COSPAS-SARSAT
DEMONSTRATION AND EVALUATION PLAN
FOR
406 MHz GEOSAR SYSTEMS

C/S R.006
Issue 1 - Revision 3
October 1997

COSPAS SARSAT

COSPAS-SARSAT DEMONSTRATION AND EVALUATION PLAN FOR 406 MHz GEOSAR SYSTEMS

History

Issue	Revision	Date	Revised Pages	Comments
1	0	December 1994		Approved by the Cospas-Sarsat Council (CSC-13)
1	1	June 1995	i, G-1, G-2	Annex amended at JC-9
1	2	October 1996	cover, i, ii, iii, iv, 1-2, 1-4, 2-3, 2-4, 3-1 to 3-8, 3-16 to 3-27, A-1, A-2, B-1, B-2, B-3, C-2, E-1, E-2, F-1, F-2, G-1, G-2, H-1, H-32 to H-37, H-40 to H-48, I-1, I-2	Approved by the Cospas-Sarsat Council (CSC-17)
1	3	October 1997	cover, i, ii, iii, iv, 3-18 to 3-27, A-1, A-2, B-1 to B-4, F-1, F-2, G-1, G-2, H-40, H-41, I-1, I-2, J-1, J-2	Approved by the Cospas-Sarsat Council (CSC-19)

LIST OF PAGES

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXES

1. INTRODUCTION

The Cospas-Sarsat Council (CSC) has directed that a demonstration and evaluation (D&E) be performed to confirm the expected benefits of a geostationary search and rescue (GEOSAR) satellite system. The CSC has further directed that this D&E establish GEOSAR technical and operational performance characteristics.

1.1 Purpose of Document

The purpose of this document is to provide the framework for the demonstration and evaluation of GEOSAR systems so that the data can be integrated into a statement of capability of individual equipment and the totality of the 406 MHz GEOSAR systems. 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 GEOSAR equipment into the existing Cospas-Sarsat System (hereafter referred to as LEOSAR).

Succinctly stated, this document provides the guidelines for:

- Conducting the Demonstration and Evaluation (D&E) of GEOSAR systems in a standard manner.
- Collecting a set of results, on an agreed basis, from individual participants.
- Establishing the process for translating the results into a set of recommendations for Cospas-Sarsat Council decision.

1.2 Scope

This D&E Plan details the actions to be taken to determine the performance of GEOSAR equipment and the effectiveness of GEOSAR data for search and rescue operations. The Plan covers geostationary satellites provided by Participants and equipped with appropriate 406 MHz repeaters, that are in operation during the D&E. It also applies to Cospas-Sarsat Participants that operate a GEOSAR ground station (GEOLUT), and to users of 406 MHz alert data. This plan includes provisions to capture data from not only 406 MHz beacons without locations, but also from those with locations provided by navigational systems such as the Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS).

The Plan is to be used in planning, conducting, analysing and reporting the results of specific and varied demonstrations of combined LEOSAR-GEOSAR operations. The plan provides a basis for the assessment of how well the proposed GEOSAR system complements the existing LEOSAR System. It presents the guidelines for data collection and analysis, for reporting demonstration and evaluation results, and for consolidation and presentation to the Council.

1.3 Background

1.3.1 GEOSAR Systems Development

In 1984, the USA, in conjunction with Canada and France, conducted an experiment on the geostationary meteorological satellite GOES-7 to determine if near-instantaneous alerts could be provided using geostationary satellites and 406 MHz beacons that comply with the Cospas-Sarsat beacon specifications. The experiment demonstrated that a 406 MHz relay capability in geostationary earth orbit can provide near-instantaneous alerting for search and rescue applications. The GOES experiment is being continued with improved ground receiving equipment and the 406 MHz geostationary relay capability provided on GOES-8 which was launched on 13 April 1994, and GOES-9, launched on 23 May 1995.

In May 1992, India launched the first geostationary satellite in the INSAT-2 series (INSAT-2A) carrying a 406 MHz repeater. India's second geostationary satellite (INSAT-2B) has been operating since August 1993. India has established a ground receiving station, linked to the Cospas-Sarsat MCC in Bangalore, for receiving 406 MHz signals from the INSAT-2 satellites and is proceeding with the evaluation of this system.

Russia has completed tests with experimental transponders on-board a LUCH tracking data relay and communications satellite and plans to equip future geostationary satellites with 406 MHz repeaters. The Russian GEOLUT will be located in Moscow.

In February 1995, Japan launched GMS-5 and during the autumn of the same year carried out various experiments on the 406 MHz GEOSAR system to verify its practical use. A future 406 MHz GEOSAR operational system is under consideration as a follow-up to GMS-5.

The various GEOSAR systems were developed independently and, consequently, a comprehensive picture of GEOSAR capability would not be available without a coordinated D&E. Therefore, the Cospas-Sarsat Council decided that a Geostationary D&E Plan should be developed to standardize the data collection objectives, procedures, and reports to ensure a valid assessment of the capabilities of the various GEOSAR systems, their component parts, and their impact on international search and rescue alerting.

1.3.2 Description of LEOSAR and GEOSAR Systems

1.3.2.1 LEOSAR System

The LEOSAR System is an international satellite and ground network system composed of satellites in polar low altitude Earth orbit (LEO). The System is designed to assist search and rescue operations by providing locations of distress beacons operating on 121.5 MHz and 406 MHz.

The LEOSAR System can detect and locate 406 MHz beacons anywhere on Earth. Locations are calculated using the Doppler effect on the received signals which result from satellite movement relative to the transmitting distress beacon. Because of orbit patterns, there can be delays between beacon activation and receipt of the signal by an orbiting satellite. Potential time delays between beacon activation and signal detection are greatest at the equator and are dependent on the number of satellites and the number and locations of local user terminals (LUTs).

1.3.2.2 GEOSAR Systems

GEOSAR systems are composed of geostationary Earth-orbiting (GEO) satellites, and their associated ground processing facilities called GEOLUTs, that have the capability to detect transmissions from Cospas-Sarsat type approved 406 MHz distress beacons. Geostationary satellites orbit at altitudes of 36,000 km at approximately 0° latitude relative to the earth and at fixed longitudes appropriate to the requirements of the space segment provider. Detailed descriptions of participating geostationary satellite and GEOLUT locations and capabilities are provided in Annexes C and D.

Because of the geostationary satellites high altitude and relatively fixed position over the Earth, GEOSAR systems offer several complementary advantages to the LEOSAR System. These advantages include:

- Near instantaneous alerting without location within the satellite coverage area.
- Permanent monitoring of the frequency band.
- Potential near-instantaneous alerting with an integrated navigation receiver.
- Extensive coverage area.

1.3.3 Concept of Combined Operations

The LEOSAR System is able, using the Doppler effect resulting from the movement of the satellite relative to a distress beacon, to calculate the position of the transmitting beacon. However, with the existing constellation of polar orbiting satellites the time from activation of a beacon to overflight of the location by a satellite can be in excess of one hour. This "waiting time" is a function of the available satellite constellation and latitude with waiting times being greatest at the equator and shortest at the poles.

Existing GEOSAR system capability does not include the ability to localize a beacon, but it does provide for near-instantaneous alerting within the satellite footprint because of the satellite's constant position relative to the Earth. GEOSAR system coverage is expected to be effective between 80°N and 80°S, approximately.

As observed above, the LEOSAR and GEOSAR systems are complementary. With existing 406 MHz beacons, GEOSAR output provides near-instantaneous alerting, but no location data, while LEOSAR provides location data but with some inherent system delays. LEOSAR satellite overflight frequency at the poles provides for short waiting times at the high latitudes where there is no geostationary coverage.

In conjunction with float or flight plans and beacon registration information, GEOSAR early alerting may allow the SAR forces to begin mission planning, initiate a search or determine the possibility of false alarms. When LEOSAR location data becomes available, this information can be transmitted to the SAR forces to pin-point their search options. A coarse beacon position may be obtained for GEOSAR alert by successfully communicating with the persons listed as points of contact in a beacon registration data base. This coarse position may allow a direction-finding equipped SAR aircraft to locate the beacon using the beacon homing signal.

1.4 Responsibilities

Each participating GEOSAR 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.

GEOSAR ground station providers are responsible for the development, implementation and operation of their GEOLUT and communication networks, and the implementation of agreed procedures for the distribution of GEOSAR alert messages.

All participants are responsible for the implementation of the agreed procedures for the distribution of GEOSAR alerts as given at Annex E (Procedures).

1.5 Schedule

The chart in Annex I provides the major milestones of GEOSAR D&E activities.

- END OF SECTION 1 -

2. GEOSAR DEMONSTRATION AND EVALUATION GOALS AND OBJECTIVES

2.1 Demonstration and Evaluation Goals

The D&E should assess technical and operational performance and offer a well supported estimate of benefits in terms of additional lives and property saved and SAR response resource savings.

Accordingly, the D&E goals are to:

a. characterize the technical performance of the GEOSAR components;

b. characterize the operational performance of the GEOSAR system;

c. evaluate the operational effectiveness of the GEOSAR system and determine the benefits to SAR of combined LEOSAR/GEOSAR operations; and

d. provide the basis for recommendations to the Cospas-Sarsat Council.

The demonstration and evaluation objectives are categorized as either technical or operational in nature. These objectives are detailed in the following sections.

2.2 Technical Objectives

Generally, the technical objectives are to confirm the technical compatibility of the various GEOSAR components and establish the baseline performance characteristics of the GEOSAR systems.

Most of the technical tests require a beacon simulator or at least one special test beacon whose power output and message content could be controlled and varied. These tests need to be conducted for several weeks to collect enough data to be statistically valid. In addition, some of the tests should also be performed for shorter durations using regular commercial beacons (coded with a test protocol) operated under controlled conditions, in order to assess GEOSAR system performance with typical beacons in use.

The results of some of these tests could form the basis of future GEOSAR technical specifications and commissioning standards, as they determine a minimum level of acceptable performance for all future GEOLUTs.

Specific technical parameters to be assessed are listed below.

T-1 Processing Threshold and System Margin
Determine the minimum value of the beacon power output (EIRP), and its corresponding C/N_0 at the GEOLUT, for which the PDEFM is at least 0.99. This threshold value allows the system margin to be computed.

T-2 Message Transfer Time (MTT)
Measure the minimum time interval between the activation of the beacon and the readout of the first error-free message at the GEOLUT. MTT_{50} is defined as the time necessary to receive at the GEOLUT an error-free message from 50% of the detected beacons, and MTT_{90} is for 90% of the detected beacons. The corresponding number of beacon bursts used in each detection should also be recorded.

T-3 Carrier Frequency Measurement Accuracy
Compare the beacon's carrier frequency computed by the GEOLUT for each valid message with the actual known carrier frequency of the beacon, for potential application in LEOSAR processing to obtain a more accurate beacon location and other possible benefits.

T-4 Beacon Processing Capacity
Assess the capability of the GEOSAR system to handle multiple simultaneous 406 MHz beacon signals (having a mixture of long and short messages).

T-5 Impact of Interference
Monitor the band for the presence of interference while the technical tests are being performed, in order to understand any anomalies in the results and to illustrate the ability of the GEOSAR system to provide valid messages in the presence of interference and noise in the 406 MHz band.

T-6 GEOSAR Satellite Coverage
Estimate the coverage area of each GEOSAR satellite to validate the predicted coverage.

T-7 Impact of Updating Encoded Position Data
Determine the impact on GEOSAR system processing when the position data encoded in the short part of a beacon message is periodically updated by an integral navigation receiver (and also with changing data in the long message extension).

T-8 System Generated False Alerts
Assess the number and causes of system generated false alerts, including any produced by the beacon self-test signal which has the inverted frame synchronization pattern.

T-9 Impact of System Beacons
Assess the impact of 406 MHz orbitography/reference beacons on the capacity and the Message Transfer Time of the GEOSAR system.

T-10 Combined Operation
Assess which data output by the GEOSAR system could help improve the performance of the LEOSAR system (e.g. beacon turn-on time, carrier frequency, etc.).

2.3 Operational Objectives

The GEOSAR D&E is to evaluate the contribution to SAR operations of alert data provided by 406 MHz GEOSAR systems and to gain operational experience in the use of GEOSAR alerts. The overall operational objectives are to:

a. assess the performance of individual GEOSAR systems in supporting actual search and rescue operations;

b. provide SAR services in each participating country with experience using GEOSAR system data and assess the effectiveness of GEOSAR alerts;

c. provide Cospas-Sarsat Ground Segment operators with experience in the distribution and use of GEOSAR alerts; and

d. evaluate the impact of GEOSAR systems on the Cospas-Sarsat 406 MHz System.

The specific operational parameters which should be measured to provide the basis for the GEOSAR operational evaluation are detailed below:

O-1 Potential Time Advantage
Determine the time advantage of the first GEOSAR alert notification over the first available LEOSAR alert notification.

O-2 Complementarity and Effectiveness of GEOSAR/LEOSAR Systems
Measure, in the coverage area of a GEOSAR satellite:

a) the percentage of 406 MHz beacon transmissions detected by the GEOSAR system which are not detected by the LEOSAR system; and

b) the percentage of 406 MHz transmissions which are not detected by the GEOSAR system but are detected by the LEOSAR system.

O-3 Duration of 406 MHz Transmissions
Determine the statistical distribution of the duration of 406 MHz transmissions.

O-4 Database Availability and Effectiveness
Measure the effectiveness of existing beacon registration databases in providing SAR services with the required beacon registration data. Evaluate how useful beacon registration data are in assisting RCCs in determining whether a 406 MHz GEOSAR alert corresponds to a real distress situation or a false alarm.

O-5 Operational Impact of GEOSAR System Generated False Alerts
Measure the volume of GEOSAR system generated false alerts and the MCC's ability to suppress invalid or incorrect messages.

O-6 Volume of GEOSAR Alert Message Processing at MCCs
Measure the additional message traffic generated by GEOSAR alerts at MCC level to determine processing capacity requirements.

O-7 Resolution of LEOSAR Location Ambiguity using GEOSAR Data
Determine the percentage of cases where GEOSAR alerts provide MCCs with information for the resolution of the ambiguity of the position in the first LEOSAR alert.

O-8 Evaluation of Benefits of GEOSAR Satellites and GEO/LEO Combination on SAR
Evaluate the direct and indirect benefits to SAR services derived from the use of GEOSAR data.

2.4 Other Suggested Data Collection

All D&E participants are encouraged to collect the following GEOSAR systems statistical data for the purpose of estimating the current and future demands on GEOSAR systems resources.

- The number of self-test bursts received.
- The number of active operational beacons received.
- The carrier frequency measurement for each beacon received.
- The total number of bursts received for each beacon.
- The total number of bursts received at the satellite per unit time.

2.5 Exchange of System Information

In order to facilitate a thorough data gathering and accurate statistical analysis, it is requested that all D&E participants maintain and distribute system status information to all other participants. This information shall include:

- all periods of GEOLUT down time;
- all periods of GEOSAR satellite down time;
- all changes of GEOSAR satellite configuration which affect the processing of GEOSAR data;
- all changes of MCC configuration which affect the processing of GEOSAR data; and
- all periods of MCC down time.

This system information shall be exchanged between the participants on a monthly basis or on an as requested basis. The specific method of data exchange shall be as mutually agreed to amongst the participants.

- END OF SECTION 2 -

3. D&E METHODOLOGY

3.1 General D&E Methodology

All participants in the D&E of a 406 MHz GEOSAR system are requested to conduct their D&E in accordance with a common set of guidelines and procedures as defined below.

The GEOSAR D&E Methodology includes:

a. standard procedures for each objective applicable to each participant for collecting, analysing and reporting data required for the evaluation of well defined performance parameters;

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

c. procedures for the exchange of messages as provided at Annex E.

The common objectives of the D&E and the definition of performance parameters are provided in section 2. The following sections describe the standard procedures applicable for collecting and analysing data, and reporting the results of performance parameter measurements by each participant.

In order to provide consistency in the reporting of objectives, a calibration test should be conducted prior to the beginning of the data collection period. A test should be designed so that the performance of each GEOLUT is documented and non-detection of beacon events is analysed. The results should be exchanged amongst the GEOLUT providers so that individual performances may be compared with others of the GEOSAR System. The results will allow individual GEOLUT providers to optimally configure their hardware and software to participate in the D&E. If such a calibration test can not be organized prior to the commencement of the data collection period, then the T-1 test should first be completed by each GEOLUT Provider and the results of this test be exchanged as described above.

Every effort should be made to ensure that testing of real or simulated beacons performed in support of the D&E Plan does not generate distress alert messages which will be interpreted in the existing LEOSAR System as real alerts. Unless essential to the test being conducted, the test beacon must either transmit outside the operational 406.025 MHz band, use the 'test' protocol, or transmit signals with the inverted frame synchronization pattern.

3.2 Technical Evaluation Procedures

3.2.1 T-1: Processing Threshold and System Margin

The processing threshold and the system margin are "figures of merit" of the GEOLUT. The processing threshold is the value of the minimum carrier to noise density ratio (C/No) in dBHz at the GEOLUT when the PDEFM is equal to or greater than 0.99. The lower this value becomes, the more sensitive the GEOLUT becomes.

The system margin is a measure of how far below a beacon EIRP of 5W (37 dBm) the GEOLUT can process beacon signals with a PDEFM of 0.99. The larger this value, the greater the range of beacon EIRPs for which the GEOSAR ground system can consistently produce valid messages.

