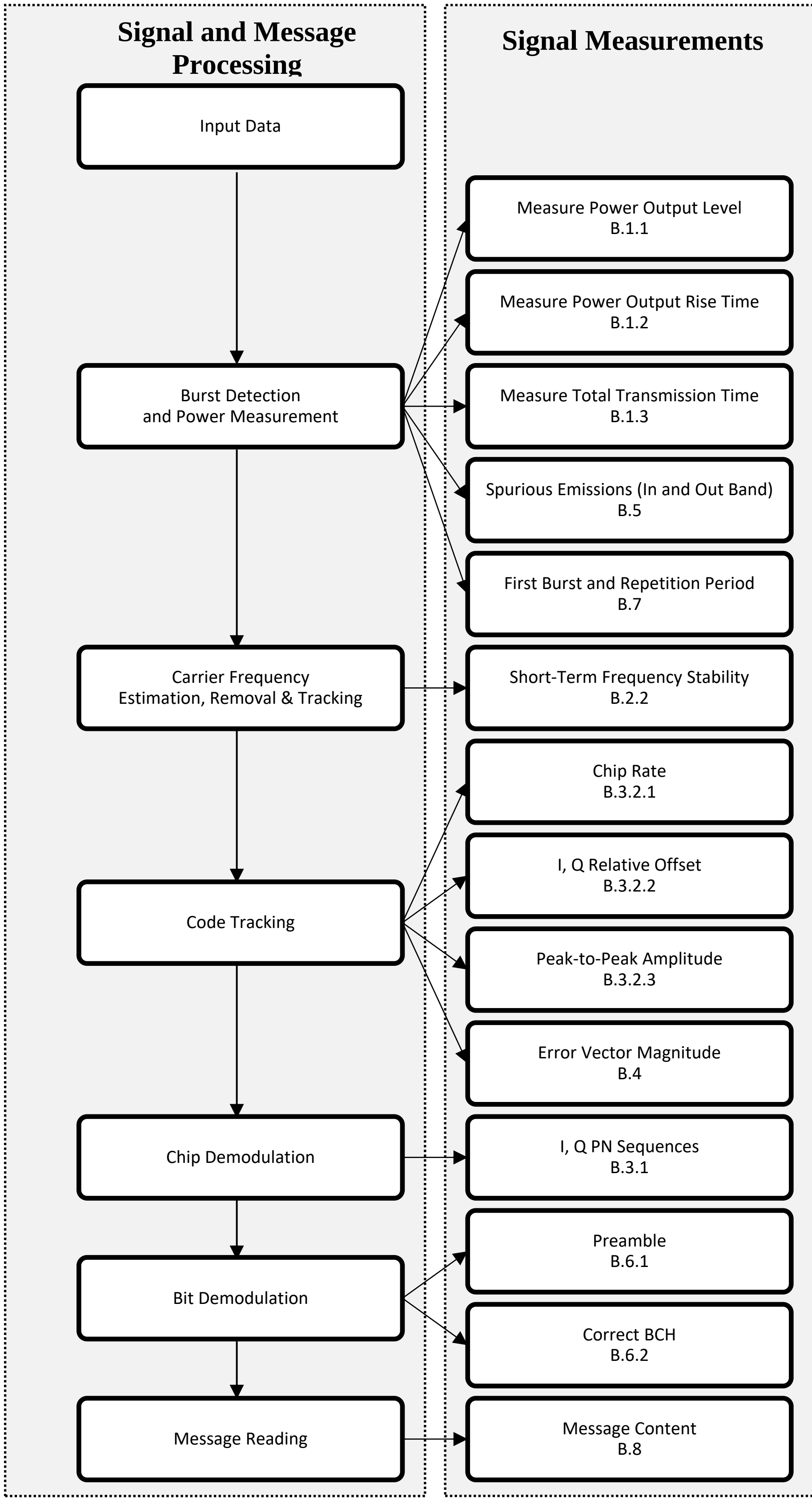


Figure B.1: Processing Steps

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 centre 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 chips. The obtained complex chips 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

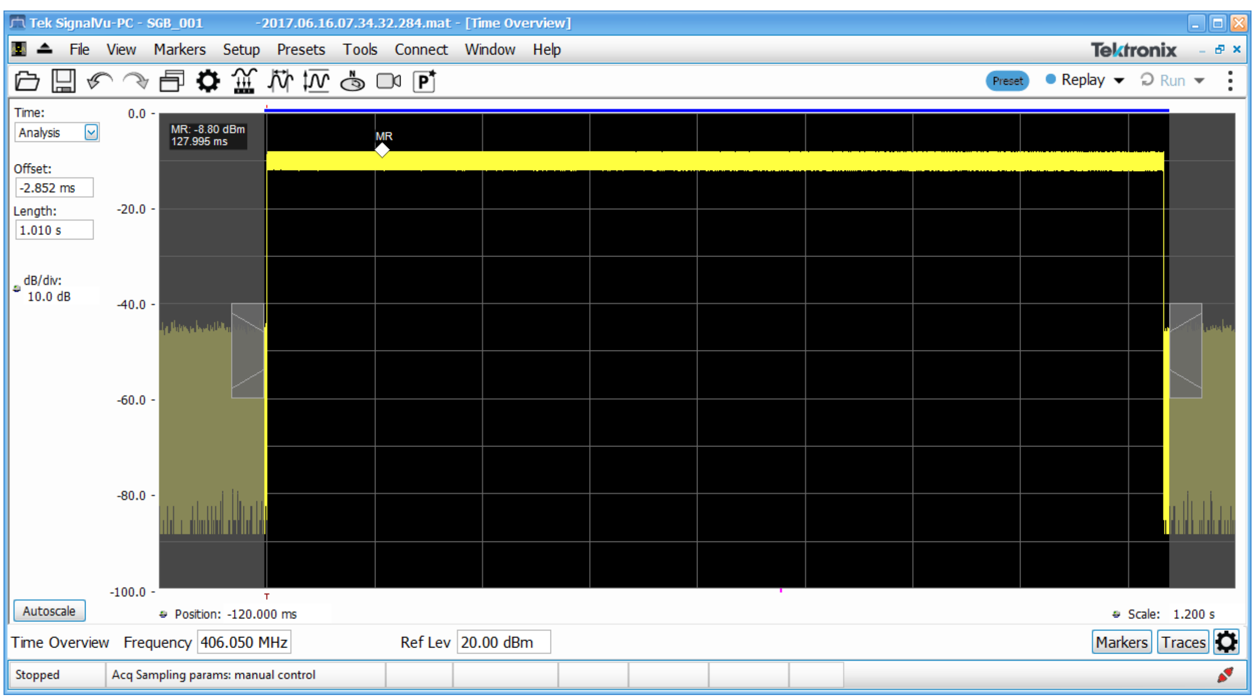


Figure B.2: Burst Energy Detection

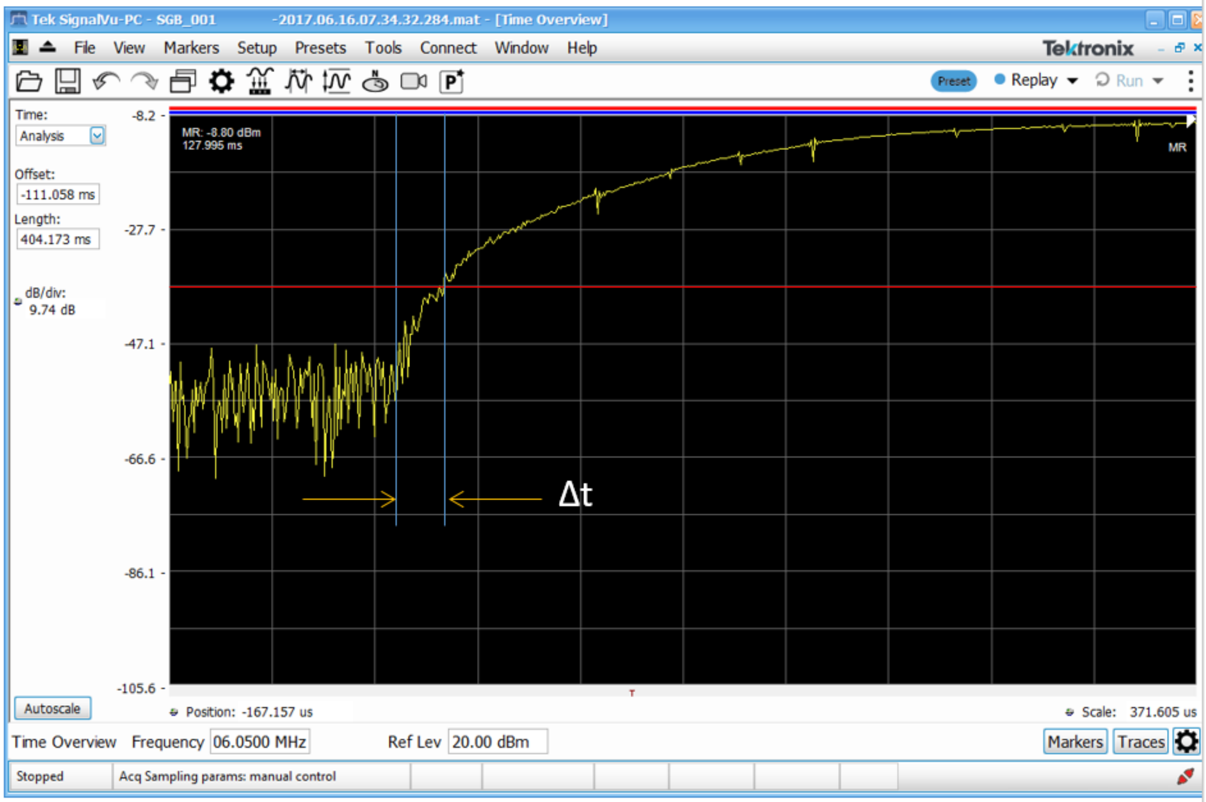


Figure B.3: Burst Detection Threshold and Margin

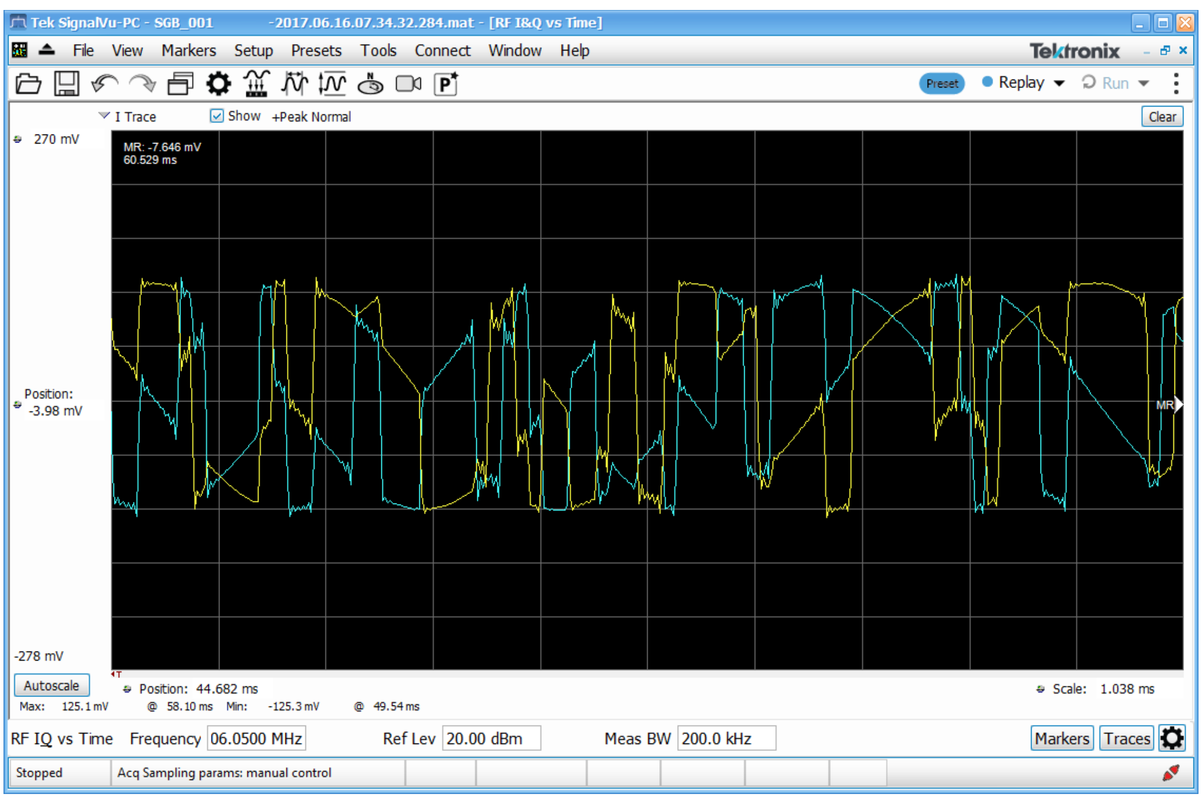


Figure B.4: Complex Signal with Carrier Frequency Offset

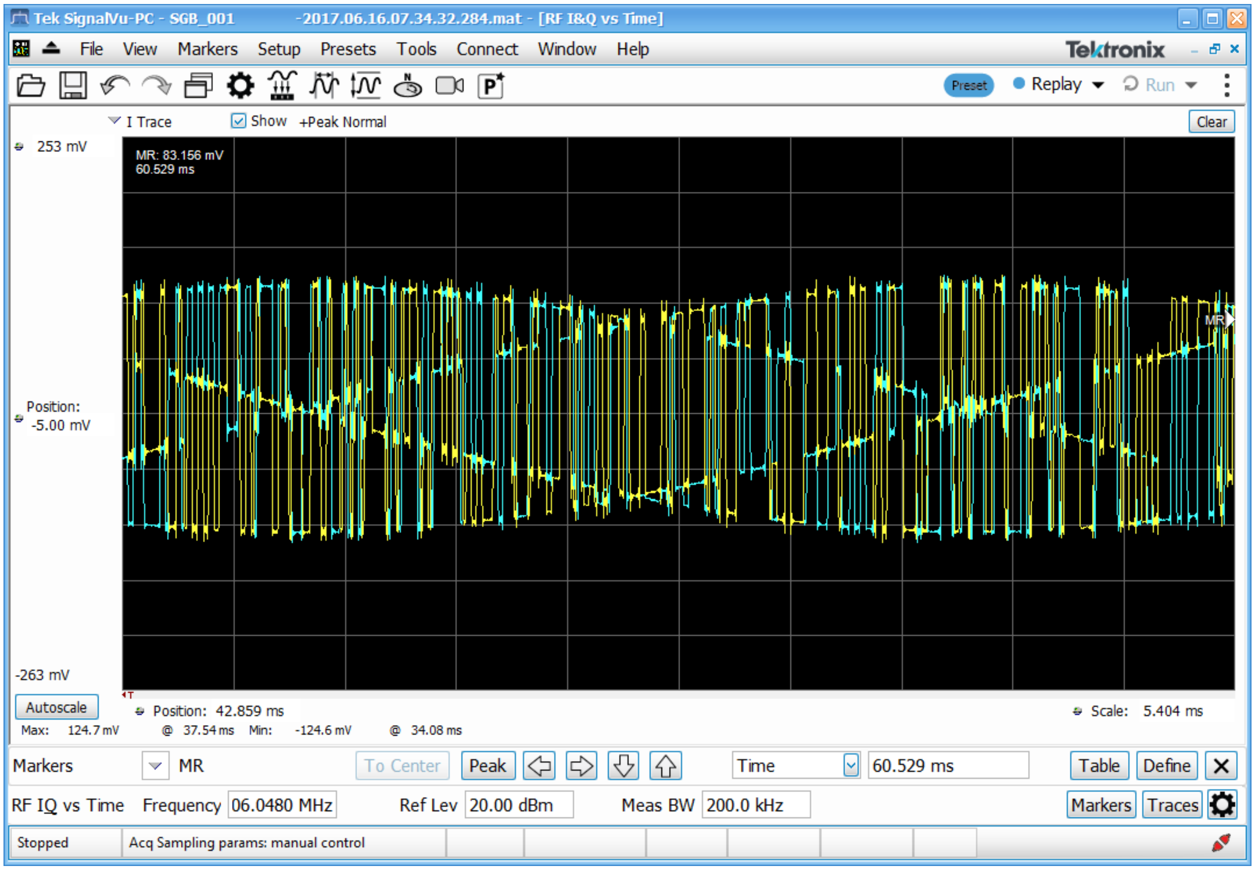


Figure B.5: Sampled Complex Baseband Data with residual carrier frequency offset

B.1 Transmitter Output Power

B.1.1 Measure Power Output Level

B.1.1.1 Requirement

T.018/S.2.4.1/R.0455

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.

The transmitted power shall be continuously monitored on the 406.0-406.1 MHz frequency band. Between bursts the power measurement can be averaged over a period of 100 ms maximum.

Note: If the measurement method is based on sampling, then the sampling rate must be sufficient to meet the measurement uncertainty required in document C/S T.008.

B.1.1.3 Required Results

The nominal power level from each burst shall be recorded. The average, minimum and maximum values of transmitter output power shall be calculated from the results of all the recorded bursts. For the purposes of EIRP calculations in B.11, the averaged value shall be used.

The maximum values of transmitter output power (averaged over a maximum period of 100 ms), in the frequency band 406.0-406.1 MHz, during intervals between 25 ms after the end (i.e., power point $t_{d,10\%}$ + 25ms on Figure B.6) of any 406 MHz burst until 25 ms before the commencement (i.e., power point $t_{r,10\%}$ - 25 ms) of the next 406 MHz burst, measured over the full test interval shall be reported in Annex E.1 if their value exceed -10dBm between any two bursts (otherwise the mention ‘<-10dBm’ shall be reported as a maximum value).

Populate the data tables as required in Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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.

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

B.1.2 Measure Power Output Rise Time and Fall Time

B.1.2.1 Requirement

T.018/S.2.4.1/R.0430
T.018/S.2.4.1/R.0440
T.018/S.2.4.1/R.0445

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.

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.

