COSPAS-SARSAT
DEMONSTRATION AND EVALUATION PLAN FOR THE 406 MHz MEOSAR SYSTEM

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History

Issue	Revision	Date	Comments
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LIST OF PAGES

Page #	Date of latest revision	Page #	Date of latest revision	Page #	Date of latest revision	Page #	Date of latest revision
i	Oct 11	4-17	Oct 11	7-1	Oct 11	E-11	Oct 11
ii	Oct 11	4-18	Oct 11	7-2	Oct 11	E-12	Oct 11
iii	Oct 11	4-19	Oct 11			E-13	Oct 11
iv	Oct 11	4-20	Oct 11	8-1	Oct 11	E-14	Oct 11
v	Oct 11	4-21	Oct 11	8-2	Oct 11	E-15	Oct 11
vi	Oct 11	4-22	Oct 11			E-16	Oct 11
				A-1	Oct 11	E-17	Oct 11
1-1	Oct 11	5-1	Oct 11	A-2	Oct 11	E-18	Oct 11
1-2	Oct 11	5-2	Oct 11			E-19	Oct 11
1-3	Oct 11	5-3	Oct 11	B-1	Oct 11	E-20	Oct 11
1-4	Oct 11	5-4	Oct 11	B-2	Oct 11	E-21	Oct 11
1-5	Oct 11	5-5	Oct 11	B-3	Oct 11	E-22	Oct 11
1-6	Oct 11	5-6	Oct 11	B-4	Oct 11	E-23	Oct 11
		5-7	Oct 11			E-24	Oct 11
2-1	Oct 11	5-8	Oct 11	C-1	Oct 11	E-25	Oct 11
2-2	Oct 11	5-9	Oct 11	C-2	Oct 11	E-26	Oct 11
2-3	Oct 11	5-10	Oct 11	C-3	Oct 11	E-27	Oct 11
2-4	Oct 11	5-11	Oct 11	C-4	Oct 11	E-28	Oct 11
2-5	Oct 11	5-12	Oct 11	C-5	Oct 11	E-29	Oct 11
2-6	Oct 11	5-13	Oct 11	C-6	Oct 11	E-30	Oct 11
		5-14	Oct 11	C-7	Oct 11	E-31	Oct 11
3-1	Oct 11	5-15	Oct 11	C-8	Oct 11	E-32	Oct 11
3-2	Oct 11	5-16	Oct 11	C-9	Oct 11	E-33	Oct 11
3-3	Oct 11	5-17	Oct 11	C-20	Oct 11	E-34	Oct 11
3-4	Oct 11	5-18	Oct 11	C-11	Oct 11	E-35	Oct 11
		5-19	Oct 11	C-12	Oct 11	E-36	Oct 11
4-1	Oct 11	5-20	Oct 11	C-13	Oct 11	E-37	Oct 11
4-2	Oct 11	5-21	Oct 11	C-14	Oct 11	E-38	Oct 11
4-3	Oct 11	5-22	Oct 11			E-39	Oct 11
4-4	Oct 11	5-23	Oct 11	D-1	Oct 11	E-40	Oct 11
4-5	Oct 11	5-24	Oct 11	D-2	Oct 11	E-41	Oct 11
4-6	Oct 11	5-25	Oct 11	D-3	Oct 11	E-42	Oct 11
4-7	Oct 11	5-26	Oct 11	D-4	Oct 11	E-43	Oct 11
4-8	Oct 11					E-44	Oct 11
4-9	Oct 11	6-1	Oct 11	E-1	Oct 11	E-45	Oct 11
4-10	Oct 11	6-2	Oct 11	E-2	Oct 11	E-46	Oct 11
4-11	Oct 11	6-3	Oct 11	E-3	Oct 11	E-47	Oct 11
4-12	Oct 11	6-4	Oct 11	E-4	Oct 11	E-48	Oct 11
4-13	Oct 11	6-5	Oct 11	E-5	Oct 11	E-49	Oct 11
4-14	Oct 11	6-6	Oct 11	E-6	Oct 11	E-50	Oct 11
4-15	Oct 11	6-7	Oct 11	E-7	Oct 11	E-51	Oct 11
4-16	Oct 11	6-8	Oct 11	E-8	Oct 11	E-52	Oct 11
		6-9	Oct 11	E-9	Oct 11		
		6-10	Oct 11	E-10	Oct 11		

LIST OF PAGES
(Continued)

Page #	Date of latest revision	Page #	Date of latest revision	Page #	Date of latest revision	Page #	Date of latest revision
F-1	Oct 11		J-1	Oct 11			
F-2	Oct 11		J-2	Oct 11			
G-1	Oct 11		K-1	Oct 11			
G-2	Oct 11		K-2	Oct 11			
H-1	Oct 11						
H-2	Oct 11						
H-3	Oct 11						
H-4	Oct 11						
H-5	Oct 11						
H-6	Oct 11						
H-7	Oct 11						
H-8	Oct 11						
I-1	Oct 11						
I-2	Oct 11						
I-3	Oct 11						
I-4	Oct 11						
I-5	Oct 11						
I-6	Oct 11						
I-7	Oct 11						
I-8	Oct 11						
I-9	Oct 11						
I-10	Oct 11						
I-11	Oct 11						
I-12	Oct 11						
I-13	Oct 11						
I-14	Oct 11						

TABLE OF CONTENTS

LIST OF ANNEXES

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The Cospas-Sarsat Council (CSC) has directed that a demonstration and evaluation (D&E) be performed to confirm the expected capabilities and benefits of a satellite system in medium-altitude Earth orbit (MEO) that uses onboard repeater instruments to relay distress alert signals emanating from 406 MHz distress radiobeacons. This system is referred to as the medium-altitude Earth orbiting search and rescue (MEOSAR) system. The CSC further directed that the D&E should establish the technical and operational performance characteristics of the MEOSAR system.

1.1 Purpose of Document

The purpose of this document is to provide the framework for the demonstration and evaluation of the MEOSAR system which should lead to a statement of capability of individual equipment and the entire 406 MHz MEOSAR system. This statement of capability will provide the information necessary for the Cospas-Sarsat Joint Committee to make recommendations to the Cospas-Sarsat Council on the integration of MEOSAR equipment into the existing Cospas-Sarsat System.

Succinctly stated, this document provides guidelines for:

- conducting the D&E of the MEOSAR system in a standard manner among the participants;
- collecting a set of results from individual participants, using compatible formats, that can be consolidated into a final report for review by Cospas-Sarsat participants and other interested parties; and
- analysing and translating the results into a set of recommendations for a decision by the Cospas-Sarsat Council.

1.2 Scope

This D&E Plan details the actions to be taken to determine the performance of MEOSAR equipment and the effectiveness of MEOSAR data for search and rescue operations. The Plan covers MEO satellites, provided by the space segment providers that are equipped with appropriate 406 MHz repeaters and that are in operation during the D&E period. It also applies to Cospas-Sarsat Participants that operate a MEOSAR ground station (MEOLUT) or an MCC that processes MEOSAR data, and to RCCs and SPOCs that might evaluate 406 MHz MEOSAR alert data. This plan includes provisions to capture data from signals generated by beacon simulators, 406 MHz test and operational beacons, and from a new beacon return link message service.

The Plan will be used to prepare, conduct, and analyse specific and varied demonstrations of MEOSAR operations and report the results. The plan provides a basis for the assessment of how well the MEOSAR system meets its expected capabilities and benefits. It presents the guidelines for data collection and analysis, for reporting demonstration and evaluation results, and for consolidation and presentation of a final report to the Cospas-Sarsat Council.

1.3 Background

Cospas-Sarsat is an international satellite system for search and rescue (SAR) distress alerting that was established in 1979 by Canada, France, the USA and the former USSR. Since its inception the Cospas-Sarsat Programme has continually expanded and, as of 2011, 43 countries and organisations share in the management of the System. At the end of 2010, more than 30,000 people had been rescued through the use of the System.

The System originally comprised satellites in low-altitude Earth orbit (LEO). The LEO satellites and associated ground receiving stations (referred to as the LEOSAR system) receive signals from distress beacons operating at 406 MHz. The LEOSAR system calculates the location of distress beacons using the Doppler effect on the received beacon signals. Because of LEOSAR satellite orbit patterns, there can be delays between beacon activation and the generation of an alert message.

In 1998, following several years of testing, the Cospas-Sarsat Council decided to augment the LEOSAR system by formally incorporating SAR instruments on geostationary satellites for detecting 406 MHz beacons (referred to as the GEOSAR system). Geostationary satellite footprints are fixed with respect to the Earth's surface; therefore, each satellite provides continuous coverage over the geographic region defined by its footprint. This reduces the detection delays associated with the LEOSAR system. Because of their altitude each GEOSAR satellite provides coverage of a very large area (about one third the surface of the Earth excluding the Polar Regions). However, because of these attributes (i.e. stationary with respect to the Earth and high altitude):

- GEOSAR systems provide location information only if this information is available from an external source (i.e. global navigation receiver in the beacon) and transmitted in the 406 MHz beacon message,
- obstructions blocking the beacon to satellite link cannot be overcome because the satellite is stationary with respect to the beacon,
- the beacon to satellite to LUT communication link budget is less robust than the LEOSAR system because of the greater distances involved (decreasing the probability that 406 MHz beacon messages are properly detected by the GEOSAR system).

In 2000, the USA, the European Commission (EC) and the Russian Federation began consultations with Cospas-Sarsat regarding the feasibility of installing 406 MHz SAR instruments on their respective medium-altitude Earth orbit navigation satellite systems (hereafter referred to as MEOSAR constellations) and incorporating a 406 MHz MEOSAR capability into the Cospas-Sarsat System. The USA MEOSAR system is called SAR/GPS[1], the European system is called SAR/Galileo, and the Russian system is referred to as SAR/Glonass.

1 The USA proof-of-concept system using GPS Block IIR and IIF satellites with an S-band downlink is referred to as the Distress Alerting Satellite System. SAR/GPS reflects the transition to an operational L-band downlink system using GPS Block III Increments B and C space vehicles.

Initial investigations identified many possible SAR alerting benefits that might be realised from a MEOSAR system, including:

- near instantaneous global coverage with accurate independent location capability,
- robust beacon to satellite communication links, high levels of satellite redundancy and availability,
- resilience against beacon to satellite obstructions, and
- the possible provision for additional (enhanced) SAR services, such as a ground to beacon return link.

In light of this potential, the Cospas-Sarsat Council decided to prepare for the introduction of a MEOSAR capability into the Cospas-Sarsat System and to encourage coordination among the space segment providers for System compatibility and interoperability with the proposed MEO satellite systems.

1.3.1 MEOSAR System Development

The MEOSAR programme time-line includes several phases which clearly delineate development and implementation activities. The following five phases were established for the realisation of the MEOSAR system[2]:

- definition and development
- proof-of-concept (POC)/in-orbit validation (IOV)
- demonstration and evaluation
- initial operational capability (IOC)
- full operational capability (FOC)

To date the first phase has been completed by all space segment providers. POC/IOV activities have been completed for the DASS space segment[3] with several participants undertaking technical tests to characterise the system. The EC and Russia plan to complete POC/IOV activities on the SAR/Galileo and SAR/GLONASS systems as soon as possible after the beginning of their constellation deployments. These POC/IOV activities are expected to be completed prior to the beginning of demonstration and evaluation activities. When D&E activities are completed, the Cospas-Sarsat Council will decide when to begin the IOC and FOC phases.

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[2] Further information on the phases of MEOSAR system implementation can be found in the document C/S R.012 (MIP).

[3] The United States began launch of GPS satellites with an experimental SAR capability in 2001. Even though these satellites were not optimally configured to fully demonstrate the full MEOSAR capability, they were adequate for POC/IOV testing. As of December 2010, there were nine DASS satellites providing POC/IOV capability.

1.3.2 Description of the MEOSAR System

1.3.2.1 MEOSAR System Space Segment

The primary missions for the three MEOSAR constellations, i.e. the Global Positioning System (GPS), Galileo and GLONASS, generally referred to as global navigation satellite systems (GNSS), are positioning, navigation, and timing. As a secondary mission, the SAR payloads have been designed within the constraints imposed by the primary mission payloads.

The three MEOSAR satellite constellations will use transparent repeater instruments to relay 406 MHz beacon signals, without onboard processing, data storage, or demodulation/remodulation. The SAR/GPS, SAR/Galileo and SAR/GLONASS payloads will operate with downlinks in the 1544 – 1545 MHz band. The planned technical characteristics of each satellite system are contained in the Cospas-Sarsat document C/S R.012 (MEOSAR implementation plan (MIP)). MEOSAR satellite providers will make their satellite downlinks available internationally for processing by MEOLUTs operated by MEOSAR D&E ground segment participants. Cospas-Sarsat MEO satellite specification and commissioning documents will be developed during the latter portion of the D&E.

1.3.2.2 MEOSAR System Ground Segment

The MEOSAR ground segment will comprise ground receiving stations (MEOLUTs), Cospas-Sarsat Mission Control Centres (MCCs) modified to process MEOSAR data, and ground control station(s) for the return link function. The MEOLUTs used during the D&E will operate under the technical requirements developed during the definition and development phase of the MEOSAR system. Cospas-Sarsat MCC and MEOLUT specification and commissioning documents will be developed during the latter stages of the D&E.

From a programmatic perspective, Cospas-Sarsat Participants and the EC are responsible for providing MEOLUTs. However, these D&E participants may not be able to provide all the MEOLUTs necessary to support global coverage during the D&E. Because the three MEOSAR constellations are expected to be interoperable, the MEOLUTs should have the capability to receive and process the downlinks of all three MEOSAR satellite constellations.

1.4 Concept of MEOSAR Operations

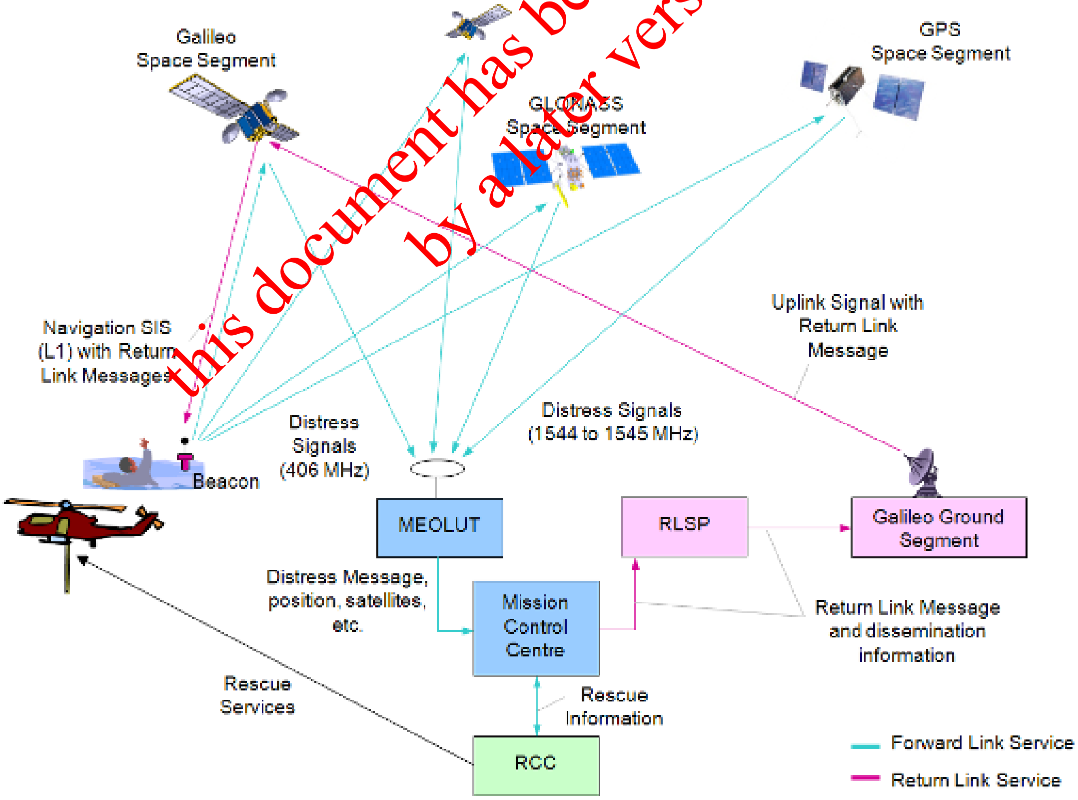
Using SAR instruments on MEO GNSS satellites and ground processing stations, the MEOSAR system will receive, decode and locate 406 MHz distress beacons throughout the world. The SAR instruments on all three MEOSAR constellations will be compatible with Cospas-Sarsat 406 MHz distress beacons as defined in document C/S T.001 (Cospas-Sarsat beacon specification).

MEOSAR satellites orbit the earth at altitudes of about 20,000 km, receiving the signals transmitted by 406 MHz distress beacons. The satellite downlinks are processed by MEOLUTs to provide beacon identification and location information. The distress alert information computed by MEOLUTs is forwarded to Cospas-Sarsat MCCs for distribution to SAR services.

Each MEOSAR satellite provides visibility of a large portion of the surface of the Earth. The MEOSAR satellite instruments will receive 406 MHz distress beacon signals and transmit them to MEOLUTs. Each MEOLUT will compute beacons' locations and transmit location data and related information to its associated MCC. Each MCC will then route beacon alert data to regional RCCs and other MCCs as appropriate.

Figure 1 below, provides a graphical summary of the MEOSAR concept. This picture shows the relay of beacon signals, via multiple satellites, to the MEOLUT. Beacon data is processed and passed onto the MCC, which in turn notifies the RCC. Also depicted is a new service offered by SAR/Galileo, the "Return Link Service" (RLS), which provides for communication back to the beacon (e.g., to acknowledge receipt of an alert). At this time, the Galileo constellation is the only system planning to deploy this emerging technology.

Figure 1: The MEOSAR System Concept



All existing and planned MEOSAR satellite instruments are 406 MHz signal repeaters. When fully implemented, each MEOSAR constellation will provide continuous visibility between a distress beacon located anywhere on Earth and at least four satellites. Simple detection is achieved when one MEOLUT antenna is in view of at least one of these satellites and location information is available if the beacon is properly equipped (i.e. if it provides an encoded position using GNSS navigation information). Upon receiving a transmission (beacon burst) from a 406 MHz distress beacon, a MEOLUT will generally obtain two key values, measurements of Time of Arrival (TOA) and Frequency of Arrival (FOA). Assuming reception of beacon transmissions by at least three MEOLUT antennas tracking distinct satellites, MEOLUT processing can provide a two-dimensional (longitude and latitude) independent beacon location using a combination of time difference of arrival (TDOA) and frequency difference of arrival (FDOA) computations. Three-dimensional locations (i.e. with the addition of a computed altitude) are possible when the beacon burst is relayed to a MEOLUT via four or more MEOSAR satellites.

In addition to calculating beacon locations using a single burst relayed by different satellites, subsequent bursts can then be used to refine the beacon location. Finally, theory and preliminary studies indicate that MEOLUTs can also improve location accuracy by processing TOA/FOA data acquired through antennas associated with a different MEOLUT, a process referred to as MEOLUT networking.

1.5 Responsibilities

Each participating MEOSAR space segment provider is responsible for ensuring that the nominal operation of its satellite instruments remains within specification during the D&E period. This responsibility includes the monitoring of critical performance parameters and the timely reporting of changes in system status.

MEOSAR ground station providers are responsible for the development, implementation and operation of their MEOLUT and communication networks, and the implementation of agreed procedures for the processing and distribution of MEOSAR alert messages and the exchange of data required for the completion of specific technical tests.

All D&E participants are responsible for the implementation of the agreed procedures for the distribution of MEOSAR alerts as given at Annex E. All participants are also responsible for collecting, analysing, and reporting the results of agreed tests as appropriate.

1.6 Schedule

The MEOSAR D&E schedule is detailed in section 6.2 which provides the major milestones of MEOSAR D&E activities. The timeline presented in section 6.2 includes concurrent activities that need to be accomplished during the D&E phase to ensure that the MEOSAR system will be able to attain IOC status, as decided by the Cospas-Sarsat Council, as soon as possible after the D&E is completed.

- END OF SECTION 1 -

2. MEOSAR DEMONSTRATION AND EVALUATION GOALS AND OBJECTIVES

2.1 Demonstration and Evaluation Goals

The MEOSAR D&E should assess technical and operational performance and offer a well supported analysis of the characteristics, capabilities, and benefits of the MEOSAR system. This MEOSAR D&E Plan offers a set of technical and operational tests which can provide this measure of performance for the future MEOSAR system. The goals of the D&E phase are to:

- characterise the technical performance of the MEOSAR system;
- characterise the operational performance of the MEOSAR system;
- evaluate the operational effectiveness of the MEOSAR system; and
- provide the basis for recommendations to the Cospas-Sarsat Council on the integration of the MEOSAR system in the Cospas-Sarsat Programme.

Therefore, D&E testing needs to be as representative of the planned MEOSAR system as possible. Even though D&E will take place before there is a fully operational space and ground segment, it is the intent to operate the MEOSAR system in a context as close as possible to that expected for standard operations.

In particular, it is assumed that:

a) the operational requirement for MEOSAR global coverage will be achieved by a distribution of stand-alone MEOLUTs;

b) MEOLUT networking will be implemented by some participants to enhance system performance and support redundancy of the Cospas-Sarsat Ground Segment;

c) each MEOLUT participating in D&E will meet the requirements of Annex C and successfully participate in the readiness tests described in Annex D; and

d) the assessment of the MEOSAR system performance during the D&E will be based on the use of first generation beacons as defined in document C/S T.001.

The D&E Plan is divided into technical and operational areas of study, with 8 technical and 7 operational tests specifically identified. The technical objectives address the compatibility of the various MEOSAR components and the determination of the baseline performance characteristics of those components. The operational objectives are structured to assess the performance and effectiveness of the MEOSAR system in supporting SAR operations.

It is unlikely that a sufficient number of satellites from either the DASS constellation (with an S-band downlink) or the SAR/Glonass and SAR/Galileo constellations (with an L-band downlink) will be available during the planned one-year D&E period in 2013, therefore, this plan assumes that both satellite bands will be processed during the D&E. However, test results will be collected separately to identify the type of satellite (i.e., S-band, L-band or both) in case the two satellite types exhibit significant differences in performance. Because the D&E will be undertaken with a mixture of satellites with S-band and L-band downlinks with different performance, it will require two phases to more confidently characterise the expected operational MEOSAR system which will only feature SAR payloads with L-band downlinks.

In the first phase, S-band systems using current beacon waveforms and beacon simulators will be used. Performance of these "preliminary" systems can be evaluated by collecting data from the existing experimental MEOLUT systems. The goal for this phase of the D&E is to demonstrate that the MEOLUT system can perform as well as, or better than, the existing LEOSAR/GEOSAR system. It is possible that a set of these tests could form the basic testing sequence for future MEOLUT commissioning.

In a second phase, when satellites with L-band downlinks will be widely available, a second series of tests replicating the tests of the first phase will be accomplished.

The technical and operational objectives of the D&E are detailed in the following sections.

2.2 Technical Objectives

The objectives of technical tests are to confirm the compatibility of the various MEOSAR components and establish the baseline performance characteristics of the MEOSAR system.

Most technical tests will be performed according to test scenarios generated by beacon simulators producing controlled signals with specified output power and message content. The beacon simulators will record beacon transmission characteristics such as frequency and time of burst transmission. However, some technical tests will use operational first generation beacons of various types (ELTs, EPIRBs and PLBs) to characterise their actual level of performance in comparison with the performance assessed using controlled beacon simulator signals.

The test scenarios will guarantee a data set large enough to ensure the statistical validity of each test result. Because of the nature of the MEO satellite constellation, the satellite tracking schedule will repeat on a 24 hour cycle, except if the satellite selection process is managed dynamically. The test scenarios are designed assuming a static selection algorithm and a 24 hour repetition of the satellite configurations. It is recognised that technical test results for MEOLUTs which process transmissions from simulators located at a great distance may exhibit differences due to less favourable satellite geometries. Therefore, MEOLUTs participating in the MEOSAR D&E technical tests should collect all available data, including from beacon signals produced by simulators which are not collocated with the MEOLUT. When appropriate, a DOP value characterising the available satellite configuration will be associated to each test result.

The results of some of these tests could form the basis of future MEOLUT technical specifications and commissioning standards, as they will define a minimum level of acceptable performance for all future MEOLUTs.

All technical tests for the MEOSAR D&E described below assume the transmission of first generation 406 MHz beacon signals, with the long message format, which meet documents

C/S T.001 and C/S T.007 specifications and standards, except for the beacon transmit power which may vary according to the defined test scenarios. However, on an optional basis, D&E participants may run parallel sequences of tests with different signal characteristics to assess the performance enhancements expected from modified antenna radiation patterns or second generation beacon signal characteristics. Successful completion of the D&E will not be dependent on the results of these optional tests, but will be decided on the results obtained with first generation beacon signals.

The specific technical parameters to be assessed are listed below. The complete description of each technical test is provided in section 4 of this document. All technical tests scenarios described in section 4 may be repeated as required by D&E participants and as decided by the Cospas-Sarsat Council for completing the evaluation of MEOSAR system performance.

As a minimum, D&E participants should endeavour to perform the tests T-1, T-3, T-4, T-5 and T-6 and provide reports on their MEOLUT performance as described in section 4. The other technical tests, i.e., T-2, T-7 and T-8, will be performed by participants as an option, depending on available ground segment equipment capability.

T-1 Processing Threshold and System Margin

Determine the minimum value of the beacon output power for which a single MEOLUT satellite channel is able to produce a valid/complete message for each beacon burst [70%] of the time. The system margin is the difference between the nominal output power of a beacon and this processing threshold.

Detection probabilities for multi-channel MEOLUTs may also be derived from this test data.

T-2 Impact of Interference

Initially assess the presence of interference in the 406 MHz frequency channel to be used for this test. Monitor the frequency channel for interference while technical tests are being performed, with a view to explaining anomalies in the results and illustrating the ability of the MEOSAR system to provide valid messages in the presence of interference and noise in the 406 MHz band.

Specific test scenarios may also be run in frequency channels with known interference to compare results with previously run tests in channels free from the known interference.

T-3 Valid/Complete Message Acquisition

<u>Valid/Complete Message Detection Probability</u>

Characterise the probability of detection of a valid/complete message by a MEOLUT after receiving one, two and seven bursts from beacons with a power output of 37 dBm and [30 dBm].

<u>Valid/Complete/Confirmed Message Transfer Time</u>

Characterise the time elapsed between beacon activation and the production by a MEOLUT of a valid/complete/confirmed message for beacons with a power output of 37 dBm and [30 dBm].

T-4 Independent 2D Location Capability

Three parameters are used to characterise the MEOSAR system 2D independent location capability. They are evaluated for stand-alone MEOLUTs in the following configurations:

- using four satellite channels only; and
- using any number of satellite channels available to the stand-alone MEOLUT.

<u>Independent Location Probability</u>

Characterise the probability for a stand-alone MEOLUT to provide an independent 2D location with a location error less than X km (X = 2, 5 or 10 km), for a given number of transmitted bursts (1 to 7 bursts) and for a beacon transmitting at 37 dBm.

<u>Independent Location Accuracy</u>

Characterise the cumulative distribution of location errors, and the average and median values of the distribution, for independent locations produced by a stand-alone MEOLUT after a given number of transmitted bursts (1 to 7 bursts) and for a beacon transmitting at 37 dBm.

<u>Time to First Independent Location</u>

Characterise the time elapsed between the beacon activation and the first 2D independent location provided by a stand-alone MEOLUT with an error less than X km (X = 2, 5 or 10 km) and for a beacon transmitting at 37 dBm.

T-5 Independent 2D Location Capability for Operational Beacons

[Characterise the 2D independent location performance of the MEOSAR system after receiving each single burst, two consecutive received bursts, three consecutive bursts, and up to seven consecutive bursts for each operational first generation beacons of various types (ELT, EPIRB and PLB), by determining two parameters used in test T-4:

- *Independent Location Probability*
- *Independent Location Accuracy]*

The above parameters are assessed for stand-alone MEOLUTs using four satellite channels only and for the stand-alone MEOLUTs using any number of satellite channels available at the MEOLUT.

T-6 MEOSAR System Capacity

The MEOSAR system capacity is defined as the number of beacons operating simultaneously that can be successfully processed without degradation of performance.

The system performance parameters used to assess the system capacity are:

- the single satellite channel throughput (probability of detecting a valid message for each transmitted burst received via a single satellite channel); and
- the single burst location probability of a stand-alone MEOLUT using four satellite channels.

T-7 Networked MEOLUT Advantage

Evaluate the performance improvement that can be achieved by exchanging data between MEOLUTs. For this evaluation the tests T-4 and T-5 listed above may be repeated, or the transmissions processed in parallel in the stand-alone and network configurations, and the results compared with results obtained for the stand-alone MEOLUT configuration.

T-8 Combined MEO/GEO Operation Performance

Evaluate the ability of a MEOLUT to merge GEO and MEO data to provide a combined MEO/GEO alert. For this evaluation, tests T-3, T-4 and T-5 as listed above need to be repeated, or processed in parallel, in the desired configurations (stand-alone MEOLUT, combined MEO/GEO, networked MEOLUT) and their results compared with results previously obtained with MEO data only.

2.3 Operational Objectives

The MEOSAR D&E operational tests aim to evaluate the contribution to SAR operations of alert data provided by the 406 MHz MEOSAR system and are designed to gain operational experience in the use of MEOSAR distress alerts. The overall operational objectives are to:

a. assess the performance of the MEOSAR system in supporting actual search and rescue operations;

b. provide SAR services with experience using MEOSAR system data and assess the effectiveness of MEOSAR alerts;

c. provide participating ground segment operators with experience in the distribution and use of MEOSAR distress alerts; and

d. assess the impact of the MEOSAR system on the Cospas-Sarsat 406 MHz System.

The specific operational parameters which should be measured to provide the basis for the MEOSAR operational evaluation are listed below. See section 5 for the complete description of operational tests.

O-1 Potential Time Advantage

Measure the elapsed time between the receipt at an MCC of MEOSAR distress alert messages as compared to those from the existing system (LEOSAR and GEOSAR alert messages).

O-2 Unique Detections by MEOSAR System as Compared to Existing System

Evaluate the performance of the MEOSAR system in detecting and locating 406 MHz beacons in relation to the existing Cospas-Sarsat System, and to visualise MEOSAR coverage during the D&E period.

O-3 Volume of MEOSAR Distress Alert Traffic in the Cospas-Sarsat Ground Segment Network

Evaluate the volume of 406 MHz MEOSAR distress alert messages exchanged between MCCs, compare it to the traffic for the existing system (LEOSAR and GEOSAR) and provide information on the totals and data volumes.

O-4 406 MHz Alert Data Distribution Procedures

Validate the initial concept of operations for alert data distribution, compare performance to the LEO/GEO system and suggest modifications required for an operational MEOSAR system.

O-5 SAR/Galileo Return Link Service (RLS)

Evaluate the SAR/Galileo RLS in respect of data volume, the effectiveness of data distribution procedures and the timely delivery of return link messages.

O-6 Evaluation of Direct and Indirect Benefits of MEOSAR System

Evaluate the direct and indirect benefits to SAR services derived from the use of MEOSAR data.

O-7 MEOSAR Alert Data Distribution – Impact on Independent Location Accuracy

[Evaluate the initial concept of operation for alert data distribution to ensure that MCCs provide SPOCs and other MCCs with accurate independent location data in a timely manner while minimising the distribution of unnecessary data.]

2.4 Other Suggested Data Collection

MEOSAR D&E participants may also consider collecting additional MEOSAR data for the purpose of completing the assessment of performance of the MEOSAR system. Such additional data may include MEOLUT processing results of self-test bursts transmissions and real beacon events resulting from operational beacon transmissions.

- END OF SECTION 2 -

3. MEOSAR D&E METHODOLOGY AND DATA EXCHANGE

3.1 General D&E Methodology

3.1.1 Overview

All participants in the MEOSAR system D&E should conduct their D&E activities in accordance with a common set of guidelines and procedures as defined below and in the remainder of this MEOSAR D&E Plan.

The MEOSAR D&E methodology includes:

a. standard procedures for each test applicable to all participants for collecting, analysing and reporting data required for the evaluation of the stated objective;

b. guidelines for interpreting and reporting the results of the D&E tests by individual participants, integrating these results into a consolidated D&E report, and drawing appropriate recommendations for submission to the Cospas-Sarsat Council;

c. procedures for the exchange of MEOSAR alert and system information messages as provided at Annex E;

d. procedures to track system changes which may affect D&E test results; and

e. procedures for interim review of D&E test progress.

The subsections below provide a broader description of the overall methodology.

3.1.2 Methodology

The overall period for collecting test data is detailed in the timeline provided in section 6.2 of this plan. Within this period, tests will be conducted according to test scripts as well as via the collection of operational and test beacon data over designated time periods for each test defined in sections 4 and 5 of this plan. Each test will be repeated as significant conditions change during the test period, such as the addition of satellites (particularly L-band satellites) and ground stations. Sections 3.2, 3.3, 7 and 8 provide guidelines for the tracking and reporting of system changes to ensure the validity of the data sets used to generate the D&E Final Report.

The schedule of test activities with relevant information on the test performed by each participant (i.e. periods of test beacon/simulator transmissions, location of transmitter, signal characteristics if not nominal, etc.) should be provided to all participants, preferably with sufficient advance notice for coordination with other participants wishing to collect data or perform similar or other tests. These test activities shall be recorded in a General Test Schedule maintained by the Secretariat, showing the originator of the test and the participants collecting data.

Analysis will be performed on large data sets comprised of beacon burst and location data collected at MEOLUTs and processing and message traffic data collected at MCCs.

A reliable and consistent D&E outcome will best be achieved by application of the same data analysis method by all participants. For example, a common analysis method can be ensured by using a standard spreadsheet with embedded macros. A macro would first validate the format and general content of the input, and given valid input would populate predefined result columns and/or summary tables.

Regardless of the technique, all participants must apply a common analysis method as documented in each test procedure. Results will be provided to the D&E Report Preparation Group which will collate results into a draft D&E Final Report. Participants are encouraged to perform additional analysis of test results.

Unless explicitly documented by specific test beacon scripts within a test plan, participants should document the transmission of beacon messages for the D&E in a common Excel spreadsheet. These populated spreadsheets will be provided to D&E participants and the D&E Report Preparation Group on a regular basis. At a minimum, this spreadsheet will contain the following fields:

Field	**Description**
Beacon ID	15 character Hex id
Power	transmission power in dBm
Frequency	transmission frequency in MHz
Duration	duration of activation in minutes
Time of first burst	time of the first burst (to nearest second)
Time of last burst	time of the last burst (to nearest second)
Latitude	decimal latitude accurate to at least 3 decimal places (6 preferred)
Longitude	decimal longitude accurate to at least 3 decimal places (6 preferred)
Altitude	decimal altitude accurate to at least 2 decimal places in metres
Antenna	simple description (e.g., linear, omni-directional)

Beacon messages should be transmitted (and notification provided) in accordance with section 3.8 of the Cospas-Sarsat DDP (C/S A.001), and as provided at Annex E. Beacon messages shall not be transmitted with an operational protocol, unless this is essential to the test being conducted.

3.1.3 MEOSAR D&E Readiness Testing

To provide consistency in the reporting of objectives, one or more readiness test will be conducted prior to the beginning of the data collection period. The test(s) will be designed so that the performance of each MEOLUT and MCC is documented. The test(s) will provide a level of confidence that the MEOSAR D&E participants and system are ready to undertake the tests detailed in this Plan. The MEOSAR D&E readiness test is described at Annex D.

The results of the readiness test(s) will be exchanged among the D&E participants and provided to the Secretariat. After review by the Secretariat, the Cospas-Sarsat Council will decide whether the readiness test(s) has demonstrated that the formal D&E tests can begin. If necessary, the readiness test(s) will be repeated until system readiness is assured. Once the Cospas-Sarsat Council has declared that formal D&E tests can begin, a baseline MEOSAR system status (e.g., MEOSAR satellites, MEOLUTs and participating MCCs) will be provided. Subsequently, all system changes should be documented and provided to the other D&E participants as outlined in sections 3.2 and 3.3.

3.2 Exchange of MEOSAR System Information

To facilitate a thorough data gathering and accurate statistical analysis, all D&E participants should maintain and distribute system status information to all other participants. This information shall include:

- all periods of MEOLUT down time;
- any change in status of MEOSAR satellites or 406 MHz repeater instruments;
- any MEOSAR satellite configuration which may affect the processing of MEOSAR data;
- any change of MEOLUT status, configuration or software which affects the collection and processing of MEOSAR data;
- any change in the status of test, orbitography and reference beacons or beacons simulators;
- all changes of MCC status, configuration or software which affect the processing of MEOSAR data or the analysis of operational tests; and
- all periods of MCC down time.

This system information shall be exchanged between the participants on a timely basis using the system status message (SIT 605).

3.3 Documentation of System Change Information during D&E Testing

To ensure accurate statistical analysis during D&E testing, each system change made after the baseline system status is provided and until the D&E is complete should be thoroughly documented. This information will allow the participants to understand the cause of possible variations in test results and determine how to use the information. Reflecting the same categorical list given in section 3.2 above, participants should document all system changes in a common Excel spreadsheet. These populated spreadsheets will be provided to D&E participants and the D&E Report Preparation Group on a regular basis. At a minimum, this spreadsheet will contain the following fields:

Field	Description
Entity	The entity or component changed (e.g., MEOLUT, MCC, satellite)
Type of Change	e.g., Newly Added, Removed/Disabled, Reinstated, Updated
Date/Time of Change	Self-explanatory
Classification	Hardware, software, software configuration
Organisation	Administration/Organisation documenting this change
Description of Change	A short but reasonable summary of the change

3.4 Monitoring of D&E Test Progress and Test Plan Adjustments

A mechanism is needed by which Cospas-Sarsat and the D&E participants can evaluate progress and determine conditions that would necessitate new analysis and/or retests. Cospas-Sarsat meetings throughout the D&E Test period will provide the opportunity to carry out these tasks (e.g., Expert Working Groups, Task Groups, Joint Committee, and Council). In each case an agenda item will be dedicated for the review of D&E test data collected and analysed to date, summaries of progress and status generated, and adjustments made as necessary in order to ensure the most reliable and complete test results possible. Participants at these intermediate meetings will determine courses of action as possible, but if decisions are required they should be deferred to the Cospas-Sarsat Council.

- END OF SECTION 3 -

4. MEOSAR D&E TECHNICAL TESTS

This section describes the technical tests to be performed during the 406 MHz MEOSAR D&E phase. Also included are the methods and procedures for conducting the tests, and directions for data collection, analysis, interpretation, and reporting.

4.1 T-1: Processing Threshold and System Margin

4.1.1 Objective and Definitions

The objective of this test is to determine the minimum power output of first generation beacons and the corresponding C/No at a MEOLUT under test, for which the throughput of a valid/complete beacon message for a transmitted burst meets expected performance for a single satellite channel and for multiple satellite channels. These threshold values will allow a computation of the system margin.

Throughput will be measured for each MEOLUT satellite channel and as a function of the number of antennas used, incrementing from 1 up to the maximum number of antennas available at the MEOLUT.

The test will be run for a period of 24 hours but will be repeated as necessary to obtain a sufficiently large data sample to be statistically significant and to allow for testing different space segment conditions.

Rationale: The high variability of spatial geometry due to constellation population density and satellite motion must be considered in this test. The MEOSAR system will consist of multiple satellites, all in motion relative to the Earth. Hence, this test must account for the variability of geometry by ensuring sufficient measurements are available for statistical validity.

The processing threshold and system margin are “figures of merit” for a MEOLUT. The processing threshold is the value of the minimum beacon transmit power for which the valid/complete message throughput at the MEOLUT is equal to or greater than the expected performance.

The system margin is a measure of how far below the nominal beacon transmit power of 5 W (37 dBm) a MEOLUT can process beacon signals and produce valid/complete messages with a throughput meeting expected performance. The range of beacon transmit power for which the MEOSAR system can consistently produce valid messages increases with the system margin which characterises the robustness of the system to signal degradation.

4.1.2 Methodology and Data Collection

Test T-1 requires the following steps to be taken:

- Use a beacon simulator as a controlled test beacon with a variable output power adjustable over a range of at least 15 dB in 1 dB steps, with a 3 second interval between individual beacon bursts.
- Ensure the beacon simulator is located within the operational radius of the MEOLUT under test.
- Select a frequency channel outside those used by operational beacons, e.g. [406.064 MHz]. Calibrate the beacon simulator's output power to ensure validity of the output level.
- Turn on the beacon simulator and allow it to stabilise.
- Transmit 10 bursts at 3 second intervals with a power output decreasing by one dB after each burst to cover the range 37 dBm to 28 dBm.
- Repeat the 10 burst sequence continuously for 24 hours, hence producing 120 bursts at each power level, each hour, for each satellite tracked, assuming a continuous visibility of the tracked satellite during the hour.
- For each transmitted burst, collect all received bursts at the MEOLUT and capture the C/No value of each received burst.
- Compile the lists of all messages produced by each MEOLUT satellite channel at each power level and determine the number of valid/incomplete messages (NVIM) and complete messages (NCM).
- Determine the number of transmitted bursts (NTB) that should have been received in each satellite channel for each power level, using the satellite visibility schedules during the 24 hour test period and assuming a minimum MEOLUT/satellite elevation angle of [5º] and a minimum beacon/satellite elevation angle of [5º].

a) <u>Single Satellite Channel Threshold and Margin</u>

- Aggregate the NVIM, NCM, NTB values for single satellite channels.
- Compute for each transmit power level the single satellite channel throughput ((NVIM+NCM)/NTB and NCM/NTB) and the average C/No for the complete 24 hour test period.
- Determine the single satellite channel processing threshold as the beacon transmit power for which the throughput drops below expected performance.
- Determine the single satellite channel margin as the difference in dB between 37 dBm and the value of beacon transmit power at which the throughput drops below expected performance.

b) <u>Multiple satellite channel threshold and margin</u>

- *[Determine the number of transmitted bursts (MNTB) that should have been received by the MEOLUT for each power level, using the satellite visibility schedules during the 24 hour test period and assuming a minimum MEOLUT/satellite elevation angle of [5º] and a minimum beacon/satellite elevation angle of [5º].*

- *Compile the lists of all messages produced by each MEOLUT satellite channel at each power level and determine the number of valid/incomplete messages (NVIM) and complete messages (NCM).*
- *Compute for each transmit power level the throughput ((NVIM+NCM)/MNTB and NCM/MNTB) and the average C/No for the complete 24 hour test period as a function of the number of antennas used. That is, compute the throughput for x antennas, with x ranging from 1 to the maximum number of antennas available.*
- *For each number of antennas used, determine the processing threshold as the beacon transmit power for which the throughput drops below expected performance.*
- *Determine the system margin as the difference in dB between 37 dBm and the transmit power value at which the throughput drops below expected performance.]*

4.1.3 Data Analysis and Results

Table 4.1 depicts the data that should be compiled for each test.

Beacon Tx power	Number of transmitted bursts: NTB	Average C/No of received bursts	Number of valid messages: NVIM	Number of complete messages: NCM	Throughput for valid messages	Throughput for complete messages
37 dBm						
36 dBm						
35 dBm						
…						
…						
28 dBm						

Table 4.1: T-1 Results for the 24 Hour Test Sequence

Note: NTB, the number of bursts will depend on the duration of beacon simulator/satellite/MEOLUT visibility during the 24-hour test period.

From this table, the processing threshold and system margin can be computed for each 24-hour test sequence. The average processing threshold and system margin should be computed for each MEOLUT and satellite type combination.

The following data should be recorded:

a) the location of the beacon simulator;

b) the time the beacon simulator was turned on and off;

c) the time of the beginning and end of each 24-hour test sequence;

d) the power of each transmitted burst;

e) the C/No of each relayed burst;

f) the satellite tracking schedules used by each MEOLUT during the 24-hour test sequence; and

g) all messages produced by the MEOLUT during the tests.

All invalid messages produced by the MEOLUT should be examined to determine if the error can be explained by a known reason that degraded the MEOLUT's ability to produce a valid/complete message.

4.1.4 Interpretation of Results

The processing threshold and system margin characterise the ability of the MEOLUT to provide valid alert messages over the expected range of beacon transmit power. Characterising throughput performance of a single antenna allows a comparison of performance between MEOLUT channels (i.e. each satellite type and MEOLUT combination). The processing threshold and system margin of a MEOLUT, as a function of the number of antennas used, allows for a measure of the number of antennas necessary for the MEOLUT to achieve a given throughput rate performance.

4.2 T-2: Impact of Interference

4.2.1 Objective and Definitions

The purpose of this test is to determine the ability of the MEOSAR system to provide valid messages and accurate locations in the presence of in-band interference and noise. The objective is to monitor the 406 MHz band for the presence of interference while the technical tests are being performed in order to understand any anomalies in the results.

4.2.2 Methodology and Data Collection

This test will use the results obtained during technical tests to determine the impact of actual interferers seen in the MEOSAR field of view. It will also examine the relationship between the characteristic nature of the interfering signals and any changes in the production of valid messages and locations.

The following methodology should be used:

a) Prior to testing, evaluate with whatever hardware is available, the current condition of both the 406 MHz and the 1544 MHz band (or S-band as appropriate) around the MEOLUT, and if possible, the interference or noise seen at the MEOLUT antennae in the downlink band. Document the time the evaluation took place, the frequency of any interferers, or any other significant noise or events of interest that may impact the MEOLUT's ability to detect messages.

b) For participants with more sophisticated spectrum monitoring hardware, characterise the interference by using spectrum monitoring hardware/software (HW/SW) as well as a data storage device to permit detailed analysis of the interfering signal after its occurrence. The spectrum monitoring HW/SW may take multiple forms, including using part of the MEOSAR processor. The test apparatus illustrated in Figure 4.1 could be used.

   Though it is not shown in Figure 4.1, it is to be understood that the signal from the antenna is down-converted from S- or L-band before reaching the signal processing segments.

c) Continuously monitor the 406 MHz band using the spectrum monitoring HW/SW. Record the output in a storage device for later detailed analysis (e.g., data plots, spectrograms, and/or spectral images).

d) When interference is detected, collect the following parameters of the interfering signal:

   i. the MEOSAR satellite and MEOLUT used for detection;
   ii. duration and time of occurrence;
   iii. location in the 406 MHz band (i.e. which part of the band is affected);
   iv. spectral occupancy;
   v. signal strength;
   vi. time patterns (e.g., on/off, continuous, sweeping versus constant, etc.);
   vii. nature of modulation (i.e., analogue versus digital), if known; and
   viii. location, if known.

