SECOND GENERATION
406 MHz BEACON IMPLEMENTATION PLAN

C/S R.017

Issue 1 – Revision 1

October 2012

COSPAS SARSAT

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406 MHz BEACON IMPLEMENTATION PLAN

History

Issue	Revision	Date	Comments
1	-	October 2011	Approved by the Cospas-Sarsat Council (CSC-47)
1	1	October 2012	Approved by the Cospas-Sarsat Council (CSC-49)

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1. INTRODUCTION

1.1 Purpose of the Document

This plan addresses the development and deployment of second generation 406 MHz beacons into the Cospas-Sarsat System.

The plan describes high level tasks and activities expected to be undertaken by Cospas-Sarsat Participants and other stakeholders to ensure the effective development, production and introduction to the market of second generation 406 MHz beacons. The plan also provides tentative time lines for the various tasks required for second generation beacon implementation along with a brief description of the required inputs and expected outputs associated with each task.

1.2 Background

The International Cospas-Sarsat System has been successfully operating since 1982 and has achieved world-wide recognition as a provider of satellite distress alerts to search and rescue (SAR) authorities. The carriage of Cospas-Sarsat 406 MHz distress beacons, whether mandated by Administrations[1] or as a result of voluntary use by individuals at risk, is becoming increasingly popular.

The LEOSAR and GEOSAR systems comprise the current operational Space Segment. Cospas-Sarsat is developing a new satellite alerting capability, the MEOSAR system, which is expected to replace the LEOSAR system. The MEOSAR system is planned to begin operating in the 2012 - 2015 time frame and become fully operational during the second half of the decade. The MEOSAR system will be backward compatible and will accommodate the operation of first-generation Cospas-Sarsat beacons as specified in document C/S T.001. The MEOSAR system is also expected to provide enhanced performance for all 406 MHz beacons currently in operation to include global, near-instantaneous alerting and locating capabilities and greater resilience to beacon-to-satellite obstructions. Detailed information on MEOSAR system development is available in the document C/S R.012 "Cospas-Sarsat 406 MHz MEOSAR Implementation Plan".

The MEOSAR system uses a time/frequency measurement to compute the position of a distress beacon. It also allows for a return link to the beacon. Preliminary analyses have indicated that a new generation of 406 MHz beacon designed to operate in a MEOSAR environment could further enhance the performance of the Cospas-Sarsat system in the future.

[1] On board aircraft and ships is mandated by Administrations in accordance with the recommendations of the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). Their use on board fishing vessels, pleasure craft and general aviation aircraft is also a requirement in numerous countries.

1.3 Goals

The deployment of second generation 406 MHz beacons requires that a number of tasks and activities be accomplished and coordinated among various Cospas-Sarsat stakeholders. The second generation 406 MHz beacon implementation plan allows the Cospas-Sarsat Programme to:

a) plan for updated beacon standards to reflect the agreed second generation beacon operational requirements described in Cospas-Sarsat document C/S R.017;

b) outline of activities needed to successfully complete the implementation of a second generation of distress beacons; and

c) provide a time line for second generation beacon implementation.

The second generation 406 MHz beacon implementation plan is managed by the Cospas-Sarsat Council which will coordinate its implementation with other stakeholders involved in the development of future 406 MHz distress beacons.

- END OF SECTION 1 -

2. ASSUMPTIONS AND CONSTRAINTS

2. Assumptions

First generation beacon specifications documented in C/S T.001 were derived from technical characteristics optimized for the LEOSAR system. This system uses frequency shift measurements of 406 MHz transmissions during periodic passage of satellite payloads at low elevation angles for independent location determination.

Second generation beacon specifications will be developed assuming operation with the Cospas-Sarsat GEOSAR and MEOSAR systems comprised only of Search and Rescue Repeaters (SARR) instruments and with all signal and data processing performed by ground receiving stations called Local User Terminals or LUTs. A complete network of standalone MEOLUTs will be available to provide the alerting and locating functions on a global basis. Independent position determination will be established based on trilateration using the time and frequency of arrival (TOA and FOA) measurements of the signals received from distress beacons. The methodology involves the processing by MEOLUTs of signals received from multiple payloads distributed around the beacon at various elevation angles. The determination of the optimal characteristics required from second generation beacon to operate within this new environment will need to consider possible trade-off between the expected performances of the various segment of the system.