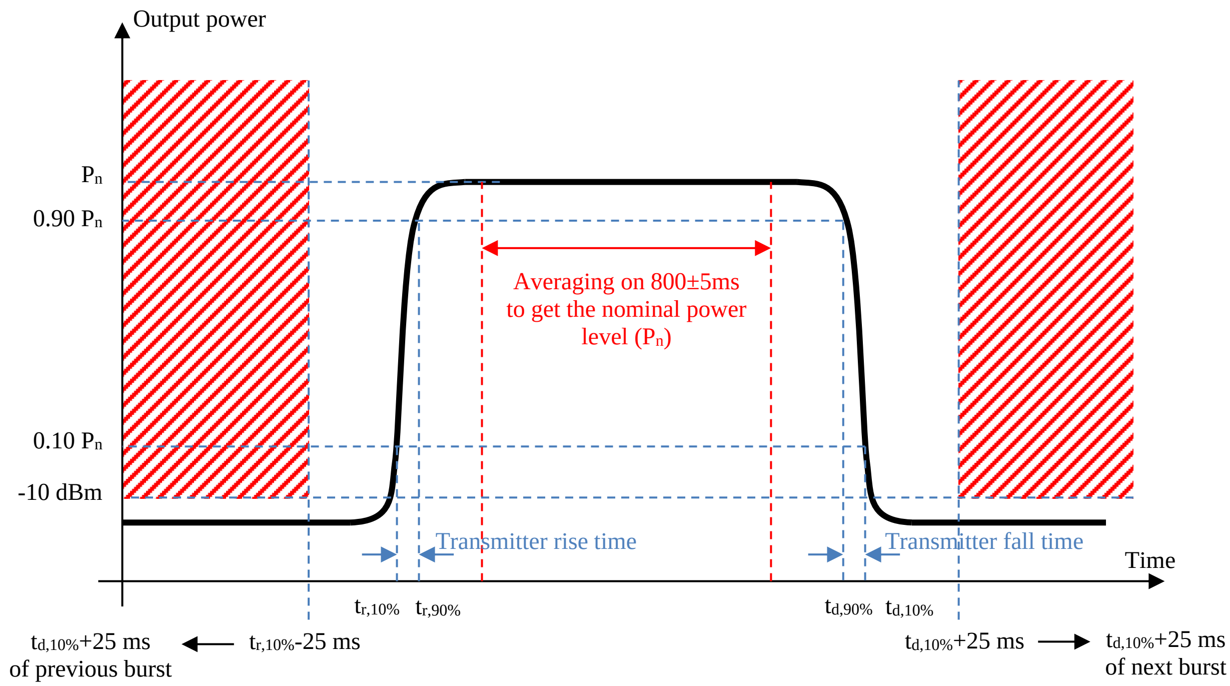

Figure B.6: Power Profile for Output Rise and Fall Time Measurement

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 transmitter fall time can be computed as the difference in time between the two falling power points ($t_{d,10\%}$- $t_{d,90\%}$).

B.1.2.3 Required Results

The transmitter rise time shall be measured for each burst. The transmitter fall 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 “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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.

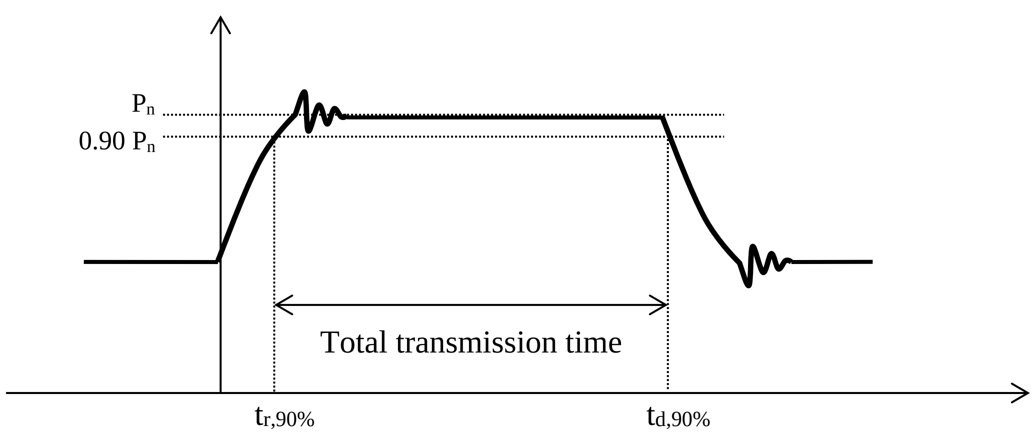

Figure B.7: Power Profile for Output Total Transmission Time

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 “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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)

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

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

d) 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).

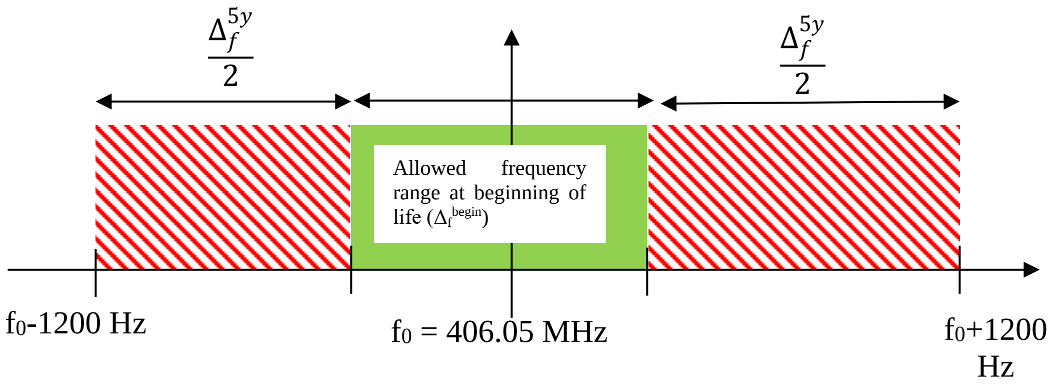

Figure B.8: Allowable Beginning-of-Life Frequency Range

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 “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", and “Annex E.1-12 - A.2.10”, as 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 the range 406.050 MHz - 1200 + (Δf_{5yr} /2) to 406.050 MHz + 1200 – (Δf_{5yr} /2) Hz as calculated in Section B.2.1.

B.2.2.3 Required Results

Populate the data tables as required in Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, “Annex E.1-3 - A.2.1 - VSWR”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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.0145
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
T.018/S.2.2.3/R.0280

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. When assessing I and Q chip errors, the first 20 chips and the last 20 chips in each burst shall be ignored.

Populate the data tables as required in Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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).

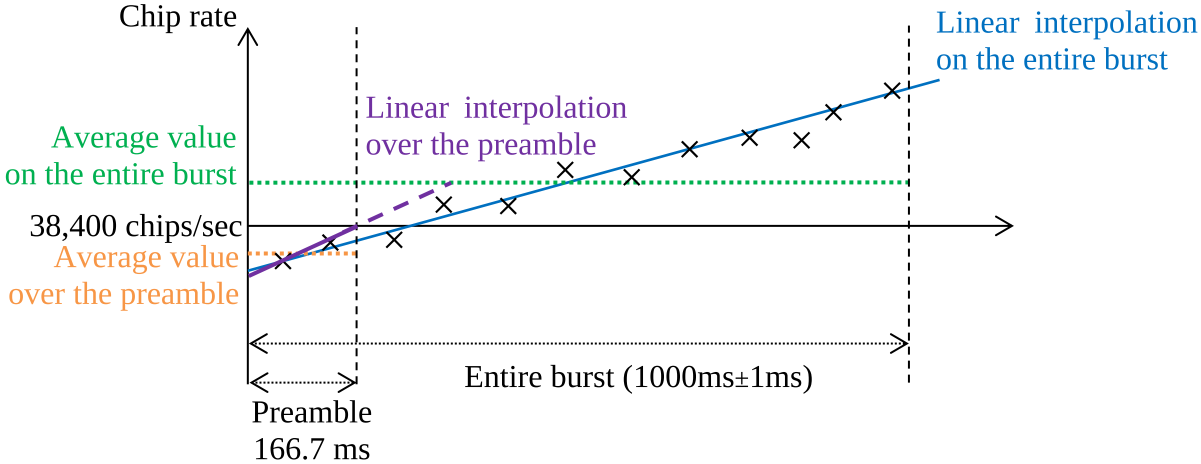

Figure B.9: Average Chip Rate and Chip Rate Variation Example

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 “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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.2.2.3/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 “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", and “Annex E.1-12 - A.2.10”, as 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:

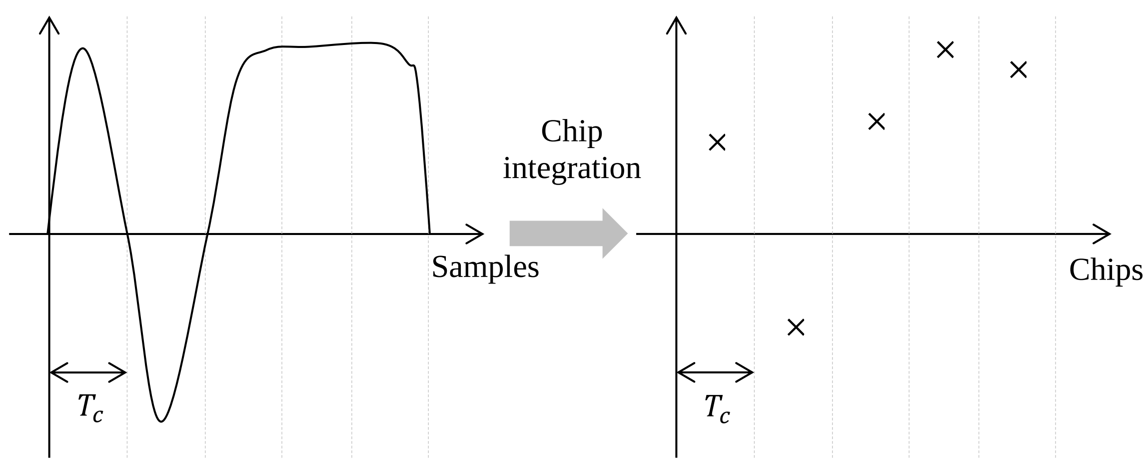

Figure B.10: Example of Chip Integration for Peak-to-Peak Amplitude

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 Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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.4 Error Vector Magnitude (EVM)

B.4.1 Requirement

T.018/S.2.3.3/R.0390

B.4.2 Method of Verification

For each burst, compute the symbol values by independently integrating windows of I and Q samples with their respective sequence in 256 chip subsets; the resulting pairs represent the complex values of the symbols.

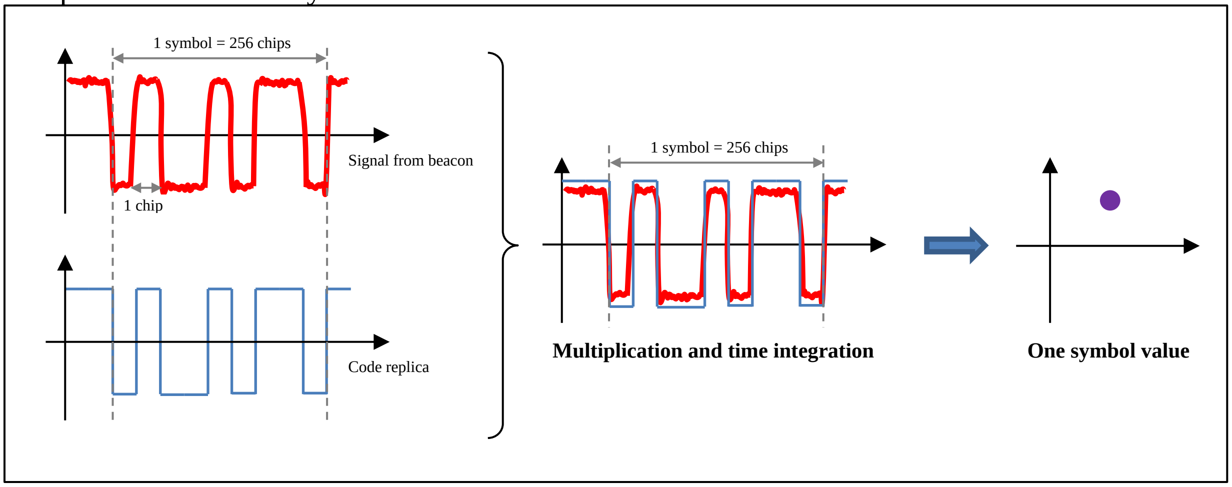

Figure B.11: Signal Integration and Symbol Values

The complex symbols obtained shall be compared to the ideal point of the constellation plot.

The RMS value of the Error Vector Magnitude (EVM) can be computed according to the following formula:

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

where:

- I_{meas} and Q_{meas} design the I and Q components of the measured signal (derived from a symbol integration for each of the 150 symbols 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 symbols, that is N = 150.

Figure B.12 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.

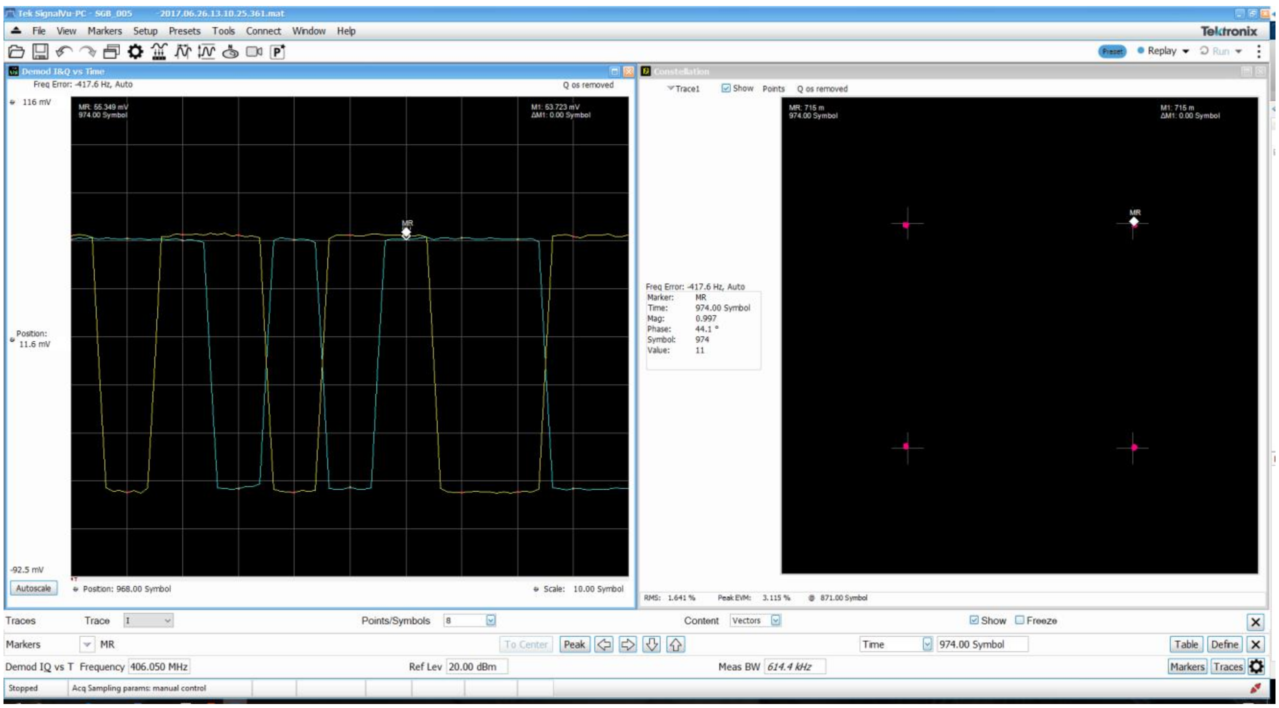

Figure B.12: Demodulation: Mapping from I/Q to Constellation

B.4.3 Required Results

One EVM value shall be determined for each burst.

Populate the data tables as required in Annex E.1: Tabs Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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). It shall be computed using a resolution bandwidth of 100Hz. Then, it shall be normalized with the reference power level computed in section B.1.1 for comparison with the spurious emission mask specified in dBc in document C/S T.018.

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 to -35 dBc and from -35 dBc to -40 dBc for 406.0 MHz to f_0-40 kHz and f_0+40 kHz to 406.1 MHz frequency bands respectively. Within these ranges mask changes linearly.
- -40 dBc for frequencies below 406 MHz and frequencies above 406.1 MHz.

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 Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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.2.2.3/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 Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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 Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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 burst transmission interval

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

For ELT(DT)s combined with Automatic ELTs both test 7.1 and 7.2 shall be performed to check that the burst repetition rate is correct when the combined device:

a) is working as a DT;
b) is working as an Automatic ELT; and
c) transitions from an ELT(DT) to an Automatic ELT.

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
T.018/S.2.2.1/R.0072
T.018/S.2.2.1/R.0074
T.018/S.2.2.1/R.0076
T.018/S.2.2.1/R.0080
T.018/S.2.2.1/R.0082
T.018/S.2.2.1/R.0084
T.018/S.2.2.1/R.0086
T.018/S.4.5.15.3/R.2450
T.018/S.4.5.15.3/R.2460

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 time between the start of successive bursts. Record the value of the time between the start of each successive burst.

c) For bursts 6 to 65, measure the time between the start of successive bursts. Record the value of the time between the start of each successive burst.

d) For bursts 65 to 115, measure the time between the start of successive bursts. Record the value of the time between the start of 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.

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[*] If the beacon can be externally and/or automatically activated (e.g., by an electrical control line to the beacon, by the start of a shock, by deformation, by water sensor immersion, etc.), then all means of external or automatic activation shall be tested. If the beacon can only be manually activated by an end user (e.g., by pressing the 'on' button) then this mode of activation shall be tested. Manually activated modes of operation on beacons with external and / or automatic means of activation do not need to be tested.

B.7.1.3 Required Result

a) For each method of activation required to be tested, 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 bursts 1 to 6: The time between the start of any two successive bursts shall be within the range of 4.80 to 5.00 seconds.

c) For bursts 6 to 65: The time between the start of any two successive bursts shall be within the range of 25.00 to 35.00 seconds. The standard deviation of T_R measured over the 59 successive bursts shall be greater than 2.5 seconds. The minimum value of T_R observed over the 59 successive bursts shall be between 25.0 and 25.2 seconds, the maximum value of T_R observed over the 59 successive bursts shall be between 34.8 and 35.0 seconds.

d) For bursts 65 to 115: The time between the start of any two successive bursts shall be within the range of 115.00 to 125.00 seconds. The standard deviation of T_R measured over the 50 successive bursts shall be greater than 2.5 seconds. The minimum value of T_R observed over the 50 successive bursts shall be between 115.0 and 115.2 seconds, the maximum value of T_R observed over the 50 successive bursts shall be between 124.8 and 125.0 seconds.

e) Populate the data tables as required in Annex E.1: Tabs Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", and “Annex E.1-12 - A.2.10”, as 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.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
T.018/S.2.2.1/R.0102
T.018/S.2.2.1/R.0104
T.018/S.2.2.1/R.0106
T.018/S.4.5.15.3/R.2360
T.018/S.4.5.15.3/R.2361
T.018/S.4.5.15.3/R.2363
T.018/S.4.5.15.3/R.2364
T.018/S.4.5.15.3/R.2450
T.018/S.4.5.15.3/R.2460

B.7.2.2 Method of Validation

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

b) For bursts 24 to 42, measure the time between the start of successive bursts. Record the value of the time between the start of each successive burst.

c) For bursts 42 to 115, measure the time between the start of successive bursts. Record the value of the time between the start of each successive burst.

d) For ELT(DT) specifically designed to withstand a crash, activate the crash sensor 45 minutes after beacon activation, then:

   i. Measure the time between the start of the first 24 bursts. Record the value of the time between the start of each successive burst.
   ii. For bursts 24 to 42, measure the time between the start of successive bursts. Record the value of the time between the start of each successive burst.
   iii. For bursts 42 to 95, measure the time between the start of successive bursts. Record the value of the time between the start of each successive burst. The time between the start of any two successive bursts shall be within the range of 27.00. to 30.00 seconds.
   iv. For bursts 95 to 115, measure the time between the start of successive bursts. Record the value of the time between the start of each successive burst. The time between the start of any two successive bursts shall be within the range of 115.00. to 125.00 seconds.

e) For ELT(DT)s combined with Automatic ELTs, activate the crash sensor 45 minutes after beacon activation, then:

   i. Measure the time between the start of the first 6 bursts. Record the value of the time between the start of each successive burst.

   ii. For bursts 6 to 65, measure the time between the start of successive bursts. Record the value of the time between the start of each successive burst. The time between the start of any two successive bursts shall be within the range of 25.00. to 35.00 seconds.

   iii. For bursts 65 to 115, measure the time between the start of successive bursts. Record the value of the time between the start of each successive burst. The time between the start of any two successive bursts shall be within the range of 115.00 to 125.00 seconds.

