COSPAS-SARSAT
INSAT GEOSAR PERFORMANCE EVALUATION REPORT

C/S R.015
Issue 1
October 2009

COSPAS SARSAT

INSAT PERFORMANCE EVALUATION REPORT

History

Issue	Revision	Date	Comments
Issue 1	-	October 2009	Approved by CSC-43

LIST OF PAGES

Page #	Date of latest revision
cover	Oct 09
i	Oct 09
ii	Oct 09
iii	Oct 09
iv	Oct 09
v	Oct 09
vi	Oct 09
1-1	Oct 09
1-2	Oct 09
2-1	Oct 09
2-2	Oct 09
3-1	Oct 09
3-2	Oct 09
3-3	Oct 09
3-4	Oct 09
3-5	Oct 09
3-6	Oct 09
3-7	Oct 09
3-8	Oct 09
3-9	Oct 09
3-10	Oct 09
4-1	Oct 09
4-2	Oct 09
A-1	Oct 09
A-2	Oct 09
B-1	Oct 09
B-2	Oct 09
C-1	Oct 09
C-2	Oct 09
D-1	Oct 09
D-2	Oct 09
D-3	Oct 09
D-4	Oct 09
E-1	Oct 09
E-2	Oct 09
F-1	Oct 09
F-2	Oct 09

TABLE OF CONTENTS

LIST OF ANNEXES

LIST OF FIGURES

LIST OF TABLES

- Page left blank -

1. INTRODUCTION

The Indian Space Research Organisation (ISRO) has installed 406 MHz Search and Rescue (SAR) repeaters on their INSAT communication and meteorological satellites. The first INSAT satellites was launched in 1992 and following payload testing of the SAR instrument and successful Cospas-Sarsat GEOSAR D&E was used operationally by Cospas-Sarsat Ground Segment operators from February 1999. However, the performance of INSAT SAR instrument had yet to be fully evaluated. The Cospas-Sarsat Council directed that an INSAT GEOSAR performance evaluation programme be conducted to

a. establish INSAT GEOSAR / GEOLUT performance;

b. validate specification and commissioning requirements for GEOLUTs which operate with the current INSAT-3A GEOSAR payload; and

c. verify the performance and, if appropriate, commission the current INSAT GEOLUT (Bangalore) into the Cospas-Sarsat System.

1.1 Background

From 1996 to 1998 Cospas-Sarsat conducted a demonstration and evaluation programme to determine the suitability of using satellites in geostationary orbit equipped with SAR instruments to process the signals from Cospas-Sarsat 406 MHz distress beacons. This programme, hereafter referred to as the GEOSAR D & E, was implemented using the GOES series of satellites provided by the USA, the Insat-2 satellites provided by India, and experimental ground segment equipment provided by Canada, Chile, India, Spain and the United Kingdom. The GEOSAR D & E demonstrated that GEOSAR satellites provided a significant enhancement to the Cospas-Sarsat system. Following from this conclusion, in October 1998 the Cospas-Sarsat Council decided that the 406 MHz GEOSAR system components should be incorporated into the Cospas-Sarsat System as soon as possible.

While the GEOSAR D & E was being conducted, new 406 MHz GEOSAR repeaters were developed by EUMETSAT and installed on the MSG meteorological satellite series. Since the technical characteristics of the MSG SAR instrument were different from SAR instruments on the GOES satellites, additional tests were performed to establish MSG GEOSAR / GEOLUT performance, and any special GEOLUT specification and commissioning requirements. The results of these tests were approved by Cospas-Sarsat in October 2004.

1.2 INSAT GEOSAR Performance Evaluation

Following the deployment of a third type of 406 MHz GEOSAR payload onboard INSAT-3A by the Republic of India and the signature of an Understanding between the Cospas-Sarsat Programme and the Republic of India on the provision of Cospas-Sarsat GEOSAR services in

February 2007, the Cospas-Sarsat Council also decided that the INSAT performance evaluation programme should be based on the technical (T) series of tests defined in the GEOSAR D & E Plan, as amended to address anticipated INSAT performance.

The INSAT GEOLUT (Bangalore) participated in the INSAT GEOSAR performance evaluation programme. Since the Bangalore terminal is the only Cospas-Sarsat GEOLUT capable of tracking the INSAT-3A payload, the commissioning of the GEOLUT was also performed as part of the INSAT GEOSAR performance evaluation.

The administrations of France and Turkey also participated in the INSAT GEOSAR performance evaluation and provided beacon simulator signals for some of the proposed tests.

The tests reported herein were performed while the INSAT 3A satellite was at its final operating position of 93.5° E. France's 406 MHz beacon simulator with a linearly polarised whip antenna was used to transmit the uplink signals developed specifically for the testing.

- END OF SECTION 1 -

2. INSAT GEOSAR PERFORMANCE EVALUATION GOALS AND OBJECTIVES

2.1 Performance Evaluation Goals

The goals of the performance evaluation programme were to:

a. characterize the technical performance of the INSAT GEOSAR / GEOLUT system and confirm that the INSAT GEOSAR satellite, and GEOLUT systems effectively provide useful 406 MHz alert data; and

b. validate specification, commissioning requirements and performance for the GEOLUT which operate with INSAT-3 satellites.

As Part of this evaluation programme, the INSAT GEOLUT was tested in accordance with the commissioning requirements detailed in document C/S T.010 and, if appropriate, will be commissioned into the Cospas-Sarsat System.

2.2 Objectives

The programme has been subdivided into specific objectives. Each objective is addressed by conducting specific tests and analysing the results. Some of the tests were performed with a beacon simulator whose power output and message content can be controlled and varied. The tests were conducted over several weeks to collect enough data to provide statistically valid results.

An overview of each objective is listed below, the detailed descriptions of these objectives are provided in section 3.2.

T-1 Processing Threshold, System Margin, and Beacon Message Processing Performance
Determine the processing threshold, processing performance, system margin and the performance in respect of long format beacon messages for GEOLUTs which operate with the INSAT payload. The test signals used to assess these parameters do not include beacon messages that collide with each other.

T-2 Time to Produce Valid and Confirmed Messages
Determine the statistical distribution of the time required for the GEOLUT to produce valid and confirmed beacon messages. The test signals used to assess this parameter do not include beacon messages which collide with each other.

T-3 Carrier Frequency Measurement Accuracy
Determine how accurately the beacon carrier frequency can be determined by the INSAT GEOSAR / GEOLUT system. The test signals used to assess this parameter do not include beacon messages which collide with each other.

T-4 INSAT GEOLUT Channel Capacity
Assess the capability of the GEOSAR system to handle multiple simultaneously active distress beacons in a single 406 MHz channel. This parameter is assessed by generating traffic loads which include beacon messages which collide with each other.

T-5 Impact of Interference
Monitor the band for the presence of interference while the 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 frequency bands used by the INSAT GEOSAR system.

T-6 Processing Anomalies
Assess the performance of the GEOLUT in respect of the production of processing anomalies.

T-7 INSAT Coverage
Estimate the geographic coverage of the INSAT GEOSAR system[1].

C-1 Commissioning of the INSAT GEOLUT (Bangalore)
Verify the compliance of the INSAT GEOLUT to the Cospas-Sarsat performance and design guidelines (specified in C/S T.009) by performing the tests specified in the GEOLUT Commissioning Standard (C/S T.010) and reporting results in the appropriate format to the Cospas-Sarsat Joint Committee for evaluation.

2.3 Priorities

In accordance with Cospas-Sarsat Council decisions, initial efforts focussed on completing the most important tests which consisted of T-1 (processing threshold), T-2 (time to produce a valid message) and C-1 (commissioning of the INSAT GEOLUT), with the understanding that the other tests would be performed as time permit.

- END OF SECTION 2 -

[1] Results from previous tests could be used to characterize the INSAT coverage.