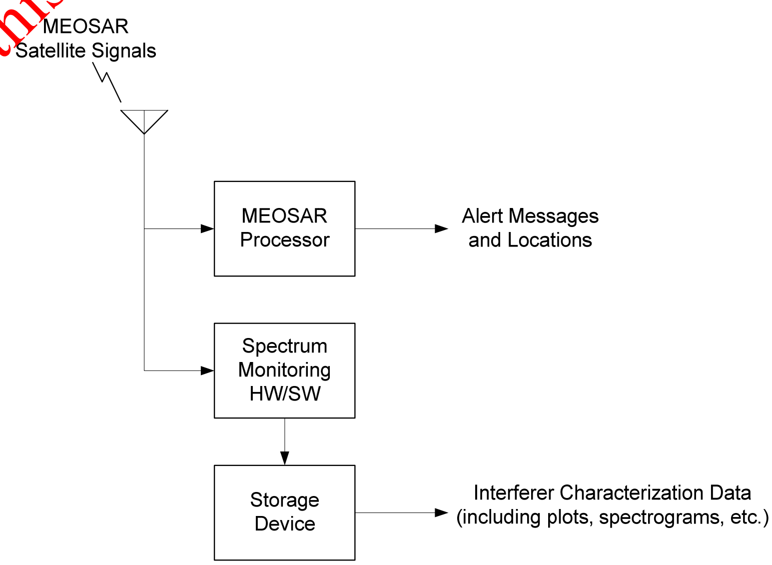
   In addition, examine the production of messages and locations by the MEOSAR processor during the period that the interference was present, noting (i) any lost or invalid messages, (ii) any increases in the message transfer time, and (iii) any increase in location accuracy or uncertainty.

e) For controlled test beacons, record the time of beacon activation and the location of the beacon.

f) Use the results obtained during applicable technical tests and compare results obtained during periods of known interference and during periods where no interference was observed.

g) Continue the data collection process until a broad range of interferers has been observed over a period of several months.

Figure 4.1: Test Apparatus for Interference Evaluation.



4.2.3 Data Analysis and Results

When interference is detected, examine all MEOSAR messages and locations produced during the period when it is present to determine if there is:

a) any loss of expected messages;

b) a decrease in the percentage of valid messages produced from [both operational and] test beacons;

c) an increase in false messages, i.e., false alerts; or

d) a decrease in the percentage or precision of computed locations.

This analysis assumes that data is recorded before, during, and after the interferer is present. Subsequently, examine the technical parameters of the interferer and try to relate the impact on both message and location processing to specific characteristics of the interferer. For example, is there a relationship between a reduction in valid messages and the interferer's signal strength?

4.2.4 Interpretation of Results

Based upon the results of the analysis, conclusions will be drawn concerning the ability of the MEOSAR system to withstand various levels and types of interfering signals. This information will permit recommendations to be made to external agencies concerning the impact of interference in the 406 MHz band upon the MEOSAR system. Cospas-Sarsat participants will gather a specific body of evidence to support deactivating 406 MHz interferers through other regulatory bodies and agencies.

4.3 T-3: MEOLUT Valid/Complete Message Acquisition

4.3.1 Objective and Definitions

Test T-3 objective is to investigate three main parameters which characterise the production of valid and complete messages by a stand-alone MEOLUT using one or several satellite channels:

(i) Valid/Complete Message Detection Probability

This parameter characterises the capability of a MEOLUT to detect valid/complete messages in a given period of time after beacon activation (i.e. after one, two and seven burst transmissions) and for beacon output powers of 37 dBm and [30 dBm].

(ii) Valid/Complete/Confirmed Message Transfer Time

This parameter characterises the time elapsed between beacon activation and the production of valid/complete/confirmed messages by a MEOLUT for beacon output powers of 37 dBm and [30 dBm].

The MEOLUT throughput is defined as the ratio of the number of valid (or complete) messages produced by the MEOLUT over the number of bursts emitted during a given period of time.

Test T-3 will be performed over a pre-determined 24-hour period.

4.3.2 Methodology and Data Collection

A beacon simulator is used to replicate beacons that transmit long format messages at the frequencies [406.064] and [406.070] MHz with two different emission powers: 37 and [30] dBm. Data is collected over a 24-hour period.

Rationale: The access probability/detection probability/transfer time are characterised at 37 dBm which is the nominal beacon power, and at a lower value [30 dBm]. The MEOLUT throughput will depend upon the elevation of the satellites used for the characterisation. However, considering that MEO satellite orbit configurations repeat approximately every 24 hours, varied geometrical configurations will be achieved, without the need for a coordinated tracking schedule, in a 24-hour period.

The following steps are required to perform test T-3:

a) In each one-hour period within 24 hours, select four time slots of at least 350 seconds (two for 37 dBm and two for [30] dBm transmissions). Ensure each time slot is adequately separated in time to ensure that MEOLUTs will separately process each transmission sequence with the same beacon ID.

b) Implement the test script provided at Annex G on a beacon simulator and calibrate the beacon simulator emission power and carrier frequency to confirm the characteristics of the transmitted signals.

c) Transmit 700 bursts per Annex G test script (7 x 100 IDs) at 37 dBm in the first time slot selected at step a, produced by the MEOLUT for the beacon IDs transmitted by the simulator.

d) Repeat the process at [30 dBm] during the second time slot selected at step a, with the appropriate scripts.

e) Repeat the test sequence in slots 3 and 4 of the first one-hour period, i.e. two 350 second transmission sequences at 37 and [30] dBm, and repeat the sequence each hour for a total duration of 24 hours.

The following test data should be recorded:

- the location of the beacon simulator;
- the time the beacon simulator was turned on and off;
- the time of the beginning and end of each 24-hour test sequence;
- the satellite tracking schedules used by each MEOLUT during the 24-hour test sequence; and
- all messages produced by the MEOLUT during the tests.

4.3.3 Data Analysis and Results

Data collected as described in section 4.3.2 is used for assessing the two parameters described in 4.3.1, each with a specific procedure for data reduction and analysis, as described below.

4.3.3.1 Valid/Complete Message Detection Probability

For the 24 hour test period, for each emission power, perform the following steps:

a) Filter the beacon bursts list collected per Annex J to retain only the valid/complete messages.

b) For each MEOLUT event, using the time stamp information, determine whether a valid and/or complete beacon message was produced.

c) Determine whether at least one valid[4] or complete message was produced after one, two and seven burst transmissions for each beacon IDs and report the corresponding numbers in each slot.

d) Determine the probability of detection of a valid/complete message after one burst, two and seven burst.

e) Build Table 4.2 for the detection probability after one, two and seven bursts, as illustrated below for the case "seven transmitted bursts":

Beacon emission power	Slot No	NTBI Number transmitted beacon IDs	NVIM After 7 Bursts.	NCM After 7 Bursts.	Valid Message Det. Prob. (%) After 7 Bursts. (NVIM+NCM)/NTBI	Complete Message Det. Prob (%) After 7 Bursts NCM/NTBI
37 dBm –	Slot 1	100				
[30 dBm]	Slot 2	100				
	...					
37 dBm –	Slot 7	100				
[30 dBm]	Slot 8	100				
37 dBm	Slot 95	100				
[30 dBm]	Slot 96	100				

Table 4.2: T-3 Detection Probability after Seven Burst Transmissions

4.3.3.2 Valid/Complete/Confirmed Message Transfer Time

For each slot and each emission power perform the following steps.

a) Filter the beacon burst lists collected per Annex J to retain only the valid/complete/confirmed messages.

[4] If: NCM = Number of Complete Messages; NVIM = Number of Valid and Incomplete Messages, then Number of Valid Messages = NVIM + NCM

b) For each slot and using the time stamp information, calculate for each beacon ID the time elapsed between beacon activation and the production of the first valid/complete and confirmed valid/complete message.

c) Using the 100 beacon IDs in each slot, derive the mean value of the time elapsed between beacon activation and the production of a valid/complete/confirmed message.

d) Build Table 4.3 for the 24-hour test sequence.

4.3.4 Interpretation of Results

T-3 test results will characterise the MEOSAR performance in decoding bursts to produce valid and complete messages, i.e. the MEOLUT throughput for valid and complete beacon messages and the time required to produce a valid or complete beacon message after beacon activation. This performance may be affected by a number of constraints, such as the distance from the beacon to the MEOLUT.

Beacon emission power	Slot No	Mean value of Valid Mess. Transfer time	Mean value of Confirmed Valid Mess. Transfer time	Mean value of Complete Mess. Transfer time	Mean value of Confirmed Complete Mess. Transfer time
37 dBm –	Slot 1				
[30 dBm]	Slot 2				
	...				
37 dBm –	Slot 7				
[30 dBm]	Slot 8				
37 dBm	Slot 95				
[30 dBm]	Slot 96				

Table 4.3: T-3 Message Transfer Time

4.4 T-4: Independent Location Capability

4.4.1 Objective and Definitions

Test T-4 objective is to investigate three main parameters which characterise the production of independent location data by stand-alone MEOLUTs using four satellite channels and by MEOLUTs using any number of satellite channels.

(i) Independent Location Probability

Characterise the capability of a MEOLUT to provide an independent 2D location with a location error less than X km (X = 2, 5 or 10 km), for a given number of transmitted bursts (1 to 7 bursts) and for a beacon transmitting at 37 dBm.

(ii) Independent Location Accuracy

Characterise the average value and the standard deviation of the location error of 2D locations provided by a MEOLUT, for a given number of bursts (1 to 7 bursts) and for a beacon transmitting at 37 dBm.

(iii) Time to First Independent Location

Characterise the time elapsed between beacon activation and the first 2D independent location provided by a MEOLUT with an error less than X km (X = 2, 5 or 10 km), for a beacon transmitting at 37 dBm.

The test T-4 will be performed over a pre-determined 24-hour period using a standard first generation beacon signal fed to a linear antenna.

4.4.2 Methodology and Data Collection

A beacon simulator is used to replicate distress beacons that transmit long format messages,

- with the nominal beacon emission power of 37 dBm; and
- at the frequencies [406.064] and [406.073] MHz.

Sequences of beacons IDs are transmitted to generate sets of 100 locations produced from 1, 2, 3, 4, 5, 6 or 7 bursts. All sequences are repeated twice in each one-hour period over a 24-hour duration.

Rationale: Beacon events are transmitted with a controlled number of bursts to clearly assess the locations calculated by the MEOLUT under varied conditions. It is relevant to assess the performance for a low number of bursts as one of the objectives of the MEOSAR system is to derive locations from a limited number of bursts. The value of 7 bursts is retained because simulations have shown that locations reach a stable and optimum value with this figure for all location methods.

The following steps are required to perform test T-4:

a) In each one-hour period within 24 hours, select two time slots of at least 1,400 seconds.

b) Implement the test script provided at Annex H on a beacon simulator and calibrate the beacon simulator emission power and carrier frequency to confirm the characteristics of the transmitted signals.

c) Transmit 1,400 bursts per Annex H test script at 37 dBm in the first time slot selected at step (a) and collect location data produced by the MEOLUT for the beacon IDs transmitted by the simulator.

d) Repeat the test sequence in the second slot of the hour and repeat both sequences each hour for a total duration of 24 hours.

4.4.3 Data Analysis and Results

Data collected in section 4.4.2 is used for assessing three parameters, each with a specific procedure for data reduction and analysis, as described below.

4.4.3.1 Independent Location Probability

For each slot perform the following steps:

a) For each location collected per Annex J, calculate the location error:

$$\text{Loc Error} = \sqrt{((\text{Lat} - \text{Lat Th}) \times 111)^2 + ((\text{Long} - \text{Long Th}) \times \text{Cos}(\text{Lat Th}) \times 111)^2}$$

Lat, Long = computed latitude and longitude in degrees
Lat Th, Long Th = theoretical (simulated) latitude and longitude in degrees
Loc Error is in km.

b) For each burst sequence, select a single 2D location.

c) For each location, determine the location error.

d) For each set of 100 IDs (i.e. Set 1 transmitted once, Set 2 transmitted twice, Set 3 transmitted three times, … and Set 7 transmitted seven times), count the number of locations:
(i) with an error less than 2 Km ($NbLoc_{2km}$).
(ii) with an error less than 5 Km ($NbLoc_{5km}$).
(iii) with an error less than 10 Km ($NbLoc_{10km}$).

e) For each set of 100 IDs calculate the probability of obtaining an independent 2D location with a location error less than 2, 5 and 10 km (i.e. the ratio $NbLoc_{Xkm}/100$).

f) Populate Table 4.4 for errors less than 2 km, 5 km and 10 km.

		Independent Location probability…						
Slot No	DOP value	1 burst	2 bursts	3 bursts	4 bursts	5 bursts	6 bursts	7 bursts
Slot 1								
…								
…								
Slot 48								

Table 4.4: T-4 Independent Location Probability with Errors less than X km (X= 2, 5 or 10 km)

4.4.3.2 Independent Location Accuracy

For each slot, perform the following steps.

a) For each burst sequence, select a single 2D location. This single location selection should not use a priori knowledge of the beacon location.

b) For each location selected per Annex J, calculate the location error:

$$\text{Loc Error} = \sqrt{((\text{Lat} - \text{Lat Th}) \times 111)^2 + ((\text{Long} - \text{Long Th}) \times \cos(\text{Lat Th}) \times 111)^2}$$

c) For each set of 100 IDs calculate the mean value and the standard deviation of the corresponding location error.

d) Populate Table 4.5.

		Independent Location Errors: Mean Value / Standard Deviation						
Slot No	DOP value	1 burst	2 bursts	3 bursts	4 bursts	5 bursts	6 bursts	7 bursts
Slot 1								
…								
…								
Slot 48								

Table 4.5: T-4 Independent Location Errors (Mean Value and Standard Deviation)

4.4.3.3 Time to First Independent Location

For each slot, perform the following steps:

a) For each burst sequence, select a single 2D location. This single location selection should not use a priori knowledge of the beacon location.

b) For each location selected per Annex J, calculate the location error:

$$\text{Loc Error} = \sqrt{((\text{Lat} - \text{Lat Th}) \times 111)^2 + ((\text{Long} - \text{Long Th}) \times \cos(\text{Lat Th}) \times 111)^2}$$

c) For each location, determine whether the location error is less than 2, 5 or 10 km and flag the list accordingly.

d) For each location flagged with a location error lower than X km, if the location probability determined per Table 4.4 is greater than [90%] use the time of beacon first burst and the time stamp of the location information to calculate the time elapsed between beacon activation and the production of the location.

e) Derive the mean value of the time elapsed between beacon activation and the production of a location.

f) Populate Table 4.6.

		Time to First Location (Mean Value)		
Slot No	DOP value	Error less than 2 km	Error less than 5 km	Error less than 10 km
Slot 1				
…				
…				
Slot 48				

Table 4.6: T-4 Time to First Location

4.4.4 Interpretation of Results

The results should indicate whether the MEOSAR system is providing locations that are accurate enough for effective operational use and illustrate the level of performance which could be expected from an operational MEOSAR system with first generation beacons.

4.5 T-5: Independent 2D Location Capability for Operational Beacons

4.5.1 Objective and Definitions

Characterise the 2D independent location performance of the MEOSAR system after receiving each single burst, two consecutive received bursts, three consecutive bursts, and so on up to seven consecutive bursts for each operational first generation beacon used in the test, by determining two parameters used in test T-4:

- *Independent Location Probability, and*
- *Independent Location Accuracy.*

The above parameters are assessed for stand-alone MEOLUTs using four satellite channels only and for stand-alone MEOLUTs using any number of satellite channels available at the MEOLUT.

Test T-5 will be performed over several days in three slots of 24 hours using a specific number of operational beacons.

4.5.2 Methodology and Data Collection

Real operational beacons will be deployed in various parts of the world. The locations of the transmitting operational beacons will be initially unknown to the MEOLUT operators but will be made available after the experiment for post processing.

Operational beacons (ELTs, EPIRBs and PLBs) coded with the Test User protocol are to be used to transmit long format messages:

- *at the nominal beacon emission power of 37 dBm (+ or – 2 dB); and*
- *in operational frequency bands.*

Each operational beacon used must be set to force the encoded location bits of the beacon message to remain in their default state throughout the test (so that the beacon position is not divulged by broadcasting the GNSS position within the beacon message).

Each operational beacon transmission sequence of 24 hours is repeated 3 times within a two-week time period. Each unique operational beacon used in the test will transmit at the same location for the three 24-hour sequences.

Rationale: Beacon bursts are transmitted over a period of 24 hours to assess the locations calculated by the MEOLUT under operational conditions and to take into account the varying satellite geometry. It is relevant to assess the performance for a low number of bursts, as one of the objectives of the MEOSAR system is to derive locations from a limited number of bursts. As well it would be useful to compute locations after longer time periods to determine if the location accuracy improves given more bursts available to compute a location. The test should be conducted three times, each time over a period of 24 hours to ensure a large database of results for statistical validity.

The following steps are required to perform test T-5:

a) *For each beacon used in the test turn the beacon on, document the activation time of the beacon and verify with a beacon tester that the beacon is transmitting per C/S T.001 requirements (e.g. proper power level and correctly coded message) with the encoded location bits set to their default state.*

b) *Keep the beacon on for a 24-hour period and collect location data produced by the MEOLUT for the transmitted beacon ID as described at Annex J.*

c) *Prior to turning the beacon off, run the beacon tester again to confirm that the beacon is still transmitting within C/S T.001 specifications (e.g. battery is still within specification).*

d) *Conduct the 24-hour test sequence a total of three times within a 2-week period.*

4.5.3 Data Analysis and Results

Data collected used for assessing two parameters, each with a specific procedure for data reduction and analysis, as described below.

4.5.3.1 Independent Location Probability and Independent location Accuracy

For each operational beacon used in each 24 hour test:

a) *For each burst received, compute a 2D location.*

b) *For each computed location, calculate the location error from the post experiment known beacon location.*

c) *Construct a histogram of location errors in 1 km increments in steps from 0-1 km to 25+ km.*

d) *Calculate the probability of obtaining an independent 2D location with a location error less than 1 km to 25 km in steps of 1 km (e.g. for the probability of location errors in the 2-3km step is the ratio of the (number of location errors within 2-3km)/(Number of beacon bursts received)).*

e) *Calculate the mean, median standard deviation and 90th percentile of all location errors computed.*

Repeat this process from step (a) for each set of two consecutive received bursts, three consecutive bursts, and so on up to seven consecutive bursts received. However, note that the denominator in the probability calculation must be changed to the number of burst groupings. For example, for grouping bursts into sets of two consecutive bursts, calculate the probability of obtaining an independent 2D location with a location error less than 1 km to 25 km in steps of 1 km (e.g. for the probability of location errors in the 2-3 km step, calculate the ratio of the (number of 2-3km location errors computed from two consecutive bursts)/(Number of sets of two consecutive beacon bursts received)).

Using the histograms, populate Table 4.7 - Independent Location Cumulative Probability [Note: Table 4.7 needs to be verified for T-5 use]

Slot No	*DOP value*	*Independent Location Cumulative Probability*						
		1 burst	*2 bursts*	*3 bursts*	*4 bursts*	*5 bursts*	*6 bursts*	*7 bursts*
Error 1 km or less								
Error 5 km or less								
Error 10 km or less								
Distance MEOLUT to beacon (km)								

Table 4.7: T-5 Independent Location Cumulative Probability with Errors less than X km (X= 1, 5 or 10 km)

Populate Table 4.8 - Independent Location Errors [Note: Table 4.8 needs to be modified for T-5 use]

Slot No	*DOP value*	*Independent Location Errors: Mean, Median, Std Dev, 90th Percentile*						
		1 burst	*2 bursts*	*3 bursts*	*4 bursts*	*5 bursts*	*6 bursts*	*7 bursts*
Mean Error								
Median Error								
Standard Deviation								
90th Percentile								
Distance MEOLUT to beacon (km)								

Table 4.8: T-5 Independent Location Errors (Mean, Median, Standard Deviation 90th Percentile)

4.5.4 Interpretation of Results

The results should indicate whether the MEOSAR system is providing locations that are accurate enough for effective operational use in various operational environments (e.g. land and sea), and illustrate the level of performance that can be expected from an operational MEOSAR system with first generation beacons. MEOLUTs which detect beacons fairly close (less than a few hundred kilometres) to their own ground station antennas will yield better results on average. Location accuracies achieved for a given operational beacon must be compared taking into account the distance of the beacon location from the MEOLUT location. The number of satellites used in the location provided must also be taken into consideration, as it is expected that, given good satellite geometry, locations computed using data from more satellites should yield better location accuracies.

[Note that DOP still needs to be defined in terms of FOA and TOA.]

4.6 T-6: MEOSAR System Capacity

4.6.1 Objective and Definitions

The MEOSAR system capacity is defined as the maximum number of beacons operating simultaneously that can be successfully processed without degradation of performance.

The system performance parameters used to assess the system capacity are:

- the single satellite channel throughput (probability of detecting a valid message for each transmitted burst received via a single satellite channel); and
- the single burst location probability of a stand-alone MEOLUT using four satellite channels.

4.6.2 Methodology and Data Collection

A 3.8 million worldwide beacon population is assumed, corresponding to 150 beacons simultaneously active in a MEO satellite area of visibility, these 150 beacons being spread among the 25 channels (3 KHz) of the 406-406.1 MHz band. In order not to disturb the operational activities, the test will be limited to 12 channels within the band 406.049 – 406.082 MHz. With 75 beacons as the target value of capacity, the test will be performed for NB = 25, 50, 75 and 100 simultaneously active beacons.

A beacon simulator will be used to replicate a number of beacons (NB) simultaneously active that transmit long format messages.

- With the nominal beacon emission power of 37 dBm.
- With the number of beacons events transmitting a first burst as follows:
  - The first beacon burst is transmitted at To.
  - The beacon burst N° X is transmitted at T = To + (X-1)*(50/NB) + DeltaT, with DeltaT a random real value within the range 0, 50/NB sec.
  - Each beacon burst is transmitted at the frequency 406.049 MHz + CH*3 KHz, with CH a random integer value within the range [0, 11].
- The 7 bursts of each beacon sequence are spaced by 50 s + Rep, with Rep a random real value within the range [- 2.5 s, + 2.5 s].
- To supply sufficient statistics, the test script is played 4 times.

The following steps are required to perform the test:

a) Using a MEOSAR system simulator or a similar tool, select a time slot with adequate satellites visibility to ensure a favourable and stable constellation configuration with a known DOP. The time slot should also be selected outside LEOSAR satellite visibility. The test script has a duration of 4*350s (about 24 minutes).

b) Once this first slot is selected, select three other time slots providing similar geometrical configurations (beacon, satellites, MEOLUT). These time slots will be used for repeating the test three times, to ensure a sufficient amount of data and statistical validity.

c) Use a beacon simulator as the source of controlled test beacons signals.

d) Implement the four test scripts provided at Annex I on the beacon simulator and calibrate the beacon simulator emission power and carrier frequency to confirm the technical characteristics of the transmitted signals.

e) Transmit the bursts corresponding to the four test scripts provided in Annex I during the time slots selected at step (a).

f) Collect the locations produced by the MEOLUT and corresponding to each beacon ID, as described at Annex J.

g) Repeat the test three times.

The full test sequence can be repeated with different satellite constellation configurations to assess the possible effect of variable satellite geometries.

4.6.3 Data Analysis and Results

4.6.3.1 System Capacity using the MEOLUT Throughput Performance

For each value of NB, perform the following steps.

a) Filter the beacon bursts list collected per Annex J to retain only the valid/complete messages.

b) For each beacon burst and using the time stamp information, determine whether a valid/complete message was produced and compute Nvalid for each value of NB, the number of beacons simultaneously active.

c) Using the number of bursts 4*NB, determine the probability of detection of a valid/complete message i.e. (Nvalid/NB), over a given period of time after beacon activation (50 s, 100 s, 150 s or 200 s).

d) Build Table 4.9.

Number of simultaneous beacons (NB)	Single Burst Probability of detection (%)
25	
50	
75	
100	

Table 4.9: T-6 MEOLUT Throughput for Capacity Testing

4.6.3.2 System Capacity using the MEOLUT Location Performance

For each value of NB, perform the following steps.

a. For each burst sequence, select a single 2D location. This single location selection should not use a priori knowledge of the beacon location.

b. For each location selected per Annex J, calculate the location error:

$$\text{Loc Error} = \sqrt{((\text{Lat} - \text{Lat Th}) \times 111)^2 + ((\text{Long} - \text{Long Th}) \times \text{Cos}(\text{Lat Th}) \times 111)^2}$$

c. For each location, determine whether the location error is less than 5 km and flag the list accordingly.

d. Using the number of burst transmissions (4*NB), calculate the probability to obtain a location error lower than 5 km for single burst transmissions.

Build a graph plotting the probability of a location error lower than 5 km as a function of the number of simultaneously active beacons (NB = 25, 50, 75 and 100). From the graph, determine the NB value which meets the 95% probability of a location error lower than 5 km.

4.6.4 Interpretation of Results

The results of this test will allow a determination of MEOSAR system capacity and the possible impact of changing satellite constellation geometries on capacity.

4.7 T-7: Networked MEOLUT Advantage

4.7.1 Objective and Definitions

The objective of the test is to evaluate the improved performance that can be achieved by exchanging data between MEOLUTs. To assess the performance improvement, tests T-4 and T-5 can be repeated. Alternatively MEOLUTs with a networking capability can process T-4 and T-5 data in two parallel modes, i.e., as stand-alone and networked MEOLUTs.

4.7.2 Methodology and Data Collection

The focus of data collection will be on assessing the time to first independent location and location errors using the networked MEOLUTs. Tests T-4 and T-5 are repeated as defined or processed in parallel modes by the MEOLUT. However, to allow for meaningful analysis, the following data shall also be collected:

a. the number of nodes (stand-alone MEOLUTs) in the network, and

b. the number of satellite channels available for each MEOLUT event (detection and/or independent location from a single burst).

To distinguish the repeated tests from the stand-alone tests, or the result of parallel processing, T-7 results will be referred to as tests T-4_N and T-5_N, where N identifies the "network" results.

		Time to First Location (Mean Value)		
Slot No	DOP value	Error less than 2 km	Error less than 5 km	Error less than 10 km
Slot 1				
…				
…				
Slot 48				

Table 4.10: T-4_N Time to First Location for Networked MEOLUTs

4.7.3 Data Analysis and Results

Using the table templates provided in Annex J for tests T-4 and T-5, and the scripts in Annex H, the network test data should be collected and reprocessed with results depicted as described for T-4 and T-5 (see Table 4.10). The data collected should be compared with the stand-alone tests of T-4 and T-5 results, with a view to assessing the benefits of various MEOLUT network types, e.g. national, regional, etc.

4.7.4 Interpretation of Results

The results of the analysis and comparison with stand-alone MEOLUT test results should highlight the performance enhancement brought by exchanging data in a MEOLUT network, on a regional or a national basis.

4.8 T-8: Combined MEO/GEO Operation Performance

4.8.1 Objective and Definitions

The objective of the test is to evaluate the ability of MEOLUTs to process data from GEO satellites and merge this GEO data with MEO data to provide a combined MEO/GEO location. Tests T-3, T-4 and T-5 can be repeated for this evaluation. Alternatively MEOLUTs with the appropriate capability can process T-3, T-4 and T-5 data in two parallel modes, i.e. as stand-alone MEOLUTs and in combined GEO/MEO mode of operation.

4.8.2 Methodology and Data Collection

Repeat tests T-3, T-4 and T-5 as for the stand-alone MEOLUTs, but with the addition of a GEO satellite receiver input, or process these test scenarios in parallel in the MEO stand-alone and combined GEO/MEO modes. To distinguish these tests results from the MEO stand-alone tests results, test T-8 results will be referred to as T-3_G, T-4_G and T-5_G with G indicating the combined GEO/MEO capability.

4.8.3 Data Analysis and Results

Collect the data using the tables provided at Annex J for tests T-3, T-4 and T-5 and build the corresponding tables (see Table 4.11 provided as example). Compare the data collected with those provided for MEO stand-alone MEOLUTs in tests of T-3, T-4 and T-5 and T-4. The MEOLUT ability to process GEO data and the expected performance enhancement should be highlighted by the analysis.

Beacon Emission Power	Slot No.	NTB	NVIM after 1 Burst	NCM after 1 Burst	Valid Message Det. Prob. (%) after 1 Burst (NVIM+NCM)/NTB	Complete Message Det. Prob (%) after 1 Burst NCM/NTB
37 dBm –	Slot 1	100				
[30 dBm]	Slot 2	100				
	...					
37 dBm –	Slot 7	100				
[30 dBm]	Slot 8	100				
37 dBm	Slot 95	100				
[30 dBm]	Slot 96	100				

Table 4.11: T-3_G Valid/Complete Message Detection Probability

4.8.4 Interpretation of Results

Based upon the results of the analysis, conclusions will be drawn concerning the MEOSAR system and how it can include data from the GEOSAR system. This test is intended to investigate compatibility of MEOSAR and GEOSAR, and to determine if combining GEOSAR data to be processed by a MEOLUT provides benefit to the overall Cospas-Sarsat System.

4.9 Management of Technical Tests

A summary of participant responsibilities and involvement in the MEOSAR D&E technical tests is shown in Table 4.12.

Test No	Participants	Additional Resources	Data Collection	Data Analysis	Report to Secretariat	Schedule	Remarks
T-1	Canada: MEOLUT France: MEOLUT USA: MEOLUT	France: beacon simulator USA: beacon simulator Canada: beacon simulator	Canada France USA	Canada France USA	Canada France USA	[month 2013]	Needs co-ordinated uplink
T-2							
T-3							
T-4							
T-5							
T-6							
T-7							
T-8							

Table 4.12: Management of Technical Tests Summary [sample]

- END OF SECTION 4 -

5. OPERATIONAL EVALUATION PROCEDURES

5.1 O-1: Potential Time Advantage (PTA)

5.1.1 Objective and Definitions

The objective of analysing the Potential Time Advantage (PTA) is to provide a comparison between the new MEOSAR system and the existing LEOSAR/GEOSAR system with respect to the timeliness in the receipt of various alert notifications at the MCC. The PTA is determined by measuring the elapsed time between the receipt of MEOSAR alert notifications versus those from the existing system.

5.1.2 Methodology and Data Collection

Measurement of PTA is applicable only when MEOSAR as well as the LEOSAR/GEOSAR system provide alert messages for the same beacon. Specific notifications may or may not include an independent location computed by a ground station and information may be received at the MCC in various combinations and/or sequences involving three possible data types: Unlocated, Encoded Position Only, and Computed Location. Hence, the first notification within each data type should be considered, as applicable and available, as well as in various combinations for a given beacon activation.

In the case of PTA data, the times of notification collected should be for the MCC in whose service area the alert is located, or if the alert is unlocated, the MCC service area associated with the country code (the last MCC in the data chain). Note, the destination MCC is based solely on the location recorded in the message not on the actual location of the beacon. PTA data should be collected for all beacons where alerts were received from MEOSAR satellites in conjunction with LEOSAR or GEOSAR. In addition, when location data is available, only data located within a predefined area of interest (AOI) shall be included. The AOI[5] is defined for the period of the test, and pertains to the practical limits of the MEOSAR ground segment coverage over that period. The alert information should be entered in the spreadsheet named "MEOSAR D&E Report Data O-1.xls" which contains entry fields for all alert notification time data. The following listing provides abbreviations referenced below and in the data collection spreadsheet:

TMANU	Time of first MEOSAR Alert Notification Unlocated
TMANE	Time of first MEOSAR Alert Notification Encoded
TMANL	Time of first MEOSAR Alert Notification Location
TLANU	Time of first LEOSAR Alert Notification Unlocated
TLANE	Time of first LEOSAR Alert Notification Encoded
TLANL	Time of first LEOSAR Alert Notification Location
TGANU	Time of first GEOSAR Alert Notification Unlocated (no encoded position)
TGANE	Time of first GEOSAR Alert Notification Encoded

5 The AOI could be a rectangle, set of rectangles (or radii) or based on MCC service areas.

Cospas-Sarsat MCCs, specifically the last MCC in the data chain, receiving 406 MHz MEOSAR and LEOSAR/GEOSAR alert messages should record the following alert notification data in the provided Excel spreadsheet (an example listing is provided below in the next subsection under Figure 5.1):

a. time of receipt of MEOSAR alert messages identified by data type (TMANU, TMANE, or TMANL);

b. time of receipt of LEOSAR alert messages identified by data type (TLANU, TLANE or TLANL) corresponding to the same beacon; and

c. time of receipt of GEOSAR alert messages identified by data type (TGANU or TGANE) corresponding to the same beacon;

5.1.3 Data Analysis, Results, and Reporting

PTA analysis is performed by Excel formulas embedded within the cells of the data collection spreadsheet. As new data rows are added, a simple "cut and paste" of the corresponding results columns will automatically populate these elements as well as updating the summary results at the top the spreadsheet.

The following listing provides abbreviations used below and in the spreadsheet:

PTAU	Potential Time Advantage Unlocated *(detected but no encoded position)*
PTAE	Potential Time Advantage Encoded *(encoded position only)*
PTAL	Potential Time Advantage Location *(computed at ground station)*
PTAA	Potential Time Advantage All Locations *(encoded and/or computed)*
PTAO	Potential Time Advantage Overall *(first notification all data types)*

The embedded formulas will compute PTAs (time differences in minutes) as available for all early MEOSAR alert notifications during the D&E as follows:

PTAU = Earliest (TLANU, TGANU) – TMANU;
PTAE = Earliest (TLANE, TGANE) – TMANE;
PTAL = TLANL – TMANL;
PTAA = Earliest (TLANE, TLANL, TGANE) – Earliest (TMANE, TMANL);
PTAO = Earliest (TLANU, TLANE, TLANL, TGANU, TGANE) – Earliest (TMANU, TMANE, TMANL);

In addition to these individual PTA statistics, summary statistics will also be generated for the mean, median and standard deviation of each PTA data collection over the specified D&E time period.

A limited set of data has been fabricated to provide example computations as shown in Figure 5.1. The nine data collection columns (Beacon ID and all time fields) are those populated by the D&E participant as discussed above. The last five columns and summary values of mean, median and standard deviation at the top of the sheet (all color shaded) are the results which are populated by the formulas embedded in the respective cells.

Figure 5.1: O-1 PTA Analysis Excel Worksheet Example

	A	B	C	D	E	F
1	PTA Summary Results (in minutes)					
2		PTAU	PTAE	PTAL	PTAA	PTAO
3	Mean:	0.03	-0.11	23.98	15.01	14.93
4	Median:	0.03	0.00	19.54	13.73	13.73
5	Standard Deviation:	0.37	0.27	15.31	14.24	14.11
6						
7	Recorded Alert Notification Times and Per Activation PTA Results (in minutes)					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
8		MEOSAR			LEOSAR/GEOSAR					PTA Results				
9	Beacon ID	TMANU	TMANE	TMANL	TLANU	TLANE	TLANL	TGANU	TGANE	PTAU	PTAE	PTAL	PTAA	PTAO
10	9FAA4929DF4B4D1			2012/01/01 09:24:21			2012/01/01 09:34:58					10.62	10.62	10.62
11	B388170D64334D1			2012/01/01 11:43:12			2012/01/01 11:59:01					15.82	15.82	15.82
12	ADCD376A85E1400	2012/01/01 18:23:56			2012/01/01 18:26:22			2012/01/01 18:24:13		0.28				0.28
13	ADCC014DD040459			2012/01/01 23:50:01			2012/01/02 00:07:12					17.18	17.18	17.18
14	AD8D0A131900A01			2012/01/02 01:09:49			2012/01/02 02:03:31					53.70	53.70	53.70
15	2DCC360B9AFFBFF		2012/01/02 02:29:17						2012/01/02 02:28:39		-0.63		-0.63	-0.63
16	2DCC3611EAFFBFF	2012/01/02 04:33:21	2012/01/02 04:34:54	2012/01/02 04:36:39			2012/01/02 05:35:43		2012/01/02 04:34:54		0.00	59.07	0.00	1.55
17	ADCD05453441401	2012/01/03 08:21:45		2012/01/03 08:22:05			2012/01/03 08:29:39					7.57	7.57	7.90
18	BEEE00678800001			2012/01/03 08:41:59			2012/01/03 08:52:02					10.05	10.05	10.05
19	2DC838746AFFBFF		2012/01/03 15:27:45	2012/01/03 15:30:19	2012/01/03 15:36:49	2012/01/03 15:39:45	2012/01/03 16:14:41	2012/01/03 15:27:38	2012/01/03 15:27:49		0.07	44.37	0.07	-0.12
20	B38950D90D034D1			2012/01/03 16:38:12			2012/01/03 16:59:16					21.07	21.07	21.07
21	2DCC3611EAFFBFF	2012/01/03 18:56:14	2012/01/03 18:57:21			2012/01/03 18:59:24		2012/01/03 18:56:00	2012/01/03 [illegible]:57:[illegible]	-0.23	-0.17		-0.17	-0.23
22	ABE8A54C34D34D1			2012/01/03 18:56:14			2012/01/03 19:13:21					17.12	17.12	17.12
23	A78E005EDC40401			2012/01/04 09:09:08			2012/01/04 09:27:42					18.57	18.57	18.57
24	9EA9531534D34D1			2012/01/04 10:35:52			2012/01/04 11:23:12					47.33	47.33	47.33
25	2DC838746AFFBFF		2012/01/04 10:55:32	2012/01/04 10:56:52			2012/01/04 11:23:19	2012/01/04 10:55:0[illegible]	2012/01/04 10:55:32		0.00	26.45	0.00	-0.52
26	DAA64BAE62E8651			2012/01/04 11:19:15	2012/01/04 11:45:37									26.37
27	ADCD018C5C42801	2012/01/05 04:23:43		2012/01/05 04:23:49			2012/01/05 04:29:19					5.50	5.50	5.60
28	C1AB5C8A28A28D1			2012/01/05 07:23:45			2012/01/05 07:44:36					20.85	20.85	20.85
29	A70E046ADC50501			2012/01/05 13:42:09			2012/01/05 13:52:12					10.05	10.05	10.05
30	ADCD021BE540C01			2012/01/06 15:12:05			2012/01/06 15:43:54					31.82	31.82	31.82
31	AA674B1030375D1			2012/01/06 16:47:32			2012/01/06 16:59:[illegible]					11.65	11.65	11.65
32	C2AA40E7E2E04D1			2012/01/06 19:58:01			2012/01/06 20:[illegible]					20.52	20.52	20.52
33	2DC8381ACEFFBFF		2012/01/07 00:00:34	2012/01/07 00:02:01			2012/01/07 [illegible]:38:[illegible]		2012/01/07 00:00:39		0.08	36.77	0.08	0.08
34	9C69575931934D1			2012/01/07 05:06:34			2012/01/07 05:[illegible]					25.75	25.75	25.75
35	2DCE4E4F92FFBFF			2012/01/07 08:08:22			2012/01/07 08:24:11					15.82	15.82	15.82
36														
37														
38														
39														
40														
41														
42														
43														

5.1.4 Interpretation of Results

It is noted that for any given beacon activation, anywhere from one to five PTA values are possible. Specifically, some cases will have notifications with multiple common data types and others will occur where there is no commonality at all and only the overall result (PTAO) might be available. It is also noted that negative values are possible and represent cases where the existing system demonstrates a time advantage over MEOSAR.

In addition to providing MEOSAR comparative performance statistics, this analysis should contribute useful information in planning decisions at the Cospas-Sarsat System level. Items under consideration might include determining the readiness of MEOSAR to be declared operational and future planning for a phase out of LEOSAR capabilities.

5.2 O-2: Unique Detections by MEOSAR System as Compared to Existing System

5.2.1 Objective and Definitions

This test will evaluate the performance of the MEOSAR system in detecting and locating 406 MHz beacons in relation to the existing Cospas-Sarsat System. The goal is to catalogue and compare beacons received by the MEOSAR system to those received from LEOSAR and GEOSAR, identify cases where one system detected a beacon that the other system missed and provide explanations wherever possible. In addition to these statistics, maps will be generated for the recorded beacon locations in order to visualize the actual MEOSAR coverage at the specified D&E time period.

5.2.2 Methodology and Data Collection

Data should be collected by the MCC in whose service area the alert is located or, if the alert is unlocated, the MCC of the service area associated with the country code (last MCC in data chain). Note, the destination MCC is based solely on the location recorded in the message not on the actual location of the beacon. All data should be collected for all beacons regardless of reception through MEOSAR, LEOSAR or GEOSAR satellites, either independently or in conjunction. For analysis, when location data is available, only data located within a predefined area of interest (AOI) shall be included (see footnote under O-1). The alert information should be entered in the spreadsheet named "MEOSAR D&E Report Data O-2.xls" which contains entry fields for alert start/end times and data types. The following listing provides abbreviations referenced below and in the data collection spreadsheet:

LGST	LEO/GEO Start Time
LGET	LEO/GEO End Time
LGDT	LEO/GEO Data Type (U=Unlocated, E=Encoded Only, L=Located)
MST	MEO Start Time
MET	MEO End Time
MDT	MEO Data Type (U=Unlocated, E=Encoded Only, L=Located)

Cospas-Sarsat MCCs, specifically the last MCC in the data chain, should:

a) collect and record first detection[6] time, last detection time, data type[7] (LGST, LGET and LGDT) and location for all operational and test beacons received by the operational LEOSAR/GEOSAR system using the provided Excel spreadsheet (see example below); and

b) collect and record first detection time, last detection time data type (MST, MET and MDT) and location for all operational and test beacons received by the MEOSAR system using the provided Excel spreadsheet.

[6] In each case, detection time is the time tag for the data type as provided by the LUT.

[7] If multiple data types are recorded, the DataType should be set based on hierarchical logic: L > E > U. Thus a beacon first detected at time X without location (U) and later detected with computed location (L) would be shown with StartTime=X and DataType=L.

Figure 5.2: O-2 Worksheet Example – Inputs LEO/GEO
(insert columns for latitude and longitude)

BeaconId	StartTime (LGST)	EndTime (LGET)	DataType (LGDT)
9FAA4929DF4B4D1	2010/01/01 01:04:40	2010/01/01 16:27:44	L
B388170D64334D1	2010/01/01 01:22:21	2010/01/01 02:57:24	L
ADCD376A85E1400	2010/01/01 04:30:03	2010/01/01 04:30:03	U
ADCC014DD040459	2010/01/01 05:19:59	2010/01/01 05:21:44	L
AD8D0A131900A01	2010/01/01 06:18:02	2010/01/01 06:18:02	U
2DCC3611EAFFBFF	2010/01/01 07:43:27	2010/01/01 08:30:24	L
ADCD05453441401	2010/01/01 08:16:07	2010/01/01 21:51:10	U
BEEE00678800001	2010/01/01 08:26:41	2010/01/01 08:40:29	L
2DC838746AFFBFF	2010/01/01 09:20:29	2010/01/01 10:57:56	L

Figure 5.3: O-2 Worksheet Example – Inputs MEO
(insert columns for latitude and longitude)

BeaconId	StartTime (MST)	EndTime (MET)	DataType (MDT)
9FAA4929DF4B4D1	2009/12/31 23:51:18	2010/01/01 16:27:57	L
B388170D64334D1	2010/01/01 00:06:02	2010/01/01 0[illegible]:33:58	L
ADCD376A85E1400	2010/01/01 03:15:47	2010/01/01 05:29:09	L
ADCC014DD040459	2010/01/01 04:01:54	2010/01/01 05:56:49	L
AD8D0A131900A01	2010/01/01 06:1[illegible]:57	2010/01/01 06:51:41	L
2DCC3611EAFFBFF	2010/01/01 06:33:42	2010/01/01 08:50:03	L
ADCD05453441401	2010/01/01 08:01:43	2010/01/01 23:28:40	L
BEEE00678800001	2010/01/01 07:1[illegible]	2010/01/01 08:40:07	L
2DC838746AFFBFF	2010/01/01 08:1[illegible]:50	2010/01/01 11:50:29	L

5.2.3 Data Analysis, Results, and Reporting

The basic analysis and generation of results is automated, and can performed by invoking an Excel macro named RunAnalysisO2[8], provided within the spreadsheet named "MEOSAR D&E Report Data O-2.xls". The macro will place results in this same file, which also provides entry points for participant explanations and comments to document underlying causes for cases where one system detected a beacon but the other did not. Determining the cause of non-detection by either the MEOSAR or LEOSAR/GEOSAR system should take into account the performance of satellites, LUTs, MCCs, and beacons (e.g., low power) as well as the impact of interference.

MEOSAR D&E participants should:

a) apply the provided Excel macro named RunAnalysisO2 to create a listing of all discrepancies; and

b) review all discrepancies providing explanatory comments within the spreadsheet as possible.

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8 RunAnalysisO2 is an embedded Visual Basic program (as are all Excel macros). The analysis of D&E tests O-3 and O-4 are implemented similarly by a programmed macro, whereas the analysis for O-1 differs being provided by formulas placed directly within the cells of the spreadsheet.

Figure 5.4: O-2 Worksheet Example – Output: Summary Data

	Count	Percentage
LEO/GEO Only Events	67	2.52%
MEO Only Events	219	8.25%
Found by Both Systems	2370	89.23%
Total Beacon Events	2656	

Figure 5.5: O-2 Worksheet Example – Output: LEO/GEO Only Detections

BeaconId	StartTime (LGST)	EndTime (LGET)	DataType (LGDT)	Explanation/Comments
346F615276FFBFF	2010/01/03 02:23:03	2010/01/03 02:23:03	U	Unknown
C1AA4935DBA98D1	2010/01/05 02:28:28	2010/01/05 02:29:18	U	Unknown
C489974A34D34D1	2010/01/06 04:12:00	2010/01/06 05:58:06	L	Unknown
DB476E2E74D34C1	2010/01/06 09:08:02	2010/01/06 09:08:02	U	Unknown
A1A65CFEC309241	2010/01/06 13:00:53	2010/01/06 13:00:53	U	Blockage to MEO suspected
ADCD02275040401	2010/01/07 01:24:19	2010/01/07 01:24:19	U	Unknown
A78E005F5C4A5F8	2010/01/07 05:56:33	2010/01/07 05:56:33	U	Weak beacon signal suspected
ADCE3701351FE6D	2010/01/07 19:32:35	2010/01/07 19:32:35	U	Unknown
ADCD04C4E941C01	2010/01/08 22:56:25	2010/01/09 00:52:05	L	Weak beacon signal suspected

Figure 5.6: O-2 Worksheet Example – Output: MEO Only Detections

BeaconId	StartTime (MST)	EndTime (MET)	DataType (MDT)	Explanation/Comments
A70E046ADC50501	2010/01/01 13:21:39	2010/01/01 16:45:56	L	LEO visibility never occurred
AA674B1030375D1	2010/01/01 15:29:25	2010/01/02 03:34:52	[illegible]	Unknown
2B261A04D6FFBFF	2010/01/02 10:20:08	2010/01/02 12:38:36	L	LEO visibility never occurred
ADCE020ACCC1C01	2010/01/02 11:54:37	2010/01/02 14:37:4[illegible]	L	LEO visibility never occurred
ADCE020960C2401	2010/01/02 13:00:21	2010/01/02 16:[illegible]8:2[illegible]	L	Unknown
ADCD04F214C0801	2010/01/02 19:16:33	2010/01/02 [illegible]:33:[illegible]5	L	Unknown
9D06492B8E6EAE1	2010/01/03 01:13:04	2010/01/0[illegible] 12:44:30	L	Unknown
A1E8D34134D34D1	2010/01/03 02:22:44	2010/01/03 03:11:44	L	Unknown
CF8A4E0CDBA54D1	2010/01/03 14:08:03	2010/01/03 15:50:56	[illegible]	Unknown

5.2.4 Interpretation of Results

The main result is the total count of detections by one system, and not the other, specifically, the LEO/GEO Only and the MEO Only totals and percentages of the data set. The key elements of this analysis are the comments and explanations provided (as possible) with all discrepancies. Final interpretation is explicitly dependent on the causes found and associated statistics if large numbers of discrepancies are found and one or more known causes have high repetition rates.

