**Autonomous Distress Tracking (ADT)**

**System-Level Requirements**

**ARINC REPORT 6XX**

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1.0 INTRODUCTION

1.1 Purpose of this Document

This document documents the end-to-end system-level requirements for an Autonomous Distress Tracking (ADT) System that are being levied by the International Civil Aviation Organization (ICAO) and individual Civil Aviation Authorities (CAAs) (both at the aircraft-level and on-ground systems). All derived system-level requirements are also documented within this report.

In addition, a System Functional Block Diagram, allocating the requirements to each functional block, is also documented.

COMMENTARY

The difficulty in locating the crash sites in previous accidents has prompted significant international effort to provide means for a global aircraft tracking capability. ICAO has worked to amend ICAO Annex 6 standards to include requirements for tracking commercial planes during all flight phases, including functionality of autonomous identification and reporting of distress situations (Autonomous Distress Tracking). In addition, the European Commission has published Commission Regulation (EU) 2015/2338 with similar, but in some cases differing, requirements.

1.2 Scope

The scope of this document is limited to documenting the system-level requirements for an Autonomous Distress Tracking (ADT) System. Requirements associated with Normal or Abnormal Tracking, as identified in ICAO or CAA documents, are not part of the ADT requirements.

1.3 Objectives

The objective of this ARINC report is to capture all documented ICAO and regulatory system-level requirements for an ADT system and develop a system-level functional block diagram. This report will then be used to develop candidate architectures (both at the aircraft-level and on-ground systems) that would meet these system-level requirements. The candidate architectures will be documented in a separate ARINC report.

1.4 Related Documents

These documents provide source requirements for the ADT system.

**COMMISSION REGULATION (EU) 2015/2338 of 11 December 2015 amending Regulation (EU) No 965/2012 as regards requirements for flight recorders, underwater locating devices and aircraft tracking systems**

**EU No. 965/2012 of 5 October 2012 laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No. 216/2008 of the European Parliament and of the Council**

**Annex II to Executive Director (ED) Decision 2015/XXX/R ‘AMC and GM to Part-CAT — Issue 2, Amendment X’ (DRAFT dated Feb. 2016)**

**ICAO Annex 6, “Operation of Aircraft”, Part I, “International Commercial Air Transport – Aeroplanes”**

**ICAO Annex 11, “Air Traffic Services”**

**ICAO Document, “Concept of Operations – Global Aeronautical Distress & Safety System” (Draft Ver. 5.11, 1 December, 2016)**

**ICAO Document 10054, “Manual on Location of Aircraft in Distress and Flight Recorder Data Recovery” *(Not yet released)***

2.0 Autonomous Distress Tracking (ADT) System-Level Requirements

ADT system-level requirements are documented within the following sub-sections.

2.1 ICAO Requirements

The ICAO requirements that apply to ADT are contained in different ICAO documents, and are documented within the following sub-sections.

2.1.1 ICAO Annex 6

The ICAO Annex 6 requirements that apply to ADT are documented in the following table. The section number refers to the section within ICAO Annex 6.