3.2.1.1 Methodology and Data Collection

3.2.1.1.1 Performance of this test requires the following steps.

a. Use a beacon simulator as a controlled test beacon with a variable output EIRP adjustable to a range of -10 dB in 0.5 dB steps.

b. Use three or four different beacon identification codes to allow immediate restarting of the test once a measurement has been completed so that there is no retention of the previous code by the GEOLUT into the next measurement.

c. Calibrate the beacon's output EIRP to ensure validity of the output level.

d. Place the beacon in the GEOSAR satellite's uplink field of view at a location that has an elevation angle to the satellite of at least 5°.

e. Turn on the beacon and allow it to stabilize (approximately 15 minutes).

f. Set the beacon's EIRP to 37 dBm.

g. Transmit 200 message blocks.

h. Collect received blocks at the GEOLUT.

i. Determine the total number that are valid.

j. Calculate the C/No for each EIRP level of the test beacon.

k. Calculate the PDEFM as the number of valid messages received by the GEOLUT divided by the total number of message blocks transmitted.

l. Decrease the EIRP of the test beacon by 0.5 dB and repeat until the calculated PDEFM drops below 0.95. The number of message blocks should be increased as the EIRP of the test beacon is decreased to ensure a statistically valid result for PDEFM.

m. Determine the processing threshold as the C/No value at which the PDEFM equals 0.99.

n. Determine the system margin, which is the difference in dB of 37 dBm and the value of EIRP of the beacon output power at which the PDEFM equals 0.99.

System margin in dB = 37 - (EIRP for which PDEFM = 0.99)

3.2.1.1.2 The following information should be recorded.

a. The beacon's deployed location.

b. The GEOSAR satellite and ground station identification.

c. The time of beacon turn on and turn off.

d. EIRP of the beacon output power setting.

e. The time at which the GEOLUT provides the first valid message for the test beacon.

f. All GEOLUT messages for the test beacon (valid or otherwise).

g. The number of bursts used in the calculation of the valid message.

3.2.1.2 Data Reduction, Analysis and Results

For each set of 200 message blocks transmitted:

a. complete the table included in Annex H as per the sample Table 3-1; and

b. read the processing threshold and system margin directly from the table.

All received invalid messages by the GEOLUT should be examined to determine if the error can be explained by a known phenomenon that degrades the processor's ability to decode valid messages. Invalid messages that can be explained by a known phenomenon will be removed from the data set.

EIRP from beacon (dBm)	C/No at GEOLUT (dBHz)	Number of Message Blocks Transmitted	Number of Valid Messages Received	PDEFM
37	30	200	200	1.00
34	'	'	'	'
32	'	'	'	'
31	'	'	'	'
30	'	'	'	'
29.5	'			
29	'			
etc.				

Table 3-1: Sample Table for Processing Threshold and System Margin Evaluation

3.2.1.3 Interpretation, Conclusion and Recommendations

The ability of the GEOLUT to provide valid alert messages over the expected range of 406 MHz beacon output powers will be determined by calculating the processing threshold and the system margin. These values may be compared with data in ITU-R Report 1175 and with the results from other GEOSAR ground segment providers to assess the relative performance of all GEOLUTs. This will ensure that operational beacons operating in degraded modes will have a high probability of detection and correct decoding by the GEOSAR system.

3.2.2 T-2: Message Transfer Time

The message transfer time (MTT) is the time interval between the activation of the beacon and the availability of the first valid message at the GEOLUT. The statistics MTT_{50} and MTT_{90} are the times to receive at the GEOLUT a valid message from 50% and 90% of the detected beacons respectively.

As an additional use of this measurement, GEOLUT providers should evaluate MTT_{90} to determine its value as an indication of time of beacon activation.

3.2.2.1 Methodology and Data Collection

This test should be performed using the same data set as for the processing threshold and system margin (test T-1). As the EIRP of the controlled test beacon is varied, the time of beacon activation is noted. The time in minutes for the GEOLUT to produce a valid message is also noted. The message transfer time is the difference between the two times. For each beacon activation, the output message is checked and the number of valid ones is determined. These are then scaled into the 50th and 90th percentile rankings. The values of these two parameters when the EIRP of the beacon is at the processing threshold (PDEFM = 0.99) will be the specified transfer times for the particular GEOLUT.

3.2.2.2 Data Reduction, Analysis and Results

For each of the EIRP settings of the controlled test beacon, at least 200 message blocks will be produced, and the transfer time for each will be noted. These may be plotted as a probability distribution function in 1 minute increments (see Figure 3-1).

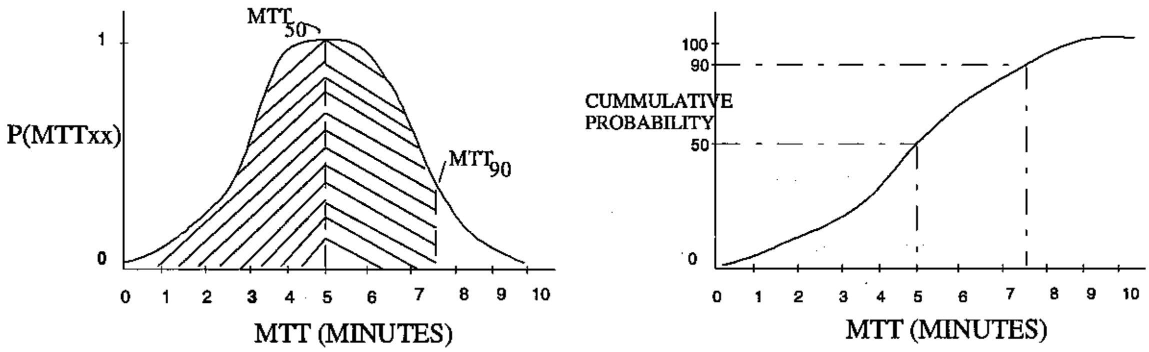


Figure 3-1 : Probability Distribution

The MTT_{50} and MTT_{90} for the GEOLUT will be those corresponding to a PDEFM of 0.99. Note also cases where no message was produced for a particular beacon activation to determine if a known system phenomenon prevented the production of a message. Such cases may be removed from the data set after their cause has been determined.

3.2.2.3 Interpretation, Conclusion and Recommendations

By calculation of the MTT at the GEOLUT's processing threshold, the probability of the worse case waiting time for the GEOLUT is determined.

3.2.3 T-3: Carrier Frequency Measurement

The purpose of this objective is to compare the beacon's carrier frequency as calculated by the GEOLUT for each valid message with the known value for the same beacon. This measurement could be used as an input to the LEOSAR system to improve the location accuracy of the Doppler processing algorithms.

3.2.3.1 Methodology and Data Collection

The following methodology should be used.

a. Turn on a nominal 406 MHz beacon and allow it to stabilize at least 15 minutes. Place the beacon in the GEOSAR satellite's field of view with a elevation angle to the satellite of at least 5°. Measure the beacon's carrier frequency with a precision frequency counter having a measurement accuracy better than 10^{-9}. Record this value.

b. The frequency measurement output of the GEOLUT for a controlled test beacon should also be examined for measurement calibration purpose, to determine if there has been any frequency shifts of the carrier component due to the down conversion process through the system.

c. For each valid message produced by the GEOLUT, calculate the difference between the measured carrier frequency and the actual carrier frequency. These measurements should be corrected for the calibration offset. Then calculate the percentage difference for each frequency measurement using the formula:

$$\%\ \text{frequency} = \frac{100 \times ((\text{MEASURED FREQUENCY} + \text{CALIBRATION FACTOR}) - \text{ACTUAL FREQUENCY})}{\text{ACTUAL FREQUENCY}}$$

d. Repeat this measurement for at least 200 unique beacon messages.

For each valid message produced by the GEOLUT, the following information should be recorded.

i) The 406 MHz beacon identification, the precise carrier frequency measurement, and the name and model number of the frequency counter used.

ii) The deployed beacon's location.

iii) The time of beacon turn on and turn off.

iv) The GEOLUT satellite and ground station used for the test.

v) The frequency calibration measurement (this will be used to correct the measured values).

vi) The GEOLUT produced beacon identification and the beacon's carrier frequency measurement.

vii) The number of integrations required by the GEOLUT to produce a valid message.

3.2.3.2 Data Reduction, Analysis, and Results

This test will produce a table of at least 200 individual frequency differences. Measurements which have large differences may be removed from the data set if the measurement error may be explained by a known phenomenon which degrades the GEOLUT's ability to produce a valid measurement. The mean and standard deviation of the remaining frequency differences should be calculated. A graph of the frequency measurement differences versus the number of integrations should also be generated to determine if such a correlation exists.

3.2.3.3 Interpretation, Conclusion and Recommendations

Based upon the accuracy of the GEOLUT's beacon carrier frequency measurement, the suitability of using the measurement as an input to the LEOSAR will be evaluated. If the GEOLUT cannot produce a frequency measurement that is statistically more accurate than the LEOSAR bias frequency calculation, then processing LEOSAR data with such frequency data is not warranted. If justified, further research concerning the specific accuracy improvement and the feasibility of incorporating such external data into the GEOLUT's processing algorithms will be required.

3.2.4 T-4: Beacon Processing Capacity

3.2.4.1 Methodology and Data Collection

The beacon processing capacity characterizes the ability for the GEOSAR system to process multiple simultaneous 406 MHz beacon signals.

Capacity measurements are to be made specifically to:

- characterize the number of simultaneous 406 MHz beacon signals that a GEOLUT can process while maintaining a PDEFM of 0.99 or above; and
- determine the 50th and 90th percentile of MTTs as beacons are incrementally added during the test to a point well below a PDEFM of 0.99.

From 10 to about 30 active test beacon signals are needed to characterize the capacity of each GEOLUT. Therefore, two alternatives are presented to meet the beacon signal requirement:

- Alternative 1 - use of a beacon simulator; or
- Alternative 2 - use of deployed test and/or orbitography beacons provided by participants.

<u>Alternative 1</u>- Beacon Simulator Supported

1) Adjust simulator to maintain a received C/No expected of a nominal beacon.

2) Set the frequency at 406.025 MHz.

3) Use an initial set of 10 test signals and transmit blocks of 20 bursts. This set will be increased incrementally by sets of 4 test signals.

4) For each set, the following information shall be recorded:

- Time of turn on and turn off of each test signals.
- Number of test signals.
- ID of all simulated test signals used.
- IDs of satellite and ground station.
- All GEOLUT messages produced for each test signal.
- MTT_{50} and MTT_{90}.
- PDEFM.

5) Repeat the test at least 5 times for each set of simulated test signals.

Alternative 2 - Test/Orbitography Beacon Supported

1) Identify participants who collectively could transmit up to 30 beacon signals in the field of view of the GEOSAR satellite.

2) Prepare a schedule for beacon activation by all participants. The schedule should require a set of 10 beacons activated initially and then sets of four beacons should be added incrementally.

3) Before activation of beacons, check and record that the beacon is operating correctly.

4) Activate beacons according to the schedule. For each set of beacons, repeat the test at least five times.

5) For each set, record:

- Time of turn on and turn off of each beacon.
- Number of beacon signals.
- Beacon ID of all beacons used.
- IDs of satellite and ground station.
- All GEOLUT messages produced for each beacon.
- MTT_{50} and MTT_{90}.
- PDEFM.

3.2.4.2 Data Reduction, Analysis and Results

The results will be presented as per the table given in Annex H. Note the number of beacons where the PDEFM drops to 0.99 and the corresponding MTTs.

3.2.4.3 Interpretation, Conclusion and Recommendation

Draw conclusions on the capacity of the GEOSAR based on the number of simultaneously transmitting beacons in the band.

Consider applying those conclusions in statistical modelling from which recommendations can be made on:

- more efficient use of the frequency band; and
- more efficient GEOLUT processing.

3.2.5 T-5: Impact of Interference Evaluation Procedures

The purpose of this objective is to determine the ability of the GEOSAR system to provide valid messages in the presence of in-band interference and noise.

3.2.5.1 Methodology and Data Collection

This objective will use both real alerts and controlled test beacons to determine the impact of actual interferers seen in the GEOSAR field of view when the interference is present. It will also examine the relationship between the characteristic nature of the interfering signals and any changes in the production of valid messages.

The following methodology should be used.

a. Characterize the interference by using a spectrum analyzer and a data storage device to permit detailed analysis of the interfering signal at a later time than its occurrence. The following test set up could be used (see Figure 3-2):

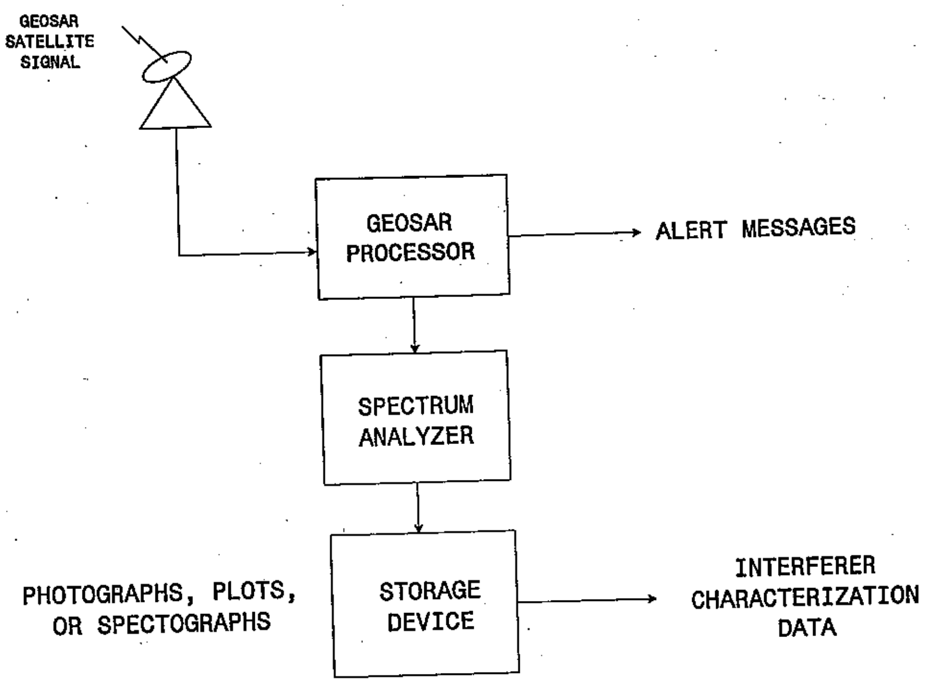


Figure 3-2: Test Set-up for Interference Evaluation

b. Continuously monitor the GEOSAR band by using the spectrum analyzer. Record the output in a storage device for later detailed analysis. Photographs, data plots, or spectrographs could be used for this purpose.

c. When interference is detected the following parameters concerning the interfering signal should be collected.

   i) The GEOSAR satellite used and the identification of the GEOLUT.

   ii) Time of occurrence and the duration of the interfering signal.

   iii) Spectral occupancy.

   iv) Signal strength.

   v) Time patterns (on/off versus continuous), (sweeping versus constant).

   vi) Nature of modulation (analogue versus digital).

   vii) Location of the interferer (if known).

   Also, examine the production of valid messages by the GEOSAR processor during the period. Note any loss of messages, the production of invalid messages or increases in the message transfer time.

d. For controlled test beacons, record the time of beacon turn on and the location of the beacon.

e. All messages from the GEOSAR processors during the test period should also be recorded. The time and carrier frequency measurement should be noted for each message produced.

f. The data collection process should continue until a broad range of interferers have been observed over a period of several months.

3.2.5.2 Data Reduction, Analysis and Results

When interference is detected, all GEOSAR messages during the period should be examined to determine:

a. if there is a loss of expected messages;

b. if there is a decrease in the number of valid messages from operational and test beacons before and after the occurrence of the interferences; and

c. if there is an increase in false messages.

Examine the technical parameters of the interferer and try to relate the impact on the message processing to specific characteristics of the interferer. For example, is there a relationship between the rate of reduction in valid messages to the interferer's signal strength?

3.2.5.3 Interpretation, Conclusion and Recommendations

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

3.2.6 T-6: GEOSAR Satellite Coverage

Coverage measurements are required to confirm predicted coverage provided by each GEOSAR satellite.

The coverage area (test T-6) can be calculated theoretically from the technical test results, but should be demonstrated using real world beacon activations which are located by the LEOSAR system, and by any beacons of opportunity (e.g. expeditions) which can be activated near the fringe of coverage.

3.2.6.1 Methodology and Data Collection

a. Determine coverage by using locations from operational beacons of opportunity, including the beacons located by the LEOSAR system.

b. Plot by 15° latitude and longitude bands the number of locations for the period of the D&E and use the resulting plot for comparison with the estimated boundaries given by the GEOSAR space segment providers or theoretically calculated.

c. Collect the following minimum data elements.

   i) Beacon ID.

   ii) Spacecraft and GEOLUT ID.

   iii) Latitude and longitude of the confirmed beacon locations.

3.2.6.2 Data Reduction, Analysis and Results

Produce and analyze the cumulative plots of beacon locations for each GEOSAR spacecraft.

Calculate the elevation angle from the known location of the beacons to the satellite.