3. INSAT PERFORMANCE EVALUATION RESULTS

3.1 T-1: Processing Threshold, System Margin, and Beacon Message Processing Performance

The processing threshold, processing performance and the system margin are "figures of merit" of the GEOLUT, as defined below.

Processing Threshold
The processing threshold is the value of the minimum carrier to noise density ratio (C/N0) at the GEOLUT processor for which the GEOLUT is able to produce a valid message for a beacon event 99% of the time (the lower this value the more sensitive the GEOLUT). Equally the processing threshold can be expressed in terms of the minimum beacon effective isotropic radiated power (EIRP) for which the GEOLUT is able to produce a valid message 99% of the time.

System Margin
The system margin is the difference between a nominal beacon (which by definition is a beacon with an EIRP of 37 dBm) and a beacon operating at the GEOLUT threshold.

Valid Message Processing Performance
The processing performance requirement documented in C/S T.009 is that GEOLUTs should be capable of producing valid messages within 5 minutes of beacon activation 95% of the time, for all beacon signals whose C/No as measured at the GEOLUT is greater than 26 dB-Hz. This test will determine the C/No for which the INSAT GEOLUT can produce a valid message for each beacon event within 5 minutes of beacon activation 95% of the time.

Long Message Processing Performance

Document C/S T.009 specifies the processing of long messages and the requirement for confirmed complete messages. However, at present Cospas-Sarsat has no GEOLUT performance requirement in respect of producing complete and confirmed long messages.

Nevertheless, with the increased use of location protocol beacons using the long message format, it is necessary to assess the INSAT system performance in this regard.

3.1.1 Methodology and Data Collection

This test assesses the INSAT GEOLUT performance in respect of its ability to produce single valid, complete and confirmed complete distress beacon messages as a function of the beacon power transmitted in the direction of the INSAT satellite (beacon EIRP).

A beacon simulator is used to replicate distress beacons that transmit long format messages at specific EIRPs, for a duration necessary to transmit 20 bursts for each beacon ID. Hereafter the term “beacon event” is used to describe a beacon being active for a period of time. The test is conducted by transmitting 50 beacon events for each EIRP, whilst ensuring that signals

from individual beacon events do not overlap in time and frequency with the signals from other beacon events. The output of the GEOLUT is monitored and the information identified in Table E-1 is recorded. The procedure is repeated at EIRP values ranging from 37 dBm to 28 dBm, in one dB increments.

3.1.2 Processing Threshold and System Margin

The processing threshold and system margin as evaluated by the Bangalore are provided at Table 3.1 below. The detailed results are provided at Annex A.

Table 3.1: Processing Threshold and System Margin

GEOLUT	THRESHOLD EIRP (dBm)	THRESHOLD GEOLUT C/N0 (dB-Hz)	SYSTEM MARGIN (dB)	NUMBER OF BEACON EVENTS USED
Bangalore	33	36.7	4	50

The results indicate that beacon signals greater than 33 dBm will be reliably detected by the INSAT GEOSAR system. Below the threshold of 33 dBm the system performance degrades rapidly, with a moderate percentage of the signals being detected with uplink EIRP values less than 32 dBm.

3.1.3 Valid Message Processing Performance

The valid message processing performance is a measure of the GEOSAR system's ability to provide a valid message within 5 minutes of beacon activation 95% of the time.

The minimum uplink EIRP required for the GEOLUTs to provide valid messages within 5 minutes is provided at Table 3.2 below. The detailed results are provided at Annex B.

Table 3.2: Valid Message Processing Performance

GEOLUT	THRESHOLD EIRP (dBm)	THRESHOLD GEOLUT C/N0 (dB-Hz)	NUMBER OF BEACON EVENTS USED
Bangalore	33	36.7	50

The Bangalore GEOLUTs satisfies the message processing requirement for uplink signals with an EIRP of 33 dBm. The results for the Bangalore GEOLUT is 96% detection of beacon signal within 5 minutes (>95th percentile as required) at 33 dBm. However, it slightly drop to 90% at 34 dBm due to presence of strong CW interfering signal in the band during the test.

3.1.4 Complete and Confirmed Complete Message Performance

The performance of the Bangalore GEOLUT to produce complete and confirmed complete messages for beacons with uplink signals at the system threshold level of 33 dBm is provided at Table 3.3 below. The detailed performance of each GEOLUT at all measured uplink signals is provided at Annex C.

Table 3.3: Complete and Confirmed Complete Message Performance at Processing Threshold (33 dBm Uplink)

GEOLUT	COMPLETE MESSAGE PROBABILITY	CONFIRMED COMPLETE MESSAGE PROBABILITY	NUMBER OF BEACON EVENTS USED
Bangalore	0.98	0.98	50

3.2 T-2: Time to Produce Valid, Complete and Confirmed Messages

This test assesses how long it takes INSAT GEOLUT operating with the INSAT-3A satellite to produce valid beacon messages, complete long messages, and confirmed complete long messages.

3.2.1 Methodology and Data Collection

For simplicity this test was conducted by analysing the data collected for test T-1 (Threshold). Note that the T-1 test scenario was specifically designed not to generate beacon bursts which overlap in time and frequency. Consequently, for operational beacon events, the times to produce valid, complete, and the time to confirm complete messages may differ from those determined during this test.

3.2.2 Time to Produce Valid, Complete and Confirmed Complete Messages at Threshold

Table 3.4 provides statistics in respect of the average time required for the Bangalore GEOLUT to produce valid, complete and confirmed complete messages for beacon signals at threshold.

Table 3.4: Time to Produce Messages at Processing Threshold (33 dBm Uplink)

GEOLUT	VALID MESSAGES Avg / Standard Deviation (Seconds)	COMPLETE MESSAGES Avg / Standard Deviation (Seconds)	CONFIRMED COMPLETE MESSAGES Avg / Standard Deviation (Seconds)
Bangalore	172/78	172/78	289/75

* Statistics calculated from 50 beacon events

Table 3.5 provides statistics in respect of the time required to produce valid, complete and confirmed complete messages for the 95th percentile, in respect of beacon signals that transmit at the processing threshold of 33 dBm.

Table 3.5: Time to Produce Messages at Processing Threshold for the 95th Percentile (33 dBm Uplink)

GEOLUT	VALID MESSAGES (Seconds)	COMPLETE MESSAGES (Seconds)	CONFIRMED COMPLETE MESSAGES (Seconds)
Bangalore	279	279	376

* Statistics calculated from 50 beacon events

The detailed data providing the time required for the GEOLUTs to produce valid, complete and confirmed complete messages for signals with different transmit EIRPs are provided at Annex D.

3.3 T-3: Carrier Frequency Measurement Accuracy

This test is to assess how accurately the beacon carrier frequency can be measured by the INSAT GEOSAR / GEOLUT system. This is accomplished by comparing the beacon's carrier frequency for each valid message as measured by the GEOLUT with the known frequency value for the same beacon, provided by the beacon simulator operator. The current GEOLUT specification (C/S T.009) requires a frequency measurement accuracy of 2 Hz.

3.3.1 Methodology and Data Collection

For simplicity, this test was conducted by analysing the data collected for test T-1. For each beacon event the frequency measurement provided by the GEOLUT for the first valid message produced was recorded.

The GEOLUT measured frequency included any calibration that would normally be performed during actual GEOLUT operations (e.g. if the GEOLUT includes features for assessing and correcting frequency measurements by applying calibration correction factors and using reference beacons, these features should be activated).

3.3.2 Frequency Measurement Accuracy Results

The detailed results for the frequency measurement accuracy testing are provided at Annex E. In summary, the frequency measurement accuracy of the Bangalore GEOLUT system less 2 Hz, but it was found to be a variation of 51 Hz in frequency of the beacons due to periodic variation in the frequency at satellite LO, because of temperature variation during a day over 24h. However, short term stability is maintained well during the detection of a beacon by the GEOLUT system. Onboard satellite oscillator (TCXO) used for frequency translation has temperature based variation in frequency during 24h in cyclic manner at different sun angles with respect to satellite.