| Section | Requirement |
| --- | --- |
| 6.18 | LOCATION OF AN AEROPLANE IN DISTRESS |
| 6.18.1 | All aeroplanes of a maximum certificated take-off mass of over 27,000 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2021, shall autonomously transmit information from which a position can be determined by the operator at least once every minute, when in distress, in accordance with Appendix 9. |
| 6.18.2 | Recommendation.—*All aeroplanes of a maximum certificated take-off mass of over 5,700 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2021, should autonomously transmit information from which a position can be determined at least once every minute, when in distress, in accordance with Appendix 9.* |
| 6.18.3 | The operator shall make position information of a flight in distress available to the appropriate organizations, as established by the State of the Operator.*Note.— Refer to 4.2.1.3.1 for operator responsibilities when using third parties.* |
| 4.2.1.3.1 | The operator shall develop policies and procedures for third parties that perform work on its behalf. |
| Appdx 9 | **LOCATION OF AN AEROPLANE IN DISTRESS***(Chapter 6, 6.18, refers)* |
| Appdx 91 | Location of an aeroplane in distress aims at establishing, to a reasonable extent, the location of an accident site within a 6 NM radius. |
| Appdx 92.1 | An aeroplane in distress shall automatically activate the transmission of information from which its position can be determined by the operator and the position information shall contain a time stamp. It shall also be possible for this transmission to be activated manually. The system used for the autonomous transmission of position information shall be capable of transmitting that information in the event of aircraft electrical power loss, at least for the expected duration of the entire flight.*Note.— Guidance on the location of an aeroplane in distress is provided in Attachment K.* |
| Appdx 92.2 | An aircraft is in a distress condition when it is in a state that, if the aircraft behaviour event is left uncorrected, can result in an accident. Autonomous transmission of position information shall be active when an aircraft is in a distress condition. This will provide a high probability of locating an accident site to within a 6 NM radius. The operator shall be alerted when an aircraft is in a distress condition with an acceptable low rate of false alerts. In case of a triggered transmission system, initial transmission of position information shall commence immediately or no later than five seconds after the detection of the activation event.*Note 1.— Aircraft behaviour events can include, but are not limited to, unusual attitudes, unusual speed conditions, collision with terrain and total loss of thrust/propulsion on all engines and ground proximity warnings.**Note 2.— A distress alert can be triggered using criteria that may vary as a result of aircraft position and phase of flight.**Further guidance regarding in-flight event detection and triggering criteria may be found in the EUROCAE ED-237, Minimum Aviation System Performance Specification (MASPS) for Criteria to Detect In-Flight Aircraft Distress Events to Trigger Transmission of Flight Information.* |
| Appdx 92.3 | When an aircraft operator or an air traffic service unit (ATSU) has reason to believe that an aircraft is in distress, coordination shall be established between the ATSU and the aircraft operator. |
| Appdx 92.4 | The State of the Operator shall identify the organizations that will require the position information of an aircraft in an emergency phase. These shall include, as a minimum:a) air traffic service unit(s) (ATSU); andb) SAR rescue coordination centre(s) (RCC) and sub-centres.*Note 1.— Refer to Annex 11 for emergency phase criteria.**Note 2.— Refer to Annex 12 for required notifications in the event of an emergency phase.* |
| Appdx 92.5 | When autonomous transmission of position information has been activated, it shall only be able to be deactivated using the same mechanism that activated it. |
| Appdx 92.6 | The accuracy of position information shall, as a minimum, meet the position accuracy requirements established for ELTs. |
| Attach K | **ATTACHMENT K. LOCATION OF AN AEROPLANE IN DISTRESS***(Supplementary to Chapter 6, 6.18)***GUIDANCE FOR LOCATION OF AN AEROPLANE IN DISTRESS** |
| Attach K1 | **1. INTRODUCTION**The following material provides guidance on locating an aeroplane in distress. The Triggered Transmission of Flight Data Working Group (TTFDWG) reviewed forty-two accidents to determine an indication of the distance from a last-known aeroplane position to the location of an accident site. The report concluded that in approximately 95 per cent of the cases, when the aircraft position was known one minute prior to the accident, the accident site location was within a 6 NM radius of that position. |
| Attach K1.2 | When an aeroplane has an accident into water and becomes submerged, the location of the accident site within a 6 NM radius on the surface becomes more important. Starting the initial search area beyond a 6 NM radius reduces the amount of time available to search for and locate the aeroplane. At current estimated underwater search capabilities of 100 km2/day, an area with a 6 NM radius could be searched in four days. Allowing for naval assets to reach the search area and conduct the search, it is estimated that an area of 2 300 km2, equivalent to a radius of 14 NM, will be able to be searched before the ULD battery degrades. Starting at an area of more than 6 NM radius reduces the probability of a successful location during an initial search, whilst extending the location requirement beyond 6 NM radius reduces the time available to search with no appreciable gain in the probability of recovery. |
| Attach K2.1 | **2. CLARIFICATION OF PURPOSE OF EQUIPMENT**Information from which a position can be determined: Information from an aircraft system which either is active, or, when automatically or manually activated, can provide position information which includes a time stamp. This is a performance-based requirement which is not system-specific and may also bring operational benefits. |

