

ED-277

MINIMUM AVIATION SYSTEM PERFORMANCE STANDARD FOR AIRCRAFT EMERGENCY LOCATOR TRANSMITTER REMOTE COMMAND VIA RETURN LINK SERVICE

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION AND PURPOSE OF DOCUMENT

The social and economic impact of an aircraft disappearance depends on the **timeliness to determine the causes of a disappearance** and locate the aircraft. Moreover, whenever an accident occurs over water, recovery of flight recorders is particularly difficult.

In the case where investigations **suffer extended search periods** (e.g. AF447 and MH370), economic and social impacts are difficult to estimate and may spiral out of control. In addition, since the cause of the accident cannot be identified, it is difficult to implement countermeasures.

For Air France flight AF447 between Rio and Paris on June 1, 2009, it took two years to find the wreckage and recorders at 4000 m depth in the South Atlantic. This has led ICAO (International Civil Aviation Organization) to develop standards so that wrecks and flight recorders, "black boxes", are likely to be found within a short time.

For the disappearance of Malaysia Airlines flight MH370 between Kuala Lumpur and Beijing on March 8, 2014, the estimated search costs exceed several hundred million euros. 4 years after the disappearance of flight MH370, the search has been stopped and the final report only gives hypotheses for probable causes of the disappearance. Concerned families remain in doubt and potentially face complicated legal procedures associated to their relatives' disappearance.

These events highlighted the need to improve performance standards and be able to activate an Emergency Locator Transmitter (ELT) in the air during distress and to know aircraft positions in order to determine its trajectory and thereby better estimate the location of the aircraft.

Today, the SAR/Galileo Service, with its **Forward Link Service** (FLS) is an integral part of the Cospas-Sarsat MEOSAR system. Beacons that are sending distress signals ("outgoing SAR signals") are detected and localised through the relay of these signals by the SAR repeaters on board the Galileo satellites, their reception by the ground stations called MEOLUTs and alerts transmission to the Cospas-Sarsat Mission Control Centres.

In addition, the SAR/Galileo Service provides a new SAR function, called the **Return Link Service** (RLS)¹, which refers to "incoming signals" from a beacon perspective. It allows to:

- Send acknowledgment messages to distress beacons, and
- Remotely command beacon activation and deactivation.

There are situations where a remote activation of an ELT for Distress Tracking (ELT(DT)) could offer the possibility to localise aircraft in-flight (e.g. in cases of a non-cooperative or incapacitated crew). This could occur prior to an automatic triggering event and enable a better determination of the aircraft trajectory to identify a search area and shorten the time to locate the aircraft and potential survivors. It complements the automatic activation as recommended by the ICAO Global Aeronautical Distress & Safety System (GADSS).

Therefore, remote activation is an additional triggering mechanism for ELT(DT) and represents a valuable service at the disposal of the key actors, i.e. the Aircraft Operator (AO) and the Air Traffic Service Unit (ATSU) to deal effectively with in-flight distress situations. In this context, this service can extend the capabilities of the SAR system to address declared distress situations following an escalation process among the key

¹ As of 2020, Galileo is the first RLS service provider, other RLS service providers are planned to be added in the future. Beacons will need to be equipped with a Galileo compatible receiver.

actors in a complementary manner to the distress situations covered by the automatic triggering system described in the MASPS ED-237.

1.2 SCOPE OF THE DOCUMENT

This document describes the characteristics of Remote Command via the SAR Return Link Service for ELT(DT) in particular for remote activation and deactivation capabilities. It is intended to be used for Service Providers and Users of the Return Link Service and focuses on high level concepts and typical functional interface user requirements.

The requirements for the Return Link Messages (RLM) are specified by the Return Link Service providers and not addressed in this MASPS.

1.3 STRUCTURE OF THE DOCUMENT

Chapter 1 (the current chapter) provides an explanation of the scope and purpose of this document and introduces the *ELT(DT) Remote Command via Return Link Service*.

Chapter 2 describes the approach and methodology for the development of the *ELT(DT) Remote Command via Return Link Service* and outlines the performance and interoperability assessments made in this document.

Chapter 3 describes Minimum System Performance Requirements for the *ELT(DT) Remote Command via Return Link Service* based upon the detailed specification of the Operational Services and Environment Definition (OSED). This chapter also contains the minimum performance standards for each subsystem/function that is a required element of minimum system performance. These standards specify the required performance under the standard environmental conditions of the OSED. This Chapter also includes the key assumptions made for the *ELT(DT) Remote Command via Return Link Service*.