Since alerts for test beacons are not normally distributed between MCCs, this should be considered in reviewing summary statistics. Also, given that operational beacons may transmit over an extended period of time, the reporting of results may depend on alert site closure rules at each MCC. While rules for closing sites are not the same at every MCC, D&E participants should at least ensure that site closure procedures are harmonised between their operational MCC and their MEOSAR D&E MCC processing.

Note : Coverage should be addressed here.

5.3 O-3: Volume of MEOSAR Distress Alert Traffic in the Cospas-Sarsat Ground Segment Network

5.3.1 Objective and Definitions

This test will evaluate the volume of 406 MHz MEOSAR distress alert messages exchanged between MCCs, compare it to the traffic for the existing system (LEOSAR and GEOSAR) and provide additional information on the combined totals and data volumes in bytes and corresponding bandwidths[9].

5.3.2 Methodology and Data Collection

Data consisting of message transmission times and SIT types is to be collected at all participating MCCs. Example inputs are provided in Figure 5.7 below. Abbreviations referenced below and in the associated spreadsheet (MEOSAR D&E Report Data O-3.xls) are:

MTT	MEO Transmission Time
MST	MEO SIT Type
LGTT	LEO/GEO Transmission Time
LGST	LEO/GEO SIT Type

Note that in Figure 5.7 the supplemental data fields of message number and destination MCC are included for data tracking purposes.

MEOSAR D&E participants should:

a) collect and record transmission time and SIT type[10] (MTT and MST) for all 406 MHz MEOSAR distress alert messages sent to other MCCs using the provided Excel spreadsheet (see example below);

b) collect and record transmission time and type (MTT and MST) for all 406 MHz MEOSAR distress alert messages received[11] from other MCCs using the provided Excel spreadsheet;

c) collect and record transmission time and type (LGTT and LGST) for all 406 MHz LEOSAR/GEOSAR distress alert messages sent to other MCCs using the provided Excel spreadsheet; and

d) collect and record transmission time and type (LGTT and LGST) for all 406 MHz LEOSAR/GEOSAR distress alert messages received from other MCCs using the provided Excel spreadsheet;

9 Bandwidth is provided as the industry standard measure of kilobits per second (kbps) and is computed as the total volume in bits (8 bits per byte) divided by the total time span in seconds.

10 As shown in the example inputs, it is recommended that Message Number be collected as additional cross reference information for each message entry (row in the table).

11 Messages that are sent or received are collected in one input table.

Figure 5.7: O-3 Worksheet Example – Inputs (LEO/GEO and MEO)

Msg No.	Dest MCC	Transmission Time (LGTT)	Sit Type (LGST)
3109	CMCC	2002/01/18 00:14:52	125
3116	CHMCC	2002/01/18 00:14:52	125
3132	CMCC	2002/01/18 02:02:16	122
3133	CMCC	2002/01/18 02:55:07	122
3149	FMCC	2002/01/18 04:13:59	125

Msg No.	Dest MCC	Transmission Time (MTT)	Sit Type (MST)
221	CMCC	2002/01/17 22:25:40	145
224	CMCC	2002/01/17 22:24:21	145
229	FMCC	2002/01/18 00:40:43	145
230	BRMCC	2002/01/18 01:54:13	145
235	FMCC	2002/01/18 03:29:26	145

In addition to the general input of message data, a configuration table is provided for MCCs to specify typical or average file sizes for respective SIT messages. Figure 5.8 below provides an example, and in this case all message sizes are defaulted to 1 Kb (1024 bytes). This exemplifies the case where the protocol (e.g., FTP) or the computer file/folder structure might dictate a minimum file size, even though the actual number of bytes within may be only several hundred. Also, this design is a simplification of the possibilities. For example, if an MCC generates SIT messages with multiple solutions within, a SIT 125 may really have a range of possible data sizes, and is such cases the MCC may have to configure this table with an estimated average.

Figure 5.8: O-3 Worksheet Example – Configuration: Message Types and Sizes

SitType	Size
122	1024
123	1024
124	1024
125	1024
126	1024
127	1024
142	1024
143	1024
144	1024
145	1024
146	1024
147	1024

5.3.3 Data Analysis, Results, and Reporting

Each MCC should apply the provided Excel macro named RunAnalysisO3 to create a summary report of all message counts, data volumes and comparisons. An example of outputs is provided below in Figure 5.9. It may be useful to note that in generating the summary output, the analysis creates columns as necessary based on the actually SIT numbers found in the data set. As part of the analysis process, each MCC should be careful to identify and account for anomalies that impact message traffic on the MEOSAR or LEOSAR/GEOSAR system; e.g., many messages may be resent due to a communication problem or many messages may have never been sent due to a software, hardware or communication problem.

Figure 5.9: O-3 Worksheet Example – Output: Summary Data

	#122	#123	#125	#127	#142	#143	#145	#147	#Total	Data Volume (bytes)	Bandwidth (kbps)
LEO-GEO	527	17	988	246	0	0	0	0	1778	1820672	0.0036
MEO	0	0	0	0	65	17	1369	240	1691	1731584	0.0034
Combined									3469	3552256	0.0070

5.3.4 Interpretation of Results

The results are simple message counts, data volumes and communication bandwidths, with statistics provided for the existing LEOSAR/GEOSAR system, the new MEOSAR system and the combined load. The interpretation includes evaluating the impact of these data volumes on standard Cospas-Sarsat data transfer technologies (e.g., FTP-VPN) to determine if loads are within the capacity of the available communication paths.

5.4 O-4: 406 MHz Alert Data Distribution Procedures

5.4.1 Objective and Definitions

The purpose of this test is to evaluate the initial concept of operations for alert data distribution and recommend modifications, as needed, for an operational MEOSAR system. In order to evaluate data distribution procedures, LEOSAR/GEOSAR and MEOSAR alerts are categorised based on the beacon activation status (e.g., first alert, confirmed alert), position type (e.g., DOA or encoded position) and alert disposition.

5.4.2 Methodology and Data Collection

Each participant will collect data to support the evaluation of the data distribution procedures as documented in the MEOSAR Implementation Plan (C/S R.012). The evaluation methodology entails collecting information on the number of times various processing scenarios occur.

It is important to note that while data sent to MCCs is usually the focus for operational D&E data collection, all data processed by the MCC (i.e., including data within the national service area) should be collected and catalogued. This additional data may assist the evaluation of other processing possibilities. In effect, the goal is to collect sufficient information to fully evaluate the MEOSAR data distribution procedures.

MEOSAR D&E participants should collect and record counts for all LEOSAR/GEOSAR and MEOSAR alerts that occur in the lifetime of selected test beacons and all operational beacon activations processed at their MCC and use the provided spreadsheet (MEOSAR D&E Report Data O-4.xls) to record the data (see Figure 5.10). Two worksheets will be provided, one for LEOSAR/GEOSAR processing results and one for MEOSAR. Each incoming alert will be counted most often in exactly one of the columns of the spreadsheet. A few conditions could occur in tandem (e.g., conflicts in both DOA and encoded positions). The actual column headers are listed in Table 5.1 with additional explanatory comments.

Figure 5.10: O-4 Worksheet Example – Inputs

Site#	BcnId15	FirstBurstTime	LastBurstTime	Number of Bursts	FA UNL	FA ENC	FA DOA	FA DOA ENC CFM	FA DOA ENC DIF	NC DOA DOA DIF	NC DOA ENC DIF	NC ENC ENC DIF	CA DOA DOA CFM	CA ENC DOA CFM	CA DOA ENC CFM	CT CFM	CT DOA DIF	CT ENC DIF	RD
1284	B388170D64334D1	2010/01/01 00:06:02	2010/01/01 03:34:22	251			1						1			13			
1285	ADCD376A85E1400	2010/01/01 03:15:47	2010/01/01 03:28:17	16			1						1						
1286	ADCC014DD040459	2010/01/01 04:01:54	2010/01/01 05:56:54	139			1						1			7			
1287	AD8D0A131900A01	2010/01/01 06:18:57	2010/01/01 06:20:37	3			1						1						
1288	2DCC3611EAFFBFF	2010/01/01 06:33:42	2010/01/01 06:35:22	3			1						1						
1289	ADCD05453441401	2010/01/01 08:01:43	2010/01/01 23:28:23	1113			1						1			61			
1290	BEEE00678800001	2010/01/01 07:19:43	2010/01/01 07:19:43	1			1												
1291	2DC838746AFFBFF	2010/01/01 08:17:50	2010/01/01 11:50:20	256				1					1			14			
1292	B38950D90D034D1	2010/01/01 08:15:04	2010/01/01 11:34:14	240			1			4			1			13			4
1293	A78E005EDC40401	2010/01/01 10:07:20	2010/01/02 06:08:10	1442			1						1			80			
1294	9EA9531534D34D1	2010/01/01 13:25:05	2010/01/01 13:25:05	1			1												
1295	DAA64BAE62E8651	2010/01/01 12:12:10	2010/01/01 12:18:50	9			1						1						
1296	ADCD018C5C42801	2010/01/01 12:43:07	2010/01/01 16:08:07	247			1						1			13			
1297	C1AB5C8A28A28D1	2010/01/01 12:50:02	2010/01/01 13:54:12	78			1						1			4			
1298	A70E046ADC50501	2010/01/01 13:21:39	2010/01/01 13:24:59	5			1						1						
1299	C2AA40E7E2E04D1	2010/01/01 14:02:18	2010/01/01 15:33:58	11[illegible]			1						1			6			

Note that for the LEOSAR/GEOSAR processing results, the columns with DOA position conflicts should be replaced with DOP (Doppler) position conflicts columns.

Except for "Redundant Data" (RD), an alert that meets the conditions for a category should be counted as such regardless of whether the MCC transmitted the alert; e.g., an alert with DOA position and no position conflict after position confirmation that met the time threshold for continued transmission would be counted under "CT CFM" regardless of whether the alert was transmitted.

Table 5.1: O-4 List of Message Status Conditions for Data Collection[12]

Column Header	Comments
FA UNL	First Alert, no location
FA ENC	First Alert with location, encoded position only
FA DOA	First Alert with location, DOA position only
FA DOA ENC CFM	First Alert with location, DOA/encoded Position Confirmation (same event)
FA DOA ENC DIF	First Alert with location, DOA/encoded Position Conflict (same event)
NC DOA DOA DIF	position Not Confirmed, DOA/DOA position conflict
NC DOA ENC DIF	position Not Confirmed, DOA/encoded position conflict
NC ENC ENC DIF	position Not Confirmed, encoded/encoded position conflict/update
CA DOA DOA CFM	Confirmation Alert, new DOA to previous DOA
CA ENC DOA CFM	Confirmation Alert[13], new DOA to previous/new encoded
CA DOA ENC CFM	Confirmation Alert, new encoded to previous DOA
CT CFM	Continued Transmission[14] event, DOA and/or Encoded positions, no position conflict
CT DOA DIF	Continued Transmission event, DOA position conflict
CT ENC DIF	Continued Transmission event, encoded position conflict/update
RD	Redundant data (same beacon event and none of the above)

5.4.3 Data Analysis, Results, and Reporting

MEOSAR D&E participants should apply the provided Excel macro named RunAnalysisO4 to create a summary report of all data counts along with some high level statistics. Example output is provided below in Figure 5.11.

Figure 5.11: O-4 Worksheet Example – Output: Summary Data

NUMBER OF SITES	2579														
NUMBER OF BURSTS	440495														
	FA UNL	FA ENC	FA DOA	FA DOA ENC CFM	FA DOA ENC DIF	NC DOA DOA DIF	NC DOA ENC DIF	NC ENC ENC DIF	CA DOA DOA CFM	CA ENC DOA CFM	CA DOA ENC CFM	CT CFM	CT DOA DIF	CT ENC DIF	RD
COLUMN TOTALS	18	17	2338	194	12	662	479	285	2003	42	52	22764	1110	567	443
SITE LEVEL STATISTICS	0.70%	0.66%	90.66%	7.52%	0.47%				77.67%	1.63%	2.02%				
BURST LEVEL STATISTICS						0.15%	0.11%	0.06%				5.17%	0.25%	0.13%	0.10%

In this case the generation and reporting of results is straight forward and automated, but the analysis itself is not. Actual analysis entails using these basic statistics to formulate conclusions as to whether or not any given aspect of the data distribution procedures is producing the desired result. The analysis should attempt to determine whether these procedures are enhancing or degrading search and rescue efforts, and/or creating excessive or unnecessary processing or data transfer loads. Specific data collection and

12 For the LEOSAR/GEOSAR processing results the DOA position is replaced by the DOP (i.e. Doppler) position to determine the position confirmation or position conflict status.

13 "CA" (Confirmation Alert) implies that location data was previously received.

14 Continued Transmission only pertains to alert data that arrives after position confirmation has occurred.

reported results, as well as examples of possible interpretations are all provided below. However, additional creativity in the analysis and interpretation processes on the part of participants is encouraged for this D&E test, as aspects unforeseen may become clear as the D&E proceeds and data is collected, reported and analysed.

5.4.4 Interpretation of Results

The analysis performed within the spreadsheet entails summing the total occurrences of each processing condition over the time interval of data collection. The columns of the spreadsheet list the total counts and percentages of all processing conditions. The analysis of these counts may prove to be more difficult as demonstrated by the following two interpretations of the results. These are just two of potentially many interpretations that could be drawn from the data as our experience with MEOSAR data distribution matures. Meaningful conclusions will best be drawn when all the real data has been collected and the opportunity to absorb it has occurred.

Analysis and Interpretation 1: Continued transmission could increase message traffic by a factor of ten.. Given the data load identified in Operational Test O-3, this is well within the capabilities of the Cospas-Sarsat communications network. This supports the proposition that "continued transmission" should be the default mechanism for MEOSAR, allowing the benefit of nearly continuous monitoring of beacon transmissions.

Analysis and Interpretation 2: Unlocated alerts occurred only 18 times in 2,579 active alert sites (0.7%). Furthermore, location was later provided in all 18 cases leaving 0 cases in this data set that remained unlocated. It may then be suggested that unlocated alerts are not needed at all, also observing that the D&E employed only a reduced set of satellites (and/or ground stations) and finally that a large majority of all detections are false alerts.

5.5 O-5: SAR/GALILEO Return Link Service

5.5.1 Objectives and Definitions

This test will encompass three objectives as detailed below. MCCs participating in the D&E will collect data on RL messages transmitted to RCCs and to the other MCCs and the FMCC as required. The major data collection and analysis will be accomplished by the FMCC, the RLSP, and entities that will operate RLS capable beacons.

5.5.1.1 Definitions

As contained in document C/S R.012 (MIP), Figure 5.12 below presents the overall procedure for the Return Link Service and the specific interfaces involved in the RLM request dissemination. All MEOSAR D&E test procedures associated with the Return Link Service will be based on the following procedure with some of the steps being applicable or not, depending on the test scenario.

Figure 5.12: High-Level Concept of RLS Process Integration within Cospas-Sarsat

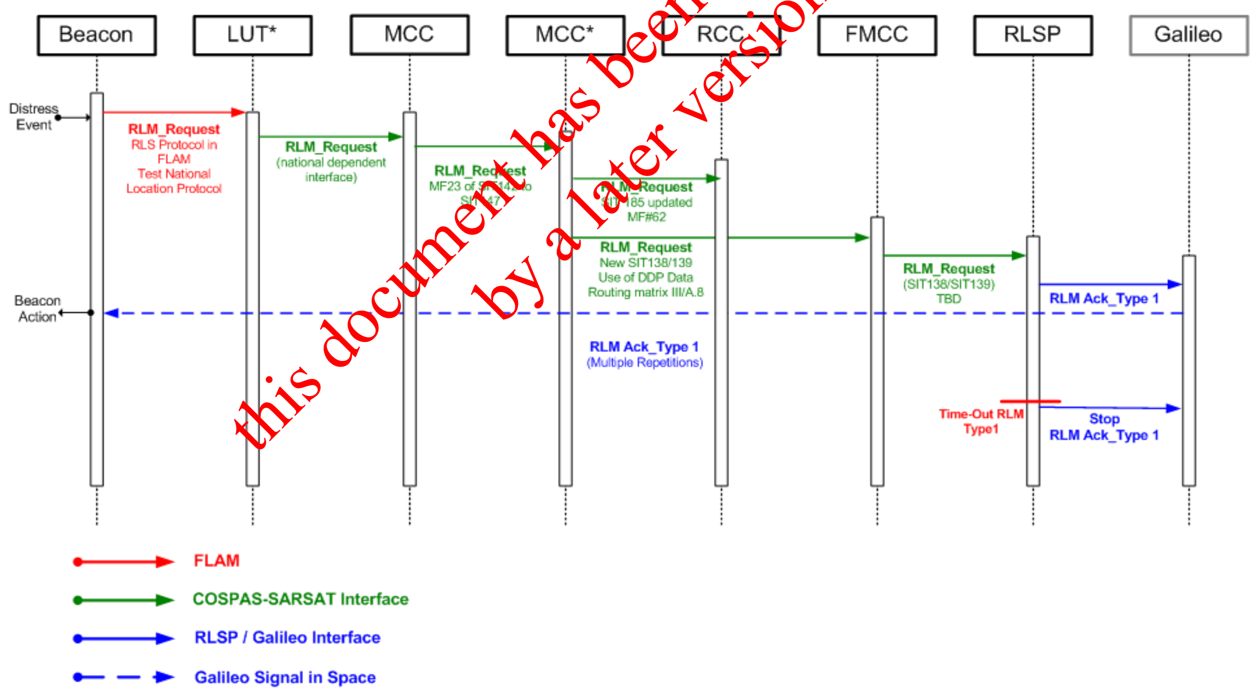

Table 5.2 presents the basic steps expected in the operational testing of the return link service.

Step ID	Entities	Step
1	Distress Beacon	The beacon is activated. The FLAM encloses the RLM_Request.
2.1 and 2.2	LUT and MCC	The beacon is detected and located by one or several MEOLUTs. MCC receives the alert. Once the MCC* has a confirmed location, the MCC* transmits the RLM_Request (SIT138 / SIT139) to the FMCC. The MCC transmits the alert with the RLS_Capability_Notification to the RCC in charge (MF#62 of SIT 185).
3	FMCC	FMCC receives the RLM_Request and transmits it to the RLSP.
4	RLSP	On RLM_Request reception, the RLSP checks the RLM_Request previous reception and [checks if the beacon is registered as a RLS enabled beacon in the RLSP database.] The acknowledgment RL message (Type 1) is created by RLSP with the "system level" parameter and transmitted to the Galileo system with a dissemination schedule/ priority.
5	Galileo System	The Galileo system receives the acknowledgment RL message, processes it and broadcasts it through the Galileo satellites. The acknowledgment RL message (Type 1) is broadcasted by Galileo SVs. The RLM is sent every TBC minutes by the Galileo system until a TBC time-out is reached.
6[#]	RCC	RCC Activation: The RCC receives the RLS_Capability_Notification in MF#62 of SIT 185 and reacts accordingly with the RLSP
7	Distress Beacon	The beacon that has already acquired several Galileo SV with its internal Galileo receiver, receives the acknowledgment RL message (Type 1). The beacon reacts upon reception of the RLM. The beacon message is not changed

MCC* - MCC responsible for the service area where the beacon is located (confirmed location)
Note - Type 2 RL messages will not be tested as part of the MEOSAR D&E. However, assessment of the MF#62 generation with RLS information will be checked. Furthermore the EC will perform these tests as part of the D&E testing by involving on an ad-hoc basis particular RCCs.

Table 5.2: RLS Test Procedure Overview

5.5.1.2 Objective RL-1: Validation of Return Link Service Interfaces

The RL-1 objective is to validate the different interfaces for a Return Link Service from the MCC responsible for the service area where the beacon is located and confirm that there is no erroneous definition in the SIT message format between the involved equipment (SIT138, SIT 139 and SIT185).

5.5.1.3 Objective RL-2: RLM Transfer Time Measure

The RL-2 objective is to assess the waiting time between the RLM request transmission by the originating MCC and the reception of the RLM by the beacon. The test will characterise both the latency of the Cospas-Sarsat System to disseminate the RLM request and the overall latency of the RLS.

5.5.1.4 Objective RL-3: RLM Detection Probability

The RL-3 objective is to determine the probability of detecting the transmission of the RLM from the Galileo system and recovering at the 406 MHz beacon with return link capability a valid RLM within 15 minutes of the RLM transmission request sent by the RLSP to the Galileo system. This is the maximum delay permitted by the SAR/Galileo Return Link User Requirements for first Return Link Message notification.

5.5.2 Methodology and Data Collection

5.5.2.1 Pre-Conditions for RLS Testing within the MEOSAR D&E Phase

The following conditions should be met in order to proceed with RLS testing in the MEOSAR D&E:

a) Availability of sufficient Galileo coverage capability to provide sufficient testing time slots: 4-6 satellites available by beginning of 2013.

b) MCC modifications: all nodal and participating MCCs shall implement the specific procedures detailed in Annex E for the RLM request dissemination.

c) FMCC modification: the FMCC shall have the specific interface to the RLSP implemented, in addition to the processing defined in Annex E.

d) Availability of RLS capable beacons: RLS capable beacons / RLS Beacon Simulators shall be available in participating countries for remote activation. In order to validate different dissemination paths, RLS capable beacons will be made available in several MCCs worldwide. It is proposed to distribute RLS capable beacons / RLS beacon simulators to the MCCs in Table 5.3. Each RLS beacon will have a dedicated output interface to extract data associated to the beacon activation and RLM reception times.

MCC	DDR	Location	Beacon Type	Confirmation
FMCC (Nodal)	Central DDR	Toulouse (France)	RLS Beacon Simulator	Yes
SPMCC (Nodal)	South Central DDR	Maspalomas (Spain)	RLS Beacon	Yes
NMCC	Central DDR	Bodoe (Norway)	RLS Beacon	Yes
CMC (Nodal)	Eastern DDR	Moscow (Russia)	RLS Beacon	TBC
USMCC (Nodal)	Western DDR	Suitland (USA)	RLS Beacon	Yes
UKMCC	Central DDR	Kinloss (UK)	RLS Beacon	Yes
AUMCC (Nodal)	South West Pacific DDR	Canberra (Australia)	RLS Beacon	Yes
CMCC	Western DDR	Trenton (Canada)	RLS Beacon	TBC

Table 5.3: Distribution of RLS Beacons for MEOSAR D&E

5.5.2.2 Return Link Message Request Distribution Procedure Evaluation

Each participant will collect data to support the evaluation of the RLM request distribution procedures as documented in Annex E of the D&E plan. The evaluation methodology entails collecting information on SIT content and time. The goal is to collect sufficient information in order to fully evaluate the Cospas-Sarsat RLS distribution procedures.

MEOSAR D&E participants should collect and record counts for all MEOSAR RLS alerts that occur in the lifetime of selected RLS test beacons using the provided spreadsheet (MEOSAR D&E Report Data O-5.xls) to record the data (see Figure 5.13).

The following interfaces will be assessed:

- FMCC – RLSP
- MCC* – FMCC
- MCC* – SPOC/RCC
- RLSP – Distress Beacon

In order to assess a variety of dissemination paths, the following scenarios will be tested:

1. FMCC is responsible for the service area (MCC*) where the alert is located
2. One MCC of the Central DDR is responsible for the service area (MCC*) where the alert is located
3. One MCC of another DDR is responsible for the service area (MCC*) where the alert is located
4. Multiple various Field Tests

Scenario 1	Beacon activation in FMCC
Scenario 2	Beacon activation in NMCC, UKMCC
Scenario 3	Beacon activation in SPMCC, USMCC, AUMCC, CMC (tbc), CMCC (tbc)
Scenario 4	Various field activation of real beacons

Distinctions have to be made between the different scenarios since not all participating MCCs will be involved in each of the test scenarios. Multiple tests will be performed for each of test scenario. The tests will be referenced through a specific Test-ID defined as S-xxx where S indicates the test scenario and xxx the specific test run.

The test procedures will be implemented as defined in Table 5.2. Steps 6 & 7, related to the RCC acknowledgment within the RLSP are not required as part of the MEOSAR D&E. However, assessment of the MF#62 generation with RLS information will be checked. Furthermore, the EC will perform these tests in conjunction with the D&E testing by involving particular RCCs on an ad-hoc basis.

5.5.2.3 Return Link Message Detection Probability Evaluation

Since measurements should be independent of the beacon location, but would rather depend on the elevation angle between the beacon and the satellite, the associated tests will be performed only at a few locations. In reality, however, as long as the Galileo system is not fully deployed, the actual performance will depend on the beacon location as satellite coverage will vary.

The following steps will be performed to determine the RLM detection probability per satellite-beacon elevation angle range of [5º]:

a) Note the number of RLMs transmitted within every satellite-beacon elevation angle range of [5º].

b) Determine the number of RLMs correctly received within [15] minutes by the Galileo beacon within every satellite-beacon elevation angle range of [5º].

c) Calculate the RLM detection probability.

5.5.2.4 RLS Test Slots

The slots for RLS testing will be based on suitable satellite configurations in order to:

a) ensure that the beacon can be detected and located using either S-band or L-band SAR transponders; and

b) ensure that a sufficient number of Galileo satellites are in visibility of the beacon to broadcast the RLM message.

Time slots for each test scenario and each individual test shall be established as part of the planning of RLS tests.

5.5.2.5 Data Collection

5.5.2.5.1 MCC Data Collection

Each MCC participating in the RLS D&E test will collect the following information, as available, and forward the data results to the FMCC, where the data will be consolidated.

a. RLS Beacon ID

b. MEOLUT ID

c. TOA of First Burst (MF14a) – [UTC]

d. Time of confirmed position in MCC (reception of SIT144/147 or position confirmation by own MEOLUT) – [UTC]

e. Time of reception / transmission of SIT138/SIT139 [UTC]

f. MCC Responsible of Service Area [Yes/No]

g. MCC Responsible for activating RLS Beacon [Yes/No]

h. Time of first RLM Reception at Beacon [UTC] for MCC activating a RLS beacon

i. Time of last RLM Reception at Beacon [UTC] for MCC activating a RLS beacon

Figure 5.13: O-5 MCC Data Collection for RLS Operational Test

TestSlotID	BcnId15	MEOLUTID	TOA FirstBurst [UTC]	Time of Confirmed Position (SIT144,147 or own LUT) [UTC]	Time of RLS SIT138 /SIT139 Transmission/ Reception	MCC = MCC*	MCC Activating RLS Beacon	RLS Beacon activation Time	RLM Received	First RLM Reception Time	Last RLM Reception Time
1001	B388170D64334D1	FR	2010/01/01 00:06:02	2010/01/01 03:34:22	2010/01/01 03:36:22	1	1	2010/01/01 00:05:02	1	2010/01/01 03:46:22	2010/01/01 03:56:22
1002	ADCD376A85E1400	EU1	2010/01/01 03:15:47	2010/01/01 03:28:17	2010/01/01 03:29:17	1	1	2010/01/01 03:15:00	1	2010/01/01 03:39:17	2010/01/01 03:59:17
3001	ADCC014DD040459	CAN	2010/01/01 04:01:54	2010/01/01 05:56:54	2010/01/01 05:57:54	0	0		0		
3002	AD8D0A131900A01	US	2010/01/01 06:18:57	2010/01/01 06:20:37	2010/01/02 06:21:37	0	0		0		
1003	2DCC3611EAFFBFF	EU1	2010/01/01 06:33:42	2010/01/01 06:35:22	2010/01/01 06:37:22	1	1	2010/01/01 06:32:42	0		
4001	ADCD05453441401	FR	2010/01/01 08:01:43	2010/01/01 23:28:23	2010/01/01 23:29:33	1	1	2010/01/01 08:00:43	0		
2001	BEEE00678800001	EU2	2010/01/01 07:19:43	2010/01/01 07:19:43	2010/01/01 07:20:43	0	0		0		
3003	2DC838746AFFBFF	US	2010/01/01 08:17:50	2010/01/01 11:50:20	2010/01/01 11:52:20	0	0		0		
4002	B38950D90D034D1	RU	2010/01/01 08:15:04	2010/01/01 11:34:14	2010/01/01 11:36:14	0	0		0		
1004	A78E005EDC40401	FR	2010/01/01 10:07:20	2010/01/02 06:08:10	2010/01/02 06:10:10	1	1	2010/01/01 10:06:20	1	2010/01/02 06:20:10	2010/01/02 06:40:10
1005	9EA9531534D34D1	FR	2010/01/01 13:25:05	2010/01/01 13:25:05	2010/01/01 13:27:05	1	1	2010/01/01 13:23:05	1	2010/01/01 13:37:05	2010/01/01 13:57:05
2002	DAA64BAE62E8651	EU2	2010/01/01 12:12:10	2010/01/01 12:18:50	2010/01/01 12:20:50	0	0		0		
3004	ADCD018C5C42801	EU3	2010/01/01 12:43:07	2010/01/01 16:08:07	2010/01/01 16:10:07	1	1	2010/01/01 12:40:07	1	2010/01/01 16:20:07	2010/01/01 16:30:07
3005	C1AB5C8A28A28D1	CAN	2010/01/01 12:50:02	2010/01/01 13:54:12	2010/01/01 13:56:12	0	0		0		
4003	A70E046ADC50501	CAN	2010/01/01 13:21:39	2010/01/01 13:24:59	2010/01/01 13:26:59	0	0		0		

5.5.2.5.2 RCC Data Collection – (For Information Only)

EC will involve some RCCs, on an ad-hoc basis, for retrieving information on the RLS tests. These RCCs will collect specific information to validate the RLS Type-2.

Figure 5.14: O-5 RCC Data Collection for RLS Operational Test

TestSlotID	BcnId15	MCCID	Alert Notification Time	Time of Notification of RLS Capability	Time of RLM Autorisation to RLSP
1001	B388170D64334D1	FMCC	2010/01/01 00:06:02	2010/01/01 03:34:22	2010/01/01 04:36:22
2001	ADCD376A85E1400	SPMCC	2010/01/01 03:15:47	2010/01/01 03:28:17	2010/01/01 04:29:17
2002	2DCC3611EAFFBFF	SPMCC	2010/01/01 06:33:42	2010/01/01 06:35:22	2010/01/01 07:37:22
2003	ADCD05453441401	NMCC	2010/01/01 08:01:43	2010/01/01 23:28:23	2010/01/01 09:29:33

5.5.2.5.3 RLSP Data Collection

The RLSP will collect the arrival time of the Return Link Message Request associated to each RLS beacon alert.

5.5.3 Data Analysis, Results, and Reporting

5.5.3.1 Return Link Service Interfaces (RL-1)

Table 5.4 depicts the results expected for Return Link indicator RL-1. The correct reception at the FMCC and RLSP (and RCC) of the RLM Request associated to each RLS beacon alert will validate the interfaces.

Parameter	Expected results	Comments
MCC*-FMCC	RLM request (SIT138/SIT139) transmission	After resolving the beacon position (Position Confirmation) either from SIT144/SIT147 reception or own location determination. The RLM request (SIT138/SIT139) will transit through different MCCs on the path from MCC* to FMCC.
FMCC-RLSP	RLM request (SIT 138/SIT139) Transmission	Upon reception of SIT138/SIT139 from MCC* or after resolving the beacon position if FMCC is the MCC responsible for the service area where the distress is located
MCC*-RCC	SIT 185 with updated text informing on beacon RLS_Capability_Notification	The MF#62 will include the following text: "WARNING THIS BEACON HAS A RETURN LINK CAPABILITY"

Table 5.4: O-5 Interfaces Validation

5.5.3.2 RLM Transfer Time (RL-2)

Based on the data collected at each MCC, the overall time transfer of the RLM request within the Cospas-Sarsat System and the end-to-end time transfer will be determined. Table 5.5 depicts the expected results for the Return Link indicator RL-2.

The time delivery is based on expected MEOSAR system latency performance and RLSP/Galileo System latency requirements. They are listed in Table 5.5 with associated expected time contribution to the return link.

Item	Probability	Expected Performance / Requirement	Contribution to RL
C/S System Latency	/	The latency between the confirmation of a RLS capable beacon position into the MCC* and the reception of the RLM request in the RLSP shall be less than 10 min. Assuming that the beacon position confirmation can be achieved within 10 min (MEOSAR requirements), the total C/S System latency to transmit a RLM request to the RLSP will be 20 min.	10 - 20 min
Delivery Time by RLSP to Galileo System	/	The RLSP shall deliver a RLM request to the Galileo system within 5 minutes after reception of confirmed distress information from a second generation beacon with RLS capability, provided by the C/S Ground Segment	0 - 5 min
Delivery Time by Galileo System to distress beacon	/	The Galileo system shall deliver the RLM to the appropriate second generation beacon within 15 minutes of its reception from the RLSP	5 - 15 min
		Total Transfer Time	15 - 40 min

Table 5.5: O-5 Expected Results for RL-2

5.5.3.3 RL-3: RLM Detection Probability

Table 5.6 depicts the expected results for the Return Link indicator RL-3. As noted above, the RL-3 objective is to determine the probability of detecting the transmission of a RLM by the Galileo system and recovering a valid RLM at the 406 MHz beacon with return link capability, within 15 minutes of the first RLM transmission request sent by the RLSP to the Galileo system. The RLM detection probability will be calculated using data collected at each MCC.

Parameter	Expected results	Comments
RLM detection Probability	> 99%	The delay established as 15 minutes from the RLM transmission by the RLSP to the Galileo system until the RLM reception at the 406 MHz beacon.

Table 5.6: O-5 Expected Results for RL-3

5.5.4 Interpretation of Results

As in section 5.5.3 above.

5.6 O-6: Evaluation of Direct and Indirect Benefits of the MEOSAR System

5.6.1 Objective and Definitions

Direct and indirect benefits provided to SAR activities should be determined by each MCC in coordination with supported SAR agencies such as RCCs and SPOCs.

5.6.2 Methodology and Data Collection

Each participating MCC should:

a) gather data on all distress and non-distress events within their service area;

b) provide narrative summaries where MEOSAR data made significant impact on SAR mission;

c) provide evaluation of benefits and disadvantages, based on guidelines contained below, to SAR activities for each summary; and

d) use the C/S A.003 SAR events reporting format to indicate whether MEOSAR provided the first alert and/or only alert, and whether MEOSAR data was found to be useful from the RCC perspective.

5.6.3 Data Analysis and Reporting

Report at the discretion of MCC operators.

5.6.4 Interpretation of Results

Direct and indirect benefits should be assessed using the following guidelines.

5.6.4.1 Direct Benefits

During D&E a number of real SAR incidents will occur. Some of these incidents will involve the use of MEOSAR data. The contribution of the MEOSAR data on a case-by-case study will be evaluated to determine the following:

a) Human Lives Lost

The MEOSAR system could contribute to a reduction in the loss of lives because of a more rapid response and rescue. A quantitative estimate of the reduction may be difficult and it will depend on the number and nature of the incidents which occur. The contribution of the MEOSAR system will be evaluated on a case-by-case basis for each incident. As a minimum, the following information should be captured, analysed and reported:

- Lives saved due to timeliness of MEOSAR alerting.
- Lives saved due to cases in which MEOSAR provided the only alert(s).

b) Search Costs

The MEOSAR satellite system with its inherent capability of providing an immediate alert could contribute to a reduction in search costs. Consider as a minimum any reductions in search costs due to MEOSAR alerts in which there is a registration data base point of contact provided location and reductions due to mitigation of false alarms. Parameters which will contribute to an assessment of this benefit are:

- Reductions in flying hours.
- Reductions in direct costs, e.g. charges for civilian assistance.
- Reductions in operating costs for air/sea searches.

c) Property Losses

Employment of the MEOSAR system could reduce the amount of property lost at sea because of quicker rescues and better detection capabilities. As a minimum, the following information could be captured, analysed and reported.

- Property saved due to timeliness of MEOSAR alerting.
- Property saved when MEOSAR provided the only alerts (s).

5.6.4.2 Indirect Benefits

The indirect benefits of the MEOSAR system should be included in the national reports. This information, while lacking in statistical validity, may be helpful in terms of greater public acceptance of 406 MHz ELTs, EPIRBs, PLBs, and the MEOSAR alerting capability.

a) Risk Reduction of SAR Forces

The introduction of the MEOSAR system could affect the SAR Force exposure to risk. Exposure to risk could be reduced because of reductions in:

- Travel distance
- Travel
- Number of search personnel

- Chance of collision or crash
- Air traffic control complexity
- Probability of rescuers being lost

b) Increased Public Confidence In and Reliance on the Value of 406 MHz ELTs, EPIRBs, and PLBs

Assuming that the D&E demonstrates that the MEOSAR system improves SAR operations, a corresponding increased public confidence in and reliance on the use of 406 MHz ELTs, EPIRBs, and PLBs could occur. This should be noted in the participants' reports.

5.6.4.3 Disadvantages

Disadvantages of the MEOSAR system when noted by the SAR services should be included in the participants' reports. This information, which could be of subjective nature, may be helpful in overall evaluation of the MEOSAR system, and could provide information that leads to system improvements.

The following are areas that could be included in participants' reports:

- increase in the number of false alerts because of better detection or single burst detection; and
- increase in the number of ceased alerts (beacon is only turned on for a short time and then turned off, detectable by MEOSAR, but not LEOSAR).

5.7 O-7: MEOSAR Alert Data Distribution – Impact on Independent Location Accuracy

5.7.1 Objective and Definitions

Similar to Operational Test O-4, the purpose of this test is to evaluate the initial concept of operation for alert data distribution and recommend modifications, as needed, for an operational MEOSAR system. This test procedure focuses on the distribution of same beacon event data. The goal is to ensure that the MCC data distribution procedures provide SPOCs and other MCCs with accurate independent DOA location data in a timely manner and minimise the distribution of unnecessary data.

The key measure of performance is tied to the accuracy of the MEOSAR location data transmitted by MCCs. Specifically, the objective is to evaluate the accuracy of filtered location data versus the accuracy of distributed location data and to determine if a quality factor can be identified which provides SPOCs and other MCCs with more accurate location data in a timely manner.

5.7.2 Methodology and Data Collection

As the analysis involves location accuracy, this testing needs be performed with beacons that have a known location. The deployment of beacons for Technical Test T-5 will be used to generate the required data.

Each participant will collect specific data whenever MEOSAR data distribution procedures determine that new location data is for the same beacon event as existing data (see Annex E, sections 3.2.3 and III/B.4). The intent is to capture a "snap-shot" of the location data and processing status when new data for the same beacon event is received, and record this information for analysis. The data collected will include at the minimum the columns shown in Figure 5.15 below, which includes both inputs and results (results computed by embedded formulas have coloured cells).

While software can be developed to collect this data, manual effort may be needed to complete the columns. Columns are provided to collect information on Quality Factor (QF) computations or algorithms; D&E participants should provide information on one or more Quality Factors (e.g., average C/N0, DOP, error ellipse). If more information on quality factors and their respective reliability is available (either from study outside the D&E, or via results from Technical Tests T-4 or T-5), the data collection and analysis could be reduced to consider only a "best" quality indicator. The site status column uses five abbreviations similar to data for O-4:

- FA = First Alert with DOA location;
- CA = Confirmation Alert (confirmed but no data beyond);
- NC = Not Confirmed (but beyond first alert with DOA location);
- CT = Continued Transmission;
- PC = Position Conflict.

This test could be performed more than once, but it is recommended that at least some data for this test be collected in the later portion of the D&E period, when more MEOSAR satellites are expected to be available, so that test results better represent the MEOSAR system that will be used operationally.

5.7.3 Data Analysis, Results, and Reporting

MEOSAR D&E participants will populate the provided spreadsheet, and then cut and paste embedded formulas to generate values in the results columns (coloured cells). The key result is a difference between the location accuracy (also represents the match distance) of the new same beacon event data relative to the existing data. Other useful information involves the relative quality factors and comments provided by MCC analysts. Figure 5.15 provides an example data set.

This test also provides an opportunity to evaluate the use of a quality factor within MCC processing. Performance of a given quality factor computation or algorithm will be best determined from the full data sets that are collected under Technical Tests T-4 and T-5, but the practical application of these potential quality factors can be captured here.

Note: If more quality factors need to be evaluated, columns should be added as necessary.

Figure 5.15: O-7 Worksheet Example – Inputs and Results

Redundant Instance Data						Key Result	Supporting Data						
Site#	BcnId15	ReceiveTime	Status	New Error	Exist Error	Error Dif	New QF1	Exist QF1	QF1 Dif	New QF2	Exist QF2	QF2 Dif	Comments
1292	B38950D90D034D1	2010/01/01 08:15:04	CA	2.13	2.67	-0.54	422	301	121	774	676	98	New data was better and both quality factors agree
1305	ADCC0189D4C5C01	2010/01/01 19:30:11	FA	1.8	1.57	0.23	771	774	-3	828	824	4	New data was worse, quality factors inclusive
1348	2DC75BF884FFBFF	2010/01/03 11:01:10	CA	4.74	3.1	1.64	299	277	22	595	499	96	New data was worse, quality factors agree
1410	9C09D30D0DC34D1	2010/01/04 21:44:49	CT	1.93	2.82	-0.89	402	355	47	699	644	55	New data was better and both quality factors agree
1430	C2A8D28C34D34D1	2010/01/05 09:25:51	NC	1.12	5.16	-4.04	634	232	402	881	367	514	Clear case where new data was better, quality factors agree
1507	B388A35D41C34D1	2010/01/07 13:54:05	CT	0.31	0.5	-0.19	899	944	-45	999	999	0	New data was better and quality factor #1 conclusive
1576	A22C416BF400209	2010/01/09 09:11:34	FA	3.14	3.33	-0.19	344	288	56	545	491	54	New data was better and both quality factors agree
1608	ADCD062D2109431	2010/01/09 18:07:42	CT	1.27	1.05	0.22	621	622	-1	754	759	-5	New data was worse and quality factors inconclusive
1625	ADCD04F26941C01	2010/01/09 23:38:40	CT	0.51	0.43	0.08	943	944	-1	999	999	0	New data was worse and quality factors inconclusive
1657	9D06492BEADD371	2010/01/10 07:19:32	CA	0.1	0.14	-0.04	955	951	4	999	999	0	New data was better and quality factors inconclusive
1677	ADCD0233ED41C01	2010/01/10 11:34:57	FA	1.53	1.67	-0.14	455	411	44	799	771	28	New data was better and both quality factors agree
1721	A689D65534D34D1	2010/01/10 15:53:37	CT	1.22	1.08	0.14	608	611	-3	751	757	-6	New data was worse and quality factors inconclusive
1768	2DD7D54ABF81FE0	2010/01/11 02:06:15	CT	2.74	2.2	0.54	399	377	22	695	680	15	New data was worse, quality factors agree
1814	ADCD04D82140401	2010/01/11 23:42:24	CT	0.23	0.45	-0.22	877	913	-36	999	999	0	New data was better and quality factor #1 conclusive
1844	C2B839EEDE6A8D1	2010/01/12 14:32:45	NC	4.32	3.99	0.33	199	123	76	295	189	106	New data was worse, quality factors agree
1845	A1A64925CFAD351	2010/01/12 16:01:38	CT	0.19	0.25	-0.06	959	984	-25	999	999	0	New data was better and quality factor #1 conclusive
1886	DB476E2E74D34C1	2010/01/13 11:52:36	CT	1.28	1.53	-0.25	741	744	-3	818	820	-2	New data was worse, quality factors inclusive
1909	ADCD020FD440801	2010/01/14 09:22:50	CT	0.05	0.11	-0.06	985	989	-4	999	999	0	New data was better and quality factors inconclusive

5.7.4 Interpretation of Results

One purpose of MCC data distribution procedures is to filter information that is cumbersome or confusing, so that the SPOC/RCC is provided only with data needed to achieve an effective and timely rescue. Any improvement in location accuracy that is achieved by distributing better quality, same beacon event data should be evaluated against the burden on SPOCs/RCCs to handle additional data and the burden on MCCs to implement additional data distribution procedures. It is noted that the burden on SPOCs/RCCs to handle additional data may vary for different SAR authorities.

Due to the complexity of this analysis, no performance threshold is specified.

In addition, the distribution of more accurate data for the same beacon event is worthwhile operationally only if a quality factor is provided to indicate, with a high probability, which location is more accurate. Thus, an important goal of this test is to validate a quality factor predictive of location accuracy.

If possible, the analysis of results should also consider the impact of distributing more accurate data in respect of timeliness for same beacon events. For example, a more accurate same beacon event location might be distributed, but an even better solution might follow on the very next burst. Thus, there may be an appropriate trade-off to consider between the effort to implement the processing which potentially distributes better quality same beacon event data and the timeliness of potentially better new data.

5.8 Summary of Management of MEOSAR D&E Operational Tests

Table 5.7 summarises the responsible D&E participant(s) for reporting final performance results for each operational test

Operational Test	Responsible Participant for Data Collection
O-1 Potential Time Advantage	MCC [(1)]
O-2 Unique Detections by MEOSAR System as Compared to Existing System	MCC [(1)]
O-3 Volume of MEOSAR Distress Alert Traffic in Ground Segment Network	MCC
O-4 406 MHz Alert Data Distribution Procedures	MCC
O-5 SAR/Galileo Return Link Service (RLS)	[FMCC]
O-6 Evaluation of Direct and Indirect Benefits of MEOSAR System	All participants
O-7 MEOSAR Alert Data Distribution – Impact on Independent Location Accuracy	MCC[(1)]

Table 5.7: Management of Operational Tests

Notes: (1) MCC in whose service area the alert is located, or if the alert is not located, MCC of the service area which includes the country designated by the country code.

- END OF SECTION 5 -

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6. MEOSAR D&E TIMELINE AND SCHEDULE

6.1 Establishing the Beginning of the D&E Testing

The following minimum requirements for a meaningful D&E of the MEOSAR system have been determined by simulation as described below.

6.1.1 Overview

The three major components of the MEOSAR System are considered for the definition of criteria to be met to start the MEOSAR D&E test phase:

- Space Segment: the total number of satellites in the constellations supporting the MEOSAR system that are equipped with MEOSAR repeaters.
- Ground Segment: the number of MEOLUTs and their respective antennas, associated MCCs, along with the required MEOSAR processing and communication capabilities of all components.
- Beacon Segment: the number and type of dedicated test beacons; operational beacons deployed in a controlled manner, beacon simulators and Cospas-Sarsat reference beacons.

As indicated in section 6.2 of this document, the testing period for the MEOSAR D&E is planned for the year 2013. Therefore the assets required are expected to be ready by 1 January 2013. Several additional MEOLUTs and a number of MEOSAR satellites are planned for deployment during the D&E testing period, and while the determination of assets required must focus on the start date, the impact of these space and ground segment additions was considered in the evaluation of readiness to begin the D&E.

6.1.2 Assets Required

6.1.2.1 Space Segment

Requirement: The determination of readiness to begin D&E testing includes the evaluation of unique satellite visibility at all participating ground stations over a portion of a given day, i.e. requiring at least 4 satellite visibility 90% of the day at each participating MEOLUT.