2.1.2 ICAO Annex 11

The ICAO Annex 11 requirements that apply to ADT are documented in the following table. The section number refers to the section within ICAO Annex 11.

| Section | Requirement |
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2.1.3 ICAO GADSS Concept of Operations (ConOps)

The ICAO GADSS ConOps requirements that apply to ADT are documented in the following table. The section number refers to the section within the ICAO GADSS ConOps document.

| Section | Requirement |
| --- | --- |
| 3.2.1 | The Autonomous Distress Tracking (ADT) function is used to identify the location of an aircraft in distress with the aim of establishing, to a reasonable extent, the location of an accident site within a 6 NM radius. |
| 3.2.2 | The ADT function uses on board systems to broadcast the 4D position, or distinctive distress signals from which the 4D position can be derived. The position information needs to be transmitted, without the need for flight crew action, at least once every minute when an aircraft is in a distress condition. An aircraft is in a distress condition when it is in a state that, if the aircraft behaviour event is left uncorrected, may result in an accident. |
| 3.2.3 | In terms of the autonomy, the ADT function needs to transmit as long as practically possible during the distress condition. “As practically possible” refers to a means to achieve resilience to failures of the aircrafts’ electrical power, navigation and communication systems as well as to human factors and unlawful human intervention or tampering. |
| 3.2.4 | The operator will need to be notified (directly or indirectly) when an aircraft is in a distress condition. The ADT function will need to include the capability to deliver the distress tracking information to SAR. |
| 3.2.5 | To identify a distress condition, the aircraft state will be analysed in real-time by aircraft systems or ground processes and the use of event detection and triggering criteria logic will initiate the notification of the alert to assist locating the aircraft in distress. Distress tracking is a combination of position reporting at intervals of one minute or less with a notification of distress. The event detection and triggering can be used to identify a distress condition (for a system that is already transmitting position information), or to notify a distress condition and also commence transmitting of positon information. Distress tracking manually initiated by the flight crew should also generate a notification. |
| 3.2.6 | The triggering criteria may include analysis of unusual altitudes, unusual speeds, potential collision with terrain, total loss of thrust/propulsion on all engines, Mode A squawk codes, etc. The triggers will be defined making sure that the criteria used maximises the probability of detection of an upcoming catastrophic event and minimises the probability of nuisance events. |
| 3.2.7 | In the case of an on-board triggered transmission system (distinctive distress signal), initial transmission of position information shall commence immediately or no later than five seconds after the detection of the distress condition.*Note: The performance specifications for the in-flight event detection and triggering criteria are detailed in EUROCAE ED-237.* |
| 3.2.8 | In case of recovery from the distress condition, distress tracking and any distress signal needs to be de-activated, however, the deactivation can only be done by the activating mechanism. |
| 3.2.9 | Functionality may be included that allows the aircraft operator to activate the ADT function, for example, when there is a (risk of) failure of the aircraft tracking systems or there is uncertainty about the status of the aircraft. |
| 3.2.10 | The ADT function approved by the State of the Operator should consider high-level performance criteria such as:1. Appropriate for the expected duration of flight
2. Quality and integrity of data being transmitted
3. Robustness of the communication link, including timely receipt of information and recovery after link-loss during unusual attitudes
4. Cyber security considerations
5. Robustness of the system performing the transmission
6. Global coverage
 |
| 3.4.1 | When it is identified that an aircraft is experiencing a distress condition, the effectiveness and efficiency of any subsequent RCC and SAR action will rely on the timely notification and sharing of relevant and consistent information between the actors involved. The source of the data will depend on which GADSS function identified the distress condition, however, in all cases the information to be shared will include:* 4D Position information:
	+ Last known position
	+ Flight Track (past position reports)
	+ Planned route as updated by ATC
* Distress event trigger or type of emergency (why is the aircraft considered to be in distress)
* Flight Plan information
	+ Field 19
* Flight/cargo manifest information
	+ Dangerous Goods
 |
| 3.4.2 | The sharing of distress tracking information requires global coverage and a global system approach. Pending the global coverage of System Wide Information Management (SWIM), this information should be made available through a distress tracking repository service as shown in the figure below: |
| 3.4.3 | The distress tracking repository service ideally should be provided through a single infrastructure for the alerting and dissemination of distress beacon information. When necessary (in case of a situation which is distress or is judged to evolve towards distress) operators will submit relevant tracking information to the repository service to ensure timely availability to local RCC(‘s). |
| 3.4.4 | The point of contact repository service should be provided to assist an operator in contacting an ATSU (and if needed an RCC). The point of contact (PoC) information repository service should allow the position of the aircraft to be correlated to the appropriate ATS units and RCC areas of responsibility. The following minimum information can be returned by submitting a position:* The identification and point of contact of the ATS unit and RCC responsible for the area of jurisdiction in which the position fits;
* In case the position is near to an ATS unit boundary the neighbouring ATS unit Identification and Point of Contact will also be provided;
* In case the position is near to an RCC boundary the neighbouring RCC Identification and Point of Contact will also be provided.
 |
| 3.4.5 | The service needs to be available 24/7 and its content is subject to a maintenance process that ensures that the information is accurate and complete to the maximum extent possible and practical. |
| 4.7 | In an Emergency phase, aircraft tracking information needs to be available to all actors. |
| 4.8 | 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. |
| 4.8.1 | When the ATS unit detects an aircraft in distress it will monitor the situation and communicate, and assist as required. The ATS unit will need to contact the aircraft operator to seek additional information and assist with the emergency phase. |
| 4.8.2 | When the aircraft operator detects a distress condition it will contact the ATS unit corresponding with the latest known position of the aircraft. The aircraft operator will provide the ATS unit any additional information deemed relevant including the event that initiated the aircraft operator action. At this point, the ATS unit initiates the appropriate emergency phase and should attempt to establish contact with the aircraft. |
| 4.8.3 | When an RCC detects an aircraft in distress it will contact the ATS unit and the aircraft operator. |
| 4.9 | Emergency phases are used as a standardised method in the ATS/SAR system (ATS units and RCCs) to notify the level of concern for the safety of persons or aircraft which may be in danger. |
| 4.10 | The figure below illustrates the main information links for an emergency requiring the sharing of aircraft tracking information. As a result of on board triggers the ADT can be activated and the information forwarded by the ADT provider to the aircraft operator and RCC. The ATS unit may make use of additional sources of information and share this with the actors. Other ATS units may also receive aircraft tracking information; for example, when there is a probability that the flight will enter their area of jurisdiction. |
| 4.11 | Upon initial notification, an event is classified by the notified RCC or ATS unit as being in one of three emergency phases as specified in Annex 11 Chapter 5: Uncertainty (INCERFA), Alert (ALERFA), or Distress (DETRESFA). The emergency phase may be reclassified as the situation develops. The current emergency phase should be used in all communications about the incident as a means of informing all interested parties of the current level of concern for the safety of persons or craft which may be in need of assistance. |
| 4.12 | Notification by ATS units to RCCs will contain such of the following information as is available in the order listed: *(NOTE – the information below is a consolidated list from Annex 11 and the IAMSAR Manual)*1. **UNCERTAINTY, ALERT** or **DISTRESS**, as appropriate to the phase of the emergency;