3.4 T-4: INSAT GEOLUT Channel Capacity

The definition of capacity in Cospas-Sarsat GEOSAR systems is the number of 406 MHz distress beacons operating simultaneously in the field of view of a GEOSAR satellite that can be successfully processed by the System to provide a valid beacon message, under nominal conditions, within 5 minutes of beacon activation 95% of the time.

3.4.1 Methodology and Data Collection

The INSAT GEOSAR channel capacity was assessed by generating traffic loads equivalent to known numbers of simultaneously active long format beacons in a Cospas-Sarsat 406 MHz channel. The time required for the GEOLUT to produce a valid beacon message, complete message and confirm a complete message for each beacon event was recorded. The number of simultaneously active beacon events was changed and the time required for the GEOLUT to produce valid, complete and complete confirmed messages was calculated and recorded for the new 406 MHz traffic load.

The test scripts transmitted by the beacon simulator conformed to the nominal conditions detailed in the Cospas-Sarsat 406 MHz frequency management plan (document C/S T.012), with the exception that the uplink EIRP was selected to be 37 dBm rather than 34 dBm. The test replicated a number of beacon messages overlapping in time and frequency commensurate with the number of simultaneously active beacons. Further, the beacon events used in the test script also replicated the beacon burst repetition period defined in document C/S T.001 (406 MHz beacon specification). The test was scheduled to avoid any potential interference caused by Cospas-Sarsat LEOSAR satellite downlink transmissions.

INSAT GEOSAR system capacity test was carried out using 15, 20 and 25 beacons at 37 dBm EIRP. For 25 beacons, only 5 test scripts were only carried out due to shortage of time. The results were plotted and observed that system provided 90% valid message detections within 5 and 10 minutes). Looking at the trend of the plots, the results can be extrapolated for 10 beacon system capacity using INSAT GEOLUT system, which was originally planned.

The detailed results of the INSAT capacity tests are provided at Annex F.

3.4.2 Capacity Results

This test was performed by the Bangalore GEOLUT, and the resulting performance statistics are provided at Table 3.6.

Table 3.6: Capacity Performance Results Measured by Bangalore GEOLUT

NUMBER OF ACTIVE BEACONS	PROBABILITY OF VALID MESSAGE WITHIN 5 MIN	PROBABILITY OF VALID MESSAGE WITHIN 10 MIN	PROBABILITY OF VALID MESSAGE WITHIN 15 MIN	PROBABILITY OF CONFIRMED COMPLETE MESSAGE WITHIN 15 MIN
*10	>95	>95	>95	>95
15	88	90	90	90
20	77	80	83	83
25	69	73	74	74

* This test was not carried out due to shortage of time. By extrapolating the curve plotted for 15, 20 and 25 beacons, the results indicate that for beacon populations with uplink EIRP values exceeding 37 dBm, the capacity would exceed detection of 10 simultaneous beacons by INSAT GEOSAR system.

3.5 T-5: Impact of Interference

The INSAT GEOLUT system is generally configured for detection of beacons in operational band only to avoid processing load on the system. Whenever there is need to test the system, reference beacon band is configured to detect the beacons. INSAT GEOSAR operates with extended C-band down link signal; hence there is no possibility of interference with the LEOSAR downlink frequency. Prior to starting the test during the month of July-August 2009, the system was thoroughly tested and qualified in the entire processing band by GEOLUT development team. During this period, there was no detection of any new beacon in the reference frequency band other than known reference beacons (Kerguelen test beacon 9C7FEC2AACD3590 and Russian orbitography beacon A22249249249240). Hence, there was no processing anomaly reported.

3.6 T-6: Processing Anomaly Performance

This test assesses GEOLUT performance in respect of its ability to suppress the processing anomalies produced.

3.6.1 Processing Anomaly as a Function of Number of Beacon Bursts

This test is conducted by monitoring the 406 MHz channel (406.022 MHz) used by Cospas-Sarsat reference beacon from the Kerguelen Island[2], and noting instances where the GEOLUT produced valid beacon messages which did not correspond to any of the reference beacons in the coverage area of the INSAT-3A satellite. Since the identifications (IDs) of all reference beacons in view of the INSAT satellite are known, it can be inferred that beacons detected in the 406.022 MHz channel which do not correspond to known reference beacons are processing anomalies.

[2] The details of the Kerguelen Island beacon are as follow: Hex ID: 9C7EC2AACD3590, Country: France, Location: 49o21.09’ S 070o15.36’ E, Freq: 406.021856, Transmission interval: 30 sec.

INSAT GEOSAR operates with extended C-band down link signal; hence there is no possibility of interference with the LEOSAR downlink frequency. Prior to starting the test during the month of July-August 2009, the system was thoroughly tested and qualified in the entire processing band by GEOLUT development team. During this period, there was no detection of any new beacon in the reference frequency band other than known reference beacons (Kerguelen test beacon 9C7FEC2AACD3590 and Russian orbitography beacon A22249249249240). Hence, there was no processing anomaly reported.

3.7 T-7: INSAT Coverage

The coverage of the INSAT GEOSAR system is evaluated using a combination of:

a. technical tests, in which a beacon is activated for a period of time, during which it crosses in or out of the INSAT GEOSAR coverage area; and

b. evaluating real beacon alerts detected by the LEOSAR system, and assessing if the same alerts were detected by the INSAT GEOSAR system.

The technical tests were carried out in 2001 with the support of Australia by mounting a test beacon on a moving ship from Australia to New Zealand. During this test beacon detection was observed till 0 deg elevation angle with respect to INSAT-2B, and there was no signal detected at -0.5 deg elevation angle. The detailed results were presented in JC-15 (INSAT-2B Edge of Coverage Test, JC-15/9/5, June 2001, see Figures 3-1 and 3-2). In real operational scenario, INSAT-3A detected number of beacons in Europe and Africa providing actual coverage close to 0 deg elevation angle in western side of INSAT-3A foot-print. The number of real alerts reported by AUMCC, which were detected by INSAT-3A confirming actual coverage close to theoretical one in the eastern side of INSAT-3A foot-print.

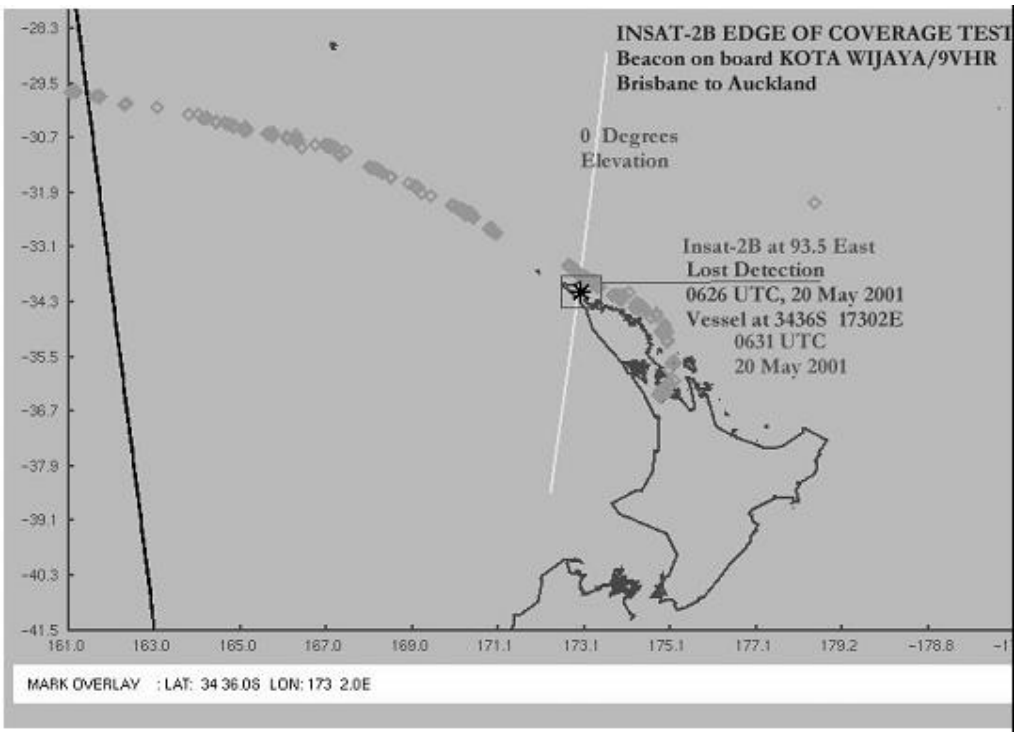

Figure 3-1: Vessel's Actual Course of Sailing, between the Two Stars, GEOLUT Lost

