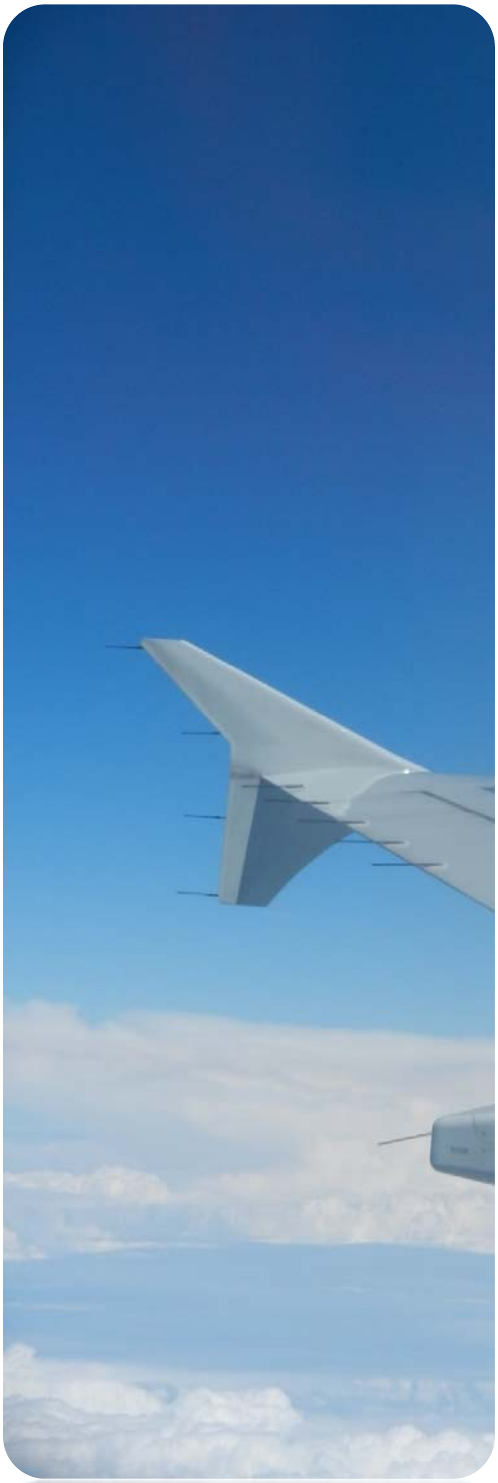

Concept of Operations

Global Aeronautical Distress & Safety System (GADSS)

Version 6.0

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Submitted on behalf of the GADSS Advisory Group:	Mr Henk Hof, Chairperson of the GADSS - AG

Executive Summary

One of the many reasons why aviation maintains a high level of safety is the willingness to learn important lessons from rare events. The tragedies of Malaysia Airlines flight 370 and Air France flight 447 have highlighted limitations in the current air navigation system which have hampered timely identification and localisation of aircraft in distress. This has significantly hindered effective search and rescue efforts and recovery operations.

On the rare occasions when accidents occur, rescuing survivors has the highest priority, followed by the recovery of casualties, the wreckage and the flight recorders. Analysis of data from these recorders is very important in supporting accident investigation which may, through identification of the cause of the accident, contribute towards enhancing safety. To achieve this intent, an effective and globally consistent approach to improving the alerting of search and rescue services is essential.

The effectiveness of the current alerting of search and rescue services should be enhanced by addressing a number of key improvement areas and by developing and implementing the Global Aeronautical Distress and Safety System (GADSS), which addresses all phases of flight under all circumstances including distress. This GADSS will maintain an up-to-date record of the aircraft progress and, in case of a crash, forced landing or ditching, the location of survivors, the aircraft and recoverable flight data.

Figure A below gives a high-level overview of the GADSS and identifies the main functions:

- Aircraft Tracking
- Autonomous Distress Tracking
- Post Flight Localization and Recovery