b) agency and person calling;c) nature of the emergency;d) significant information from the flight plan, including:* Aircraft call sign and type;
* point of departure and departure time;
* route of flight;
* destination and estimated time of arrival (ETA);
* number of persons on board;
* endurance;
* colour and distinctive markings;
* survival equipment carried;
* dangerous goods carried;
* telephone number of pilot in command;

e) unit which made last contact, time and means used;f) aircraft tracking information including last position report and how determined (course, speed, altitude);i) any action taken by reporting office;j) any direction finder equipment available; andj) other pertinent remarks. |
| 4.13 | Information which is not available at the time notification is made to an RCC should be sought by an ATS unit prior to the declaration of a distress phase, if there is reasonable certainty that this phase will eventuate. Further notification to the RCC will, without delay, be furnished by ATS units with:a) any useful additional information, especially on the development of the state of emergency through subsequent phases; orb) information that the emergency situation no longer exists.*Note - The cancellation of action initiated by the RCC is the responsibility of that centre.* |
| 4.20 | ATS units and RCCs will normally interact with aircraft operators when there is a need due to an emergency involving one of their aircraft. ATS units/RCCs and aircraft operators may collaborate for emergency planning or exercise purposes. |
| 4.21 | When an area control or a flight information centre decides that an aircraft is in the Uncertainty or the Alert phase, it will, when practicable, advise the operator prior to notifying the RCC. On the other hand, if an aircraft is in the distress phase, the RCC is notified immediately. The operator is then notified when practicable and receives the same information as the RCC. |
| 4.22 | The emergency status is monitored by the ATS unit and the RCC. The emergency phase may be cancelled as a result of determination of a false alarm or disappearance of the cause of the emergency. Confirmation needs to be received from the crew, ATS unit, aircraft operator and RCC as applicable. |

2.2 Regulatory Requirements

Regulatory requirements that apply to ADT are contained in different regional, national, and Civil Aviation Authority (CAA) documents, and are documented within the following sub-sections.

2.1.1 European Union (EU) Regulation

The EU regulation that mandates ADT is:

**COMMISSION REGULATION (EU) 2015/2338 of 11 December 2015 *amending Regulation (EU) No 965/2012 as regards requirements for flight recorders, underwater locating devices and aircraft tracking systems***

EU 2015/2338 amends EU No. 965/2012 of 5 October 2012 *laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No. 216/2008 of the European Parliament and of the Council*

Specifically, EU No. 965/2012,.*Annex IV COMMERCIAL AIR TRANSPORT OPERATIONS [PART-CAT] SUBPART A GENERAL REQUIREMENTS* is amended by adding the following new requirement:

**CAT.GEN.MPA.210 Location of an aircraft in distress — Aeroplanes**

The following aeroplanes shall be equipped with robust and automatic means to accurately determine, following an accident where the aeroplane is severely damaged, the location of the point of end of flight:

1. all aeroplanes with an MCTOM of more than 27 000 kg, with an MOPSC of more than 19 and first issued with an individual CofA on or after 1 January 2021; and
2. all aeroplanes with an MCTOM of more than 45 500 kg and first issued with an individual CofA on or after 1 January 2021

MCTOM - Maximum Certified Take-Off Mass

2.1.2 European Aviation Safety Agency (EASA) Requirements

**Annex II to Executive Director (ED) Decision 2015/XXX/R ‘AMC and GM to Part-CAT — Issue 2, Amendment X’ (DRAFT dated Feb. 2016)**

Proposes the following new Acceptable Means of Compliance (AMC) and Guidance Material (GM) in order to comply with COMMISSION REGULATION (EU) 2015/2338:

**AMC1 CAT.GEN.MPA.210 Location of an aircraft in distress - Aeroplanes ROBUST AND AUTOMATIC MEANS TO ACCURATELY DETERMINE THE LOCATION OF THE POINT OF END OF FLIGHT AFTER AN ACCIDENT WHERE THE AIRCRAFT IS SEVERELY DAMAGED**

(a) The robust and automatic means to determine, following an accident where the aircraft is severely damaged, the location of the point of end of flight should:

(1) be operational whenever the aeroplane is airborne;

(2) be so designed that it is very likely to work, indistinctively if the accident is survivable or not;

(3) be robust to loss of normal electrical power on board;

(4) not offer any control to deactivate it or power it off during the flight;

(5) have a global coverage; and

(6) be so designed that the location of the point of end of flight can be determined:

1. with an absolute horizontal accuracy (95%) of 6 NM and within 3 hours of the accident time if the aeroplane is first issued with an individual CofA before 01 January 2023; and
2. with an absolute horizontal accuracy (95%) of 3 NM and within 30 minutes of the accident time if the aeroplane is first issued with an individual CofA on or after 01 January 2023.

(b) The robust and automatic means to determine, following an accident where the aircraft is severely damaged, the location of the point of end of flight may use any technology. However, an automatic fixed ELT or an automatic portable ELT are not acceptable for this purpose if they are not designed to successfully emit in extreme non-survivable accident conditions or to emit upon automatic detection of an emergency situation or a situation likely to result into an accident. In addition, an automatic deployable ELT that only relies on water immersion sensors and negative acceleration sensors (‘g’ switches) for detecting impact with water or ground is not acceptable.