Chapter 4 introduces the Interoperability Requirements applicable to the *ELT(DT) Remote Command via Return Link Service*.

Chapter 5 describes the minimum system test procedures to verify system/application performance (e.g., end-to-end performance verification) and that the subsystem performance meets the minimum performance requirements in Chapter 3. These system test procedures should be particularly helpful in prototyping and preoperational trials of the *ELT(DT) Remote Command via Return Link Service*. The performance verification procedures specified in this document are intended to be used as a means of demonstrating compliance with the performance requirements. Although specific test procedures are cited, it is recognised that other methods may be used. These alternate procedures may be used if it can be demonstrated that they provide at least equivalent information.

Annex A describes the Operational Procedures for the *ELT(DT) Remote Command via Return Link Service*. The assessment of these procedures, driven by the OSED, determines the minimum performance requirements of Chapter 3.

Annex B states that the scope of this MASPS does not encompass collision risk model/comparative analysis. This Annex is thus not applicable.

Annex C provides a list of Reference Documents.

Annex D describes the Cyber Security Considerations for the *ELT(DT) Remote Command via Return Link Service*.

Annex E provides a list of acronyms.

Annex F contains a list of contributors to the document development.

1.4 RELATIONSHIP TO ICAO DOCUMENTS

All requirements and procedures outlined in the MASPS are intended to be consistent and compliant with the applicable recommendations, standards and common practices, in particular, those stemming from the International Civil Aviation Organisation (ICAO).

The pertinence of the remote activation and deactivation functionality by aircraft operators has been recognised and envisaged in the ICAO **GADSS Concept of Operations**, which indicates in section 3.2.9 that “A *functionality to allow the aircraft operator to activate the ADT function could be included, for example, when there is uncertainty about the status of the aircraft and attempts to establish communications*

with the flight crew have failed". It is aligned with ICAO **Doc 10054** 'Manual on Location of Aircraft in Distress and Flight Recorder Data Recovery' that states "*tracking an aeroplane in distress is the responsibility of the operator.*" (section 2.4.2.1)

ICAO **Annex 6** requires the Aircraft Operator to track its aircraft (section 3.5 Aircraft Tracking, under certain circumstances), and in case of distress (section 6.18 Location of an Aeroplane in Distress) to make available the position information to the appropriate organisations as established by the State of the Operator, the appropriate ATSU and RCC according with standard procedures. Information provided by the Autonomous Distress Tracking (ADT) function may be made available through the Location of an Aircraft in Distress Repository (LADR). Annex 6 does also address the relation between the means for activation and deactivation in Part I Appendix 9 as it specifies that "*when autonomous transmission of position information has been activated, it shall only be able to be deactivated using the **same mechanism** that activated it*". This means, that if the beacon has been remotely activated it will also need to be remotely deactivated.

The procedures for handling emergencies in-flight are specified in ICAO **Annex 11** 'Air Traffic Services', Chapter 5 - Alerting Service, and ICAO **Annex 12** 'Search and Rescue'. Annex 11 provisions are further developed by ICAO **Doc 4444** 'Procedures for Air Navigation Services - Air Traffic Management', abbreviated as PANS-ATM. The corresponding ATSU plays a central role and is responsible for defining the emergency level, which activates the SAR services (RCC).

Finally, ICAO **Circular 347** 'Aircraft Tracking Implementation Guidelines' is also relevant to the remote activation and deactivation functionality that describes in Chapter 8 the process following a missed 4D/15 position report by the aircraft operator and its notification to the ATSU.

1.5 REFERENCES

The reference documents are listed in Annex C.

1.6 SECURITY

Cyber security in aircraft operations is a growing concern. As the Return Link Service introduces additional connectivity links between the ground, the user and the beacon onboard the aircraft, the cyber security risks associated must be addressed and have been considered during the development of this MASPS. The outcome of this assessment, supported by the EUROCAE WG-72 on aeronautical systems security, is presented and developed in Annex D on Cyber Security.

By analysis and in accordance with EUROCAE documents ED-201, ED-202A and ED- 203A, all examined scenarios for all Services included in this MASPS resulted in an acceptable risk².

In addition, and as preventive actions, several recommendations are proposed to Aircraft Operators, GNSS providers, aviation Remote Activation Service Facilities (aRASf) and beacon manufacturers to mitigate the identified risks.

² As defined according to ED-203A.