And

- GADSS Information Management and Procedures

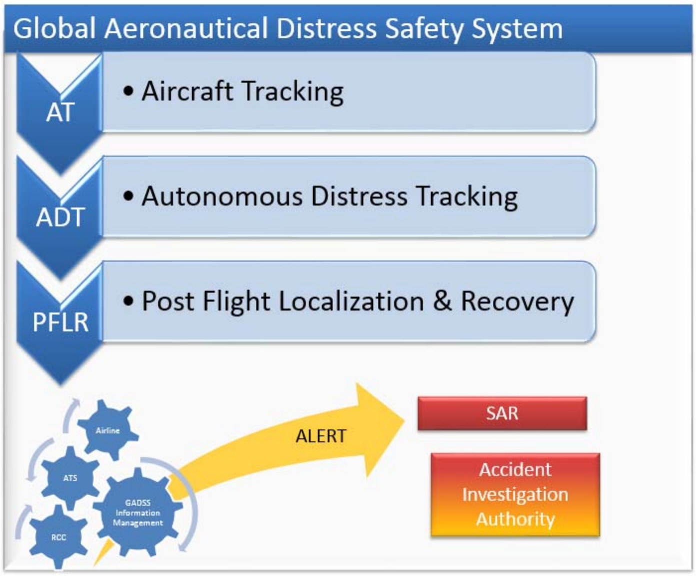


Figure A: high level overview of the GADSS identifying the main functions

The effectiveness of the alerting and search and rescue services is only as good as the weakest link in the chain of people, procedures, systems and information. It is therefore of paramount importance that a global perspective be adopted in designing the GADSS, including key areas of improvement such as the availability of 4D aircraft position information for each aircraft, improved coordination and information sharing and enhanced training of personnel in reacting to rarely-encountered circumstances.

Implementation of the GADSS will have an impact on States and industry. For example, some aircraft will require modifications while some States may need to invest more in the implementation of its SAR responsibilities. However, the benefits stemming from greater effectiveness of the alerting, search, rescue and recovery services will offset any cost.

Contents

1.0 Historical Background

1.0.1 In May 2014 ICAO convened a multi-disciplinary meeting with States, Industry, chairs and co-chairs of several Air Navigation Commission (ANC) panels, and related specialists to reach a common agreement on the first key steps in making global aircraft tracking a priority, to agree that there is a need to track flights and to coordinate with Industry Initiatives.

1.0.2 The meeting recommended a draft concept of operations on aircraft tracking be developed that includes a clear definition of the objectives of aircraft tracking and ensures information is provided in a timely fashion to the right people to support search and rescue, recovery and accident investigation activities, as well as the roles and responsibilities of all stakeholders.

1.0.3 The recommendation that a final high level concept of operations should be delivered to the ICAO High Level Safety Conference (HLSC 2015, February, Montreal) was approved by the ICAO Council on 16 June 2014. (C-DEC 202/3)

1.0.4 ICAO tasked an ad-hoc working group (AHWG), consisting of ANC panel chairpersons, ANC Commissioners, Secretariat personnel and experts in the field of Search and Rescue, to develop the draft concept of operations. Coordination with the IATA Aircraft Tracking Task Force (ATTF) was ensured through IATA participation in the AHWG.

1.0.5 The AHWG commenced its task on the 03 June 2014 and developed the initial concept of operations (ConOps) for the Global Aeronautical Distress Safety System (GADSS).

1.0.6 The GADSS was reviewed and endorsed by States at the High Level Safety Conference in February 2015. The ConOps was further updated by the AHWG in 2015 to reflect the outcomes of the ICAO Council approval of new standards and recommended practices in the relation to the GADSS concept.

1.0.7 This 2017 version contains further updates to reflect feedback to State comments in the SARP's development process and to further elaborate on the key functions required in order to implement the GADSS.

1.1 Scope of the Concept of Operations

1.1.1 This Concept of Operations document specifies the high-level requirements and objectives for the GADSS. The GADSS is a system of systems and procedures intended to apply to commercial air transport operations (ICAO Annex 6 Part 1 applicability) initially. However, the ConOps takes an overall system approach and consequently is not restrictive to a particular type of operation. Furthermore, the implementation of this target concept will also have implications for the provision of services such as air traffic control, search and rescue and accident investigation.

1.1.2 Responding to the requirements and objectives, the ConOps specifies the high-level functions needed, with a description of users and usages of aircraft position information, in all airspaces, during all phases of flight, both normal and distress flight conditions including the timely and accurate location of an aircraft accident site and recovery of flight data. The ConOps does not prescribe new specific technical solutions but provides a framework of scenarios that can be used to verify whether a solution complies with the Concept.