2.2 Constraints

The current GEOSAR space segment is in operation and the planned MEOSAR space segment has already been designed. Specifications for second generation beacons will be constrained by the characteristics of these constellations and the design of their Search and Rescue instruments.

The GEOSAR and MEOSAR constellations will consist of various satellite systems which could introduce variations of performance levels due to system design differences. Minimum interface requirements[2] have been established to minimise such variations and ensure full interoperability with commissioned space and ground segment equipment in the Cospas-Sarsat System. These requirements are constraints to be taken into consideration in the cost and benefit trade-offs for the development of second generation beacon specifications.

In order to maintain the relevance of 406 MHz beacons, second generation beacon specifications should allow for technology to be available at a reasonable cost to users.

Second generation beacons designed to meet new specifications may not be interoperable with the LEOSAR SARP processing. If second generation beacons are not interoperable with LEOSAR SARP instruments, the LEOSAR system will not provide the alerting and locating functions for these beacons on a global basis.

[2] See the "MEOSAR Space Segment Interoperability Parameters" provided at Annexes E and F of document C/S R.012 (MIP).

Modifications to beacon signal characteristics and coding protocols will require new processing software to be implemented in existing GEOLUTs to provide the alerting service. Additionally, MEOLUTs installed by Participants to support the MEOSAR system development may require upgrades to be compatible with second generation beacons. Furthermore, in regions where MEOLUT coverage will not be adequate prior to the MEOSAR FOC, existing LEOLUTs may also need to be upgraded to process second generation beacon signals relayed via LEOSAR satellite repeaters (SARR).

Finally, software upgrades will also be implemented in Cospas-Sarsat Mission Control Centres (MCCs) to forward and distribute distress alerts originating from second generation beacons to Rescue Coordination Centres (RCCs) and SAR Points of Contact (SPOCs).

The time line of second generation beacon deployment activities will need to take in consideration all of these constraints.

- END OF SECTION 2 -

3. IMPLEMENTATION ACTIVITIES AND TIME LINE

Cospas-Sarsat needs to determine what operational requirements are expected for second generation beacons operating in a MEOSAR system. Once these requirements have been ascertained, system analysis and trade-offs are required to define the performance expected for the various space, ground and beacon segments of the MEOSAR system. The expected beacon performance will be documented in a new beacon specification (document C/S T.101). This document, along with a new type approval procedure (document C/S T.107), will be used by beacon manufacturers to develop new beacon models. In parallel with this development, it is expected that Administrations will also update standards which complement the Cospas-Sarsat specifications in areas not related with the 406 MHz signal. New beacon models would then be tested for conformance with Cospas-Sarsat and non-Cospas-Sarsat standards. Provided adequate changes have been made to the Cospas-Sarsat ground segment (LUTs and MCC's) to accommodate second generation beacons, these beacons could then be made available to owners for use with the Cospas-Sarsat system.

Given the backward compatibility of the first generation 406 MHz beacon with the MEOSAR system, the deployment of second generation beacons is not a pre-requisite to declare full operational capability of the MEOSAR system. However many Cospas-Sarsat stakeholders may consider that an early deployment of second generation beacons is desirable as it would allow for an enhanced position determination and for a more attractive product to beacon manufacturers and users.

Depending on the compatibility of second generation beacons with the LEOSAR system, the early deployment of the new beacon may not be possible until a minimum MEOSAR space and ground segment coverage becomes available.

