ACTION PLAN IN THE EVENT OF POSSIBLE LEOSAR DEGRADATION PRIOR TO MEOSAR FULL OPERATIONAL CAPABILITY

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HISTORY

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Table of Contents

1. INTRODUCTION 1-1
1.1 Purpose and Objectives 1-1
1.2 Background 1-1
1.3 Scope 1-2
2. OPERATIONAL IMPACT OF A DEGRADED LEOSAR SPACE SEGMENT 2-1
3. REVIEW OF POSSIBLE ACTIONS TO MITIGATE LEOSAR SPACE SEGMENT DEGRADATION 3-1
3.1 Actions Taken to Use Available MEOSAR Capability to Augment the LEOSAR System 3-1
3.2 Actions Taken to Accelerate the Transition from the LEOSAR System to the MEOSAR System 3-2
4. MEOSAR IMPLEMENTATION ACTIONS TO MITIGATE LEOSAR SPACE SEGMENT DEGRADATION 4-1
4.1 General Considerations 4-1
4.2 Implementation of the Action Plan 4-1
4.3 Guidelines for Work for Designated Panel of Experts 4-2
4.4 Actions to be taken if LEOSAR Space Segment Degradation Occurs Prior to IOC 4-2
4.5 Actions to be taken if LEOSAR Space Segment Degradation Occurs During IOC 4-3
5. SUMMARY 5-1

1. INTRODUCTION

1.1 Purpose and Objectives

The purpose of this plan is to:

- provide information and guidance to LEOSAR and MEOSAR ground segment providers for the period covering the transition from the LEOSAR system to the MEOSAR system; and
- consider possible courses of action the Cospas-Sarsat Council may take in the event the LEOSAR space segment is degraded to the point where latency of alerts unduly increases the delay in SAR authorities receiving distress alerts.

The objectives of this plan are to:

- reduce the consequences of any LEOSAR space segment operational discontinuity prior to the MEOSAR system being declared at Full Operational Capability (FOC); and
- take advantage of MEOSAR ground segment deployment so that users will be able to benefit as soon as possible from early capabilities of the MEOSAR system.

The document directly addresses strategic goal #1 of the Cospas-Sarsat Strategic Plan, which aims to provide continuity of space and ground operations within a twenty-year timeframe.

1.2 Background

The Cospas-Sarsat Programme was established under the International Cospas-Sarsat Agreement (ICSPA) signed by Canada, France, the USSR, and the United States (the "Parties") in Paris on 1 July 1988. The Parties are to contribute to the Programme on a long term basis so as to maintain the Space Segment of the System. The Agreement provides the basis for the continuity of the Cospas-Sarsat Space Segment and its availability to all States on a non-discriminatory basis, and free of charge for the end-user in distress. The Agreement stipulates contributions of the Parties to the Space Segment, under normal conditions, that result in the availability of four operating payloads delivering relevant Cospas-Sarsat alert and location data to search and rescue authorities (Article 5 of the Agreement.). Effectively, this is the minimum operational configuration considered acceptable to the Parties. However, the ICSPA does not address how many unique orbits the four satellites should maintain or the minimal acceptable performance. It is clear that the performance achieved by four satellites in a single orbit would be a significant reduction in capability compared to four satellites in two or more orbits and, therefore, the number of unique orbits maintained by the satellites is a contributing factor in the determination of degraded capability.

As of May 2015 there were five LEOSAR payloads in orbit and plans to replenish the constellation were proceeding. The United States SIDAR Program is planning to launch a LEOSAR satellite at the end of 2019. The Russian Federation is also working on plans to sustain the LEOSAR constellation

by launching two satellites potentially in 2016 and 2017. Even with these plans there is still a risk of a gap in the constellation if a launch is not successful or some operational satellites fail.

This document establishes a minimal level of performance for the LEOSAR space segment for the purpose of determining when mitigation actions are necessary to offset any degradation of LEOSAR system performance prior to the declaration of MEOSAR system FOC.

A smooth transition from LEOSAR plus GEOSAR (LEO/GEO) system operations to MEOSAR plus GEOSAR (MEO/GEO) operations requires that adequate LEOSAR infrastructure and LEOSAR operation be maintained until the MEOSAR infrastructure is ready and the MEOSAR system is declared at FOC. Space segment management issues are particularly challenging because the hardware used has long procurement cycles, operating lifetime variability, and high development, manufacturing and operation cost. For the Cospas-Sarsat Programme, this difficulty is often compounded by the fact that Cospas-Sarsat payloads are secondary payloads onboard satellites with a larger primary payload, which add schedule and orbit constraints.