3.2.6.3 Interpretation, Conclusion and Recommendations

Draw conclusions on the accuracy of the predicted coverage areas when compared to the actual data collected. Recommended adjustments to coverage boundaries should be made as required.

3.2.7 T-7: Impact of Updating Encoded Position Data

3.2.7.1 Methodology and Data Collection

Since future beacons will be able to periodically change their message content, this test assesses the impact that changing the position data encoded in a beacon has on the PDEFM and MTT. To assess this:

a. Ensure that the special test beacon will <u>not</u> generate distress messages which the existing unmodified LEOSAR system would interpret as real distress alerts coded in accordance with the former Maritime/Location Protocol (as there was no test format for that protocol). Therefore, the test beacon must either transmit outside the operational 406.025 MHz band, use the 'test' protocol, or transmit signals with the inverted frame synchronization pattern (to appear as "self-test" signals to the LEOSAR system).

b. Change the position data in the beacon code once during each message block initially after the first burst, then after the second burst, etc. until after the 20th burst.

c. Repeat the test 10 times for each level of EIRP.

d. Compare the MTT & PDEFM values with those obtained when the beacon code was fixed (i.e. Tests T-1 & T-2).

3.2.7.2 Data Reduction, Analysis and Results

To analyze the data:

a. examine the output messages for comparison with those of the originally transmitted beacons;

b. determine if any false alerts are generated by the GEOLUT as a result of the beacon code changes; and

c. plot the MTT histogram for each case.

3.2.7.3 Interpretation, Conclusion and Recommendations

Comparison of the MTT values for changing beacon data versus MTTs for fixed beacon data, as well as evaluation of the number of lost messages and system generated false alerts, could be used to assess the impact the 20 minute update rate in the beacon message.

3.2.8 T-8: System Generated False Alerts

Analyses are required to assess the number and causes of system generated false alerts, including any produced by the beacon self-test signal which has the inverted frame synchronization pattern.

3.2.8.1 Methodology and Data Collection

a. Analyze any alert messages generated by the processor which do not match the expected messages from the test beacons.

b. Transmit some "self-test" signals with the inverted frame synchronization from a beacon at various repetition rates.

c. Eliminate any known real-world signals received in the test band from the data set.

d. Check if there is a partial match between these messages and real test messages, particularly during the capacity tests.

e. Assess whether any "self-test" signals produce messages from the GEOLUT.

f. Determine if there are any interfering signals present in the band when the false messages are detected.

3.2.8.2 Data Reduction, Analysis and Results

a. Compute the percentage and rate at which false messages are produced.

b. Examine all false GEOSAR alert messages for any patterns or trends related to the codes produced.

3.2.8.3 Interpretation, Conclusion and Recommendations

Determine if there is a significant false alert problem from the results of the analysis.

3.2.9 T-9: Impact of System Beacons

The aim of this objective is to access the impact of orbitography/reference beacons upon the GEOSAR system.

3.2.9.1 Methodology and Data collection

Orbitography/reference beacons represent an overhead to the GEOSAR system and waste processing resources. However, as they are a necessary component of the LEOSAR system, their use must be tolerated by the GEOSAR system. The impact will be demonstrated in two ways: firstly, through an analysis of traffic loading on the system and, secondly, by experiencing the masking effects of orbitography/reference beacons upon real beacon bursts.

The following methodology should be used.

a. Determine the volume of messages produced by the GEOLUT from existing orbitography beacons.

b. Calculate the percentage of total beacon messages that are from orbitography beacons over a period of at least one week.

c. Determine the MTT for a controlled test beacon operating in the GEOSAR satellite's field of view. Consider placing the carrier frequency of this beacon outside the band where current orbitography beacons operate to minimize the interference from these beacons.

d. Calculate the MTT for various levels of EIRP of the controlled test beacon.

e. Repeat this ten times for each EIRP level used.

f. Shift the carrier frequency of the controlled test beacon into the portion of the band containing the current orbitography/reference beacons and recalculate the MTT for each of the same levels of EIRP used above.

g. Examine any differences in the MTT values for each EIRP level. Determine if any of the messages from the control test beacon were lost.

The following data elements should be noted.

i) Number and identification of all orbitography beacons present during the test period.

ii) The EIRP of the controlled test beacon.

iii) All GEOSAR messages produced during the test period.

3.2.9.2 Data Reduction, Analysis and Results

Examine the effects upon the GEOSAR system capacity as a function of both the volume and masking effects of the orbitography/reference beacons. Determine what is the volume of orbitography/reference beacon messages produced by the GEOSAR system, if there are lost beacon messages, and what increases in the MTT are seen.

3.2.9.3 Interpretation, Conclusion and Recommendations

Depending on the percentage of orbitography/reference beacon messages produced, and the degree of MTT increase due to such messages, possible solutions could be to either physically relocate some of these beacons out of the GEOSAR system's field of view, reduce the number of such beacons, or shift the carrier frequency of these beacons to another part of the 406 MHz band where they would have less impact on operational beacons.

3.2.10 T-10: Combined Operations

Characterize the capability of the GEOSAR system and the LEOSAR system working together, to process and distribute 406 MHz alerts.

3.2.10.1 Methodology and Data Collection

The possible use of GEOSAR alert data to improve the LEOSAR processing should be assessed as follows.

a. Collect all GEOSAR and LEOSAR alert messages over a given time period of at least four to six weeks.

b. Use the GEOSAR carrier frequency measurement to enable completion of location processing or to improve the location accuracy of the LEOSAR system. Note: Individual LEOSAR ground segment providers would need to investigate the feasibility of incorporating the external frequency measurement into their LUT's processing system.

c. Investigate the use of the beacon's turn on time provided by the GEOSAR system as a quality indicator for locations provided by the LEOSAR system. If the beacon's turn on time is close to the time of closest approach (TCA) provided for the beacon by the LEOSAR system, a high carrier frequency drift or a partial

Doppler curve may be encountered from the LEOSAR system. These could be indicators of poor quality data which may be examined more closely.

3.2.10.2 Data Reduction, Analysis and Results

Examine the beacon turn on times provided by the GEOSAR system and compare them to the TCA times for the LEOSAR alerts for the same beacons. Note any relationship between the turn on time and the carrier frequency drift measurement, the error ellipse size and the location accuracy of the LEOSAR data.

3.2.10.3 Interpretation, Conclusion and Recommendations

Individual LEOSAR ground segment providers would determine the improvement in location accuracy gained through the use of the GEOSAR carrier frequency measurement in the Doppler processing when compared to the LEOSAR's own calculated values for the carrier frequency.

Recommendations concerning possible modifications of LEOSAR systems to take advantage of the GEOSAR frequency measurements and beacon turn on times as data quality indicators would be made based on the utility of such GEOSAR data.

3.3 Operational Evaluation Procedures

3.3.1 O-1: Potential Time Advantage (PTA)

3.3.1.1 Definition and Methodology

The Potential Time Advantage is determined by measuring the elapsed time between the receipt at a MCC of the first GEOSAR alert notification and the first LEOSAR alert notification or NOCR message for the same beacon.

This measurement is applicable only when both GEOSAR and LEOSAR systems provide an alert message for the same beacon.

3.3.1.2 Data Collection and Result Reporting Guidelines

Cospas-Sarsat MCCs receiving 406 MHz GEOSAR alerts according to the "unlocated alert procedure" for all beacons with Country Codes of countries in their Service Area, should:

a. record the time of receipt of the messages providing a GEOSAR alert notification (TGAN);

b. record the time of receipt of the first LEOSAR alert notification (TLAN) corresponding to the same beacon, if the 406 MHz beacon is located in their Service Area (SIT 125) or, alternatively, the time of receipt of the NOCR message, for a 406 MHz beacon located outside their Service Area (SIT 133) or the time of receipt of the SIT 135 if the 406 MHz beacon is unlocated but contains a country code associated with their MCC service area;

c. collect the PTA (i.e. TGAN-TLAN) for all GEOSAR alert notifications during the D&E;

d. report the results as a Table of the number of PTAs, in 10 minutes steps for the first three hours and as a single group for all PTAs over three hours; and

e. compute the mean, median and standard deviation of the PTA distribution.

3.3.1.3 Interpretation of Results

GEOSAR alerts from 406 MHz beacons coded with "User" protocols will not include position information. However, if beacon registration data is obtained from the appropriate database, the RCC may be able to obtain a rough position information and initiate a search or resolve a false alert situation.

Additionally, if a beacon uses a protocol that allows the tail number, radio call sign or MMSI, the RCC/SPOC may be able to get additional information without beacon registration data.

Therefore, the benefit to SAR services of GEOSAR alerts increases in proportion to the GEOSAR alert time advantage over the LEOSAR alert. However, the final assessment of the effectiveness of the GEOSAR time advantage can only be made in conjunction with the determination of the effectiveness of 406 MHz beacon databases (O-4) and of the usefulness of GEOSAR data in discriminating between real distress and false alert situations (O-5).

3.3.2 O-2: Complementarity and Effectiveness of GEOSAR / LEOSAR Systems

3.3.2.1 Definition and Methodology

The complementarity and effectiveness of GEOSAR and LEOSAR systems, in the GEOSAR coverage area, is assessed by the evaluation of:

a. the total number of 406 MHz alerts detected in a given period of time using the GEOSAR system <u>and/or</u> the LEOSAR system (but located in the GEOSAR coverage area as defined by a 0 degree elevation angle from the beacon to the satellite);

b. the ratio of alerts detected by the GEOSAR system only, over the total number of alerts;

c. the ratio of alerts detected by both GEOSAR and LEOSAR systems, over the total number of alerts; and

d. the ratio of alerts from beacons in the GEOSAR coverage area, detected only by the LEOSAR system.

3.3.2.2 Data Collection and Results Reporting Guidelines

Each participating MCC in the D&E should compute and report for all beacons with country codes of countries within its MCC service area:

a. the total number of 406 MHz GEOSAR alerts in the footprint of a GEOSAR satellite (NGASA);

b. the number of alerts detected by GEOSAR only (NGOA);

c. the number of 406 MHz GEOSAR alerts which are correlated with a confirmed LEOSAR alert for the same beacon (NGLA);

d. the number of confirmed 406 MHz LEOSAR only alerts, located in the footprint of the GEOSAR satellite, which are not detected by the GEOSAR system (NLOA);

e. plot by 15 degree latitude and longitude bands the number of confirmed alerts detected by LEOSAR which were not detected by GEOSAR;

f. plot the confirmed position of the Doppler location of those 406 MHz LEOSAR alerts also detected by the GEOSAR system;

g. provide for all alerts the beacon hexadecimal ID, detection time and date, the latitude and longitude of the location, and the detection system used. Specifiy detections by GEOLUT and if confrimed by LEOSAR; and

h. each participating MCC shall provide the above collected data in electronic format (MS Excel file preferred but delimited text is also acceptable if possible). The data should be formatted in the following manor given the column titles listed below:

HEX ID	=	XXXXXXXXXXXXXXX
DATE & TIME	=	YY DDD HHMM SS
LATITUDE	=	+-dd.dd
LONGITUDE	=	+-ddd.dd
G8(3165)	=	Y or N
G8(2242)	=	Y or N
G8(2322)	=	Y or N
G8(7253)	=	Y or N
G9(3166)	=	Y or N
INSAT	=	Y or N
LEOSAR Confirmed	=	Y or N

Note: Eliminate known invalid GEOSAR alerts. Confirmed alerts are LEOSAR alerts where ambiguity has been resolved or the true position is provided by SAR forces. For moving beacons use the first confirmed position.

3.3.2.3 Interpretation of Results

Considering that the total number of active beacons (in the GEOSAR coverage area) is (NGASA+ NLOA) compute the following:

$$\text{GEOSAR Effectiveness (\%)} = \frac{(NGOA + NGLA) \times 100}{NGASA + NLOA}$$

$$\text{GEOSAR Unique Contribution (\%)} = \frac{NGOA \times 100}{NGASA + NLOA}$$

$$\text{LEOSAR Unique Contribution (\%)} = \frac{NLOA \times 100}{NGASA + NLOA}$$

The plot-chart of LEOSAR locations which were also detected by the GEOSAR system provides an indication of the actual operational coverage of the GEOSAR system. Additionally, the plot of the number of alerts not received by GEOSAR gives an indication of the effect of latitude and longitude on GEOSAR effectiveness.

3.3.2.4 Verification of GEOSAR Effectiveness

Technical test T-1 documents the GEOSAR system's ability to detect and process 406 MHz beacons. However, there may be some operational beacons within a GEOSAR satellite's footprint that are not detected by the GEOSAR system i.e., no GEOLUT detected an operational beacon. The analysis documented in Annex J ensures that logical explanations are sought for incidents where the LEOSAR System detects beacons that the GEOSAR systems do not. Possible explanations include scenarios where local obstructions prevent the GEOSAR satellites from detecting the beacon signal, interference in the 406 MHz band, or the non-availability of GEOSAR components, i.e., GEOLUT(s) or GEOSAR satellites.

The analysis will be initiated by the MCC in whose service area a LEOSAR alert exists with no corresponding GEOSAR alert. For alerts with Doppler positions in two different MCC service areas, either the MCC with the "A" or "B" position may initiate the analysis. For unlocated alerts, the MCC servicing the country with the country code of the beacon will initiate the analysis. Annex J details the steps to follow in analyzing non-detections of 406 MHz beacons.

Note: This analysis will be performed on a best-effort basis; it may not be possible to complete all the analysis documented.

3.3.3 O-3: Duration of 406 MHz Transmissions

3.3.3.1 Definitions and Methodology

This parameter is obtained by measuring the elapsed time between the first and the last error free message of a 406 MHz beacon, produced by the GEOLUT.

3.3.3.2 Data Collection and Results Reporting Guidelines

GEOLUT Operators should, for all detected 406 MHz beacons:

a. record the time of the first valid GEOSAR alert produced by the GEOLUT (or the time of the first detected burst, used in the integration algorithm);

b. record the time of the last burst detected for the same beacon;

c. collect the individual transmission duration and report in two tables:

   (i) in steps of 10 minutes for duration of less than 2 hours;

   (ii) in steps of 1 hour for all transmission durations; and

   (iii) beacons durations less than 10 minutes should be separated in two categories, transmissions with one error free message and transmissions with two or more error free messages; and

d. compute the mean, median and standard deviation of the distribution of 406 MHz transmission durations.

3.3.3.3 Interpretation of Results

The distribution of the durations of 406 MHz transmissions is expected to provide information on:

a. the number of short transmission durations (less than 10 minutes) which could be interpreted as false alerts generated either by the noise in the 406 MHz frequency band or by the testing of operational beacons;

b. the number of transmissions of less than 2 hour duration which may not be detected by the LEOSAR system and is useful to the assessment of the complementarity of the two GEOSAR/LEOSAR systems; and

c. the number of transmissions of over 2 hour duration which has a significant impact on the capacity of the GEOSAR system.

3.3.4 O-4: Database Effectiveness

3.3.4.1 Definition and Methodology

The database effectiveness is an evaluation of the percentage of 406 MHz GEOSAR alerts received at a MCC for which a database exists and the registration information could be used by the SAR forces.

To further evaluate the effectiveness of GEOSAR alerts when used with registration information, the usefulness of registration information in silencing false alarms and the improvement in RCC response time is studied.

The evaluation of the effectiveness of GEOSAR alert, together with database information, in resolving 406 MHz false alert cases can be made only when:

- beacon registration information is provided to RCCs;
- RCCs provide the MCCs with feedback information on the resolution of the 406 MHz GEOSAR alert; and
- the GEOSAR alert is received before the LEOSAR alert.

3.3.4.2 Data Collection and Results Reporting Guidelines

All MCCs should assess the effectiveness of existing 406 MHz beacon registration databases in their service area by recording and reporting:

a. the number of GEOSAR alerts for which beacon registration details are available from the registration databases and provided information for SAR forces (NGC);

b. the number of cases resolved where the GEOSAR alert and beacon registration data provided to the RCC or SPOC allowed the SAR forces to discriminate between a real or false alarm (NCR), and where it was a false alarm, the number of cases the registration data helped to turn the beacon off before SAR resources were utilized (NFAR);

c. the percentage of cases resolved which characterize the real/false alarm discrimination effectiveness of 406 MHz GEOSAR alerts, i.e., the percentage of alert discrimination effectiveness (RADE):

$$RADE = \frac{NCR * 100}{NGC}$$

d. the percentage of cases resolved where SAR resources were not launched due to registration data that determined an incident to be a false alarm (RFARBL):

$$RFARBL = \frac{NFAR * 100}{NGC}$$

e. the time of the first LEOSAR alert (same as TLAN in section 3.3.1.2) and the time RCCs or SPOCs could initiate a search or determine a false alarm based on information from a GEOSAR alert and registration data (TGISF); and calculate the mean, median and standard deviation of search initiation/false alarm determination time improvement (SITI) (only calculated for cases where a GEOSAR and LEOSAR alert exists for the same beacon:

SITI = TLAN - TGISF

3.3.4.3 Interpretation of Results

The potential time advantage of the GEOSAR alert is most likely to be beneficial only if beacon database information is available to the MCC/SPOC that receives the GEOSAR alert.

Therefore, the effectiveness of the database provide the means of assessing the usefulness of GEOSAR data to SAR forces. Specifically, MCCs should draw conclusions on how effective GEOSAR alerts are in conjunction with registration data. Additionally, the data should be analyzed to determine the SAR forces' ability to discriminate between false and real alerts based on GEOSAR alerts with registration data. The potential time advantage in search initiation by SAR forces should also be recorded.