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) Bursts 1 to 24: The time between the start of any two successive bursts shall be within the range of 4.80 to 5.00 seconds.

b) Bursts 24 to 42: The time between the start of any two successive bursts shall be within the range of 9.80 to 10.0 seconds.

c) Bursts 42 to 115: The time between the start of any two successive bursts shall be within the range of 27.00 to 30.00 seconds. The standard deviation over the 73 successive bursts of T_R shall be greater than 0.8 seconds. The minimum value of T_R observed over the 73 successive bursts shall be between 27.0 and 27.2 seconds, the maximum value of T_R observed over the 73 successive bursts shall be between 29.8 and 30.0 seconds.

d) For ELT(DT)s specifically designed to withstand a crash, perform the same measurements for bursts transmitted right after crash sensor activation:

   i. Bursts 1 to 24: The time between the start of any two successive bursts shall be within the range of 4.8 to 5.0 seconds.
   ii. Bursts 24 to 42: The time between the start of any two successive bursts shall be within the range of 9.8 to 10.0 seconds.
   iii. Bursts 42 to 95: The time between the start of any two successive bursts shall be within the range of 27.00 to 30.00 seconds. The standard deviation over the 53 successive bursts of T_R shall be greater than 0.8 seconds. The minimum value of T_R observed over the 53 successive bursts shall be between 27.0 and 27.2 seconds, the maximum value of T_R observed over the 53 successive bursts shall be between 29.8 and 30.0 seconds.
   iv. Bursts 95 to 115: The time between the start of any two successive bursts shall be within the range of 115.00. to 125.00 seconds. The standard deviation over the 20 successive bursts of T_R shall be greater than 2.5 seconds. The minimum value of T_R observed over the 20 successive bursts shall be between 115.0 and 115.2 seconds, the maximum value of T_R observed over the 20 successive bursts shall be between 124.8 and 125.0 seconds.

e) For ELT(DT)s combined with Automatic ELTs, perform the same measurements for bursts transmitted right after crash sensor activation:

   i. For bursts 1 to 6: The time between the start of any two successive bursts shall be within the range of 4.80 to 5.00 seconds.
   ii. For bursts 6 to 65: The time between the start of any two successive bursts shall be within the range of 25.00 to 35.00 seconds. The standard deviation of T_R measured over the 59 successive bursts shall be greater than 2.5 seconds. The minimum value of T_R observed over the 59 successive bursts shall be between 25.0 and 25.2 seconds, the maximum value of T_R observed over the 59 successive bursts shall be between 34.8 and 35.0 seconds.
   iii. For bursts 65 to 115: The time between the start of any two successive bursts shall be within the range of 115.00 to 125.00 seconds. The standard deviation of T_R measured over the 50 successive bursts shall be greater than 2.5 seconds. The minimum value of T_R observed over the 50 successive bursts shall be between 115.0 and 115.2 seconds, the maximum value of T_R observed over the 50 successive bursts shall be between 124.8 and 125.0 seconds.

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 Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", and “Annex E.1-12 - A.2.10”, as 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.2.2.1/R.0030
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.4.5.7.1/R.2025
T.018/S.4.5.7.1/R.2026
T.018/S.4.5.7.2/R.2028
T.018/S.4.5.7.2/R.2029
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 initiate a cancellation on 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.

f) Initiate a cancellation on the beacon, measure the first cancellation message delay, and record the value.

g) Measure the burst transmission interval 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 TR, 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 “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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 and in Table B.8-1. The correct message content, as specified in Table B.8-2 and the correct RLS indicator operation (if fitted) shall be verified for each type of beacon and message in Table B.8-1.

Table B.8-1 - B.8 Test Sections to be Verified by Type of Beacon

Type of Beacon	Self-Test Transmission	Normal Transmission	Cancellation Message
All beacons except those below	B.8.1 and B.8.2 (see Note 1)	B.8.1 and B.8.2 (see Note 1)	B.8.1 and B.8.6 (see Note 1)
ELT(DT)s	B.8.1 and B.8.3 (see Note 1)	B.8.1 and B.8.3 (see Note 1)	B.8.1 and B.8.6 (see Note 1)
Beacons with RLS capability enabled	B.8.1 and B.8.4	B.8.1, B.8.2, and B.8.4	B.8.1 and B.8.6 (see Note 1)
National Use Coded Beacons	B.8.1 and B.8.5 (see Note 1)	B.8.1 and B.8.5 (see Note 1)	B.8.1 and B.8.6 (see Note 1)

Notes:

1. For all other types of beacon and message modes, during the message content testing it shall be verified that the RLS Indicator (if fitted) is never illuminated.

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.8-2 - Message Content Values and Results Reference

Item	Values to be coded into the Beacon Message	Expected and Recorded Results
Main Message Field	Table C.1-1	Annex E.2-1, E.2-2, E.2-3, E.3-1, E.4-1, E.5-1, E.9-1, E.10-1, and E.11-1
Rotating Field #0	Table C.1-2	
Rotating Field #1	Table C.1-3	
Rotating Field #2	Table C.1-4	
Rotating Field #3	Table C.1-5	
Rotating Field #15	Table C.1-6	

B.8.1 Main Field

B.8.1.1 Requirement

T.018/S.2.2.3/R.0250
T.018/S.2.2.6/R.0260
T.018/S.3.3/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 as required in Table B.8-1.

Populate the data tables as required in Annex E.1: Tabs Annex E.1: Tabs “Annex E.1-1 - A.2.1 - Normal”, “Annex E.1-2 - A.2.1 - Self-Test”, "Annex E.1-4 - A.2.2”, “Annex E.1-5 - A.2.3”, “Annex E.1-6 - A.2.4", “Annex E.1-11 - A.2.9”, and “Annex E.1-12 - A.2.10”, as 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 Default Rotating Field #0 (C/S G.008 Objective Requirements)

B.8.2.1 Requirement

T.018/S.2.2.3/R.0240
T.018/S.2.2.3/R.0250
T.018/S.3.3/R.0610
T.018/S.3.4/R.0625

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 as required in Table B.8.2.

B.8.2.3 Required Results

The required results are contained in the tables in Annex E as required in Table B.8.2.

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, unless bit combination 111 indicates that this feature is not provided in this beacon:

000 <= 5% remaining
001 > 5% and <=10% remaining
010 > 10% and <= 25% remaining
011 > 25% and <= 50% remaining
100 > 50% and <= 75% remaining
101 > 75% and <= 100% remaining

Populate the data tables as required in Annex E as required in Table B.8.2 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.2.2.3/R.0240
T.018/S.2.2.3/R.0250
T.018/S.3.3/R.0610
T.018/S.3.4/R.0625
T.018/S.4.5.16.2/R.2400
T.018/S.4.5.16.2/R.2410
T.018/S.4.5.16.2/R.2420
T.018/S.4.5.16.2/R.2425
T.018/S.4.5.16.2/R.2426
T.018/S.4.5.16.2/R.2430
T.018/S.4.5.16.2/R.2440

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 as required in Table B.8.2.

2. For ELT(DT)s combined with Automatic ELTs ensure that Rotating Field #1 continues to be transmitted when the device is activated as an Automatic ELT and does not change to Rotating Field #0 and that Bits 138 to 140 in the message remain as "011".

B.8.3.3 Required Results

The required results are contained in the tables in Annex E as required in Table B.8.2.
For the following subfield, the required results are as follows:

Remaining Battery Capacity: The remaining battery capacity in the beacon compared to its initial capacity shall be verified as follows unless the bit combination 11 indicates that this feature is not provided in this beacon:

00 ≤ 33% remaining
01 > 33% and ≤ 66% remaining
10 > 66% remaining

Populate the data tables as required in Annex E as required in Table B.8.2., 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.8.4 RLS – Rotating Field #2

B.8.4.1 Requirement

T.018/S.2.2.3/R.0240
T.018/S.2.2.3/R.0250
T.018/S.3.3/R.0610
T.018/S.3.4/R.0625

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 as required in Table B.8.2.

B.8.4.3 Required Results

The required results are contained in the tables in Annex E as required in Table B.8.2.

Populate the data tables as required in Annex E as required in Table B.8.2 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.8.5 Beacon Message Content – Rotating Field#3

B.8.5.1 Requirement

T.018/S.2.2.3/R.0240
T.018/S.2.2.3/R.0250
T.018/S.3.3/R.0610
T.018/S.3.4/R.0625

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.9 Table E.9-5.

B.8.5.3 Required Results

The required results are contained in the tables in Annex E as required in Table B.8.2.

Populate the data tables as required in Annex E as required in Table B.8.2 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.8.6 Cancellation – Rotating Field #15

B.8.6.1 Requirement

T.018/S.2.2.3/R.0240
T.018/S.2.2.3/R.0250
T.018/S.3.3/R.0610
T.018/S.3.4/R.0625

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 as required in Table B.8.2.

B.8.6.3 Required Results

The required results are contained in the tables in Annex E as required in Table B.8.2.

Populate the data tables as required in Annex E as required in Table B.8.2 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.9 Voltage Standing Wave Ratio (VSWR)

B.9.1 Requirement

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

B.9.2 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:

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

B.9.3 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 Requirement

T.018/S.2.3.5/R.0420

B.10.2 Met hod 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.10.3 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.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

* The message content is as defined in Annex C.

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
T.018/S.2.4.3/R.2470
T.018/S.2.4.3/R.2490
Power output is defined in terms of EL-EIRP, not power into a 50-ohm load. Required EL-EIRP varies with elevation angle. 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.

ELT(DT)s combined with Automatic ELTs does not have to meet the requirement for 90% of measured EIRP values to meet the limits shown at elevation angles below 55 degrees (but does have to meet the other requirements in document C/S T.018, section 2.4.2).

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.

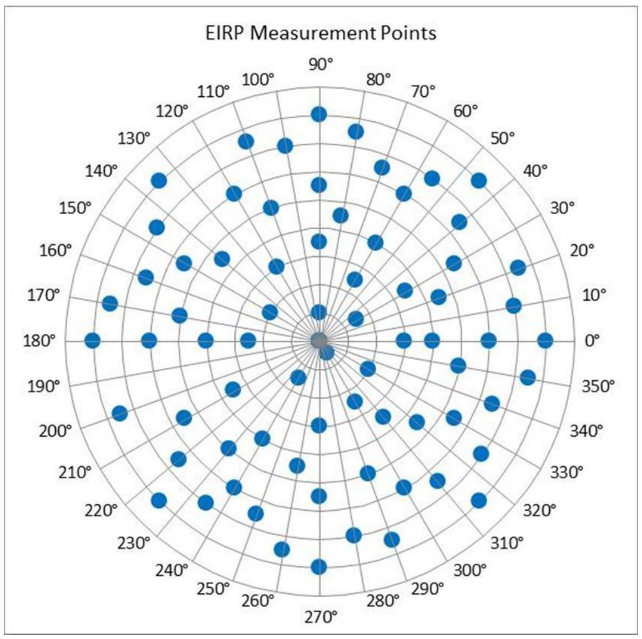


Figure B.13: Distribution of EIRP Measurement Points

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 after 30 minutes of beacon ‘on’ time, if required, the beacon may be turned off and back on again, so that it restarts the first 30 minutes more rapid repetition transmission sequence. 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 centre 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 with Radar Absorbing Material (RAM) to a minimum radius of 1.8m to reduce RF-reflections from the floor surface. Any type of RAM[*] may be used if it provides at least 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 centre 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.

[*] The RAM total height shall not exceed 45 cm.

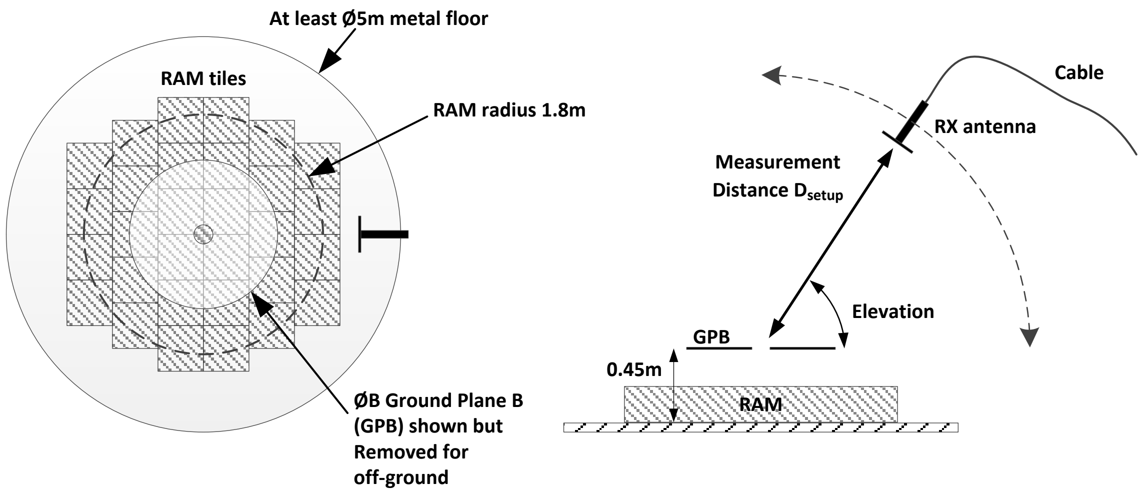


Figure B.14: Illustration of RAM zone and RX antenna path

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_{Setup}) to the receive (RX) antenna and defined as follows:
Configuration #1: B = 2.5 m and D_{Setup} = 2 m, or
Configuration #2: B = 2.25 m and D_{Setup} = 4 m.
The RX antenna shall follow a 10˚ to 90˚ elevation arc at a measurement distance of D_{Setup}* ±5% from the central test/pivot position to the phase/calibration centre 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 centre 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 configured to minimize interference in the measurement results (e.g., supported on axis behind the antenna, then supported or shielded behind the mast or RAM, etc.) 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.

The RHCP antenna should be small to allow minimise ambiguity over its phase/calibration centre 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:

* Either of the two configurations are allowed to be used by test facilities. Whichever setup is selected, all tests shall be carried out in that configuration.

(a) cross-dipole (90˚ phasing either by λ/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 EIRP Receiver Calibration Procedure

B.11.1.2.4.1 Introduction

Prior to the commencement of taking EIRP measurements on each Beacon Under Test (BUT) the test setup shall be calibrated in accordance with the following procedure. During EIRP measurements if the test equipment, antennas or cables used are changed in any way (e.g., replaced with alternative items) then this calibration procedure shall be repeated before carrying on taking EIRP measurements.

B.11.1.2.4.2 Calibration Procedure Setup

The test site shall be set up as detailed in Sections B.11.1.2.2, B.11.1.2.3 and B.11.1.2.6 as appropriate for the BUT.

Disconnect the Rx antenna and replace it with a UHF Signal Generator producing a CW output signal at the operating frequency of the BUT +/- 1 kHz at a power level of 6 dBm (this level is typical of the level at the output of the measuring antenna) to an accuracy of equal to or better than +/- 0.5 dB. If necessary, the output of the signal generator can be connected directly to an RF Power Meter or similar item of test equipment to set it up accurately.

Connect the output of the UHF Signal Generator to the coaxial cable that would normally be connected to the Rx antenna.

B.11.1.2.4.3 Measurement Method

With the system set up as described in Section B.11.1.2.4.2 above record the resultant signal level on the Test Receiver (e.g., Field Strength Meter, Spectrum Analyzer, etc.).

B.11.1.2.4.4 Calibration Factor Computation

Calculate the Loss Calibration Factor (L_c) using the following equation:

$$L_c \text{ (dB)} = P_{tx} - P_{rx}$$

Where:

P_{tx} = transmitted signal generator power (dBm)
P_{rx} = received power (dBm)

In subsequent EL-EIRP computations, as described in Section B.11.1.2.5, use the above calculated value of L_c in all EL-EIRP calculations.

B.11.1.2.5 EL-EIRP computation

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

$$\text{EL-EIRP (dBm)} = P_{rx} + L_c - G_{rx} + L_p$$

Where

- P_{rx} = received power (dBm)
- L_c = Loss Calibration Factor (dB) (as calculated in B.11.1.2.4)
- G_{rx} = RX antenna gain (dBi) where dBi implies Gain for Linear polarization
- L_p = Propagation loss (dB) = $20\log(4\pi D/\lambda)$ where D = Distance)

The actual test distance D at each elevation shall be measured for each beacon test configuration and this value shall be used at each elevation to calculate L_p. The actual measured distance D in each case shall be the distance between the mid-point of the beacon antenna (or the remote antenna as applicable) and the focal point of the RX antenna.

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

Cospas-Sarsat sets EL-EIRP requirements assuming linear polarization and link budgets allow for a 3dB polarization 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 -3 dB. 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 polarization. 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.11.1.2.6 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.

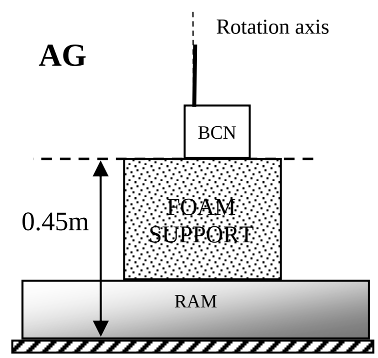
Table B.11-2 - Test Configurations

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.11.1.2.7 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 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.

B.11.1.2.8 On-ground (GP-XX) configurations

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

For this configuration RF ground is approximated by a non-magnetic highly electrically conductive (i.e., with a conductivity of $>3x10^7$ S/m) (e.g., copper or aluminium) disk B meters in diameter called Ground Plane B. This is raised 0.45m above floor level on non-conductive supports. A central hole in the disk caters for different beacon/antenna attachment methods as below:

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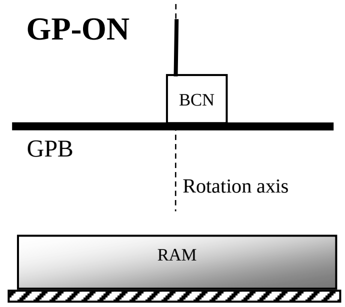
[*] Configuration required for ELT(AP) with the portable antenna installed, as applicable.
[†] Configuration required for ELT(AP) with the portable antenna installed, as applicable.
[‡] Configuration required for ELT(AP) with the fixed external antenna(s)attached, as applicable.