Rationale: Although some level of testing could occur before adequate visibility is achieved, it is appropriate to perform the majority of D&E testing when system capabilities are representative of the future system, in particular those tests addressing location accuracy and the timeliness of independent locations.

Annex E of the Cospas-Sarsat MIP, document C/S R.012, defines the minimum performance requirements that should be satisfied by a MEOSAR system at full operational capability (FOC) to ensure compatibility with the existing 406 MHz

Cospas-Sarsat System. The criteria that affect MEOSAR performance and its evaluation are summarised by the following definition of the MEOSAR coverage area:

> **MEOSAR Coverage Area**: The geographic area where an unambiguous independent position within 5 km from the actual beacon position is obtained within 10 minutes from the first beacon message transmission, with a minimum probability objective.

The current target date for the start of D&E testing is the beginning of 2013. Twenty one satellites are expected to be available at this time (17 from the GPS II (DASS) constellation, 2 from Galileo and 2 from GLONASS constellations) and the coverage area where independent location accuracy is better than 5 km within 10 minutes at least 75% of the time includes much of the northern hemisphere (at FOC the requirement is to be met 95% of the time).

Among the anticipated MEOLUTs, the corresponding minimum percentage of daily visibility of at least 4 satellites is 94.7%. Allowing for the dynamics of actual satellite launch dates and specific orbital positions, setting the 4 satellite mutual visibility requirement at each participating MEOLUT at 90% is considered a reasonable goal.

6.1.2.2 Ground Segment

Country	Location	Antennas	Latitude	Longitude
Brazil	Brasilia	2 to 4[15]	-15.86	-47.90
Canada	Ottawa	7	45.34	-75.89
China	Beijing	4	39.91	116.01
France	Toulouse	4 to 6	43.56	1.48
Russia	Moscow	4	55.62	37.51
Turkey	Ankara	2 to 4	40.14	32.99
UK	Kinloss	2 to 4	57.65	-3.57
USA	Maryland	4	39.00	-76.85
USA	Hawaii	6	21.52	-158.00

Table 6.1: List of MEOLUTs at 1 January 2013 (as assumed in the simulation)

Requirement: A minimum number of MEOLUTs with their associated MCC must be in place to adequately evaluate the performance of the MEOSAR system.

Rationale: For the purpose of the simulation, nine MEOLUTs have been assumed to be available at the start of D&E testing. It is also assumed that these ground stations, or an equivalent set of ground segment components, meet the minimum number required to begin the D&E. An associated MCC is required as the host for each participating MEOLUT. Table 6.1 provides details on anticipated MEOLUTs. These MEOLUTs should meet the performance requirements outlined in Annex C of this document.

[15] MEOLUT assets that are listed as a range of the number of antennas indicate potential planned expansion of the minimum number. For purposes of the analysis and requirements the maximum number of antennas was used.

6.1.2.3 Beacon Segment

Requirement: Readiness to begin the majority of D&E testing requires that visibility at each participating MEOLUT of at least one beacon simulator via at least 4 satellites be achieved at least 30% of the time.

Rationale: The current target for starting D&E testing is the beginning of 2013. 21 satellites are expected to be available at this time and coverage area where independent location accuracy better than 5 km within 10 minutes is achieved at least 75% of the time includes most of the northern hemisphere (at FOC the requirement is to be met 95% of the time). Among the anticipated MEOLUTs, the minimum mutual visibility at this time between four or more satellites and at least one beacon simulator is 32.5%.

Allowing for the dynamics of actual satellite launch dates and specific orbital positions, setting the requirement at 30% is considered a reasonable goal.

Four beacon simulators have been identified as participating equipment at the start of D&E testing. These or an equivalent set of dedicated transmitters are required to begin the D&E. The anticipated beacon simulators are provided in Table 6.2.

Name	Country	Location	Latitude	Longitude	Type
Maryland	USA	Maryland	39.00	-76.85	Simulator
Hawaii	USA	Hawaii	21.52	-158.00	Simulator
Ottawa	Canada	Ottawa	45.34	-75.89	Simulator
France	France	Toulouse	43.56	1.48	Simulator

Table 6.2: Anticipated Beacon Simulators for MEOSAR D&E

While not explicitly required, Cospas-Sarsat orbitography and reference beacons will provide supplemental beacon sources throughout the D&E. These transmitters are listed in Table 6.3 below.

Name	Beacon ID	Country	Latitude	Longitude	Type
Thule	9B62197CA703590	Denmark	77.465	-69.217	Orbitography
Toulouse	9C6000000000001	France	43.5605	1.4808	Orbitography
Longyearbyen	A0234BF8A7335D0	Norway	78.229	15.396	Orbitography
McMurdo	ADC268F8E0D3780	USA	-77.846	166.712	Orbitography
Edmonton	A79EEE26E32E1D0	Canada	53.679	-113.315	Reference
Kerguelen	9C7FEC2AACD3590	France	-49.352	70.256	Reference
Moscow	A23C00000000000	Russia	55.62	37.508	Reference
Combe Martin	9D1FCFA7AB0D990	UK	51.17	-4.051	Reference
Toulouse	9C634E2AB509240	France	43.5605	1.4808	MEOSAR Ref.

Table 6.3: Cospas-Sarsat Orbitography / Reference Beacons

6.1.2.4 Processing and Communication Capabilities

Requirement: Key requirements are:

- All participating MCCs must have software upgrades installed that provide the processing defined in the MEOSAR D&E Data Distribution Plan (found in Annex E of this MEOSAR D&E Plan).
- All participating MCCs must have established appropriate MCC to MCC communication paths and protocols for MEOSAR "alert data" traffic.
- All participating MEOLUTs that will support tests that involve the sharing of TOA/FOA data (i.e., networking) must have appropriate software installed.
- All participating MEOLUTs that will support tests that involve the sharing of TOA/FOA data (i.e., networking) must have appropriate communication paths and protocols established.
- The characteristics of beacon simulators and reference beacons to be used in the testing need to be provided to all participants (see Annex C).

Rationale: In addition to having appropriate satellites, MEOLUTs, and beacons in place, appropriate processing and communications related capabilities must be established before the MEOSAR D&E can begin.

6.1.3 Supporting Assumptions

The minimum requirements pertaining to the space, ground and beacon segments outlined above were determined via simulations of MEOSAR system performance. Beyond the criteria listed above for the three segments, the assumptions listed in Table 6.4 were applied in the simulations. These assumptions are based on a combination of experimental data and expectations for future system performance. The actual results achieved may vary in the operational environment of the D&E phase.

6.1.4 Required Preparation

The following steps are necessary to determine that the MEOSAR D&E participants are ready to begin MEOSAR D&E testing:

a) confirm the general availability of space, ground and beacon segment capabilities at least equivalent to those outlined above;

b confirm the availability of processing and communication capabilities listed above for all participating ground segment components; and

c) perform a D&E Readiness Test as referenced in section 3 and specified in Annex D of this document.

Prior to a D&E Readiness Test, the Secretariat will compile the basic status of MEOSAR assets, and if the resources are notably different from those outlined above, the Cospas-Sarsat Council will decide whether or not the available assets are adequate to begin D&E Testing.

Name	Comment	Applied in Simulation
TOA	Standard deviation of time measurement error	20 µs
FOA	Standard deviation of frequency measurement error	0.4 Hz
Single Satellite Throughput	Modeled using a distribution involving the beacon to satellite elevation angle	70% for S-Band 85% for L-Band
Networking	Sharing of TOA/FOA data pairs between MEOLUTs	None (i.e., Stand-Alone)
MEOLUT Minimum Elevation Angle	Between MEOLUT antennas and satellites	5 degrees
Beacon Minimum Elevation Angle	Between beacons and satellites	5 degrees
Minimum Satellites	Minimum number of unique satellites providing TOA/FOA considered necessary for computation of an independent position	3
Location Algorithm	Some form of triangulation or linear regression algorithm	Linear regression
Improvement in Location Accuracy	Improvement in location accuracy expected as a result of adding each additional burst over the activation period for a given beacon	Error from first burst divided by the square root of the number of bursts
Satellite Tracking Algorithm	When more satellites are in view of the MEOLUT than available receive antennas, some selective tracking algorithm should be applied, e.g., highest elevation for simpler cases; optimised algorithm for cases with many satellites (e.g., > 35)	Highest elevation
Number of Bursts	The number of bursts available after a beacon is activated (roughly 33% only transmit 3 bursts or fewer)	Model based on actual data collected at the USMCC over a 3-month period

Table 6.4: Supporting Assumptions Applied to the Simulation of MEOSAR Performance

6.2 MEOSAR D&E Activities and Schedule

This section provides a brief description of the major activities to be undertaken in preparation of and during the MEOSAR D&E Phase.

The overall schedule/time line for the MEOSAR D&E Phase is based on a four-year period that takes into consideration the readiness of the MEOSAR space and ground segment components and Cospas-Sarsat institutional constraints. In a broad view this schedule considers that in the years 2011 through 2014 the following will occur:

2011 – planning for MEOSAR D&E testing;

2012 – participant ground segment preparation for D&E testing;

2013 – MEOSAR D&E testing; and

2014 – compilation of test results and analysis, and preparation of final D&E report.

Preparation of specifications and commissioning requirements for MEOSAR ground segment equipment will be undertaken during this four year period. Near the conclusion of the D&E phase, activities will be undertaken to transition to the MEOSAR Initial Operational Capability (IOC) Phase. Also considered in the time line is the possibility to engage in the distribution of MEOSAR distress alert data to augment the LEOSAR/GEOSAR systems before the MEOSAR system is declared at IOC.

Figure 6.1 presents the tentative time line of D&E activities that are further amplified in the following sections.

6.2.1 MEOSAR D&E Planning and Preparation

The first portion of the MEOSAR D&E phase will consist of planning and preparation for the D&E operational and technical tests and the analysis and reporting of the results of those tests. The D&E Plan should be completed during 2011 and Issue 1 should be approved by the Council at the CSC-47 Session (October 2011). Once the initial Plan is approved, D&E ground segment participants can undertake actions necessary to contribute to the D&E test activities, such as MEOLUT and MCC modifications. As required, the D&E Plan may be modified during 2012 with a revision approved by the Council at the CSC-49 Session (October 2012).

After the expected Council approval of the D&E Plan and before beginning D&E test activities, a D&E readiness test will be conducted to ensure that all MEOSAR components are ready to engage in the testing.

6.2.2 MEOSAR D&E Test Activities

The MEOSAR D&E test activities should occur during 2013 and 2014. These activities include the actual tests, data collection, analysis, and reporting. The final D&E report should be ready for approval by the Council in 2014 for a decision to begin the MEOSAR IOC phase in 2015.

Interim findings, reports, and analyses may be prepared for review and consideration at Task Group and Joint Committee meetings, as appropriate.

6.2.3 System Documentation Development

To be prepared to begin the MEOSAR IOC phase in 2015, system documentation must be completed to allow for the commissioning of MEOLUTs and for commissioning MCCs with MEOSAR processing capabilities. The development of the MEOSAR system specification documents could begin in 2012 and continue during the next two years to be ready for Council approval in 2014. This Plan specifically addresses the development of ground segment specification and commissioning documents necessary to begin the IOC phase. However, several other Cospas-Sarsat System documents will need to be modified to reflect the new MEOSAR system capabilities.

6.2.4 Pre Initial Operational Capability

There may be a period prior to the official declaration of MEOSAR IOC when MEOSAR alert data could be used to supplement the existing LEOSAR/GEOSAR system. In this situation data availability would not be guaranteed, but efforts would be made to ensure data quality. The decision to implement pre-IOC operations will be based on the results of the D&E readiness test and the operational and technical test activities to date. During a pre-IOC phase, MEOSAR alert data would be forwarded to RCCs using the MCC network and the data distribution procedures developed for the exchange of operational data during the D&E.

The decision to authorise operational use of MEOSAR alert data before the declaration of MEOSAR IOC status will be made by the Cospas-Sarsat Council in response to a request by MEOLUT operators to proceed with the distribution of MEOSAR alert data to RCCs and SPOCs. The Council will decide on the basis of an evaluation of specific D&E test results whether MEOSAR alert data quality is acceptable for pre-IOC use. MEOSAR data will not be merged with nor used to filter LEOSAR or GEOSAR data during pre-IOC operations.

Ground Segment operators wishing to participate in pre-IOC alert data distribution will be requested to collect specific data as part of the MEOSAR D&E to evaluate the MEOSAR capability of their equipment in terms of beacon message validation, location accuracy, and timing.

6.2.5 IOC Preparation

After the Council has adopted the final D&E Report and approved the ground segment documentation (i.e. MEOLUTs specifications and commissioning standard, MEOSAR alert data processing requirements for MCCs), MEOLUT and MCC providers can undertake required equipment modifications and conduct the appropriate commissioning tests. This preparation for IOC operations could take place in 2015.

During this period, ground segment equipment operators' training shall be provided as well as training for SPOCs and RCCs. Finally, the Cospas-Sarsat Council will establish the system requirements to be met to begin IOC and decide on the initiation of that phase of MEOSAR implementation, with a formal declaration of MEOSAR IOC status.

The decision to move to IOC preparation is tentatively scheduled in October 2014 (see Figure 6.1). It is based only on the successful completion of the D&E and the approved definition of operational requirements for MEOLUTs and MCCs.

The second decision will depend on the actual status of the MEOSAR system (i.e. number of commissioned L-band satellites, MEOLUTs and MCCs) and minimum MEOSAR system requirements adopted by the Council. In particular, the transition from pre-IOC operations to IOC operations, where MEOSAR alert data will be merged with LEO and GEO alert data, is to be considered to ensure that all MCCs have the minimum operational capability to process MEOSAR data. Minimum upgrades may be required for all MCCs, to be implemented at a date to be determined by the Council, before effective IOC can be declared.

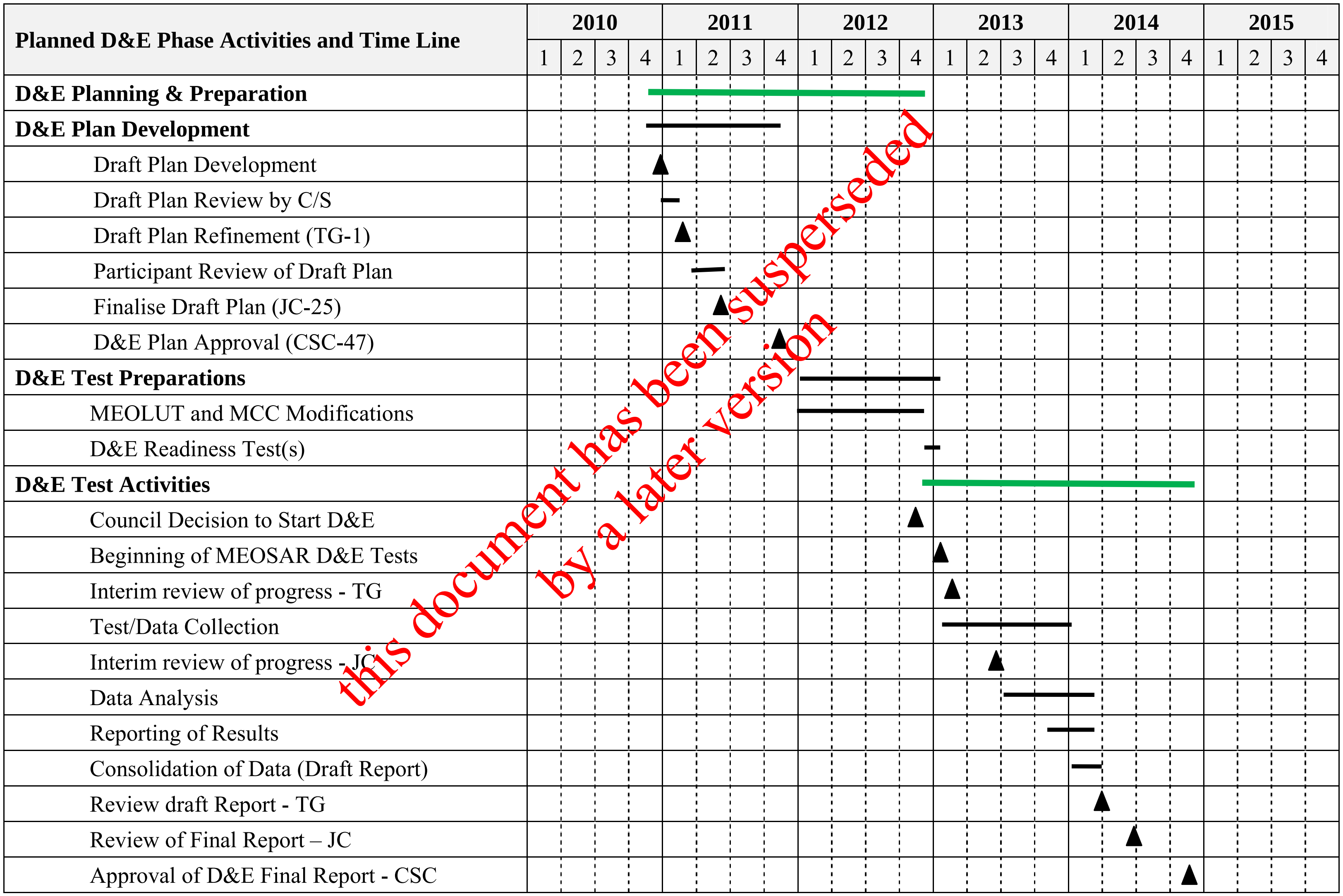

Figure 6.1: Tentative Schedule of D&E Activities

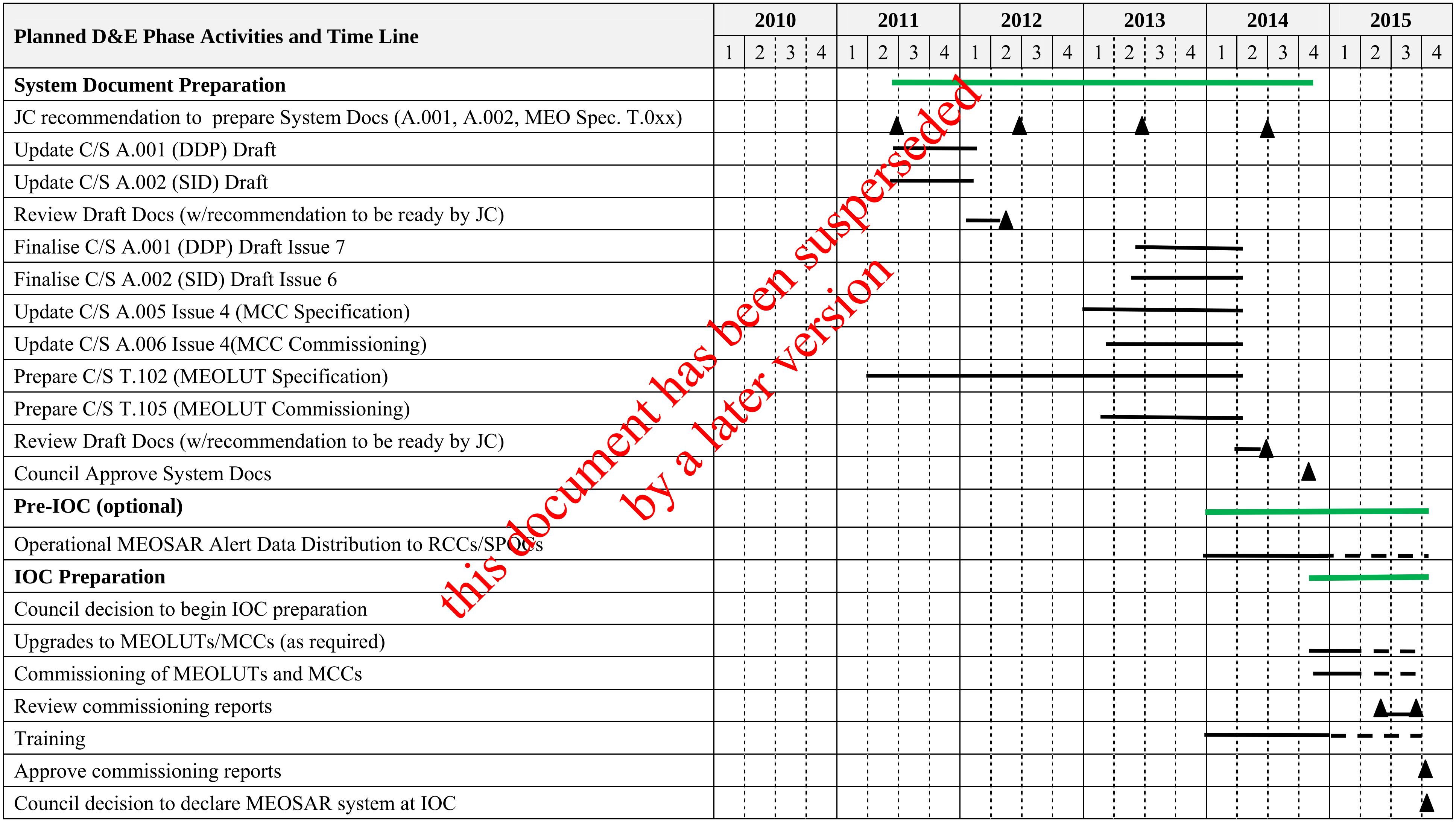

Figure 6.1 (cont.): Tentative Schedule of D&E Activities

6.3 Criteria for Successful Completion of the MEOSAR D&E

The achievement of the following conditions will characterise the successful completion of the Cospas-Sarsat MEOSAR demonstration and evaluation phase:

- a final report that provides official results of the evaluation, including the confirmation of MEOSAR system performance using test and operational beacons, and the characterisation of operational performance;
- a sufficient amount of test results using only satellites with L-band downlinks to confirm the expected performance of the operational MEOSAR system;
- confirmation of system architecture;
- commissioning standards for MEOSAR space and ground segment equipment; and
- completion of plans for the exchange of MEOSAR data, system operation and system monitoring.

Except for the testing of combined MEO/GEO operation (Test T-8), all tests proposed in the D&E plan should have been accomplished by some D&E participant.

Successful completion of demonstration and evaluation activities should form the basis for a Cospas-Sarsat Council decision on the operational use of the MEOSAR system as part of the Cospas-Sarsat System.

- END OF SECTION 6 -

7. INTERNATIONAL COORDINATION

The D&E test period of the MEOSAR system is expected to begin on 1 January 2013. Prior to this date, MEOSAR satellite and MEOLUT providers should declare their equipment "ready for D&E testing" and advise all participants of changes in equipment status which could impact on factors being evaluated in the D&E. All participants shall notify other participants if they intend to bring additional satellites or MEOLUTs into use, and the date on which this equipment will be available for D&E testing.

Tests beyond those specifically detailed in this plan may be needed to meet national or regional requirements. These tests should be designed and managed to have the minimum impact on the Cospas-Sarsat System or the international MEOSAR D&E effort. Coordination with MCCs or SPOCs likely to be affected must occur prior to the test. Responsibility for the coordination rests with the participant initiating the test. Tests by organisations which are not D&E participants are not permitted unless they are conducted under the sponsorship and the direct oversight of a D&E participant.

To ensure appropriate coordination among all interested D&E participants and avoid possible schedule conflicts between tests run by different participants, a General Test Schedule will be maintained by the Cospas-Sarsat Secretariat. This General Test Schedule will record:

- the test coordinator, i.e., the D&E participant who will oversee the execution of the test;
- the originator(s) of the test data, i.e. the D&E participant(s) who plans to transmit test signals using test units or beacon simulators;
- the planned schedule of the test;
- the applicable technical or operational test objective, as described in sections 4 and 5 of this document;
- a brief description of the signals transmitted or a reference to the applicable annex to this Plan; and
- the list of participants having declared their intention to collect test data and provide reports.

Each D&E participant should provide reports in accordance with the MEOSAR D&E guidelines. The guidelines concerning the administration and coordination of the technical tests are provided in section 4 and those for the operational tests are provided in section 5.

For each test outlined in the General Test Schedule, one participant, the test coordinator, will assume responsibility for the arrangement and provisioning of the resources required, data collection activities and data analysis activities. Arrangements may be made with supporting participants for particular resources or activities as shown in sections 4 and 5. The test coordinator shall provide to the Secretariat the information to be recorded in the General Test Schedule.

- END OF SECTION 7 -

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8. REPORTING GUIDELINES

The primary objective of the final D&E report is to present overall MEOSAR technical and operational characteristics in a clear and concise way that will demonstrate the capabilities of the system. The report will include conclusions on the MEOSAR system performance and recommendations regarding its transition to operational capability substantiated by the D&E results. In particular, the D&E report should aim to facilitate the final decision by the Cospas-Sarsat Council on the integration of the MEOSAR system into Cospas-Sarsat operations.

Each technical and operational parameter evaluated in the D&E will be reported and will include a statement on the parameter contribution to the global MEOSAR system performance, particularly with regard to the ultimate derivation of conclusions and recommendations.

Technical and operational test reporting formats are detailed in sections 4 and 5, and in Annex K. Each participant shall submit to the Secretariat a report after completion of testing of each technical objective identified in this D&E Plan and its final report addressing both technical and operational test results by [31 December 2013]. This report will cover the results of the D&E tests undertaken by that participant and any D&E activities in which the participant engaged in an active way. The Secretariat will compile the reports received from participants for submission to the D&E Report Preparation Group for consolidation and to the Cospas-Sarsat Joint Committee for review in June 2014. The Joint Committee will complete the final report, draw the relevant conclusions from the results provided and make appropriate recommendations to the Council. The Cospas-Sarsat Council will then consider at the Open Meeting of the CSC-53 Session (October 2014) the final draft of the D&E Report and decide on its adoption.

The Final Report will be a compendium of the results of the participants' endeavours and the combined impact of MEOSAR operations on workload, communications requirements and search and rescue alerting and responding.

Participants are encouraged to submit interim and progress reports of MEOSAR D&E testing to Cospas-Sarsat working groups or to the Joint Committee, as appropriate, at anytime during the D&E testing phase.

- END OF SECTION 8 -

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ANNEXES TO
DOCUMENT C/S R.018

COSPAS-SARSAT
DEMONSTRATION & EVALUATION PLAN
FOR THE 406 MHz MEOSAR SYSTEM

ANNEX A

LIST OF ACRONYMS[16]

2D Two dimensional position (latitude and longitude)

3D Three dimensional position (latitude, longitude and altitude)

DASS Distress Alerting Satellite System
Developmental nomenclature for modernisation and transition as a proof-of-concept hosted payload (S-band) on GPS IIR and IIF space vehicles. Used during the USA proof-of-concept phase of the MEOSAR program implementation effort.

DOA *"Difference Of Arrival" measurements allowing the computation of an independent position: includes both time of arrival (TOA) and frequency of arrival (FOA) types of measurements.*

DOP *Dilution Of Precision: DOP factors are based on the geometry of the beacon/transmitter to satellite links and are used to characterise the expected impact of this geometry on the precision of a computed location.*

FOA *Frequency Of Arrival (frequency of the signal received by the satellite antenna, as measured by the LUT)*

GEOLUT Local User Terminal (ground Earth station) in a 406 MHz GEOSAR system

GEOSAR Geostationary satellite system used for distress alerting

LEO Low-altitude Earth Orbit

LEOSAR LEO satellite system used for distress alerting and positioning

MTT Message Transfer Time

PTA Potential Time Advantage (see definitions in Annex B)

RLM Return Link Message

RLS Return Link Service

SAR/Galileo *The SAR mission on the European Galileo navigation satellite system in medium Earth orbit which comprises 406 MHz repeaters on Galileo satellites with an L-band downlink.*

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[16] *Text in Italic fonts was not reviewed at JC-25.*

SAR/GPS: The USA and Canadian partnership to fly 406 MHz repeaters on GPS Block III Increments B & C space vehicles with an L-band downlink.

SAR/Glonass *The SAR mission on the Russian Glonass navigation satellite system in medium Earth orbit which comprises 406 MHz repeaters on Glonass satellites with an L-band downlink.*

TOA *Time Of Arrival (time of the beacon signal arrival at the satellite antenna, as measured by the LUT)*

- END OF ANNEX A –

ANNEX B

DEFINITIONS OF TERMS [17]

Beacon Event

Alert data produced by a LUT for a specific beacon identification in a specific time frame (see also Same Beacon Event).

Combined MEO/GEO Processing

The procedures and algorithms allowing the computation of independent location data by combining FOA/TOA measurements from MEO and GEO satellites.

Complete Beacon Message

A 406 MHz first generation beacon message produced by a MEOLUT is complete when it consists of:

- the first protected field (PDF-1+BCH-1) of a valid short message; or
- the first and second protected fields (PDF-1+BCH-1+PDF-2+BCH-2) of a valid long message where the second protected field contains less than 2 corrected bit errors.

Bits 113 to 144 of the second protected field of a valid long message shall all be set to “1” if this field contains 2 or more bit errors. The message is then declared incomplete.

Confirmed Beacon Message

A confirmed beacon message may be a confirmed valid message or a confirmed complete message. The message confirmation process requires that two independent burst processing results produce identical valid or complete messages.

The confirmation can be obtained from successive transmitted burst processing or, in the case of the MEOSAR system and multi channel MEOLUT processing, from the result of the processing of the same transmitted burst via two or more satellite channels provided each received burst is processed independently to produce a beacon message and both messages produced are identical.

Dependent MEOLUT

A MEOLUT with one or more antennas, which may or may not be co-located, that relies on data from another MEOLUT in order to generate an independent location.

[17] *Text in Italic fonts was not reviewed at JC-25.*

First Generation Beacon

A 406 MHz beacon which complies with the specifications of document C/S T.001 and is tested against the type approval standards of document C/S T.007.

Independent Location

A location computed by the LEOSAR or the MEOSAR system, independently of the data encoded in the beacon message. The LEOSAR system provides independent beacon locations using a Doppler technique based on received beacon burst frequency measurements over a LEO satellite pass. The MEOSAR system provides independent locations using a triangulation technique based on multiple TOA/FOA measurements from burst detections received through a number of MEO satellite channels.

MEOLUT Event

In the MEOSAR system, a MEOLUT event is the reception at a MEOLUT of a beacon burst transmission through one or several satellite channels and its processing to produce an independent location and/or a beacon message (which may include an encoded GNSS location). The time of a MEOLUT event is the average TOA for all measurements associated with the same transmitted burst.

If measurement data from several MEOLUT events is used by the MEOLUT to generate an alert message sent to the associated MCC (i.e. a MEOSAR beacon event), such beacon event must be time tagged to the last MEOLUT event used to produce the alert data.

MEOLUT Network

A group of MEOLUTs that exchange FOA/TOA measurement data on a regular basis to enhance coverage or improve independent location data.

MEOSAR Beacon Event

Alert data produced by the MEOLUT from any number of bursts sent to the MCC, and time tagged to the last burst.

MEOSAR system

The Cospas-Sarsat MEOSAR system will comprise a space segment consisting of several interoperable MEO satellite constellations and a ground segment consisting of a number of MEOLUTs suitably located around the globe to ensure that beacon transmissions, anywhere on the globe, are received by at least one MEOLUT via at least three MEOSAR satellite channels.

Message Transfer Time (MTT)

The minimum time interval between the activation of a beacon and the readout of the first valid or complete message at the LUT.

Position Confirmation

The procedures / algorithms used to confirm location data from a unique source (e.g. Doppler location, encoded location or MEO location) through a matching process with other location data from a separate source or a different beacon event (e.g. Doppler with a different TCA, MEO location derived from different satellite channels or different beacon event, etc.).

Processing Threshold

The minimum value of the beacon transmit power for which the single channel throughput is greater than or equal to [0.7].

PTA

The Potential Time Advantage (PTA) is the elapsed time between the receipt at a MCC of the first MEOSAR alert notification and the first LEOSAR or GEOSAR alert notification for the same 406 MHz beacon.

Same Beacon Event

Alert data produced by LEOLUTs is considered to be the same beacon event when it has the same beacon identification, is received by the same spacecraft and has the same time of closest approach (TCA) ± 20 minutes.

Alert data produced by MEOLUTs is considered to be the same beacon event when it has the same beacon identification and any portion of the time period associated with the first alert (i.e., the time from the first to last burst) is within +/-[2] seconds of any portion of the time period associated with the second alert.

Satellite channel

The unique combination of a single MEOLUT antenna and MEO satellite in visibility. Collocated antennas tracking the same MEO satellite do not provide independent satellite channels.

Second Generation Beacon

A 406 MHz beacon which complies with the specifications of document C/S T.101 and is tested against the type approval standards of document C/S T.107.

Second generation beacon signal characteristics, message format and message contents have not been defined at this stage.

Stand-alone MEOLUT

A MEOLUT which can reliably produce an independent location for transmitting Cospas-Sarsat beacons in accordance with minimum Cospas-Sarsat requirements, using several independent satellite channels, i.e. a group of receiving antennas (or a multi-beam antenna system) simultaneously tracking an equal number of satellites.

System Margin

The difference between the minimum processing threshold and the typical transmit power of a beacon, i.e. 37 dBm.

Throughput (satellite channel throughput)

The probability of detecting a valid message from a single burst transmission relayed by a single satellite channel.

In the MEOSAR system the satellite channel throughput is the PDVM of a single channel MEOLUT.

Valid Beacon Messages

A 406 MHz first generation beacon message produced by a MEOLUT is valid when:

- the first protected field (PDF-1 + BCH-1) has 2 or less corrected bit errors and the fixed bits of Standard and National location protocols that start at bit 107 contain no errors; or
- the first protected field (PDF-1 + BCH-1) has 3 corrected bit errors and is confirmed by an identical match with another valid message from the same beacon event and the fixed bits of Standard and National location protocols that start at bit 107 contain no errors.

Valid MEO Alert Message

A 406 MHz MEOSAR alert message transmitted by an MCC. A valid MEO alert message is composed of one valid or complete beacon message provided by a MEOLUT with additional processing performed to validate the 406 MHz message content, including such information as country code, protocol or other data.

- END OF ANNEX B -

ANNEX C[18]

MEOSAR D&E GROUND SEGMENT

C.1 BASIC REQUIREMENTS FOR MEOLUTS PARTICIPATING IN MEOSAR D&E

C.1.1 Overview

The primary function of a MEOLUT is to receive and process signals transmitted by 406 MHz emergency distress beacons that operate in accordance with documents C/S T.001 and the planned C/S T.101 for future second generation beacons. In general, a MEOLUT shall detect and locate 406 MHz emergency beacons and transmit associated data to an associated Mission Control Centre (MCC). During the Cospas-Sarsat D&E phase, a MEOLUT shall be capable of receiving L- and S-Band or L-Band downlinks from GNSS satellites equipped with 406 MHz SAR repeaters, known as MEOSAR satellites.

A MEOLUT shall measure the frequency of arrival (FOA) and time of arrival (TOA) of detected bursts and use the results to locate the beacon. This method of beacon location is referred to as Difference of Arrival (DOA) which includes combinations of Frequency Difference of Arrival / Time Difference of Arrival (FDOA/TDOA) methods. A MEOLUT shall calculate an unambiguous location for the beacon after receiving a single transmission (burst) of the beacon message.

For the purposes of the D&E, the following types of MEOLUTs are noted from the definitions in the document C/S R.012 (MIP):

a) Dependent MEOLUT – A MEOLUT with one or more antennas, which may or may not be co-located, that must rely on data from another MEOLUT in order to generate an independent location.

b) Stand-Alone MEOLUT – A MEOLUT with multiple antennas (or equivalent), which may or may not be co-located, that does not rely on any other MEOLUT or antenna(s) to generate an independent location.

The level of participation in the MEOSAR D&E tests will be dependent on the type of MEOLUT involved. Data exchanged via MEOLUT networking shall not be used during tests that assess the performance of Standalone MEOLUTs.

[18] *Text in Italic fonts was not reviewed at JC-25*

C.1.2 Basic Operational Requirements

C.1.2.2 Satellites

A MEOLUT shall process signals from 406 MHz distress beacons that are relayed from GNSS satellites equipped with 406 MHz repeaters. During the Cospas-Sarsat D&E phase, this includes GPS Block II satellites using an S-Band downlink, and/or constellations using L-Band downlinks (SAR/Galileo, SAR/Glonass and SAR/GPS). MEOSAR L-Band satellite parameters are provided in document C/S R.012 (MIP).

C.1.2.3 Satellite Tracking

A MEOLUT shall be capable of simultaneously tracking as many visible MEOSAR satellites equipped with SAR instruments as the MEOLUT has tracking antennas or in its field of view if using other technology (e.g. phased-array antenna). A MEOLUT shall be capable of continuously receiving and processing all available satellite data for all portions of a satellite pass above its specified field of view (e.g. five degree elevation) with the exception of minor local obstructions (site masking).

C.1.2.4 Transmission of Alert Data to an Associated MCC

A MEOLUT shall process signals and transmit 406 MHz distress beacon data to the associated MCC as per the specifications in the following sections.

C.1.2.5 RF Radiation and Emissions

A MEOLUT shall not radiate or emit any radio frequency (RF) signals that will interfere with the functioning of the Cospas-Sarsat System or systems operating on other radio frequencies.

C.1.2.6 Data Archival

At a minimum, a MEOLUT shall store all beacon message, TOA/FOA and location data, [orbital data (as defined in Annex M of C/S R.012); periodic (e.g. one minute) antenna azimuth and elevation angles for the duration of a given pass, and pass schedule (i.e. Satellite, AOS, LOS)] used to support D&E testing. It is recommended that the MEOLUT operator maintain this stored data for a period of at least [90] days.

C.1.3 Functional and Processing Requirements

C.1.3.1 Antenna Subsystem

The S-band downlink is centred at 2226.472340 MHz with a -3 dB bandwidth of 200 kHz through a left-hand-circularly polarised antenna. S-Band antenna subsystems of a MEOLUT shall be able to acquire, track and receive the S-band downlink from GPS II satellites equipped with SAR repeater capability.

The L-band downlink can be centred anywhere in the 1544-1545 MHz band with a -3 dB bandwidth of 100 kHz through a left or right-hand-circularly polarised antenna. L-Band antenna subsystems of a MEOLUT shall be able to acquire, track, and receive L-band downlinks as described in document C/S R.012.

C.1.3.2 Time Subsystem

A MEOLUT shall maintain accurate system time and sufficient precision in the measurement of time and frequency. It is recommended that the MEOLUT time source be maintained to within [0.2] microseconds of universal coordinated time (UTC).

C.1.3.3 Orbit Maintenance Subsystem

A MEOLUT shall maintain accurate GNSS satellite orbit vectors. It is recommended that the MEOLUT maintain orbit vector accuracy to within [50] centimetres and [20] nanoseconds before and after any propagation.

C.1.3.4 Satellite Tracking

A MEOLUT shall maintain accurate tracking schedules for all L-Band and S-Band MEOSAR satellites, as applicable, that have been declared as operational for the D&E.

C.1.3.5 Beacon Message Data Recovery

The MEOLUT shall process and transmit to the associated MCC only beacon messages that achieve a perfect match of bits 16 to 24 with the 9 bit frame synchronisation pattern as described in document C/S T.001.

Self-test mode beacon messages have an inverted frame synchronisation pattern as described in document C/S T.001. A MEOLUT shall process and archive self-test mode beacon messages in the same manner as noted above.

C.1.3.6 Bit Verification

A MEOLUT shall detect and correct bit errors in the 406 MHz beacon messages, as follows.

a. The digital message transmitted by 406 MHz beacons includes a 21-bit BCH error correcting code, and, in the long message format, an additional 12-bit BCH error correcting code (except for the orbitography protocol as noted below). A MEOLUT shall use these BCH codes to verify and correct as necessary received data. All beacon messages include the following fields:

i. first protected data field (PDF-1, bits 25 to 85) which contains the beacon identification and can include position data; and

ii. first BCH error correcting field (BCH-1, bits 86 to 106) which contains the 21-bit BCH error correcting code that protects the 82 bits of PDF-1 and BCH-1. The 82 bits of PDF-1 and BCH-1 are also referred to as the first protected field.

b. The long message format also includes:

i. the second protected data field (PDF-2, bits 107 to 132) which contains position and supplementary data; and

ii. the second BCH error correcting field (BCH-2, bits 133 to 144) which contains the 12-bit BCH error correcting code that protects the 38 bits of PDF-2 and BCH-2. The 38 bits of PDF-2 and BCH-2 are also referred to as the second protected field.

c. A MEOLUT shall use BCH-1 to correct all messages that have a maximum of three bit errors in the first protected field, and detect the existence of more than three (3) errors with a probability of 95%. A MEOLUT shall use BCH-2 to correct any messages that have one bit error in the second protected field of the long message format and to detect the existence of two or more bit errors. When a MEOLUT determines there are 2 or more bit errors in the second protected field, bits 113 to 144 shall all be replaced with "1".

d. A MEOLUT shall process the orbitography protocol beacon messages with the short message portion (bits 25-106) which is error corrected by BCH-1; the MEOLUT shall send the uncorrected data in bits 107 to 144.

As defined in document C/S T.001, Specification for Cospas-Sarsat 406 MHz Distress Beacons, Standard location protocol beacon messages contain fixed values of (1101) in bits 107-110 and National location protocol beacon messages contain fixed values of (110) in bits 107-109. These fixed bits, which immediately follow BCH-1, are used to identify a beacon message that is corrupted due to bit-shift errors, in case the bit-shifted beacon message passes BCH-1 error detection. After using the BCH-1 and BCH-2 to correct bit errors in the 406 MHz beacon message (as defined above), the MEOLUT shall verify the fixed bits that begin in bit 107 for location protocol beacons (i.e., bits 107-110 for Standard location protocol beacons and bits 107-109 for National location protocol beacons).

C.1.3.7 Beacon Message Validation

A 406 MHz beacon message is valid when the first protected field (PDF-1 + BCH-1) has 2 or less corrected bit errors and, for location protocol beacons, the fixed bits that start in bit 107 contain no errors.

A 406 MHz beacon message is complete when it is a valid long message and the second protected field contains no errors or 1 corrected bit error or it is a valid short message.

If a long message is valid but not complete, bits 113 to 144 of the second protected field shall all be set to “1” by a MEOLUT, provided that the protocol is not orbitography.

C.1.3.8 Beacon Message Bursts

Beacon messages shall only be treated as being for the “same burst” when the associated times are within [1.5] seconds. If the associated times for two beacon messages exceeds this threshold, then the messages should be treated as being for separate bursts.

C.1.3.9 Beacon Message Association

In order to provide updated beacon messages and to generate DOA locations, it is necessary to associate 406 MHz beacon messages received from different satellites and at different times for the “same” beacon. This section specifies the rules for associating independent TOA/FOA data for the same beacon.

Two 406 MHz beacon messages are associated when the fixed bits of the first protected field (PDF-1 + BCH-1) of the two beacon messages are identical. Since the encoded position data in 406 MHz beacon messages using location protocols may change over time (per document C/S T.001), only fixed bits in a beacon message can be used for matching. Beacon messages shall be matched based on the fixed bits per Protocol type, as follows:

Protocol	Fixed Bits
User	25 to 85 (61 bits)
Standard Location	25 to 64 (40 bits)
National Location	25 to 58 (34 bits)
Undefined	25 to 106 (82 bits)

If a beacon message is not valid, then its Protocol is “undefined” and matching shall be based on bits 25 to 106, as specified above.

In addition, if one beacon message has 3 corrected bit errors in [PDF-1 + BCH-1] it can be associated with a valid message provided its PDF-1 is identical to the PDF-1 of the valid beacon message and the associated burst times are within [20] minutes.

C.1.3.10 Data Sharing with International MEOLUTs

A MEOLUT may provide TOA/FOA data to, and/or receive TOA/FOA data from other MEOLUTs. If exchanging TOA/FOA data with other MEOLUTs, the MEOLUT shall be transfer data according to the specifications contained in C/S R.012.

C.1.3.11 DOA Location Processing

A MEOLUT shall measure the FOA and TOA of each beacon message received. When the same burst is received from the same beacon through three or more satellites, a MEOLUT shall use these measurements to calculate a DOA location. It is noted that a MEOLUT may produce a location with less than three satellites.

A MEOLUT shall be capable of identifying and filtering beacon messages with low quality measurements that degrade location accuracy.

A MEOLUT shall be capable of identifying the quality of the calculated location. (*comment: Quality still needs to be defined in C/S R.012*)

A MEOLUT shall be capable of computing and forwarding to the associated MCC a single burst location.

A MEOLUT may also be capable of combining data from multiple bursts (transmissions) in order to improve location accuracy.

C.1.3.12 Processing Logic and Transmission of Data to the Associated MCC

A MEOLUT shall process all available data for a beacon burst before sending data to the associated MCC for that burst. The MEOLUT shall wait [15] seconds after the first detection of each burst before processing the burst data.

A MEOLUT shall send an alert with DOA location and/or encoded position for a 406 MHz beacon to the associated MCC as soon as it is available. A MEOLUT shall not send a located solution if the location is outside the footprint of any satellite for which data was used to compute the location at the time of the associated burst data.

If a MEOLUT has not previously sent a located alert for a given beacon, it shall send an unlocated alert to the associated MCC:

- *as soon as the valid beacon message is confirmed, or*
- *after [3] minutes from the time of its validation if the valid beacon message is not confirmed, with the indication that the message is not confirmed.*

After sending an alert for a given beacon, the MEOLUT shall continue to send alerts every [5] minutes at a minimum or as required by the associated MCC.

MEOLUTs shall provide to the associated MCC all information needed to satisfy the requirements of documents C/S A.001 and C/S A.002 as defined at Annex E.

The MEOLUT shall have the capability to suppress all orbitography and calibration beacon messages and pass them to the MCC only on request.

C.1.3.13 Status and Monitoring Functions

A MEOLUT shall monitor environmental conditions (e.g., temperature, wind speed, and humidity), test hardware and software to verify operational capability. A MEOLUT shall automatically send warning messages and alarm messages to the associated MCC on events that may significantly impact the MEOLUT operation when the time of impact is either in the near future (warnings) or immediately (alarms). All status and alarm information shall be logged.

C.1.3.14 Minimum Performance Requirements for MEOLUTs

The table provided below defines the minimum performance requirements that should be satisfied by a MEOLUT. These minimum requirements should be satisfied assuming that:

a) the 406 MHz beacon transmissions satisfy the specifications of document C/S T.001;

b) beacon transmissions will be relayed through the MEOSAR space segment currently identified in the MEOSAR Implementation Plan, C/S R.012;

c) the performance requirements will be met over a coverage area of [TBD] [based on simulations (USA document JC-25/8/14 "Simulations Supporting Section 6.1 of C/S R.018 (MEOSAR D&E Plan)" that support document JC-25/8/15 (USA) "Draft Updates to Section 6.1 of Document C/S R.018 (MEOSAR D&E Plan)"]; and

d) MEOLUTs at full operational capability may exhibit better performance than the requirements specified below.