CHAPTER 2

APPROACH AND METHODOLOGY

2.1 DOCUMENT DEVELOPMENT PROCESS

This document was developed using a process that is top-down in nature with an initial focus on the operational perspective. Subsequently, the work involves operational systems experts as the requirements for a system or an application are developed to meet the operational needs specified in the Operational Services and Environment Definition (OSED). The work is iterative in nature as each phase of the process feeds back into the previous work, to mature and refine the work and ensure completeness and consistency. As an example, during performance requirements development, comments are fed back into the OSED identifying required additions or needs for clarification.

As the process moved from a more operational perspective to a system-oriented one, it was critical that both key operational and analytical experts were involved throughout, to ensure overall consistency and coherence of the work and material.

2.2 METHODOLOGY

Requirements were developed for the *ELT(DT) Remote Command via Return Link Service* by developing an Operational Services and Environment Definition (OSED), deriving system, subsystem, and function requirements, allocating requirements to the relevant subsystems, and developing interoperability requirements (INTEROP) which specify the interfaces between the subsystems as well as between the *ELT(DT) Remote Command via Return Link Service* and external systems. Each of these areas is described in the subsections below.

2.2.1 Operational Services and Environment Definition (OSED)

The OSED describes the initial conditions and operational procedures associated with the services and intended functions of the *ELT(DT) Remote Command via Return Link Service* (see Annex A).

2.2.2 System Performance Requirements (SPR)

The System Performance Requirements for the *ELT(DT) Remote Command via Return Link Service* are addressed in Chapter 3.

2.2.3 Interoperability Requirements (IR/INTEROP)

The objective of the interoperability requirements is to ensure that the entities involved in the *ELT(DT) Remote Command via Return Link Service* will correctly work together to carry out their intended function in a standardised manner.

Recommendations are proposed so that systems are designed in a robust fashion to accommodate growth and future operations. The document defines interoperability requirements at the interfaces between the entities (see Chapter 4).

All telecommunications broadcasted by the system need to comply with the recommendations of the International Telecommunication Union (ITU).

2.3 KEY TERMS

This section defines key terms used throughout this document, such as assumptions, mitigation means, requirements, and recommendations. Assumptions and mitigation means are important aspects of the operational definition of the *ELT(DT) Remote Command via Return Link Service* and have a profound impact on the associated requirements. While the primary objective of this document is to present minimum requirements needed for the operations defined for the *ELT(DT) Remote Command via Return Link Service*, recommendations are also proposed – primarily in the Interoperability Requirements in Chapter 4 and in the Cyber Security Considerations in Annex D.

2.3.1 Use of Requirements, Recommendations and Key Words

This document contains “shall”, “should” and “will” statements with the following meanings:

- The use of the word “shall” indicates a mandated criterion; i.e., compliance with the criterion is mandatory and no deviations are allowed;
- The use of the word “should” indicates, that although the criterion is regarded as the preferred option, alternative solutions may be implemented. For such solutions, approval plans shall be developed and agreement sought from the certification/operational approval authority;
- The use of the word “will” describes expected system behaviour when the system complies with the reference requirements, and/or this chapter’s requirements.

2.3.2 Assumptions

Assumptions form an important basis for all assessments and analyses contained in this document. All requirements must be considered within the context of the assumptions made, as well as the operations and environments defined. For the implementation of the *ELT(DT) Remote Command via Return Link Service*, any deviation from the assumptions noted in this document could impact the corresponding requirements, and therefore must be accounted for in supporting analysis or introduction of other assumptions and/or mitigations.

Assumptions have been made at various stages of the development process of this document. A listing of major assumptions used in developing the requirements in this document is found in Chapter 3.3.

2.3.3 Mitigation Means

Mitigation means are procedures, alerts, or other aspects that are put in place to help reduce the frequency of exposure to hazards and/or to alleviate the consequences of hazards when encountered.

Some mitigations are fall-back procedures or capabilities. These are called External Mitigation Means (EMM) as they are mitigations that are outside the *ELT(DT) Remote Command via Return Link Service*.

Other mitigations are internal to the *ELT(DT) Remote Command via Return Link Service*, and are therefore called Internal Mitigation Means (IMM).

Both External and Internal Mitigation Means were translated into initial conditions and operational procedures and are included in Annex A.

2.3.4 Requirements

Operational Requirements are specified within the OSED (Annex A) and are enumerated with the “OR#” tag. These include initial conditions and operational procedures that must be followed for the *ELT(DT) Remote Command via Return Link Service* to be properly executed.