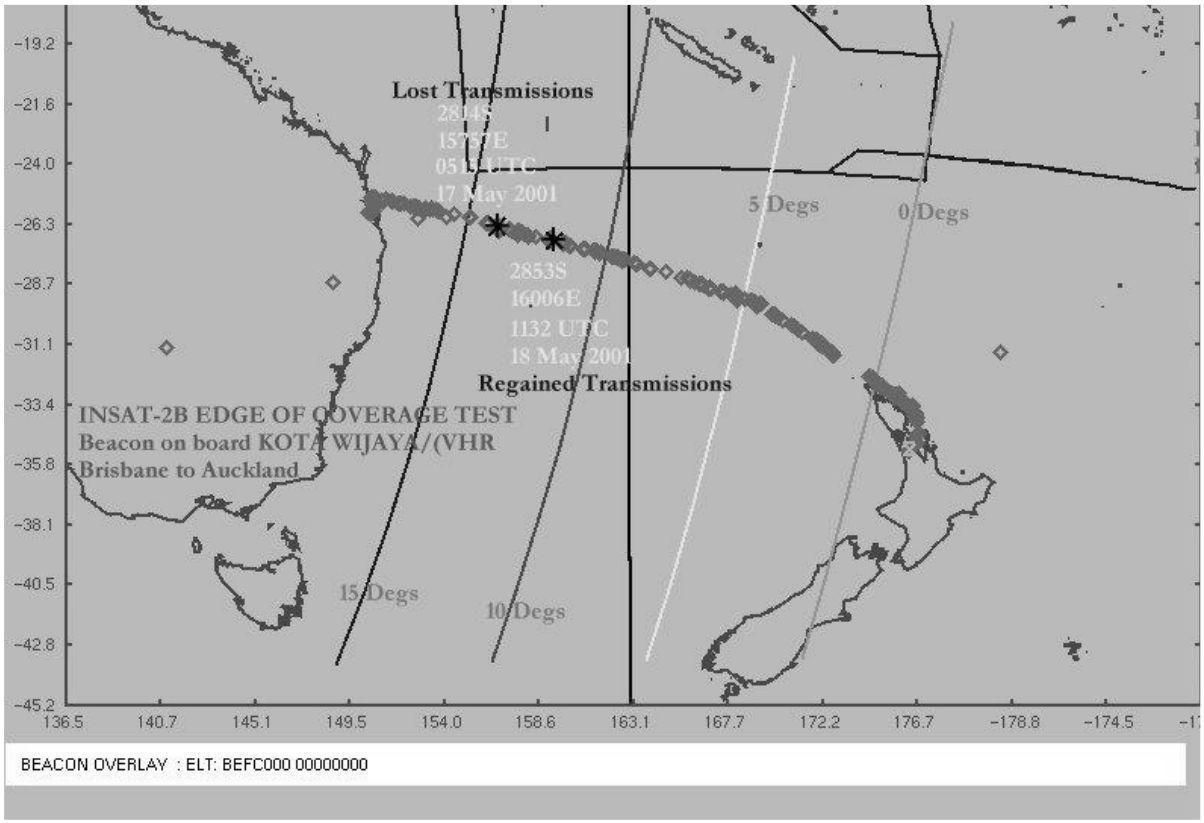

Figure 3-2: INSAT-2B, Loss of Beacon Detection at 0° Elevation

3.8 C-1: Commissioning of the INSAT GEOLUT

The downlink antennas of the INSAT-3A satellite have directive beams that can be only received in the Indian region. Currently, the only GEOLUT attached to the INSAT satellite is located in Bangalore. Part of the INSAT GEOSAR performance evaluation plan includes the verification of the compliance of INSAT GEOLUT with the performance specification (C/S T.009).

Document C/S T.010 provides the detailed testing and reporting requirements for the commissioning of the Cospas-Sarsat INSAT GEOLUT. The annexes of the documents define the test data format requirements and the content and format of the commissioning report which is to be submitted to the Cospas-Sarsat Secretariat.

Table 3.7 provides a summary of the Bangalore GEOLUT Commissioning Test results. Detailed description and performance is available as part of the Bangalore GEOLUT Commissioning Report provided separately.

Table 3.7: Summary of the GEOLUT Commissioning Test Results *

Slno	Requirement or Test	Result	Pass/ Fail	Method of Compliance	Declaration/Verification or Comments
1	Bit Rate Tolerance Check Test - BR1	N/A	Pass	M	Both the Beacons (2DDDF3B4145753D, 2DDDF3B4145753D) were detected and sent to MCC.
2	Beacon Message Recovery Test MR1	Beacon not detected	Pass	M	Beacon (ADDC00000000008) was suppressed as expected.
3	Beacon Message Recovery Test MR2	Beacon not detected	Pass	M	Beacon (2DDE0000938299A) suppressed as expected.
4	Bit Verification Test BV1	Beacon detected	Partial Pass	M	One beacon (ADDC00000000000) with no bit error was detected, another beacon missed: ADDC22000000000).
5	Bit Verification Test BV2	Beacon detected	Pass	M	Beacon was detected and sent to MCC (ADC21C348649240), without error correcting in long message, as expected.
6	Bit Verification Test BV3	Beacon detected	Pass	M	Error bits corrected at bit 138, and transmitted to MCC as required (ADDD55555555554).
7	Beacon Message Validation Test MV1	Beacon Detected	Partial Pass	M	Beacon detected (2DDC0000004E534), verified and found that bits 113-144 are not set to "1" as required.
8	Beacon Message Processing Test MP1	Beacon not Detected	Partial Pass	M	One beacon (2DDFFFFFDF81FE0) was detected with default position, and another one with updated position was missed (2DDFFFFF938299C).
9	Processing Performance Test PP1	100%	Pass	M	All 25 beacons detected within 5 minutes.

M-Measurement, D-Declaration, and V-Verification

* The results are preliminary. Formal commissioning of the GEOLUT is under review.

- END OF SECTION 3 -

page left blank

4. CONCLUSIONS

The INSAT GEOSAR performance evaluation test results show that the INSAT GEOSAR system reliably detects beacons with uplink EIRPs greater 32 dBm. Furthermore at the 33 dBm threshold the system also reliably provides confirmed complete beacon messages.

The ability to provide confirmed complete messages indicates that the INSAT GEOSAR system will effectively provide MCCs with precise encoded location information when this data is transmitted in location protocol beacons.