1.3 Scope

This Plan will be in effect from the time of its approval until the MEOSAR system (space and ground segment) is declared at full operational capability. This period will include the MEOSAR demonstration and evaluation (D&E), MEOSAR Early Operational Capability (EOC), and MEOSAR Initial Operational Capability (IOC). During this time a constantly changing system configuration is expected as Participants introduce MEOSAR ready ground segment equipment and additional MEOSAR satellites.

Therefore, the details of the actions that may be required to respond to any particular situation of LEOSAR space segment degradation will depend, among other things, on the status of the Programme at the time this action plan must be put into effect.

The Plan outlines the actions that Participants can undertake to minimise the impact of LEOSAR degradation prior to MEOSAR system FOC, and the guidelines which the Council can use to provide direction in the event of any determined degradation beyond the minimal acceptable performance.

The Plan does not address any programmatic issues, but focuses on the pragmatic actions that can be taken by all Programme Participants.

- END OF SECTION 1 -

2. OPERATIONAL IMPACT OF A DEGRADED LEOSAR SPACE SEGMENT

The most significant consequence of a degraded LEOSAR space segment is the increased average time required to detect and locate an activated distress beacon. As the number of LEOSAR payloads in orbit or the number of unique orbits decreases, the time interval between satellite passes over any particular geographic location increases[1]. The maximum waiting time required to establish the position of an active beacon is determined by the interval between satellite passes as seen by the beacon. The average time between satellite passes varies as a function of satellite configurations (number of satellites and orbital planes) and beacon latitude. Given the different orbital parameters of the various LEOSAR satellites and the drift of orbits over time, the time interval between satellite passes that might be experienced by a hypothetical beacon at a given location cannot be uniquely solved (because the geometry is not sufficiently stable and repetitive). Therefore, this can only be analysed in a statistical manner.

This kind of analysis shows that in general, a reduced number of LEOSAR payloads have a more noticeable impact at low and medium latitudes, where median satellite gap times increase by up to six times when comparing baseline (ICSPA nominal deployment) and worst case satellite configurations. The analysis shows that satellite gap times are not only influenced by the number of satellites in orbit but also by the number of orbital planes used by these satellites.

The LEOSAR space segment should be considered as starting to degrade beyond the minimal acceptable performance when any LEOSAR space segment time delay between two satellite passes at the equator exceeds 4 hours 95% of the time. When this condition is met, an assessment of actions should be invoked as outlined in section 4 of this document.

It is noted that the immediate detection capability permitted by the GEOSAR system allows SAR responders to initiate the search and rescue process that will mitigate latency degradation. In addition, data from registration databases will provide useful information to operational search and rescue services.

- END OF SECTION 2 -

[1] Gaps between satellite passes constitute the maximum delays that a user would experience. Users can activate their beacons anytime between satellite passes. While a "fortunate" beacon user might activate his beacon shortly before a satellite pass, the "unfortunate" one might activate his beacon shortly after a satellite pass and would have to wait for the next satellite pass to get the distress signals forwarded through the LEOSAR system. Considering that activations are spread over the total duration of satellite gaps, average latency experienced by the system would be approximately half of the values calculated for the satellite gaps.

3. REVIEW OF POSSIBLE ACTIONS TO MITIGATE LEOSAR SPACE SEGMENT DEGRADATION

Actions which could be undertaken by the Cospas-Sarsat Participants if the LEOSAR space segment performance drops to an unacceptable level prior to the MEOSAR declaration of FOC can be summarized as:

- those actions taken to use available MEOSAR capability to augment the LEOSAR system,
- those actions taken to accelerate the transition to MEOSAR EOC, IOC and FOC.

3.1 Actions Taken to Use Available MEOSAR Capability to Augment the LEOSAR System

These actions include the use of the available capability of the MEOSAR system to provide detections and independent locations thereby providing additional alert data to the existing LEO/GEO data distribution channel.

This approach is dependent on the availability of both the MEOSAR space and ground segments. Adequate evaluation of MEOSAR performance will likely be achievable only once a certain amount of MEOSAR D&E testing has been completed. Both of these conditions will likely be met at MEOSAR system EOC, and will be met at MEOSAR IOC at the latest. To begin any operational phase, it must be determined that the data provided by the MEOSAR system does not degrade the performance of the Cospas-Sarsat System.