Performance Requirements are specified within the OPA (Chapter 3.5) and are enumerated with the “PR#” tag. These are minimum requirements needed for the *ELT(DT) Remote Command via Return Link Service* to properly work under nominal (no fault) conditions.

Interoperability Requirements are specified in Chapter 4 and are enumerated with the “IR#” tag. These are requirements for the interfaces between the entities of the *ELT(DT) Remote Command via Return Link Service*.

2.3.5 Recommendations

The primary objective of this document is to specify the minimum system performance needed for implementation of the *ELT(DT) Remote Command via Return Link Service*.

This document also proposes recommendations (“should”) for preferred implementation options. These recommendations are made to ensure the development of a robust *ELT(DT) Remote Command via Return Link Service* capable of supporting both present and future operations and applications.

CHAPTER 3

SYSTEM PERFORMANCE REQUIREMENTS

3.1 INTRODUCTION

The SAR Return Link Service (RLS) for the aviation sector shall provide the following services:

Acknowledgement Service: The so-called Return Link Acknowledgement Service³ is a function of the Return Link Service that provides an automatic confirmation to the beacon acknowledging that the localisation of the alert has been confirmed by the Cospas-Sarsat system.

Command Service: This is a function of the Return Link Service enabling to send commands via Return Link Messages (RLM) to a beacon to perform specific actions. The procedures described in this document are related to the:

- **Remote Activation/Deactivation Service** (to remotely activate/deactivate the beacon transmission of the Forward Link);
- **Remote Triggering of a Self-Test.**

The Acknowledgement Service is specified in the Cospas-Sarsat documents and, for Galileo, in the SAR/Galileo Service Definition Document (SDD) and is out of the scope of this document. This MASPS focuses on the Command Service for an ELT(DT) on-board an aircraft that the Aircraft Operator (AO) and/or the corresponding ATSU believe is likely in distress.

The general process considers that the AO is performing the normal tracking of the aircraft in its fleet on a world-wide basis according to ICAO Annex 6.

If the AO misses two normal 4D/15⁴ tracking position reports, the AO initiates a 'dialogue' process with the corresponding ATSU (ref. ICAO Circular 347, Chapter 8). At this point in time, the reason for lacking those two normal 4D/15 tracking reports is unknown.

To determine if an aircraft is in a Distress Phase, the ATSU, considering the last known positions of the aircraft, undertakes an investigation process, e.g. radar surveillance, contact with the crew via radio, collection of information from other aircraft operating in the vicinity of the aircraft that is suspected to be in distress.

As stated in the ICAO GADSS CONOPS V6.0, 4.2.2, "In order to identify the nature of the situation and any corrective measures, communications will be established between the relevant ATS unit(s) and the aircraft operator. This will help eliminate any time lag regarding the establishment of the communications themselves; and analysis both by the aircraft operator and the ATS unit of action required."

An emergency phase is defined as a generic term comprising of Uncertainty Phase, Alert Phase or Distress Phase. The different emergency phases, which include the Distress Phase, are described here after (ref. ICAO Annex 11):

- **Uncertainty Phase** (INCERFA). A situation wherein uncertainty exists as to the safety of an aircraft and its occupants;
- **Alert Phase** (ALERFA). A situation wherein apprehension exists as to the safety of an aircraft and its occupants;
- **Distress Phase** (DETRESFA). A situation wherein there is reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger or require immediate assistance.

The conclusion of the ATSU investigation may confirm that the criticality of the situation and the Distress Phase justify the need to receive a Distress Tracking position information to locate the aircraft.

³ Formerly also referred to as "Acknowledgment Type-1"

⁴ Provision of latitude, longitude, altitude and time every 15 minutes

This need from the ATSU to have the aircraft position could be addressed by an ELT(DT) which could be remotely activated (i.e. it is Remote Activation Capable).

The escalation process is defined as below:

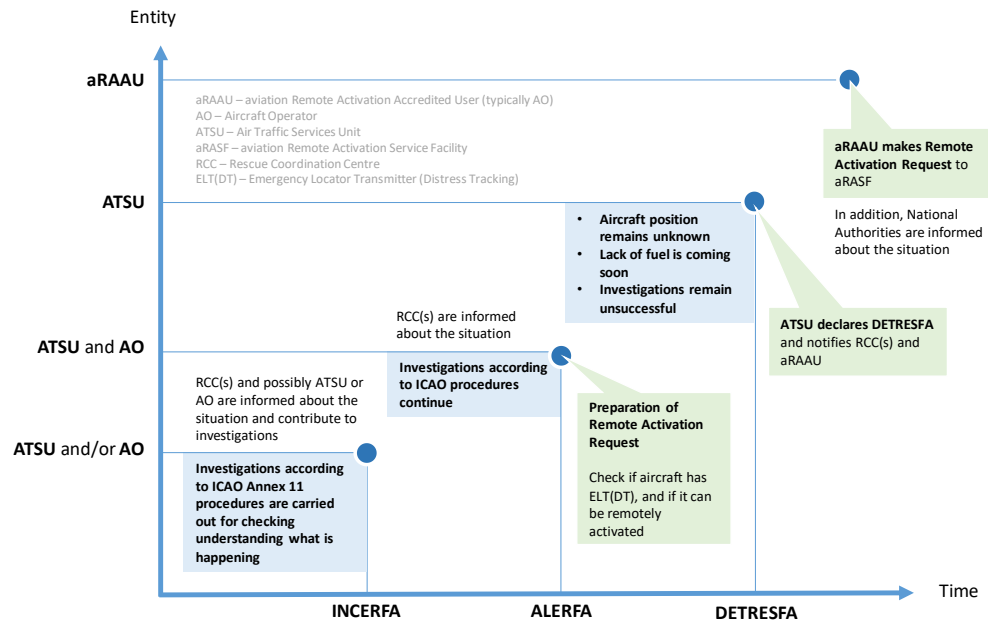


FIGURE 1 – EMERGENCY PHASE ESCALATION PROCESS

The Remote Activation/Deactivation Service shall be used after declaration of a DETRESFA, in particular in oceanic or remote regions, for example in the following cases:

- Scenario 1: Unexpected crew/aircraft behavior for unknown reason(s).
- Scenario 2: Confirmed non-cooperative crew (crew incapacitation, suicide attempt);
- Scenario 3: Confirmed Hijacking;
- Scenario 4: Confirmed high risk of upcoming in-flight destruction of the aircraft (in-flight fire, bomb warning);

Further details about the role and responsibilities in case of a distress situation are provided in ICAO Doc 10054 Manual on Location of Aircraft in Distress and Flight Recorder Data Recovery – First edition, 2019, section 2.6 (AO process), section 2.8 (ATSU processes) and section 2.9 (RCC processes).

3.1.1 Operational Performance Assessment (OPA) Process

The Operational Performance Assessment (OPA) for the *ELT(DT) Remote Command via Return Link Service* sets Performance Requirements for the system and subsystem in order to ensure the service provision.

The results can be found in Chapter 3.5.

3.1.2 Collision Risk Model (CRM) Process / Comparative Analysis Process

CRM is not applicable in this document.

3.2

DEFINITION OF TERMS

Services

Acknowledgment Service: The Return Link Acknowledgement Service is a function of the Return Link Service that provides an automatic confirmation to the beacon acknowledging that the localisation of the alert has been confirmed by the Cospas-Sarsat system.

Command Service: This is a function of the Return Link Service enabling to send commands via Return Link Messages (RLM) to a beacon to perform specific actions. The procedures described in this document are related to the Remote Activation/Deactivation Service and the Remote Triggering of a Self-Test.

Entities

Cospas-Sarsat System: Composed of Search And Rescue satellite payloads, Mission Control Centre (MCC) network, Local User Terminals. The Cospas-Sarsat network, fulfilling its standard dissemination functions of distress alert messages broadcasted by emergency beacons.

ATSU (Air Traffic Service Unit): A generic term meaning variously, air traffic control unit, flight information centre or air traffic services reporting office. (ICAO Doc 4444, PANS-ATM, Chapter 1 – Definitions).

AO (Aircraft Operator): Any aircraft operator for which the carriage of ADT is mandatory according to ICAO Annex 6.

aRAAU (aviation Remote Activation Authorised User): The user of the Remote Activation/Deactivation Service, who needs authorisation for requesting the service from the aRASf. This user, typically an aircraft operator, is supported by the corresponding ATSU, i.e. the ATSU in charge of the airspace where the aircraft is located according to its last known position.

aRASf (aviation Remote Activation Service Facility): The aRASf includes the user interface with aRAAU, the Return Link Message generation facility, the GNSS, and the operator of the Command Service. It also collects SAR data from remotely activated/deactivated ELT(DT).

RCC (Rescue Coordination Centre): Entity responsible for coordinating and conducting Search and Rescue operations within a given region.