Performance Parameter	Requirement	Definition	Reference in LEOLUT Performance Specification C/S T.002
Detection Probability	99%	The probability of detecting the transmission of a 406 MHz beacon and recovering at the MEOLUT a valid beacon message, within 10 minutes from the first beacon message transmission.	Paragraph 5.3.2
Independent Location Probability	98%	The probability of obtaining at the MEOLUT a 2D location (Lat./Long.), independently of any encoded position data in the 406 MHz beacon message, within 10 minutes from the first beacon message transmission.	Paragraph 5.3.3
Independent Location Error	P(e < 5 km) > 95%	The system independent location solution should be within 5 km from the actual beacon position 95% of the time.	Paragraph 5.3.6
Single Burst Independent Location Probability	90%	The probability of obtaining at the MEOLUT a 2D location (Lat/Long), independently of any encoded position data in the 406 MHz beacon message, using a single burst transmission.	
Single Burst Independent Location Error	P(e < 5 km) > 90%	The Single Burst independent location solution should be within 5 km from the actual beacon position 90% of the time.	
Sensitivity	≤34.8 dB-Hz	The minimum C/No level at which the MEOLUT will correctly process beacon messages, where C/No is the ratio of the unmodulated carrier power to noise power density in dB-Hz. The value is that necessary to obtain a $5x10^{-5}$ BER for the beacon message.	Paragraph 5.3.1

Table C.1: MEOLUT Minimum Performance Requirements

C.2 DESCRIPTION OF MEOLUTS PARTICIPATING IN D&E

Table C.2 provides characteristics and reference information for all MEOLUTs participating in the D&E. The status column is populated based on MEOLUT readiness to participate, with a status of "D&E Ready" indicating that the MEOLUT satisfies all the requirements and provides all the capabilities identified in this Annex.

Country or Organisation	Status (Planned or D&E Ready)	City / State	Name (Table[19] II / B.3 in C/S A.001)	Source ID (MF#11)	Antenna Name	Antenna ID (MF#71)	Latitude (Degrees)	Longitude (Degrees)	Altitude (m)	Antenna Diameter (m)	Antenna G/T (db/K)	Comments
Brazil	Planned	Brasilia			Bra-1		15.0572 S	47.90227 W	1046.4	2.4	10.4	
					Bra-2		15.0566 S	47.90224 W	1047.1	2.4	10.5	
Canada	Planned	Ottawa			Can-1		45.35303 N	75.90141 W	89.8	2.4	10	
					Can-2		45.35295 N	75.90116 W	89.7	2.4	10	
					Can-3		45.35264 N	75.90139 W	90.6	2.4	10	
					Can-77		45.2987 N	75.90689 W	74.0	2.4	10	
China	Planned	Beijing			Chn-1							
					Chn-2							
					Chn-3							
					Chn-4							
France	Planned	Toulouse			Fra-1		43.5584 N	1.4805 E	200	2.4	9.9	
					Fra-2		43.5584 N	1.4805 E	200	2.4	9.9	
EC/ESA	Planned				EC-1		43.55896 N	1.48373 E	144	3.0	10.0	
					EC-2		43.55896 N	1.48373 E	144	3.0	10.0	
					EC-3		43.55896 N	1.48373 E	144	3.0	10.0	

19 New table proposed to capture MEOLUT information in the DDP, including a unique MEOLUT "name", used to support FTPV communications etc.

Country or Organisation	Status (Planned or D&E Ready)	City / State	Name (Table[19] II / B.3 in C/S A.001)	Source ID (MF#11)	Antenna Name	Antenna ID (MF#71)	Latitude (Degrees)	Longitude (Degrees)	Altitude (m)	Antenna Diameter (m)	Antenna G/T (db/K)	Comments
					EC-4		43.55896 N	1.48373 E	144	3.0	10.0	
UK	Planned	Kinloss			UK-1		57.658 N	3.5585 W	8.0	2.4	10.2	
					UK-2		57.658 N	3.5585 W	8.0	2.4	10.2	
Russia	Planned	Moscow			Rus-1		55.74767 N	37.72301 E	207.0	3.8	20	
					Rus-2							
					Rus-3							
					Rus-4							
USA	Planned	Maryland			Mar-1		38.99908 N	76.8543 W	100	4.3		
					Mar-2		38.99942 N	76.8534 W	100	4.3		
					Mar-3		38.99893 N	76.8533 W	100	4.3		
					Mar-4		38.99868 N	76.8539 W	100	4.3		
USA	Planned	Hawaii			Haw-1		21.52491 N	158.0015 W	374.9	3.7	15(S)/12(L)	
					Haw-2		21.52458 N	158.0012 W	374.0	3.7	15(S)/12(L)	
					Haw-3		21.52521 N	158.0012 W	375.8	3.7	15(S)/12(L)	
					Haw-4		21.52488 N	158.0010 W	375.8	3.7	15(S)/12(L)	
					Haw-5		21.52455 N	158.0008 W	374.3	3.7	15(S)/12(L)	
					Haw-6		21.52428 N	158.001500	371.9	3.7	15(S)/12(L)	
Turkey	Planned	Ankara			TRK-1		40.141461 N	32.990039 E	936		10.3	
					TRK-2		40.141194 N	32.989814 E	936		10.2	

Table C.2 – MEOLUTs Participating in D&E

C.3 DESCRIPTION OF ORBITOGRAPHY, REFERENCE, AND BEACON SIMULATORS TO BE USED IN D&E

Name	Type (Orb Ref Sim)	Beacon ID	Latitude (Degrees)	Longitude (Degrees)	Alt (m)	Freq (MHz)	Power (dBm)	Rep Rate (sec)	Rep Period (fixed, Var)	Bit Rate (bps)	Carrier Duration (ms)	Antenna Polarisation	Mod Index (rad)	Mod Time (µs)	Mod Sym
Thule	Orb	9B62197CA703590	77.465 N	69.217 W											
Toulouse	Orb	9C6000000000001	43.55999 N	1.48 E	214	406.022	39-41	30	fixed	400.0	160	RHCP	1.1	150	0
Longyearbyen	Orb	A0234BF8A7335D0	78.229 N	15.396 E											
McMurdo	Orb	ADC268F8E0D3780	77.846 S	166.712 E											
Edmonton	Ref	A79EEE26E32E1D0	53.679 N	113.315 W											
Kerguelen	Ref	9C7FEC2AACD3590	49.352 S	70.256 E											
Moscow	Ref	A23C00000000000	55.62 N	37.508 E											
Combe Martin	Ref	9D1FCFA7AB0D990	51.17 N	4.051 W											
Maryland	Sim	TBD	38.9986 N	76.8422 W	53.35	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Hawaii	Sim	TBD	21.52 N	158.00 W											
Ottawa	Sim	TBD	45.34 N	75.89 W											
France	Sim	TBD	43.56 N	1.48 E											

Table C.3 – Beacons Used in the D&E

C.4 DESCRIPTION OF PLANNED MEOLUT NETWORKING

MEOLUTs shall transfer data to/from other MEOLUTs in accordance with all specifications detailed in C/S R.012. Planned connections and readiness status are captured in Table C.4.

Send →	**Brasilia**		**Ottawa**		**Beijing**		**Toulouse**		**Moscow**		**Ankara**		**Kinloss**		**Maryland**		**Hawaii**	
Receive ↓	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready
Brasilia															X		X	
Ottawa															X		X	
Beijing																	X	
Toulouse															X			
Moscow															X			
Ankara															X			
Kinloss															X			
Maryland	X		X				X		X		X		X				X	
Hawaii	X		X		X										X			

Table C.4 – Planned MEOLUT Networking during D&E

C.5 MCCs PLANNING TO PARTICIPATE IN D&E

MCCs shall process MEOSAR data and transfer alert data to/from other MCCs in accordance with all specifications detailed in C/S R.012 and/or Annex E of this document (captured as updates to C/S A.001, the DDP). Planned connections and readiness status are captured in Table C.5.

Send →	**BRMCC**		**CMCC**		**CNMCC**		**FMCC**		**CMC**		**TRMCC**		**UKMCC**		**USMCC**	
Receive ↓	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready	Planned	Ready
BRMCC															X	
CMCC															X	
CNMCC															X[20]	
FMCC									X		X		X		X	
CMC							X								X	
TRMCC							X						X			
UKMCC							X				X					
USMCC	X		X		X[2]		X		X							

Table C.5 – MCCs Participating in the MEOSAR D&E

- END OF ANNEX C -

[20] Pending involvement of JAMCC (North West Pacific DDR), CNMCC might be treated as part of the Western DDR for the purposes of the D&E.

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ANNEX D

PROCEDURES FOR MEOSAR D&E READINESS TEST

D.1 Objective and Definitions

This purpose of this test is to establish that the minimum criteria for starting the MEOSAR D&E provided in section 6.1 of this D&E plan are satisfied. As noted in section 6.1, the respective areas of interest reflect the three major components of the Cospas-Sarsat System:

> Space Segment: constellations and numbers of satellites in each that are equipped with MEOSAR repeaters.
>
> Ground Segment: number of MEOLUTs and their respective antennas, associated MCCs, along with the related MEOSAR processing and communication capabilities of all components.
>
> Beacon Segment: number and type of dedicated beacons; operational beacons deployed in a controlled manner, beacon simulators and Cospas-Sarsat reference beacons (i.e., test and orbitography protocols).

The test procedure exercises all three components, collecting data at both MEOLUTs and MCCs, to ensure that all components are functioning as expected. Specifically, beacon simulators need to provide beacon transmissions, satellites need to relay the bursts, MEOLUTs need to receive and process the bursts, and MCCs need to receive process and distribute the resulting alert data.

The philosophy of the readiness test described in this annex is that all basic components of the MEOSAR system are available and can be exercised at the same time. If the readiness test is deemed successful, then all D&E tests could proceed. However, based on unplanned contingencies, it may be possible to perform a subset of the readiness test so that some D&E tests, e.g., channel detection characterisation, may be undertaken before a complete end-to-end readiness test can be completed.

In addition, based on the results of the readiness test, a follow-up test, or tests, may be required. The decision to undertake additional tests and any decision to undertake partial incremental tests will be made by the Cospas-Sarsat Council.

D.2 Methodology and Data Collection

The D&E readiness test will be performed over a [36] hour period. The test will include all MEOSAR satellites, MEOLUTs, and participating MCCs, as well as all beacon simulators that will contribute data to D&E tests.

There are two categories of data collection involved in this test. The first collects burst detection data at MEOLUTs to obtain a basic statistic that demonstrates the availability of the required space segment along with a ground segment that can successfully collect data relayed via these satellites. The second collects MCC messages received at all participating MCCs in order to validate a basic end-to-end alert data transmission capability.

D.2.1 MEOLUT Data Collection

All burst data received by each MEOLUT during the test will be placed in the provided spreadsheet, MEOSAR D&E Report Data D&E Readiness Test.xls (example data listing provided in Figure D.1 below). The intent is of this testing is to demonstrate sufficient visibility between the ground and space segments within a predefined area of interest[21]. As such, even though specific beacons will be simulated for the MCC data collection portion of the test, all burst data should be recorded regardless of the source. MEOLUT networking should not be implemented during this test as the inclusion of additional satellites gained via networking could affect the evaluation of satellite detections at each MEOLUT[22]. The only data collected will be coarse date and time (fractional seconds associated with TOA are not needed) and the satellite ID. Optional fields of Beacon ID, TOA, FOA and CN_0 could be collected as supplemental information but are not needed for the basic analysis.

Date/Time	Satellite	Beacon ID	TOA	FOA	CN0

Figure D.1 - MEOLUT Burst Data

D.2.2 MCC Data Collection

The second goal of this testing is to demonstrate that MEOSAR data moves through the system and arrives at its proper destination. As such there needs to be a least one beacon simulator physically located outside of each MCC service area, yet mutually visible some portion of the day to the associated MEOLUT such that simulated beacons result in messages being sent to the responsible MCC (where the simulator is physically located). Using beacon simulators located in four locations (Toulouse, France; Hawaii, USA; Maryland, USA; and Ottawa, Canada), initial analysis indicates that during the test period roughly 100 or more unique activations should be mutually visible to all participants and hence provide a reasonable basis for a statistical result.

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21 The area of interest could be a rectangle, set of rectangles (or radii), or based on MCC service areas.

22 Separate validation of MEOLUT networking connections and data transfer are encouraged.

All beacon simulators will transmit long format messages using test protocols and with nominal beacon emission power (37 dBm), at frequencies between 406.061 and 406.073 MHz and otherwise nominal beacon characteristics (linear antenna pattern, 50 second repetition period, etc.). All beacon simulators will transmit data throughout the test period, for [600] seconds per beacon Id, with [600] second delays between transmission blocks ([108] unique beacon "activations" for each simulator over the period). The beacon identification code for each beacon activation will be unique. Each simulator will transmit a distinct set of beacon Ids.

MCCs will receive alert data from associated MEOLUTs and foreign MCCs, and process alert data per the DDP procedures provided in Annex E[23]. MCCs will collect and record alert messages for these designated beacon IDs received during the test period from other MCCs in the provided spreadsheet, D&E Readiness Test.xls (example data listing provided in Figure D.2 below). The required data is the sending MCC, the beacon ID and the SIT type; optional fields of message number and the date and time of message reception could be collected as supplemental information but are not needed for the basic analysis.

Sending MCC	Beacon ID	SIT Type	Msg No.	Receive Date/Time

Figure D.2 Messages Received from Other MCCs

D.3 Data Analysis and Results

Each D&E participant will collect data received from its associated MEOLUT(s) and MCC, as described above. Participants will forward this data to [the Secretariat] to collate results and generate a summary report.

All participating MEOLUTs will provide data, but for the purposes of this test the analysis will only pertain to those that receive data on four or more satellite channels. The analysis will provide a statistic for the percentage of one minute slots during the period where the MEOLUT detected beacon data from four independent satellites. Note that the MEOLUT need not detect bursts from any specific beacon ID, nor the same ID from multiple satellites, in order for a given one minute slot to be counted as successful. Figure D.3 shows an example of compiled results for all MEOLUTs, with each participating MEOLUT providing the data for the corresponding row.

23 It is useful for MCCs to have a configuration that allows all beacon IDs using test protocols to be handled as operational data so that messages are generated and sent accordingly, to avoid having to set configuration per beacon Id for up to 432 beacon Ids (108 Ids per simulator * 4 simulators).

MEOLUT	Minutes with Four Sats Det	Total Minutes	% Four Sats Det
Brazil Brasilia	2145	2160	99.3%
Canada Ottawa	2122	2160	98.2%
China Beijing	2134	2160	98.8%
France Toulouse	2088	2160	96.7%
Russia Moscow	2102	2160	97.3%
Turkey Ankara	2111	2160	97.7%
UK Kinloss	2135	2160	98.8%
USA Hawaii	2144	2160	99.3%
USA Maryland	2116	2160	98.0%

Figure D.3 - MEOLUT Four Satellite Reception Statistics

The second key result involves the reception of MCC messages for MEOSAR data associated with the designated set of beacon IDs for the test period. The goal is to use this data to validate that the end-to-end components (beacon, space and ground segments) are all operating as expected. Specifically, the goal is to validate that beacons transmitted, were detected, located and confirmed with location data provided to National MCCs, and that resulting alert data was passed through the Cospas-Sarsat MCC network as required by MEOSAR D&E data distribution procedures.

This measure of "end to end" functionality is accomplished by analysing data received at the destination MCC and transiting nodal MCCs[24], based on the location of the transmitting beacon simulator. Figure D.4 shows an example of compiled results pertaining to the reception of SIT 147 (Position Confirmation) messages at all MCCs, with each receiving MCC providing the data for the corresponding row. A similar data set could be compiled for SIT 145 messages (First Alert) as well if deemed necessary. The columns for predicted message receptions will be populated by simulation, and will need to take into account the available MEOSAR space segment, MEOLUT antennas numbers and positions, beacon simulator positions and the rules for MCC data distribution including the potential for filtering of redundant data at nodal MCCs.

	Maryland: ABCDE1234512345		Hawaii: ABCDE1234512345		Ottawa: ABCDE1234512345		Toulouse: ABCDE1234512345		Totals		Key Result
	Received at USMCC		Received at USMCC		Received at CMCC		Received at FMCC				
From	Received	Predicted	Received	Predicted	Received	Predicted	Received	Predicted	Total Received	Total Predicted	% Success
BRMCC	82	85			78	80	71	76	231	241	95.9%
CMCC	106	107	70	71			86	92	262	270	97.0%
CNMCC			75	78			44	48	119	126	94.4%
FMCC	83	87			85	92			168	179	93.9%
CMC	78	79	25	27	78	87	103	108	284	301	94.4%
TRMCC	55	57			67	67	106	108	228	232	98.3%
UKMCC	91	94			97	98	107	108	295	300	98.3%
USMCC					170	177	82	86	252	263	95.8%

Figure D.4 – SIT 147 Messages Received at Each MCC

24 The nodal MCC for the CNMCC (JAMCC) is not currently expected to participate in the D&E test activities, and it is assumed in this example that the CNMCC distributes alerts to the USMCC, as if it were part of the Western DDR.

D.4 Interpretation of Results

The two key measures of success are:

Measure of Visibility: The percentage for detection throughout the test period where simultaneous data from four satellites at each MEOLUT included in the analysis is [95%] or higher

End to End Functionality: The rate[25] of receipt of Position Confirmation messages by destination MCCs and transiting nodal MCCs is [90%] or higher

As noted above, participants will forward this data to [the Secretariat] to collate results and generate a summary report. This report will be submitted to the Cospas-Sarsat Council, but if the next scheduled Council meeting will occur after the planned start date of the D&E, then the Representatives will decide on the commencement of the D&E by correspondence.

- END OF ANNEX D -

[25] The number of beacon activations reported between MCCs is a function of the time frames over which beacons located in another MCC service area are mutually visible to the associated National MEOLUT. Comparisons between actual data and simulation are subject to differences in the selection of satellites to be tracked throughout the period. In lieu of dictating the tracking schedule at each MEOLUT, some allowance is made for potential discrepancies by a requirement of 90% (instead of 95%).

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ANNEX E

MEOSAR D&E ALERT DATA DISTRIBUTION PROCEDURES AND MESSAGE FORMATS

Note: This Annex is based on documents C/S A.001 (DDP) and C/S A.002 (SID); therefore, section numbers in this Annex are referenced to those documents.

MEOSAR ALERT DATA DISTRIBUTION PROCEDURES (reference C/S A.001)

3. PROCEDURES

3.1 General Procedures for the Distribution of Cospas-Sarsat Alert Data

3.1.1 Introduction

Alert data is the generic term for Cospas-Sarsat alert and position[26] data derived from 406 MHz distress beacon signal processing. Alert data derived from beacon signals may contain beacon position information and other coded information, including the beacon identification.

Beacon signals are relayed via three satellite systems, low earth orbiting (LEO), geostationary earth orbiting (GEO) and medium earth orbiting (MEO). Position data can be derived in three ways:

- by Doppler processing via the tracking of a LEO satellite receiving 406 MHz beacon transmissions,
- by difference of arrival (DOA) processing using time of arrival (TOA) and frequency of arrival (FOA) measurements received from multiple MEO satellites relaying the same beacon transmissions,
- by position data encoded in beacon messages.

MCCs receive alert data from their LUTs or from other MCCs and distribute this alert data to the appropriate RCC or SPOC in their service area, or forward the alert data to another MCC. MCCs should transmit Cospas-Sarsat alert data in accordance with the principles for data distribution listed in section 2.2 of this Cospas-Sarsat Data Distribution Plan (DDP). The corresponding procedures are outlined in Figures 3.1 and 3.2, and in the following sections. These procedures are further detailed at Annex III / B of this DDP.

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[26] *Position is used throughout as the generic term for locations determined by any type of processing, Doppler, DOA or via encoded information in the beacon identification code.*

Alert data received from MEO satellites shall be processed and distributed independently from alert data received from LEO and GEO satellites. Alert data received from a single LEO satellite pass or in a single MCC message shall be processed in TCA or detection time order.

3.1.2 Geographical Sorting of Alert Data

Alert data are distributed according to the geographical sorting of the available position(s). The geographical distribution of alert data is organised as follows:

a) Beacon position is within an MCC's service area:

An MCC that receives alert data for a beacon position in its own service area forwards the alert data to the appropriate SPOC or national RCC, in accordance with the applicable Cospas-Sarsat or national procedures.

b) Beacon position is within another MCC's service area:

An MCC that receives alert data for a beacon position in another MCC's service area forwards the alert data to the appropriate MCC, in accordance with the applicable Cospas-Sarsat procedures as described in the Annexes III / A and III / B to this DDP.

c) Unlocated alerts:

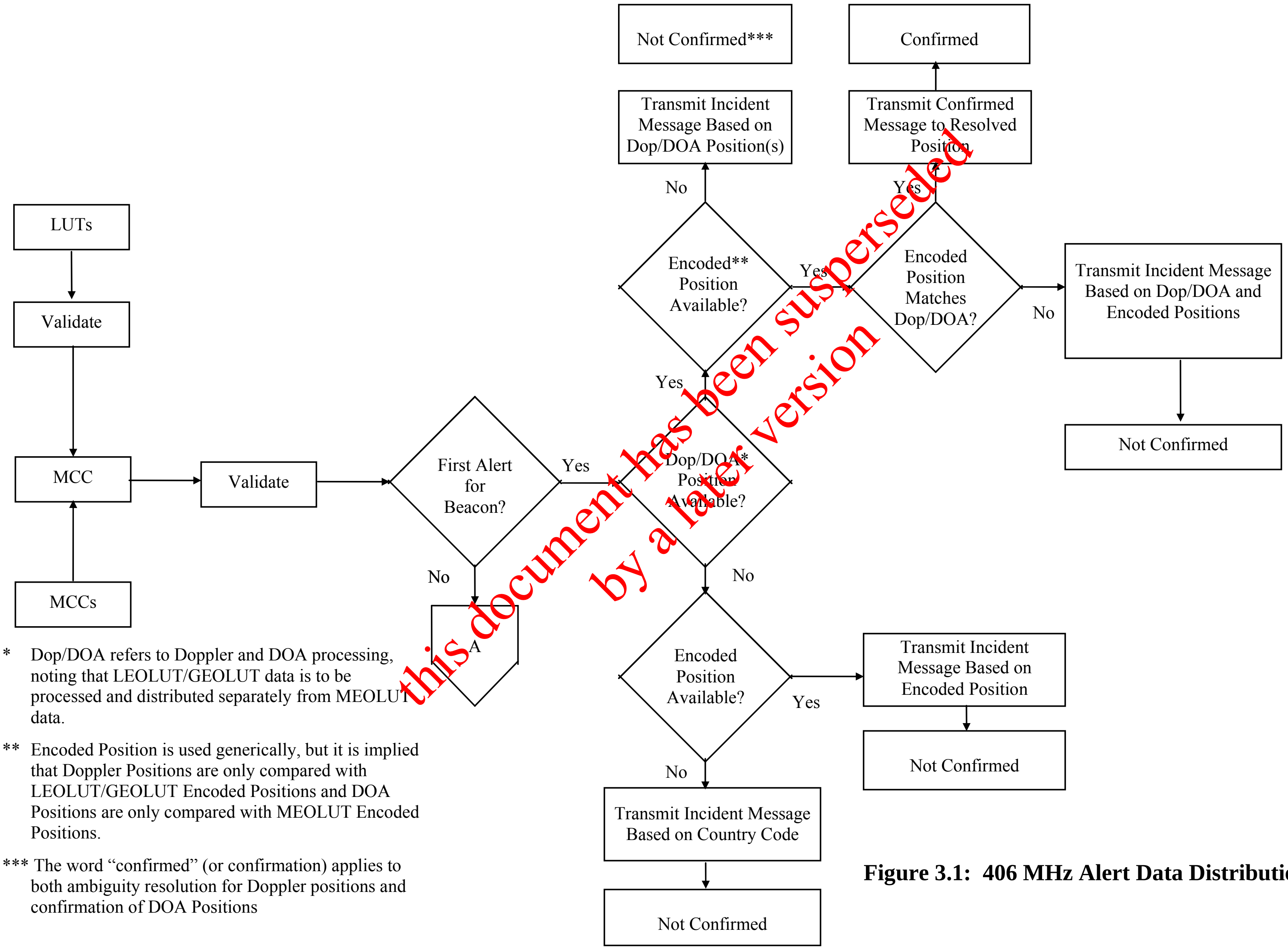
There will be occasions when a LEOLUT or MEOLUT is unable to calculate a position for a beacon or a beacon is detected by a GEOLUT, and the only information available is the beacon message. If this data does not contain an encoded position, the alert is unlocated. In these cases the only information available will be the digital identification contained in the beacon message which includes a country code designating the country of registration of the beacon. MCCs will transmit this information to the country of registration according to the procedure described in section 3.2.8.

3.1.3 Message Formats

Alert messages are exchanged between MCCs using standard formats which permit automatic processing and retransmission of all data. These message formats are referenced in the Cospas-Sarsat Mission Control Centres Standard Interface Description (C/S A.002). A list of message formats that are implemented at each MCC is provided at Annex II / D of this DDP.

3.1.4 Beacon Identification

MCCs when transmitting narrative messages and making reference to beacon identification should take particular care in providing the identification as 15 contiguous hexadecimal characters comprising bits 26 to 85 of the beacon message. If a location protocol beacon is involved, the coarse position fields must be set to the specified default values.



* Dop/DOA refers to Doppler and DOA processing, noting that LEOLUT/GEOLUT data is to be processed and distributed separately from MEOLUT data.

** Encoded Position is used generically, but it is implied that Doppler Positions are only compared with LEOLUT/GEOLUT Encoded Positions and DOA Positions are only compared with MEOLUT Encoded Positions.

*** The word "confirmed" (or confirmation) applies to both ambiguity resolution for Doppler positions and confirmation of DOA Positions

Figure 3.1: 406 MHz Alert Data Distribution Procedures (1/2)

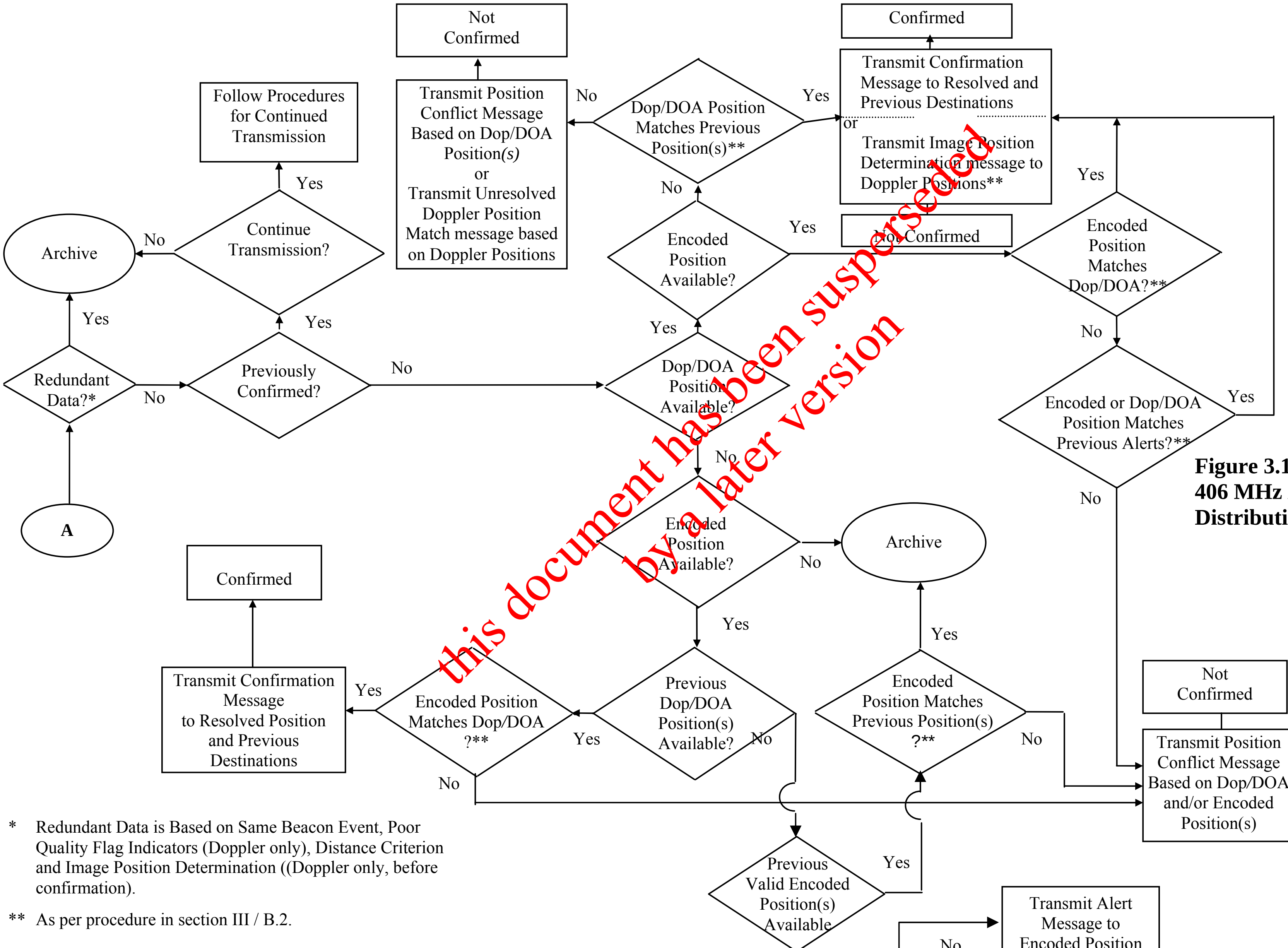


Figure 3.1:
406 MHz Alert Data Distribution Procedures (2/2)

* Redundant Data is Based on Same Beacon Event, Poor Quality Flag Indicators (Doppler only), Distance Criterion and Image Position Determination ((Doppler only, before confirmation).

** As per procedure in section III / B.2.

3.2 406 MHz Alert Data Distribution Procedures

3.2.1 Doppler, DOA, and Encoded Positions

Position data provided by Doppler processing and DOA processing of 406 MHz signals relayed through LEO and MEO Cospas-Sarsat satellites respectively and position data encoded in beacon messages which are relayed through all Cospas-Sarsat satellites, constitute independent sources of beacon position information. All types of position data are used by MCCs in the filtering and geographical sorting process, and distributed with alerts to RCCs and / or SPOCs, in accordance with the procedures described hereunder.

Position data provided by LEOLUT Doppler processing shall not be removed or altered by a distributing MCC, unless the Doppler position fails Doppler footprint validation.

3.2.2 Validation of Beacon Message Data

Under various circumstances such as interference, weak beacon signals or high noise levels, the LUT processing can produce erroneous alert data (i.e. processing anomalies) which may cause false alerts.

The alert data produced by the LUTs must be validated in accordance with the requirements of document C/S T.002. In addition, to avoid propagating invalid alerts through the Cospas-Sarsat Ground Segment, the procedure for validating alert data described at Annex III / B of this DDP should be implemented at the MCC level to satisfy the requirements of document C/S A.005.

3.2.3 Filtering of Redundant Data

After validation, alert data received by an MCC must be compared to previous information concerning the same beacon identification which has already been processed by that MCC.

Alert data produced by LEOLUTs is considered to be the same beacon event when it has the same beacon identification, is received by the same spacecraft and has the same time of closest approach (TCA) ± 20 minutes. LEOLUT/GEOLUT data is deemed to be redundant if, using the distance criterion defined at Annex III / B of this DDP, either:

a) the new alert message does not include Doppler position data and the LEOLUT/GEOLUT encoded position matches LEOLUT/GEOLUT encoded position information received earlier by the MCC; or

b) the new alert message includes Doppler position data, each Doppler position in the new alert matches a Doppler position in an alert received previously for the same beacon event and, either:
   - the new alert message does not include LEOLUT/GEOLUT encoded position data, or
   - the LEOLUT/GEOLUT encoded position data in the new alert message matches LEOLUT/GEOLUT encoded position information received earlier by the MCC; or

c) an alert with the same beacon ID has already been processed for the same beacon event and the new alert message does not include Doppler position data or LEOLUT/GEOLUT encoded position data.

Before ambiguity resolution for Doppler positions, LEOLUT data for the same beacon event should not be considered redundant if it contains information on image position determination not previously received (see document C/S A.002, Appendix B.2 to Annex B).

Alert data produced by MEOLUTs is considered to be the same beacon event when it has the same beacon identification and any portion of the time period associated with the first alert (i.e., the time from the first to last burst) is within +/-[2] seconds of any portion of the time period associated with the second alert. MEOLUT alert data is deemed to be redundant if, using the distance criterion defined at Annex III / B of this DDP, either:

a) the new alert message does not include DOA position data and the MEOLUT encoded position matches MEOLUT encoded position information received earlier by the MCC; or

b) the new alert message includes DOA position data, the DOA position in the new alert matches a DOA position in an alert received previously for the same beacon event and, either:

- the new alert message does not include MEOLUT encoded position data, or
- the encoded position data in the new alert message matches MEOLUT encoded position information received earlier by the MCC; or

c) an alert with the same beacon ID has already been processed for the same beacon event and the new alert message does not include DOA position data or MEOLUT encoded position data.

Alert data produced by GEOLUTs for the same beacon identification is deemed to be redundant if:

a) the new alert message does not include encoded position data; or

b) the encoded position data in the new alert message matches encoded position data received in an earlier message, using the distance matching criterion defined at Annex III / B of this DDP.

To minimise redundant message traffic in the Ground Segment, MCCs must not distribute alert data which have been determined as redundant in accordance with the procedure described at Annex III / B of this DDP.

The matching test for new encoded position data shall be performed with all encoded position data previously received and forwarded (i.e. not deemed redundant) for the same ID, without respect to whether the new position is coarse (i.e. without usable encoded position in the second protected field of the beacon message) or refined (i.e. with usable encoded position in the second protected field of the beacon message). However, the matching test for a coarse encoded position shall also be performed with the position derived from the first protected field of previous non-redundant messages: a coarse encoded position will be deemed redundant if it matches the position encoded in the first protected field of a previous beacon message.

LEOSAR, GEOSAR and MEOSAR data deemed to be redundant shall not be used to determine whether subsequent data is redundant.

3.2.4 Confirmation of 406 MHz Positions

The objective of this process is to confirm the position of a beacon on the basis of independent information.

Doppler data always includes two sets of position data, the 'true' and the 'image' solutions which are symmetrical relative to the trace of the orbit. Each solution is associated with a probability which is generally sufficient to resolve the Doppler ambiguity. However, the actual characteristics of the 406 MHz transmission are not known by the receiving LUT and reliable ambiguity resolution of the Doppler solutions can only be achieved with a set of Doppler positions from two different beacon events, or using an external source of data such as position data encoded in the beacon message. Ambiguity resolution is a specific type of position confirmation; as such, the 'true' position is a type of confirmed position, the 'image' position is a type of incorrect position and an unresolved (Doppler) position is a type of unconfirmed position.

While a DOA position does not have any inherent ambiguity, it is still appropriate to require confirmation of the position as errors may occur. Confirmation of MEOLUT alert data can only be achieved with a set of DOA positions from two different beacon events, or using an external source of data such as position data encoded in the beacon message and received via a MEO satellite.

A beacon message with encoded position data provides a unique position which may be very accurate in most circumstances. However, since the source of that position data is not under the control of Cospas-Sarsat, errors could remain undetected and confirmation of the encoded position via an independent source is also desirable. As several alert messages from the same beacon received through different satellites and/or different LUTs can all originate from the same beacon transmission and, therefore, from the same navigational data, confirmation of encoded position data can only be provided by a Doppler position matching the encoded position from a LEOLUT or GEOLUT or by a DOA position matching the encoded position from a MEOLUT.

Therefore, independent position information will consist of either:

a) Doppler positions obtained from two different beacon events;

b) Doppler position and LEOLUT/GEOLUT encoded position data;

c) DOA positions obtained from two different beacon events; and

d) DOA position and MEOLUT encoded position data.

The beacon position is confirmed only if two independent sets of position data match the distance criterion specified at Annex III / B of this DDP.

Alert data for beacons located outside an MCC's service area will be forwarded until beacon position is confirmed. Once the position is confirmed, an ambiguity resolution message or a position confirmation message shall be transmitted to each MCC and/or SPOC that has the confirmed position or a previous incorrect position in its MCC service area, or its SAR Region(s), respectively.

3.2.5 Continued Transmission after Position Confirmation

If necessary, continued transmission of alert data after position confirmation may be requested by an MCC.

Alert data transmitted after position confirmation should not be geographically sorted according to the received position, but sent to the same MCC, SPOC or RCC which received the alert for the confirmed beacon position or requested the continued transmission.

MCCs shall provide continued transmission of DOA position data every [15] minutes[27], based on the time of the latest beacon transmission included in the associated alert, unless a request is made to discontinue transmission.

3.2.6 Exchange of Ship Security Alerts

Ship security alerts are initiated and transmitted by vessels whose security is threatened and who need to notify a competent authority designated by the flag state. The transmission of ship security alerts is based on the country code contained in the beacon identification, which is then used to route the alert to the appropriate MCC or competent authority.

MCCs will exchange ship security alerts using the formats specified in the document C/S A.002 and according to the ship security alert distribution procedures described in Annex III / B of this DDP.

An MCC will transmit a ship security alert only to the MCC or competent authority associated with the country code. An MCC will not transmit a ship security alert to the RCC or SPOC associated with the position of the alert.

3.2.7 Requesting Transmission of Alerts

MCCs, SPOCs or RCCs may request transmission of alerts by geographical area or 15 hexadecimal beacon identifier.

If the request is by geographical area, then the request should specify the area for which new alerts would be provided, either as a radius in nautical miles around a position or as a rectangle defined by two opposing corner positions.

[27] This interval implies a similar requirement for a minimum interval of updates between the MEOLUT and its associated MCC at the National level. In addition, a maximum timeout is required which ensures that MEOSAR unlocated/encoded position only data, or a DOA position before confirmation, is forwarded to the MCC in a timely manner (e.g., 5 minutes).

The request should indicate the MCCs that would receive alerts for that area in real time from their associated LUTs and take into account that some MCCs may not have associated MEOLUTs. A nodal MCC that receives a request for transmission should forward the request to the appropriate MCCs, to ensure that the requested alerts are sent.

The requesting agency should indicate when transmissions are to be discontinued.

3.2.8 Exchange of Unlocated Alerts

When a LEOLUT or MEOLUT is unable to calculate a position for a beacon, or a beacon message is detected by a GEOLUT, the only information available is the beacon message. If this data does not contain an encoded position, the alert is unlocated. An unlocated alert shall be distributed using the country code in the beacon identification for routing to the appropriate MCC or SPOC. Unlocated alerts shall be validated at LUT and MCC level in accordance with the applicable procedure.

MCCs will exchange unlocated alert messages using the format specified in the document C/S A.002 and according to the alert distribution procedures described in Annex III / A of this DDP.

An MCC will transmit an unlocated alert message only if no position information has been received previously for the same beacon identification. To increase the probability of Image Position Determination (as defined in C/S A.002 Appendix B.2 to Annex B), multiple LEOLUT/GEOLUT unlocated alert messages may be transmitted for a beacon, provided that:

a) only one unlocated alert message is sent per GEO satellite, and

b) only one unlocated alert message is sent per LEO satellite beacon event.

3.2.9 Combined LEO/GEO Processing

For the purposes of alert data distribution procedures, solutions derived from combined LEO/GEO processing shall be treated as LEOSAR alerts.

3.3 Notification of Country of Beacon Registration (NOCR) Service

.../...

3.11 Return Link Service (RLS)

The Return Link Service (RLS) provides notification to a 406 MHz beacon that an alert transmitted by the beacon has been detected by a MEOLUT and distributed via the C/S MCC network to the designated Return Link Service Provider (RLSP). This service is intended to provide information to persons in distress about the disposition of the SAR effort, and is only available for 406 MHz beacons coded to provide a return link.

While variations on the RLS have been envisaged, Cospas-Sarsat participation in the RLS is limited to notification to the RLSP that a RLS capable beacon has been located (per C/S R.012, F.7.6.1, Type 1. Once notified, the RLSP interfaces to the Galileo ground segment for uploading return link messages to Galileo satellites, which, in turn, download return link messages to the transmitting beacon. Further information on the Return Link Service is provided in C/S R.012, sections 7.1 and 7.2.

The detailed procedure for the RLS is described in Annex III / B, section III/B.10.

ANNEX III / A

[…]

III / A.5 INTER-MCC ROUTING OF ALERT DATA

The receiving MCC shall route alert data (other than ship security alerts) to the MCC in which service area the alert is located (i.e., the destination MCC) as described in Figure III / A.8.

Location data provided by LEOLUT Doppler processing shall not be removed or altered by a distributing MCC, unless the Doppler location fails Doppler footprint validation. Location data provided by MEOLUT DOA processing shall not be removed or altered by a distributing MCC.

III / A.6 INTER-MCC ROUTING OF SYSTEM INFORMATION

The routing of System information between MCCs is described in Figure III / A.9 "System Information Distribution". MCCs shall route System information as described in Figure III / A.8.

ANNEX III / B

DETAILED IMPLEMENTATION OF DATA DISTRIBUTION PROCEDURES

The following sections provide detailed implementation information on selected data distribution procedures and requirements. These procedures are agreed by the Joint Committee and apply to all MCCs unless otherwise stated. A reference to the contents of this Annex follows:

III / B.1 ALERT MESSAGE VALIDATION (FILTERING ANOMALOUS DATA)

Alert message validation should be performed at each MCC to prevent incorrect data from being transmitted to other MCCs and eventually to RCCs and SPOCs. The flowchart (Figure III / B.1) is provided to illustrate data validation procedures for ease of comprehension, given the complexity of the validation process. The flowchart is intended to clarify data validation procedures and incorporates all the validation requirements for LEOSAR and GEOSAR of Annex III / B. It is not intended to replace the detailed requirements provided in the remainder of Annex III / B. The associated alert message validation table (Table III / B.1) follows the logic of the flowchart and includes the same decision diamonds.

III / B.1.1 Validation of Alert Message Format and Content

Each MCC should validate all incoming MEOSAR, LEOSAR and GEOSAR beacon alert messages based on the format and content of the SIT message.

III / B.1.1.1 Validation of SIT Message Format

The format of a SIT message should be deemed corrupt if:

- any message field is missing;
- the size of any message field is incorrect;
- a numeric message field contains non-numeric character(s); or
- a space or decimal point is incorrectly placed.

The resultant MCC action is defined by Table III / B.1.

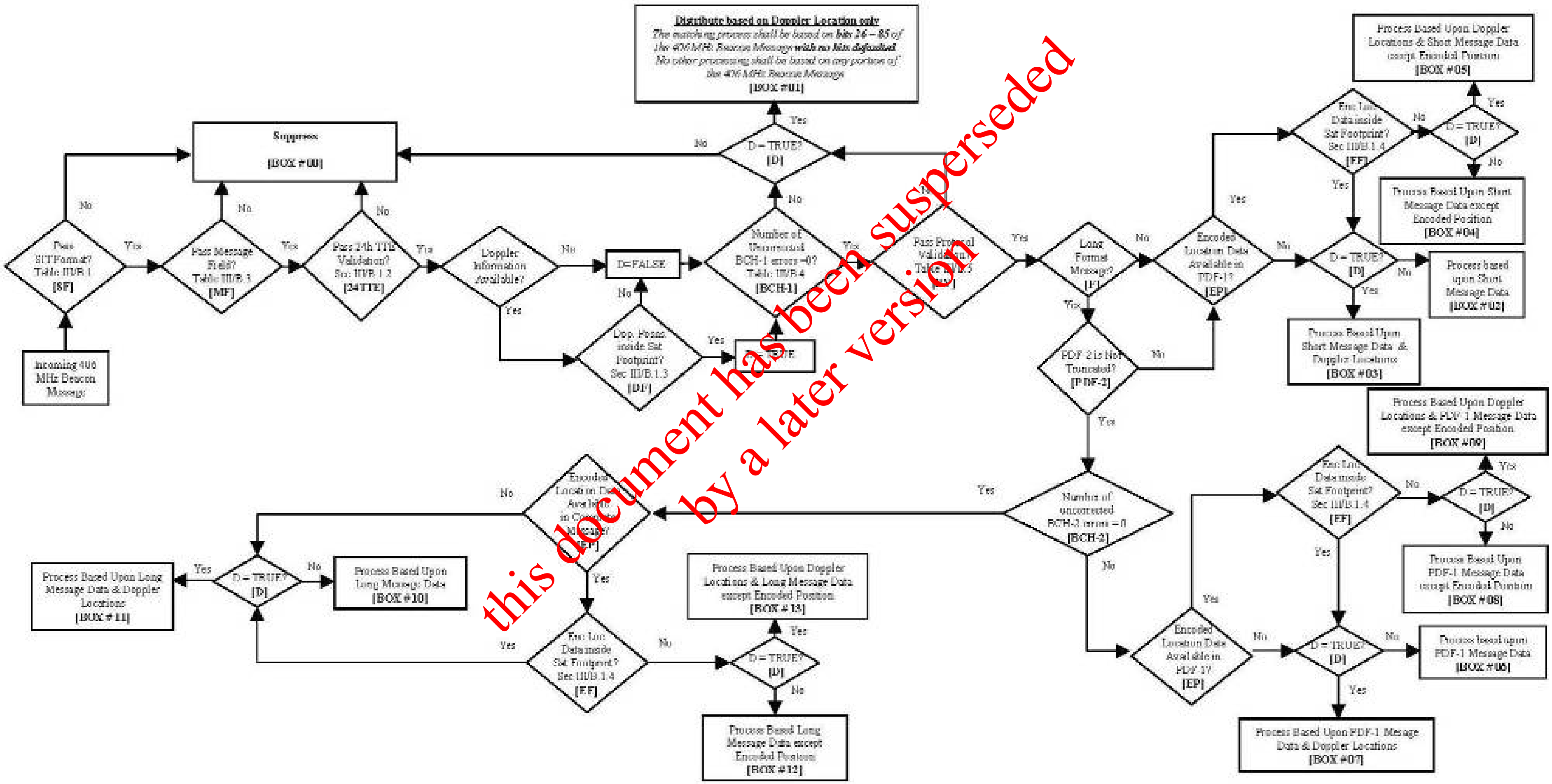


Figure III / B.1 : 406 MHz Alert Message Validation Flowchart

SIT Format	ACTION
Corrupt	Suppress
Not Corrupt	See Table III / B.2

Table III / B.1 : MCC Action Based on SIT Format

	1	2	3	4	5	6	7	8	9	10	11	
	SF	**MF**	**24TTE**	**BCH-1**	**PV**	**F**	**PDF-2**	**BCH-2**	**EP**	**EF**	**D**	**BOX**
1	0											**00**
2	1	0										**00**
3	1	1	0									**00**
4	1	1	1	0							0	**00**
5	1	1	1	0							1	**01**
6	1	1	1	1	0						0	**00**
7	1	1	1	1	0						1	**01**
8	1	1	1	1	1	0			0		0	**02**
9	1	1	1	1	1	0			0		1	**03**
10	1	1	1	1	1	0			1	0	0	**04**
11	1	1	1	1	1	0			1	0	1	**05**
12	1	1	1	1	1	0			1	1	0	**02**
13	1	1	1	1	1	0			1	1	1	**03**
14	1	1	1	1	1	1	0		0		0	**02**
15	1	1	1	1	1	1	0		0		1	**03**
16	1	1	1	1	1	1	0		1	0	0	**04**
17	1	1	1	1	1	1	0		1	0	1	**05**
18	1	1	1	1	1	1	0		1	1	0	**02**
19	1	1	1	1	1	1	0		1	1	1	**03**
20	1	1	1	1	1	1	1	0	0		0	**06**
21	1	1	1	1	1	1	1	0	0		1	**07**
22	1	1	1	1	1	1	1	0	1	0	0	**08**
23	1	1	1	1	1	1	1	0	1	0	1	**09**
24	1	1	1	1	1	1	1	0	1	1	0	**06**
25	1	1	1	1	1	1	1	0	1	1	1	**07**
26	1	1	1	1	1	1	1	1	0		0	**10**
27	1	1	1	1	1	1	1	1	0		1	**11**
28	1	1	1	1	1	1	1	1	1	0	0	**12**
29	1	1	1	1	1	1	1	1	1	0	1	**13**
30	1	1	1	1	1	1	1	1	1	1	0	**10**
31	1	1	1	1	1	1	1	1	1	1	1	**11**

Table III / B.2 : 406 MHz Alert Message Validation

Legend – Flowchart abbreviation equivalence

SF: Equivalent to diamond: <"Pass SIT Format? Table III/B.1">: (0= No / 1=Yes)
MF: Equivalent to diamond: <"Pass Message Field? Table III/B.2">: (0=No / 1=Yes)
24TTE: Equivalent to diamond: <"Pass 24h TTE Validation? Sec III/B.1.2">: (0=No / 1=Yes)
BCH-1: Equivalent to diamond <"Number of Uncorrected BCH-1 errors=0? Table III/B.3">: (0=No /1=Yes)
PV: Protocol Validation (0=Fail / 1=Pass)
F: Format (0=Short / 1=Long)
PDF-2: Equivalent to diamond <PDF-2 is Not Truncated?>: (0=No / 1=Yes)
BCH-2: Equivalent to diamond <Number of uncorrected BCH-2 errors=0?>: (0=No / 1=Yes)

EP: Encoded Position (0=No / 1=Yes)
EF: LEOSAR/GEOSAR Encoded Location in Footprint (0=No / 1=Yes)
D: Valid Doppler Locations. Equivalent to Diamond <D=TRUE? >:
(0 =No / 1=Yes). If YES, the flag means that there are Doppler locations available, and both Doppler locations are inside satellite footprint, if NO, it is otherwise.