3.3.5 O-5: Operational Impact of GEOSAR System Generated False Alerts

3.3.5.1 Definition and Methodology

The operational impact of GEOSAR system generated false alerts due to incorrect or invalid beacon messages needs to be analyzed in terms of alerts passed between MCCs, and to RCCs and SPOCs. The total number of invalid or incorrect beacon messages received at an MCC and transmitted to RCCs and SPOCs as well as the ratio of system generated false alerts should be collected.

Analysis should be performed on the effectiveness of how well each MCC detects and removes invalid or incorrect messages.

3.3.5.2 Data Collection and Results Reporting Guidelines

To support this analysis, MCCs should collect data from 406 MHz beacons with country codes associated with the MCC service area, and:

a. record the total number of 406 MHz GEOSAR alerts received at the MCC from other MCCs (NGMR) by satellite and GEOLUT;

b. record the total number of 406 MHz GEOSAR alerts passed to RCCs and SPOCs (NGAR);

c. record the number of 406 MHz GEOSAR alerts received at the MCC from other MCCs that are confirmed to be incorrect or invalid (GIAR) by satellite and GEOLUT;

d. record the number of 406 MHz GEOSAR alerts transmitted to RCCs and SPOCs that are confirmed to be incorrect or invalid (GIAT) by satellite and GEOLUT;

e. compute the percentage of GEOSAR system generated false alerts received at the MCC (SGFAM) by satellite and GEOLUT:

$$SGFAM = \frac{GIAR \times 100}{NGMR}$$

f. compute the percentage of GEOSAR system generated false alerts transmitted to RCCs and SPOCs (SGFAR) by satellite and GEOLUT:

$$SGFAR = \frac{GIAT \times 100}{NGAR}$$

3.3.5.3. Interpretation of Results

The GEOSAR system generated false alerts received at the MCC will serve to quantify the percentage of GEOSAR alerts in the system that are invalid or incorrect. This parameter allows an evaluation of the invalid or incorrect GEOSAR alerts after proper detection and suppression at the GEOLUT/MCC level.

The percentage of GEOSAR system generated false alerts transmitted to RCCs or SPOCs quantifies the impact of false alerts on the SAR forces. This will also help MCCs analyze their software to determine if better quality checks are necessary at the MCC level.

3.3.6 O-6: Volume of GEOSAR Message Processing at MCCs

3.3.6.1 Definition and Methodology

The number, measured by each MCC, of 406 MHz GEOSAR messages received from and/or transmitted to another MCC, provides an evaluation of the actual increase of inter-MCC communications and of additional processing requirements for each MCC, which result from the distribution of 406 MHz GEOSAR messages.

3.3.6.2 Data Collection and Results Reporting Guidelines

This parameter is computed for each MCC individually by adding, over the D&E reporting period, the number of 406 MHz GEOSAR messages received by a MCC from other MCCs and the number of GEOSAR messages retransmitted by that MCC (i.e. the volume of GEOSAR traffic at the MCC = VGT).

VGT (in and out) should also be compared to the volume of non-GEOSAR alert message traffic (VNGT), excluding narrative and System messages, to determine the GEOSAR traffic ratio (GTR) over the reporting period:

$$GTR = \frac{VGT \times 100}{VNGT}$$

3.3.6.3 Interpretation of Results

The GEOSAR Traffic Ratio (GTR) is a direct measurement of the traffic increase generated by the distribution of GEOSAR messages. However, this ratio is likely to increase as more GEOSAR systems and GEOLUTs become operational. Any adjustment of the procedure for distribution of GEOSAR alerts may also have a direct impact on the GTR. The traffic increase at MCCs generated by the GEOSAR systems will not be the same for every MCC. MCCs having an associated GEOLUT will experience a higher increase than other MCCs.

3.3.7 O-7: Resolution of LEOSAR Location Ambiguity using GEOSAR Data

3.3.7.1 Definition and Methodology

The 406 MHz Doppler location ambiguity can be resolved for the first LEOSAR satellite pass, in some instances, if a 406 MHz GEOSAR alert notification is received before receiving the second LEOSAR alert for the same beacon activation. The resolution is possible if the 406 MHz beacon is at the fringe of the GEOSAR system coverage and one solution is outside the GEOSAR coverage area (if a GEOSAR notification is available, then "true" position is obviously inside the GEOSAR coverage area).

3.3.7.2 Data Collection and Results Reporting Guidelines

The number of such occurrences should be recorded by each MCC and reported as:

a. the number of successful resolutions of the LEOSAR Doppler location ambiguity using GEOSAR data (i.e. the Number of LEOSAR Location Ambiguity Resolution = NLLAR);

b. the total number of 406 MHz alerts located by the LEOSAR system in the MCC Service Area (TNLAM) during the same reporting period; and

c. the percentage of effectiveness of LEOSAR location ambiguity resolution using GEOSAR data (RELLAG).

$$RELLAG = \frac{NLLAR * 100}{TNLAM}$$

3.3.7.3 Interpretation of results

The Doppler location ambiguity can be resolved only when the image solution of the Doppler location falls outside the GEOSAR coverage area and the true solution is inside the coverage area. The number of such occurrences will be dependent upon the partial overlap of an MCC service area with one (or several) GEOSAR satellite coverage area.

The ratio will characterize the particular situation of an individual MCC but should not be integrated with results from other MCCs as a "mean value" of these ratios would have no practical significance.

3.3.8 O-8: Evaluation of Benefits of GEOSAR Satellites and GEO/LEO Combination on SAR

3.3.8.1 Definition and Methodology

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.

3.3.8.2 Data Collection on Results Reporting Guidelines

Each participating MCC should:

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

b. provide narrative summaries where GEOSAR data made significant impact on SAR mission; and

c. provide evaluation of benefits, based on guidelines contained below, to SAR activities for each summary.

3.3.8.3 Interpretation of Results

Direct and indirect benefits should be assessed based on the following:

3.3.8.3.1 DIRECT BENEFITS

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

a. Human Lives Lost

The experimental system could contribute to a reduction in the loss of lives because of quicker rescues. 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 GEOSAR system will be evaluated on a case-by-case basis for each incident. As a minimum, the following information should be captured, analyzed and reported.

- Lives saved due to timeliness of GEOSAR alerting.
- Lives saved due to cases in which GEOSAR provided the only alert(s).
- Lives lost before and after notification was received by the RCC/SPOC.

b. Search Costs

The Geostationary satellite systems with their 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 GEOSAR 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 aid
- Reductions in operating costs for air/sea searches.

c. Property Losses

Employment of the Geostationary satellites could reduce the amount of property lost at sea because of quicker rescues and better detection capabilities. As a minimum, the following information should be captured, analyzed and reported.

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

3.3.8.3.2 INDIRECT BENEFITS

The indirect benefits of the geostationary satellite 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 and EPIRBs and geostationary alerting capability.

a. Risk Reduction of SAR Forces

The introduction of geostationary satellites 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

Assuming that the D&E does demonstrate that geostationary satellites improves SAR operations, a corresponding increased public confidence in and reliance on the use of 406 MHz ELTs and EPIRBs could occur. This should be noted in the national reports.

- END OF SECTION 3 -

page left blank

4.0 REPORTING GUIDELINES

The primary objective of the D&E reports is to present overall GEOSAR benefits to SAR and technical and operational characteristics in a clear and concise way. The reports will include conclusions and recommendations sufficiently substantiated by results to facilitate an ultimate decision by the CSC on the integration of the LEOSAR and GEOSAR into a cohesive single Cospas-Sarsat System.

Each technical and operational parameter evaluated in the D&E will be reported on and will include a statement of capability regarding the degree to which the parameter contributes to the attainment of the goals and objectives. This information is extremely necessary for the ultimate derivation of conclusions and recommendations.

A report will be submitted by each participant to the Secretariat by 31 January of each year. This report will cover each preceding year during which the participant engaged in the D&E in an active way. The Secretariat will compile the reports received from the participants and forward them to Canada/NSS where the reports will be consolidated for submission and presentation to the Cospas-Sarsat Joint Committee for review and presentation to the CSC. To assess individual satellite performance, separate forms are required for completion from each GEOLUT and each MCC on data received from GEOSAR satellites. The report formats are shown at Annex H.

- END OF SECTION 4 -

this page left blank

5.0 INTERNATIONAL COORDINATION

The D&E plan for the GEOSAR system will become effective 1 January 1995. At this date, satellite and GEOLUT providers should declare the status of their equipment 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 GEOLUTS into use, of the date on which these equipments will be considered operational, and which of these equipments should be included in the D&E process.

Tests beyond those specifically detailed in this plan to meet national or regional requirements may be required. These tests should be developed so as to have the minimum impact on the Cospas-Sarsat System and coordination with MCCs or SPOCs likely to be affected must occur. The responsibility for the coordination rests with the participant initiating the tests. Tests by other than Cospas-Sarsat participants are not permitted unless they are conducted under the sponsorship of a participant.

All Cospas-Sarsat participants are expected to participate in the D&E and follow the approved procedures.

Each participant should provide reports in accordance with D&E Guidelines. The Guidelines concerning the administration and coordination of the technical objectives are provided in Annex G. For each objective one participant 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 Annex G. For the technical objectives where the responsible country is indicated as "GEOLUT provider", each participant should produce an annual annex and a final report and forward them to the Secretariat for inclusion into the consolidated D&E final report. In cases where a particular participant is indicated, that participant will forward an annual annex and a final report to the Secretariat. These Reports are to be forwarded to the Secretariat by the 31st of January each year as input to a consolidated Report. Development of the Consolidated Report will be the responsibility of Canada. The individual designated by Canada will evaluate the potential workload involved in developing each Report and may seek assistance from participants or may seek Council's approval to constitute a Report Consolidation Task Group. Regardless of the methodology used to develop the Consolidated Report, it will be a Report agreed to by the participants providing either or both a geostationary satellite or GEOLUT. The annual Consolidated Report will be submitted to the Joint Committee for review and forwarding to Council.

As there has been no finite number of satellites or ground stations defined as a "System", the D&E may be a progressive evaluation as components are added or subtracted; therefore, no date has been established for a Final D&E Report. Rather the Council will request a Special Report when it is deemed that sufficient data have been gathered on certain satellite ground station segments to declare the D&E phase for these components to have been completed.

Special Reports may include not only the consolidated data from national reports, but also subjective comments reflecting the Joint Committee's views on the utility of geostationary satellites to the improvement of search and rescue alerting or responding.

Special Reports will also address specific items requested by the Council.

A Final Report will ultimately be produced which will be a compendium of the results of the Indian, Japanese, and Russian national endeavours, the American, Canadian, French and Spanish endeavour, and the combined impact of all the foregoing on workload, communications requirements and search and rescue alerting and responding.

- END OF SECTION 5 -

ANNEXES TO THE COSPAS-SARSAT DEMONSTRATION & EVALUATION PLAN FOR 406 MHz GEOSAR SYSTEMS

ANNEX A

LIST OF ACRONYMS

DAR	database availability ratio (see Definitions in Annex B)
DER	database effectiveness ratio (see Definitions in Annex B)
EOC	edge of coverage
GEOLUT	Local User Terminal (ground Earth station) in a 406 MHz GEOSAR system
GEOSAR	geostationary satellite system used for distress alerting
GIAR	GEOSAR invalid alerts received
GIAT	GEOSAR invalid alerts transmitted
GTR	GEOSAR Traffic Ratio (see Definitions at Annex B)
LEO	low altitude Earth orbit
LEOSAR	LEO satellite system used for distress alerting and positioning
MTT	message transfer time (see Definitions in Annex B)
NCR	number of cases resolved (see Definitions in Annex B)
NFAR	(see Definitions in Annex B)
NGA	number of GEOSAR alerts (see Definitions in Annex B)
NGAR	number of GEOSAR alerts passed to RCC/SPOC
NGASA	(see Definitions in Annex B)
NGC	(see Definitions in Annex B)
NGLA	number of GEOSAR/LEOSAR alerts (see Definitions in Annex B)
NGMR	number of GEOSAR alerts received at the MCC (see Definitions in Annex B)
NGOA	number of GEOSAR only alerts (see Definitions in Annex B)
NLLAR	number of LEOSAR location ambiguity resolution (see Definitions in Annex B)
NLOA	number of LEOSAR-only alerts (see Definitions in Annex B)

PDEFM	probability of detecting an error free message (see Definitions in Annex B)
PTA	potential time advantage (see Definitions in Annex B)
RADE	ratio of alert discrimination effectiveness
RELLAG	ratio of effectiveness of LEOSAR location ambiguity using GEOSAR data
RFARBL	(see Definitions in Annex B)
SGFAM	system generated false alerts (received at) MCC
SGFAR	system generated false alerts (transmitted to) RCCs
SITI	search initiation/false alarm determination time
TGAN	time of GEOSAR alert notification
TGISF	time of search initiation based on GEOSAR alert and registration data
TLAN	time of LEOSAR alert notification
TNLAM	total number of 406 MHz alerts located by LEOSAR system in the MCC Service area
VGT	volume of GEOSAR traffic
VNGT	volume of non-GEOSAR traffic

- END OF ANNEX A -

ANNEX B

DEFINITIONS OF TERMS

DAR : Database Availability Ratio : The percentage of 406 MHz GEOSAR alerts received at a MCC, with country codes from countries/territories in that MCC service area, for which a database register could be interrogated.

DER : Database Effectiveness Ratio : The percentage of 406 MHz GEOSAR alerts received at a MCC, with country codes from countries/territories in that MCC service area which provided access to their database, for which beacon registration information was available and retrieved.

Error Free Message :

A message that has no bit errors at the GEOLUT output.

GTR : GEOSAR Traffic Ratio : The ratio of GEOSAR message traffic, over the Non-GEOSAR traffic, at a particular MCC, expressed as a percentage.

Message Transfer Time (MTT) :

The minimum time interval between the activation of a beacon and the readout of the first error-free message at the earth station.

NCR : Number of Cases Resolved : The number of cases where the GEOSAR alert data provided to a RCC allowed that RCC to discriminate between a real distress or a false alert situation.

NGA : The number of GEOSAR alerts detected in the coverage area of a GEOSAR satellite.

NGMR : The total number of 406 MHz GEOSAR alerts received at an MCC from other MCCs.

NGOA : The number of alerts with country codes of countries within the MCC service area detected only by the 406 MHz GEOSAR systems.

NFAR : The number of cases the 406 MHz registration database assisted in beacon deactivation before SAR resources were used.

NGASA : The number of GEOSAR alerts received by a given MCC, with country codes from countries/territories in that MCC service area.

NGC : The number of GEOSAR alerts received by a given MCC, with country codes from countries/territories in the MCC service area, for which beacon details were available in a beacon registration database.

NGLA : Number of GEOSAR+LEOSAR Alerts : The number of 406 MHz beacon alerts with country codes of countries within the MCC service area and located inside a GEOSAR satellite coverage area, which were detected by both the GEOSAR and the LEOSAR systems.

NLLAR : The number of successful resolution of the LEOSAR Doppler location ambiguity using GEOSAR data.

NLOA : Number of LEOSAR-Only Alerts : The number of 406 MHz beacon alerts with country codes of countries within the MCC service area and located inside a GEOSAR satellite coverage area, which were detected only by the LEOSAR systems.

PDEFM : Probability of Detecting an Error-Free Message is the probability that a valid alert message is produced by the GEOSAR earth station within 20 bursts from a beacon. The Nominal System Performance PDEFM is at least 0.99.

Processing Threshold :

The minimum value of the beacon EIRP, and its corresponding C/N_o at the Earth station, for which the PDEFM is greater than or equal to 0.99

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

RADE : Ratio of Alert Discrimination Effectiveness : The percentage of cases a RCC could discriminate between a real distress and a false alert situation, using GEOSAR alert data.

RELLAG : Ratio of effectiveness of LEOSAR location ambiguity resolution using GEOSAR data. Effectiveness of GEOSAR data in resolving ambiguity of LEOSAR alerts by comparing total number of 406 MHz LEOSAR alerts in MCC Service Area to the number that had successful ambiguity resolution by using GEOSAR data.

RFARBL : The percentage of cases SAR resources not used because 406 MHz database and GEOSAR alerts determined beacon activation was false alarm.

System Margin :

The difference between the minimum processing threshold and the typical EIRP of a beacon (37 dBm).

TGAN : Time receipt of GEOSAR Alert Notification : The date/time at which the MCC responsible for distributing a GEOSAR alert (with or without position information attached) received the first GEOSAR alert data from a GEOLUT or from another MCC, regarding a particular 406 MHz beacon ID.

TLAN : Time receipt of LEOSAR Alert Notification : The date/time at which the MCC responsible for distributing a LEOSAR alert (or the NOCR message if the beacon is located outside its service area) received the first LEOSAR data (406 MHz alert data, alert message or NOCR message) from its national LUT(s) or another MCC, regarding a particular beacon ID.

TNLAM : The total number of 406 MHz alerts located by the LEOSAR system in the reporting MCC's service area. TNLAM is used in the measurement of the effectiveness of LEOSAR ambiguity resolution using GEOSAR data.