Emergency Locator Transmitters (ELT)

Return Link Service Capable ELT: An Emergency Locator Transmitter (ELT) capable of receiving and processing Return Link Messages (RLM) of the Acknowledgement Service (as defined in MOPS ED-62B).

Distress Tracking ELT (ELT(DT)): This type of ELT is designed to be activated prior to a possible crash upon detection of a distress condition by logic such as that defined by EUROCAE MASPS ED-237, this MASPS ED-277, or by manual crew activation. This type of ELT is intended to provide information to more reliably locate an accident site. The ELT(DT) could be deactivated in case that a safe situation is recovered or in case of a false alert.

Remote Activation Capable ELT(DT): This type of ELT(DT) can be remotely activated and deactivated by means of RLS. This beacon also allows for a Self-Test through the RLS Test Service.

Further types of ELT:

- **Automatic Fixed ELT (ELT(AF)):** This type of ELT is intended to be permanently attached to the aircraft before and after a crash, to automatically activate upon a crash, and is designed to aid SAR teams in locating a crash site and/or survivor(s).
- **Automatic Portable ELT (ELT(AP)):** This type of ELT is intended to be rigidly attached to the aircraft before a crash, to automatically activate upon a crash, but is readily removable from the aircraft after a crash. If the ELT does not employ an integral antenna, the aircraft-mounted (external) antenna may be disconnected and an auxiliary antenna (stored on the ELT case) connected in its place. After removal from the aircraft, the ELT can

be tethered to a survivor or a life raft. This type of ELT is intended to aid SAR teams in locating a crash site and/or survivor(s).

- **Automatic Deployable ELT (ELT(AD)):** This type of ELT is intended to be rigidly attached to the aircraft before a crash or ditching and automatically deployed when a crash occurs or after activation by a water sensor. This type of ELT also operates while floating in water and is intended to aid SAR teams in locating a crash site and/or survivor(s). The ELT(AD) may be either a stand-alone beacon or may be a part of an Automatic Deployable Flight Recorder (ADFR).
- **Survival ELT (ELT(S)):** This type of ELT is intended to be removed from the aircraft after a crash and activated manually by survivors or automatically with the deployment of other survival equipment. There are two categories of ELT(S), Category A which is buoyant and designed to operate when floating in water and Category B which is not designed to operate when floating in water. This type of ELT is intended to aid SAR teams in locating survivor(s).

Other terms

Last known position: Typically, this would be the position from the last normal 4D/15 tracking position report received. In special circumstances, the service could also work with a less precise, generic input.

Beacon ID: Refers to the appropriate Hex ID of an ELT(DT) beacon. This Hex ID might be provided by the ELT(DT) or programming adapters or dongles as defined by C/S.

Aircraft ID: The aircraft registration, unique to each aircraft (e.g. flight MH370 was registered in Malaysia as 9M-MRO).

3.3

ASSUMPTIONS

For the Remote Activation/Deactivation Service, the system is structured around three main entities: aviation Remote Activation Authorised User (aRAAU), aviation Remote Activation Service Facility (aRASf) and Cospas-Sarsat. The coordination among these three entities should be well documented to ensure efficient and reliable service provision.

Cospas-Sarsat could accept several aRASf offering the *ELT(DT) Remote Command via Return Link Service* (e.g. provided by Galileo, GLONASS, Beidou).

3.4

OPERATIONAL REQUIREMENTS

Operational Requirements and procedures for the use of the Acknowledgment Service are described in the Cospas-Sarsat documents (see C/S A series documentation).

Operational Requirements for the Remote Activation/Deactivation Service are applicable to entities involved in the service delivery and are compatible with ICAO Standard and Recommended Practices (SARPs) as stated in ICAO Annexes as well as with other supporting documents such as ICAO Manuals and Circulars (see Chapter 1.4).

The applicability of ICAO Standard and Recommended Practices (SARPs) or any other ICAO regulations or standards should be checked with the relevant National Civil Aviation Authority before the use of the service. Locally authorised deviations from ICAO Standards and Procedures can be found in each country's Aeronautical Information Publication (AIP).

The Operational Procedures for the Remote Activation/Deactivation Service include the typical escalation process leading to the declaration of a Distress Phase (DETRESFA) and the need to track an aircraft (see Annex A).

Prior to use, the **Users of the Remote Activation/Deactivation Service**, such as Aircraft Operators, shall:

- Be **authorised** by the aviation Remote Activation Service Facility (aRASf) by concluding a legally binding User Agreement with aRASf in which the conditions of use for the service are defined. The User Agreement shall include specific