- END OF SECTION 4 -

page left blank

ANNEXES TO THE COSPAS-SARSAT INSAT GEOSAR PERFORMANCE EVALUATION REPORT

ANNEX A

PROCESSING THRESHOLD AND SYSTEM MARGIN TEST RESULTS

Processing Threshold and System Margin Test Results Measured by Bangalore's GEOLUT

Table A-1: Analysed Results for Objective T-1

EIRP from simulator (dBm)	Calculated C/No at GEOLUT (dBHz)	Number of Beacon Events Used (Valid Msg Sample Set)	Number of Beacon Events for which		Probability of Valid Message	Probability of Valid Message within 5 Min
			Valid Message was Produced	Valid Message was Produced within 5 Min		
28.0	31.8	50	01	01	0.02	0.02
29.0	32.8	50	10	00	0.20	0.00
30.0	33.7	50	42	19	0.84	0.38
31.0	34.7	50	37	10	0.74	0.20
32.0	35.7	50	49	37	0.98	0.74
33.0	36.7	50	50	47	1.00	0.94
34.0	37.6	50	50	45	1.00	0.90
35.0	38.6	50	50	50	1.00	1.00
36.0	39.6	50	50	49	1.00	0.98
37.0	40.6	50	50	49	1.00	0.98

EIRP from simulator (dBm)	Number of Beacon Events Used (Complete Msg Sample Set)	Number of Beacon Events Used (Confirmed Complete Msg Sample Set)	Number of Beacon Events for which a Complete Message was Produced	Number of Beacon Events for which a Confirmed Complete Message was Produced	Probability of Complete / Confirmed Complete Msg
28.0	50	50	01	01	0.02 / 0.02
29.0	50	50	10	10	0.20 / 0.20
30.0	50	50	42	42	0.84 / 0.84
31.0	50	50	37	37	0.74 / 0.74
32.0	50	50	49	49	0.98 / 0.98
33.0	50	50	50	50	1.00 / 1.00
34.0	50	50	50	50	1.00 / 1.00
35.0	50	50	50	50	1.00 / 1.00
36.0	50	50	50	50	1.00 / 1.00
37.0	50	50	50	50	1.00 / 1.00

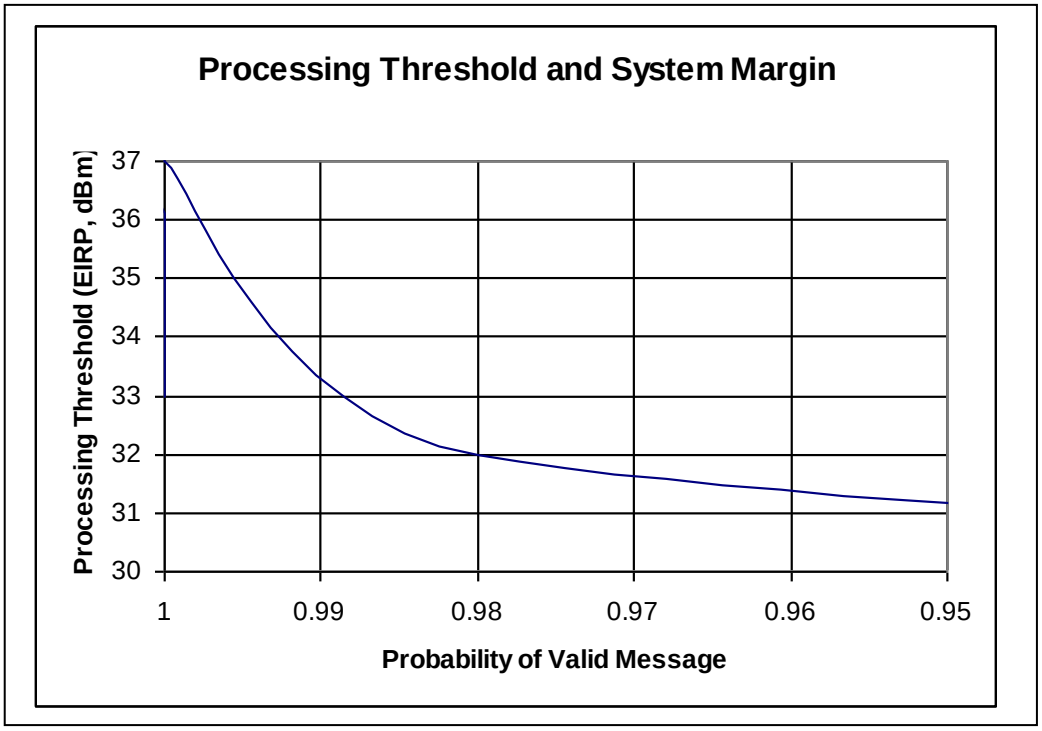

Figure A-1: Processing Threshold and System Margin Performance (T1)

- END OF ANNEX A -

ANNEX B

VALID MESSAGE PROCESSING PERFORMANCE

Valid Message Processing Performance Test Results Measured by Bangalore's GEOLUT

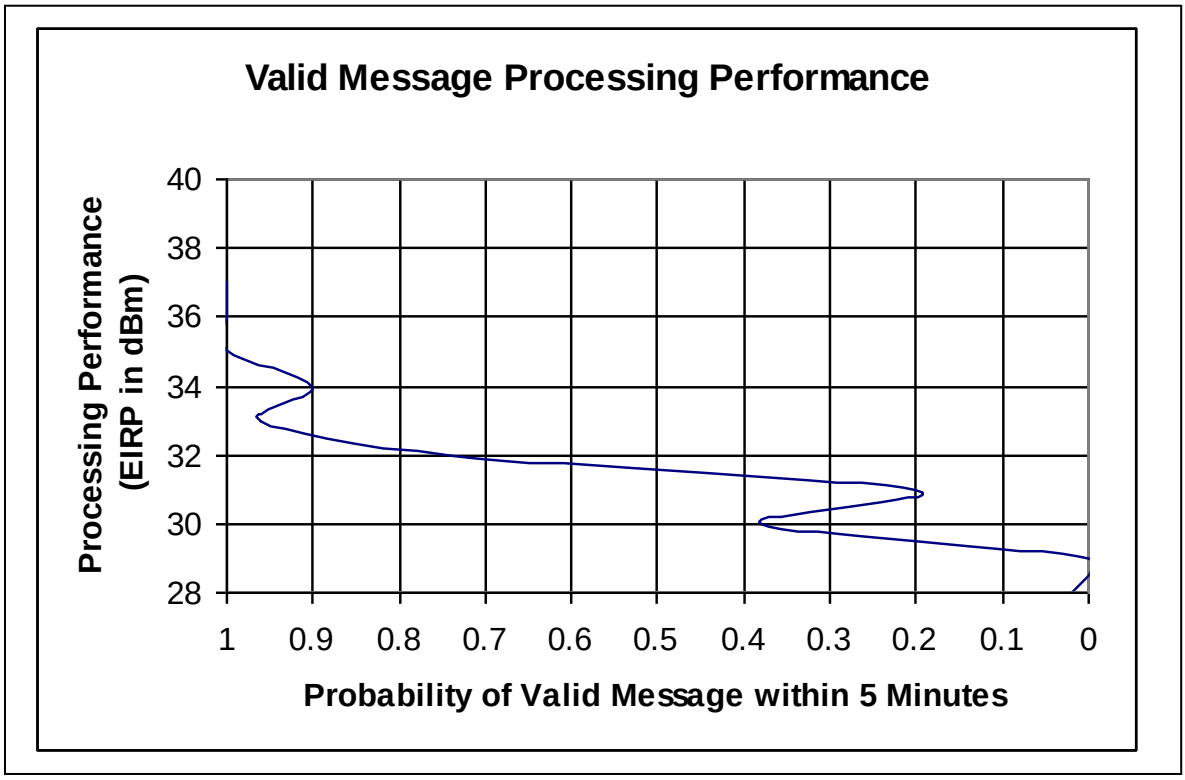

Figure B-1: Valid Message Processing Performance within 5 minutes (T1)

- END OF ANNEX B -

page left blank

ANNEX C

COMPLETE AND CONFIRMED COMPLETE MESSAGE PERFORMANCE TEST RESULTS

Complete and Confirmed Complete Performance Test Results
Measured by Bangalore's GEOLUT