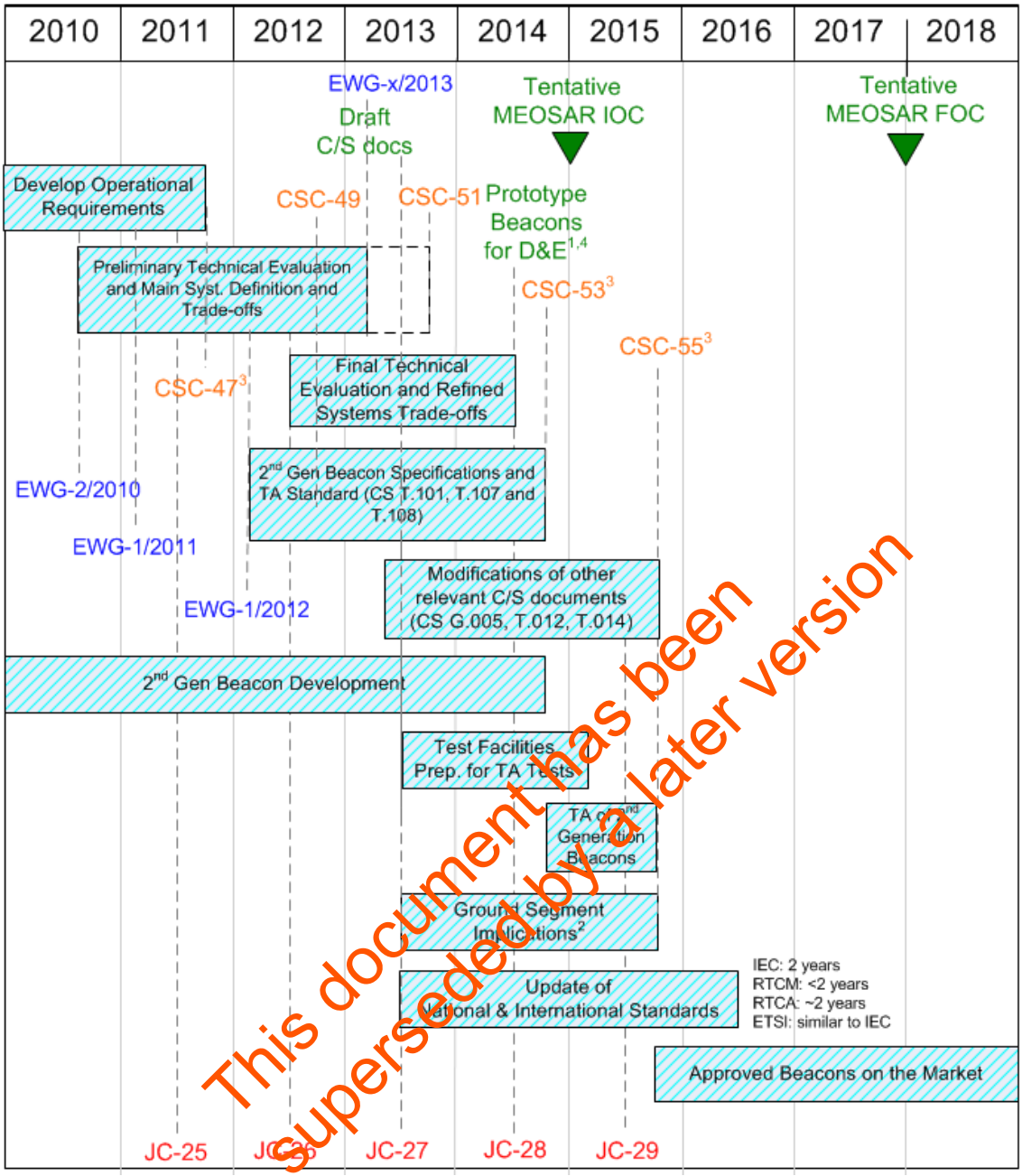
Figure 1 provides a list of high level tasks expected to be completed for the deployment of second generation beacons, along with a tentative time line for each tasks. The schedule also includes major Cospas-Sarsat meetings where relevant documents and progress reports will be reviewed.

The planned time line indicates a possible deployment of second generation beacons towards the beginning of 2016 corresponding to the IOC phase described in the MEOSAR Implementation Plan[3]. The schedule shown assumes a timely execution of all activities and is therefore success oriented.

The following sections provide a brief explanation of the activities required for the deployment of second generation beacons along with the inputs expected to trigger the activities and their expected output.

[3] As per Annex I of document C/S R.012.

Figure 1: Second Generation Beacon Implementation Schedule



1. The MEOSAR D&E phase is scheduled to occur between January 2013 and December 2014(*). Note that the MEOSAR D&E does not depend on the availability of second generation beacons.
2. The Ground Segment needs to be upgraded to process next generation beacon messages.
3. Key meetings:
   - EWG-1/2011 (next generation beacon - operational requirements) in February 2011,
   - EWG-1/2012 (second generation beacons - technical specifications) in February 2012,
   - EWG-x2013 (second generation beacon – technical specifications) in first quarter February 2013,
   - CSC-47 in October 2011 (C/S R.017 approval),
   - CSC-53 in October 2014 (approval of 2nd generation beacon requirements and TA standards),
   - CSC-55 in October 2015 (approval of modifications to other Cospas-Sarsat relevant documents).
4. The MEOSAR D&E is not dependant on the availability of next generation beacons.