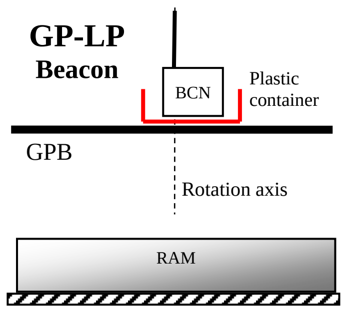
a) Configuration GP-ON

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

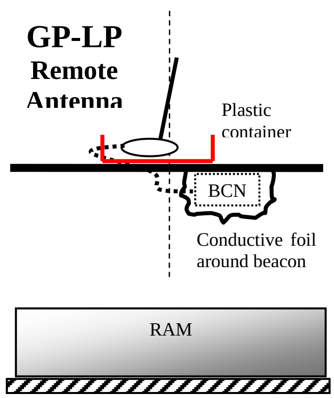


For this configuration GPB has a conductive metal sheet across its central hole and the beacon is stood in its intended operating manner on GPB so that its antenna is at the centre of GPB.

b) Configuration GP-LP



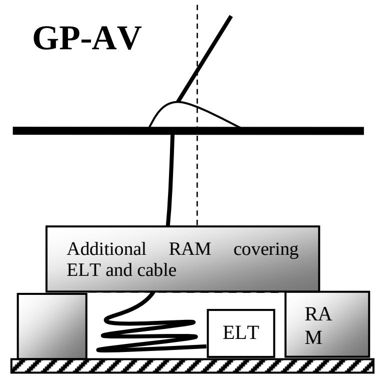
This is appropriate for beacons (or remote antennas) where these are designed to be attached to a personal flotation device, such as a foam life preserver (LP) or a gas-filled life jacket, where salt water may have a detrimental effect on the performance of the beacon and / or antenna under test. These materials will not affect RF performance. For this configuration GPB has a conductive metal sheet across its central hole. This test is to be performed by placing the beacon in a thin plastic container with a flat bottom on the GPB ground plane, such that there is no more than a 1 mm gap between the base of the beacon and the ground plane. The EL-EIRP of the beacon is then measured with the PLB remaining dry. After which without moving the beacon it shall be gently sprayed with a 5% by weight solution of salt water such that water can be seen running from the surface of the beacon and any pockets or crevices on the beacon are filled up with salt water and there is between 1 mm and 5 mm of water in the base of the container, then the EL-EIRP measurements shall be repeated. If during testing there is any sign of the PLB drying out, then it shall be sprayed again to keep it ‘wet’ throughout all the second set of tests.



For LP remote antennas, the beacon shall be attached to the underside of GPB by suitable means (e.g., copper tape) and then shall be covered in conductive foil. Any additional length of feed cable to the antenna shall be coiled up and secured next to the beacon under GPB and shall also be covered in conductive foil. The cable shall be the correct type and maximum length as recommended by the manufacturer.

c) Configuration GP-AV

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

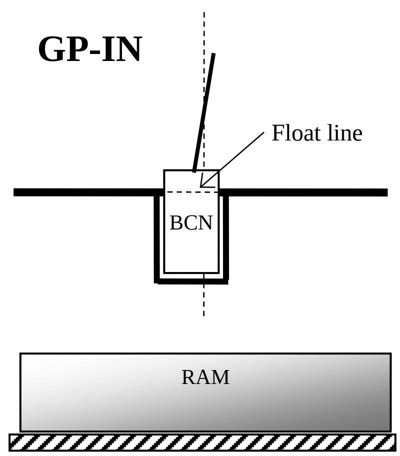


For this configuration the antenna must be mounted into the centre of GPB in its intended operational manner so that the electrical centre of the antenna is central and variations in test distance with rotation are minimised. If the antenna tilts by design then the manufacturer should specify the electrical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

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 centred 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 Annex E-1, tab E.7-1 - EL-EIRP "Raw EIRP Measurements" table with supporting data (e.g., photos provided in the test report) 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 the average level (burst) from the transmitter output power test performed at ambient temperature for a beacon with a new battery as the 0dB reference point.

g) Worst case increase and decrease in dBm over the operating lifetime test, taking the dBm value of the transmitter output power at the start of the test (the operating lifetime test at minimum temperature (or at other worst case operating temperature if applicable)) with a new battery as the 0dB reference point.

Analysis of the results table to determine pass/fail shall be as follows:

1) The worst-case correction factor to be applied to the EL-EIRP values shall be calculated as follows:
   i. Calculate the maximum increase in output power in dBm from f) above
   ii. Calculate the maximum increase in output power (if any) in dBm from g) above
   iii. Add the results of i) and ii) above together and add them to the measured EL-EIRP results and enter the results in the EL-EIRP Max Table in Annex E-1, tab E.7-1.
   iv. Calculate the maximum decrease in output power in dBm from f) above
   v. Calculate the maximum decrease in output power (if any) in dBm from g) above
   vi. Add the results of iv) and v) above together and subtract them from the measured EL-EIRP results and enter the results in the EL-EIRP Min Table in E.7-1.
2) For beacons with an integral antenna assess the results in the EL-EIRP Max and Min Tables in E.7-1 and highlight any values outside of the limits in Table B.11-3 below by striking out the results (e.g. ~~31-7~~). For beacons with a remote antenna go to step 3) below.

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
Min dBm – AG configuration only	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31

3) Where cable loss needs to be taken into account (see section B.11.2), calculate a further EL-EIRP correction factor as follows:

   i. Calculate the difference between the actual cable loss used during the EL-EIRP measurements and the minimum cable loss declared by the beacon manufacturer
   ii. Add the result of i) above to the results in the EL-EIRP Max Table and enter the results in the EL-EIRP Antenna Max Table E.7-1.
   iii. Calculate the difference between the actual cable loss used during the EL-EIRP measurements and the maximum cable loss declared by the beacon manufacturer
   iv. Subtract the result of iii) above from the results in the EL-EIRP Min Table and enter the results in the EL-EIRP Antenna Min Table E.7-1.

4) Assess the results in the EL-EIRP Antenna Max and Min Tables in E.7-1 and highlight any values outside of the limits in Table B.11-3 above by striking out the results (e.g. 31-7).

5) Measurement uncertainty of 2dB may now be applied to a maximum of 6 values between the two results tables (either EL-EIRP Max and Min or EL-EIRP Antenna Max and Min) that have failed to meet limits but would pass if measurement uncertainty were applied. Where the value is low a notional 2dB is added, where the value is high a notional 2dB 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).

6) Count the number of values remaining with strikeouts and subtract this from the total number of results 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.

7) 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 (i.e., antenna cable assembly min/max RF- losses at 406 MHz, declared in G.1).

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.11.1.2.6 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 and 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.11.1.2.6.

B.11.2.3 Required Results

An EL-EIRP result table per Annex E.7: Tab: Annex E.7-1 - 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,
d) Maximum permitted cable loss,

The worst case correction factors to be applied to the EL-EIRP results shall be applied in accordance with the methodology in B.11.1.3

B.11.3 Recalculation of EIRP Results

This section provides a methodology for recalculation of the original EL-EIRP values and re-evaluation of EL-EIRP over temperatures and operating lifetime related to changes to type approved beacons.

B.11.3.1 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

B.11.3.2 Method of Validation

For recalculation of the original EL-EIRP values taking into account a re-evaluation of EL-EIRP over temperature and at the end of the operating lifetime, the following guidance shall be used:

a) recalculate EL-EIRP values of the original test campaign (before applying any correction factors) for all beacon-antenna combinations and all applicable test configurations by correcting the EIRP values for all measurement points in the result table per Annex E.7: Tab: Annex E.7-1 - EL-EIRP, taking into account:
   - differences in the Transmitter Power Output at ambient with a new battery between the original and current test campaigns,

b) annotate the recalculated EL-EIRP test results as per Annex E.7: Tab: Annex E.7-1 - EL-EIRP;

c) apply the new worst case correction factors determined during testing of the beacon after the change has been applied to the recalculated EL-EIRP results in accordance with the methodology in B.11.1.3.

B.11.3.3 Required Results

Calculate a new set of EL-EIRP results in Annex E.7: Tab: Annex E.7-1 - EL-EIRP using the new data for all original test configurations and beacon-antenna system configurations.

Provide a detailed explanations of any EIRP adjustments due to changes in the antenna cable loss, and values of the Transmitter output power at ambient, changes over the operating temperature range and over the operating lifetime test.

If necessary, a measurement uncertainty of 0.5 dB may be applied to the specification limits. If applied, highlight the measurement points to which the measurement uncertainty of 0.5 dB was applied in Annex E.7: Tab: Annex E.7-1 - EL-EIRP.

B.12 Auxiliary Radio Locating Signal (Reserved)

B.12.1 Requirement

T.018/S.4.5.3/R.0590
T.018/S.4.5.3/R.0780
T.018/S.4.5.3/R.0790
T.018/S.4.5.3/R.0810
T.018/S.4.5.3/R.0820
T.018/S.4.5.3/R.0830
T.018/S.4.5.15.5/R.2380

B.12.2 Method of Validation

Intentionally left blank.

B.12.3 Required Results

Intentionally left blank.

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/R.0860
T.018/S.4.5.4/R.0870
T.018/S.4.5.4/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.0987
T.018/S.4.5.4.1/R.0990
T.018/S.4.5.4.2/R.1000
T.018/S.4.5.4.2/R.1005
T.018/S.4.5.4.2/R.1010
T.018/S.4.5.4.2/R.1020
T.018/S.4.5.4.2/R.1030
T.018/S.4.5.4.2/R.1040
T.018/S.4.5.4.2/R.1050
T.018/S.4.5.4.2/R.1060
T.018/S.4.5.4.2/R.1070
T.018/S.4.5.4.2/R.1075
T.018/S.4.5.4.2/R.1077
T.018/S.4.5.4.2/R.1079
T.018/S.4.5.5.3/R.1572
T.018/S.4.5.5.3/R.1574

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 presence of a GNSS self-test mode shall be verified for an ELT(DT).

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;

d) the beacon battery status, if included in the self-test feature, is as described by the manufacturer and complies with B.20; and

e) the RLS Indicator provides an indication when an RLS capable beacon has the RLS functionality enabled.

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 or paragraph 4.5.5.4 for an external navigation device input. If the manufacturer has declared that the beacon is capable of using multiple navigation sources for the GNSS self-test, then all of them shall be tested in turn. 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.

In addition for beacons with an interface to external navigation device and that have an internal GNSS receiver, both of which can provide a location during a GNSS self-test, then the test shall be repeated with both the internal navigation device and the external interface active (with an offset position of between 3 and 5 km from the actual beacon position) and it shall be confirmed that the GNSS self-test conforms to the requirements of C/S T.018 paragraph 4.5.4 f).

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.13.4 Testing for Repetitive Automated Interrogation of a Beacons Status

If the beacon includes a means of initiating some form of repetitive automated interrogation of its status from either a control on the beacon, or from a remote means of activation of such a function (e.g., an electrical control line interface to the beacon, a wireless interface etc.) then the following test procedure shall be applied.

B.13.4.1 Requirement

T.018/S.4.5.4/R.0895
T.018/S.4.5.4/R.0897

B.13.4.2 Method of Validation – Beacon Off

The transmitter output of the beacon shall be monitored for any transmissions at either 406 MHz or any of the radio locating signal operating frequencies (if applicable). The beacon shall be kept in its off or non-operational status. The means of activation of the repetitive automated interrogation of beacon status shall then be initiated and left functioning and the output of the beacon shall be monitored for a period of time equivalent to at least three times the repetition period of the automated interrogation system as declared by the beacon manufacturer in Annex G. That is if the repetition period of the automated interrogation system is 15 minutes, then the beacon output shall be monitored for at least 45 minutes. The means of activation of the repetitive automated interrogation of beacon status shall then be terminated.

B.13.4.3 Required Results – Beacon Off

During the above monitoring period no 406 MHz or any of the radio locating signal operating frequencies (if applicable) shall be detected at the transmitter output that exceed a signal level of -10 dBm. Populate the data tables with the results as required in Annex E: Tab: Annex E.1-2.

B.13.4.4 Method of Validation – Beacon On

If the repetitive automated means of interrogation is meant to function while the beacon is active, then this function will be tested as part of the normal type-approval testing to ensure that it does not interfere with the normal operation of the beacon. However, if the repetitive automated means of interrogation is not meant to function while the beacon is active, then perform the following test.

The transmitter output of the beacon shall be monitored for transmissions at 406 MHz and at any of the radio locating signal operating frequencies (if applicable). The beacon shall then be turned on, so that it is functioning in its normal operational status. The means of activation of the repetitive automated interrogation of beacon status shall then be initiated and left functioning and the output of the beacon shall be monitored for a period of time equivalent to at least three times the repetition period of the automated interrogation system as declared by the beacon manufacturer in Annex G. That is if the repetition period of the automated interrogation system is 15 minutes, then the beacon output shall be monitored for at least 45 minutes. The means of activation of the repetitive automated interrogation of beacon status shall then be terminated and then the beacon shall be turned off / deactivated.

B.13.4.5 Required Results – Beacon On

While the beacon is turned on its output shall be monitored to ensure that activation of the repetitive automated interrogation of beacon status does not interrupt or affect transmissions from the beacon as would be expected under normal operation (e.g., 406 MHz bursts occur at the correct times and contain valid messages and do not have the self-test frame synchronization pattern, etc.). Populate the data tables with the results as required in Annex E: Tab: Annex E.1-2.

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 - Summary of Encoded Position Test Requirements

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 and R.1572 and R.1573
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

T.021 Clause Number	Test Name	Requirements
B.14.2.8	RLS GNSS Receiver Satellite Tracking	TBD
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.1865

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 Annex G.

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 (-130 dBm +/- 3 dB) 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 be validated by one of the following means:

a) by measuring the GNSS signal strength at the point where the GNSS antenna in the beacon will be situated; or

b) by theoretical 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; or

c) by assessment of the C/No levels at the point where the GNSS antenna in the beacon will be situated.

The following procedure may be used to achieve option c) above.
The beacon under test shall be replaced by a GNSS patch antenna coupled to a modern GNSS Receiver capable of receiving signals from all the satellite constellations that the beacon under test is capable of receiving. The GNSS patch antenna shall be at least 18 mm by 18 mm in size. The GNSS Receiver shall be capable of outputting the received Signal to Noise Ratio (C/No) levels of the detected satellites (for example the IEC 61162-1 (NMEA 0183) GSV sentence can be used for this purpose).

The GNSS simulator shall then be set up as follows:

- The mask angle shall be set to 5 degrees above the horizon.
- Any satellite- based augmentation (SBAS) shall be turned off.

- No interference shall be superimposed on the satellite signals.
- Where possible the simulator should be set to choose satellites that will produce the best DOP for each constellation.
- The location shall be static and that of the relevant test in the following sections of B.14.
- The signal level produced by the simulator shall be adjusted for each constellation in turn, using the number of satellites from that constellation, as required by each specific test in the following sections of B.14, ideally the selected satellites should have elevations between 30 and 60 degrees.
- The signal level shall be set to provide an average C/No level of between 43 and 45 dB-Hz from all the satellites of each constellation in turn, as required by each specific test in the following sections of B.14, as received at the GNSS Receiver.

ELT(DT)s combined with Automatic ELTs shall be tested to 14.1, 14.2, 14.3 and if applicable 14.4. When functioning as an ELT(DT) tests 14.1.1, 14.1.2, 14.1.3, 14.3 and if applicable 14.4 shall be performed. When functioning as an Automatic ELT tests 14.1.1, 14.1.3, 14.2 and if applicable 14.4 shall be performed.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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 D will be run. In addition, for RLS capable beacons, there are additional test scripts in Table D.2-2 in Annex D, designed to check that RLS beacons only respond to RLMs containing the correct 15 Hex ID (truncated from the 23 Hex ID) applicable to that beacon. 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.2.

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.2
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.2 and then deactivate the beacon.
6. Run the Self-Test navigation test scripts as instructed in Annex D.2.
7. For RLS capable beacons, run the additional RLS test scripts as instructed in Annex D.2.

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. Record the results of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

For each navigation input method declared by the beacon manufacturer in their type approval application running the test scripts in Annex D.2 shall result in the beacon correctly encoding the location bits in the transmitted beacon message as defined in Annex D.2. Record the results of the Annex D.2 tests in Annex E: Tab: E.8-1 – Navigation System.

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

T.018/S.4.5.5.1/R.1145
T.018/S.4.5.5.3/R.1572
T.018/S.4.5.5.3/R.1573
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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).

Test for retention of location data prior to ELT(DT) activation.

1. Configure a device which will be able to send appropriate GNSS sentences to the internal GNSS device and if applicable to the external navigation interface, 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 (if applicable).
2. Ensure that location data is provided to the internal and if applicable external interface for a period of at least 3 minutes. After this time remove all sources of navigation data and within 1 to 5 minutes from when the signals are removed activate the ELT(DT).
3. Record the location provided in the transmitted messages.
4. Modify location #1 by at least 500 meters to provide location #3. Modify location #2 by at least 500 meters to provide location #4.
5. Reapply all navigation sources (with locations #3 and #4) to the ELT(DT) and leave it activated for a further period of at least 2 minutes and then deactivate the ELT(DT).

6. Record the location provided in the transmitted messages after the navigation signals are reapplied.

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.

Results for retention of location data prior to ELT(DT) activation.

5. Transmissions during the first 2 minutes after the ELT(DT) is activated shall contain either location #1 or #2 as applicable.
6. Transmissions shall change to provide either location #3 or #4 as applicable once the navigation sources are reapplied.

Record all the results in Annex E: Tab: E.1-9 – A.2.7.

B.14.1.3 Navigation Device Failure

B.14.1.3.1 Requirement

T.018/S.4.5.5.2/R.1150
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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. Record the results of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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. Record the results of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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. Record the results of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

B.14.2.3 Cold Start

B.14.2.3.1 Requirement

T.018/S.4.5.5.2/R.1190
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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. Record the results of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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. Ensure that when either a 2D Fix or No Fix is reported the transmitted message provide default altitude.
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. Ensure that when either a 2D Fix or No Fix is reported the transmitted message provide default altitude.
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.

Ensure that default altitude is provided in the transmitted message when either a 2D Fix or No Fix is indicated in bits 45-46 of rotating field #0.