The minimum level of performance of the MEOSAR system, more specifically the MEOLUTs, needs to be defined for each phase of the MEOSAR development. This would also require the development of suitable parallel processes for data distribution from non-operational (or non-commissioned) MEOLUTs to RCCs. While this mitigation action could provide tangible benefits and reduce the impact of a shortage of LEOSAR payloads, its benefits would be limited to areas adequately covered by a sufficient number of MEOLUT antennas. The information provided by MEOLUTs may also not be available in a reliable manner as MEOLUTs used prior to MEOSAR system IOC may not be providing 24/7 services.

Actions taken to use available MEOSAR capability to augment the LEOSAR system as it degrades are inherently limited by the state of the MEOSAR assets, processes and procedures at the time when it becomes necessary. While these actions would be necessary components of any action plan, it is equally important to consider how progress towards global MEOSAR coverage might be accelerated to maximize the MEOSAR system’s capability to augment the LEOSAR system and eventually to replace it.

3.2 Actions Taken to Accelerate the Transition from the LEOSAR System to the MEOSAR System

This category of actions includes possible actions aimed at reducing the time for the Cospas-Sarsat Programme to transition from an operational LEOSAR system to an operational MEOSAR system that can provide partial and eventually full global coverage.

These actions also provide a more comprehensive solution to the issue of the potential degradation of the LEOSAR space segment. As such, they require important changes to the current MEOSAR implementation schedule and significant efforts from the Programme in the short term.

The proposed mitigation actions consist of the Cospas-Sarsat Programme accelerating development and implementation of the MEOSAR capabilities and distribution system to maximize the capability of the MEOSAR system by:

- using the S-band DASS MEOSAR payloads in a combined S- and L-band MEOSAR system until the MEOSAR L-band system alone will be declared at FOC,
- increasing MEOLUT networking capability to provide enhanced MEOSAR coverage beyond what would be available from a ground segment consisting only of stand-alone MEOLUTs,
- assessing MEOLUT MEO/GEO capability to augment the number of channels available to provide data for the difference of arrival processing that is used in the MEOSAR system to generate independent location solutions,
- accelerating the expansion of the MEOLUT coverage area and global MEOSAR coverage definition,
- establishing procedures, specifications and standards, as well as the interim procedures to be able to execute this action plan smoothly.

It should be noted advancing MEOSAR FOC would require the accelerated deployment of a world-wide network of MEOLUTs and LEO/GEO/MEO MCCs, and the completion of the MEOSAR D&E (including implementation of the EOC) and the IOC phases. This would require additional commitments and effort from Administrations involved in activities during these phases.

- END OF SECTION 3 -

4. MEOSAR IMPLEMENTATION ACTIONS TO MITIGATE LEOSAR SPACE SEGMENT DEGRADATION

4.1 General Considerations

As soon as possible the Cospas-Sarsat Ground Segment Providers should prepare for the potential degradation of the 406 MHz LEOSAR space segment. Because it is not possible to predict, or infer, an exact date when the space segment degradation might occur, it is necessary to consider that it could happen at any time prior to FOC being achieved. All ground segment providers should develop plans to implement a rapid transition to the use of MEOSAR data operationally.

It is unrealistic to expect that ground segment providers who have not already begun the process of acquiring and implementing MEOSAR ground segment equipment can put MEOSAR equipment into place quickly because of the realities of funding, contracting, and implementation. However, if there is a rapid degradation of the LEOSAR space segment, operators of MCCs that are not MEOSAR-ready need to have a process in place, consistent with the A-series operational documents describing the procedures, specifications and standards applicable to each MEOSAR implementation phase, that will enable their MCCs to receive MEOSAR distress alert messages and distribute them to the appropriate RCC/SPOC.

Although this Plan assumes that Participants planning to install MEOLUTs and LEO/GEO/MEO MCCs are taking steps before MEOSAR FOC to ensure a viable MEOSAR ground segment, as stated in section 1.2, it is critical that the LEOSAR infrastructure and LEOSAR operation be maintained until the MEOSAR system is declared at FOC. To this end the Cospas-Sarsat Council engages Participants providing LEOSAR ground segment equipment to request support from their suppliers with the necessary software upgrades that will allow the actions identified in this plan to be quickly implemented.

Full operational capability of the MEOSAR system will not be declared until the Council has assurance that global coverage is provided by the MEOSAR space and ground segments. Therefore, the LEOSAR space segment, even if degraded, will continue to play a very important role during MEOSAR EOC and IOC by providing global coverage using the SARP memory. Considering this, each ground segment provider should evaluate its position to sustain their LEOLUT equipment as long as possible.