Valid Alert Message :

A 406 MHz GEOSAR alert message transmitted by an MCC. A valid alert message is composed of one or more error free messages provided by a GEOLUT with additional processing performed to validate the 406 MHz message based on such factors as country code, protocol or message content.

VGT : Volume of GEOSAR Traffic : The number, measured by a particular MCC, of 406 MHz GEOSAR alert messages received from, and/or transmitted to, another Cospas-Sarsat MCC.

VNGT : Volume of Non-GEOSAR Traffic : The volume of alert message traffic between MCCs measured by a particular MCC, excluding all GEOSAR related message traffic.

- END OF ANNEX B -

page left blank

ANNEX C

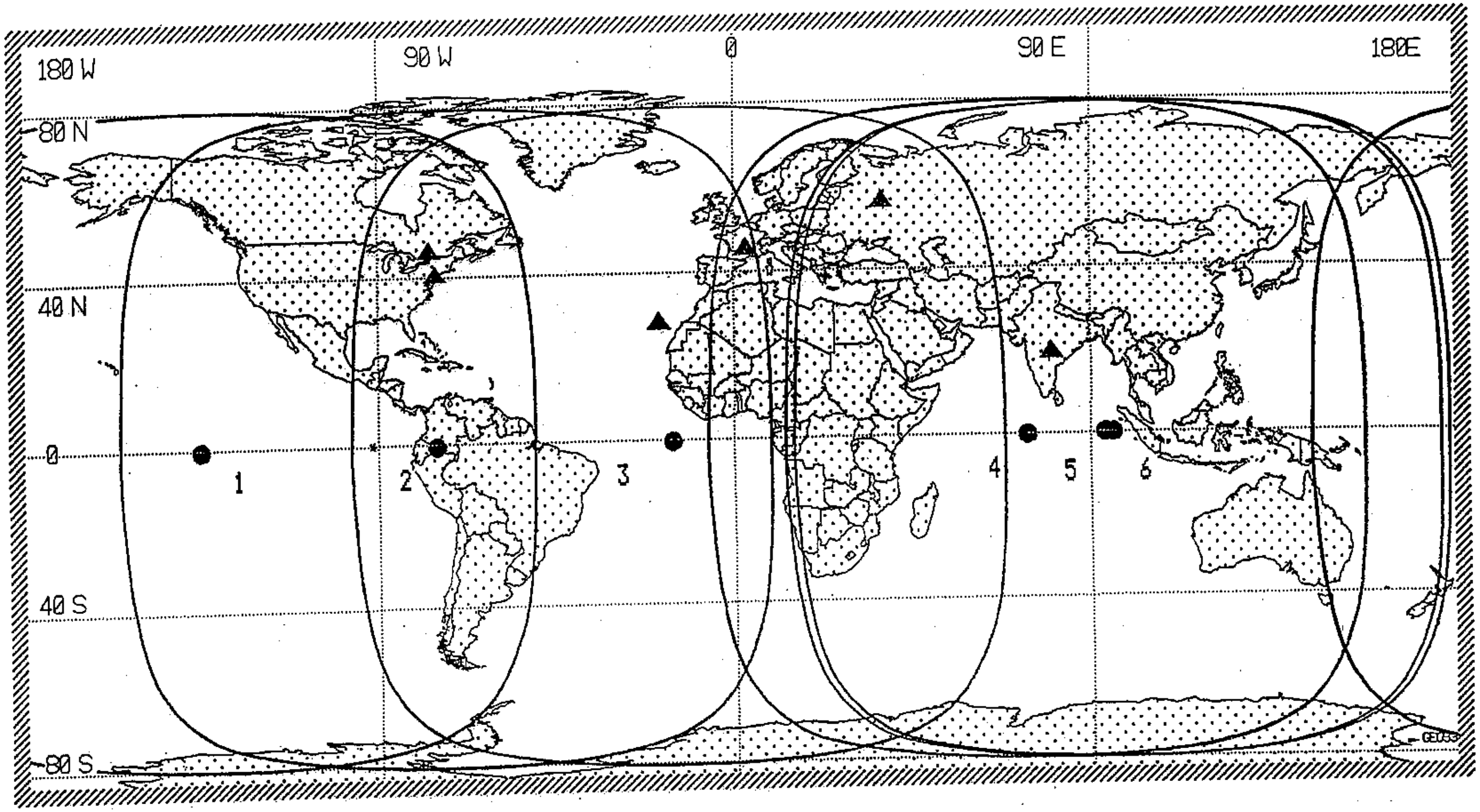
GEOSAR SPACE SEGMENT

C.1 SUMMARY OF GEOSAR SATELLITE TECHNICAL PARAMETERS AND COVERAGE

Table C-1: Summary of Satellite Parameters

Satellite	Satellite Position	406 MHz Coverage Area	Up-link Received Band-width(s)	Receiving Antenna Gain	Receiving G/T	Down-link Frequency	Type of Down-link Beam	Down-link Reception Area	Existing/Planned Ground Stations
GMS-5	140^0 E	Asia, Australasia & Western Pacific Ocean	100 kHz	9.1 dB	-21.8 dB/K	1698.325 MHz	Broad	Asia, Australasia & Western Pacific Ocean	Hatoyama (Japan)
GOES-8	75^0 W	Americas & Atlantic Ocean	25 & 100 kHz	T.B.D.	-17.3 dB/K	1544.5 MHz	Broad	Americas & Atlantic Ocean	Maspalomas (Spain), Trenton (Canada), Kourou (France), Washington (USA) Santiago (Chile)
GOES-9	135^0 W	Americas & Pacific Ocean	25 & 100 kHz	T.B.D.	-17.3 dB/K	1544.5 MHz	Broad	Americas & Pacific Ocean	Trenton (Canada), Santiago (Chile), Washington (USA)
INSAT-2 A	74^0 E	Africa, Asia, Australasia & Indian Ocean	25 & 80 kHz	11.0 dB	-19.0 dB/K	4505.7 MHz	Narrow	India	Hassan (India)
INSAT-2 B	93.5^0 E	Africa, Asia, Australasia & Indian Ocean	25 & 80 kHz	11.0 dB	-19.0 dB/K	4507.0 MHz	Narrow	India	Hassan (India)
LUCH-M East	95^0 E	Africa, Asia, Australasia & Indian Ocean	100 kHz	T.B.D.	-13.5 dB/K	11381.05 MHz	Spot	Moscow region (Russia)	Moscow (Russia)
LUCH-M West	16^0 W	Africa, Europe, South America & Atlantic Ocean	100 kHz	T.B.D.	-13.5 dB/K	11381.05 MHz	Spot	Moscow region (Russia)	Moscow (Russia)
METEOSAT (MSG)	0^0	Africa, Europe, South America & Atlantic Ocean	T.B.D.	T.B.D.	T.B.D.	[1698.65 MHz]	Broad	Africa, Europe, South America & Atlantic Ocean	T.B.D.
GOES-7	100^0 W	Americas & Pacific Ocean	100 kHz	T.B.D.	-17.8 dB/K	1698.65 MHz	Broad	Americas & Pacific Ocean	Trenton (Canada), Washington (USA)

Note: T.B.D - To be determined.



Notes: 1 - GOES W; 2 - GOES E; 3 - LUCH-M W; 4 - INSAT-2 A; 5 - INSAT-2 B; 6 - LUCH-M E; ▲ - ground receiving station

Figure C-1: Up-link Coverage of Planned 406 MHz GEOSAR Systems by Year 1995, to 0° Elevation

C.2 : GMS-5

Performance Summary of the SAR Geostationary System

Receiving antenna gain	9.7 dB
Receiving noise temperature	26.7 dBK
G/T	-17.0 dB/K
Received power from beacon	-141.0 to -121.0 dBW/m^2
Transponder bandwidth	100 kHz
EIRP	+33.5 dBm (total)
Down-link carrier frequency	1698.325 MHz

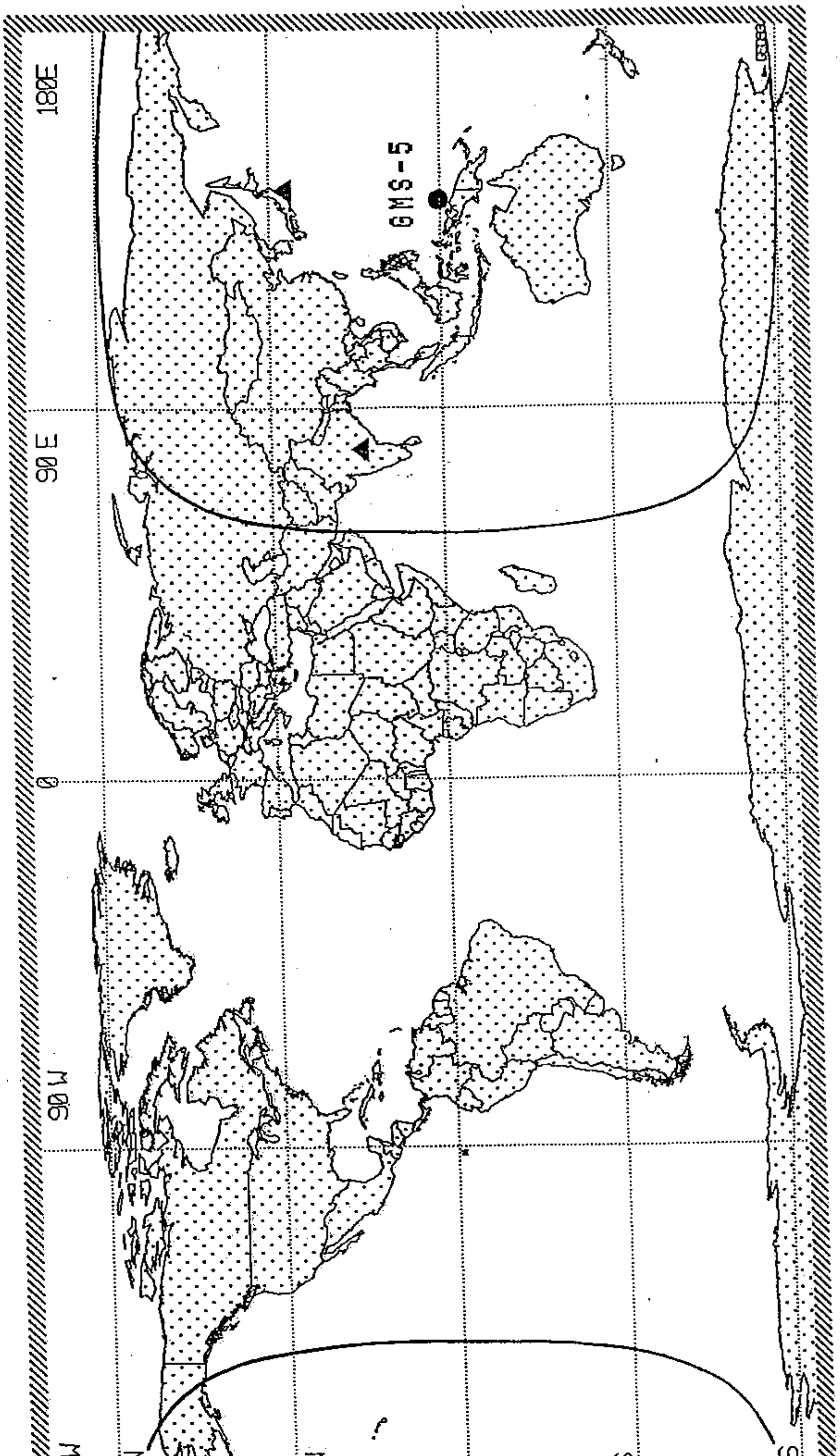


Figure C-2: Up-link Coverage of GMS-5, to 0° Elevation

Note: ▲ - ground receiving station

C.3 : GOES-Next

SAR Frequencies

Up-link	406.025 MHz (narrowband mode) 406.050 MHz (wideband mode)
Down-link	1544.50 MHz

UHF Antenna Gain G/T

Specification	- 22.0 dB/K
Worst case design	- 18.0 dB/K
Predicted performance	- 17.3 dB/K

Spacecraft EIRP

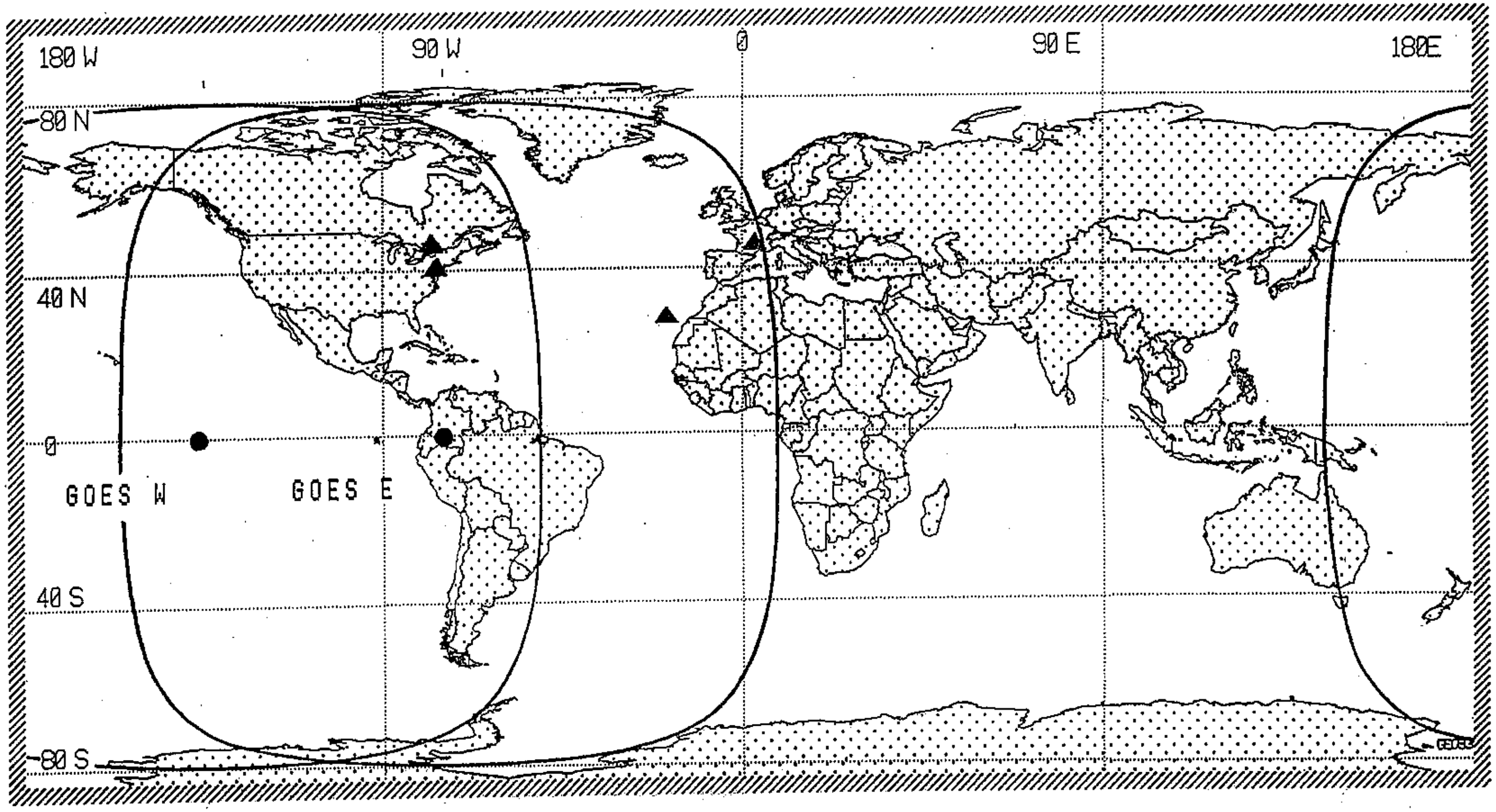
Specification	45 dBm
Worst case design	45.4 dBm
Predicted performance	45.5 dBm

D.C. Power - Synchronous Orbit

SAR receiver	5.4 W (uncertainty: 0.4 W)
SAR transmitter	17.0 W (uncertainty: 1.1 W)

SAR Subsystems Mass

SAR transmitters (2), L-band antenna, SAR equipment, UHF diplexer, SAR receivers (2), coaxial cable and receive antenna	14.62 kg