Record the results of the assessment of compliance of the manufacturers documentation and tests in Annex E: Tab: E.1-9 – A.2.7 and the details of the results in Annex E: Tab: E.8-2 – B.14.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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 if required stop the GNSS simulator, then deactivate one GNSS satellite in the simulator to make sure only three in view satellites are transmitting to the beacon
10. If required reactivate the Simulator and then reactivate the beacon and run the GNSS simulator for a further 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. Verify that default altitude is provided in the transmitted digital message when there is a 2D fix.
14. 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 5 minutes, 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 no later than the first burst transmitted after 2 minutes from beacon activation (to allow for randomisation of the transmitted messages) of beacon activation.
Calculate the probability of first provision of location within first bursts after 2 minutes = (# times location provided within first burst after 2 minutes / (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 no later than the first burst transmitter after 2 minutes of beacon activation with a probability of 95%.
Record all the results in Annex E: Tab: E.1-9 – A.2.7 and the details of the results in Annex E: Tab: E.8-2 – B.14.

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.1355
T.018/S.4.5.5.3/R.1580
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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 beacon’s 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 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 then changes at least every 15 minutes to which 90 seconds may be added for the GNSS receiver acquisition time or in accordance with the manufacturers declared GNSS update rate if more often for the remaining 70 minutes of the test. Note that due to the lack of synchronization between the internal navigation device timing and the timing of transmissions, if transmissions are being used to monitor position updates then there may be up to 2 minutes and 5 seconds between updates.

B.14.2.6.3 Required Results

Internal navigation devices shall operate continuously during the initial 30-minute 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. This can be demonstrated by checking the location in each transmitted burst and comparing it to the actual or simulated location at the time of each transmitted burst. The location of the beacon is moving at a rate of between 140 metres per minute and 1000 metres per minute and the required static accuracy is 30 metres 95% of the time. As the location is required to be updated every second and transmitted by the beacon within 1 second of receipt, then the difference between the location in each transmitted burst and the actual or simulated location should be within 30 metres plus the rate of travel divided by 30 for at least 95% of the transmitted bursts. For example, if the beacon is actually moving or the movement is being simulated at a rate of 300 metres per minute then the required accuracy is within (30 + 10 =) 40 metres 95% of the time.

During the remaining 70 minutes of the test, similar criteria shall be applied to determine that the beacon is updating the transmitted location at least every 15 minutes from the last attempt or in accordance with the manufacturer’s declaration if more frequent and is encoding this into the next transmitted message. This is achieved by checking how often the location is updated and by ensuring that the provided locations are within 30 metres plus the distance equivalent to 2 minutes and 7 seconds of travel at the actual or simulated rate of movement 95% of the time.

Record all the results in Annex E: Tab: E.1-9 – A.2.7.

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/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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 at least 90 seconds prior to each transmitted burst unless a valid location is obtained earlier.

B.14.2.7.3 Required Results

The manufacturers documentation shall confirm that the internal navigation receiver shall be on for at least 90 seconds prior to the next transmission unless a valid location is obtained earlier. Record the result of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

B.14.2.8 RLS GNSS Receiver Satellite Tracking

For RLS capable beacons equipped with a single-constellation GNSS receiver, the beacon manufacturer shall provide a written declaration with supporting details demonstrating that the GNSS receiver used in their RLS capable beacon is configured to maximise reception of GNSS satellites in view above 5 degrees of elevation of the associated RLS provider's GNSS constellation.

For RLS capable beacons which are equipped with a multi-constellation GNSS receiver the following test shall be performed.

B.14.2.8.1 Requirements

T.018/S.4.5.9.1/R.2101
T.018/S.4.5.9.1/R.2102

B.14.2.8.2 Introduction

This test is designed to ensure that the GNSS receiver in the beacon is capable of receiving signals from the satellites in view above 5 degrees elevation within the relevant RLS constellation. This test may be performed by either the beacon manufacturer or the Cospas-Sarsat test facility. If performed by the beacon manufacturer then an annotated results file shall be provided to the test facility, so that they can verify the results obtained.

B.14.2.8.3 Setup

This test requires a specially configured type approval beacon fitted with a new battery pack, for the avoidance of doubt, it is not acceptable to just test a GNSS receiver in isolation. The GNSS receiver shall be configured such that it is permanently on and the output of the GNSS receiver shall be connected to a data logger and configured to output NMEA or equivalent proprietary sentences that provide details of the satellites being tracked (e.g., NMEA 0183 GSV (GNSS Satellites in View) sentence). There shall be a method of time stamping the data provided, such as by linking it to another output sentence (e.g., NMEA 0183 ZDA (Time and Date)) or by having the data logger time stamp the incoming data.

The data logger shall be capable of recording the NMEA or equivalent proprietary sentences being output by the GNSS receiver, at least once every minute for a minimum of 24 hours. Only those sentences applicable to the RLS providers GNSS constellation need to be recorded. The sentences shall be time stamped in some way.

The test may be performed either outside, with a clear view of the sky in all directions above 5 degrees in elevation, or with the use of a GNSS simulator. If a GNSS simulator is used, then it shall be able to produce, as a minimum, a full GPS satellite constellation and a full satellite constellation of the relevant RLS service provider. The simulator shall be adjusted to produce a signal level at the input to the beacon under test of around -130 dBm. The simulator shall initially run in real time, using its current location, time and date and shall provide all of the appropriate satellites in view at that time and place from, as a minimum, both the GPS and RLS constellations. Note if using a simulator, then if required, rather than just leaving the simulator running in real time, it is permissible to jump ahead in time between each data logging event to the start of the next event.

B.14.2.8.4 Test Procedure

The test is intended to gather data on the satellites in view of the RLS service providers constellation, as detected by the GNSS receiver in the beacon, over a period of 15 minutes every hour for 12 hours and compare this with the actual satellites in view, in order to assess how well the receiver tracks all the satellites in view.

The beacon under test shall either be placed outside on level ground with a clear view of the sky, or in the test chamber with the simulator as appropriate. Note if using a simulator, then great care shall be taken to ensure that the beacon under test cannot also receive signals from overhead GNSS satellite constellations.

The simulator shall be turned on (if applicable) and the beacon under test shall be connected to the data logger. The beacon shall then be turned on and shall be left on for a period of between 12 hours and 12 hours plus 15 minutes (this period may be less if using a simulator and jumping time ahead). During this entire time the output of the GNSS receiver shall be monitored by the data logger and the received sentences shall be time stamped and stored for subsequent analysis. During the test the data shall be monitored on a regular basis to ensure that the correct NMEA or equivalent proprietary sentences are being time stamped and recorded. At the end of the time period the beacon and all the test equipment shall be turned off.

B.14.2.8.5 Data Analysis

The beacon manufacturer or the test facility (as applicable) shall establish which satellites in the RLS service provider’s constellation were operational at the time of the test, by reviewing the published satellite health data for the satellite constellation in question. That is the list of the RLS service provider’s satellites providing navigation signals at the time of the test. Care shall be taken to ensure that any satellites that only provided navigation data for a part of the test period were actually above the horizon at the test site at this time, otherwise they shall be discarded.

The beacon manufacturer or the test facility (as applicable) shall then review the constellation data for the time and date of the test and determine for the first 15 minutes of each hour of the test which satellites were more than 5 degrees above the horizon for the entire 15 minute time period.

This list of satellites shall then be compared to those satellites that were received during that same time period.

B.14.2.8.6 Pass / Fail Criteria

The beacon under test shall have detected at least 90%, rounded down to the nearest integer number, of the RLS provider's GNSS satellites above 5 degrees over the horizon at least once in each 15-minute test period. Record all the results in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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. Record the results of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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.
Record the results of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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). Record the result of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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. Ensure that when either a 2D Fix or No Fix is reported the transmitted message provides default altitude in bits 22-31 of rotating field #1.
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. Ensure that when either a 2D Fix or No Fix is reported the transmitted message provides default altitude in bits 22-31 of rotating field #1.
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.

Default Altitude is provided in the transmitted message when either a 2D Fix or No Fix is indicated in bits 36-37 of rotating field #1.

Record all the results in Annex E: Tab: E.1-9 – A.2.7 and the details of the results in Annex E: Tab: E.8-2 – B.14.

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
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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. Verify that default Altitude is provided in the transmitted digital message when there is a 2D fix.
14. 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 5 minutes, 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%.

Record all the results in Annex E: Tab: E.1-9 – A.2.7 and the details of the results in Annex E: Tab: E.8-2 – B.14.

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

T.018/S.4.5.5.3/R.2365
T.018/S.4.5.5.3/R.2367
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

B.14.3.6.2 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 beacon's transmissions.

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.3 and monitor the encoded 3D positions provided by the ELT(DT) while running the simulator scenario in Annex D.3, 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.

The logging system shall be synchronized with the GNSS simulator scenario time within 10 ms, or the delay between the reference time of the logging system and the GNSS simulator scenario time shall be measured to an accuracy better than 10 ms. This delay shall be taken into account in the analysis described hereafter.

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.3 scenario (which in effect simulates a rapid deceleration resulting from an impact). Check that the last available location transmitted by the ELT(DT) before impact is less than 11.1 km (6 NM) from the impact location (latitude = 13.69361° and longitude = 40.71091°) and that a location within 200 m of the impact location (latitude = 13.69361° and longitude = 40.71091°) is transmitted not later than 15 seconds after the 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.
Record all the results in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S.4.5.5.3/R.1605
T.018/S4.5.16.6/R.2530
T.018/S4.5.16.6/R.2540
T.018/S4.5.16.6/R.2550
T.018/S4.5.16.6/R.2560

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 at least 15 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 25 seconds when two bursts have occurred without the receiver providing a location.

The manufacturer supplied documentation shall be inspected to determine if the design of the beacon keeps the GNSS receiver on for at least 180 seconds once every hour after the first hour following beacon activation.

B.14.3.7.3 Required Results

The manufacturer's documentation shall confirm that the internal navigation receiver shall be on for at least 15 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 at least 25 seconds prior to the next transmission. In addition, it shall be confirmed from the documentation that the internal navigation receiver is on for at least 180 seconds once every hour, after the first hour following beacon activation. Record the result of the assessment of compliance of the manufacturers documentation in Annex E: Tab: E.1-9 – A.2.7.

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. Record the results of the inspection of the beacon installation and user manual in Annex E: Tab: E.1-9 – A.2.7.

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.1840
T.018/S.4.5.5.4/R.1850
T.018/S.4.5.5.4/R.1860
T.018/S.4.5.5.4/R.1865

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 (DOP not applicable for ELT(DT)s) 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 (not applicable for ELT(DT)s).
11. Record the fix type for each burst.
12. Check that the horizontal location error in each burst does not exceed 20 metre
13. Check that the altitude error in each burst does not exceed 40 metres
14. Check that the HDOP and VDOP values encoded into each transmitted message match those injected into the beacon (not applicable for ELT(DT)s).
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.

B.14.4.2.3 Required Results

The horizontal location error shall not exceed 20 metres in each burst.

The altitude error shall not exceed 40 metres in each burst.

The location is updated in each transmitted burst.

The HDOP and VDOP are correctly encoded in each transmitted burst (not applicable to ELT(DT)s).
The fix type information is correctly encoded in each transmitted burst.

Ensure that the last encoded location and default data are correctly handled by the beacon (i.e., the beacon continues to transmit the last encoded location and increments the 'time of last encoded location' and then reverts to transmitting default data once the beacon is reactivated).

Record all the results in Annex E: Tab: E.1-9 – A.2.7.

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
T.018/S.4.5.6/R.1912
T.018/S.4.5.6/R.1914
T.018/S.4.5.6/R.1918

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. Record the results of the inspection and analysis of the beacon in Annex E: Tab: E.1-11 – A.2.9.

B.15.2 ELT(DT)s

This section includes requirements for all types of ELT(DT)s unless specifically stated otherwise herein.

B.15.2.1 Requirement – ELT(DT)s

T.018/S.4.5.6.1/R.1920
T.018/S.4.5.6.1/R.1930
T.018/S.4.5.7.1/R.1940
T.018/S.4.5.6.1/R.1950
T.018/S.4.5.6.1/R.1955
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
T.018/S.4.5.16.4/R.2470
T.018/S.4.5.16.4/R.2490

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.

In addition, ELT(DT)s combined with Automatic ELTs shall be tested to ensure that they continue to meet B.15.2.2 when functioning as an Automatic ELT.

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

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

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. Specifically, this shall include details of all the external control lines to the ELT(DT) from the aircraft and its avionics systems including any interactions between them (e.g., an air/ground switch, 28V supply presence or absence, ARINC labels (including if there are multiple ARINC lines the interactions between them), and hard-wired inputs etc.).

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

B.15.2.2.1 Activation and Deactivation Tests

The tests in Table B.15-1 are designed to check for correct activation and deactivation of the ELT(DT) coupled with the transmission of the correct message bits and the Cancellation Message at the appropriate time. The complete test shall be performed once with the automatic activation by external means provided by an ARINC label (or equivalent).

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 Table B.15-1 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.

B.15.2.2.2 Automatic Activation by External Means Interaction Tests

A subset of the tests in Table B.15-1 shall then be repeated for all the other means of activation as to ensure that every means of activation results in activation of the ELT(DT) as follows:

- Manual activation from the beacon: Tests 1, 8 and 11
- Automatic activation by the beacon (only if there is more than one means of these): Tests 1, 14 and 19[*]
- Automatic activation by external means: Tests 1, 2 and 5

The test facility shall examine the information provided by the beacon manufacturer related to all the external control lines to the ELT(DT) from the aircraft and its avionics systems and take note of any interactions between these inputs (for example where one input is designed to prevent or allow another input to function correctly, or where there are other interactions between inputs).

Tests 1, 2 and 5 in Table B.15-1 shall then be repeated for all the interaction combinations of these inputs as identified by the beacon manufacturer.

In each case the results of Test 2 shall depend on the permissible interactions, for example if the ELT(DT) has an ‘air/ground’ switch then the test shall be performed with this switch in the ‘air’

[*] The ELT(DT) when activated by the crash sensor (i.e., automatic activation by the beacon) may need to be reset by a means defined by the beacon manufacturer in order to return to the Armed mode.

position with an ARINC input applied and shall pass and shall then be repeated with the switch in the 'ground' position with an ARINC input applied and the test shall fail.

B.15.2.2.3 Automatic Activation by External Means Sequential Activation Tests

In addition to the above test, a sequence of activations/deactivations shall be performed such that each automatic activation by external mean is activated successively and then deactivated successively. An example is given in Table B-15.2 below in the case of four automatic activation by external means. The test facility shall modify the table to adapt to the number of automatic activation by external means available at the beacon and replace the activation means number by its description (e.g., "automatic activation means #1" → "Activation through ARINC label").

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, Transmission of a Cancellation Message Sequence in accordance with section B.16.2.3, Correct BCH and Correct ELT(DT) status) shall be recorded in the results table,
d) The results of each of the interaction tests shall be recorded in the results table with details of the combinations of input conditions defined and the related pass fail results noted against each combination,
e) The results of the sequential activation tests shall be recorded in the results table with details of the sequential activation test results in the expected performance.

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.

Record the results of the inspection of the beacon and its documentation together with the results of the Activation and Deactivation tests in Annex E: Tab: E.1-11 – A.2.9.

Table B.15-1 - ELT(DT) Beacon Activation Tests

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
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 ‡	Disabled	Disabled	N/A	ARMED
24b	Enabled §	Disabled	Disabled	0100	ON
25	Disabled	Disabled	Disabled	N/A	ARMED

* 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.

‡ 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

Table B.15-2 - ELT(DT) Sequential Automatic Activation by External Means Tests (example with four automatic-activations by external means)

Test No	Auto activation #1	Auto activation #2	Auto activation #3	Auto activation #4	Message Bits 186-189	ELT(DT) status
A	Disabled	Disabled	Disabled	Disabled	N/A	ARMED
B	Enabled	Disabled	Disabled	Disabled	1000	ON
C	Enabled	Enabled	Disabled	Disabled	1000	ON
D	Enabled	Enabled	Enabled	Disabled	1000	ON
E	Enabled	Enabled	Enabled	Enabled	1000	ON
F	Disabled	Enabled	Enabled	Enabled	1000	ON
G	Disabled	Disabled	Enabled	Enabled	1000	ON
H	Disabled	Disabled	Disabled	Enabled	1000	ON
I	Disabled	Disabled	Disabled	Disabled	N/A	ARMED

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.4.5.7.3/R.2021
T.018/S.4.5.7.3/R.2022
T.018/S.4.5.7/R.2024
T.018/S.4.5.7.1/R.2025
T.018/S.4.5.7.1/R.2026
T.018/S.4.5.7.2/R.2028
T.018/S.4.5.7.2/R.2029
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
T.018/S.4.5.16.5/R.2520

B.16.2 Method of Validation

For ELT(DT)s combined with Automatic ELTs, test B.16.2.3 shall be performed while the device is functioning as a DT and test B.16.2.4 shall be performed while the device is functioning as an Automatic ELT.

B.16.2.1 Inspection – all beacons (except ELT(AD)s, (AF)s, and (DT)s)

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 (except ELT(AD)s, (AF)s, and (DT)s)

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).

Before activating the beacon, initiate the cancellation function and check that the beacon does not activate and does not transmit any cancellation messages or provide an indication of the transmission of any cancellation messages.

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

a) transmitter power output, per para. B.1;

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 burst transmission interval, per para B.7.3;

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; and

i) provides an indication of the transmission of the cancellation messages.

Leave the beacon for at least 5 minutes and then activate the beacon and ensure that it is transmitting as normal. Then deactivate the beacon using the Off/Reset control and ensure that the beacon ceases transmitting and does not transmit any cancellation messages.

Wait for a period of 170 +/- 5 seconds and then initiate the cancellation function and check that the beacon activates and transmits a sequence of 10 cancellation messages and provides an indication of this and then ceases transmitting.

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* The message content is as defined in Annex C.

Leave the beacon for at least 5 minutes and then activate the beacon and ensure that it is transmitting as normal. Then deactivate the beacon using the Off/Reset control and ensure that the beacon ceases transmitting and does not transmit any cancellation messages.

Wait for a period of 190 +/- 5 seconds and then initiate the cancellation function and check that the beacon does not activate and does not transmit any cancellation messages or provide an indication of the transmission of any cancellation messages.

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

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. B.1;
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 burst transmission interval, per para B.7.3;
g) message structure and content[*], per para B.6 and para B.8 sub-sections, as appropriate; and
h) after transmitting 10 cancellation messages the beacon ceases transmitting.

B.16.2.4 Cancellation Message – ELT(AD)s, (AF)s, and (AP)s only

The ELT shall be remotely activated by both the automatic activation by the beacon (e.g., G-switch) and by the remote manual activation (e.g., Remote Control Panel) and then shall be deactivated by the same means. The test specified below shall be performed at ambient temperature only.

In one of the above two tests verify g) and h) below and then during the other test verify all of the parameters below:

a) transmitter power output, per para. B.1;
b) carrier frequency stability, per para B.2.2;

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

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 burst transmission interval, per para B.7.3;

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

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

B.16.2.5 Reactivation Test – all beacons (except ELT(AD)s, (AF)s, and (DT)s)

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 on the beacon. 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 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.16.2.6 Reactivation Test – ELT(AD)s, (AP)s, (AF)s, and (DT)s only

This test is in addition to the test in B.16.2.5 for ELT(AP)s. The test specified below shall be performed at ambient temperature only.