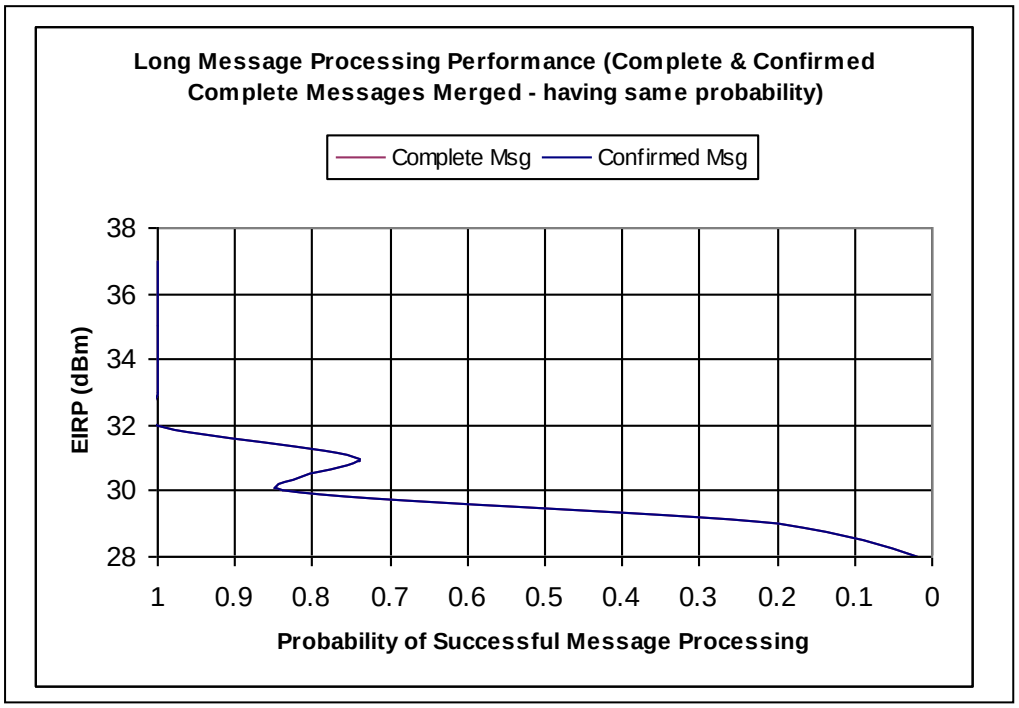

Figure C-1: Long Message Processing Performance (T1)

- END OF ANNEX C -

page left blank

ANNEX D

TIME TO PRODUCE VALID, COMPLETE AND CONFIRMED COMPLETE MESSAGES TEST RESULTS

Time to Produce Valid, Complete and Confirmed Complete Message Test Results
Measured by Bangalore's GEOLUT

Table D-1: Analysed Results for Objective T-2

EIRP (dBm)	C/No (dBHz)	ATVM (Sec)	Standard Deviation of ATVM	ATCM (Sec)	Standard Deviation of ATCM	ATCCM (Sec)	Standard Deviation of ATCCM
28	31.8	211	0	211	0	690	0
29	32.8	674	157	674	157	810	172
30	33.7	469	331	469	331	594	326
31	34.7	541	263	541	263	643	241
32	35.7	209	149	209	149	308	138
33	36.7	172	78	172	78	289	75
34	37.6	179	79	179	79	291	74
35	38.6	135	34	135	34	269	49
36	39.6	133	42	133	42	257	51
37	40.6	144	59	144	59	266	64

EIRP (dBm)	C/No (dBHz)	95th Percentile			98th Percentile		
		Valid Msg (Sec)	Complete Msg (Sec)	Confirmed Msg (Sec)	Valid Msg (Sec)	Complete Msg (Sec)	Confirmed Msg (Sec)
28	31.8	211	211	690	211	211	690
29	32.8	838	838	982	910	910	1052
30	33.7	941	941	1056	992	992	1066
31	34.7	847	847	964	910	910	975
32	35.7	535	535	582	583	583	637
33	36.7	279	279	376	429	429	490
34	37.6	352	352	419	357	357	424
35	38.6	198	198	373	239	239	380
36	39.6	202	202	349	213	213	355
37	40.6	238	238	350	261	261	407

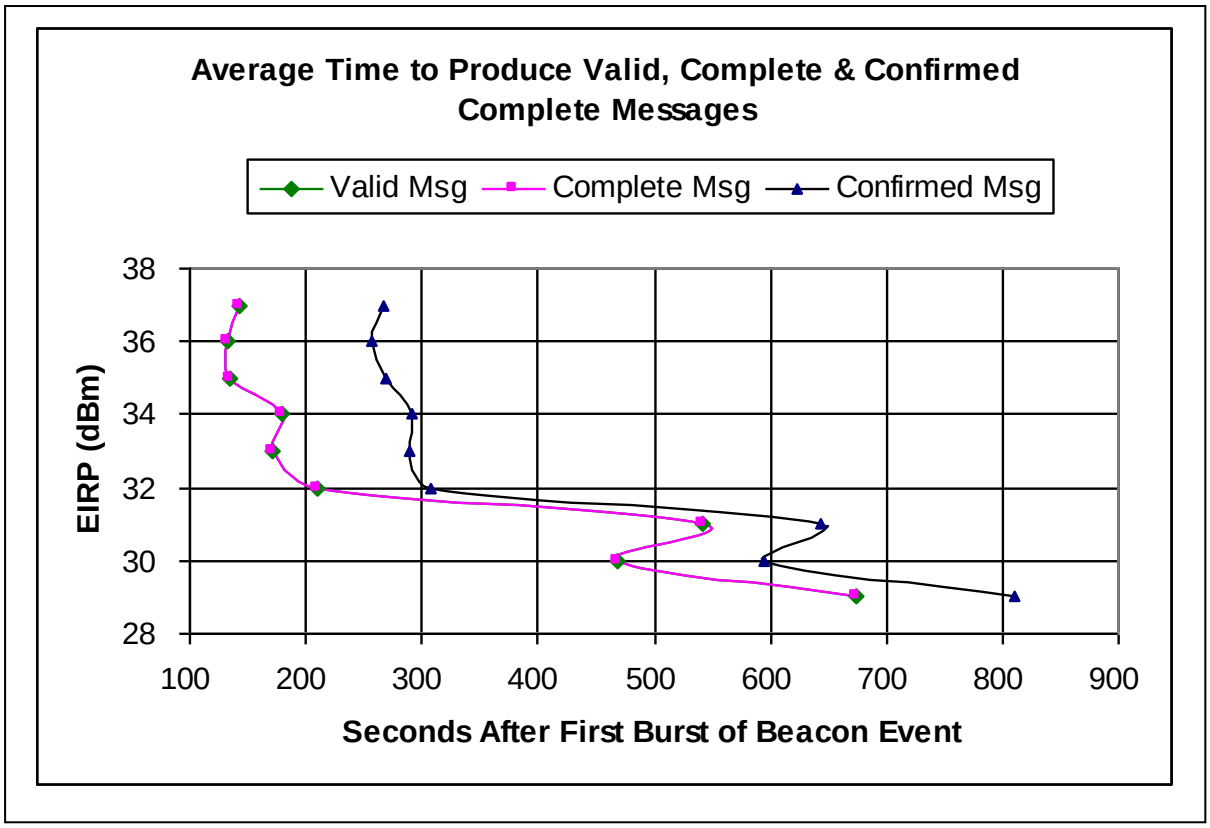

Figure D-1: Graphs Depicting Message Production Avg. Time (T2)