4.2 Implementation of the Action Plan

If a degradation of LEOSAR space segment performance is suspected, a panel of experts established by the Parties will be requested by the Council to investigate the status of the LEOSAR space segment and provide findings of their assessment results to the Council. They will provide recommendations to the Council on specific actions to be taken.

The expert panel will provide the Council with an analysis of System performance at the time of the degradation. Coverage areas and expected latency timing should be identified and communicated to the Council in a report. The analysis results will be considered at Council Session in conjunction with information on the status of the MEOSAR system implementation, including current status of MEOSAR ground and space segments, as well as other relevant information. The Council will then provide the updated performance level of the existing LEOSAR/GEOSAR/MEOSAR systems to Cospas-Sarsat Participants and Programme stakeholders (IMO/ICAO).

Nodal MCCs will be notified by the Secretariat, acting on behalf of the Council, to provide system status messages to all MCCs advising them of the recommended Council actions. Each nodal MCC will then coordinate the data distribution procedures to implement in its data distribution region based on prior coordination.

4.3 Guidelines for Work for Designated Panel of Experts

The panel of experts identified by the Council to assess the status of the LEOSAR space segment and the MEOSAR space and ground segments should be composed of individuals with the operational and technical expertise to perform the tasks required to advise the Council on the appropriate actions to take in the event of a degradation of the LEOSAR space segment performance prior to MEOSAR IOC. When activated by the Council the panel should:

- confirm that the LEOSAR space segment has degraded below the performance level identified in section 2,
- assess the status of the MEOSAR space and ground segment implementation and the performance of the MEOSAR system,
- provide a brief summary report to Council that provides the findings of the panel and recommendations for actions that the Council should consider.

4.4 Actions to be taken if LEOSAR Space Segment Degradation Occurs Prior to IOC

If an unacceptable degradation of the LEOSAR space segment occurs prior to IOC of the MEOSAR system, all formal MEOSAR technical and operational standards, system components (space and ground segments) and data distribution protocols may not be ready for MEOSAR implementation. The Council will determine, based on the MEOSAR D&E results to date, that the data provided by the MEOSAR system will not degrade the performance of the Cospas-Sarsat System and should be distributed in the ground network.

If an unacceptable degradation of the LEOSAR space segment occurs before EOC has been declared, not all MCCs will have the capability to automatically process inbound MEOSAR alert messages nor have established procedures to process MEOSAR alert data. These MCCs should be capable of handling these messages and forwarding them to the appropriate RCC/SPOC for action.

If an unacceptable degradation of the LEOSAR space segment occurs after EOC has been declared, the panel of experts will analyse if the path to IOC implementation can be re-sequenced or

accelerated in order to maximize the universal and uniform distribution of MEOSAR data across the operational COSPAS-SARSAT System.

4.5 Actions to be taken if LEOSAR Space Segment Degradation Occurs During IOC

If unacceptable degradation of the LEOSAR space segment occurs during MEOSAR IOC, each nodal MCC should be capable of receiving, processing and transmitting MEOSAR alert data to all MCCs within its data distribution region. Each nodal MCC should coordinate with all MCCs within its data distribution region on the method of data distribution. For example, nodal MCCs could format and transmit MEOSAR distress alert messages as SIT 185 (SPOC/RCC format) to non-MEOSAR ready MCCs in its region. Therefore, the method of distribution between MCCs may not be the same for all data distribution regions and between MCCs and RCCs/SPOCs in each MCC service area.

- END OF SECTION 4 -

5. SUMMARY

Along with measures that are being considered for maintaining and strengthening the LEOSAR space segment, this plan recognizes the need to address potential degradation of LEOSAR performance below the minimal acceptable level and identifies actions that have to be taken by the Cospas-Sarsat Council and Participants as required in case of such occurrence.

The plan concentrates on early operational use of MEOSAR capabilities available to mitigate potential LEOSAR degradation if it occurs before MEOSAR FOC. In this regard, it is noted that efforts under way in preparations for and completion of MEOSAR EOC and IOC would effectively contribute to this objective.

The plan also recognizes that the required mitigation actions cannot be fully detailed in advance as they would depend upon an actual cause of degradation and the progress in MEOSAR implementation at the time of degradation occurrence. To this end, the Expert Panel, established by the Parties, will be activated by the Council to assess the extent of LEOSAR performance degradation if and when such degradation is suspected. This panel will then provide the Council with recommendations on specific actions to be taken.

The plan envisages subsequent actions by the Council and Participants as stipulated in Section 4. In particular, ground segment providers are encouraged to maintain their LEOSAR equipment in parallel with implementing their MEOSAR system contributions.

- END OF SECTION 5 -

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