The ELT shall be activated by one of the means external to the ELT (either auto-activation by the beacon, auto-activation by external means, or remote-manual activation) 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 the ELT shall be reactivated by the same means as above.

The transmissions from the ELT shall be monitored to ensure that the ELT 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.

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* The message content is as defined in Annex C.

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 except ELT(AD)s, (AF)s, and (DT)s
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 except ELT(AD)s, (AF)s, and (DT)s
c) The beacon shall be checked to ensure that the cancellation function meets the requirements of B.16.2.2 (at all three operating temperatures), B.16.2.3 (at ambient only) and B.16.2.4 (at ambient only) as appropriate.
d) 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.
e) On ELT(AD)s, (AF)s, (AP)s, and (DT)s only the cancellation message shall be initiated by a means external to the ELT(AD)s, (AF)s, (AP)s, and (DT)s and part way through the cancellation sequence the ELT(AD)s, (AF)s, (AP)s, and (DT)s 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.1-11 – 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.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 and GNSS Self-Test Controls

B.18.1.1 Requirements

T.018/S.4.5.4.1/R.0990
T.018/S.4.5.4.2/R.1010

B.18.1.2 Method of Validation

To determine, if a beacon transmits only one self-test transmission as required by document C/S T.018, section 4.5.4, it shall be tested, at ambient temperature only, in the following way.

a) For beacons that have a common self-test and GNSS self-test control (which may or may not be combined with other functions) where the only differentiation between the activation of either of these two self-test modes 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’. Perform test i) below but only maintain the control in the self-test activation mode for X-1 seconds and then release it. Then perform test ii) as detailed below.

b) For beacons where either self-test function is initiated by the release of the control, rather than by its activation, the following 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.

c) For all other beacons perform tests i) and ii) as shown below.

Tests Procedure

i. The 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.

ii. If the beacon is equipped with a GNSS self-test mode then the GNSS self-test control(s) shall be activated and, where possible, the(se) control(s) shall be then 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.

B.18.1.3 Required Results

Determine the type of beacon control(s) included in the beacon design to determine what testing is required and then populate the data tables as required in Annex E.1-11 - A.2.9.

B.18.2 Operational Controls

B.18.2.1 Requirements

T.018/S.4.5.6/R.1914
T.018/S.4.5.6/R.1918

B.18.2.2 Method of Validation

To verify that the beacon:

1) does not transmit more frequently than at the minimum burst transmission interval (as defined in document C/S T.018 section 2.2.1) regardless of the duration of activation of any controls or the activation of any combination of controls and
2) once activated and transmitting, the activation of any control other than the 'Off', 'Reset' or 'Cancellation' controls does not stop the beacon from transmitting (as defined in document C/S T.018 section 4.5.6),

the beacon shall be tested, at ambient temperature only, in the following way:

a) Each manual operational control designed to activate the beacon (e.g., On, Remote On, etc.) shall be activated individually 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 (e.g., for beacons that have separate controls to manually activate the beacon in operational mode and in the self-test/GNSS self-test mode), 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 2 seconds 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. In the case of test b)i., when the automatic activation of the beacon precedes this test step, the beacon is expected to remain in the 'on' condition and continue transmissions of normal operating mode messages in an uninterrupted manner.

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 burst transmission interval defined in document 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.18.2.3 Required Results

Populate the data tables as required in Annex E.1-11 - A.2.9.

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.4.5.9.2.1/R.2110
T.018/S.4.5.9.2.1/R.2120
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.4.5.9.3/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.4.5.9.4/R.2255
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 bit 42 set to “1”, and bit 43 set to “1”). 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: 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.

[*] 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.

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.2135
T.018/S.4.5.9.2.1/R.2140
T.018/S.4.5.9.2.1/R.2145
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.

Note, that each accepted test facility and beacon manufacturer shall choose one of the Hex IDs assigned to it as indicated in Table B.19-1. Accepted test facilities and/or beacon manufacturers shall coordinate the on-air tests with the relevant MCC and the Return Link Service Provider (RLSP)[†].

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 corresponds to the one, which was chosen by the TA facility and manufacturers.

[*] 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.
† A general Cospas-Sarsat rule is that, for on-air tests, test beacons shall be test coded (bit 43 = 1), and that these tests shall be coordinated with and receive approval from the responsible MCC and/or National authority. It is recommended that requests for on-air tests be submitted to MCCs well in advance of the planned test date and include information related to the planned test.

Table B.19-1 - 23 Hex ID values used in M_{offset} and UTC Tests

TA Facility or Manufacturers	23 Hex ID value	S/N	M_{offset}
EPG	99349C3C3E7C0F0F0F00000	999	54
	99349C3C3F3C0F0F0F00000	1011	
	99349C3C434C0F0F0F00000	1076	
	99349C3C43EC0F0F0F00000	1086	
	99349C3C461C0F0F0F00000	1121	
Mayak Bincos	99349C3D0FDC0F0F0F00000	4349	11
	99349C3D100C0F0F0F00000	4352	
	99349C3D105C0F0F0F00000	4357	
	99349C3D128C0F0F0F00000	4392	
	99349C3D12DC0F0F0F00000	4397	
Omega	99349C3D00BC0F0F0F00000	4107	27
	99349C3D01FC0F0F0F00000	4127	
	99349C3D023C0F0F0F00000	4131	
	99349C3D037C0F0F0F00000	4151	
	99349C3D043C0F0F0F00000	4163	
TC NIIR	99349C3C36BC0F0F0F00000	875	33
	99349C3C36EC0F0F0F00000	878	
	99349C3C391C0F0F0F00000	913	
	99349C3C3C1C0F0F0F00000	961	
	99349C3C3C4C0F0F0F00000	964	
TÜV SÜD	99349C3D006C0F0F0F00000	4102	48
	99349C3D00CC0F0F0F00000	4108	
	99349C3D012C0F0F0F00000	4114	
	99349C3D018C0F0F0F00000	4120	
	99349C3D0A6C0F0F0F00000	4262	
Manufacturer	99349C3D1A8C0F0F0F00000	4520	40
	99349C3D1ADC0F0F0F00000	4525	
	99349C3D1FDC0F0F0F00000	4605	
	99349C3D2E3C0F0F0F00000	4835	
	99349C3D300C0F0F0F00000	4864	

Turn the beacon on at any time between 5 minutes and 15 minutes past any natural hour (e.g., between 09:05 and 09:15, between 15:05 and 15:15 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 the subsequent 5 odd numbered bursts are also Rotating Field #2;

- that bits 42-43 in the 406 MHz transmitted message (in the Main Message Field) are set to ‘11’ (Beacon RLS Test Capability);

- 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 170-175 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘000000’ (Beacon Feedback);
- that the second transmitted message is Rotating Field #0 and that the subsequent 5 even numbered bursts are also Rotating Field #0;

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 175 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 170-175 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘101111’ (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 either is on or turns on at M_{offset} minutes +/- 5 seconds in the same natural hour, if (t_{on} +30) ≤ M_{offset}, or at M_{offset} minutes ± 5 seconds in the next natural hour, if (t_{on} +30) > M_{offset} (e.g., if the beacon was first activated at 10:11 check to ensure that the GNSS Receiver either is on or turns on again at 10 hours and M_{offset} minutes +/- 5 seconds, if M_{offset} ≥ 41, or at 11 hours M_{offset} minutes ± 5 seconds, if M_{offset} < 41);

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 off and on one or more times as the manufacturer may choose to implement, consistent with other requirements of this document);

l) monitor the GNSS Receiver for a further hour and ensure that it either is on or turns on at M_{offset} minutes +/- 5 seconds after the next natural hour (e.g., if the beacon was first activated at 10:11 check to ensure that the GNSS receiver either is on or turns on again this time at 11 hours and M_{offset} minutes +/- 5 seconds, if $M_{offset} \geq 41$, or at 12 hours M_{offset} minutes ± 5 seconds, if $M_{offset} < 41$); 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: 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.

Correctness of the RLS indication shall be verified during RLS test, and, where appropriate, during testing of other test parameters by taking necessary observations of the test beacon indication. The results of the test shall be recorded in the Annex E.1, for observations of the following beacon indication.

During the RLS test, make necessary measurements and observations and verify the correctness of the RLS indication and that:

a) the unique distinct indication RLS request, which shall be provided within 5 seconds after the beacon activation, and until a valid RLM Type 1, or Test RLM message is received, or the beacon is switched off, or the beacon battery is expired (this indication shall be verified as part of the test, described in section B.19.2.2, item a)); and

b) distinct indication that the RLM Type-1 or Test RLM has been received, which shall be provided within 5 seconds after the RLM has been received until either the beacon is deactivated or the beacon battery is expired (this indication shall be verified during the test, described in section B.19.2.2, item f)).

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.2135
T.018/S.4.5.9.2.1/R.2140
T.018/S.4.5.9.2.1/R.2145
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 15 minutes past any natural hour (e.g., between 09:05 and 09:15, between 15:05 and 15:15, 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 the subsequent 5 odd numbered bursts are also Rotating Field #2;
   - that bits 42-43 in the 406 MHz transmitted message (in the Main Message Field) are set to ‘11’ (Beacon RLS Test Capability);
   - 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 170-175 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘000000 (Beacon Feedback;
   - that the second transmitted message is Rotating Field #0 and that the subsequent 5 even numbered bursts are also Rotating Field #0;
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 170-175 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to ‘000000’ (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 off and on one or more times as the manufacturer may choose to implement, consistent with other requirements of this document);
i) monitor the GNSS Receiver and ensure that it either is on or turns on at M_{offset} minutes +/- 5 seconds in the same natural hour, if (t_{on} +30) ≤ M_{offset}, or at M_{offset} minutes ± 5 seconds in the next natural hour, if (t_{on} +30) > M_{offset} (e.g., if the beacon was first activated at 10:11 check to ensure that the GNSS Receiver either is on or turns on again

at 10 hours and M_{offset} minutes +/- 5 seconds, if $M_{offset} \geq 41$, or at 11 hours M_{offset} minutes ± 5 seconds, if $M_{offset} < 41$). Note that 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 off and on one or more times as the manufacturer may choose to implement, consistent with other requirements of this document);

k) monitor the beacon's 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 170-175 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '000000' (Beacon Feedback).

l) monitor the GNSS Receiver for a further hour and ensure that it either is on or turns on at M_{offset} minutes +/- 5 seconds after the next natural hour (e.g., if the beacon was first activated at 10:11 check to ensure that the GNSS Receiver either is on or turns on again this time at 11 hours and M_{offset} minutes +/- 5 seconds, if $M_{offset} \geq 41$, or at 11 hours M_{offset} minutes ± 5 seconds, if $M_{offset} < 41$);

m) within 10 seconds to 20 seconds of the GNSS Receiver required M_{offset} turn on time 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 (an RLM); and

p) monitor bits 161 to 175 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 170-175 in the 406 MHz transmitted message (when transmitting Rotating Field #2) are set to '101111' (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: 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.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 (e.g., CPO, CCO, CBP, etc., see ANNEX H.1.25) necessary to perform the test procedure.

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 minimum duration of continuous operation, and/or the PIE criteria is <u>not</u> 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 <u>is met</u>.

<u>**Step-**1: Verification of the Self-Test Indication of Sufficient Battery Energy</u>

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.1.25).

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 $\mathbf{C_{PO} + C_{SP\ AMB}}$ **+ 30 minutes)**[*]**,** or until the amount of the residual battery energy indicated by the beacon manufacturer as their criteria for triggering PIE indication plus 30 minutes, if this amount is different from $\mathbf{C_{CO}}$**.** 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.

[*] 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 A.2.3, 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 $\mathbf{C_{SP\text{-}AMB}}$.

B.21 Beacon Labelling

B.21.1 Requirement

T.018/S.4.5.11/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)
5) If applicable any Programming Adapter is labelled with the Beacon Model that it relates to, its own unique TAC and Serial Number and that there is space to provide the Country Code and Vessel ID information programmed into the adapter
6) For RLS capable beacons the presence of wording on the Beacon Identity label (TAC / Hex ID Label) indicating whether the RLS function is enabled or disabled,
7) For RLS capable beacons, confirm that the RLS and RLM indicator(s) are correctly identified, e.g., using a label(s).

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: XXXXXX XXXXXX XXXXXX XXXXX
    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.
7) That any Programming Adapter (if applicable) is labelled with the Beacon Model that it relates to, its own unique TAC and Serial Number and that there is space to provide the Country Code and Vessel ID information programmed into the adapter
8) That RLS-capable beacons are correctly labelled on the Beacon Identity label (TAC / Hex ID Label) indicating whether the RLS function is enabled or disabled.
9) That RLS-capable beacons correctly identify the RLS and RLM indicator(s), e.g., using a label(s).

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.1-13 - A.2.11, 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.4.5.5.4/R.1680
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, Cancellation Function, 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, Cancelation Function, 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 compliant result shall be indicated in the test report by a ‘Y’ and a non-compliant result shall be indicated by a ‘N’ 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.1-13 - A.2.11, for each test parameter indicated above using the data collected during the test.

B.23 PROGRAMMING ADAPTER TESTS

If a beacon model can be supplied and / or fitted with an optional Programming Adapter carry out the following additional requirements / tests.

B.23.1 Programming Adapter Requirements

B.23.1.1 Requirement

T.018/S.3.7/R.0651
T.018/S.3.7/R.0652
T.018/S.3.7/R.0653

T.018/S.3.7/R.0654
T.018/S.3.7/R.0655
T.018/S.3.7/R.0656
T.018/S.3.7/R.0657
T.018/S.3.7/R.0658
T.018/S.3.6/R.0675
T.018/S.3.6/R.0676
T.018/S.3.6/R.0677
T.018/S.3.6/R.0678

A Programming Adapter shall only be capable of functioning with one particular Beacon Model; separate Beacon Models shall require the use of a different Programming Adapter.

Each Programming Adapter shall be given its own unique Serial Number by the beacon manufacturer.

The manufacturer shall program a unique combination of TAC Number and Serial Number into every Programming Adapter before it leaves their factory. The TAC Number and Serial Number shall not be capable of being deleted from that Programming Adapter or being overwritten by any means.

If a unit is destroyed or recycled at the end of its life, the unique combination of TAC Number and Serial Number used in that Programming Adapter shall not be used in another Programming Adapter.

All data stored in a Programming Adapter shall be in non-volatile memory.

B.23.1.2 Method of Validation

The manufacturer shall supply evidence that all of the above functionality is complied with, this evidence shall be inspected by the test facility to determine that it satisfactorily meets the above requirements.

B.23.1.3 Required Results

At the end of the inspection all functionality 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.1-11 - A.2.9, for each requirement indicated above, based upon the inspection of evidence carried out.

B.23.2 Programming Adapter Tests

B.23.2.1 Requirement

T.018/S.3.7/R.0652
T.018/S.3.6/R.0677

The beacon without the Programming Adapter attached shall be tested in accordance with Section 4.6 to determine the operating mode that draws maximum battery energy. The test shall be repeated on the mode that draws maximum battery energy, but with the Programming Adapter attached to the beacon.

B.23.2.2 Method of Validation

The mode (either with the Programming Adapter attached or detached) which draws the maximum battery energy shall be subjected to all the relevant tests in Annex A, just like any other beacon. If there is no difference in the maximum battery energy between the two modes, or the difference is less than [100uA], then the tests shall be performed with the PA attached to the beacon.

Note that during both sets of Beacon Coding Software tests (A.2.8) the TAC, Serial Number and Country Code as well as the Vessel ID shall be verified in each case.

The alternative mode (e.g., if the Programming Adapter was attached for the above tests, then for these tests it shall be detached) which draws less battery energy shall then be subjected to the following tests:

- A.2.1 – Electrical and Functional Tests at Constant Ambient Temperature
- A.2.8 – Beacon Coding Software

B.23.2.3 Required Results

Populate the data tables as required in Annex E.1: Tabs for the A.2.1 tests:

Annex E.1-1 - A.2.1 – Normal Sequence,
Annex E.1-2 - A.2.1 – Self-Test Sequences,
Annex E.1-3 - A.2.1 - VSWR, and
Annex E.2-1 – Constant Temperature Test Details (Normal Sequence)
Annex E.2-2 – Constant Temperature Test Details (Self-Test Sequence)
Annex E.2-3 – Constant Temperature Test Details (VSWR)

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.

Populate the data tables as required in Annex E.1: Tabs for the A.2.8 tests, as applicable:

Annex E.1-10 - A.2.8, and
Annex E.11-1

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.

B.23.3 Programming Adapter (PA) Message Coding Tests

B.23.3.1 Requirement

T.018/S.3.7/R.0664
T.018/S.3.7/R.0659
T.018/S.3.7/R.0661
T.018/S.3.7/R.0662
T.018/S.3.7/R.0663

T.018/S.3.6/R.0677

B.23.3.2 Method of Validation

The following tests shall be carried out for one Vessel ID option only. The same Vessel ID type (e.g., Aircraft Registration Marking) shall be used for both the beacon and the programming adapter. The beacon shall be coded in accordance with Table C.1-1 and the programming adapter shall be coded in accordance with Table C.1-7.

Then the following tests shall be performed.

1) Connect the PA into the beacon.
2) Activate the beacon.
3) Ensure that the transmitted message contains the PA TAC, Serial Number, Country Code and Vessel ID as defined in Table C.1-7.
4) Leave the PA connected and deactivate the beacon.
5) Carry out a self-test and ensure that the self-test digital message contains the PA TAC, Serial Number, Country Code and Vessel ID as defined in Table C.1-7.
6) Reactivate the beacon and ensure that the transmitted message contains the PA TAC, Serial Number, Country Code and Vessel ID as defined in Table C.1-7.
7) Leaving the beacon activated, disconnect the PA.
8) Ensure that the transmitted message still contains the PA TAC, Serial Number, Country Code and Vessel ID as defined in Table C.1-7.
9) Deactivate the beacon and leave it off for at least 5 minutes.
10) Carry out a self-test and ensure that the self-test digital message contains the Beacon TAC, Serial Number, Country Code and Vessel ID as defined in Table C.1-1.
11) Reactivate the beacon.
12) Ensure that the transmitted message contains the Beacon TAC, Serial Number, Country Code and Vessel ID as defined in Table C.1-1.
13) Leaving the beacon activated, reconnect the PA.
14) Ensure that the transmitted message still contains the Beacon TAC, Serial Number, Country Code and Vessel ID as defined in Table C.1-1.
15) Leaving the PA connected, deactivate the beacon and leave it off for at least 5 minutes.
16) Reactivate the beacon.
17) Ensure that the transmitted message now contains the PA TAC, Serial Number, Country Code and Vessel ID as defined in Table C.1-7.
18) Deactivate the beacon.

B.23.3.3 Required Results

Populate the data tables as required in Annex E.1: Tab Annex E.1-11 - A.2.9, using the results obtained during the above test sequence.