Note: ▲ - ground receiving station

Figure C-3: Up-link Coverage of GOES E and GOES W, to 0° Elevation

C.4 : INSAT-2

Specifications of the SAR Payload

No.	Parameter	Specification
1.0	Frequency band assignments:	
1.1	Receive	
	a) Wideband mode (3.0 dB)	405.990-406.110 MHz
	b) Narrowband mode (3.0 dB)	406.0075-406.0425 MHz
1.2	Receive centre frequency	
	a) Wideband mode	406.050 MHz
	b) Narrowband mode	406.025 MHz
1.3	Transmit	4505.54-4505.86 MHz
1.4	Transmit centre frequency	4505.7 MHz (INSAT-2A) 4507.0 MHz (INSAT-2B)
2.0	EIRP (min.) at EOC	3.8 dBW
3.0	G/T over global coverage	-19.0 dB/K
4.0	Antenna requirements:	
4.1	Receive coverage	Global
4.2	Transmit coverage	National (India)
4.3	Receive polarization	RHCP
4.4	Transmit polarization	Linear
4.5	Receive axial ratio	3.0 dB
4.6	Transmit axial ratio	20.0 dB
4.7	Receive gain	11.0 dB (EOC)
4.8	Transmit gain	26.8 dB (EOC)
5.0	Receiver image rejection	-60 dBc min.
6.0	Frequency stability:	
	Transmit	+/-4.0 kHz p-p/day
	Modulator input	+/-0.5 kHz p-p/day
7.0	Dynamic range	No signal to -125 dBm at receiver input
8.0	Receive out-of-band response:	
	Wideband: -1.0 dB	80 kHz min.
	-3.0 dB	120 kHz min.
	-20.0 dB	200 kHz min.
	Narrowband: -1.0 dB	25 kHz min.
	-3.0 dB	35 kHz min.
	-20.0 dB	50 kHz min.
9.0	Level control up to modulator input	By temperature compensation of gain
10.0	Gain stability up to modulator input:	
	Over 24 hours	1.0 dB pk-pk
	Over 1 year	3.0 dB pk-pk
11.0	Transmitter output power	14.4 dBm
12.0	Modulation	Phase modulation
12.1	Modulation index	Nominal 1.0 radian with composite signal plus noise baseband
12.2	Carrier suppression	3.0 dB with thermal noise plus two beacon signals at modulator input
12.3	Phase jitter	Within 10 deg. rms in 50 Hz bandwidth
13.0	Transmitter output spectrum:	
13.1	Harmonics	-40 dBc or less
13.2	Spurious	Less than -60 dBW in any 4 kHz at feed input

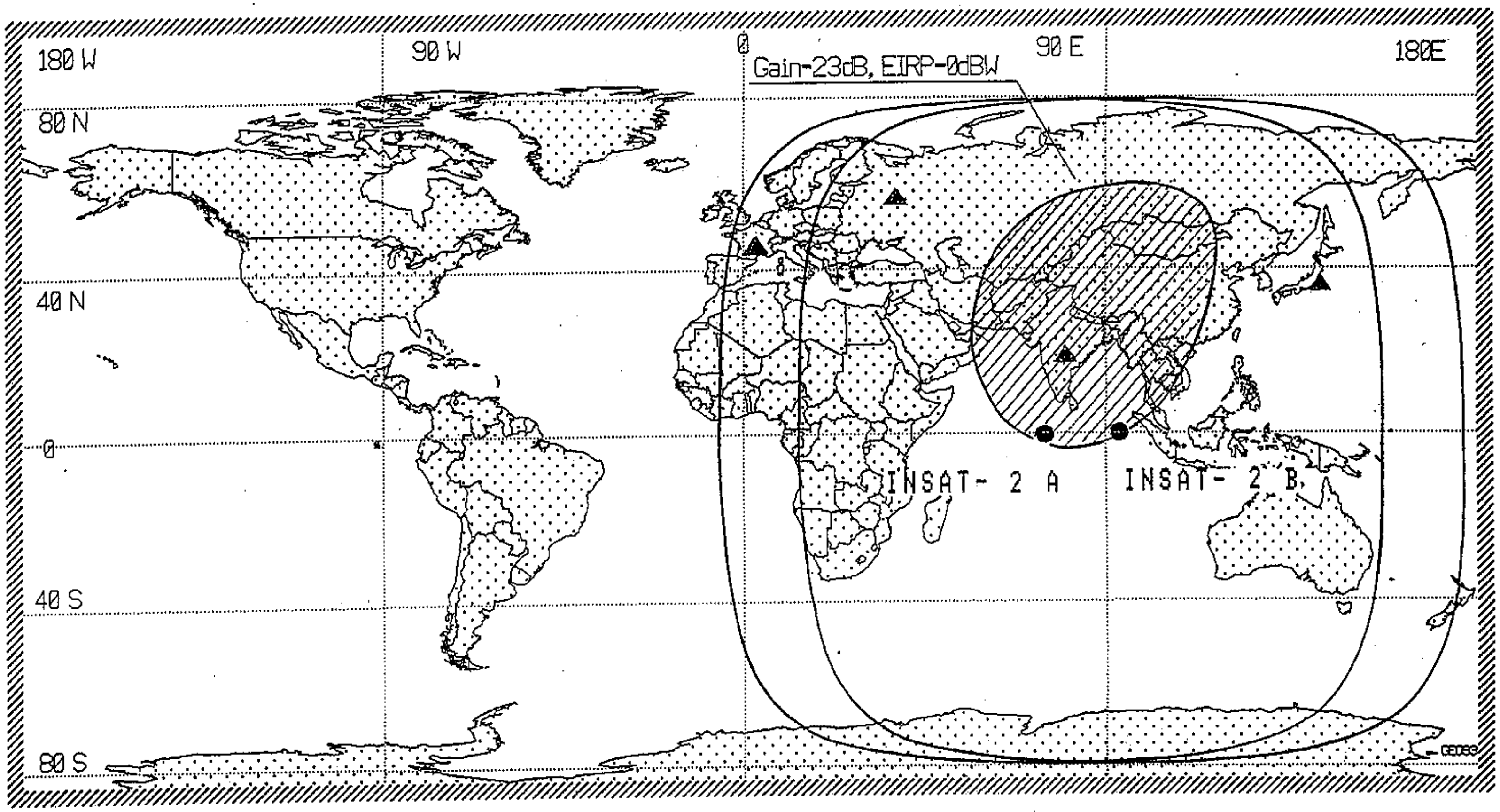


Figure C-4: Up-link Coverage and Down-link Reception of INSAT-2 A and INSAT-2 B, to 0° Elevation

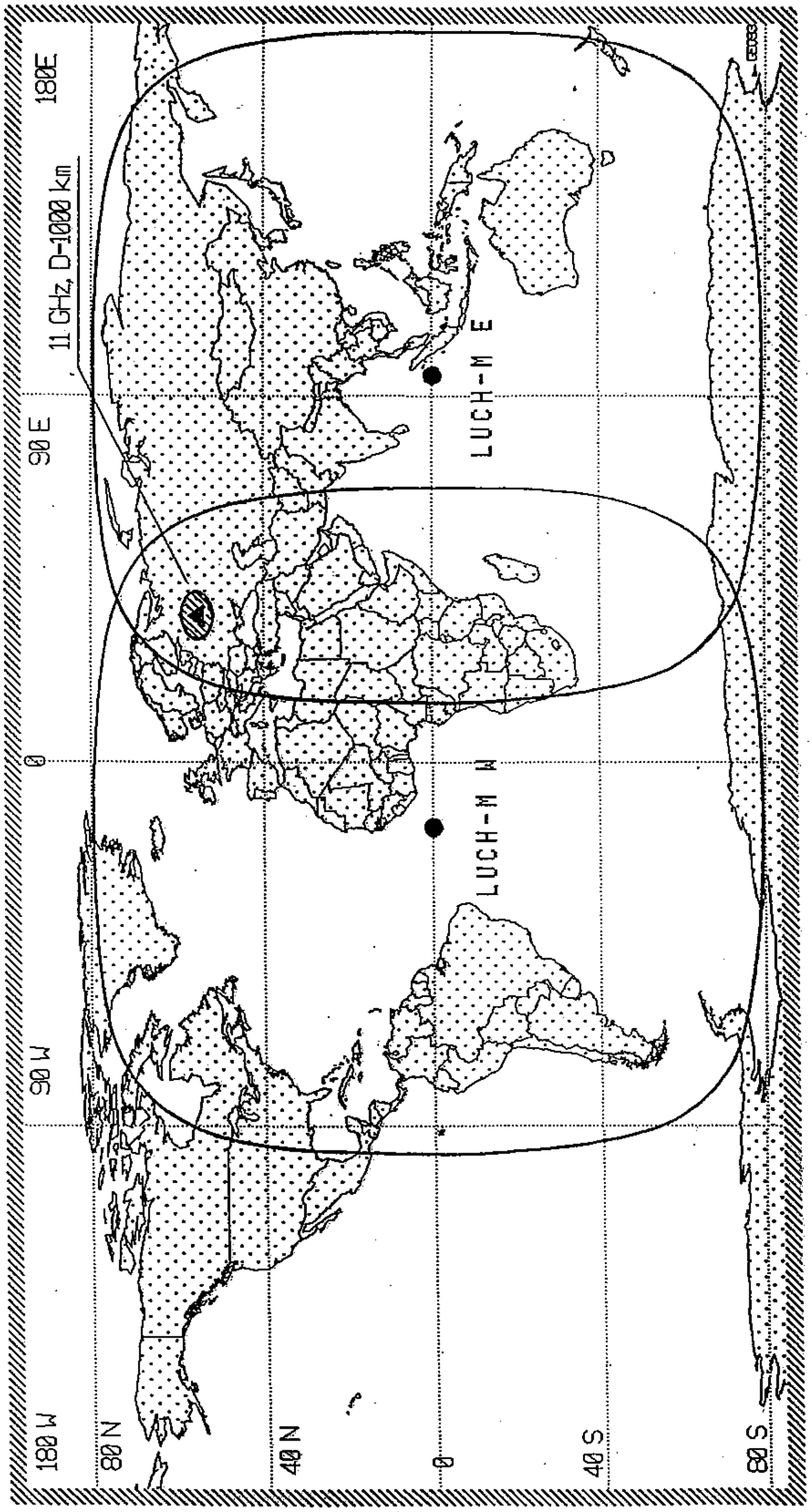
INSAT-2A Link for 406.025 MHz Beacons

Uplink

Frequency (MHz)	:	406.025 MHz
Tx EIRP (min)	:	+2 dBW
Pol loss due to linear pol.	:	3 dB
Max path loss	:	176.9 dB
Sat. Ant. gain	:	11 dB
Sat. Rx G/T	:	-19 dB/deg. K
Uplink C/No	:	31.7 dBHz
C/N (Rx B/W 120 KHz)	:	19.1 dB

Downlink

Frequency	:	4505.7 MHz
Tx EIRP	:	+3.8 dBW
PM side band level	:	-4.1 dB
C/N Sat.	:	-19.1 dB
Effective EIRP	:	-19.4 dB
Path loss	:	-197 dB
Rx G/T	:	25.7 dB/deg.K
Downlink C/No	:	37.9 dBHz
Uplink C/No	:	31.7 dBHz
Total C/No	:	30.76 dBHz



Note: ▲ - ground receiving station

Figure C-5: Up-link Coverage and Down-link Reception of LUCH-M E and LUCH-M W, to 0° Elevation

C.5 : LUCH-M

Performances of Satellite

Orbit	Geostationary
Orbit locations	16° W, 95° E
Spacecraft mass	2400 kg
Power supply	1800 W
Attitude control accuracy	±0.1°
Station keeping accuracy (longitude)	±0.05°
Lifetime	5 years
Spacecraft overall dimensions in orbit	8500 x 11000 x 16000 mm
Launching	"Proton" launch vehicle and "D" booster

406 MHz Repeater Specification

G/T ratio of geostationary satellite antenna up-link	-13.5 dB/K
Up-link carrier frequency	406.05 MHz
Repeater noise bandwidth	325 kHz
Down-link EIRP	21.5 dBW
Down-link carrier frequency	11381.05 MHz
Diameter of the spot beam	1000 km

- END OF ANNEX C -

ANNEX D

GEOSAR GROUND SEGMENT

D.1 Canadian GEOLUT

a. Baseband Input Frequency 125 kHz

b. System Capacity

406 MHz ELT/EPIRB detections/messages	5/second
Active 406 MHz beacons	250

c. System Thresholds

95% Detection Threshold	23 db-Hz C/N_o
50% Message Error Rate	
Laboratory Beacons	30 dB-Hz C/N_o
10^{-3} BER	35 db-Hz C/N_o

d. System Output

Beacon Id, extended message	120 bits
Signal Strength	±0.1 dB C/N_o
Time of Start of Frame Sync	±0.1 msec UTC
Carrier Frequency	±0.5 Hz
Message Transmission Bit Rate	±0.1 bps
Number of Integrated Messages	0-100
Number of Beacon ID Corrected Bit Errors	0-3
Error Free Frame Synchronization Flag	Y/N

D.2 French GEOLUT

To be provided.

D.3 Indian GEOLUT

a.	Input Frequency Band :	0-12 KHz with carrier centre frequency 6 KHz (corresponds to 406,025 MHz)
b.	System Threshold :	28 dBHz
c.	PDEFM :	Better than 0.99 at C/N_0 of 28 dBHz
d.	Capacity :	Minimum 10 beacons simultaneously

e.	MTT :	15 minutes or less for C/N_0 of 28 dBHz
f.	Output :	Beacon ID with time

D.4 Russian GEOLUT

a.	Input Frequency Band :	260 kHz with carrier centre frequency 11,381.00 MHz (corresponds to 406.025 MHz)
b.	Processing Threshold :	30 dBHz
c.	PDEFM :	Better than 0.99 at C/N_o of 30 dBHz
d.	Capacity :	To process minimum 10 beacons simultaneously (within the band of 10 kHz)
e.	Message transfer time (MTT):	6 minutes or less for C/N_o of 30 dBHz
f.	Output :	Beacon ID with time
g.	Dish antenna diameter	2 m
h.	Antenna G/T ratio	19 dB/K
i.	Elevation angle to each geostationary satellite	13° (Luch-M West) 4° (Luch-M East)
j.	Location	Moscow, Russia

D.5 Spanish GEOLUT

a.	Location	Maspalomas Tracking Station (Gran Canaria)
b.	Antenna	
	Dish Diameter	5 m
	Antenna Pointing Angles	254.5° Azimuth, 18.6° Elevation
	Downlink Carrier Frequency	1544.5 MHz (can receive 1689.65 MHz)
c.	Signal Processor	
	Data Processing Band	406.015 MHz to 406.035 MHz
	System Threshold	< 25 dB-Hz
	PDEFM	> 99% (at 30 dB-Hz)
	MTT	193 seconds (average at 30 dB-Hz)
	Capacity	> 60 simultaneous beacons
	Automatic Operation	Yes

ANNEX E

PROCEDURES FOR DISTRIBUTION OF 406 MHz GEOSAR ALERTS

1. BACKGROUND

GEOSAR alert data should be exchanged among participating MCCs during the D&E period of the GEOSAR systems. This data can be used operationally, but may be considered "experimental" such as the LEOSAR data was during the early years of Cospas-Sarsat. This information may also be useful for LEOSAR data interpretation in such areas as ambiguity resolution and large location error determination.

To provide a documented framework on which the participants can operate, the procedures documented hereunder provide a common set of operating principles and guidelines. These guidelines should be followed during the D&E period of GEOSAR systems and could be enhanced as a result of the experienced gained during the pre-operational period.

2. GENERAL DISTRIBUTION GUIDELINES

All MCCs will distribute GEOSAR alerts according to the procedures detailed in the Cospas-Sarsat Data Distribution Plan (DDP), C/S A.001. Specifically, distribution of alerts for beacons without encoded position information will be according to the DDP procedures for unlocated alerts with "Beacon Location" determined by the country code contained in the beacon identification. Alerts generated by location protocol beacons that contain encoded position data will be distributed according to the prescribed rules for alerts with location. In these cases, the encoded position data contained in the beacon-ID will be used to sort the proper message destination, in accordance with the current Cospas-Sarsat geographical sorting procedure.

In addition, special procedures could be implemented during the D&E period to assist in data collection and analysis. These special procedures could include provisions to transmit data between MCCs which would normally be considered to be "redundant" alert data such as, "unlocated" 406 MHz GEOSAR data arriving after LEOSAR data with Doppler positions, or 406 MHz GEOSAR unlocated data originating from two different satellites or GEOLUTs for the same beacon activation.

- END OF ANNEX E -

Page Left Blank

ANNEX F

MANAGEMENT OF OPERATIONAL OBJECTIVES

Table F-1: Management of Operational Objectives

Operational Objective		Responsible Operator for Data Collection
O-1	Potential Time Advantage	MCC(1)
O-2	Complementarity and Effectiveness of GEOSAR/LEOSAR Systems	MCC(1)
O-3	Duration of 406 MHz Transmissions	GEOLUT
O-4	Database Effectiveness	MCC(1)
O-5	Operational Impact of GEOSAR System Generated False Alerts	MCC(1)
O-6	Volume of GEOSAR Alert Message Processing at MCCs	MCC
O-7	Resolution of LEOSAR Location Ambiguity using GEOSAR Data	MCC
O-8	Evaluation of Benefits of GEOSAR Satellites and GEO/LEO Combination on SAR	MCC(2)

Notes: (1) For 406 MHz beacons with country codes of countries within the MCC service area.

(2) For 406 MHz beacons located within the MCC service area.