Note**:** If a test is irrelevant in a particular context (e.g. the BCH-2 test for Short Format Messages [F=0]) then the cell in the table is shaded.

III / B.1.1.2 Validation of SIT Message Field Content

Some message fields are essential to MCC alert processing. Each MCC should validate the contents of these fields. The contents of the message fields can be validated against allowable values defined in documents C/S A.002 or C/S T.001. Message Fields 2, 4, 6, 8, 10, 12, 13, 14, 20, 21, 25, 26, 27 and 31 should be checked against the range of values contained in Table B.1 of C/S A.002. Table III / B.3 defines the resultant action of the validation process.

Message Field	**Data Contents (According to C/S A.002, Table B.1)**	
	In Range	Out of Range
2, 4, 6, 8, 10, 12, 13, 14, 20, 21, 25, 26, 27 and 31	Process	Suppress
Other SIT Fields	Process	Process

Table III / B.3: MCC Action Based on Message Field Content

Alert messages shall not be suppressed based on out-of-range values unless the message field is contained in the above list.

III / B.1.1.3 406 MHz Beacon Message Validation

In addition to the above validation, each MCC should perform a BCH check of all incoming 406 MHz alert messages from MCCs and LUTs to ensure that the 406 MHz beacon message (message field 23) is valid. If the first protected field (bits 25 - 106) contains any uncorrected BCH errors, then the MCC shall:

a) match for the "same beacon Id" based on bits 26 – 85 of the 406 MHz Beacon Message with no bits defaulted;

b) perform no other processing based on any portion of the 406 MHz Beacon Message;

c) distribute the alert based on Doppler/DOA position only; and

d) not distribute the data if there is no Doppler/DOA position.

In addition, when the first protected field has no BCH errors, each MCC should compare the beacon message contents against a known protocol specification. Specifically, the following items in the protected field(s) should be validated against C/S T.001:

- country code,
- user protocol,
- Baudot characters,
- supplementary data field,
- binary coded decimal fields, and
- encoded latitude and longitude.

A 406 MHz beacon alert message fails when one or more of the conditions in Table III / B.4 below are met.

Item to Check	Bits	Fail if:
Country Code Not Allocated	27 - 36	Decimal Value < 200 or > 780 or not allocated between 200 and 780
User Protocol	37 - 39	Bit 26 = 1 and Bits 37 - 39 = 101
Serial User Protocol	40 - 42	Bit 26 = 1 and Bits 40 - 42 = 101 or 111
Standard Location Ship Security Protocol	25 - 26	Bit 25 = 0 and Bit 26=0 and Bits 37 – 40 = 1100
Standard Location Ship Security Protocol	61 – 64	Bit 25 = 1 and Bit 26 = 0 and Bits 37 - 40 = 1100 and Bits 61 - 64 ≠ 0000
RLS Location Protocol	41-42	Bit 25 = 1 and Bit 26 = 0 and Bits 41-42 = 11
Maritime User or Radio Call Sign	82 - 83	Bit 26 = 1 and Bits 37 - 39 = 010 or 110 and Bits 82 - 83 are non-zero
Unallocated Location Protocols	37 - 40	Bit 26 = 0 and Bits 37 - 40 = 0000, 0001, or 1001
Modified Baudot Code	Varies	Unassigned Baudot Character
Binary Coded Decimal	Varies	Decimal Value for Four Bit Group > 10
Encoded Latitude and Longitude	Varies	Encoded Latitude > 90 or Encoded Longitude > 180
Supplementary Data (Standard Location Protocols)	107 - 110	Bit 26 = 0 and Bits 37 - 40 = 0010, 0011, 0100, 0101, 0110, 0111 1110, and Bits 107 - 110 ≠ 1101
Supplementary Data (Standard Location Ship Security Protocol)	107 - 110	Bit 25 = 1 and Bit 26 = 0 and Bits 37 - 40 = 1100, and Bits 107 - 110 ≠ 1101
Supplementary Data (National Location Protocol, Short)	107 - 110	Bit 25=0 and Bit 26 = 0, and Bits 37 - 40 = 1000, 1010, 1011 or 1111, and Bits 107 - 110 ≠ 1101
Supplementary Data (National Location Protocol, Long)	107 - 109	Bit 25=1 and Bit 26 = 0, and Bits 37 - 40 = 1000, 1010, 1011, 1101 or 1111, and Bits 107 - 109 ≠ 110

Table III / B.4: Protocol Validation for 406 MHz Alert Messages

If the 406 MHz beacon fails any condition in Table III / B.4, then the MCC shall:

a) match for the "same beacon Id" based on bits 26 – 85 of the 406 MHz Beacon Message with no bits defaulted;

b) perform no other processing based on any portion of the 406 MHz Beacon Message;

c) distribute the alert based on Doppler/DOA position only; and

d) not distribute the data if there is no Doppler/DOA position.

If the second protected field (bits 107 - 144) has uncorrected BCH errors, then no processing shall be based on any portion of this field, except for the Supplementary Data Bits as defined in Table III / B.4.

III / B.1.4 Encoded Position Footprint Validation

Each MCC shall implement the algorithm for determining if the encoded position is inside the LEOSAR or GEOSAR satellite footprint at the time of detection (MF#14 per C/S A.002) as per Figure B.2 of the Cospas-Sarsat MCC Standard Interface Description, C/S A.002 document. If the encoded position is conclusively outside the footprint then no processing shall be based on the encoded position.

MCCs are not required to validate encoded position from MEOSAR satellites, as MEOSAR alerts typically contain data from multiple MEOSAR satellites and MEOSAR alerts received by the MCC may not identify the MEOSAR satellites. (Per C/S A.002, MEOSAR alerts exchanged by MCCs do not identify the MEOSAR satellites.)

III / B.2 POSITION MATCHING

Position matching is the comparison of the computed distance between two beacon positions and a set distance criterion. It is used to decide if two positions should be considered operationally as a unique beacon position or as separate beacon positions. The matching process can include other technical parameters.

Matching criteria are necessary to determine if two sets of independent position data should be regarded as corresponding to the same beacon position. Such matching criteria are used, for example, in the ambiguity resolution process to determine whether two Doppler positions from two independent beacon events, or an encoded position and a Doppler position, are sufficiently close to determine which Doppler position is the "true" position and which is the image or incorrect position(s). Matching criteria are also used, before position confirmation, to decide if a separate alert message should be transmitted for a beacon when a new position is at a distance from any previously received position greater than the distance separation defined by the matching criteria.

The points listed below concerning the matching of positions apply to the matching criteria distance to be used by MCCs:

a) for Doppler to Doppler matches and Doppler to encoded matches, the distance match criterion to be used for position confirmation and for position conflict determination shall be the same;
b) the Doppler to Doppler distance match criterion shall be 50 kilometres;
c) the Doppler to encoded distance match criterion shall be 50 kilometres;
d) the encoded to encoded distance match criterion shall be 3 kilometres;
e) the DOA to DOA distance match criterion shall be [10] kilometres;
f) the DOA to encoded distance match criterion shall be [10] kilometres;
g) each of the above distance match criterion shall be configurable;
h) in the match process, the "best" match shall be used to confirm position when multiple candidate positions meet the match criterion; however
i) if both pairs of Doppler positions meet the match criterion prior to position confirmation for different satellite passes, this is deemed an Unresolved Doppler Position Match, and:
   (i) position shall not be confirmed from either pair of Doppler positions,
   (ii) other pairs of positions shall remain eligible to confirm position, even if the "best" distance match was between ineligible Doppler positions;
j) the distance between positions shall be computed independent of altitude (which may be provided for DOA positions).

III / B.3 POSITION CONFIRMATION

Position confirmation is the process by which the beacon position is confirmed by data from an independent source. This is achieved by the matching of Doppler position data from two unique LEO satellite passes (beacon events), the matching of encoded position data with Doppler position data from a LEO satellite pass, the matching of DOA position data from two different MEOSAR beacon events, the matching of encoded position data with DOA position data or by using operational criteria. Details on position matching are provided in Annex III / B.2.

Position confirmation is necessary because some uncertainty exists in the determination of a unique beacon position when position information is available from only one data source - either an encoded position, a DOA position from a single MEOSAR beacon event or Doppler positions from a single LEO satellite pass. This uncertainty can be resolved by successfully matching position data from at least two independent beacon events.

Two separate inputs with encoded position only **cannot** be considered as independent beacon events. However, position confirmation can be achieved with Doppler position and encoded position from a single LEO satellite pass or DOA position and encoded position in a single MEOSAR beacon event.

Based on the principles above, the following rules concerning position confirmation notifications apply between MCCs:

a) alert data shall be transmitted between MCCs until position is confirmed;

b) all MCCs shall provide position confirmation notification;

c) MCCs shall send a position confirmation notification to each MCC that has the resolved position or a previous incorrect position in its service area;

d) LEOSAR and GEOSAR alert data will not be transmitted between MCCs after position is confirmed unless an MCC requests continued transmission;

e) MEOSAR alert data will be transmitted between MCCs after position is confirmed unless the destination MCC (i.e., the MCC with the confirmed position in its service area) requests that transmission be discontinued; and

f) an MCC requesting continued transmission after position confirmation should co-ordinate its request with the appropriate MCC(s).

III / B.4 PROCEDURES TO DETERMINE BETTER QUALITY ALERT DATA FOR SAME BEACON EVENT POSITION CONFLICTS

III / B.4.1 Introduction

A position conflict exists when an alert is received at an MCC and the position data fails to match (see section III / B.2 above) any previously received position data for the same beacon. The filtering procedure detailed below should be used by MCCs for filtering **Doppler** position conflict alerts for the same beacon event when position confirmation has not been achieved, or continued transmission has been requested.

The purpose of the filtering procedure is to minimise the distribution of alert messages containing “poor” quality Doppler position data. If a new alert with Doppler position conflict is for the same beacon event as previously received data, additional checks can be performed to determine if the new Doppler position data is of better quality than previously received Doppler position data and should be transmitted, or is of poorer quality and can be deemed redundant. If the relative quality of the Doppler positions cannot be determined, then the new data should be transmitted. The procedure below ensures that “good” data will not be suppressed while limiting the amount of erroneous data distributed to RCCs and SPOCs.

III / B.4.2 Position Conflict Procedure

[...]

III / B.5 DETAILED PROCEDURES FOR ALERT DATA DISTRIBUTION

III / B.5.1 Analysis and General Representation of Alert Data Processing

Alert data received by a Cospas-Sarsat MCC, either from its associated LUTs or from another MCC, must be forwarded to a MCC, a SPOC or a RCC if it contains 'new' information useful to SAR services. The alert data distribution process consists of a set of rules commonly used by Cospas-Sarsat MCCs for deciding whether new input data concerning a particular 406 MHz beacon ID contains 'new' information. It is based on a number of parameters (defined in the document C/S G.004 'Cospas-Sarsat Glossary') and matching rules (defined in this document), which include:

- the definitions of 'beacon events', 'position confirmation' and 'position conflict'; and
- the definition of distance criteria for matching Doppler, DOA and encoded position data.

However, these basic rules and the variety of position data available in 406 MHz alert messages create a large number of possible combinations which need to be thoroughly analysed to ensure the consistency of the alert data distribution process throughout the Cospas-Sarsat MCC network.

In order to implement this data distribution process, the 'position information content' of each valid incoming alert message (referred to as 'Input' or 'I' in this Annex) must be compared with the information already transmitted concerning the same beacon ID. Therefore, the history of all data already transmitted must be preserved. For each beacon ID, that history can be summarised in a 'Status word' (Sw). Input and Status words are both characterised by the type of position information (received in the input or transmitted in previous messages). Similarly, the 'action(s)' resulting from the process (i.e. the message to be transmitted, its format and recipients) can be summarised in an 'Action word' (Aw) and characterised by the type of position information to be forwarded, taking also into account position data already distributed. The functional relations between 'Input', 'Status word' and 'Action word' in the process are summarised in Figure III / B.2.

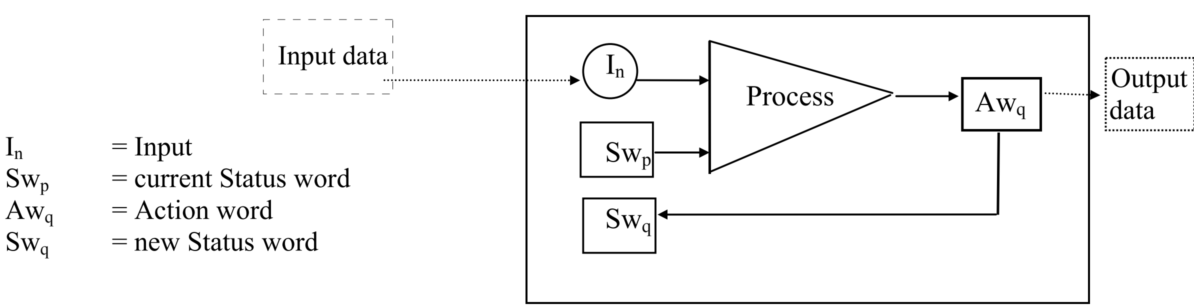


Figure III / B.2 : Alert Data Processing Concept

III / B.5.2 Definition of Input, Status and Action Words

The possible combinations of position data which characterise an input (I), the current status (Sw) or the resulting action (Aw) of the process concerning a given beacon ID, are described in Figure III / B.3. No other combinations of the type of position data are allowed and the possible position information contents of I, Sw and Aw are summarised in the last column.

Figure III / B.3 : Definition of the Input, Status and Action Words for 406 MHz Alerts

Input	Type of position data					Status word	Action word	Comments
	No Position Data	DOA Doppler Positions	Encoded Position Data	DOA Doppler Pos.	Dop./DOA A & E Positions Matched			Position Information Content
-	0	0	0	0	0	Sw_0	Aw_0	No message received or sent
I_1	1	0	0	0	0	Sw_1	Aw_1	Unlocated alert
I_2	0	1	0	0	0	Sw_2	Aw_2	Doppler/DOA positions only
I_3	0	0	1	0	0	Sw_3	Aw_3	Encoded position only
I_4	0	1	1	0	0	Sw_4	Aw_4	Doppler/DOA & E positions all Unmatched
I_5	0	1	0	1	0	Sw_5	Aw_5	Doppler/DOA only Position confirmed.
I_6	0	1	1	1	0	Sw_6	Aw_6	Doppler/DOA pos. (position confirmed) + E pos. unmatched
I_7	0	1	1	1	1	Sw_7	Aw_7	Resolved positions (Doppler/DOA & E matched)

Notes:
- The Input word (I) is specific to each individual input and independent of the origin of the data (e.g. another MCC or the LUTs associated with the receiving MCC).
- The Status word (Sw) summarises all previous inputs and actions in respect of a particular beacon ID. Sw_5, Sw_6 and Sw_7 are functionally equivalent in the process since no further transmissions are required after position confirmation. However, the distinction between the various position information contents after position confirmation is relevant for the Input and Action words.
- The Actions to be carried out as a result of the process depend on the Input / Status combination, but also on the results of comparisons (matching tests) between 'old' and 'new' position data received by the MCC, as shown in the matrix (Figure III / B.3). The selected Action word is also used to define the message format to be sent and, before position confirmation, characterises the new status associated with that beacon ID after completion of the selected Action (i.e.: $Aw_i \longrightarrow Sw_i$).

III / B.5.3 Process Matrix for Alerts

The process is summarised in Figures III / B.4.1 and III/ B.4.2 which define, for each Input / Status combination, the possible output (Action words), the corresponding SIT message numbers (to be used if the new data in the Input has to be forwarded to another MCC, outside the processing MCC service area) and the appropriate recipient(s) of this information, as determined by the geographic sorting of position data. These figures do not describe the distribution of NOCR messages and RLS messages.

III / B.5.3.1 Processing Before Position Confirmation (Sw_0, Sw_1 , Sw_2 , Sw_3 , Sw_4 Status)

The process is quite simple when no data was previously received for the beacon ID in a new Input (Status Sw_0), or when the previously received alert(s) for that ID did not include any position information (Status Sw_1).

However, as shown in Figures III / B.4.1 and III / B.4.2, a number of Input / Status combinations may result in several possible Actions. This occurs when a number of alert messages have been received prior to the new input but the available position data did not satisfy the matching criteria for ambiguity resolution. The new position data in the input message must then be compared with all positions previously received for the same beacon ID, and these matching tests can lead to different Actions. The position information content of each possible Action is used to select the appropriate Action word as illustrated in the special algorithm described in section B.5.4 (Figures III / B.5, III / B.6, III / B.7 and III / B.8).

Figure III / B.4.1: Processing Matrix, Message Formats and Distribution of 406 MHz LEOSAR/GEOSAR Alerts

	I_1 (no position data)			I_2 (A / B Doppler positions)			I_3 (Encoded only)			I_4 (A / B / E unmatched)			I_5 (Confirmed Doppler)			I_6 (Conf. D + E unmatched)			I_7 (Confirmed D and E)		
	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest
Sw_0	Aw_1	122	C	Aw_2	125	AB	Aw_3	122	E	Aw_4	126	ABE	Aw_5	127	R	Aw_6	127	R	Aw_7	127	R
Sw_1	Aw_0 Aw_1	- 122	- C	Aw_2	125	AB	Aw_3	122	E	Aw_4	126	ABE	Aw_5	127	R	Aw_6	127	R	Aw_7	127	R
Sw_2	Aw_0	-	-	Aw_5 Aw_0 Aw_2 Aw_2	127 - 126 125	RI - AB AB	Aw_7 Aw_4	124 123	RI E	Aw_7 Aw_6 Aw_4	127 127 126	RI RI ABE	Aw_5	127	RI	Aw_6	127	RI	Aw_7	127	RI
Sw_3	Aw_0	-	-	Aw_7 Aw_4	127 126	RI AB	Aw_0 Aw_3	- 123	- E	Aw_7 Aw_4	127 126	RI ABE	Aw_7 Aw_6	127 127	RI RI	Aw_7 Aw_6	127 127	RI RI	Aw_7	127	RI
Sw_4	Aw_0	-	-	Aw_7 Aw_6 Aw_0 Aw_4	127 127 - 126	RI RI - AB	Aw_7 Aw_0 Aw_4	124 - 123	RI - E	Aw_7 Aw_6 Aw_0 Aw_4	127 127 - 126	RI RI - ABE	Aw_7 Aw_6	127 127	RI RI	Aw_7 Aw_6	127 127	RI RI	Aw_7	127	RI
Sw_5 Sw_6 Sw_7	Ct_0	-	-	Ct_0 Ct_2 Ct_5	- 126 127	- RD RD	Ct_0 Ct_3 Ct_7	- 123 124	- RD RD	Ct_0 Ct_4 Ct_7	- 126 127	- RD RD	Ct_0 Ct_5	- 127	- RD	Ct_0 Ct_6	- 127	- RD	Ct_0 Ct_7	- 127	- RD

Notes:.JC-23/Annex 4.

I_i = Input
A = A Doppler position
R = Confirmed position
Dest = Destination of SIT message
Sw_i = Status word

B = B Doppler position
I = Incorrect previous position(s)
SIT = Subject Indicator Type / (standard message format)
Aw_i = Action word

E = Encoded position
C = Country code destination
Ct_i = Continue transmission
RD = Requesting destination

Figure III / B.4.2: Processing Matrix, Message Formats and Distribution of 406 MHz MEOSAR Alerts

	I_1 (no position data)			I_2 (DOA position)			I_3 (Encoded only)			I_4 (O / E unmatched)			I_5 (Confirmed DOA)			I_6 (Conf. D + E unmatched)			I_7 (Confirmed D and E)		
	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest	Aw	SIT	Dest
Sw_0	Aw_1	142	C	Aw_2	145	O	Aw_3	142	E	Aw_4	146	OE	Aw_5	147	R	Aw_6	147	R	Aw_7	147	R
Sw_1	Aw_0 Aw_1	- 142	- C	Aw_2	145	O	Aw_3	142	E	Aw_4	146	OE	Aw_5	147	R	Aw_6	147	R	Aw_7	147	R
Sw_2	Aw_0	-	-	Aw_5 Aw_0 Aw_2 Aw_2	147 - 146 145	RI - O O	Aw_7 Aw_4	144 143	RI E	Aw_7 Aw_6 Aw_4	147 147 146	RI RI OE	Aw_5	147	RI	Aw_6	147	RI	Aw_7	147	RI
Sw_3	Aw_0	-	-	Aw_7 Aw_4	147 146	RI O	Aw_0 Aw_3	- 143	- E	Aw_7 Aw_4	147 146	RI OE	Aw_7 Aw_6	147 147	RI RI	Aw_7 Aw_6	147 147	RI RI	Aw_7	147	RI
Sw_4	Aw_0	-	-	Aw_7 Aw_6 Aw_0 Aw_4	147 147 - 146	RI RI - O	Aw_7 Aw_0 Aw_4	144 - 143	RI - E	Aw_7 Aw_6 Aw_0 Aw_4	147 147 - 146	RI RI - OE	Aw_7 Aw_6	147 147	RI RI	Aw_7 Aw_6	147 147	RI RI	Aw_7	147	RI
Sw_5 Sw_6 Sw_7	Ct_0	-	-	Ct_0 Ct_2 Ct_5	- 146 147	- RD RD	Ct_0 Ct_3 Ct_7	- 143 144	- RD RD	Ct_0 Ct_4 Ct_7	- 146 147	- RD RD	Ct_0 Ct_5	- 147	- RD	Ct_0 Ct_6	- 147	- RD	Ct_0 Ct_7	- 147	- RD

Notes:

I_i = Input
O = DOA position
R = Confirmed position
Dest = Destination of SIT message

Sw_i = Status word
E = Encoded position
I = Incorrect previous position(s)
SIT = Subject Indicator Type/(standard message format)

Aw_i = Action word
C = Country code destination
Ct_i = Continue transmission
RD= Requesting destination

III / B.5.3.2 Processing After Position Confirmation (Sw_5 , Sw_6 , Sw_7 Status)

After position confirmation, the distribution of input MEOSAR alert data is normally continued, and the distribution of input LEOSAR and GEOSAR alert data is normally discontinued unless continued transmission is specifically requested by a SPOC or an MCC. If continued transmission is enabled, a different processing logic must be implemented since the initial objective of increasing the position information content to obtain a confirmed position has already been achieved. To reflect this different approach, the new 'Actions' are identified in the matrices as Ct_i (see Figures III / B.4.1, III / B.4.2, and III / B.8).

All input position data is compared to the last confirmed position processed by the MCC, in accordance with the usual processing criteria. The confirmed position may be formed from a merge of matching positions, which may be based on a weighting factor assigned to each matching position. If the process results in an Action different from Ct_0 (redundant data not to be distributed), the input position data is sent to the destination(s) which requested the continued transmission (for the LEOSAR/GEOSAR and MEOSAR systems) or the destination in whose service area the position is confirmed (for the MEOSAR system).

Notes:
The suffix of Inputs (I words), Actions (Ct) and Status (Sw) remain consistent with the definitions of Figure III / B.3, although there is no practical differences between the three Status words (Sw_5, Sw_6, and Sw_7) in terms of processing after position confirmation in the specified procedure.

Although Figures III / B.4.1 and III / B.4.2 indicates several possible outcome for all Inputs but one after position confirmation, only one comparison is performed between the new position data in the Input and the known confirmed position. Therefore, the outcome is always unambiguous and no 'priority rule' is required.

III / B.5.4 Special Processing Procedures

III / B.5.4.1 Tests and Flag Setting for Special Processing Procedures

a) Before position confirmation, five flags may be positioned to determine the output of an In / Swp combination which requires special procedures:

DEM = Doppler / DOA to Encoded positions Matching flag : set to "1" if a Doppler or DOA position and an Encoded position match the distance separation criterion (and other criteria as may be required) and set to "0" otherwise. However, in some Input / Status combinations this flag has no relevance, for example, if the Input is the I_2 type, containing only Doppler or DOA position data. In such cases the DEM flag is assumed to be set to default value "0".

In the DEM test, the E position is compared to all previously received Doppler/DOA positions or the confirmed D (Doppler/DOA) position. Alternatively, the A / B Doppler positions or DOA position of the Input are compared with any E position previously received at the MCC. A correct match with one solution of a Doppler location or the DOA position is sufficient to achieve position confirmation. It also provides very reliable information since the D and E data are totally independent.

SBE = the 'Same Beacon Event' flag is to be set for each matching test as follows:

SBE set to "1" if, for the same Beacon ID:

a) previous A / B Doppler positions to be compared with Input are from same satellite and same TCA $\pm$ 20 minutes; or

b) any portion of the time period associated with any previous non-redundant DOA position (i.e., the time from the first to last burst) is within +/-[2] seconds of any portion of the time period associated with the new DOA position; or

c) the time of the latest beacon burst used to compute the new DOA position is within 15 minutes of the latest beacon burst used to compute a previously sent DOA position.

Otherwise, SBE set to "0".

The SBE flag is used only in relation with the Doppler to Doppler and DOA to DOA position matching tests. It has no relevance for DEM or EEM tests and is assumed to be set to the default value "0" in such cases.

DDM = Doppler to Doppler and DOA to DOA positions Matching flag: set to "1" if two Doppler positions or two DOA positions match the distance separation criterion (and other criteria as may be required) and set to "0" otherwise. For an Unresolved Doppler Position Match (as specified in Annex III / B.2) set to "0". However, in some Input / Status combinations this flag has no relevance, for example, if the current status is Sw_3 (previous alert data received at the MCC contain only encoded position data). In such cases the DDM flag is assumed to be set to default value "0".

EEM = Encoded position / Encoded position Matching flag : set to "1" if two encoded positions match the distance separation criterion (and other criteria as may be required) and set to "0" otherwise. However, the EEM test is relevant only in a limited number of cases (e.g. for the processing of I_3 type Inputs (E position only) in a Sw_3 context (only E positions were previously received)). In all other situations the EEM flag should be set to its default value "0".

PQF = Poor Quality Flag : The Poor Quality Flag is used in conjunction with the DDM test only, when a position conflict exists between Doppler positions for the same beacon event (SBE = 1 and DDM = 0). In such cases, parameters characterising the quality of the position data are tested to determine whether the new data provide a better quality position.

PQF is set to "1" if the new position data is of inferior quality than the data previously processed by the MCC for the same beacon event. The new data should then be considered as redundant.

PQF is set to "0" if the new position data is of better quality than the data previously processed for the same beacon event, or if the relative quality of the new versus the old position data cannot be determined. PQF is set to "0" for DOA to DOA position matches. If PQF is set to “0”, the new data should then be forwarded as a position conflict alert.

b) After position confirmation, if continued transmission of alerts for a particular beacon ID is enabled, the same principles apply, but input Doppler or DOA position is compared for redundancy test only with the confirmed (R) position previously processed by the MCC, and all additional information is forwarded to the recipient of the confirmed position data (no additional geographic sorting is performed using the new position data) or to the requesting MCC/SPOC.

In this context, the DDM test is reinterpreted as a DRM test (Doppler or DOA to Confirmed position Matching). Input encoded position is compared for redundancy test with the confirmed (R) position previously distributed by the MCC only if there is no previous encoded position. The SBE and PQF tests are unchanged in their definition. The DEM test is not applicable after position confirmation.

III / B.5.4.2 Selection of the Relevant Action in Input / Status Combinations with Multiple Outputs

When the I / Sw combination leads to several possible actions, it is essential to clarify which Action in the sequence supersedes others and should be completed. The logic to be followed in this selection is always that:

Actions enhancing the ‘position information content’ of the alert to be forwarded by the MCC should have overall precedence ($Aw_7 > Aw_6 > Aw_5 >$ etc.) provided the ‘position information content’ (or suffix) of the Action word is superior to the suffix of the current Status word; and

Action Aw_0 (which means that the same data as in the Input has already been processed) has precedence over an Action which has same ‘position information content’ as the current Status (in Sw_4 status, $Aw_0 > Aw_4$). This rule reflects the fact that the Input is redundant, i.e. the Input matches all the characteristics of at least one set of data previously received, and all other matching tests have failed to enhance the ‘position information content’ of the possible output.

III / B.5.4.3 Definition of Special Processing Matrices

Special processing matrices are defined for each Status of the process to clarify the implementation of the test sequence to be performed for each possible input data. The Input / Status combinations which have a unique output Action (see Figures III / B.4.1 and III / B.4.2) are not repeated in the special processing matrices shown in the following sections.

Notes:
Shaded cells in the ‘Input’ columns correspond to flag combinations which are not applicable for the particular Input / Status combination.

The default value for all flags is “0”. If a test is irrelevant in a particular context (e.g. in the Sw_2 status, DEM = 1 and DDM = 1 means the PQF test is irrelevant) then the corresponding flag is set to “0” and the cell in the matrix is shaded. The flag column is entirely shaded if the corresponding test is inapplicable for all inputs in the Sw context (e.g. the EEM column in the Sw_2 status).

An "X" indicated in the flag column means that both flag values are possible, but the actual flag value does not affect the output Action (therefore the test can be ignored in this context).

III / B.5.4.3.1 Sw_2 Special Processing Matrix

Doppler or DOA positions for the same beacon ID have already been processed by the MCC which receives the new input I_j.

Since no encoded position has previously been received, the EEM test is irrelevant (see shaded column). Similarly, the PQF test is irrelevant when a DEM test or a DDM test show a successful match (DEM = 1 and / or DDM =1).

Figure III / B.5 : Special Processing for Sw_2 Status

DEM	SBE	DDM	PQF	EEM	I_2 [A / B] [O]	I_3 [E]	I_4 [A / B / E] [O / E]
1	X	1	0	0			Aw_7
1	X	0	0	0		Aw_7	Aw_7
0	1	1	0	0	Aw_0		Aw_4
0	1	0	1	0	Aw_0		Aw_4
0	1	0	0	0	Aw_2	Aw_4	Aw_4
0	0	1	0	0	Aw_5		Aw_6
0	0	0	0	0	Aw_2	Aw_4	Aw_4
Aw priority if multiple matching tests are required					$Aw_5 > Aw_0 > Aw_2$	$Aw_7 > Aw_4$	$Aw_7 > Aw_6 > Aw_4$

III / B.5.4.3.2 Sw_3 Special Processing Matrix

An 'E' (encoded) position for the same beacon ID has already been processed by the MCC which receives the new input I_j, but no Doppler or DOA position data were received.

Therefore, the Doppler / Doppler and DOA / DOA matching tests, and the associated SBE and PQF tests, are irrelevant in this Status (columns SBE, DDM and PQF are shaded).

Figure III / B.6 : Special Processing for Sw_3 Status

DEM	SBE	DDM	PQF	EEM	I_2 [A / B] [O]	I_3 [E]	I_4 [A / B / E] [O / E]	I_5 [D]	I_6 [D+(E)]
1	0	0	0	1			Aw_7		Aw_7
1	0	0	0	0	Aw_7		Aw_7	Aw_7	Aw_7
0	0	0	0	1		Aw_0	Aw_4		Aw_6
0	0	0	0	0	Aw_4	Aw_3	Aw_4	Aw_6	Aw_6
Aw priority if multiple matching tests are required					Aw_7 > Aw_4	Aw_0 > Aw_3	Aw_7 > Aw_4	Aw_7 > Aw_6	Aw_7 > Aw_6

III / B.5.4.3.3 Sw_4 Special Processing Matrix

Doppler or DOA positions and encoded position data for the same beacon ID have already been processed by the MCC which receives the new input, but no Doppler / Doppler, Doppler / encoded, DOA / DOA or DOA / encoded position matching tests have been successful.

Figure III / B.7 : Special Processing for Sw_4 Status

DEM	**SBE**	**DDM**	**PQF**	**EEM**	I_2 [A / B] [O]	I_3 [E]	I_4 [A / B / E] [O / E]	I_5 [D]	I_6 [D+(E)]
1	X	1	0	0	Aw_7		Aw_7	Aw_7	Aw_7
1	X	0	0	0	Aw_7	Aw_7	Aw_7	Aw_7	Aw_7
0	1	1	0	1			Aw_0		Aw_6
0	1	1	0	0	Aw_0		Aw_4	Aw_6	Aw_6
0	1	0	1	1			Aw_0		Aw_6
0	1	0	1	0	Aw_0		Aw_4	Aw_6	Aw_6
0	X	0	0	1		Aw_0	Aw_4		Aw_6
0	X	0	0	0	Aw_4	Aw_4	Aw_4	Aw_6	Aw_6
0	0	1	0	1			Aw_6		Aw_6
0	0	1	0	0	Aw_6		Aw_6	Aw_6	Aw_6
Aw priority if multiple matching tests are required					Aw_7 > Aw_6 > Aw_0 > Aw_4	Aw_7 > Aw_0 > Aw_4	Aw_7 > Aw_6 > Aw_0 > Aw_4	Aw_7 > Aw_6	Aw_7 > Aw_6

III / B.5.4.3.4 Special Filtering Matrix After Position Confirmation

It is assumed that continued transmission is enabled, otherwise no action should be taken when receiving new alerts for the particular beacon ID under consideration.

The filtering procedure after position confirmation is as follows:

- the Doppler or DOA position data received in the new input is compared only to the confirmed position (R) used for reference (i.e. the DRM test replaces the DDM test);
- the encoded position data received in the new input is compared to previous encoded position, unless there is no previous encoded position, in which case it is compared to the confirmed position (R) used for reference;
- all new beacon events are transmitted, based on the setting of the Same Beacon Event flag; and
- position data for same beacon events is forwarded if any one of the possible tests fails.

Figure III / B.8 : Special Processing for Sw_5 , Sw_6 and Sw_7 Status

SBE	DRM	PQF	EEM*	I_2 [A / B] [O]	I_3 [E]	I_4 [A / B / E] [O / E]	I_5 [D]	I_6 [D+(E)]	I_7 [Conf. D+E]
1	1	0	1			Ct_0		Ct_0	Ct_0
1	1	0	0	Ct_0		Ct_4	Ct_0	Ct_6	Ct_7
1	0	1	1			Ct_0		Ct_0	Ct_0
1	0	1	0	Ct_0		Ct_4	Ct_0	Ct_6	Ct_7
1	0	0	1		Ct_0	Ct_4		Ct_6	Ct_7
1	0	0	0	Ct_2	Ct_3	Ct_4	Ct_5	Ct_6	Ct_7
0	1	0	1			Ct_7		Ct_6	Ct_7
0	1	0	0	Ct_5		Ct_4	Ct_5	Ct_6	Ct_7
0	0	0	1		Ct_7	Ct_4		Ct_6	Ct_7
0	0	0	0	Ct_2	Ct_3	Ct_4	Ct_5	Ct_6	Ct_7

* The encoded position data received in the new input is compared to the confirmed position (R) used for reference if there is no previous encoded position.

III / B.6 DISTRIBUTION OF BEACON REGISTRATION INFORMATION

[...]

III / B.7 NOCR PROCEDURES

III / B.7.1 Procedure

An NOCR message is initiated by an MCC when a 406 MHz alert for a beacon ID is first located in its service area and the country code in the 406 MHz beacon message is associated with another country's search and rescue region (SRR). The MCC service area includes the entire service area of the MCC and is not limited to its national SRR. When the beacon country code in the 406 MHz beacon message is associated with a country's search and rescue region (SRR) in the service area of an MCC sending the first location, the same MCC should also process and send an NOCR message to the associated country's SPOC or RCC. The location can be provided by either Doppler location processing, DOA processing or by the encoded position contained in beacons coded using a location protocol. In some conditions multiple MCCs may initiate an NOCR message to the same support MCC.

An MCC in whose service area an alert is located transmits the NOCR message to the associated MCC (i.e., the destination MCC) based on the distribution matrix provided in Figure III / A.8. The appropriate associated MCC for NOCR message distribution is determined by the country code contained in the beacon ID of the message.

An MCC that has assumed backup responsibilities for another MCC shall initiate and distribute NOCR messages on behalf of the MCC being backed up.

In addition to distributing the NOCR message to the appropriate SPOC, the associated MCC should also process the NOCR message as an alert message, in accordance with Figures III / B.4.1 and III / B.4.2.

An NOCR message is not required for unlocated alerts because, by definition, the message initiation process is based on geographic position information. An MCC is not required to send an NOCR message to another MCC when the sending MCC has already sent to the receiving MCC an alert located in the service area of the receiving MCC.

The receiving MCC may filter redundant NOCRs for the same beacon ID.

III / B.8 Distribution of 406 MHz Ship Security Alerts

The identification data in the beacon message includes a protocol code which can identify the 406 MHz transmission as a ship security alert. In addition, the beacon message also contains a country code which can be associated with the "flag state" of the vessel. When an MCC receives a ship security alert, the alert should be processed according to the same procedures that apply for distress alerts except that the resulting ship security alert message will be forwarded based only on the country code included in the beacon message.

> *All States wishing to use the Cospas-Sarsat System to relay ship security alerts should make the necessary arrangements with their associated MCC. Arrangements should include the identification of the competent authority responsible for receiving the ship security alert and the communication link to the competent authority*

III / B.8.1 Procedure

An MCC will process ship security alerts (beacon message bits 37-40 = 1100) according to the logic provided in Figure III / B.9. Routing of ship security alerts will be based on the country code contained in the beacon message, that is, the message will be transmitted to the MCC associated with the country code, and not transmitted to other MCCs, RCCs, or SPOCs based on the Doppler positions, DOA position or encoded position contained in the beacon message. Message routing for ship security alerts will follow the data distribution matrix as provided at Figure III / A.8. Ship security message will be exchanged between MCCs using the formats and data content for alert messages as contained in document C/S A.002 (SID).

When a ship security alert is received by the Associated MCC, that MCC will notify the relevant competent security authority as provided by IMO or another appropriate point of contact as previously arranged.

MCCs will continue to transmit the appropriate alert messages until the position is confirmed, except for the Associated MCC which will continue to provide information to the competent authority after position confirmation, as described in section 3.2.5.

III / B.9 PROCESSING AND DISTRIBUTION OF 406 MHz INTERFERENCE DATA

III / B.9.1 406 MHz Interference Data Processing

When processing 406 MHz interference data, the matching of interferer solutions is based strictly on location, with a 100 km criterion. In addition, the thresholds for closing interferer sites, 72 hours without new data or 20 missed LEO satellite passes, takes into account the fact that interferers often do not transmit continually.

III / B.9.2 406 MHz Interference Data Distribution

MCCs exchange 406 MHz interference data received from LEOLUTs and MEOLUTs in the SIT 121 and SIT 141 message formats, respectively. MCCs shall automatically distribute 406 MHz interference data to other MCCs only when the position is confirmed based on the location of the interferer. MCCs shall send at least two messages to other MCCs for each interferer site.

Interference data received from MEO satellites shall be processed and distributed independently from interference data received from LEO satellites.

III / B.10 RETURN LINK SERVICE (RLS) PROCEDURES

III / B.10.1 Procedure

An MCC shall initiate a Return Link Service (RLS) message to the FMCC when the position of a 406 MHz beacon with Return Link capability (beacon message bits 37 to 40: 1101) is confirmed to be in the MCC's service area. A RLS message is only sent for beacons with Return Link capability. Beacon position is confirmed as specified in section 3.2.4. The FMCC shall distribute the RLS message to the Return Link Service Provider (RLSP).

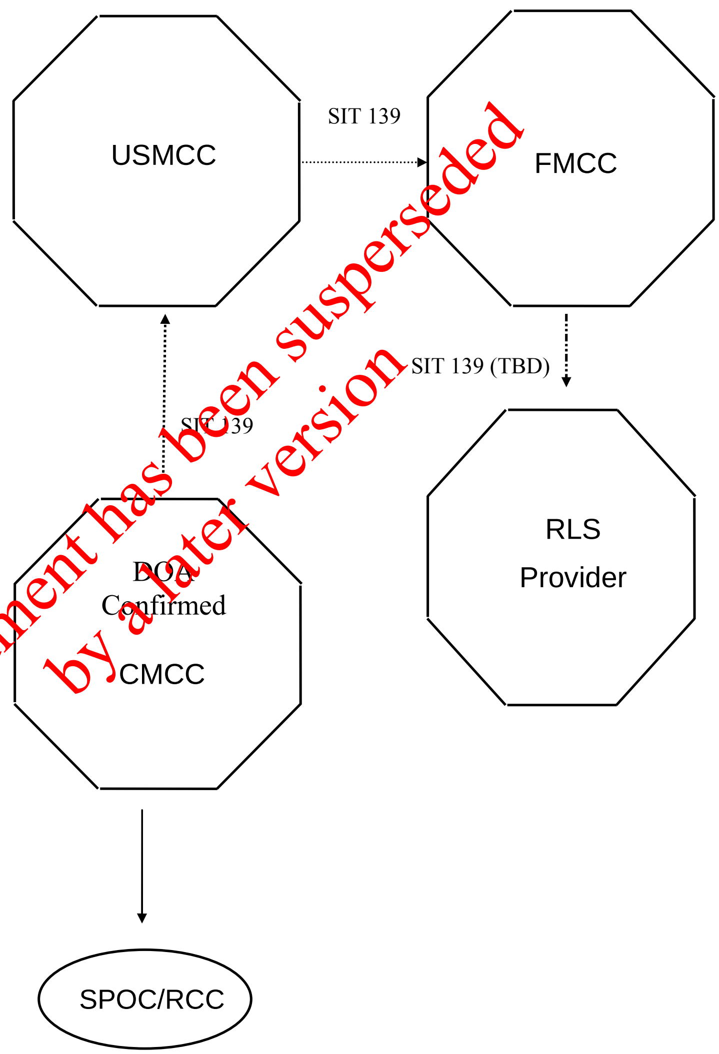
RLS messages shall be transmitted to the FMCC based on the distribution matrix provided in Figure III / A.8. In addition to distributing the RLS message to the appropriate MCC or the RLSP, MCCs shall also process the RLS message as an alert message, in accordance with Figures III/B.4.1 and III / B.4.2.

An MCC that has assumed backup responsibilities for another MCC shall initiate and distribute RLS messages on behalf of the MCC being backed up.

III / B.10.2 RLS Example

<u>Scenario</u>

Country code in Beacon ID: Australia (503)
Confirmed (DOA) Position Service Area: CMCC (Canadian MCC)



MEOSAR D&E SIT MESSAGES FORMAT AND CONTENT (reference C/S A.002)

Table 1: SIT Message Correlations from Existing LEOSAR/GEOSAR System to MEOSAR System

SIT		Meaning	New SIT	
121	406 DOPPLER INTERFERER NOTIFICATION	This message is used for notification of 406 MHz interferer signals.	**141**	406 DOA INTERFERER NOTIFICATION
122	406 INCIDENT (NO DOPPLER)	A 406 MHz alert message with no Doppler/DOA positions. An encoded position may or may not be available.	**142**	406 INCIDENT (NO DOA)
123	406 POSITION CONFLICT (ENCODED ONLY)	A 406 MHz alert message with no Doppler/DOA positions for which the encoded position differs by more than the match criteria from all previous positions.	**143**	406 POSITION CONFLICT (ENCODED ONLY)
124	406 AMBIGUITY RESOLUTION (ENCODED ONLY)	A 406 MHz alert message with no Doppler/DOA positions that identifies the confirmed position of a 406 MHz alert.	**144**	406 POSITION CONFIRMATION (ENCODED ONLY)
125	406 INCIDENT	A beacon alert message computed from 406 MHz incident data. The message contains Doppler/DOA position.	**145**	406 INCIDENT
126	406 POSITION CONFLICT	A beacon alert message computed from 406 MHz incident data. The message contains Doppler/DOA and/or encoded position(s) which differ from other position(s) by the match criteria.	**146**	406 POSITION CONFLICT
127	406 AMBIGUITY RESOLUTION	A 406 MHz alert message with Doppler/DOA positions that identifies the resolved/confirmed position of a 406 MHz alert. It may or may not contain an encoded position.	**147**	406 POSITION CONFIRMATION
132	406 NOTIFICATION OF COUNTRY OF REGISTRATION (ENCODED ONLY)	This message is used between MCCs to notify the country of registration of a 406 MHz beacon (NOCR). This message contains only an encoded position.	**136**	406 NOTIFICATION OF COUNTRY OF REGISTRATION (ENCODED ONLY)
133	406 NOTIFICATION OF COUNTRY OF REGISTRATION	This message is used between MCCs to notify the country of registration of a 406 MHz beacon (NOCR). This message contains Doppler/DOA position. It may or may not contain an encoded position.	**137**	406 NOTIFICATION OF COUNTRY OF REGISTRATION

SIT		Meaning	New SIT	
N/A	See note 1	This message is used between MCCs to notify the responsible MCC (FMCC) of a 406 MHz beacon with RLS capability. This message contains only an encoded position.	**138**	406 NOTIFICATION OF RETURN LINK SERVICE PROVIDER (ENCODED ONLY)
N/A	See note 1	This message is used between MCCs to notify the responsible MCC (FMCC) of a 406 MHz beacon with RLS capability. This message contains a DOA position. It may or may not contain an encoded position.	**139**	406 NOTIFICATION OF RETURN LINK SERVICE PROVIDER

Note 1: SIT formats are not currently defined to notify the RLSP. In the Return Service Link operational phase, corresponding SIT messages (e.g., 134 and 135) would be defined to notify the RLSP, based on alerts from the LEO/GEO system that may or may not contain Doppler position.

