COSPAS-SARSAT ORBITOGRAPHY NETWORK SPECIFICATION

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COSPAS SARSAT

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History

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1 - INTRODUCTION

1.1 Overview

The purpose of the Cospas-Sarsat System is to provide distress alert and location data for search and rescue (SAR), by using spacecraft and ground facilities to detect and locate distress signals and transmit the computed position and other related information to appropriate SAR authorities.

The Doppler technique, used by Local User Terminals that track Cospas-Sarsat low altitude Earth orbiting satellites (LEOLUTs) to locate distress signals, needs an accurate determination of the satellite position. The Cospas-Sarsat orbitography network is used by LEOLUTs to compute accurate satellite ephemeris.

1.2 Scope

This document describes the Cospas-Sarsat orbitography network and gives the specifications of its elements.

1.3 Reference Documents

The following documents contain useful information to the understanding of this C/S T.006 document:

a) Introduction to the Cospas-Sarsat System, C/S G.003;

b) Specification for Cospas-Sarsat 406 MHz Distress Beacons, C/S T.001;

c) Cospas-Sarsat LEOLUT Performance Specification and Design Guidelines, C/S T.002;

d) Description of the Payloads Used in the Cospas-Sarsat LEOSAR System, C/S T.003;

e) Cospas-Sarsat Data Distribution Plan, C/S A.001.

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2 - COSPAS-SARSAT ORBITOGRAPHY NETWORK DESCRIPTION

2.1 Purpose

The Cospas-Sarsat 406 MHz system provides world-wide global coverage. All LEOLUTs have the capability to locate 406 MHz distress beacons anywhere on the Earth. Achieved location accuracy is dependent on various parameters. Of these parameters, satellite orbit ephemeris is dealt within the document.

The contribution to the location error budget due to orbit determination error is required to be less than 2 km (see Cospas-Sarsat LEOLUT Performance Specification and Design Guidelines, C/S T.002). An efficient way to achieve such an accuracy is to perform orbit ephemeris updates based on data received from high-quality beacons placed at accurately known locations.

2.2 Characteristics

The network consists of three 406 MHz orbitography beacons located at high latitudes and the time reference beacon located at Toulouse, France. The identification and location of these beacons are given in the Cospas-Sarsat Data Distribution Plan, (document C/S A.001). These beacons provide sufficient data to allow any Cospas-Sarsat LEOLUT to achieve the specified orbit determination accuracy. If an orbitography beacon fails then data from the time calibration beacon (see the Cospas-Sarsat Data Distribution Plan, C/S A.001) may be used until the beacon which had failed has been returned to service.

2.3 Back-up Procedures

In case of failure of satellite on-board equipment, back-up procedures for updating the orbit ephemeris are necessary.

In order to collect data from the orbitography beacons, the onboard Search and Rescue Processor (SARP), including its memory, has to function properly. In case of on-board SARP memory failure, the recommended back-up procedures are to update orbit ephemeris using data collected from either the Cospas-Sarsat MCC Network or measurements on the satellite down-link frequency. Degraded accuracy in orbit ephemeris determination is accepted in this back-up mode. The preferred orbit update methods, listed in order of priority for each specific payload, is provided at Annex III/D of document C/S A.001 (DDP).

2.4 List of Orbitography Beacons in System

The orbitography beacons used in the Cospas-Sarsat System are provided by Denmark, Norway and the USA. The complete list of beacons, including the identification and location of each, is provided in the Cospas-Sarsat Data Distribution Plan (document C/S A.001).

- END OF SECTION 2 -

3 - ORBITOGRAPHY BEACON REQUIREMENTS AND SPECIFICATIONS

3.1 Requirements for Supplying an Orbitography Beacon

Supplying an Orbitography Beacon:

An orbitography beacon is supplied by a country accepting the commitment stated in Annex A.

Availability:

Once an orbitography beacon has been installed, its availability shall be greater than 95%.

Location Data:

The beacon antenna location (longitude, latitude, altitude) shall be provided with a three dimensional accuracy better than 10m. This location shall be given with respect to the Bureau International de l'Heure (BIH) Conventional Terrestrial System, having a reference ellipsoid defined as follows:

Semi-Major Axis	=	6378137 m
Flattening (Ellipticity)	=	1/298.2572

The location of all orbitography beacons is given in document C/S A.001 "Cospas-Sarsat Data Distribution Plan".

Antenna Blockage:

The orbitography beacon antenna should be located to provide the widest possible horizon.