A 'Concept of Operations' is a user-oriented document that describes systems characteristics for a proposed system from a user's perspective. The ConOps document is used to communicate overall quantitative and qualitative system characteristics to the user, buyer, developer and other organizational elements (for example training, facilities, staffing and maintenance). It is used to describe the user organization(s), mission(s), and organizational objectives from an integrated systems point of view. (Source: IEEE Std 1362TM – 1998 (R2007)).

1.2 Definitions

1.2.1 The following definitions apply in the context of this document. Definitions in italics indicate they are existing definitions already used in ICAO annexes and PANs.

- ***Aircraft Tracking***. A process, established by the operator, that maintains and updates, at standardised intervals, a ground-based record of the four dimensional position of individual aircraft in flight. (ICAO Annex 6)
- **Air navigation system.** A generic term for all systems as detailed in the ICAO Annexes and any related systems required to interface with these aviation systems.
- ***Air traffic service (ATS).*** A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service). (ICAO Annex 11)
- ***Alerting service.*** A service provided to notify appropriate organizations regarding aircraft in need of search and rescue aid, and assist such organizations as required. (ICAO Annex 11)
- ***Alerting post.*** Any facility intended to serve as an intermediary between a person reporting an emergency and a rescue coordination centre or rescue sub centre. (ICAO Annex 11 & 12)
- ***Automatic Deployable Flight Recorder*** *(ADFR)*. A combination flight recorder installed on the aircraft which is capable of automatically deploying from the aircraft.

- **Autonomous Distress Tracking (ADT).** The capability using transmission of information from which a position of an aircraft in distress can be determined at least once every minute and which is resilient to failures of the aircraft's electrical power, navigation and communication systems.
  Note: this capability is described under 'Location of an Aeroplane in Distress' in ICAO Annex 6 Part 1.

- **Cospas-Sarsat System.** A satellite-based system designed to detect and locate activated distress beacons transmitting in the frequency band of 406.0-406.1 MHz and to distribute these alerts to RCCs. (ICAO/IMO IAMSAR Manual)
- ***Emergency locator transmitter (ELT).*** A generic term describing equipment which broadcast distinctive signals on designated frequencies and, depending on application, may be automatically activated by impact or be manually activated. (ICAO Annex 6 & 10)
- **Emergency locator transmitter (distress tracking).** Emergency locator transmitter for ICAO specified in-flight distress tracking (Cospas-Sarsat Glossary C/S G.004 - Issue 2)
- ***Emergency phase*.** A generic term meaning, as the case may be, uncertainty phase, alert phase or distress phase. (ICAO Annex 11 & 12)
  - ***Uncertainty phase***. A situation wherein uncertainty exists as to the safety of an aircraft and its occupants.
  - ***Alert phase.*** A situation wherein apprehension exists as to the safety of an aircraft and its occupants.
  - ***Distress phase***. A situation wherein there is reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger or require immediate assistance.
- **False alert.** An alert received from any source, including communications equipment intended for alerting, when no distress situation actually exists, and a notification of the alert should not have resulted.
- **GADSS Information Management.** The infrastructure and services used for the exchange and timely dissemination of information in support of the GADSS
- **Mission Control Centre (MCC).** A component of the Cospas-Sarsat ground segment that follows a prescribed set of data processing and distribution rules to process distress alert data from 406 MHz beacons, exchange it with other MCCs, and send it to RCCs
- ***Rescue Coordination Centre (RCC).*** A unit responsible for promoting efficient organization of search and rescue services and for coordinating the conduct of search and rescue operations within a search and rescue region. (ICAO Annex 11 & 12) *NOTE – The term RCC is used in this document to apply generically to an aeronautical, maritime or joint (aeronautical and maritime) rescue coordination centre (ARCC, MRCC, JRCC respectively).*
- ***Search and Rescue Region (SRR).*** An area of defined dimensions, associated with a rescue coordination centre, within which search and rescue services are provided. (ICAO Annex 12)

- ***Survival ELT (ELT(S)).*** An ELT which is removable from an aircraft, stowed so as to facilitate its ready use in an emergency and manually activated by survivors. (ICAO Annex 6 & 10)

1.3 ICAO Annex References

1.3.1 This section briefly outlines which of the Annexes to the Chicago Convention have provisions related to this ConOps. All ICAO Annex and PANS can be accessed through the ICAONET.

Annex 2 (Amendment 45) provides provisions for flight plans, distress and urgency signals.