(*) Must be consistent with the MEOSAR D&E timeline.

3.1 Development of Operational Requirements

This task is the initial step for the development of relevant second generation beacon specifications and consists in the generation of minimum and objective operational requirements expected to be met by second generation beacons operating in the Cospas-Sarsat MEOSAR System. The task involves the participation of various Cospas-Sarsat stakeholders, in particular Search and Rescue (SAR) organizations which will use the information provided by the MEOSAR system. The outcome of this activity is compiled in document C/S G.008 "Operational Requirements for Cospas-Sarsat 406 MHz beacons".

This activity is completed when document C/S G.008 is approved by the Cospas-Sarsat Council. However, the document may need to be reviewed and updated in the future, in particular once the technical evaluation of the requirements has been completed.

Although some operational requirements could be challenging to attain, especially during the initial phase of the MEOSAR system implementation programme, it is expected that these requirements will stimulate innovation and be achieved in the long-term.

3.2 Preliminary Technical Evaluation and Main System Definition and Trade-offs

This task is initiated once beacon operational requirements are available. The core of this task consists in the performance evaluation and feasibility review of possible second generation beacon designs. The activity includes system trade-offs between expected performances of MEOLUTs and beacons, to address specific operational requirements, and should allow Cospas-Sarsat Participants to make an educated decision on the definition of second generation beacon requirements. It is expected that this activity will span over two Joint Committee meetings. The proposed system definition will then be reviewed and endorsed by the Cospas-Sarsat Council.

The completion of this task will finalise key signal parameters and interoperability requirements of second generation beacons. It will also trigger the development of second generation beacon specifications and type approval standards.

3.3 Final Technical Assessment and Refined System Trade-offs

The task is a continuation of the preliminary technical evaluation and main system definition trade-offs. It involves the development of more refined system analysis (for example various antenna performance and beacon protocols). It is also expected that preliminary results from MEOSAR D&E tests will become available during this period which will allow a refined assessment of system capabilities and expected beacon performance. It is also expected that two Joint Committee meetings will be required to finalize all desired beacon characteristics and 406 MHz signal parameters. The completion of this task is required for the finalisation of the beacon performance requirements.

3.4 Development of Second Generation Beacon Specification and Type Approval Standard (documents C/S T.101, C/S T.107)

This activity is at the centre of the future second generation 406 MHz beacon development. The task consists in defining and creating second generation 406 MHz beacon specification (C/S T.101) and type approval standard (C/S T.107). This project involves the participation of all stakeholders interested in the development and testing of future beacon models. It is expected that the development of these documents will span over two years and require the establishment of Experts Working Groups. The changes in second generation beacon design and the added capabilities of these beacons may generate changes regarding the Cospas-Sarsat acceptance of 406 MHz beacon type approval test facilities (C/S T.108). All new or modified documents will require approval by the Council.

Approval of these documents by the Council will allow beacon manufacturers to finalize the development and design of second generation beacon prototypes and initiate type approval testing.

3.5 Modifications of other Relevant Cospas-Sarsat Documents (e.g. C/S G.005, C/S T.012 and C/S T.014)

The development of second generation beacon specifications will likely require changes to other Cospas-Sarsat documents. The extent of the modifications will depend on the magnitude of the changes between the current beacon specifications and future second generation specifications. For example, change in beacon frequencies, duration of burst transmission or repetition periods would impact frequency channel capacity detailed in document C/S T.012 (Frequency Management Plan) and the link budget, frequency requirements and coordination procedures described in C/S T.014 (Cospas-Sarsat Frequency Requirements and Coordination Procedure). Changes in protocols would also require modifications to document C/S G.005 (Cospas-Sarsat Guideline on 406 MHz Beacon Coding, Registration and Type Approval).