- END OF ANNEX F -

page left blank

ANNEX G : MANAGEMENT OF TECHNICAL OBJECTIVES

Table G-1: Management of Technical Objectives

Item No	Lead Country	Support with Resources	Support with Data Collection	Support with Data Analysis	Provide Report to Secretariat	Schedule	Remarks
T-1	Canada: GEOLUT France: GEOLUT India: GEOLUT Spain: GEOLUT UK: GEOLUT	France: beacon simulator India: beacon simulator USA: beacon simulator	Canada France India Spain UK	Canada France India Spain UK	Canada France India Spain UK	August 1996	co-ordinated uplink*
T-2	Canada: GEOLUT France: GEOLUT India: GEOLUT Spain: GEOLUT UK: GEOLUT	France: beacon simulator India: beacon simulator USA: beacon simulator	Canada France India Spain UK USA: LEOLUT	Canada France India Spain UK USA: LEOLUT	Canada France India Spain UK	August 1996	co-ordinated uplink*
T-3	Canada: GEOLUT France: GEOLUT India: GEOLUT Spain: GEOLUT UK: GEOLUT	France: beacon simulator India: beacon simulator USA: beacon simulator	Canada France India Spain UK	Canada France India Spain UK	Canada France India Spain UK	August 1996	
T-4	USA	France: beacon simulator + 2 beacons USA: beacon simulator (if req.) + 1 beacon Spain: 1 beacon UK: 2 beacons, Canada: 5 beacons Others: as needed/available	Canada France Spain UK	Canada France Spain UK	USA	USA to co-ordinate beacons as required late 1996 or early 1997	co-ordinated uplink*
T-5	Canada: GEOLUT France: GEOLUT India: GEOLUT Spain: GEOLUT UK: GEOLUT	Not required	Canada France India Spain UK	Canada France India Spain UK	Canada France India Spain UK	Ongoing activity throughout the D&E	

Notes: * Coordinated reception at multiple GEOLUTs of a single uplink signal could be arranged.

Table G-1: Management of Technical Objectives (Cont.)

Item No	Lead Country	Support with Resources	Support with Data Collection	Support with Data Analysis	Provide Report to Secretariat	Schedule	Remarks
T-6	France India	Canada/France/UK/USA/Spain: beacons placed on vessels of opportunity Australia/USA: beacons placed on vessels of opportunity for India	LEOSAR provider in footprint of satellite Other GEOLUT providers	France India	France India	Ongoing activity throughout the D&E	Consider use of GPS beacons if available
T-7	Canada France Spain UK	France: 1 GPS beacon USA: beacon simulator	Canada France Spain UK	Canada France Spain UK	Canada France Spain UK	Commence in early 1997	co-ordinated uplink*
T-8	Canada: GEOLUT France: GEOLUT India: GEOLUT Spain: GEOLUT UK: GEOLUT	USA: beacon simulator France: beacon simulator India: beacon simulator Others: test beacons with inverted frame synch	Canada France India Spain UK	Canada France India Spain UK	Canada France India Spain UK	Beacon testing to commence in early 1997 Interference monitoring - ongoing activity throughout the D & E	Requires beacons and/or simulator with inverted frame synch
T-9	Spain	USA: beacon simulator France: beacon simulator ORB/Ref. beacons as available	Spain France UK	Spain	Spain	Commence in early 1997	
T-10	Canada India	Spain: LEOLUT, GEOLUT Canada: LEOLUT, GEOLUT India: LEOLUT, GEOLUT USA: beacon simulator	Canada India Spain USA	Canada India Spain USA	Canada India USA	Commence in early or mid 1997	

Notes: * Coordinated reception at multiple GEOLUTs of a single uplink signal could be arranged.

- END OF ANNEX G -

ANNEX H

FORMATS FOR NATIONAL REPORTING

1. Contents

Annex H contains the tables and forms to be used for reporting the results obtained by participants performing the measurements, evaluations and tests outlined in the GEOSAR D&E Plan. These tables were prepared using MS Word 6.0 and the files are available from the Secretariat.

2. Instructions

Participants should report the results of their D&E evaluations using the tables and formats provided in this annex. The forms should be completed using a word processor or should be copied and hand-completed. Completing the forms electronically will facilitate data reduction when preparing a final combined report. The data required in this annex is the minimum that should be provided in the reports by participants. However, additional supporting data can be included in the report, and other compatible automated formats can be substituted for the forms listed in this annex.

Some tables or forms require data reporting by month and by satellite. The participants should make the necessary copies of the electronic forms or hard copies of those forms to complete their report.

All reports should be prefixed with a short narrative introduction including relevant information concerning the D&E evaluation performed by a participant and any general pertinent comments. The reports, including completed forms and tables in electronic format and corresponding hard copies, should be forwarded to the Secretariat by 31 January each year.

T-1: Processing Threshold and System Margin
(Section 3.2.1)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 Analysis (section 3.2.1.2).

a. Processing threshold.

From the table, determine the value of C/No at which the PDEFM is equal to 0.99. This is the processing threshold.

Processing threshold = ______________ (dBHz)

b. System margin.

From the table, determine the beacon's EIRP at which the PDEFM is equal to 0.99. The system margin may be calculated as:

system margin (dB) = 37 - (EIRP at which PDEFM = 0.99)

System margin = _______________ (dB)

T-1: Processing Threshold and System Margin (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRP) (dBm)				
Antenna Type (beacon/remote)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-1: Processing Threshold and System Margin (cont.)

Table for Processing Threshold and System Margin Error

GEOSAR Satellite: __________

Beacon EIRP (dBm)	C/No at the GEOLUT (dBHz)	Number of Message Blocks Transmitted	Number of Valid Messages Received	PDEFM

T-2: Message Transfer Time
(Section 3.2.2)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 Analysis (section 3.2.2.2).

Message transfer time:

From the table, for the threshold value of C/No (PDEFM = 0.99), plot the probability distribution function or the cumulative probability distribution of message transfer times. From these plots, determine MTT_{50} and MTT_{90} at threshold.

MTT_{50} = ______________ (sec)

MTT_{90} = ______________ (sec)

Note: Include plot of probability distribution.

Comments: ______________________ (continue on separate pages as necessary)

T-2: Message Transfer Time (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRP) (dBm)				
Antenna Type (beacon/remote)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-2: Message Transfer Time (cont.)

Table for Determining Message Transfer Time

GEOSAR Satellite: __________

Beacon EIRP (dBm)	C/No at the GEOLUT (dBHz)	Beacon Turn on Time (UTC)	Time of First Valid Message (UTC)	Message Transfer Time (sec)

T-3: Carrier Frequency Measurement
(Section 3.2.3)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 GEOLUT calibration factor (MHz):

7.0 Analysis (section 3.2.3.2).

Carrier frequency measurement:

From the table, determine the percentage difference between the GEOLUT's frequency measurement and the actual measured value by:

percent frequency difference =

$$\frac{100 \times ((\text{MEASURED FREQUENCY} + \text{CALIBRATION FACTOR}) - \text{ACTUAL FREQUENCY})}{\text{ACTUAL FREQUENCY}}$$

Plot these differences as a probability distribution function (note: include plot(s) and graph(s) with report), and determine the distribution's :

Mean: __________
Standard deviation: __________

T-3: Carrier Frequency Measurement (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRE) (dBm)				
Antenna Type (beacon/remote)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-3: Carrier Frequency Measurement (cont.)

Table for Determining Carrier Frequency Measurement Suitability

GEOSAR Satellite: ____________

Beacon Identification Code	GEOLUT Frequency Measurement (MHz)	GEOLUT Calibration Factor (MHz)	Actual Beacon Carrier Frequency	Percentage Difference	Number of Beacon Bursts Used

T-4: Beacon Processing Capacity
(Section 3.2.4)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 Analysis (section 3.2.4.2).

a. System processing capacity:

From the table, determine the maximum number of beacons at which the PDEFM = 0.99.

Processing capacity = ______________ beacons

b. System transfer time:

From the table, at the maximum capacity number of simultaneous beacons, determine the message transfer time for the 50th and 90th percentiles.

MTT_{50} = ______________ (sec)

MTT_{90} = ______________ (sec)

T-4: Beacon Processing Capacity (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRE) (dBm)				
Antenna Type (beacon/remote)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-4: Beacon Processing Capacity (cont.)

Table for Processing Capacity Evaluation

GEOSAR Satellite: __________

Number of Beacons Used	Number of Message Blocks Sent	Number of Valid Messages Received	PDEFM	Message Transfer Time 50%	Message Transfer Time 90%

T-5: Impact of Interference
(Section 3.2.5)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 Additional information:

Include, if possible, photographs, data plots, or spectrographs of the interfering signals.

7.0 Analysis (sections 3.2.5.1 and 3.2.5.2)

Interferer impact:

From the table, determine and comment upon the impacts of the interfering signals in terms of decrease or loss of expected messages, increase in false messages, or relate the impact of the interferer upon the GEOLUT's performance to patterns or characteristics in the interferer's signal.

Comments: ______________________ (continue on separate sheets as required)

T-5: Impact of Interference (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRE) (dBm)				
Antenna Type (beacon/remote)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-5: Impact of Interference (cont.)

Table for Determining Impact of Interference

GEOSAR Satellite: __________

Time of Occurrence (DDD HHMM)	Time Duration (HHMM)	Estimated Signal Strength (Watts)	Modulation Type (Analog/Digital)	Time Patterns (on-off/continuous) (sweeping/constant)	Location (+dd.ddd +ddd.ddd) (if known)	Impact on GEOLUT

T-6: GEOSAR Satellite Coverage
(Section 3.2.6)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 Analysis (section 3.2.6.2).

GEOSAR satellite coverage:

For each GEOSAR satellite used, plot by 15° latitude and longitude bands the number of known beacon locations, as recorded in the data collection table, from which a valid message is received from a GEOLUT. Coverage contour plots should also be made, and included with the report, as a function of the elevation angle to the GEOSAR satellite. Data should be collected over a period of at least one year in order to accumulate a sufficient density of points.

Comments: ______________________ (continue on separate pages as required)

T-6: GEOSAR Satellite Coverage (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRE) (dBm)				
Antenna Type (beacon/remote)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-6: GEOSAR Satellite Coverage (cont.)

Table for Collecting Beacon Location and Elevation Angle Information for Determining GEOSAR Satellite Coverage

GEOSAR Satellite: __________

Beacon Identification Code	Location (±dd.ddd/±ddd.ddd)	Elevation Angle to GEOSAR Satellite (Degrees)	Valid GEOLUT Message Received (Y/N)

T-6: GEOSAR Satellite Coverage (cont.)

Plot of Number of Known Locations Detected by GEOSAR Satellite

GEOSAR Satellite: __________

	-180	-165	-150	-135	-120	-105	-90	-75	-60	-45	-30	-15	+15	+30	+45	+60	+75	+90	+105	+120	+135	+150	+165	+180
+90																								
+75																								
+60																								
+45																								
+30																								
+15																								
-15																								
-30																								
-45																								
-60																								
-75																								
-90																								

T-7: Impact of Updating Encoded Position Data
(Section 3.2.7)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 Analysis (section 3.2.7.2).

Impact of updating encoded position data:

Examine the received beacon messages and compare them to the transmitted message blocks and note any differences. Note if there is any correlation between the burst number (up to 20) which is changed and errors in the beacon code received by the GEOLUT.

Note if there are any false messages produced by the GEOLUT and what beacon code was being transmitted when the false message was produced.

Plot the MTT histogram for each case required and include with the report.

Comments: __________________________ (continue on separate pages as required)

T-7: Impact of Updating Encoded Position Data (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRP) (dBm)				
Antenna Type (beacon/remote)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-7: Impact on Updating Encoded Position Data (cont.)

Table for Data Collection for Impact of Updating Encoded Position Data

GEOSAR Satellite: __________

Beacon EIRP (dBm)	No. of Bursts Before Location Data Changed	Beacon Code Received (initial, changed, or both)	PDEFM	Message Transfer Time (sec)

T-8: System Generated False Alerts
(Section 3.2.8)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 Analysis (section 3.2.8.2).

System generated false alerts:

Determine if any GEOLUT output messages have come from beacons with inverted frame synchronization. Determine if there were any interferers present when the GEOLUT produced false messages. If so, analyze the message content and rate of false message production and the signal characteristics (as described in T-5) of the interferer to determine if there are patterns or trends between the interferer and the GEOLUT's false message. Each unique case should be described separately.

Percentage and rate at which false messages are produced: __________

Comments: ________________________ (continue on separate pages as required)

T-8: System Generated False Alerts (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRE) (dBm)				
Antenna Type (beacon/remote)				
Inverted Frame Sync (yes/no)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-8: System Generated False Alerts (cont.)

Table for Data Collection on System Generated False Alerts

GEOSAR Satellite: ________

Beacon Code Transmitted	Beacon Code Received	Interference Present (Yes/No)	GEOLUT Impact Assessment and Other Comments

T-9: Impact of System Beacons
(Section 3.2.9)

1.0 Lead country: __________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: __________
Resources provided:

b. Supporting country: __________
Resources provided:

3.0 Test dates and times: __________

4.0 GEOLUT identification: __________
GEOLUT location: __________

5.0 GEOSAR satellites used.

a. __________

b. __________

6.0 Analysis (sections 3.2.9.1 and 3.2.9.2).

Impact of system beacons:

Determine the percentage of total valid messages produced by the GEOLUT that originate from orbitography beacons. Percentage is __________

From the table, determine the changes in message transfer time as a function of the number of orbitography beacons transmitting simultaneously in the field of view of the GEOSAR satellite. If possible, place the test beacon outside the SAR band containing the orbitography beacons and calculate the message transfer time for the various levels of EIRP of the test beacon. Note any differences in the message transfer time for the test beacon in and out of the band containing the orbitography beacons.

Comments: __________________________ (continue on separate pages as required)

T-9: Impact of System Beacons (cont.)

Summary of 406 MHz Beacons Used

	Beacon #1	Beacon #2	Beacon #3	Beacon #4
Beacon Description:				
Manufacturer				
Model Number				
Serial Number				
Identification Code				
Carrier Frequency (MHz)				
Burst Repetition Period (sec)				
Output Power (EIRP) (dBm)				
Antenna Type (beacon/remote)				
Location (decimal degrees):				
Latitude(±dd.ddd)				
Longitude(±ddd.ddd)				
Beacon Activation Times (UTC):				
Time On (DDD HHMM)				
Time Off (DDD HHMM)				

T-9: Impact of System Beacons (cont.)

Table for Collecting Data for System Beacons

GEOSAR Satellite: __________

Beacon EIRP (dBm)	Number of Orbitography Beacons in View	Beacon Turn on Time (UTC) (DDD HHMM)	Time of First Valid Message (UTC)	Message Transfer Time (sec)

T-10: Combined Operations
(Section 3.2.10)

1.0 Lead country: ________
Resources provided:

2.0 Supporting assistance.

a. Supporting country: ________
Resources provided:

b. Supporting country: ________
Resources provided:

3.0 Test dates and times: ________

4.0 GEOLUT identification: ________
GEOLUT location: ________

5.0 GEOSAR satellites used.

a. ________

b. ________

6.0 Analysis (sections 3.2.10.1 and 3.2.10.2).

Examine beacon turn on times provided by the GEOSAR system and note any relationship between that time and the frequency drift measurement, the error ellipse size, and the location accuracy of the LEOSAR data. Note any impact the GEOSAR system can make in determination of LEOSAR data quality indicators or in location accuracy improvement.

Comments: ____________________ (continue on separate pages as required)

T-10: Combined Operations (cont.)

Table for Evaluation of LEOSAR/GEOSAR Combined Operations

GEOSAR Satellite: ________

Beacon Turn on Time (DDD HHMM)	LEOSAR Data					GEOSAR Frequency Measurement (MHz)	
	TCA (DDD HHMM)	Location Error (NM)	Frequency Drift (Hz)	Partial Curve (Y/N)	Error Ellipse Size (MMM/mmm)	First Detection	Stable Detection

O-1: Potential Time Advantage (PTA)

GEOSAR Satellite: ________

	Number of PTAs by Month - Time Period in 10 Minute Increments (Sections 3.3.1.2.a-d)																			
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	>3 Hrs	Totals
JAN																				
FEB																				
MAR																				
APR																				
MAY																				
JUN																				
JUL																				
AUG																				
SEP																				
OCT																				
NOV																				
DEC																				
Total																				

Note: For all cases of PTA > 3 hours, provide a detailed explanation of the circumstances, if possible.

Total Number of PTAs Reported Above: ________

Total Number of Events Not Reported Because
LEOSAR Alert Arrived Before GEOSAR Alert: ________

PTA Distribution (Section 3.3.1.2.e)

Mean: ________
Median: ________
Standard Deviation: ________

Narrative Comments for O-1:

O-2: Complementarity and Effectiveness of GEOSAR/LEOSAR Systems
(includes unresolved locations within GEOSAR footprint)

Summary of GEOSAR/LEOSAR Detections
(Sections 3.3.2.2.a-d)

GEOSAR Satellite: ________

MONTH	A Total Alerts in 0 degree GEOSAR Footprint (NGA+NLOA)	B Alerts Detected by GEOSAR only (NGOA)	C GEO Unique Contribution (B/A)*100	D Alerts Detected by both GEOSAR and LEOSAR (NGLA)	E GEOSAR Effectiveness ((B+D)/A) *100	F Alerts in GEOSAR Footprint detected only by LEOSAR (NLOA)	G LEOSAR Unique Contribution (F/A)*100
JAN							
FEB							
MAR							
APR							
MAY							
JUN							
JUL							
AUG							
SEP							
OCT							
NOV							
DEC							
Totals							

O-2: Complementarity and Effectiveness of GEOSAR/LEOSAR Systems (cont.)

Plot of Number of Confirmed Alerts Detected by LEOSAR Not Detected by GEOSAR
(Section 3.3.2.2.e)

GEOSAR Satellite: _______
Month: _______

	-180	-165	-150	-135	-120	-105	-90	-75	-60	-45	-30	-15	+15	+30	+45	+60	+75	+90	+105	+120	+135	+150	+165	+180
+90																								
+75																								
+60																								
+45																								
+30																								
+15																								
-15																								
-30																								
-45																								
-60																								
-75																								
-90																								

O-2: Complementarity and Effectiveness of GEOSAR/LEOSAR Systems (cont.)