- 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 (16 bits)	1-16	9,999 decimal for TAC
Serial Number (14 bits)	17-30	999 decimal for serial number for non-RLS beacons, or see Table B.19-1 for S/N to use for RLS beacons.
Country Code (10 bits)	31-40	201 decimal
Status Of Homing Device (1 bit)	41	Set by the beacon
RLS function (1 bit)	42	"0" beacon without RLS capability or with this capability disabled "1" beacon with RLS capabilities enabled
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 or national use (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

Field name (main field)	**Bit positions**	**Value**
Vessel ID: Radio call sign (44 bits)	94-137	100100 100100 100100 100100 100100 100100 100100 00 binary
Vessel ID field ID – Aircraft registration Marking (3 bits)	91-93	011 binary
Vessel ID – Aircraft Registration Marking (44 bits)	94-137	100100 100100 100100 100100 100100 100100 100100 00 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: Aviation 24 bit address and 3LD “AAA” (44 bits)	94-137	0000 1111 0000 1111 0000 1111 11000 11000 11000 00000 binary
Vessel ID field ID: Aircraft operator and serial number (3 bits)	91-93	101 binary
Vessel ID: Aircraft operator “AAA” and serial number “1” (44 Bits)	94-137	11000 11000 11000 0000 0000 0001 1111 1111 1111 11111 binary
Vessel ID: Reserved for System Testing (3 bits)	91-93	111 binary
Vessel ID: Reserved for System Testing (44 Bits)	94-137	All 0’s
Beacon Type (3 bits)	138-140	As appropriate to the beacon type (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
Unassigned (2 bits)	159-160	00 binary
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

Table C.1-7 - Programming Adapter Coding

Field name (main field)	Bit positions	Value
TAC Number + Serial Number (30 bits)	1-30	9,998 decimal for TAC, 998 decimal for serial number
Country Code (10 bits)	31-40	202 decimal
Select from the following Vessel ID values depending on the Vessel ID type used by the beacon under test		
Vessel ID field ID: MMSI (3 bits)	91-93	001 binary
Vessel ID:MMSI (44 bits)	94-137	111000000 decimal plus 10101010101010 binary
Vessel ID field ID: Radio call sign (3 bits)	91-93	010 binary
Vessel ID: Radio call sign (44 bits)	94-137	011000 011000 011000 011000 011000 011000 011000 00 binary
Vessel ID field ID – Aircraft registration Marking (3 bits)	91-93	011 binary
Vessel ID – Aircraft Registration Marking (44 bits)	94-137	011000 011000 011000 011000 011000 011000 011000 00 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	1111 0000 1111 0000 1111 0000 0000 0000 0000 0000 0000 binary
Vessel ID: Aviation 24 bit address and 3LD (44 bits)	94-137	1111 0000 1111 0000 1111 0000 11000 11000 11000 00000 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 0011 1111 1111 1111 11 binary

- 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 a total of 18 tests, the first 9 of which test for the correct encoding of GNSS data in the beacon message, the next 2 tests check the encoding during self-test transmissions and the final 7 are additional scripts for RLS capable beacons. 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 first 11 tests to check for correct GNSS data encoding is provided below:

1. Default, no GNSS data
2. Test at equator and prime meridian: mostly all zero's ("0"s) in encoded location field, with low Altitude and DOPs
3. Test at equator and prime meridian testing whether the N/S and E/W flags can switch for the same location, 2D fix, with low HDOP
4. Test at a location where the encoded location field is an alternating "10" pattern 3D fix, mid-range DOP's, low altitude
5. Test where the encoded location field is almost all ones ("1"s). 2D fix, with mid-range HDOP
6. Test near North Pole and just east of international dateline 3D fix, high but viable DOP's, high altitude
7. Test near South Pole and just west of international dateline 3D fix, very high DOP's, and high altitude
8. Repeat of script 7 but with high but viable DOPs and high altitude
9. Test at Dead Sea with no altitude, 2D fix, no DOP's available
10. Self-test with no GNSS data
11. For beacons with GNSS self-test capability, test at equator and prime meridian: mostly all zero's ("0"s) in encoded location field, with low Altitude and DOPs

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 first 9 scripts should be completed within 30 minutes of first activating the beacon in order to ensure that the GNSS data correctly updates in the next transmitted burst. 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, *unless otherwise indicated in the scripts*.

The test results shall be reported in the format provided at Table E.8-1.

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 GNSS Data Bits Transmitted by Beacon	Location Correct (√)	Required Value GNSS Data Bits*
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

* 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 a sufficient number of bits to equal 4 bits for a Hex character, leading zeroes are used to fill in.

Script	Value of GNSS Data Bits Transmitted by Beacon	Location Correct (√)	Required Value GNSS Data Bits*
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 2 minutes for beacons with internal navigation or 5 seconds for ELT(DT)s and all external navigation inputs. Rotating field #0 Bits 176-185 = 019 Bits 186-189 = 4 Bits 190-193 = 6 Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 019 Bits 190-191 = 2
3. Keeping the beacon active, change the navigation input to the beacon to: 0° 0 min 0 sec North, in decimal degrees 0.00000 N 0° 0 min 0 sec East, in decimal degrees 0.00000 E Altitude:Not Available Fix 2D HDOP: 2.0 VDOP: Not Available 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 = 3FF Bits 186-189 = 1 Bits 190-193 = F Bits 199-200 = 1 Rotating field #1 Bits 176-185 = 3FF Bits 190-191 = 1

Script	Value of GNSS Data Bits Transmitted by Beacon	Location Correct (√)	Required Value GNSS Data Bits*
4. Keeping the beacon active, change the navigation input to the beacon to: 42° 39 min, 59.96338 sec North, in decimal degrees, 42.66666 N 170° 39 min, 59.96338 sec East, in decimal degrees 170.66666 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 = 155555 Bits 67-90 = 555555 Rotating field #0 Bits 176-185 = 02D Bits 186-189 = 8 Bits 190-193 = C Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 02D Bits 190-191 = 2
5. Keeping the beacon active, change the navigation input to the beacon to: 63° 59 min 59.892 sec South, in decimal degrees 63.99997 127 ° 59 min 59.892 sec West, in decimal degrees 127.99997. Altitude: Not Available Fix: 2DHDOP: 9 VDOP: Not Available 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 = 3FF Bits 186-189 = 8 Bits 190-193 = F Bits 199-200 = 1 Rotating field #1 Bits 176-185 = 3FF Bits 190-191 = 1

Script	Value of GNSS Data Bits Transmitted by Beacon	Location Correct (√)	Required Value GNSS Data Bits*
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: 45 VDOP: 45 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 = 3F8 Bits 186-189 = D Bits 190-193 = D Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 3F8 Bits 190-191 = 2
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: 15974m Fix: 3D HDOP: 55 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 = 2 Rotating field #1 Bits 176-185 = 3FE Bits 190-191 = 2

Script	Value of GNSS Data Bits Transmitted by Beacon	Location Correct (√)	Required Value GNSS Data Bits*
8. 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: 15974m Fix: 3D HDOP: 45 VDOP: 45 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 = D Bits 190-193 = D Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 3FE Bits 190-191 = 2
9. 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: Not Available Fix: 2D HDOP: Not Available VDOP: Not Available 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 = 0FC000 Bits 67-90 = 11C000 Rotating field #0 Bits 176-185 = 3FF Bits 186-189 = F Bits 190-193 = F Bits 199-200 = 1 Rotating field #1 Bits 176-185 = 3FF Bits 190-191 = 1
Self-Test Navigation Test Scripts			
10. 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

Script	Value of GNSS Data Bits Transmitted by Beacon	Location Correct (√)	Required Value GNSS Data Bits*
11. 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 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 = 018 Bits 186-189 = 1 Bits 190-193 = 1 Bits 199-200 = 2 Rotating field #1 Bits 176-185 = 018 Bits 190-191 = 2

Table D.2-2 - RLS Capable Beacons Additional Test Scripts

Script	Expected Result†	Actual Result	Pass/Fail (√ or x)
1. Ensure that the beacon is correctly coded as per C/S T.021 Annex C‡. Carry out a self-test.	Ensure that the encoded 15 Hex ID is '99349C3C3E78000'	Hex ID =	
2. Turn the beacon on and check that it is transmitting, and what the Hex ID is, and that there is an indication of an RLS request. Decode the transmitted message in the RLS Rotating Field #2 and ensure that bits 155 to 174 are correctly encoded.	Transmitted 15 Hex ID is '99349C3C3E78000' Visual Indication of RLS request Bits 155 to 174 are '22020'.	Hex ID = Confirm Indication is as per manufacturer's instructions Bits 155 to 174 =	

† The 15 Hex ID is always the truncated version of the full 23 Hex ID.
‡ For these tests the Vessel ID Field (Bits 91-93) and the Vessel ID (Bits 94-137) must be set to "No Identity", that is all "0"s.

Script	Expected Result*	Actual Result	Pass/Fail (√ or x)
3. Provide an IEC 61162-1 RLM[†] Test Service sentence or an equivalent proprietary RLM Test Service sentence defined by the GNSS-receiver manufacturer as the navigation input to the beacon with the following data: 15 Hex ID = 99349C3C3E78000 Message Type = 1 UTC Time = any valid random data Decode the next transmitted message and ensure that bits 155 to 174 are correctly encoded.	Ensure that a different indication of receipt of an RLS request acknowledgement is provided within 5 seconds of the application of the RLM sentence. Bits 155 to 174 are '22037'	Confirm Indication is as per manufacturer's instructions Bits 155 to 174 =	
4. Turn the beacon off and remove the RLM sentence from the navigation input. Turn the beacon on and check that it is transmitting, and what the Hex ID is, and that there is an indication of an RLS request. Decode the transmitted message and ensure that bits 155 to 174 are correctly encoded.	Transmitted 15 Hex ID is '99349C3C3E78000' Visual Indication of RLS request. Bits 155 to 174 are '22020'.	Hex ID = Confirm Indication is as per manufacturer's instructions Bits 155 to 174 =	

[†] All RLM sentences shall comply with the requirements of the Return Link Message Content as defined in the SAR/GALILEO Service Definition Document (SDD) Version 2.0.

Script	Expected Result*	Actual Result	Pass/Fail (√ or x)
5.† Provide an IEC 61162-1 RLM Test Service sentence or an equivalent proprietary RLM Test Service sentence defined by the GNSS-receiver manufacturer as the navigation input to the beacon with the following data: 15 Hex ID = 99349C3C3E68000 Message Type = 1 UTC Time = any valid random data Decode the transmitted message and ensure that bits 155 to 174 are correctly encoded.	Monitor the RLS Indicator for a minimum of 5 minutes and ensure that it continues to provide an indication of an RLS request. Bits 155 to 174 are ‘22020’.	Confirm Indication is as per manufacturer’s instructions Bits 155 to 174 =	
6. Turn the beacon off and remove the RLM sentence from the navigation input. Turn the beacon on and check that it is transmitting, and what the Hex ID is, and that there is an indication of an RLS request. Decode the transmitted message and ensure that bits 155 to 174 are correctly encoded.	Transmitted 15 Hex ID is ‘99349C3C3E78000’ Visual Indication of RLS request Bits 155 to 174 are ‘22020’	Hex ID = Confirm Indication is as per manufacturer’s instructions Bits 155 to 174 =	

† Test 5 is aimed at providing a valid change to the beacon serial number from 999 to 998 in the return link message and at confirming that the beacon ignores this message which is not addressed to the beacon under test.

Script	Expected Result[*]	Actual Result	Pass/Fail (√ or x)
7.[†] Provide an IEC 61162-1 RLM Test Service sentence or an equivalent proprietary RLM Test Service sentence defined by the GNSS-receiver manufacturer as the navigation input to the beacon with the following data: 15 Hex ID = 99549C3C3E78000 Message Type = 1 UTC Time = any valid random data	Monitor the RLS Indicator for a minimum of 5 minutes and ensure that it continues to provide an indication of an RLS request.	Confirm Indication is as per manufacturer's instructions	
Decode the transmitted message and ensure that bits 155 to 174 are correctly encoded.	Bits 155 to 174 are '22020'.	Bits 155 to 174 =	

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.

[†] Test 7 makes a different change to the return link message in that it alters the Country Code which should not result in a successful RLM receipt. This test ensures that beacons are simply not ignoring the Country Code in favour of only checking the beacon TAC Number and Serial Number bits in their return link message validation of the 15-Hex ID.

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), Galileo – 24 satellites in Orbital Planes A (Slots 01-08), B (Slots 01-08) and C (Slots 01-08), and BDS – 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, 2018 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;
b) accelerate due North at a rate of 5.55 m/s2 for 60 seconds in a straight line, while climbing to 5,000 m;
c) maintain an horizontal speed to 333 m/s for 60 seconds while climbing to 10,000 m;
d) level out (pitch, roll and heading set to 0) and at a constant horizontal speed of 333 m/s, apply the following during 30 seconds:

- Roll : bank right by +30 °/s until reaching +30°, then bank left by -30 °/s until reaching -30°; continue this sequence until the end of the 30 seconds sequence,
- Heading, pitch, Altitude (at about 10,000 m) and speed remain unchanged, with parameters defined in the embedded CSV file;

e) still maintaining the same altitude and at a constant horizontal speed of 333 m/s and simultaneously apply the following during 2 seconds:

- Pitch: pitch down by -10 °/s until reaching -20°,
- Roll : bank left by -30 °/s until reaching -60°,
- Heading, Altitude and speed remain unchanged;

f) From this point until the impact, maintain a constant speed of 333 m/s while implementing a trajectory with the following characteristics until the impact:

- Maintain Pitch: -20°
- and decrease the altitude using a vertical speed of : -80 m/s
- and simultaneously repeat the following sequence:
    - i. during 17.5 seconds
        1. maintain Roll at : -60°
        2. and decrease the heading at a yaw rate:-10°/s
    - ii. during 4 seconds
        1. increase Roll at 30°/s to reach +60°
        2. decrease yaw rate at 5°/s² to reach +10°/s
    - iii. during 17.5 seconds
        1. maintain Roll at : +60°
        2. and increase the heading at a yaw rate: +10°/s
    - iv. during 4 seconds
        1. decrease Roll at -30°/s to reach -60°
        2. decrease yaw rate at -5°/s² to reach -10°/s

g) once impact with the ground occurs maintain 60 seconds of stationary position.

Note - the above trajectory and aircraft attitude shall be implemented such that:

a) 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.

Click the paper clip for the embedded CSV file:

- 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_Issue_1_Rev_5.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 CONSTANT TEMPERATURE TEST RESULTS

E.3 THERMAL SHOCK TEST RESULTS

E.4 OPERATING LIFE TEST RESULTS

E.5 TEMPERATURE GRADIENT TEST RESULTS

E.6 SATELLITE QUALITATIVE TEST SUMMARY REPORT

E.7 406 MHz BEACON EL-EIRP / ANTENNA TEST RESULTS SHEET

E.8 NAVIGATION SYSTEM TEST RESULTS

E.9 BEACON CODING SOFTWARE RESULTS

E.10 BATTERY STATUS INDICATION

E.11 ELT(DT) – EXTERNAL POWER RESULTS

- 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]*

* The template provides an example of a type approval test results report that may be used by test facilities to submit results to the Secretariat. The report template requires further development, so for the time being it should be used for guidance only. Text shown in square brackets is intended to be filled in by the test facility.

[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 (See Annex E for embedded file):

"C-S_T.021_Annex_E-G_Issue_1_Rev_5.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.

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)

G.6 CHECKLIST OF DATA ITEMS

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

- END OF ANNEX G -

ANNEX H: TECHNICAL DATA

H.1 Overview – DATA ITEM DESCRIPTION

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 indicated as necessary (See Annex G.6) shall be provided to the accepted test facility (in a completed or preliminary state) 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 data items described in this section.

H.1.1 Type Approval Application Form

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.

H.1.2 Test Facility Application Form

A test facility application form (ANNEX G, section G.2), 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.

H.1.3 Quality Assurance Plan

The beacon-model quality assurance plan (ANNEX G, section G.3).

H.1.4 Change Notice Form

A completed change notice form, (ANNEX G, section G.4)), for applications involving the modification to previously approved beacon model(s).

H.1.5 Assignment of Additional Model Name Form

A completed assignment of additional model name form, (ANNEX G, section G.5)), for applications involving adding an alternative name to a previously approved beacon model.

H.1.6 Checklist of Data Items

A completed check-list of technical information provided in support of the type-approval or change-notice application, as per (ANNEX G, section G.6).

H.1.7 Photos of Operational Configurations

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.

H.1.8 Beacon Modes and Battery Current Measurements

A list and descriptions of all automatic and manually selectable operating modes, description of beacon working cycle phases and durations (including for ELT(DT)s the variations in repetition rates, inclusion of homing signals, all logic conditions which could result in state transition (e.g., dependency on Air/Ground state for homing activation, ARINC inputs/loss, etc.), etc., pre- and post-crash for all modes of activation), and analysis supported by results of battery current measurements, provided as per ANNEX E.4-2 - Operating Current, 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 cycle covering all operational states and modes in a normal activation sequence (measurement interval),
iv. for ELT(DT)s designed to withstand a crash, an assessment of the test condition (with supporting evidence) that maximizes battery energy consumption during the operating lifetime at minimum temperature test, taking into account the variations in the battery energy required to provide 406 MHz transmissions, GNSS receiver operations, homing and locating signals and any other sources of energy consumption that vary between the time prior to and after crash sensor activation.

    (e.g., Measure the charge (C) taken from the battery in the first 30 minutes after worst case mode of ELT(DT) activation and again between 30 and 60 minutes after activation. Then activate the crash sensor and measure the charge (C) taken from the battery in the first 30 minutes after crash sensor activation and again between 30 and 60 minutes (assuming that no beacon functions that would change the current consumption vary after 60 minutes) after crash sensor activation. Given that the pre-crash ELT(DT) mode of operation is between 10 and 370 minutes, use this data to calculate the pre-crash time that results in the worst case conditions for the operating lifetime test (the point at which switching between pre-crash and post-crash modes results in maximum drain on the battery)).

H.1.9 Pre-Discharge Battery Analysis

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 ANNEX E.4-3 - Battery Discharge.

H.1.10 Beacon Operating Instructions

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 beacon operational configurations for all declared antenna(s) deployed,
iv. beacon system configuration, including connection of external 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,
viii. for beacons with voice-transceivers, providing for design limitation of the voice-transceiver operation, indication of the maximum cumulative transmit-mode 'on' time, and appropriate warnings to the users, that for voice-transceiver transmit operation exceeding the declared maximum cumulative transmit-mode 'on' time, the duration of operation of the activated 406-MHz beacon may be reduced,
ix. for beacons with RLS capability, the operation of the RLS function shall be clearly explained, such that it can be easily understood, including any limitations of the overall RLS system, and
x. for ELT(DT)s a description of any limitations that might result from the beacon being active in an "in-flight" mode beyond the 370-minute limit described as the "in-flight" mode of operation rather than switching to the "post-crash" mode.

H.1.11 Beacon-model Marketing Brochure

Beacon-model marketing brochure, if available.