It is anticipated that approval of modifications to these documents would not be required for type approval of second generation beacons, but would be needed prior to the deployment of the second generation beacons. Amendments to these documents are expected to be made and approved one year after the approval of new documents C/S T.101 and C/S T.107.

3.6 Beacon Development

Beacon development is undertaken by beacon manufacturers sometimes supported by Administrations. This development is made in parallel with the second generation beacon requirement definition in particular to verify the feasibility of the proposed changes and additional capabilities (for example return link to the beacon) and ensure that the expected characteristics of future beacons remain achievable.

This activity cannot be completed before document C/S T.101 is approved by the Cospas-Sarsat Council. Beacon manufacturers may require additional time after the approval of the beacon specification to finalize the design of their new beacon models. The extent of this additional development time will be dependent upon the challenges associated with the new beacon specification and the willingness of beacon manufacturers to take commercial risks (i.e. to initiate the development of their new beacon model prior to the finalization of the specification to be first on the market).

3.7 Test Facilities Preparation for Type Approval Testing

This activity represents the work to be undertaken by 406 MHz beacon type approval test facilities to modify their equipment and test set-up in preparation for type approval testing of second generation beacon. As for the beacon development, the extent of this task would be dependent upon the differences between the current type approval procedures and new type approval procedures required for future beacons. Test laboratories may initiate this activity while the beacon specification and type approval procedures are being developed (in particular for new tests required to address new features such as the return link capability), but this activity is not expected to be completed until at least six months after the approval of new type approval procedures. This six month period is the minimum time needed by the Cospas-Sarsat Programme to ensure that the modifications made by the test facilities allow these facilities to undertake the new type approval procedure.

Completion of this activity, at least in some of the test laboratories, allows formal Cospas-Sarsat type approval process to take place.

3.8 Type Approval of Second Generation Beacons

This task consists in the formal Cospas-Sarsat type approval of 406 MHz second generation beacon. The activity requires Council approval of all Cospas-Sarsat second generation beacon documents (C/S T.101, C/S T.107) and that test facilities successfully demonstrate compliance of their equipment and expertise of their personnel with the new Cospas-Sarsat type approval procedure. It is anticipated that first Cospas-Sarsat type approval of second generation 406 MHz beacon could take place one year after the approval of relevant beacon documentation.

Completion of this task is a pre-requisite for the availability of second generation beacon on the market. Note that national Administrations would still need to authorize the use of these beacons in the Cospas-Sarsat System. This may require additional tests to demonstrate compliance with national or international standards.

3.9 Ground Segment Implications

The second generation beacon specification will probably include new coding protocols. In order to ensure that the signals emitted from the new beacons are properly decoded by the Cospas-Sarsat Ground Segment, LUTs will need to be modified. In particular this may require that:

a) existing LEOLUTs and GEOLUTs be upgraded to process second generation beacon signals relayed via LEOSAR and GEOSAR repeaters (SARR); and

b) MEOLUTs installed by Participants to support the MEOSAR system development, be upgraded if warranted by second generation beacon design.

Additionally, as indicated in section 2.2, second generation beacons designed to revised specifications may not be interoperable with the LEOSAR SARP processing which may prevent these beacons from being located if the coverage of the MEOLUT network is insufficient at that time.

Ground segment modifications to the current LEOLUT and GEOLUTs may be initiated when the new beacon protocols are defined as part of the second generation beacon development. Development and commissioning of MEOLUTs capable of processing second generation beacons require the finalization of the system trade-off defined in section 3.3 and MEOLUT specification and commissioning standard documents.

3.10 Updates to National and International Standards

As described in section 3.8, the deployment of second generation 406 MHz beacons requires that administrations approve updates to their current national and international standards to make reference to the new beacon specification. Given the numerous standards impacted by the process, it is unlikely that all standards will be modified simultaneously. However partial deployment of second generation beacons could be allowed as Administrations update their standards for specific types of beacons.

It is expected that the revision of these standards will be initiated as second generation beacon specification is generated and could be completed two years after the approval of the beacon specification.

3.11 Overall Time Line

Noting the anticipated scope of the tasks and activities described above and the various dependencies between them, it is anticipated that once the operational requirements for Cospas-Sarsat second generation 406 MHz beacons are approved (Task 3.1), a minimum of four years will be required for the deployment of these beacons in the System.

- END OF SECTION 3 -

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