Plot of Number of Confirmed Positions of 406 MHz GEOSAR Alerts as Confirmed by LEOSAR
(Section 3.3.2.2.f)

GEOSAR Satellite: _______
Month: _______

	-180	-165	-150	-135	-120	-105	-90	-75	-60	-45	-30	-15	+15	+30	+45	+60	+75	+90	+105	+120	+135	+150	+165	+180
+90																								
+75																								
+60																								
+45																								
+30																								
+15																								
-15																								
-30																								
-45																								
-60																								
-75																								
-90																								

Narrative Comments for O-2:

O-3: Duration of 406 MHz Transmissions

Transmission Durations of Less Than Two Hours in Ten Minute Increments
(Section 3.3.3.2.c.(i, iii))

GEOSAR Satellite: ______

Month	Number of Beacons with Transmission Durations of:												
	0-10Mins 1 EFM*	0-10Mins > 1 EFM	10-20 Mins	20-30 Mins	30-40 Mins	40-50 Mins	50-60 Mins	60-70 Mins	70-80 Mins	80-90 Mins	90-100 Mins	100-110 Mins	110-120 Mins
JAN													
FEB													
MAR													
APR													
MAY													
JUN													
JUL													
AUG													
SEP													
OCT													
NOV													
DEC													
Totals													

* error free message

O-3: Duration of 406 MHz Transmissions (cont.)

Transmission Durations in One Hour Increments
(Section 3.3.3.2.c.(ii))

GEOSAR Satellite: __________

Month	Number of Beacons with Transmission Durations of:																								
	0-1 Hr	1-2 Hrs	2-3 Hrs	3-4 Hrs	4-5 Hrs	5-6 Hrs	6-7 Hrs	7-8 Hrs	8-9 Hrs	9-10 Hrs	10-11 Hrs	11-12 Hrs	12-13 Hrs	13-14 Hrs	14-15 Hrs	15-16 Hrs	16-17 Hrs	17-18 Hrs	18-19 Hrs	19-20 Hrs	20-21 Hrs	21-22 Hrs	22-23 Hrs	23-24 Hrs	>24 Hrs
JAN																									
FEB																									
MAR																									
APR																									
MAY																									
JUN																									
JUL																									
AUG																									
SEP																									
OCT																									
NOV																									
DEC																									
Totals																									

O-3: Duration of 406 MHz Durations (cont.)

Summary Statistics (Section 3.3.3.2.d):

GEOSAR Satellite	Total Number of Beacons	Mean*	Median*	Standard Deviation*

* Distribution of 406 MHz transmission durations

Narrative Comments for O-3:

O-4: Database Effectiveness
(Section 3.3.4.2)

a	Number of 406 MHz GEOSAR alerts for which database information was acquired and provided to SAR forces (NGC)	
b1	Number of cases where GEOSAR alert and beacon registration data allowed SAR forces to discriminate between real alert or false alarm (NCR)	
b2	Number of false alarm cases in which registration data was instrumental in terminating alarm without the use of SAR resources (NFAR)	
c	Ratio of Alert Discrimination (RADE) NCR/NGC x 100	
d	Ratio of False Alarm Resolved Before Launch (RFARBL) NFAR/NCR x 100	

e1	Search Initiation/false alarm determination Time Improvement (SITI)* Number of SITIs in ten minute increments up to two hours												
	10	20	30	40	50	60	70	80	90	100	110	120	>120

* SITI is calculated as the time advantage provided by a GEOSAR alert as compared to the LEOSAR alert which allowed an RCC or SPOC to initiate a search or determine that a false alarm existed.

O-4: Database Effectiveness (cont.)

e2. Statistics for SITI

Mean: _______

Median: _______

Standard Deviation: _______

Narrative Comments for O-4:

O-5: Operational Impact of GEOSAR System Generated False Alerts
(Section 3.3.5.2)

a. Number of 406 MHz GEOSAR alerts received at MCC (NGMR)		
Satellite Identifier	GEOLUT Identifier	Number of Alerts
Total All GEOSAR Satellites/All GEOLUTs: __________		

b. Total GEOSAR Alerts Passed to RCCs/SPOCs (NGAR): ___________

c. GEOSAR Alerts Received at MCC and Confirmed as Invalid (GIAR)		
Satellite Identifier	GEOLUT Identifier	Number of Alerts
Total All GEOSAR Satellites/All GEOLUTs: __________		

O-5: Operational Impact of GEOSAR System Generated False Alerts (cont.)

d. GEOSAR Alerts Forwarded to RCCs/SPOCs Which Are Confirmed as Invalid (GIAT)		
Satellite Identifier	GEOLUT Identifier	Number of Alerts
Total All GEOSAR Satellites/All GEOLUTs: __________		

e. Ratio of GEOSAR System Generated False Alerts received at MCC (SGFAM) GIAR/NGMR x 100		
Satellite Identifier	GEOLUT Identifier	SGFAM
Total All GEOSAR Satellites/All GEOLUTs: ________		

O-5: Operational Impact of GEOSAR System Generated False Alerts (cont.)

f. Ratio of GEOSAR System Generated False Alerts transmitted to RCCs and SPOCs (SGFAR) GIAT/NGAR x 100

Satellite Identifier	GEOLUT Identifier	SGFAR

Total All GEOSAR Satellites/All GEOLUTs: _______

Narrative Comments for O-5:

O-6: Volume of GEOSAR Message Processing at MCCs
(Section 3.3.6.2)

GEOSAR Satellite	Total GEOSAR Message Traffic Received and Transmitted by Month and by Satellite												Totals
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Totals													

Total GEOSAR alert message traffic received and transmitted at MCC during reporting period (VGT): _______

Total volume of non-GEOSAR alert traffic during reporting period (VNGT): _______

GEOSAR Traffic Ratio (GTR) = VGT/VNGT x 100. GTR: _______

Narrative Comments for O-6:

O-7: Resolution of LEOSAR Location Ambiguity Using GEOSAR Data

(Section 3.3.7.2)

GEOSAR Satellite	Total of Successful Ambiguity Resolutions of LEOSAR Locations Using GEOSAR Data by Month and by Satellite												Totals
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Totals													

a.	Total number of successful resolutions of LEOSAR Doppler location ambiguity using GEOSAR data during reporting period (NLLAR).	NLLAR
b.	Total number of 406 MHz alerts located by the LEOSAR system in the MCC Service Area during reporting period (TNLAM).	TNLAM
c.	Ratio of Effectiveness of LEOSAR Location Ambiguity using GEOSAR Data (RELLAG). RELLAG = NLLAR/TNLAM x 100	RELLAG

Narrative Comments for O-7:

O-8: Evaluation of Benefits of GEOSAR Satellites and GEO/LEO Combination on SAR

Narrative assessment of direct and indirect benefits to SAR of GEOSAR systems and GEOSAR/LEOSAR systems used in combination.

Direct Benefits (see section 3.3.8.3.1):

a. Human Lives Lost:

b. Search Costs:

c. Property Losses:

Indirect Benefits (see section 3.3.8.3.2):

a. Risk Reduction of SAR Forces:

b. Increased Public Confidence In and Reliance on the Value of 406 MHz Beacons:

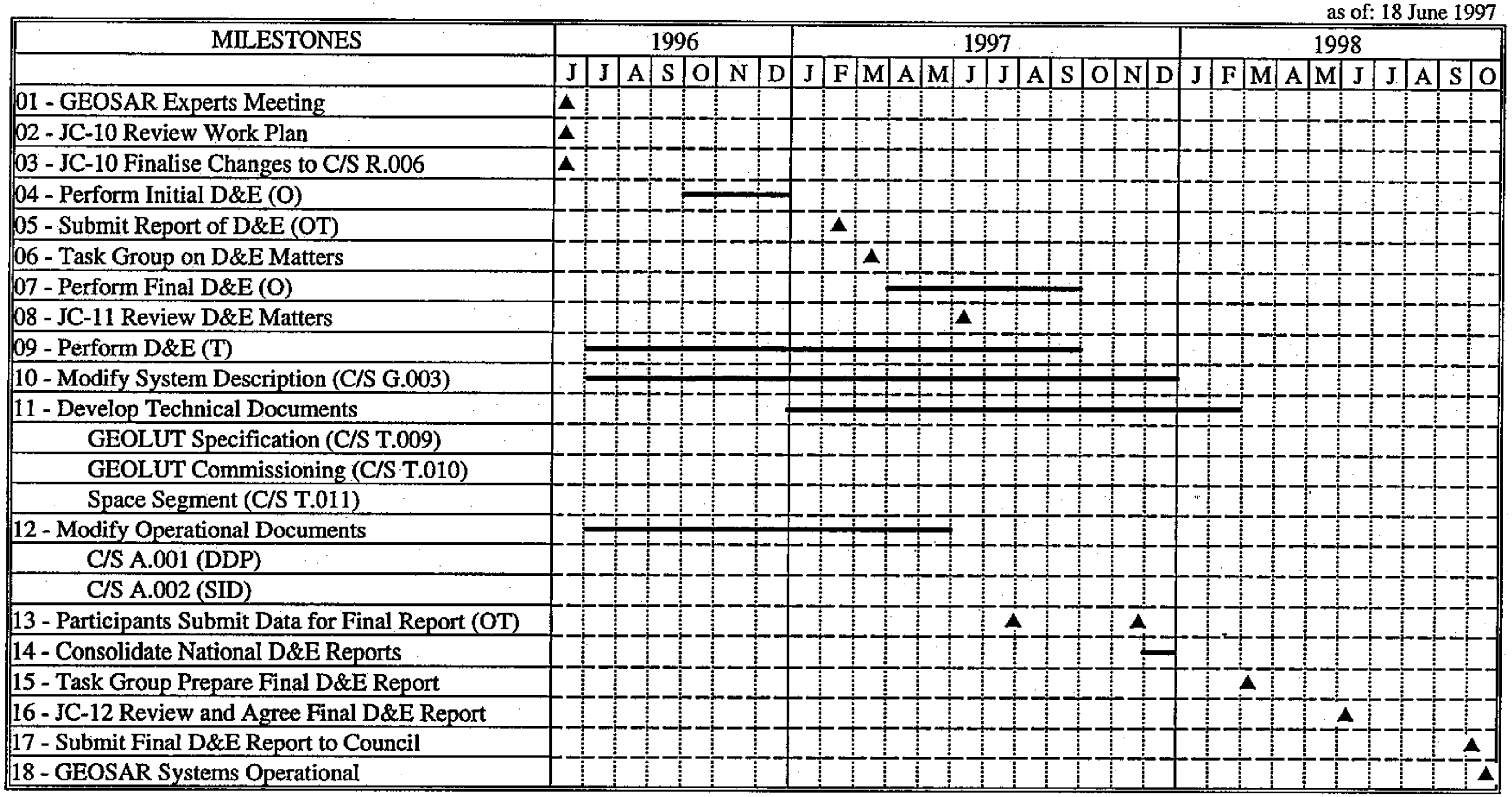
- END OF SECTION H -

this page left blank

ANNEX I

GEOSAR DEMONSTRATION AND EVALUATION PLAN

GEOSAR D&E MILESTONES



Notes: O - Operational Objectives
T - Technical Objectives
OT - Both

- END OF SECTION I-

page left blank

ANNEX J

VERIFICATION OF GEOSAR EFFECTIVENESS (Objective O-2)

The flow diagram contained in Figure J-1 and the text in Table J-1 document the analysis to be performed for non-detection of operational beacons by the GEOSAR system. Reference numbers in Figure J-1 correspond to actions and responsible parties in Table J-1.

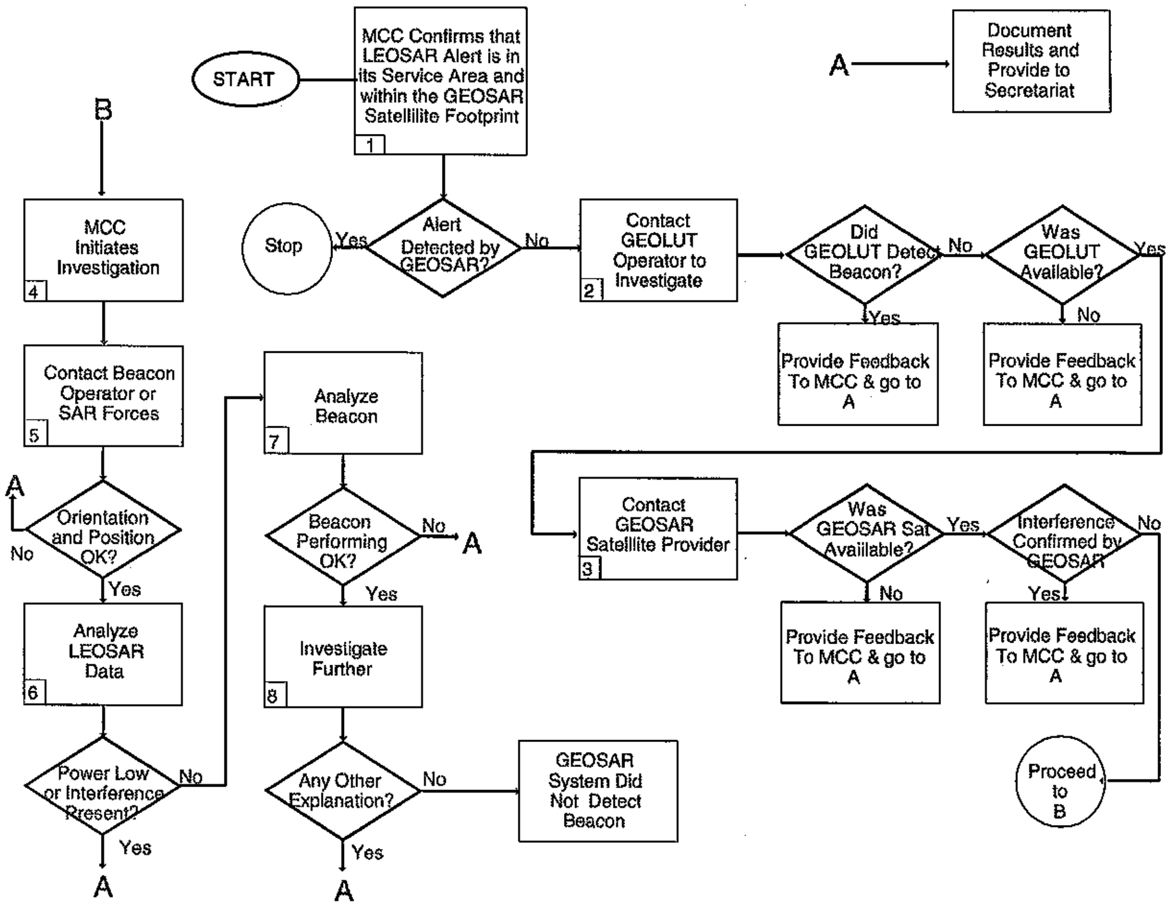


Figure J-1: Flow Diagram for Analysis of Non-detection of 406 MHz Beacons

Table J-1: Table of Responsibilities

Reference Number	Responsible Party	Action(s) Required
1	MCC[1] Operator	MCC confirms that LEOSAR alerts in service area have a corresponding GEOSAR alert. If a GEOSAR alert does not exist then the MCC should contact all the GEOLUT operators tracking the relevant satellite(s) as soon as possible.
2	MCC Operator	The MCC should provide the beacon identifier, TCA of the LEOSAR data and the frequency of the missed detection.
	GEOLUT Operator	Research archived data to ensure that the beacon or a similar bit pattern was detected at the time in question. If no detection is present ensure that the GEOLUT was operating nominally at the time in question. Notify MCC of results.
3	GEOLUT Operator	Contact relevant GEOSAR satellite operator.
	GEOSAR Satellite Operator	Ensure that the satellite and relevant payload was operational. If payload was operational investigate for the presence of interference in the 406 MHz band. This may be accomplished by using the satellite telemetry to track the automatic gain control. Notify MCC of results.
4	MCC Operator	Initiate research of operational scenario.
5	MCC Operator	Evaluate the presence of local obstructions between the beacon and satellite (i.e., beacon obstructed by wheelhouse or other structure on a vessel or a local mountain). Obstructions will become more prominent at greater distances from the satellite sub-points. The location and type of beacon should also be considered (i.e., a beacon with a monopole antenna directly below the satellite position may not be detected).
6	MCC Operator	Coordinate with any LEOLUT operator to perform an analysis of global PDS LEOSAR data.
	LEOLUT Operator	Provide data and analysis on LEOLUT data. Analysis should include documenting the power level of the beacon in question (e.g., beacons below -120 dBm might not be detected), power level of beacons detected at the same time period for that satellite pass, and missing or corrupted beacon messages.
7	MCC Operator	Investigate the beacon by evaluating historical data for the beacon, studying the antenna, measuring the power level through the use of a commercial beacon tester or performing satellite tests using the beacon.
8	MCC Operator	Perform additional analysis as feasible.

(1) MCC in whose service area a LEOSAR alert exists without a corresponding GEOSAR.

- END OF DOCUMENT -