MEOSAR SIT Formats

All MEOSAR SIT messages contain message fields 1 – 5, per the current SID. There are two MEOSAR SIT formats, one for alerts with DOA position (per Table 2.1) and the other for alerts without DOA position (per Table 2.2).

Table 2.1: Message Content for MEOSAR SITs with DOA Position (SITs 141,145,146,147,137,139)

Field Name	MF#	Description
Number of Alerts	8	Number of alerts in message (with DOA position)
MEOLUT ID	11	MEOLUT identifier
Frequency	13	Frequency
Time Tag First Burst	14a	Time of the first burst (average TOA) – same format as TCA (MF 14)
Time Tag Last Burst	14b	Time of the last burst (average TOA) – same format as TCA (MF 14)
Bursts	21	The number of independent 406 MHz beacon bursts (transmissions) used in generating this alert.
Beacon Message	23	30 character hexadecimal (bits 25-144). For SIT 141 messages (i.e., Interference detected by the MEOSAR system), the beacon message is not applicable and is set to zeroes.
Service Area	24	DDR/Service Area and position status flag
Latitude	25	Latitude for the position
Longitude	26	Longitude for the position
Altitude	77*	Altitude for the position
DOA Quality Factor	78*	A measure of the quality of the position (TBD)
Average C/No	79*	The average Carrier over Noise Density of RTBs associated with this alert
RTBs	80*	Number of Received Transponded Bursts (i.e., beacon bursts as received by a MEOLUT antenna) used to generate this alert.
Antennas	81*	Number of unique antennas used to generate this alert.

* New field

Table 2.2: Message Content for MEOSAR SITs without DOA Position (SITs 142,143,144,136,138)

Field Name	MF#	Description
Number of Alerts	10	Number of alerts in message (with no DOA position)
MEOLUT ID	11	MEOLUT identifier
Frequency	13	Frequency
Time Tag First Burst	14a	Time of the first burst (average TOA) – same format as TCA (MF 14)
Time Tag Last Burst	14b	Time of the last burst (average TOA) – same format as TCA (MF 14)
Bursts	21	The number of independent 406 MHz beacon bursts (transmissions) used in generating this alert.
Beacon Message	23	30 character hexadecimal (bits 25-144).
Average C/No	79*	The average Carrier over Noise Density of RTBs associated with this alert
RTBs	80*	Number of Received Transponded Bursts (i.e., beacon bursts as received by a MEOLUT antenna) used to generate this alert.
Antennas	81*	Number of unique antennas used to generate this alert.

* New field

CHANGES TO C/S A.002 - ANNEX B
(Only changes and new fields included)

TABLE B.1
Message Fields Description

MF#	NAME	CONTENT	CHARACTER TEXT
8	NUMBER OF ALERTS WITH DOPPLER/DOA POSITIONS	01 -> 99	nn
10	NUMBER OF ALERTS WITHOUT DOPPLER/DOA POSITIONS	01 -> 99	nn
24	DDR/SERVICE AREA	MCC COUNTRY CODE = 100 -> 999	snnn
	PS FLAG	POSITION STATUS: "+" IN 'A' AND 'B' = NO CONFIRMED POSITION "+" = CONFIRMED 'A', 'B', or DOA OR NON-IMAGE UNCONFIRMED 'A' or 'B' POSITION "-" = INCORRECT 'A', 'B', or DOA, OR UNCONFIRMED DOA POSITION	
54	POSITIONS*	HEADING	8.bbPOSITIONS
54a	CONFIRMED POSITION	HEADING	bbbbbbbbCONFIRMEDbb-b
	CONFIRMED LATITUDE	LAT	nnbnn.na
	DEGREES	00 -> 90	
	MINUTES	00.0 -> 59.9	
	NORTH OR SOUTH	N or S	
	CONFIRMED LONGITUDE	LONG	bbnnnbnn.na
	DEGREES	000 -> 180	
	MINUTES	00.0 -> 59.9	
	EAST OR WEST	E or W	

Note: * If the latitude is exactly 90 degrees (North or South) or if the longitude is exactly 180 degrees (East or West) for a Confirmed, DOA or Doppler Position, then the corresponding value for minutes must be exactly 00.0.

MF#	NAME	CONTENT	CHARACTER TEXT
54b	A POSITION & PROBABILITY	HEADING	bbbbbbbbDOPPLERbAb-b
	A LATITUDE DEGREES MINUTES NORTH OR SOUTH	LAT 00 -> 90 00.0 -> 59.9 N or S	nnbnn.na
	A LONGITUDE DEGREES MINUTES EAST OR WEST	LONG 000 -> 180 00.0 -> 59.9 E or W	bbnnnbnn.nabbbb
	A PROBABILITY(%)	PROB 01 -> 99	PROBbnn
54c	B POSITION & PROBABILITY	HEADING	bbbbbbbbDOPPLERbBb-b
	B LATITUDE	(SAME AS MF#54b)	nnbnn.na
	B LONGITUDE	(SAME AS MF#54b)	bbnnnbnn.nabbbb
	B PROBABILITY(%)	(SAME AS MF#54b)	PROBbnn
54d	DOA POSITION AND ALTITUDE	HEADING	bbbbbbbbDOAbbbbbbb-b
	DOA LATITUDE	(SAME AS MF#54b)	nnbnn.na
	DOA LONGITUDE	(SAME AS MF#54b)	bbnnnbnn.nabbb
	DOA ALTITUDE	ALTITUDE	ALTITUDEbnnnnn.nnn
54e	ENCODED POSITION & TIME OF UPDATE	HEADING	bbbbbbbbENCODEDbbb-b
	ENCODED LATITUDE	(SAME AS MF#54b)	nnbnn.nna
	ENCODED LONGITUDE	(SAME AS MF#54b)	bbnnnbnn.nnabbbb
	TIME OF UPDATE	TIME OF UPDATE	UNKNOWN
77	ALTITUDE	00000.000 ->99999.999 DEFAULT VALUE = 99999.999	nnnnn.nnn
78	DOA QUALITY FACTOR	001-> 999 DEFAULT VALUE = 000	nnn
79	AVERAGE CARRIER TO NOISE RATIO	00.00 -> 99.99 DEFAULT VALUE = 99.99	nn.nn
80	RTBs (RECEIVED TRANS- PONDED BURSTS)	01-> 99 DEFAULT VALUE =00	nn
81	ANTENNAS	01-> 99 DEFAULT VALUE = 00	nn

MESSAGE FIELDS DEFINITION

MF #	Message Fields Definition

8. Number of Alerts with Doppler/DOA Positions

The number of alerts of this SIT format with Doppler or DOA positions, that are included between the SIT header and the SIT trailer as specified in Table C.1. 406 MHz alerts may or may not contain encoded position information.

10. Number of Alerts without Doppler/DOA Positions

The number of alerts of this SIT format without Doppler or DOA positions, that are included between the SIT header and the SIT trailer as specified in Table C.1.

14. TCA

For LEOSAR Doppler location data, the Time of Closest Approach (TCA) indicates the time at which the satellite was closest to the beacon. For LEOSAR detect only solutions, the TCA is the time of the last data point. For GEOSAR, the TCA field contains the time of the first beacon burst for the alert. For MEOSAR, the TCA field contains the time of the burst as computed by averaging the associated TOA measurements; the time of the first burst (field 14a) and the time of the last burst (field 14b) are provided separately.

For LEOSAR alerts, the value for this field shall be computed from the 'A' solution.

21. Number of Points (406 MHz)

For data originating from the LEOSAR system: The number of bursts detected by the LEOLUT for each 406 MHz beacon identification, used to develop a solution. For combined SARP and SARR, it is the number of unique time-frequency data points after the two processes have been merged.

For data originating from the GEOSAR system: The number of independent integrations performed to produce a 406 MHz beacon message as described in document C/S T.009. For unconfirmed messages, the number of points shall be set to "1". For confirmed messages the number of independent integrations shall be reported.

For combined LEO/GEO processing, it is the number of data points used from the 406 MHz LEOSAR channel in the combined processing.

The value for this field shall be computed from the 'A' solution.

For data originating from the MEOSAR system: The number of bursts used to develop the DOA position or, when no DOA position is provided, the number of bursts associated with the alert.

24. DDR/Service Area

The MCC country code for the individual MCC service area or the MCC country code of the nodal MCC for the DDR as provided in System document C/S A.001 "Cospas-Sarsat Data Distribution Plan". Nodal MCCs will fill this field with service area.

Position Status Flag

Indicates the position status as confirmed, non-image, unconfirmed or incorrect.

For position confirmation messages, "+" indicates the confirmed position and "-" indicates an incorrect position. A "-" in both the "A" and "B" solution, or in the DOA solution, indicates that the confirmed position is the encoded position contained in the Beacon Message.

For messages with Doppler position prior to position confirmation, a "+" in both the "A" and "B" solution indicates that no position is confirmed. If one ("A" or "B") solution is set to "-" and the other solution is set to "+", then a "-" indicates that this position is an image (incorrect) and a "+" indicates that this position is a non-image, as determined by the "406 MHz LEOSAR Image Position Determination" algorithm in Appendix B.2 to Annex B. Determining that a position is an image prior to position confirmation is optional.

For messages with DOA position prior to position confirmation, a "-" indicates that the position is unconfirmed.

45. Message Type

For a ship security alert, the message type begins with "SHIP SECURITY COSPAS-SARSAT …", otherwise the message type begins with "DISTRESS COSPAS-SARSAT …".

Indicates type of alert message, for example:

- DISTRESS COSPAS-SARSAT POSITION CONFIRMED ALERT
- DISTRESS COSPAS-SARSAT POSITION CONFIRMED UPDATE ALERT
- DISTRESS COSPAS-SARSAT POSITION CONFLICT ALERT
- DISTRESS COSPAS-SARSAT INITIAL ALERT
- DISTRESS COSPAS-SARSAT UNRESOLVED DOPPLER POSITION MATCH
- DISTRESS COSPAS-SARSAT NOTIFICATION OF COUNTRY OF BEACON REGISTRATION ALERT
- SHIP SECURITY COSPAS-SARSAT POSITION CONFIRMED ALERT
- SHIP SECURITY COSPAS-SARSAT POSITION CONFIRMED UPDATE ALERT
- SHIP SECURITY COSPAS-SARSAT POSITION CONFLICT ALERT
- SHIP SECURITY COSPAS-SARSAT INITIAL ALERT

48. Detection Time & Spacecraft ID

The detection time is TCA (as defined at MF#14) and abbreviation for months is as per table below. The time is followed on the same line by the identity of the LEOSAR or GEOSAR satellite which provided the alert data. For MEOSAR alerts, the time of the first burst is provided and is followed on the same line by "MEOSAR".

Abbreviation	Month	Abbreviation	Month
JAN	January	JUL	July
FEB	February	AUG	August
MAR	March	SEP	September
APR	April	OCT	October
MAY	May	NOV	November
JUN	June	DEC	December

51. User Class of Beacon

User class information as per table below and produced from beacon information by the MCC. Enter "NIL" if the Beacon Message is invalid per C/S A.001, section III/B.1.1.3.

Beacon Protocol	User Class in RCC Message
Standard Location Protocol	STANDARD LOCATION - followed by
Aviation	ELT - AIRCRAFT SERIAL NO: CSTA CERTIFICATE NO
	ELT - AIRCRAFT 24-BIT ADDRESS 6 HEX CHARACTERS:
	ELT - AIRCRAFT OPERATOR DESIGNATOR OPERATOR: SERIAL NO:
Maritime	EPIRB - SERIAL NO: CSTA CERTIFICATE NO
	EPIRB - MMSI LAST 6 DIGITS:
Personal Locator Beacon	PLB - SERIAL NO: CSTA CERTIFICATE NO:
Ship Security	SHIP SECURITY - MMSI LAST 6 DIGITS:
National Location Protocol	NATIONAL LOCATION - followed by
Aviation	ELT - SERIAL NO:
Aviation	ELT (RETURN LINK) - SERIAL NO:
Maritime	EPIRB - SERIAL NO:
Maritime	EPIRB (RETURN LINK) - SERIAL NO:
Personal Locator Beacon	PLB - SERIAL NO:
Personal Locator Beacon	PLB (RETURN LINK) - SERIAL NO:

54. Position Information

The position information associated with the confirmed position, A & B Doppler positions, DOA position and the encoded position as appropriate.

54a Confirmed Position
Latitude and longitude of confirmed position. This position may be formed by a merge of matching positions, which may be based on a weighting factor assigned to each matching position.

54b. A Position & Probability
The latitude and longitude of the A Doppler Position and the percentage probability that the A Position is the actual position of the incident.

54c. B Position & Probability
Same as MF#54b above but for B Position.

54d. DOA Position and Altitude
Latitude and longitude of the DOA position and the altitude of the DOA position from the mean sea level in kilometers. Enter "NIL" for altitude if it is not available.

54e. Encoded Position and Time of Update
Latitude and longitude of encoded position. Time of update is UNKNOWN.
Enter "NIL" if the Beacon Message is invalid per C/S A.001, section III/B.1.1.3.

55. Source of Encoded Position Data

This indicates whether the encoded position data was provided to the beacon by an internal or external device. Enter "NIL" if the Beacon Message is invalid per C/S A.001, section III/B.1.1.3.

56. Next Pass / Expected Data Times

The predicted time (predicted Loss of Signal – LOS) at which the next LEOSAR beacon event (in local mode) for the position being reported will occur or the time period for which MEOSAR alert data is expected to be distributed.

56a. Next Time of Visibility/ Expected Data Time of Confirmed Position

1. LEOSAR/GEOSAR: Optional information indicating the next time of LEOSAR visibility for the confirmed position; "UNKNOWN" if the information is not available.
2. MEOSAR: Enter "NIL" as default. After position confirmation, optionally provide the time period for which the DOA position is provided; e.g., NORMALLY DISTRIBUTED EVERY [15] MINUTES".

56b. Next Time of Visibility A Doppler Position
Same as MF#56a.1 above but for A Position.

56c. Next Time of Visibility B Doppler Position
Same as MF#56a.1 above but for B Position.

56d. Next Expected Data Time of DOA Position
MEOSAR: Same as for MF#56a.2 but for the Encoded Position.

56e. Next Time of Visibility of Encoded Position
LEOSAR/GEOSAR: Same as for MF#56a.1 but for the Encoded Position.
MEOSAR: Same as for MF#56a.2 but for the Encoded Position.

61. Operational Information

Operational information obtained separately from encoded beacon information such as:

- reliability indicator for encoded or Doppler position data *
- database registry information
- people on board
- 'NIL' if not available.

The statement, "THE [A|B] POSITION IS LIKELY TO BE AN IMAGE POSITION." shall be included, as appropriate, per the "LEOSAR Image Position Determination" algorithm in Appendix B.2 to Annex B. Determining that a position is an image prior to ambiguity resolution is optional.

Note 1: * The warning "RELIABILITY OF DOPPLER POSITION DATA - SUSPECT" for 406 MHz solutions shall be included on the SIT 185 message when at least one of the following criteria from the alert data values is satisfied:

- Window factor $\geq$ 3, or
- Bias standard deviation > 20 Hz, or
- The absolute value of the cross track angle is < 1 or > 22, or
- Position calculated from < 4-point solution.

This warning is only included in messages before ambiguity resolution.

Note 2: * The warning "RELIABILITY OF DOPPLER POSITION DATA - SUSPECT DUE TO SATELLITE MANOEUVRE." shall be included in the SIT 185 message during the 24-hour period after the manoeuvre when the maximum expected error in Doppler location exceeds 10 kilometres within 24 hours of the manoeuvre. See C/S A.001, section 3.7.5.

Note 3: * The warning "WARNING: AMBIGUITY IS NOT RESOLVED" shall be included in the SIT 185 message for an Unresolved Doppler Position Match, as defined in document C/S A.001, Annex III / B.2.

If the Beacon Message is invalid per C/S A.001, section III/B.1.1.3 then the warning "DATA DECODED FROM THE BEACON MESSAGE IS NOT RELIABLE" shall be included in SIT 185 message.

The statement "POSITION CONFLICT BASED ON DISTANCE SEPARATION OF AT LEAST [10] KM" shall be included on the SIT 185 Position Conflict message for DOA position.

62. Remarks

Heading for the variable length section of the message. Additional information may be provided at the discretion of the originating MCC as illustrated in the sample alert messages. 'NIL' if no Remarks are available. Remarks about beacon type (e.g., for ship security beacons and return link beacons) are not provided if the Beacon Message is invalid per C/S A.001, section III/B.1.1.3.

For ship security alerts the following should be included: "THIS IS A SHIP SECURITY ALERT. PROCESS THIS ALERT ACCORDING TO RELEVANT SECURITY REQUIREMENTS."

For Return Link Service (RLS) beacons, the following should be included: "THIS BEACON HAS RETURN LINK CAPABILITY".

77. Altitude

The calculated altitude of the DOA position relative to mean sea level, given in kilometres.

78. DOA Quality Factor

A measure of quality associated with the DOA position (algorithm TBD).

79. Average Carrier to Noise Ratio

The average Carrier to Noise Ratio as computed from all contributing TOA/FOA measurements, computed by taking the log of the average of inverse logs of all measurements.

80. Received Transponded Bursts (RTBs)

Number of Received Transponded Bursts (i.e., beacon bursts as received by a MEOLUT antenna) used to generate this alert.

81. Antennas

Number of unique antennas used to generate this alert.

TABLE C.3
MESSAGE CONTENT
FOR SIT 185 MESSAGES

PRINTED LINE #	MF #	TITLE
	[…]	
8	54	POSITIONS
9	54a	CONFIRMED POSITION
10	54b	A POSITION & PROBABILITY
11	54c	B POSITION & PROBABILITY
12	54d	DOA POSITION AND ALTITUDE
13	54e	ENCODED POSITION AND TIME OF UPDATE
14	55	SOURCE OF ENCODED POSITION DATA
15	56	NEXT PASS / EXPECTED DATA TIMES
16	56a	NEXT TIME OF VISIBILITY / EXPECTED TIME OF CONFIRMED POSITION
17	56b	NEXT TIME OF VISIBILITY A POSITION
18	56c	NEXT TIME OF VISIBILITY B POSITION
19	56d	NEXT EXPECTED TIME OF DOA POSITION
20	56e	NEXT TIME OF VISIBILITY OF ENCODED POSITION
21	[…]	

SAMPLE MESSAGE FOR

SITs 141, 145, 146, 147, 137, 139

FORMAT FRAMES	MF#	CONTENT
HEADER		(as per communication network requirements if any)
INFO	1,2,3	/01614 00000/3660/09 280 1518
	4,5,8	/145/3160/02
	11,13,14a	/3668/-00405.0 001.0 +99.99/09 280 1516 36.21
	14b,21,23	/09 280 1518 16.19/03/123456789ABCDEF012345600000000
	24,25,26,77,78	/+316/+53.225/-130.102/06379.410/750
	79,80,81	/35.12/09/04
	11,13, 14a,	/3667/+01923.0 999.9 +99.99/09 280 1517 10.01
	14b,21,23	/09 280 1517 10.01/01/23456789ABCDEF012345670000000
	24,25,26,77,78	/+316/+58.451/-140.810/99999.999/250
	79,80,81	/34.39/05/05
	42	/LASSIT
	43	/ENDMSG
TRAILER		(as per communication network requirements if any)

Note: MF #4 must reflect SIT which is being used.

SAMPLE MESSAGE FOR

SITs 142, 143, 144, 136, 138

FORMAT FRAMES	MF#	CONTENT
HEADER		(as per communication network requirements if any)
INFO	1,2,3	/01614 00000/3660/09 280 1518
	4,5,8	/142/3160/02
	11,13,14a	/3668/-00405.0 001.0 +99.99/09 280 1516 36.21
	14b,21,23	/09 280 1518 16.19/03/123456789ABCDEF012345600000000
	79,80,81	/35.12/09/04
	11,13,14a	/3667/+01923.0 999.9 +99.99/09 280 1517 10.01
	14b,21,23	/09 280 1517 10.01/01/23456789ABCDEF0123456700000000
	79,80,81	/34.39/05/05
	42	/LASSIT
	43	/ENDMSG
TRAILER		(as per communication network requirements if any)

Note: MF #4 must reflect SIT which is being used.

SAMPLE MESSAGE FOR SIT 185

SAMPLE 406 MHz INITIAL DOA POSITION ALERT

(STANDARD LOCATION – EPIRB: SERIAL NUMBER)

1. DISTRESS COSPAS-SARSAT INITIAL ALERT

2. MSG NO: 00306 BRMCC REF: 12345

3. DETECTED AT: 17 DEC 10 1627 UTC BY MEOSAR

4. DETECTION FREQUENCY: 406.0371 MHz

5. COUNTRY OF BEACON REGISTRATION: 316/ CANADA

6. USER CLASS: STANDARD LOCATION - EPIRB
   SERIAL NO: 05918

7. EMERGENCY CODE: NIL

8. POSITIONS:
   CONFIRMED - NIL
   DOPPLER A - NIL
   DOPPLER B - NIL
   DOA - 05 10.1 S 178 01.4 E ALTITUDE 45.123
   ENCODED - NIL
   UPDATE TIME WITHIN 4 HOURS OF DETECTION TIME

9. ENCODED POSITION PROVIDED BY: EXTERNAL DEVICE

10. NEXT PASS / EXPECTED DATA TIMES:
    CONFIRMED - NIL
    DOPPLER A - NIL
    DOPPLER B - NIL
    DOA - NIL
    ENCODED - NIL

11. HEX ID: 278C362E3CFFBFF HOMING SIGNAL: 121.5 MHZ

12. ACTIVATION TYPE: NIL

13. BEACON NUMBER ON AIRCRAFT OR VESSEL: NIL

14. OTHER ENCODED INFORMATION:
    CSTA CERTIFICATE NO: 0108
    BEACON MODEL - ACR, RLB-33

15. OPERATIONAL INFORMATION:
    BEACON REGISTRATION AT CMCC

16. REMARKS: NIL

END OF MESSAGE

SAMPLE MESSAGE FOR SIT 185

SAMPLE 406 MHz DOA POSITION CONFIRMATION ALERT

(STANDARD LOCATION – EPIRB: SERIAL NUMBER)

1. DISTRESS COSPAS-SARSAT POSITION CONFIRMED ALERT

2. MSG NO: 00306 BRMCC REF: 12345

3. DETECTED AT: 17 DEC 10 1630 UTC BY MEOSAR

4. DETECTION FREQUENCY: 406.0371 MHz

5. COUNTRY OF BEACON REGISTRATION: 316/ CANADA

6. USER CLASS: STANDARD LOCATION - EPIRB
SERIAL NO: 05918

7. EMERGENCY CODE: NIL

8. POSITIONS:
CONFIRMED - 05 10.1 S 178 01.3 E
DOPPLER A - NIL
DOPPLER B - NIL
DOA - 05 10.2 S 178 01.2 E ALTITUDE 45.123
ENCODED - NIL
UPDATE TIME WITHIN 4 HOURS OF DETECTION TIME

9. ENCODED POSITION PROVIDED BY: EXTERNAL DEVICE

10. NEXT PASS / EXPECTED DATA TIMES:
CONFIRMED - NORMALLY DISTRIBUTED EVERY 15 MINUTES
DOPPLER A - NIL
DOPPLER B - NIL
DOA - NORMALLY DISTRIBUTED EVERY [15] MINUTES
ENCODED - NIL

11. HEX ID: 278C362E3CFFBFF HOMING SIGNAL: 121.5 MHZ

12. ACTIVATION TYPE: NIL

13. BEACON NUMBER ON AIRCRAFT OR VESSEL: NIL

14. OTHER ENCODED INFORMATION:
CSTA CERTIFICATE NO: 0108
BEACON MODEL - ACR, RLB-33

15. OPERATIONAL INFORMATION:
BEACON REGISTRATION AT CMCC

16. REMARKS: NIL

END OF MESSAGE

SAMPLE MESSAGE FOR SIT 185

SAMPLE 406 MHz INITIAL ALERT

(RETURN LINK LOCATION –PLB: SERIAL NUMBER)

1. DISTRESS COSPAS-SARSAT POSITION CONFLICT ALERT

2. MSG NO: 00308 USMCC REF: 12345

3. DETECTED AT: 18 DEC 10 1630 UTC BY SARSAT S09

4. DETECTION FREQUENCY: 406.0370 MHz

5. COUNTRY OF BEACON REGISTRATION: 227/ FRANCE

6. USER CLASS: NATIONAL LOCATION – PLB (RETURN LINK)
SERIAL NO: 00029

7. EMERGENCY CODE: NIL

8. POSITIONS:
CONFIRMED - NIL
DOPPLER A - NIL
DOPPLER B - NIL
DOA - NIL
ENCODED - 17 44.1 N 087 26.3 E
UPDATE TIME WITHIN 4 HOURS OF DETECTION TIME

9. ENCODED POSITION PROVIDED BY: EXTERNAL DEVICE

10. NEXT PASS / EXPECTED DATA TIMES:
CONFIRMED - NIL
DOPPLER A - NIL
DOPPLER B - NIL
DOA - NIL
ENCODED - 18 DEC 10 1655 UTC

11. HEX ID: 1C7B000EBF81FE0 HOMING SIGNAL: 121.5 MHZ

12. ACTIVATION TYPE: NIL

13. BEACON NUMBER ON AIRCRAFT OR VESSEL: NIL

14. OTHER ENCODED INFORMATION: NIL

15. OPERATIONAL INFORMATION:
BEACON REGISTRATION AT FMCC

16. REMARKS: THIS BEACON HAS RETURN LINK CAPABILITY

END OF MESSAGE

- END OF ANNEX E -

ANNEX F

TEST SCRIPT FOR TEST T-1

This annex provides a description of the test signals that have to be transmitted by a beacon simulator for test T-1, for a given slot during a 24-hour period, at the nominal power of 37 dBm.

The purpose of this test is to determine the system margin for each MEOLUT; i.e. the minimum C/No level of a beacon burst which allows that burst to be received, processed and correctly decoded by a given MEOLUT with an acceptable probability. As per the T-1 test definition, a beacon simulator is used to transmit bursts every 3 seconds, at 1dB power steps between 22 dBm and 37 dBm for a period of 24 hours. Long message with 144 data bits (520 ms transmit time which includes the 160 ms of unmodulated carrier time) are transmitted with a bit rate set at 400bps, the modulation index set at 1, and the rise and fall times each at 150 µs.

In order to facilitate the identification of each different type of burst transmitted, a unique 15 HEX ID is used for bursts that correspond to a set transmit power level. Only the last hexadecimal digit of the 15 HEX ID will be varied to indicate the transmitted power of the burst at the output of the cable that connects to the beacon simulator antenna (see Truth Table included below). The appropriate country code is coded within the 15 HEX ID to indicate which beacon simulator is transmitting the burst.

Country Code	Bits	Value
316 – **Canada**	27-36	0100111100

Even though it is recommended that tests T-1 not be performed in parallel (e.g. multiple beacon simulators transmitting at the same time) in an effort to reduce the impact on the operational Cospas-Sarsat system, it would be useful to code them with unique 15 HEX ID for proper record keeping of the data collected. The coding structure of the beacon simulator file for the T-1 test is provided below. A linear antenna must be used on the beacon simulators for test T-1 to better simulate the antenna pattern of a beacon.

Beacon Coding Scenario for Test T-1

Beacon Message / Transmit Power / 15 HEX ID / TX Frequency / Start Time offset

```
 1. D3C869A69A69A067CCE60000000000 -> Nominal 22 dBm -> A790D34D34D3400 ->406064000 ->0
 2. D3C869A69A69A067CCE60000000000 -> Nominal 23 dBm -> A790D34D34D3401 ->406064000 ->3
 3. D3C869A69A69A074A0178000000000 -> Nominal 24 dBm -> A790D34D34D3402 ->406064050 ->6
 4. D3C869A69A69A084ADBE8000000000 -> Nominal 25 dBm -> A790D34D34D3413 ->406064100 ->12
 5. D3C869A69A69A097C14F0000000000 -> Nominal 26 dBm -> A790D34D34D3414 ->406064150 ->15
 6. D3C869A69A69A0A2745D8000000000 -> Nominal 27 dBm -> A790D34D34D3415 ->406064200 ->18
 7. D3C869A69A69A0B118AC0000000000 -> Nominal 28 dBm -> A790D34D34D3416 ->406064250 ->21
 8. D3C869A69A69A0C0A8004000000000 -> Nominal 29 dBm -> A790D34D34D3417 ->406064300 ->24
 9. D3C869A69A69A0D3C4F1C000000000 -> Nominal 30 dBm -> A790D34D34D3418 ->406064350 ->27
10. D3C869A69A69A0E671E34000000000 -> Nominal 31 dBm -> A790D34D34D3419 ->406064400 ->30
11. D3C869A69A69A0F51D12C000000000 -> Nominal 32 dBm -> A790D34D34D341A ->406064450 ->33
12. D3C869A69A69A0F51D12C000000000 -> Nominal 33 dBm -> A790D34D34D341B ->406064450 ->36
13. D3C869A69A69A0F51D12C000000000 -> Nominal 34 dBm -> A790D34D34D341C ->406064450 ->39
14. D3C869A69A69A0F51D12C000000000 -> Nominal 35 dBm -> A790D34D34D341D ->406064450 ->42
15. D3C869A69A69A0F51D12C000000000 -> Nominal 36 dBm -> A790D34D34D341E ->406064450 ->45
16. D3C869A69A69A0F51D12C000000000 -> Nominal 37 dBm -> A790D34D34D341F ->406064450 ->48
```

The same sequence of 16 bursts is repeated for a period of 24 hours.

```
 1. D3C869A69A69A067CCE60000000000 -> Nominal 22 dBm -> A790D34D34D3400 ->406064000 ->0
 2. D3C869A69A69A074A0178000000000 -> Nominal 23 dBm -> A790D34D34D3401 ->406064050 ->3
 3. D3C869A69A69A084ADBE8000000000 -> Nominal 24 dBm -> A790D34D34D3412 ->406064100 ->6
 4. D3C869A69A69A097C14F0000000000 -> Nominal 25 dBm -> A790D34D34D3413 ->406064150 ->9
 5. D3C869A69A69A0A2745D8000000000 -> Nominal 26 dBm -> A790D34D34D3414 ->406064200 ->12
 6. D3C869A69A69A0B118AC0000000000 -> Nominal 27 dBm -> A790D34D34D3415 ->406064250 ->15
 7. D3C869A69A69A0C0A8004000000000 -> Nominal 28 dBm -> A790D34D34D3416 ->406064300 ->18
 8. D3C869A69A69A0D3C4F1C000000000 -> Nominal 29 dBm -> A790D34D34D3417 ->406064350 ->21
 9. D3C869A69A69A0E671E34000000000 -> Nominal 30 dBm -> A790D34D34D3418 ->406064400 ->24
10. D3C869A69A69A0F51D12C000000000 -> Nominal 31 dBm -> A790D34D34D3419 ->406064450 ->27
11. D3C869A69A69A0F51D12C000000000 -> Nominal 32 dBm -> A790D34D34D341A ->406064450 ->30
12. D3C869A69A69A0F51D12C000000000 -> Nominal 33 dBm -> A790D34D34D341B ->406064450 ->33
13. D3C869A69A69A0F51D12C000000000 -> Nominal 34 dBm -> A790D34D34D341C ->406064450 ->36
14. D3C869A69A69A0F51D12C000000000 -> Nominal 35 dBm -> A790D34D34D341D ->406064450 ->39
15. D3C869A69A69A0F51D12C000000000 -> Nominal 36 dBm -> A790D34D34D341E ->406064450 ->42
15. D3C869A69A69A0F51D12C000000000 -> Nominal 37 dBm -> A790D34D34D341F ->406064450 ->45
16. D3C869A69A69A0F51D12C000000000 -> Nominal 37 dBm -> A790D34D34D341F ->406064450 ->48
```

*** note the Beacon Message is an example for format only, it is not representative of the specific 15 HEX ID outlined on the right of each numbered line.

-TRUTH TABLE-	**15TH HEX DIGIT OF 15 HEX BEACON ID - indicates transmit power level**				
15th HEX Digit	MSB			LSB	
0	0	0	0	0	5 Watts -15 dB (22 dBm)
1	0	0	0	1	5 Watts -14 dB (23 dBm)
2	0	0	1	0	5 Watts -13 dB (24 dBm)
3	0	0	1	1	5 Watts -12 dB (25 dBm)
4	0	1	0	0	5 Watts -11 dB (26 dBm)
5	0	1	0	1	5 Watts -10 dB (27 dBm)
6	0	1	1	0	5 Watts -9 dB (28 dBm)
7	0	1	1	1	5 Watts -8 dB (29 dBm)
8	1	0	0	0	5 Watts - 7dB (30 dBm)
9	1	0	0	1	5 Watts -6 dB (31 dBm)
A	1	0	1	0	5 Watts -5dB (32 dBm)
B	1	0	1	1	5 Watts -4dB (33 dBm)
C	1	1	0	0	5 Watts - 3dB (34 dBm)
D	1	1	0	1	5 Watts -2dB (35 dBm)
E	1	1	1	0	5 Watts -1dB (36 dBm)
F	1	1	1	1	5 Watts (37 dBm)

ANNEX G

TEST SCRIPT FOR TEST T-3

This annex provides a description of the test signals that have to be transmitted by a beacon simulator for test T-3, for a given slot during a 24-hour period, at the nominal power of 37 dBm.

The script is comprised of a basic sequence repeated 6 times, i.e. a total of 7 transmissions. The basic sequence, provided in the table below, is comprised of 100 beacon events. The beacon events are spaced by 0.5s, using alternatively the 406.064 or 406.070 MHz frequencies. The test script repeats 7 times the basic sequence with a fixed repetition period of 50s, and has a total duration of 350 s.

The 100 available beacon events transmitted with 7 bursts allow building the required statistics, for a given time slot and for the nominal power of 37 dBm. The script to be used at [30 dBm] can be easily derived from the one at 37 dBm.

The 15 Hex ID of beacon events are coded as follows: 9C9D000YYY00037

- 9C9D000 : Fixed value for all beacon events
- YYY : Beacon event serial 001 to 100
- 000 : Fixed value for all beacon events
- 37 : value of emission power

15 Hex ID of bcn	30 Hex bcn message	Time of bcn burst	Emission power	Frequency
9C9D00000100037		T0	37 dBm	406.064 MHz
9C9D00000200037		T0 + 0.5s	37 dBm	406.070 MHz
9C9D00000300037		T0 + 1.0s	37 dBm	406.064 MHz
9C9D00000400037		T0 + 1.5s	37 dBm	406.070 MHz
9C9D00000500037		T0 + 2.0s	37 dBm	406.064 MHz
9C9D00000600037		T0 + 2.5s	37 dBm	406.070 MHz
9C9D00000700037		T0 + 3.0s	37 dBm	406.064 MHz
9C9D00000800037		T0 + 3.5s	37 dBm	406.070 MHz
9C9D00000900037		T0 + 4.0s	37 dBm	406.064 MHz
9C9D00001000037		T0 + 4.5s	37 dBm	406.070 MHz
9C9D00001100037		T0 + 5.0s	37 dBm	406.064 MHz
9C9D00001200037		T0 + 5.5s	37 dBm	406.070 MHz
9C9D00001300037		T0 + 6.0s	37 dBm	406.064 MHz
9C9D00001400037		T0 + 6.5s	37 dBm	406.070 MHz
9C9D00001500037		T0 + 7.0s	37 dBm	406.064 MHz
9C9D00001600037		T0 + 7.5s	37 dBm	406.070 MHz
9C9D00001700037		T0 + 8.0s	37 dBm	406.064 MHz
9C9D00001800037		T0 + 8.5s	37 dBm	406.070 MHz
9C9D00001900037		T0 + 9.0s	37 dBm	406.064 MHz
9C9D00002000037		T0 + 9.5s	37 dBm	406.070 MHz
………..		………….		
………..		………….		

………..		………….		
………..		………….		
………..		………….		
9C9D00009100037		T0 + 45s	37 dBm	406.064 MHz
9C9D00009200037		T0 + 45.5s	37 dBm	406.070 MHz
9C9D00009300037		T0 + 46.0s	37 dBm	406.064 MHz
9C9D00009400037		T0 + 46.5s	37 dBm	406.070 MHz
9C9D00009500037		T0 + 47.0s	37 dBm	406.064 MHz
9C9D00009600037		T0 + 47.5s	37 dBm	406.070 MHz
9C9D00009700037		T0 + 48.0s	37 dBm	406.064 MHz
9C9D00009800037		T0 + 48.5s	37 dBm	406.070 MHz
9C9D00009900037		T0 + 49.0s	37 dBm	406.064 MHz
9C9D00010000037		T0 + 49.5s	37 dBm	406.070 MHz

- END OF ANNEX G -

ANNEX H

TEST SCRIPT FOR TEST T-4

This annex provides a description of the test signals that have to be transmitted by a beacon simulator for objectives of T-4. The script is comprised of 100 beacon events which are transmitted with NB bursts, NB being from 1 to 7. The 100 beacon events for NB=1 are different from the 100 beacon events for NB=2, NB=3, etc.

These beacon events are intertwined in 28 periods of exactly 50s. The beacon events are spaced by 0.5s, using alternatively the 406.064 or 406.070 MHz frequencies.

The 15 Hex ID of beacon events are coded as follows: 9C9D00XYYY00037

- 9C9D00 : Fixed value for all beacon events
- X : NB burst
- YYY : Beacon event serial 001 to 100
- 000 : Fixed value for all beacon events
- 37 : value of emission power

The script thus defined has a duration of 1400s. The 28 periods of 50s are defined in detail as follows.

Period n°1

15 Hex ID	30 Hex message	Time of beacon burst	Emission power	Frequency
9C9D00600100037		T0	37 dBm	406.064 MHz
9C9D00700100037		T0 + 0.5s	37 dBm	406.070 MHz
9C9D00600200037		T0 + 1.0s	37 dBm	406.064 MHz
9C9D00700200037		T0 + 1.5s	37 dBm	406.070 MHz
9C9D00600300037		T0 + 2.0s	37 dBm	406.064 MHz
9C9D00700300037		T0 + 2.5s	37 dBm	406.070 MHz
9C9D00600400037		T0 + 3.0s	37 dBm	406.064 MHz
9C9D00700400037		T0 + 3.5s	37 dBm	406.070 MHz
9C9D00600500037		T0 + 4.0s	37 dBm	406.064 MHz
9C9D00700500037		T0 + 4.5s	37 dBm	406.070 MHz
…….				
9C9D00604600037		T0 + 45s	37 dBm	406.064 MHz
9C9D00704600037		T0 + 45.5s	37 dBm	406.070 MHz
9C9D00604700037		T0 + 46.0s	37 dBm	406.064 MHz
9C9D00704700037		T0 + 46.5s	37 dBm	406.070 MHz
9C9D00604800037		T0 + 47.0s	37 dBm	406.064 MHz
9C9D00704800037		T0 + 47.5s	37 dBm	406.070 MHz
9C9D00604900037		T0 + 48.0s	37 dBm	406.064 MHz
9C9D00704900037		T0 + 48.5s	37 dBm	406.070 MHz
9C9D00605000037		T0 + 49.0s	37 dBm	406.064 MHz
9C9D00705000037		T0 + 49.5s	37 dBm	406.070 MHz

The periods n° 2, 3, 4, 5 and 6 are identical to Period n°1 in respect of the list of IDs; they are transmitted at times To + 50s, To + 100s, To + 150s, To + 200s and To + 250s.

Period n°7

15 Hex ID	30 Hex message	Time of beacon burst	Emission power	Frequency
9C9D00605100037		T0 + 300.0s	37 dBm	406.064 MHz
9C9D00700100037		T0 + 300.5s	37 dBm	406.070 MHz
9C9D00605200037		T0 + 301.0s	37 dBm	406.064 MHz
9C9D00700200037		T0 + 301.5s	37 dBm	406.070 MHz
9C9D00605300037		T0 + 302.0s	37 dBm	406.064 MHz
9C9D00700300037		T0 + 302.5s	37 dBm	406.070 MHz
9C9D00605400037		T0 + 303.0s	37 dBm	406.064 MHz
9C9D00700400037		T0 + 303.5s	37 dBm	406.070 MHz
9C9D00605500037		T0 + 304.0s	37 dBm	406.064 MHz
9C9D00700500037		T0 + 304.5s	37 dBm	406.070 MHz
………..				
9C9D00609600037		T0 + 345.0s	37 dBm	406.064 MHz
9C9D00704600037		T0 + 345.5s	37 dBm	406.070 MHz
9C9D00609700037		T0 + 346.0s	37 dBm	406.064 MHz
9C9D00704700037		T0 + 346.5s	37 dBm	406.070 MHz
9C9D00609800037		T0 + 347.0s	37 dBm	406.064 MHz
9C9D00704800037		T0 + 347.5s	37 dBm	406.070 MHz
9C9D00609900037		T0 + 348.0s	37 dBm	406.064 MHz
9C9D00704900037		T0 + 348.5s	37 dBm	406.070 MHz
9C9D00610000037		T0 + 349.0s	37 dBm	406.064 MHz
9C9D00705000037		T0 + 349.5s	37 dBm	406.070 MHz

Period n°8

15 Hex ID	30 Hex message	Time of beacon burst	Emission power	Frequency
9C9D00605100037		T0 + 350.0s	37 dBm	406.064 MHz
9C9D00705100037		T0 + 350.5s	37 dBm	406.070 MHz
9C9D00605200037		T0 + 351.0s	37 dBm	406.064 MHz
9C9D00705200037		T0 + 351.5s	37 dBm	406.070 MHz
9C9D00605300037		T0 + 352.0s	37 dBm	406.064 MHz
9C9D00705300037		T0 + 352.5s	37 dBm	406.070 MHz
9C9D00605400037		T0 + 353.0s	37 dBm	406.064 MHz
9C9D00705400037		T0 + 353.5s	37 dBm	406.070 MHz
9C9D00605500037		T0 + 354.0s	37 dBm	406.064 MHz
9C9D00705500037		T0 + 354.5s	37 dBm	406.070 MHz
………..				
9C9D00609600037		T0 + 395.0s	37 dBm	406.064 MHz
9C9D00709600037		T0 + 395.5s	37 dBm	406.070 MHz
9C9D00609700037		T0 + 396.0s	37 dBm	406.064 MHz
9C9D00709700037		T0 + 396.5s	37 dBm	406.070 MHz
9C9D00609800037		T0 + 397.0s	37 dBm	406.064 MHz
9C9D00709800037		T0 + 397.5s	37 dBm	406.070 MHz
9C9D00609900037		T0 + 398.0s	37 dBm	406.064 MHz
9C9D00709900037		T0 + 398.5s	37 dBm	406.070 MHz
9C9D00610000037		T0 + 399.0s	37 dBm	406.064 MHz
9C9D00710000037		T0 + 399.5s	37 dBm	406.070 MHz

The periods n° 9, 10, 11, and 12 are identical to Period n°8 in respect of the list of IDs; they are transmitted at times To + 400s, To + 450s, To + 500s and To + 550s.

Period n°13

15 Hex ID	**30 Hex message**	**Time of beacon burst**	**Emission power**	**Frequency**
9C9D00500100037		T0 + 600.0s	37 dBm	406.064 MHz
9C9D00705100037		T0 + 600.5s	37 dBm	406.070 MHz
9C9D00500200037		T0 + 601.0s	37 dBm	406.064 MHz
9C9D00705200037		T0 + 601.5s	37 dBm	406.070 MHz
9C9D00500300037		T0 + 602.0s	37 dBm	406.064 MHz
9C9D00705300037		T0 + 602.5s	37 dBm	406.070 MHz
9C9D00500400037		T0 + 603.0s	37 dBm	406.064 MHz
9C9D00705400037		T0 + 603.5s	37 dBm	406.070 MHz
9C9D00500500037		T0 + 604.0s	37 dBm	406.064 MHz
9C9D00705500037		T0 + 604.5s	37 dBm	406.070 MHz
………..				
9C9D00504600037		T0 + 645.0s	37 dBm	406.064 MHz
9C9D00709600037		T0 + 645.5s	37 dBm	406.070 MHz
9C9D00504700037		T0 + 646.0s	37 dBm	406.064 MHz
9C9D00709700037		T0 + 646.5s	37 dBm	406.070 MHz
9C9D00504800037		T0 + 647.0s	37 dBm	406.064 MHz
9C9D00709800037		T0 + 647.5s	37 dBm	406.070 MHz
9C9D00504900037		T0 + 648.0s	37 dBm	406.064 MHz
9C9D00709900037		T0 + 648.5s	37 dBm	406.070 MHz
9C9D00505000037		T0 + 649.0s	37 dBm	406.064 MHz
9C9D00710000037		T0 + 649.5s	37 dBm	406.070 MHz

The period n° 14 is identical to Period n° 13 in respect of the list of IDs; it is transmitted at time To + 650s.

Period n°15

15 Hex ID	**30 Hex message**	**Time of beacon burst**	**Emission power**	**Frequency**
9C9D00500100037		T0 + 700.0s	37 dBm	406.064 MHz
9C9D00400100037		T0 + 700.5s	37 dBm	406.070 MHz
9C9D00500200037		T0 + 701.0s	37 dBm	406.064 MHz
9C9D00400200037		T0 + 701.5s	37 dBm	406.070 MHz
9C9D00500300037		T0 + 702.0s	37 dBm	406.064 MHz
9C9D00400300037		T0 + 702.5s	37 dBm	406.070 MHz
9C9D00500400037		T0 + 703.0s	37 dBm	406.064 MHz
9C9D00400400037		T0 + 703.5s	37 dBm	406.070 MHz
9C9D00500500037		T0 + 704.0s	37 dBm	406.064 MHz
9C9D00400500037		T0 + 704.5s	37 dBm	406.070 MHz
………..				
9C9D00504600037		T0 + 745.0s	37 dBm	406.064 MHz
9C9D00404600037		T0 + 745.5s	37 dBm	406.070 MHz
9C9D00504700037		T0 + 746.0s	37 dBm	406.064 MHz
9C9D00404700037		T0 + 746.5s	37 dBm	406.070 MHz
9C9D00504800037		T0 + 747.0s	37 dBm	406.064 MHz
9C9D00404800037		T0 + 747.5s	37 dBm	406.070 MHz
9C9D00504900037		T0 + 748.0s	37 dBm	406.064 MHz
9C9D00404900037		T0 + 748.5s	37 dBm	406.070 MHz
9C9D00505000037		T0 + 749.0s	37 dBm	406.064 MHz
9C9D00405000037		T0 + 749.5s	37 dBm	406.070 MHz

The periods n° 16 and 17 are identical to Period n° 15 in respect of the list of IDs; they are transmitted at times To + 750s and To + 800s.