3.2 Specification Unique to Orbitography Beacons

Orbitography beacons shall conform to all specifications defined in the Specification for Cospas-Sarsat 406 MHz Distress Beacons (document C/S T.001), except for the following:

Repetition period:

The period between transmissions shall be 30 s + 5%. Variation of the repetition period is recommended. If the repetition period is not varied, beacon activation must be co-ordinated with other providers of orbitography beacons to prevent repeated transmission collisions. The time calibration beacon in Toulouse (which must have a constant repetition period) is the standard to which other non-varied beacons should be co-ordinated.

Transmitted Frequency:

A crystal warm-up period of up to 2 hours is allowed before transmissions occur. Power outages should reset this timer.

Initial frequency:
The transmitted frequency shall be 406.022 MHz ± 1 kHz. The exact transmit frequency of each orbitography beacon is provided in document C/S A.001 (DDP).

Long term frequency stability:
The transmitted frequency shall not vary more than 1 part in 10^{10} per day.

Short term frequency stability:
The transmitted frequency shall not vary more than 1 part in 10^{10} in 100 ms.

Medium term frequency stability:
The mean slope shall not exceed 5 parts in 10^{11} per minute. Residual frequency variation shall not exceed 1 part in 10^{10}.

Antenna Characteristics:

The antenna polarization shall be right-hand circular polarization (RHCP).

Environmental and Operational Requirements:

The orbitography beacon is designed to be operated within a controlled environment and therefore is not subjected to the thermal or other operational requirements specified in C/S T.001.

Temperature requirements
Operating temperature range: +15° C to +40° C
Storage temperature range: -20° C to +60° C

Orbitography Protocol:

The orbitography user protocol must be used. This protocol, defined in C/S T.001, is as follows:

Bits	**Usage**
1-15	bit synchronization
16-24	frame synchronization
25	format flag ("0" for short message and "1" for long message)
26	protocol flag (set bit to "1")
27-36	country code (MID)
37-39	orbitography protocol ("000")
40-81	seven character orbitography beacon clear text identifier using the modified Baudot code (see C/S T.001) The seven characters shall be right justified. Characters not used shall be filled with the "space" character (100100).
82-85	4 binary zeros ("0000")
107	national use (set bit to "0")
108-112	national use
113-144	optional long message. National use.

The 15 hexadecimal character identification used by the MCCs describes bits 26 though 85 (i.e. 60 bits).

- END OF SECTION 3 -

4 - TIME CALIBRATION BEACON CHARACTERISTICS

This beacon is a special time calibration unit operated by, and under the responsibility of, France. This beacon is used to compute the roll-over time of the on-board counter of the 406 MHz Search and Rescue Processors (SARPs) on Sarsat satellites (i.e. Sarsat time calibration), and has the following characteristics:

- it complies with the orbitography beacon performance standard and, therefore, can be used as an orbitography beacon;

- each burst transmission is synchronized with UTC, such that the negative-going transition of the 23rd bit occurs 216.25 ms ± 0.01 ms after the UTC time encoded in the burst, as described below; and

- the message field is 144 bits.

The time calibration beacon transmits UTC in the "long message" format described in C/S T.001, where the coding of bits 113 to 144 is as follows:

Bits	**Usage**
113 - 144	Universal Coordinated Time as follows:
113 - 124	Julian days (BCD)
125 - 132	hours (BCD)
133 - 140	minutes (BCD)
141 - 144	tens of seconds (BCD)

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ANNEX A

COMMITMENT OF THE ORBITOGRAPHY BEACON PROVIDER

The installation and operation of an orbitography beacon is based upon a mutual agreement between Cospas-Sarsat and the country providing such a beacon, whereby the Cospas-Sarsat Council accepts the proposed provision of the orbitography beacon and the providing country agrees to abide to the following principles:

- the host country will assume all costs of providing, operating and maintaining the beacon in service;
- in taking the decision where to place an orbitography beacon, both Cospas-Sarsat system requirements and the supplying country's requirements should be taken into account;
- the supplying country will inform Cospas-Sarsat of the precise location of the orbitography beacon;
- the orbitography beacon shall meet the Cospas-Sarsat specifications defined in document C/S T.006;
- both Cospas-Sarsat and the country supplying the beacon may request the termination of the operation of the orbitography beacon;
- such decision will be subject to discussions and will not take effect until 12 months after the request has been made by one of the parties involved; and
- in case of a major failure of the beacon, the supplying country will not be obliged to supply a new beacon.

- END OF ANNEX A -

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