H.1.12 Battery Data

a) The technical data sheet for the battery cells used in the beacon model indicating:
    i. nominal cell capacity,
    ii. self-discharge rate over the declared battery replacement period, and

b) the electric diagram of the beacon model's battery pack.

H.1.13 Beacon Markings and Labels

i. Copy of the beacon-model markings and labels indicating, as per C/S T.018 section 4.5.11: placement for the beacon 23-Hex ID;
ii. operating temperature range (e.g., -20°C to +55°C);
iii. minimum operating lifetime (e.g., 24 hours).

H.1.14 Oscillator Data

The technical information on the reference oscillator and circuitry, including:
i. oscillator type and specifications including technical data sheet,
ii. technical data on long-term frequency stability,
iii. report on the oscillator ageing characteristics,

iv. 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 test characteristics from the reference oscillator manufacturer, if applicable.

H.1.15 Design Descriptions

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 B.10),
ii. meets the frequency stability requirements over 5 years (see section B.2.1), a description of the beacon-model circuitry that converts the oscillator frequency to the transmitter output frequency clarifying how this maintains the frequency stability,
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 B.13.2),
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 encoded location capable 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.018).

H.1.16 Matching Network

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;

H.1.17 Antenna Cable Data

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;

H.1.18 Internal GNSS Receiver Data

For beacon models with an internal GNSS receiver:

i. description of the GNSS receiver operation cycle and its functional phases, including duration and average battery current measured for each phase,

ii. technical data sheet of the internal GNSS receiver and GNSS receiver antenna from the navigation-receiver and antenna manufacturers, and
iii. description to demonstrate that the beacon design provides for the cold start of the internal GNSS receiver by clearing on a beacon restart the GNSS receiver internal memory, including time, data on the current (last) location determined by the GNSS receiver, the GNSS satellites almanac data, and the GNSS satellite ephemeris data.

H.1.19 External Navigation Interface Data

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.

H.1.20 Additional Features

For beacon models with additional features (e.g., external G-switches and other activation devices, remote control panels, audio- and light-indicators, S-VDR memory module etc.):

i. technical data sheets, photographs and description for all the external components/devices/features,
ii. schematic diagrams, indicating electrical connections to the beacon.

H.1.21 Beacon Model Family Description

For beacon model families with several beacon models, a comprehensive description of differences between these models;

H.1.22 Design Description if Worst-case Not at Minimum Temperature

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.

H.1.23 Description of any known Non-Compliances

A statement and description of any known non-compliances, if any are declared in Annex G.1.

H.1.24 Test Sample Alignment

A statement from the beacon manufacturer that the test samples are aligned in 406 MHz conducted output power levels to within 0.3 dB of each other if multiple beacon samples are provided for type approval testing.

H.1.25 Potentially Insufficient Energy (PIE) Information

Technical information for characterisation of the self-test indication of insufficient battery energy to be provided as per Annex E.10-1 - PIE:

i. Manufacturer-declared Minimum Operating Lifetime (CCO), which is declared by the manufacturer in the type-approval application form, Annex G.1 of document C/S T.021, as the Operating Lifetime;
ii. Full Battery Pack Capacity (CBP), which is defined as the duration in hours that a beacon with a fresh battery pack will continuously operate for in the worst-case operating mode (i.e. operating mode that draws the highest current from the battery) until it the beacon fails to meet C/S T.018 requirements;
iii. Capacity corresponding to the Pre-Operational Losses (CPO), which is defined as the duration in hours required to deplete the fresh battery by the value corresponding to the Calculated Battery Pack Pre-Discharge (LCDC) of the Annex E.4-3 - Battery Discharge[*] by operating the beacon in the worst-case operating mode;
iv. Spare battery pack capacity at ambient temperature (CSP-AMB), which corresponds to the battery energy that could remain after the beacon with a pre-discharged battery has been operated in the worst-case mode at minimum temperature for the duration of the declared minimum continuous operation. CSP-AMB may be calculated as the Full Battery Pack Capacity (CBP) deducted by the sum of the Capacity of Pre-Operational Losses (CPO) and the Manufacturer-Declared Minimum Operating Lifetime (CCO). The value of CSP-AMB shall be declared by the beacon manufacturer or measured by the test facility; and
v. Description of conditions and specification of criteria that shall be met to trigger the indication of Potentially Insufficient Battery Energy (PIE) during self-test.

H.1.26 Programable Options

For beacon models with multiple programmable options, except for message protocols:

i. a list of and description of all programmable options and programmable parameters that can change performance of an operational beacon,
ii. a statement indicating which of the available programmable options are associated with the type-approval application,
iii. description of technical means to set the desired programmable options and set programmable parameters.

[*] **L_{CDC}** - as defined in Appendix E to Annex F of document C/S T.007, and include among others battery capacity losses due to self-discharge, self-tests, GNSS self-tests and operation of the beacon circuitry while in the stand-by mode.

H.1.27 External Power Supply

For beacon models with external power supply:

i. schematic diagrams, indicating electrical connections to the beacon
ii. description providing details of external power supply,
iii. description of the nominal voltage conditions and performances,
iv. description of the worst-case (nominal minimum and nominal maximum)[*] external power supply voltage conditions.

H.1.28 Programming Adaptors

If the beacon model can be fitted with a Programming Adapter, provide the necessary documentation to enable the test facility to confirm by inspection of evidence that the requirements of document C/S T.018 Section 3.7 paragraphs 2 to 6 inclusive are met.

H.1.29 Repetitive Automated Means of Interrogation

For beacon models supporting repetitive automated interrogation of beacon status:

i. description of the feature including triggering mechanism, timing of interrogation and items/functions verified,
ii. details of how this feature is powered, including assessment of its impact on the beacon battery.

- END OF ANNEX H -

[*] For example, the nominal minimum and maximum voltages for the 14 V and 28 V DC power supplies on the aircraft, as described in documents EUROCAE ED-14G and RTCA DO-160G, are as follows:

Nominal Aircraft Power Supply Voltage	Nominal Minimum Aircraft Power Supply Voltage	Nominal Maximum Aircraft Power Supply Voltage
14.0V	11.0V	15.15V
28.0V	20.5V	32.2V

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 Centre 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 (not ELT(DT))	**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	ELT(DT)	No	Aircraft Registration Marking* (Tail Number)	No	#3: National Use
No	System Beacon*	No	Aircraft 24-bit Address	No	#4 to #14: Spare
No	Spare	No	Aircraft Operator and Serial Number*	**Yes**	**#15: Cancellation**
		No	Reserved for System Testing†		
		No	Spare		

* Note: for ELT(DT) TACs using these Vessel IDs, the following warning will be added:
WARNING: These coding schemes when used in an ELT(DT) (i.e., bits 138-140 are '011'), are NOT compliant with the mandatory data elements defined in ICAO document 10150 (either no 3LD aircraft operator (for 3 - Aircraft Registration Marking) or no aircraft identifier is available (for 5 - Aircraft operator and serial number)) and the associated data cannot be stored in the LADR. Manufacturers wishing to comply with ICAO GADSS requirements and use these coding options should consult the relevant Administration's aviation authorities for guidance prior to coding a beacon with these coding options.

† Cospas-Sarsat does not currently have a specific process for approving System Test beacons.

COSPAS SARSAT

- END OF ANNEX I -

ANNEX J: CHANGES TO TYPE APPROVED BEACONS

J.1 Changes to Type Approved Beacons

General guidance on changes to type approved beacons is provided in section 2.4. Manufacturers should refer to this section prior to consulting the following sections for relevant detailed guidance on specific changes. The Programme has defined the following changes in this Annex:

- Alternative Batteries
- Internal Navigation Devices
- Interface to External Navigation Devices
- Changes to Frequency Generation
- Alternative Antennas
- Additional Vessel IDs or Rotating Fields
- Other Beacon Hardware or Software Modifications
- Minor Changes
- Change of Beacon Manufacturer
- Alternative Model Names for a Type Approved Beacon

J.2 Alternative Batteries

If a beacon manufacturer wishes to make changes to the battery pack configuration, battery cell manufacturer, type or model of cell(s) after the beacon has been Cospas-Sarsat type approved, the change notice form in Annex G.4 shall be completed and submitted to the Secretariat, and the beacon with the new battery shall be subjected to the following tests at a Cospas-Sarsat accepted test facility:

a. electrical tests at ambient and maximum constant temperature, only transmitter power output and chip characteristics during normal operation (section A.2.1 a), b), c) and d));

b. operating lifetime at minimum temperature (section A.2.3);

c. battery status indication (section B.20);

d. re-calculations and analysis of EL-EIRP for all approved 406 MHz antenna models, based on results of the original type approval testing (see section B.11.3) [(only if beacon output power over temperature and/or at the end of operating lifetime have changed by more than 0.5 dB compared to the original type approval test results); and

e. satellite qualitative tests (section A.2.5).

The beacon manufacturer shall submit technical information per Annex H, sections H.1.1, H.1.2, H.1.3, H.1.4, H.1.6, [H.1.8], H.1.9, H.1.10 vii, H.1.12 and H.1.25.

J.3 Internal Navigation Device

J.3.1 Inclusion of an Internal Navigation Device

A type-approved beacon modified to add an internal navigation device shall be completely retested (full type approval test) at a facility accepted by Cospas-Sarsat.

J.3.2 Change to Internal Navigation Device

J.3.2.1 Drop-in Replacement to Internal Navigation Device

For changes to the internal navigation device of a type-approved beacon where the change is limited to simply replacing the device with a drop-in replacement, without any associated hardware or software changes to the beacon, the tests identified below shall be conducted at a Cospas-Sarsat accepted facility (unless stated otherwise):

a. the manufacturer shall provide the results and analysis of tests conducted at the manufacturer’s facilities that assess the change in load on the battery of the beacon compared to the originally- approved device (per Annexes E.4-2 and E.4-3). If the pre-test discharge current (Annex E.4-3) and the average current in the worst-case operating mode (Annex E.4-2) are both equal to or less than that of the original device it is not necessary to perform an operating lifetime at minimum temperature test. If the load is higher than that of the original device then an operating lifetime at minimum temperature test shall be performed (see Annex A.2.3);

b. Encoded Location Data (see B.14.1.1), Location Accuracy and Information tests (see B.14.2.4 or B.14.3.4 as applicable) and First Provision of Location and Dimensions tests (see B.14.2.5 or B.14.3.5 as applicable); and

c. satellite qualitative tests (section A.2.5).

The beacon manufacturer shall submit technical information per Annex H, sections H.1.1, H.1.2, H.1.3, H.1.4, H.1.6, H.1.8, H.1.9, and H.1.18.

J.3.2.2 Changes to Internal Navigation Device affecting the Beacon Hardware and/or Software

If the change of internal navigation device requires a change to the beacon hardware or software in order to function correctly, the scope of testing shall be determined by Cospas-Sarsat (see ANNEX J.8 for guidance) after reviewing a description of the proposed change provided by the manufacturer.

J.4 Interface to External Navigation Device

J.4.1 Modifications to Add an Interface to Accept Encoded Position Data from an External Navigation Device

A type approved beacon modified by the inclusion of either hardware and/or software changes, to accept position data from an external navigation device shall be tested at a Cospas-Sarsat type approval facility. The tests to be performed shall consist of:

a. electrical and functional tests at ambient and maximum temperatures only, excluding VSWR test (section A.2.1);

b. operating lifetime at minimum temperature (section A.2.3);

c. navigation system tests (sections B.14.1 and B.14.4);

d. beacon coding software (section A.2.8); and

e. re-calculations and analysis of EL-EIRP for all approved 406 MHz antenna models, based on results of the original type approval testing (see section B.11.3) [(only if beacon output power over temperature and/or at the end of the operating lifetime have changed by more than 0.5 dB compared to the original type approval test results)].

f. satellite qualitative tests (section A.2.5).

In addition, the beacon manufacturer shall also provide technical data per Annex H, sections H.1.1, H.1.2, H.1.3, H.1.4, H.1.6, H.1.8, H.1.9, H.1.10, H.1.15 v., and H.1.19.

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 (e.g., a change from navigation data provided by an NMEA sentence to navigation data provided by an ARINC label), the tests identified below shall be conducted at a Cospas-Sarsat accepted facility:

a. the manufacturer shall provide the results and analysis of tests conducted at the manufacturer's facilities that assess the change in load on the battery of the beacon compared to the originally interface (per Annexes E.4-2 and E.4-3). If the pre-test discharge current (Annex E.4-3) and the average current in the worst-case operating mode (Annex E.4-2) are both equal to or less than that of the original interface it is not necessary to perform an operating lifetime at minimum temperature test. If the load is higher than that of the original interface, then an operating lifetime at minimum temperature test shall be performed (see Annex A.2.3);

b. navigation system tests (sections B.14.1 and B.14.4);

c. satellite qualitative tests (section A.2.5); and.

d. [other tests TBD]

In addition, the beacon manufacturer shall also provide technical data per Annex H, sections H.1.1, H.1.2, H.1.3, H.1.4, H.1.6, H.1.8, H.1.9, H.1.10, H.1.15 v) and H.1.19.

For a change to the navigation interface that requires a change to the beacon hardware or software in order to function correctly the scope of testing will be determined by Cospas-Sarsat (see ANNEX J.8 for guidance) after reviewing a description of the proposed changes provided by the manufacturer.

J.5 Changes to Frequency Generation

J.5.1 Oscillator Replacement

In the case of an oscillator replacement due to obsolescence of the original part or for some other reason that does not involve a change to the 406 MHz frequency generation circuitry or the Chip Rate generating circuitry the following tests shall be carried out by a Cospas-Sarsat accepted test facility, unless stated otherwise:

a. Frequency Stability Test with Temperature Gradient (A.2.4),

b. Thermal Shock (section A.2.2 (tests A.2.2.2 b), c) and d) only)); and

c. the manufacturer shall provide the results and analysis of tests conducted at the manufacturer's facilities that assess the change in load on the battery of the beacon compared to the oscillator used in the approved beacon (approved oscillator) (per Annexes E.4-2 and E.4-3). If the pre-test discharge current (Annex E.4-3) and the average current in the worst-case operating mode (Annex E.4-2) are both equal to or less than that of the approved oscillator it is not necessary to perform an operating lifetime at minimum temperature test. If the load is higher than that with the approved oscillator then an operating lifetime at minimum temperature test shall be performed (see Annex A.2.3);

d. [satellite qualitative test (section A.2.5).]

In addition, the beacon manufacturer shall also provide technical data per Annex H, sections H.1.1, H.1.3, H.1.4, H.1.6, H.1.8, H.1.9 and H.1.14.

J.5.2 Other Changes to Frequency Generation

For a change that affects the frequency generating circuitry and thus might affect other aspects of beacon performance, the scope of testing will be determined by Cospas-Sarsat (see ANNEX J.8 for guidance) after reviewing a description of the proposed changes provided by the manufacturer.

J.6 Alternative Antennas

In cases of a beacon modification to include an alternative antenna, such beacon shall undergo at a Cospas-Sarsat accepted test facility the following testing:

a. antenna tests (section A.2.6) in all declared configurations as required by section B.11.1.2.6;

b. satellite qualitative test (section A.2.5).

The beacon manufacturer shall complete and submit Annex H, sections H.1.1, H.1.2 H.1.3, H.1.4, H.1.5 (if applicable), H.1.6, H.1.7 (with new antenna), H.1.10 (if different), H.1.11 (if different), H.1.13 (if different, H.1.16, H.1.17 (if applicable) and H.1.21 (if applicable), H.1.24.

J.7 Additional Vessel IDs or Rotating Fields

J.7.1 Additional Vessel IDs

In cases when an additional Vessel ID of an earlier type approved beacon is added, the beacon manufacturer or an accepted test facility shall perform and submit results of the Beacon Coding Software test (see section A.2.8) for the additional Vessel IDs at ambient (see A.2.1 test B.8 only) for National Use coded beacons.

The beacon manufacturer shall also submit the following technical data to the Secretariat Annex H, sections H.1.1 and H.1.4.

J.7.2 Additional Rotating Fields

In cases when the RLS Rotating Field is added see section J.8, in cases where the National Use Rotating Field is added see below, in cases where any other Rotating Field is proposed to be added the beacon manufacturer shall seek guidance from the Cospas-Sarsat Secretariat before making any changes.

In cases where the National Use Rotating Field is added to a previously approved beacon the beacon manufacturer, or an accepted test facility shall perform and submit results of the Message Content test at ambient (see A.2.1 test B.8 only) for National Use coded beacons.

The beacon manufacturer shall also submit the following technical data to the Secretariat Annex H, sections H.1.1 and H.1.4.

J.8 Other Beacon Hardware or Software Modifications

Any significant change to the beacon hardware or software which changes the beacon electrical performance not specifically addressed elsewhere in this Annex shall be supported by a change notice form (Annex H.1.4) and test results as appropriate. The normal scope of the testing and the required technical data to be submitted is set out below. Beacon manufacturers should consult with the Cospas-Sarsat Secretariat prior to testing to ensure that the scope set out below is acceptable.

The normal testing requirements typically include:

a. transmitted frequency (section A.2.1) at minimum, ambient and maximum temperatures;

b. the manufacturer shall provide the results and analysis of tests conducted at the manufacturer's facilities that assess the change in load on the battery of the beacon compared to the originally design (per Annexes E.4-2 and E.4-3). If the pre-test discharge current (Annex E.4-3) and the average current in the worst-case operating mode (Annex E.4-2) are both equal to or less than that of the original design it is not necessary to perform an operating lifetime at minimum temperature test. If the load is higher than that of the original design, then an operating lifetime at minimum temperature test shall be performed (see Annex A.2.3);

c. frequency stability with temperature gradient (section A.2.4);

d. re-calculations and analysis of EL-EIRP for all approved 406 MHz antenna models, based on results of the original type approval testing (see section B.11.3) [(only if beacon output power over temperature and/or at the end of the operating lifetime have changed by more than 0.5 dB compared to the original type approval test results)]; and

e. satellite qualitative test (section A.2.5).

The beacon manufacturer shall submit the following technical data to the Secretariat, all sections of Annex H relevant to and affected by the change, which shall always include Annex H, sections H.1.1, H.1.3, H.1.4, H.1.6, H.1.8 and H.1.9.

J.9 Minor Changes

Generic requirements related to minor changes to beacons are provided in section 2.4.3 of this document. As further definitive requirements related to minor changes are developed they will be included in this Annex.

J.10 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, sections H.1.1, H.1.3, H.1.6, H.1.10, H.1.11, H.1.13 and H.1.21.

J.11 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), the beacon manufacturer shall submit the following technical data to the Secretariat, Annex H, sections H.1.1, H.1.3, H.1.4, H.1.5, H.1.6, H.1.10, H.1.11, H.1.13 and H.1.21.

- 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.

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.

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 Matrix

Click the paper clip for the current version of the embedded Excel file.

- END OF ANNEX L -

ANNEX M: SAMPLE PROCEDURE FOR TESTING BEACONS WITH VOICE TRANSCEIVER

Annex M is currently still under development, see Section 5.2 for further details.

- END OF ANNEX M -

- END OF DOCUMENT -

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