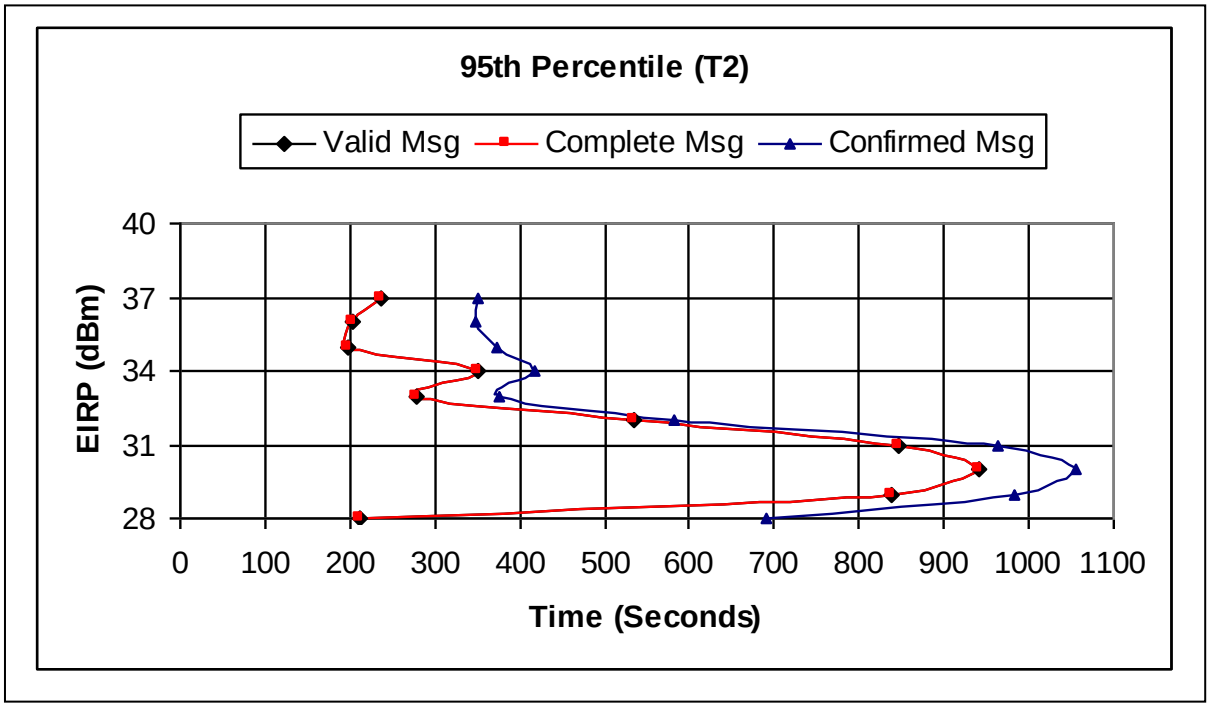

Figure D-2: Graphs Depicting Message Production Time – 95th Percentile (T2)

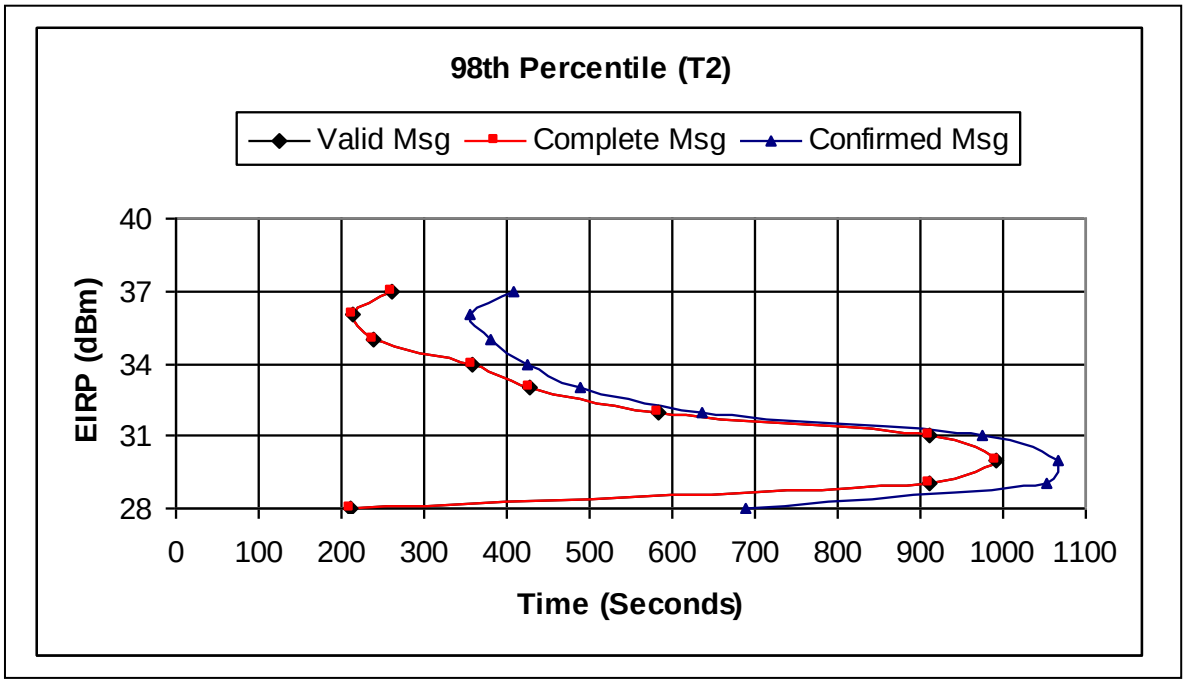

Figure D-3: Graphs Depicting Message Production Time – 98th Percentile (T2)

- END OF ANNEX D -

page left blank

ANNEX E

FREQUENCY MEASUREMENT ACCURACY TEST RESULTS

Frequency Measurement Accuracy Test Results Measured by Bangalore's GEOLUT

Table E-1: Analysed Results for Objective T-3

EIRP (dBm)	Calculated C/No at GEOLUT (dBHz)	Avg Freq Measurement Error (Hz rounded to 1 decimal place)	Std Deviation of Error (Hz)
28	31.8	-37.22	N.A. (1 data point)
29	32.8	-16.77	0.71
30	33.7	-50.57	0.15
31	34.7	-50.89	0.22
32	35.7	21.63	0.71
33	36.7	13.6	0.30
34	37.6	5.53	0.24
35	38.6	-1.63	0.16
36	39.6	-49.15	0.15
37	40.6	-47.10	0.13