**GM1 CAT.GEN.MPA.210 Location of an aircraft in distress –Aeroplanes ACCIDENT WHERE THE AIRCRAFT IS SEVERELY DAMAGED**

For the purpose of the robust and automatic means to determine, following an accident where the aircraft is severely damaged, the location of the point of end of flight,

(a) ‘accident where the aircraft is severely damaged’ means an accident where the aircraft sustains damage or structural failure which adversely affects the structural strength, performance or flight characteristics of the aircraft, and would normally require major repair or replacement of the affected component, except:

(1) for engine failure or damage, when the damage is limited to a single engine, (including its cowlings or accessories);

(2) when the damage is limited to a single propeller, wing tips, antennas, probes, vanes, tires, brakes, wheels, fairings, panels, landing gear doors, windscreens, the aircraft skin (such as small dents or puncture holes); or

(3) in case of minor damages to the landing gear, or minor damages resulting from hail or bird strike (including holes in the radome).

**GM2 CAT.GEN.MPA.210 Location of an aircraft in distress –Aeroplanes EXAMPLES OF ROBUST AND AUTOMATIC MEANS TO ACCURATELY DETERMINE THE LOCATION OF THE POINT OF END OF FLIGHT AFTER AN ACCIDENT WHERE THE AIRCRAFT IS SEVERELY DAMAGED**

(a) Historical data of large aeroplane accidents that occurred in the 1990s and 2000s have shown that quite frequently the ELT, while compliant with industry standards, did not emit a signal because it was destroyed, its antenna was destroyed or the link between the ELT and the antenna was cut. It is expected that if used to comply with CAT.GEN.MPA.210, an automatic fixed ELT or an automatic portable ELT would be capable of emitting a signal upon detection of an emergency situation (i.e. before the time of impact) or that the ELT would be designed to successfully emit a signal even in non-survivable accident conditions.

(b) Several cases of premature end of recording with flight recorders installed on board aeroplane and helicopters involved in accidents have raised concern about the reliability of negative acceleration sensors (‘g’ switches) for detecting impact initiation. This is why EUROCAE Document 112A (Minimum Operational Performance Specifications for crash-protected airborne recorder systems) specifies that the impact sensors of an automatic deployable flight recorder should be designed such that they will only trigger when the structure has been significantly deformed, and that negative acceleration sensors should not be used as the sole means of detection. It is expected that if used to fulfill the objective of the robust and automatic means to determine the location of the point of end of flight, an automatic deployable ELT would have impact detection means as robust as those specified for automatic deployable flight recorders.

(c) Examples of robust and automatic means to determine the location of the point of end of flight after an accident where the aircraft is severely damaged:

(1) an aircraft tracking system (refer to CAT.GEN.MPA.205) with in addition:

(i) Position reporting accuracy and position reporting rate sufficient to ensure that the point of end of flight can be localized within the specified accuracy and timeframe;

(ii) Alternate power source capable of automatically engaging after a total failure of the normal electrical generating system, with an autonomy sufficient to cover for the longest duration of gliding possible for the aircraft; and

(2) emission by the aeroplane of a signal upon detection of an emergency situation or a situation likely to result into an accident. The emission would start within seconds of detection and continue until the detection criteria have disappeared. The emission would be robust to unusual aircraft attitudes and to loss of normal electrical power on board and there would be no control available to aircraft occupants to disable the detection or the emission in flight. There would be reliable ground infrastructure to receive the emergency signal, store it and trigger an alert. The signal would contain aircraft position information or post-processing of the signal would allow determining the aircraft position. Examples of criteria triggering transmission are: unusual aircraft attitude, unusual airspeed or vertical speed, stall condition, risk of collision with the terrain, , total loss of thrust/propulsion on all engines;

(3) an automatic deployable flight recorder fitted with an ELT, compliant with ETSO-C123b, ETSO-C124b, ETSO-C177 or an acceptable equivalent.’

2.2 AEEC Derived Requirements

The following derived system-level requirements that apply to ADT are documented in the following table.

| Section | Requirement |
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