Period n°18

15 Hex ID	30 Hex message	Time of beacon burst	Emission power	Frequency
9C9D00505100037		T0 + 850.0s	37 dBm	406.064 MHz
9C9D00400100037		T0 + 850.5s	37 dBm	406.070 MHz
9C9D00505200037		T0 + 851.0s	37 dBm	406.064 MHz
9C9D00400200037		T0 + 851.5s	37 dBm	406.070 MHz
9C9D00505300037		T0 + 852.0s	37 dBm	406.064 MHz
9C9D00400300037		T0 + 852.5s	37 dBm	406.070 MHz
9C9D00505400037		T0 + 853.0s	37 dBm	406.064 MHz
9C9D00400400037		T0 + 853.5s	37 dBm	406.070 MHz
9C9D00505500037		T0 + 854.0s	37 dBm	406.064 MHz
9C9D00400505037		T0 + 854.5s	37 dBm	406.070 MHz
………..				
9C9D00509600037		T0 + 895.0s	37 dBm	406.064 MHz
9C9D00404600037		T0 + 895.5s	37 dBm	406.070 MHz
9C9D00509700037		T0 + 896.0s	37 dBm	406.064 MHz
9C9D00404700037		T0 + 896.5s	37 dBm	406.070 MHz
9C9D00509800037		T0 + 897.0s	37 dBm	406.064 MHz
9C9D00404800037		T0 + 897.5s	37 dBm	406.070 MHz
9C9D00509900037		T0 + 898.0s	37 dBm	406.064 MHz
9C9D00404900037		T0 + 898.5s	37 dBm	406.070 MHz
9C9D00510000037		T0 + 899.0s	37 dBm	406.064 MHz
9C9D00405000037		T0 + 899.5s	37 dBm	406.070 MHz

Period n°19

15 Hex ID	30 Hex message	Time of beacon burst	Emission power	Frequency
9C9D00505100037		T0 + 900.0s	37 dBm	406.064 MHz
9C9D00405100037		T0 + 900.5s	37 dBm	406.070 MHz
9C9D00505200037		T0 + 901.0s	37 dBm	406.064 MHz
9C9D00405200037		T0 + 901.5s	37 dBm	406.070 MHz
9C9D00505300037		T0 + 902.0s	37 dBm	406.064 MHz
9C9D00405300037		T0 + 902.5s	37 dBm	406.070 MHz
9C9D00505400037		T0 + 903.0s	37 dBm	406.064 MHz
9C9D00405400037		T0 + 903.5s	37 dBm	406.070 MHz
9C9D00505500037		T0 + 904.0s	37 dBm	406.064 MHz
9C9D00405505037		T0 + 904.5s	37 dBm	406.070 MHz
………..				
9C9D00509600037		T0 + 945.0s	37 dBm	406.064 MHz
9C9D00409600037		T0 + 945.5s	37 dBm	406.070 MHz
9C9D00509700037		T0 + 946.0s	37 dBm	406.064 MHz
9C9D00409700037		T0 + 946.5s	37 dBm	406.070 MHz
9C9D00509800037		T0 + 947.0s	37 dBm	406.064 MHz
9C9D00409800037		T0 + 947.5s	37 dBm	406.070 MHz
9C9D00509900037		T0 + 948.0s	37 dBm	406.064 MHz
9C9D00409900037		T0 + 948.5s	37 dBm	406.070 MHz
9C9D00510000037		T0 + 949.0s	37 dBm	406.064 MHz
9C9D00410000037		T0 + 949.5s	37 dBm	406.070 MHz

The periods n° 20, 21 and 22 are identical to Period n° 19 in respect of the list of IDs; they are transmitted at times To + 950s, To + 1000s and To + 1050s.

Period n°23

15 Hex ID	30 Hex message	Time of beacon burst	Emission power	Frequency
9C9D00300100037		T0 + 1100.0s	37 dBm	406.064 MHz
9C9D00200100037		T0 + 1100.5s	37 dBm	406.070 MHz
9C9D00300200037		T0 + 1101.0s	37 dBm	406.064 MHz
9C9D00200200037		T0 + 1101.5s	37 dBm	406.070 MHz
9C9D00300300037		T0 + 1102.0s	37 dBm	406.064 MHz
9C9D00200300037		T0 + 1102.5s	37 dBm	406.070 MHz
9C9D00300400037		T0 + 1103.0s	37 dBm	406.064 MHz
9C9D00200400037		T0 + 1103.5s	37 dBm	406.070 MHz
9C9D00300500037		T0 + 1104.0s	37 dBm	406.064 MHz
9C9D00200500037		T0 + 1104.5s	37 dBm	406.070 MHz
………..				
9C9D00304600037		T0 + 1145.0s	37 dBm	406.064 MHz
9C9D00204600037		T0 + 1145.5s	37 dBm	406.070 MHz
9C9D00304700037		T0 + 1146.0s	37 dBm	406.064 MHz
9C9D00204700037		T0 + 1146.5s	37 dBm	406.070 MHz
9C9D00304800037		T0 + 1147.0s	37 dBm	406.064 MHz
9C9D00204800037		T0 + 1147.5s	37 dBm	406.070 MHz
9C9D00304900037		T0 + 1148.0s	37 dBm	406.064 MHz
9C9D00204900037		T0 + 1148.5s	37 dBm	406.070 MHz
9C9D00305000037		T0 + 1149.0s	37 dBm	406.064 MHz
9C9D00205000037		T0 + 1149.5s	37 dBm	406.070 MHz

The period n° 24 is identical to Period n° 23 in respect of the list of IDs; it is transmitted at times To + 1150s.

Period n°25

15 Hex ID	30 Hex message	Time of beacon burst	Emission power	Frequency
9C9D00300100037		T0 + 1200.0s	37 dBm	406.064 MHz
9C9D00205100037		T0 + 1200.5s	37 dBm	406.070 MHz
9C9D00300205037		T0 + 1201.0s	37 dBm	406.064 MHz
9C9D00205200037		T0 + 1201.5s	37 dBm	406.070 MHz
9C9D00300300037		T0 + 1202.0s	37 dBm	406.064 MHz
9C9D00205300037		T0 + 1202.5s	37 dBm	406.070 MHz
9C9D00300400037		T0 + 1203.0s	37 dBm	406.064 MHz
9C9D00205400037		T0 + 1203.5s	37 dBm	406.070 MHz
9C9D00300500037		T0 + 1204.0s	37 dBm	406.064 MHz
9C9D00205500037		T0 + 1204.5s	37 dBm	406.070 MHz
………..				
9C9D00304600037		T0 + 1245.0s	37 dBm	406.064 MHz
9C9D00209600037		T0 + 1245.5s	37 dBm	406.070 MHz
9C9D00304700037		T0 + 1246.0s	37 dBm	406.064 MHz
9C9D00209700037		T0 + 1246.5s	37 dBm	406.070 MHz
9C9D00304800037		T0 + 1247.0s	37 dBm	406.064 MHz
9C9D00209800037		T0 + 1247.5s	37 dBm	406.070 MHz
9C9D00304900037		T0 + 1248.0s	37 dBm	406.064 MHz
9C9D00209900037		T0 + 1248.5s	37 dBm	406.070 MHz
9C9D00305000037		T0 + 1249.0s	37 dBm	406.064 MHz
9C9D00210000037		T0 + 1249.5s	37 dBm	406.070 MHz

Period n°26

15 Hex ID	**30 Hex message**	**Time of beacon burst**	**Emission power**	**Frequency**
9C9D00305100037		T0 + 1250.0s	37 dBm	406.064 MHz
9C9D00205100037		T0 + 1250.5s	37 dBm	406.070 MHz
9C9D00305205037		T0 + 1251.0s	37 dBm	406.064 MHz
9C9D00205200037		T0 + 1251.5s	37 dBm	406.070 MHz
9C9D00305300037		T0 + 1252.0s	37 dBm	406.064 MHz
9C9D00205300037		T0 + 1252.5s	37 dBm	406.070 MHz
9C9D00305400037		T0 + 1253.0s	37 dBm	406.064 MHz
9C9D00205400037		T0 + 1253.5s	37 dBm	406.070 MHz
9C9D00305500037		T0 + 1254.0s	37 dBm	406.064 MHz
9C9D00205500037		T0 + 1254.5s	37 dBm	406.070 MHz
………..				
9C9D00309600037		T0 + 1295.0s	37 dBm	406.064 MHz
9C9D00209600037		T0 + 1295.5s	37 dBm	406.070 MHz
9C9D00309700037		T0 + 1296.0s	37 dBm	406.064 MHz
9C9D00209700037		T0 + 1296.5s	37 dBm	406.070 MHz
9C9D00309800037		T0 + 1297.0s	37 dBm	406.064 MHz
9C9D00209800037		T0 + 1297.5s	37 dBm	406.070 MHz
9C9D00309900037		T0 + 1298.0s	37 dBm	406.064 MHz
9C9D00209900037		T0 + 1298.5s	37 dBm	406.070 MHz
9C9D00310000037		T0 + 1299.0s	37 dBm	406.064 MHz
9C9D00210000037		T0 + 1299.5s	37 dBm	406.070 MHz

Period n°27

15 Hex ID	**30 Hex message**	**Time of beacon burst**	**Emission power**	**Frequency**
9C9D00305100037		T0 + 1300.0s	37 dBm	406.064 MHz
9C9D00100100037		T0 + 1300.5s	37 dBm	406.070 MHz
9C9D00305205037		T0 + 1301.0s	37 dBm	406.064 MHz
9C9D00100200037		T0 + 1301.5s	37 dBm	406.070 MHz
9C9D00305300037		T0 + 1302.0s	37 dBm	406.064 MHz
9C9D00100300037		T0 + 1302.5s	37 dBm	406.070 MHz
9C9D00305400037		T0 + 1303.0s	37 dBm	406.064 MHz
9C9D00100400037		T0 + 1303.5s	37 dBm	406.070 MHz
9C9D00305500037		T0 + 1304.0s	37 dBm	406.064 MHz
9C9D00100500037		T0 + 1304.5s	37 dBm	406.070 MHz
………..				
9C9D00309600037		T0 + 1345.0s	37 dBm	406.064 MHz
9C9D00104600037		T0 + 1345.5s	37 dBm	406.070 MHz
9C9D00309700037		T0 + 1346.0s	37 dBm	406.064 MHz
9C9D00104700037		T0 + 1346.5s	37 dBm	406.070 MHz
9C9D00309800037		T0 + 1347.0s	37 dBm	406.064 MHz
9C9D00104800037		T0 + 1347.5s	37 dBm	406.070 MHz
9C9D00309900037		T0 + 1348.0s	37 dBm	406.064 MHz
9C9D00104900037		T0 + 1348.5s	37 dBm	406.070 MHz
9C9D00310000037		T0 + 1349.0s	37 dBm	406.064 MHz
9C9D00105000037		T0 + 1349.5s	37 dBm	406.070 MHz

Period n°28

15 Hex ID	**30 Hex message**	**Time of beacon burst**	**Emission power**	**Frequency**
9C9D00305100037		T0 + 1350.0s	37 dBm	406.064 MHz
9C9D00105100037		T0 + 1350.5s	37 dBm	406.070 MHz
9C9D00305205037		T0 + 1351.0s	37 dBm	406.064 MHz
9C9D00105200037		T0 + 1351.5s	37 dBm	406.070 MHz
9C9D00305300037		T0 + 1352.0s	37 dBm	406.064 MHz
9C9D00105300037		T0 + 1352.5s	37 dBm	406.070 MHz
9C9D00305400037		T0 + 1353.0s	37 dBm	406.064 MHz
9C9D00105400037		T0 + 1353.5s	37 dBm	406.070 MHz
9C9D00305500037		T0 + 1354.0s	37 dBm	406.064 MHz
9C9D00105500037		T0 + 1354.5s	37 dBm	406.070 MHz
………..				
9C9D00309600037		T0 + 1395.0s	37 dBm	406.064 MHz
9C9D00109600037		T0 + 1395.5s	37 dBm	406.070 MHz
9C9D00309700037		T0 + 1396.0s	37 dBm	406.064 MHz
9C9D00109700037		T0 + 1396.5s	37 dBm	406.070 MHz
9C9D00309800037		T0 + 1397.0s	37 dBm	406.064 MHz
9C9D00109800037		T0 + 1397.5s	37 dBm	406.070 MHz
9C9D00309900037		T0 + 1398.0s	37 dBm	406.064 MHz
9C9D00109900037		T0 + 1398.5s	37 dBm	406.070 MHz
9C9D00310000037		T0 + 1399.0s	37 dBm	406.064 MHz
9C9D00110000037		T0 + 1399.5s	37 dBm	406.070 MHz

- END OF ANNEX H -

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ANNEX I

TEST SCRIPT FOR TEST T-6

This annex provides a description of the test signals that have to be transmitted by a beacon simulator for capacity testing T-6. There is one script for each value of NB, the number of beacons simultaneously active (NB = 25, 50, 75 or 100). Each script has a duration of 350s (7 bursts*50s). The four scripts needed for testing the four capacity levels (NB = 25, 50, 75 and 100) require a time slot lasting 1400s (4*350s). To obtain sufficient data, the four scripts are performed four times. The IDs in the script for NB = 50, 75 and 100 are different to clearly separate the locations.

The beacon event N° X is transmitted at T = T0 + (X-1)*DeltaT, DeltaT being a random real value within the range [0, 50/NB sec].
Each beacon event is transmitted at the frequency 406.049 MHz + CH*3 KHz, CH being a random integer value within the range [0, 11].
The 7 bursts of each beacon event are spaced by 50s + Rep, Rep being a random real value within the range [- 2.5s, + 2.5s].

The 15 Hex ID of beacon events are coded as follows: 9C9D00XXXYYY037

- 9C9D00 : Fixed value for all beacon events
- XXX : Beacon event serial 001 to NB
- YYY : NB value (025, 050, 075 or 100)
- 0 : Fixed value for all beacon events
- 37 : value of emission power

Test script for NB = 25 simultaneous beacons (Part 1: Time and Frequency)

15 Hex ID of Beacon	30 Hex beacon message	Time of bcn burst T0 + Xsec	Frequency MHz
9C9D00001025037		0,00	406,076
9C9D00002025037		1,37	406,073
9C9D00003025037		2,19	406,064
9C9D00004025037		5,70	406,061
9C9D00005025037		6,13	406,082
9C9D00006025037		8,40	406,052
9C9D00007025037		11,79	406,082
9C9D00008025037		12,97	406,076
9C9D00009025037		14,57	406,058
9C9D00010025037		17,57	406,052
9C9D00011025037		19,58	406,070
9C9D00012025037		20,07	406,070
9C9D00013025037		23,85	406,070
9C9D00014025037		24,70	406,073
9C9D00015025037		27,99	406,073
9C9D00016025037		28,29	406,058
9C9D00017025037		30,71	406,082
9C9D00018025037		32,79	406,061
9C9D00019025037		35,24	406,064
9C9D00020025037		36,44	406,067
9C9D00021025037		39,99	406,064
9C9D00022025037		41,55	406,082
9C9D00023025037		42,27	406,064
9C9D00024025037		44,64	406,067
9C9D00025025037		47,13	406,070

Test script for NB = 25 simultaneous beacons (Part 2: Repetition intervals)

15 Hex ID of Beacon	1st repetition interval	2nd repetition interval	3rd repetition interval	4nd repetition interval	5nd repetition interval	6rd repetition interval
9C9D00001025037	49,28	47,57	48,43	48,39	48,53	49,81
9C9D00002025037	48,50	51,73	48,88	50,88	49,04	50,07
9C9D00003025037	51,82	47,96	47,93	49,48	50,25	51,25
9C9D00004025037	48,42	52,16	52,44	50,91	49,93	48,14
9C9D00005025037	49,81	50,04	51,90	51,85	47,56	49,97
9C9D00006025037	50,69	50,79	51,77	52,03	50,86	51,95
9C9D00007025037	51,25	50,45	49,08	52,49	48,88	51,72
9C9D00008025037	48,07	49,72	52,34	50,80	51,61	49,39
9C9D00009025037	49,22	49,14	51,23	49,23	52,07	49,07
9C9D00010025037	50,84	50,25	49,12	48,65	48,39	50,03
9C9D00011025037	48,16	49,29	49,83	49,38	51,21	48,89
9C9D00012025037	47,53	51,94	49,37	47,61	51,51	50,60
9C9D00013025037	48,52	49,28	52,41	48,96	51,14	51,78
9C9D00014025037	50,14	48,10	52,28	49,54	48,00	48,22
9C9D00015025037	50,79	50,85	51,32	47,91	51,20	52,33
9C9D00016025037	48,62	51,60	50,25	51,32	49,36	52,33
9C9D00017025037	52,04	52,05	48,66	47,85	49,13	49,07
9C9D00018025037	51,18	50,21	50,05	49,96	51,18	51,02
9C9D00019025037	47,68	51,91	51,68	48,64	48,01	50,82
9C9D00020025037	52,06	51,26	52,47	49,88	50,92	48,80
9C9D00021025037	51,55	50,41	50,86	51,99	52,48	51,76
9C9D00022025037	49,88	50,13	51,20	48,57	50,73	47,89
9C9D00023025037	48,02	51,56	49,29	52,15	47,71	50,87
9C9D00024025037	51,10	49,55	48,38	50,72	51,89	47,54
9C9D00025025037	47,69	48,13	51,32	51,34	49,07	47,97

Test script for NB = 50 simultaneous beacons (Part 1: Time and Frequency)

15 Hex ID of Beacon	30 Hex Beacon Message	Time of Beacon Burst T0 + Xsec	Frequency MHz
9C9D00001050037		0,00	406,049
9C9D00002050037		0,16	406,070
9C9D00003050037		1,25	406,067
9C9D00004050037		2,84	406,061
9C9D00005050037		3,05	406,079
9C9D00006050037		4,53	406,052
9C9D00007050037		5,30	406,073
9C9D00008050037		6,57	406,055
9C9D00009050037		7,85	406,067
9C9D00010050037		8,12	406,064
9C9D00011050037		9,79	406,073
9C9D00012050037		10,68	406,055
9C9D00013050037		11,68	406,070
9C9D00014050037		12,89	406,070
9C9D00015050037		13,50	406,073
9C9D00016050037		14,65	406,058
9C9D00017050037		15,38	406,052
9C9D00018050037		16,87	406,082
9C9D00019050037		17,76	406,061
9C9D00020050037		18,51	406,064
9C9D00021050037		19,35	406,064
9C9D00022050037		20,73	406,064
9C9D00023050037		21,95	406,073
9C9D00024050037		22,06	406,055
9C9D00025050037		23,44	406,064
9C9D00026050037		24,80	406,070
9C9D00027050037		25,38	406,058
9C9D00028050037		26,14	406,079
9C9D00029050037		27,91	406,073
9C9D00030050037		28,11	406,073
9C9D00031050037		29,85	406,058
9C9D00032050037		30,65	406,073
9C9D00033050037		31,44	406,073
9C9D00034050037		32,20	406,082
9C9D00035050037		33,29	406,073
9C9D00036050037		34,83	406,073
9C9D00037050037		35,87	406,058
9C9D00038050037		36,85	406,055
9C9D00039050037		37,70	406,082
9C9D00040050037		38,46	406,055
9C9D00041050037		39,13	406,055
9C9D00042050037		40,86	406,067
9C9D00043050037		41,32	406,082
9C9D00044050037		42,85	406,049
9C9D00045050037		43,58	406,073
9C9D00046050037		44,22	406,058
9C9D00047050037		45,02	406,073
9C9D00048050037		46,38	406,049
9C9D00049050037		47,77	406,076
9C9D00050050037		48,80	406,073

Test script for NB = 50 simultaneous beacons (Part 2: Repetition intervals)

15 Hex ID of Beacon	**1st repetition interval**	**2nd repetition interval**	**3rd repetition interval**	**4nd repetition interval**	**5nd repetition interval**	**6rd repetition interval**
9C9D00001050037	47,68	49,58	48,26	49,20	48,23	49,36
9C9D00002050037	50,23	47,60	50,53	52,43	48,58	50,64
9C9D00003050037	48,47	48,00	52,11	47,99	47,84	48,28
9C9D00004050037	50,32	50,46	48,33	49,67	49,73	48,65
9C9D00005050037	52,39	50,08	52,21	51,27	52,32	49,47
9C9D00006050037	49,35	51,35	50,81	52,09	48,16	49,07
9C9D00007050037	47,65	49,68	48,35	47,87	51,40	48,21
9C9D00008050037	47,97	48,54	47,56	50,38	49,97	48,27
9C9D00009050037	49,58	49,12	48,80	50,65	48,32	48,34
9C9D00010050037	51,22	50,87	52,19	50,74	48,15	50,43
9C9D00011050037	49,76	50,35	49,37	48,00	48,45	49,00
9C9D00012050037	50,80	49,34	50,88	51,02	49,91	49,51
9C9D00013050037	50,26	48,95	51,61	50,02	52,39	51,36
9C9D00014050037	51,92	51,73	51,24	50,80	48,08	51,82
9C9D00015050037	50,65	50,86	51,09	51,81	48,50	47,95
9C9D00016050037	49,26	50,42	47,61	51,81	48,59	48,52
9C9D00017050037	47,66	47,75	48,24	50,04	50,74	50,06
9C9D00018050037	49,88	49,37	50,44	51,04	49,05	50,74
9C9D00019050037	49,11	47,82	49,89	49,40	50,90	51,85
9C9D00020050037	51,26	50,10	50,10	49,33	51,89	51,25
9C9D00021050037	49,62	49,82	52,30	51,39	51,14	50,80
9C9D00022050037	52,41	49,17	49,44	52,05	52,27	48,77
9C9D00023050037	50,18	51,42	48,28	48,17	48,68	48,99
9C9D00024050037	50,99	48,75	51,10	48,23	47,89	47,75
9C9D00025050037	48,56	48,01	47,68	48,57	51,08	49,29
9C9D00026050037	48,11	50,56	48,72	50,13	51,82	51,13
9C9D00027050037	50,61	50,85	49,25	47,88	52,43	48,00
9C9D00028050037	47,89	50,23	50,83	50,65	48,21	47,75
9C9D00029050037	49,77	48,90	49,59	51,36	48,05	48,01
9C9D00030050037	49,85	47,71	50,47	48,31	50,23	51,07
9C9D00031050037	50,23	49,33	52,43	52,03	48,24	48,59
9C9D00032050037	47,53	48,73	48,03	50,01	49,81	51,72
9C9D00033050037	47,71	51,64	50,34	49,57	51,94	49,18
9C9D00034050037	50,00	47,95	51,08	49,88	49,68	48,11
9C9D00035050037	48,07	48,73	52,21	50,38	51,41	48,51
9C9D00036050037	52,00	52,46	48,92	49,49	48,12	51,23
9C9D00037050037	47,52	49,63	50,31	52,08	48,29	49,32
9C9D00038050037	52,40	48,38	49,73	48,95	49,66	48,86
9C9D00039050037	50,76	47,82	50,65	49,73	48,06	48,68
9C9D00040050037	52,24	47,53	47,59	48,94	51,63	50,02
9C9D00041050037	48,76	48,53	49,41	51,04	49,80	51,66
9C9D00042050037	49,27	52,09	49,13	50,55	47,79	47,54
9C9D00043050037	51,38	48,48	47,99	47,99	50,94	51,32
9C9D00044050037	50,91	49,20	48,38	51,59	51,40	49,25
9C9D00045050037	48,66	50,64	48,49	49,40	49,67	47,67
9C9D00046050037	51,32	47,62	48,66	52,48	49,97	49,03
9C9D00047050037	48,21	50,64	48,79	51,90	52,08	51,11
9C9D00048050037	52,39	49,98	49,47	48,72	49,78	50,77
9C9D00049050037	51,45	48,04	49,45	48,93	50,75	50,76
9C9D00050050037	48,39	50,60	50,25	48,13	51,71	48,59

Test script for NB = 75 simultaneous beacons (Part 1: Time and Frequency)

15 Hex ID of Beacon	30 Hex beacon message	Time of bcn burst T0 + Xsec	Frequency MHz
9C9D00001075037		0,00	406,064
9C9D00002075037		0,18	406,049
9C9D00003075037		1,22	406,079
9C9D00004075037		1,67	406,055
9C9D00005075037		2,43	406,073
9C9D00006075037		2,84	406,061
9C9D00007075037		3,90	406,070
9C9D00008075037		4,25	406,058
9C9D00009075037		4,95	406,064
9C9D00010075037		5,56	406,082
9C9D00011075037		6,51	406,064
9C9D00012075037		6,77	406,064
9C9D00013075037		7,80	406,070
9C9D00014075037		8,28	406,082
9C9D00015075037		9,08	406,082
9C9D00016075037		9,65	406,064
9C9D00017075037		10,28	406,070
9C9D00018075037		10,94	406,082
9C9D00019075037		11,52	406,052
9C9D00020075037		12,13	406,067
9C9D00021075037		13,32	406,064
9C9D00022075037		13,92	406,055
9C9D00023075037		14,60	406,061
9C9D00024075037		15,23	406,058
9C9D00025075037		15,71	406,076
9C9D00026075037		16,29	406,079
9C9D00027075037		17,17	406,055
9C9D00028075037		17,43	406,052
9C9D00029075037		18,09	406,055
9C9D00030075037		18,88	406,049
9C9D00031075037		19,92	406,064
9C9D00032075037		20,31	406,058
9C9D00033075037		20,95	406,076
9C9D00034075037		21,47	406,073
9C9D00035075037		22,56	406,079
9C9D00036075037		22,71	406,070
9C9D00037075037		23,71	406,061
9C9D00038075037		24,21	406,082
9C9D00039075037		25,12	406,055
9C9D00040075037		25,85	406,070
9C9D00041075037		26,43	406,064
9C9D00042075037		27,25	406,079
9C9D00043075037		27,56	406,052
9C9D00044075037		28,00	406,070
9C9D00045075037		28,91	406,082
9C9D00046075037		29,45	406,079
9C9D00047075037		30,49	406,055
9C9D00048075037		30,70	406,082
9C9D00049075037		31,74	406,061
9C9D00050075037		32,41	406,076

Test script for NB = 75 simultaneous beacons (Part 1: Time and Frequency continued)

15 Hex ID of Beacon	30 Hex beacon message	Time of bcn burst T0 + Xsec	Frequency MHz
9C9D00051075037		32,70	406,064
9C9D00052075037		33,52	406,067
9C9D00053075037		34,63	406,079
9C9D00054075037		35,03	406,079
9C9D00055075037		35,76	406,070
9C9D00056075037		36,47	406,073
9C9D00057075037		37,30	406,079
9C9D00058075037		37,70	406,052
9C9D00059075037		38,12	406,052
9C9D00060075037		38,76	406,076
9C9D00061075037		39,35	406,073
9C9D00062075037		40,51	406,058
9C9D00063075037		40,85	406,058
9C9D00064075037		41,57	406,058
9C9D00065075037		42,50	406,049
9C9D00066075037		43,30	406,058
9C9D00067075037		43,73	406,058
9C9D00068075037		44,34	406,070
9C9D00069075037		45,20	406,076
9C9D00070075037		45,44	406,064
9C9D00071075037		46,51	406,049
9C9D00072075037		47,13	406,061
9C9D00073075037		47,94	406,055
9C9D00074075037		48,36	406,064
9C9D00075075037		49,12	406,076

Test script for NB = 75 simultaneous beacons (Part 2: Repetition intervals)

15 Hex ID of Beacon	1st repetition interval	2nd repetition interval	3rd repetition interval	4nd repetition interval	5nd repetition interval	6rd repetition interval
9C9D00001075037	51,52	48,50	51,44	52,07	48,76	48,01
9C9D00002075037	48,74	52,20	47,93	47,54	52,07	52,43
9C9D00003075037	47,56	49,32	50,01	47,83	49,99	49,25
9C9D00004075037	52,30	47,61	48,74	51,54	49,64	48,48
9C9D00005075037	49,06	52,00	49,00	50,33	50,77	49,44
9C9D00006075037	49,99	48,37	49,06	52,18	48,16	48,48
9C9D00007075037	47,98	51,60	52,03	48,95	51,79	50,25
9C9D00008075037	48,06	51,08	51,37	50,82	48,58	49,33
9C9D00009075037	48,19	49,70	51,95	48,72	52,31	50,77
9C9D00010075037	50,33	48,49	51,83	49,69	52,47	50,02
9C9D00011075037	48,80	48,05	51,29	50,31	51,94	50,05
9C9D00012075037	50,92	47,64	49,10	49,08	51,37	51,64
9C9D00013075037	51,46	51,35	48,43	48,32	50,55	51,64
9C9D00014075037	48,56	48,63	49,54	51,45	47,98	50,09
9C9D00015075037	47,64	49,21	47,89	51,21	49,58	50,98
9C9D00016075037	47,81	51,26	48,30	50,58	49,62	50,09
9C9D00017075037	50,87	51,15	48,07	51,10	47,89	49,59
9C9D00018075037	50,83	50,99	49,82	49,73	51,90	50,65
9C9D00019075037	51,42	48,44	49,14	49,89	51,80	52,09
9C9D00020075037	49,19	47,96	52,44	52,23	51,44	51,22
9C9D00021075037	49,42	48,06	48,99	49,89	49,02	52,25
9C9D00022075037	49,64	47,54	48,67	51,48	51,43	51,21
9C9D00023075037	51,00	49,46	52,08	51,02	48,87	49,21
9C9D00024075037	49,27	51,64	49,51	49,16	50,23	49,34
9C9D00025075037	49,88	50,32	52,26	47,53	48,19	49,80
9C9D00026075037	49,74	49,71	49,59	47,62	51,14	47,51
9C9D00027075037	49,72	50,50	49,03	49,42	51,61	50,39
9C9D00028075037	52,16	50,57	49,62	51,16	52,43	48,39
9C9D00029075037	50,63	49,29	47,93	49,21	52,04	50,91
9C9D00030075037	49,41	48,81	51,04	51,10	48,39	51,92
9C9D00031075037	48,44	51,96	51,22	48,78	50,05	48,23
9C9D00032075037	52,26	50,70	48,23	48,41	51,25	48,03
9C9D00033075037	49,21	51,61	51,60	51,94	49,14	49,65
9C9D00034075037	49,33	48,96	51,91	50,02	48,82	48,55
9C9D00035075037	50,95	47,70	49,26	48,16	48,28	50,62
9C9D00036075037	52,20	48,61	49,96	52,10	50,75	51,43
9C9D00037075037	48,53	49,30	49,47	50,17	48,64	52,05
9C9D00038075037	49,95	52,34	48,85	51,11	50,36	49,49
9C9D00039075037	49,45	52,38	52,05	50,46	51,58	52,26
9C9D00040075037	52,15	52,41	50,27	49,66	47,93	51,23
9C9D00041075037	48,07	49,75	47,56	51,65	50,88	47,80
9C9D00042075037	51,60	50,22	49,84	48,17	50,70	47,51
9C9D00043075037	52,25	50,92	49,44	49,72	50,42	49,52
9C9D00044075037	50,04	52,35	49,21	49,74	51,21	48,88
9C9D00045075037	50,31	48,97	48,40	48,97	51,55	52,09
9C9D00046075037	51,71	47,50	50,69	48,48	49,59	48,89
9C9D00047075037	47,52	49,61	51,04	52,48	49,71	49,67
9C9D00048075037	50,45	47,70	51,34	51,61	50,84	49,63
9C9D00049075037	50,59	50,82	51,78	52,19	50,04	51,99
9C9D00050075037	48,70	51,95	49,19	49,75	52,40	48,26

Test script for NB = 75 simultaneous beacons (Part 2: Repetition intervals continued)

15 Hex ID of bcn	1st repetition interval	2nd repetition interval	3rd repetition interval	4nd repetition interval	5nd repetition interval	6rd repetition interval
9C9D00051075037	48,47	51,62	51,77	50,76	51,24	49,10
9C9D00052075037	50,65	48,46	48,65	50,77	50,86	48,20
9C9D00053075037	52,34	47,74	51,39	52,22	52,43	51,07
9C9D00054075037	50,65	52,02	51,70	52,28	49,53	48,62
9C9D00055075037	48,75	50,95	50,56	50,66	52,24	51,13
9C9D00056075037	48,87	48,11	48,54	50,28	51,51	48,12
9C9D00057075037	48,43	51,76	49,73	48,58	51,45	48,24
9C9D00058075037	52,23	48,48	48,84	48,95	48,03	51,42
9C9D00059075037	51,47	50,80	48,52	49,01	48,15	48,44
9C9D00060075037	49,58	49,66	51,14	48,96	51,27	50,69
9C9D00061075037	48,38	51,89	51,11	48,07	47,70	52,24
9C9D00062075037	49,69	47,64	50,71	52,43	49,67	51,29
9C9D00063075037	48,74	47,55	51,20	49,34	48,85	48,80
9C9D00064075037	51,42	52,10	50,64	49,88	47,66	50,23
9C9D00065075037	47,54	51,72	50,14	51,94	50,12	49,69
9C9D00066075037	51,58	47,76	50,69	50,53	49,86	48,93
9C9D00067075037	50,48	52,49	52,34	48,63	47,97	50,11
9C9D00068075037	50,69	50,94	49,86	52,18	49,32	48,59
9C9D00069075037	51,07	49,41	50,98	50,39	50,09	49,96
9C9D00070075037	50,14	51,62	51,08	48,02	49,34	48,54
9C9D00071075037	48,67	52,41	50,35	49,96	50,18	51,85
9C9D00072075037	48,17	49,22	50,47	49,64	51,70	51,08
9C9D00073075037	50,72	48,65	48,58	50,52	49,60	50,56
9C9D00074075037	51,93	51,88	50,87	50,85	47,88	51,39
9C9D00075075037	52,45	50,64	51,40	50,10	49,42	50,02

Test script NB = 100 simultaneous beacons (Part 1: Time and Frequency)

15 Hex ID of bcn	30 Hex beacon message	Time of bcn burst T0 + Xsec	Frequency MHz
9C9D00001100037		0,00	406,073
9C9D00002100037		0,12	406,049
9C9D00003100037		0,83	406,049
9C9D00004100037		1,44	406,082
9C9D00005100037		1,74	406,073
9C9D00006100037		2,08	406,079
9C9D00007100037		2,55	406,064
9C9D00008100037		3,05	406,061
9C9D00009100037		3,57	406,058
9C9D00010100037		4,38	406,049
9C9D00011100037		4,66	406,049
9C9D00012100037		5,44	406,082
9C9D00013100037		5,58	406,073
9C9D00014100037		6,44	406,082
9C9D00015100037		6,73	406,055
9C9D00016100037		7,36	406,073
9C9D00017100037		7,91	406,076
9C9D00018100037		8,27	406,061
9C9D00019100037		8,69	406,052
9C9D00020100037		9,46	406,076
9C9D00021100037		9,72	406,049
9C9D00022100037		10,03	406,073
9C9D00023100037		10,69	406,052
9C9D00024100037		11,44	406,064
9C9D00025100037		11,63	406,079
9C9D00026100037		12,18	406,049
9C9D00027100037		12,56	406,073
9C9D00028100037		13,00	406,052
9C9D00029100037		13,76	406,052
9C9D00030100037		14,05	406,052
9C9D00031100037		14,52	406,073
9C9D00032100037		15,28	406,076
9C9D00033100037		15,80	406,070
9C9D00034100037		16,12	406,064
9C9D00035100037		16,74	406,049
9C9D00036100037		17,16	406,067
9C9D00037100037		17,55	406,058
9C9D00038100037		18,08	406,067
9C9D00039100037		18,78	406,058
9C9D00040100037		19,42	406,067
9C9D00041100037		19,93	406,049
9C9D00042100037		20,14	406,070
9C9D00043100037		20,73	406,055
9C9D00044100037		21,47	406,067
9C9D00045100037		21,51	406,055
9C9D00046100037		22,21	406,067
9C9D00047100037		22,77	406,082
9C9D00048100037		23,15	406,058
9C9D00049100037		23,87	406,082
9C9D00050100037		24,13	406,082

Test script for NB = 100 simultaneous beacons (Part 1: Time and Frequency continued)

15 Hex ID of bcn	30 Hex beacon message	Time of bcn burst T0 + Xsec	Frequency MHz
9C9D00051100037		24,63	406,070
9C9D00052100037		25,05	406,061
9C9D00053100037		25,54	406,079
9C9D00054100037		26,47	406,076
9C9D00055100037		26,84	406,049
9C9D00056100037		27,02	406,049
9C9D00057100037		27,62	406,061
9C9D00058100037		28,28	406,064
9C9D00059100037		28,56	406,079
9C9D00060100037		29,13	406,070
9C9D00061100037		29,63	406,073
9C9D00062100037		30,22	406,052
9C9D00063100037		30,65	406,070
9C9D00064100037		31,05	406,070
9C9D00065100037		31,92	406,079
9C9D00066100037		32,16	406,058
9C9D00067100037		32,86	406,067
9C9D00068100037		33,11	406,079
9C9D00069100037		33,78	406,082
9C9D00070100037		34,17	406,070
9C9D00071100037		34,95	406,061
9C9D00072100037		35,24	406,073
9C9D00073100037		35,51	406,070
9C9D00074100037		36,03	406,076
9C9D00075100037		36,69	406,079
9C9D00076100037		37,42	406,064
9C9D00077100037		37,76	406,049
9C9D00078100037		38,14	406,049
9C9D00079100037		38,60	406,058
9C9D00080100037		39,38	406,079
9C9D00081100037		39,55	406,073
9C9D00082100037		40,46	406,073
9C9D00083100037		40,58	406,052
9C9D00084100037		41,37	406,064
9C9D00085100037		41,87	406,052
9C9D00086100037		42,36	406,049
9C9D00087100037		42,74	406,067
9C9D00088100037		43,11	406,073
9C9D00089100037		43,59	406,049
9C9D00090100037		44,13	406,079
9C9D00091100037		44,66	406,067
9C9D00092100037		45,28	406,076
9C9D00093100037		45,69	406,064
9C9D00094100037		46,42	406,073
9C9D00095100037		46,72	406,070
9C9D00096100037		47,04	406,058
9C9D00097100037		47,65	406,049
9C9D00098100037		48,08	406,055
9C9D00099100037		48,78	406,049
9C9D00100100037		49,19	406,082

Test script NB = 100 simultaneous beacons (Part 2: Repetition intervals)

15 Hex ID of bcn	1st repetition interval	2nd repetition interval	3rd repetition interval	4nd repetition interval	5nd repetition interval	6rd repetition interval
9C9D00001100037	49,62	48,66	50,19	49,82	52,01	50,99
9C9D00002100037	48,38	48,35	47,82	52,09	48,02	51,10
9C9D00003100037	49,37	48,90	49,44	49,62	49,56	48,32
9C9D00004100037	49,70	49,45	48,15	48,90	52,42	48,86
9C9D00005100037	51,81	50,89	51,50	51,45	51,12	51,76
9C9D00006100037	51,02	47,71	51,29	51,35	50,80	50,06
9C9D00007100037	49,86	47,95	52,17	48,06	48,26	47,79
9C9D00008100037	51,33	51,94	50,73	51,67	49,90	48,89
9C9D00009100037	48,21	50,99	50,25	49,61	52,21	48,59
9C9D00010100037	48,36	51,92	49,19	51,26	47,99	52,37
9C9D00011100037	50,57	51,07	48,77	51,52	48,60	50,72
9C9D00012100037	52,44	52,33	49,43	50,31	47,72	49,14
9C9D00013100037	49,16	51,58	49,68	49,48	49,98	47,87
9C9D00014100037	51,09	50,55	49,73	49,57	50,13	48,77
9C9D00015100037	50,45	50,64	51,55	49,27	49,99	49,46
9C9D00016100037	48,61	51,44	47,78	48,17	51,72	48,15
9C9D00017100037	49,13	50,80	48,76	51,42	51,20	52,06
9C9D00018100037	51,83	51,62	51,50	50,87	51,03	50,82
9C9D00019100037	49,26	48,59	51,36	51,54	52,17	49,55
9C9D00020100037	49,50	51,75	51,60	47,59	48,97	49,48
9C9D00021100037	49,23	49,18	47,70	49,31	48,34	50,16
9C9D00022100037	51,11	48,17	50,50	47,93	50,40	50,05
9C9D00023100037	48,65	47,84	51,73	48,55	51,68	51,49
9C9D00024100037	50,30	51,01	49,00	51,92	50,30	48,71
9C9D00025100037	49,24	51,67	47,68	51,63	51,02	49,36
9C9D00026100037	50,57	52,07	51,47	48,85	50,32	52,18
9C9D00027100037	48,34	49,48	51,97	51,45	52,00	47,60
9C9D00028100037	49,86	51,35	52,40	47,97	51,49	50,81
9C9D00029100037	47,61	50,06	51,99	51,61	48,74	51,46
9C9D00030100037	47,99	52,45	48,15	49,81	50,74	49,19
9C9D00031100037	48,70	50,32	48,92	50,02	48,39	49,19
9C9D00032100037	50,54	48,34	50,32	47,91	49,56	51,81
9C9D00033100037	50,07	49,34	49,16	52,04	50,45	47,95
9C9D00034100037	50,63	50,87	47,74	48,32	48,13	48,97
9C9D00035100037	50,76	52,40	48,61	50,15	48,65	50,13
9C9D00036100037	48,83	47,98	51,67	51,44	47,95	52,27
9C9D00037100037	50,11	52,49	47,59	47,99	49,09	48,59
9C9D00038100037	49,70	50,87	51,91	49,07	48,24	49,69
9C9D00039100037	51,57	50,51	50,89	52,27	50,55	48,23
9C9D00040100037	52,26	50,01	49,70	47,79	47,86	47,78
9C9D00041100037	52,01	52,36	50,54	51,29	49,26	48,07
9C9D00042100037	51,08	49,57	48,77	47,90	48,65	51,19
9C9D00043100037	49,96	47,74	48,26	50,04	48,04	47,82
9C9D00044100037	48,74	47,84	50,94	51,26	49,18	50,75
9C9D00045100037	48,82	49,57	50,72	51,16	49,38	47,98
9C9D00046100037	48,20	48,24	52,45	47,90	50,46	51,86
9C9D00047100037	48,30	48,71	50,72	48,16	49,50	48,98
9C9D00048100037	51,81	48,17	50,84	48,55	51,31	48,16
9C9D00049100037	48,92	50,73	47,83	48,92	51,06	52,33
9C9D00050100037	51,70	51,46	51,15	49,72	48,99	48,06

Test script NB = 100 simultaneous beacons (Part 2: Repetition intervals continued)

15 Hex ID of bcn	1st repetition interval	2nd repetition interval	3rd repetition interval	4nd repetition interval	5nd repetition interval	6rd repetition interval
9C9D00051100037	50,46	48,89	48,17	48,52	52,22	48,87
9C9D00052100037	51,05	48,86	49,48	49,47	49,87	48,08
9C9D00053100037	49,57	52,38	51,72	51,46	51,23	50,89
9C9D00054100037	51,23	49,04	49,66	49,38	51,95	51,00
9C9D00055100037	51,52	51,61	51,29	51,75	51,87	47,92
9C9D00056100037	48,73	48,83	51,46	50,49	50,62	47,64
9C9D00057100037	49,92	50,36	50,72	49,86	50,32	49,08
9C9D00058100037	48,78	52,20	48,20	51,71	51,57	52,21
9C9D00059100037	50,91	52,16	51,56	49,31	50,00	50,80
9C9D00060100037	48,22	48,85	47,86	48,26	52,34	50,02
9C9D00061100037	50,21	49,78	52,42	47,84	50,05	49,59
9C9D00062100037	50,29	47,84	50,64	51,73	51,62	47,67
9C9D00063100037	50,93	48,04	48,33	48,30	47,97	51,57
9C9D00064100037	50,28	51,64	50,84	50,49	47,65	50,77
9C9D00065100037	52,25	50,83	48,21	49,02	49,51	49,78
9C9D00066100037	51,17	49,00	50,19	48,16	50,80	49,52
9C9D00067100037	50,60	48,35	48,49	50,87	49,59	49,74
9C9D00068100037	51,61	50,67	50,16	48,26	51,04	52,29
9C9D00069100037	50,33	51,41	51,36	49,62	49,32	47,79
9C9D00070100037	50,44	51,24	47,91	50,20	49,24	49,87
9C9D00071100037	52,17	49,91	50,78	47,51	52,07	51,76
9C9D00072100037	49,61	47,99	51,89	51,13	47,89	47,56
9C9D00073100037	49,96	51,77	49,87	51,11	49,52	49,76
9C9D00074100037	51,99	49,35	49,81	47,69	48,48	47,68
9C9D00075100037	50,64	50,41	51,01	52,01	48,73	52,11
9C9D00076100037	49,51	47,61	48,31	48,42	52,15	50,71
9C9D00077100037	50,64	49,19	50,23	51,81	50,92	48,95
9C9D00078100037	50,04	47,88	51,06	48,51	49,29	47,81
9C9D00079100037	49,01	51,07	49,21	49,52	52,02	47,85
9C9D00080100037	51,00	48,87	49,50	52,02	52,03	51,78
9C9D00081100037	51,42	49,28	50,53	50,83	48,41	50,67
9C9D00082100037	52,47	49,98	49,61	48,76	50,93	51,81
9C9D00083100037	48,18	48,60	52,11	52,01	48,01	48,46
9C9D00084100037	49,55	49,90	47,85	50,14	47,99	48,34
9C9D00085100037	49,92	51,30	49,32	52,31	51,80	49,89
9C9D00086100037	51,83	49,22	48,46	50,71	51,91	52,20
9C9D00087100037	50,48	52,25	51,85	52,13	50,00	47,56
9C9D00088100037	48,43	48,66	51,34	48,70	50,74	48,01
9C9D00089100037	49,64	50,77	48,31	50,68	52,44	51,66
9C9D00090100037	49,41	51,51	49,73	50,60	51,15	51,44
9C9D00091100037	48,24	49,20	48,06	50,64	48,90	49,22
9C9D00092100037	52,46	51,28	50,46	51,72	49,54	50,27
9C9D00093100037	51,22	51,94	52,19	50,14	51,13	49,85
9C9D00094100037	52,45	47,62	48,74	52,49	49,07	49,56
9C9D00095100037	48,29	51,39	50,83	52,15	51,38	49,87
9C9D00096100037	49,51	50,85	50,34	48,28	51,61	50,37
9C9D00097100037	49,37	49,09	48,34	52,34	48,88	48,62
9C9D00098100037	49,22	47,80	49,82	49,53	47,72	51,96
9C9D00099100037	49,30	47,94	52,07	48,17	52,26	51,19
9C9D00100100037	52,19	51,45	51,31	49,92	51,48	49,03

- END OF ANNEX I -

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ANNEX J

DATA TO BE COLLECTED FOR TECHNICAL TESTS

Tests T-3

Raw message	Beacon 15 Hex ID	Time of beacon burst	TOA provided by the MEOLUT	Time stamp provided by the MEOLUT

Tests T-4

Raw message	Beacon 15 Hex ID	Time of first beacon burst	Time stamp provided by the MEOLUT	Latitude	Longitude

Test T-5

Raw message	Beacon 15 Hex ID	Time of first beacon burst	Time Stamp provided by the MEOLUT	Latitude	Longitude

- END OF ANNEX J -

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ANNEX K

REPORTING FORMATS FOR TECHNICAL AND OPERATIONAL TESTS

TO BE COMPLETED

- END OF ANNEX K -

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