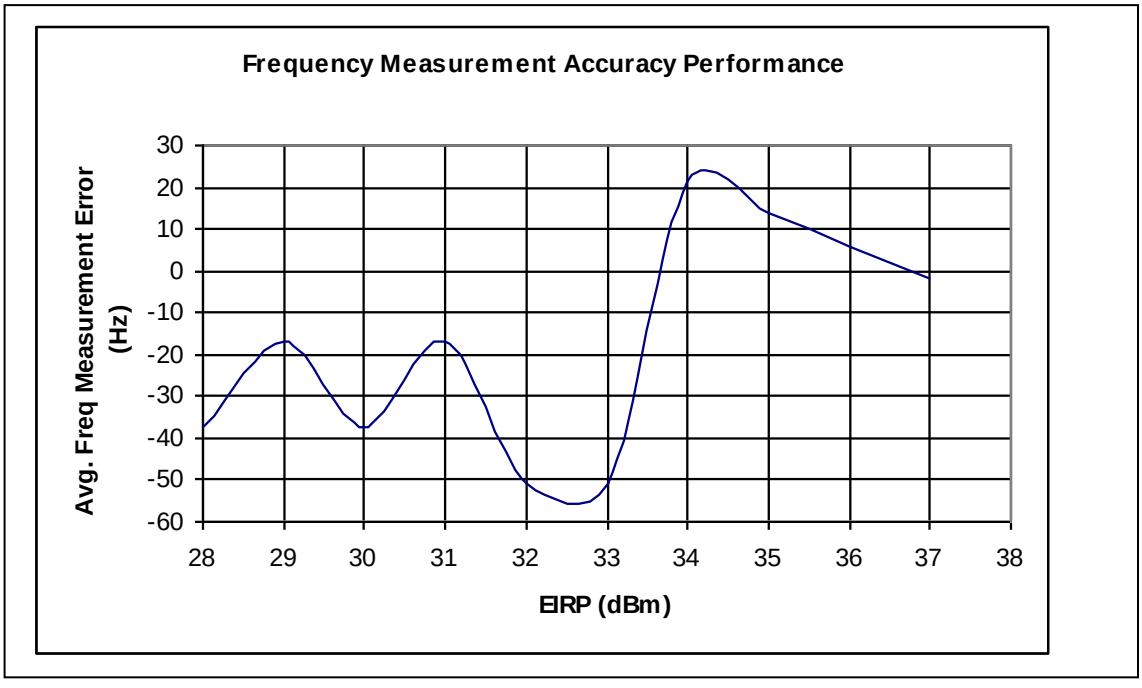

Figure E-1: Average Frequency Measurement Accuracy Performance (T3)

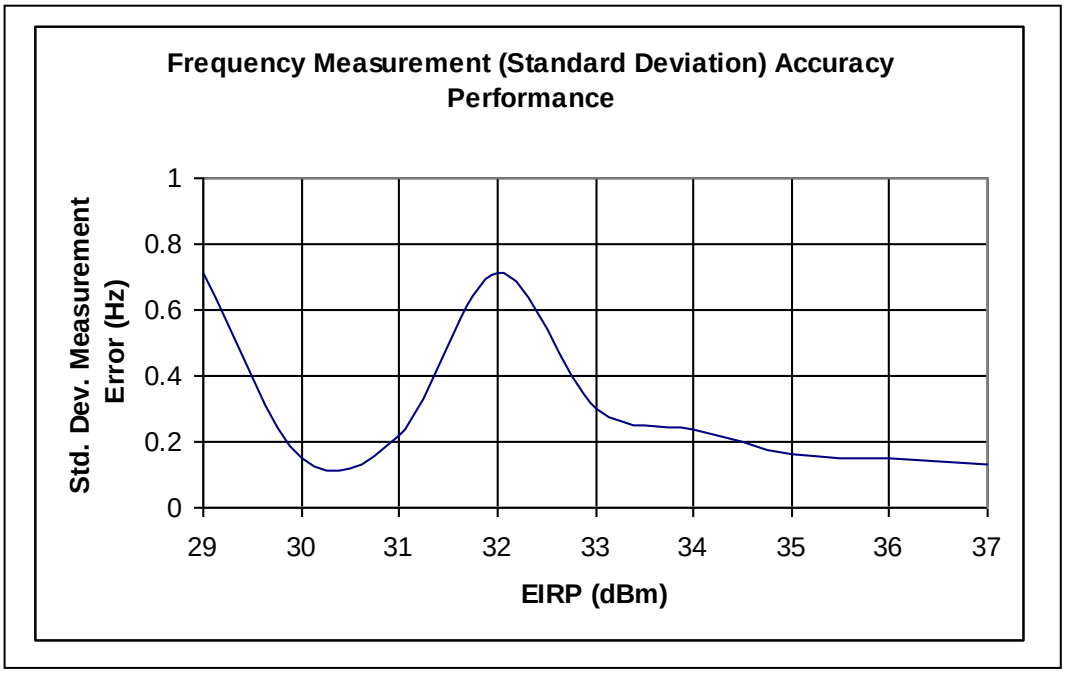

Figure E-2: Average Frequency Measurement Standard Deviation Accuracy Performance (T3)

- END OF ANNEX E –

ANNEX F

CAPACITY TEST RESULTS

Capacity Test Results Measured by Bangalore's GEOLUT

Table F-1: Capacity Statistics for Test Objective T-4

Channel: 406.06300 MHz				
# of Active Bcn Events	**% Valid Msg within 5 Min**	**% Valid Msg within10 Min**	**% Valid Msg within 15 Min**	**% Confirmed Complete Msg within 15 Min**
*10	>95	>95	>95	>95
15	88	90	90	90
20	77	80	83	83
25	69	73	74	74

* This test (with 10 beacons) was not carried out due to shortage of time. By extrapolating the curve plotted for 15, 20 and 25 beacons, the results indicate that for beacon populations with uplink EIRP values exceeding 37 dBm, the capacity would exceed detection of 10 simultaneous beacons by INSAT GEOSAR system.

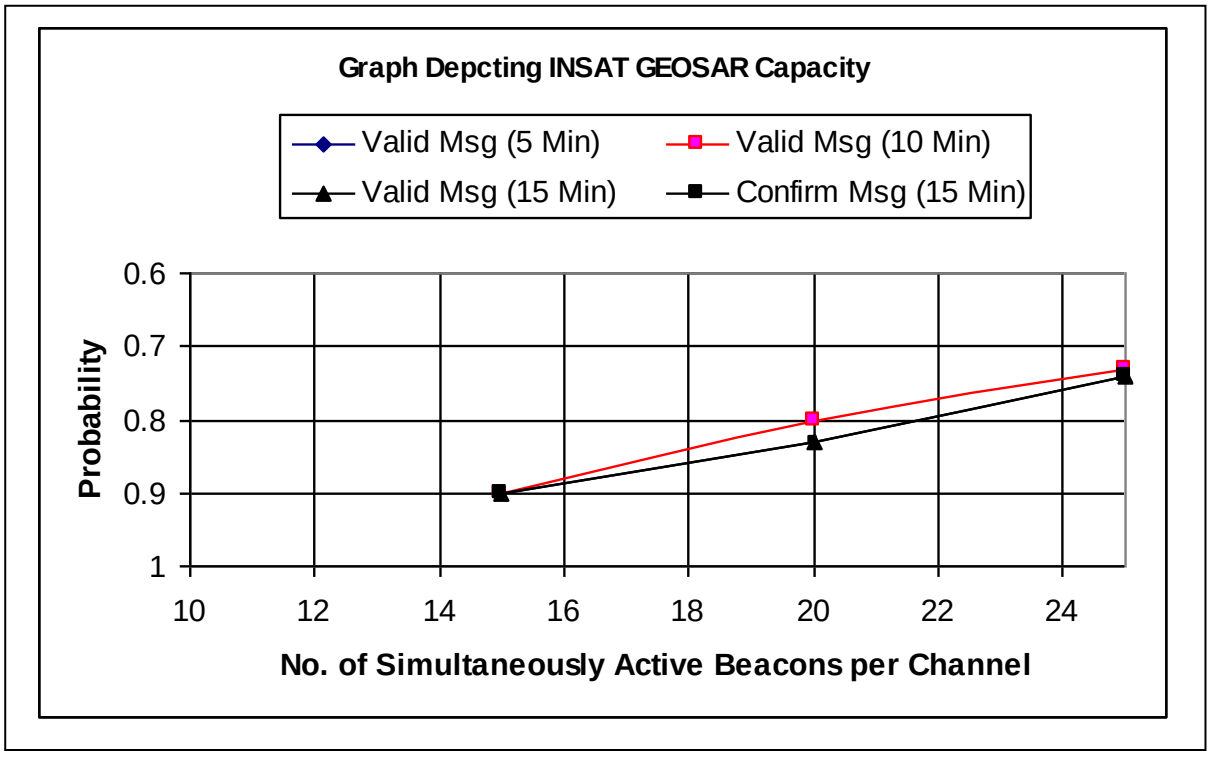

Figure F-1: INSAT GEOSAR Capacity (T4)

- END OF ANNEX F -

- END OF DOCUMENT -

page left blank

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