Annex 6 Part I (Amendment 42) provides provisions for aircraft operators. Some specific examples include requirements for aircraft tracking, location of an aeroplane in distress, ELTs and flight recorder data recovery, in-flight fuel management, and communication and navigation equipment.

Annex 8 (Amendment 105-A) provides provision for the design, production and maintenance of aircraft including the requirement for safety and survival equipment.

Annex 10 (Vol I,II, III Amendment 90) (Vol IV Amendment 89) (Vol V Amendment 88-A) provides provisions for radio navigation aids, communication procedures, communication systems, surveillance radar and collision avoidance systems and aeronautical radio frequency spectrum utilization.

Annex 11 (Amendment 50-A) Chapter 5 details the provisions for an Alerting Service.

Annex 12 (Amendment 18) details the operating procedures for Search and Rescue

Annex 13 (Amendment 15) provides the provisions for accident investigation, including the availability and protection of information related to an incident or accident.

PANS-ATM (Amendment 7A) details procedures including those for the filing of flight plans, position reporting, ATS surveillance service and specific procedures related to emergencies, communication failure voice communication procedures and controller pilot data link communications operation and contingencies as well as alerting services.

PANS-OPS (Vol I, II Amendment 7) details procedures including the use of secondary surveillance radar transponder operation and phraseology.

IAMSAR Manuals (IAMSAR Manual 1 July 2016)**,** the three-volume International Aeronautical and Maritime Search and Rescue Manual, details the common aviation and maritime approach to organizing and providing search and rescue (SAR) services. Volume I, Organization and Management, discusses the global SAR system concept, the establishment and improvement of national and regional SAR systems and co-operation with neighbouring States to provide effective and economical SAR services. Volume II, Mission Co-ordination, assists personnel who plan and co- ordinate SAR operations and exercises. Volume III, Mobile Facilities, is intended to be carried aboard rescue units, aircraft and vessels to help with performance of a search, rescue or on-scene co-ordinator function.

2.0 High Level Objectives of the GADSS

2.1 The GADSS is designed to address three specific issues;

a) the late notification of SAR services when aircraft are in distress (as defined in ICAO Annex 11),
b) missing or inaccurate end of flight aircraft position information i.e. the location of wreckage and
c) lengthy and costly retrieval of flight data for accident investigation.

2.2 The consequent objectives of the GADSS are:

- **Ensure timely detection of aircraft in distress**
  - **To timely initiate SAR actions**
- **Ensure tracking of aircraft in distress and timely and accurate location of end of flight**
  - **To accurately direct SAR actions**
- **Enable efficient and effective SAR operations**
- **Ensure timely retrieval of Flight Recorder Data**

2.3 The effectiveness of SAR also depends on the progress in other areas not directly covered by the GADSS. A number of these areas of potential improvement are identified and are detailed in appendix B. These areas of improvement can be realised separately to the implementation of the GADSS. They include:

- State verification that their operators are meeting the 406MHZ ELT requirements
- Review of existing aeroplane emergency and abnormal emergency procedures to maximise the potential of the ELT to perform effectively and provide a distress signal by manual inflight activation.
- Improvement in the overall registration of 406MHz ELTs
- Improvements in coordination to prevent any compromise in the mechanism to receive overdue position reports.
- Implementation of State testing of their initial and continuous proficiency in emergency procedures
- Improvement in military/civil coordination in support of emergency situations
- Improvement in ICAO SARPS for raising an emergency phase by reducing the time period of communication checks leading to declaration.
- Encourage alignment of SAR regions and FIRs
- Encourage alignment of SAR regions and maritime SRRs
- Improvement in compliance with ICAO Annex 12 provisions
- Improvement in RCC situational awareness by providing knowledge of air traffic in its SAR region
- Improvement in the transition of an event from ICAO Annex 12 (Search and Rescue) to ICAO Annex 13 (Accident Investigation) responsibility

3.0 GADSS Architecture

3.0.1 This chapter details the key characteristics needed to deliver on the high-level objectives of the GADSS.

3.0.2 The efficiency and effectiveness of ATS unit Alerting and SAR services rely on timely and accurate information. GADSS operates on a worldwide scale for all flights that meet the applicable criteria as defined in standards/regulations.

3.0.3 The GADSS consists of the following main system components:

- ***Aircraft Tracking Function;***
- ***Autonomous Distress Tracking function;***
- ***Post Flight Localization and Recovery function; and***
- ***GADSS Information Management and Procedures***

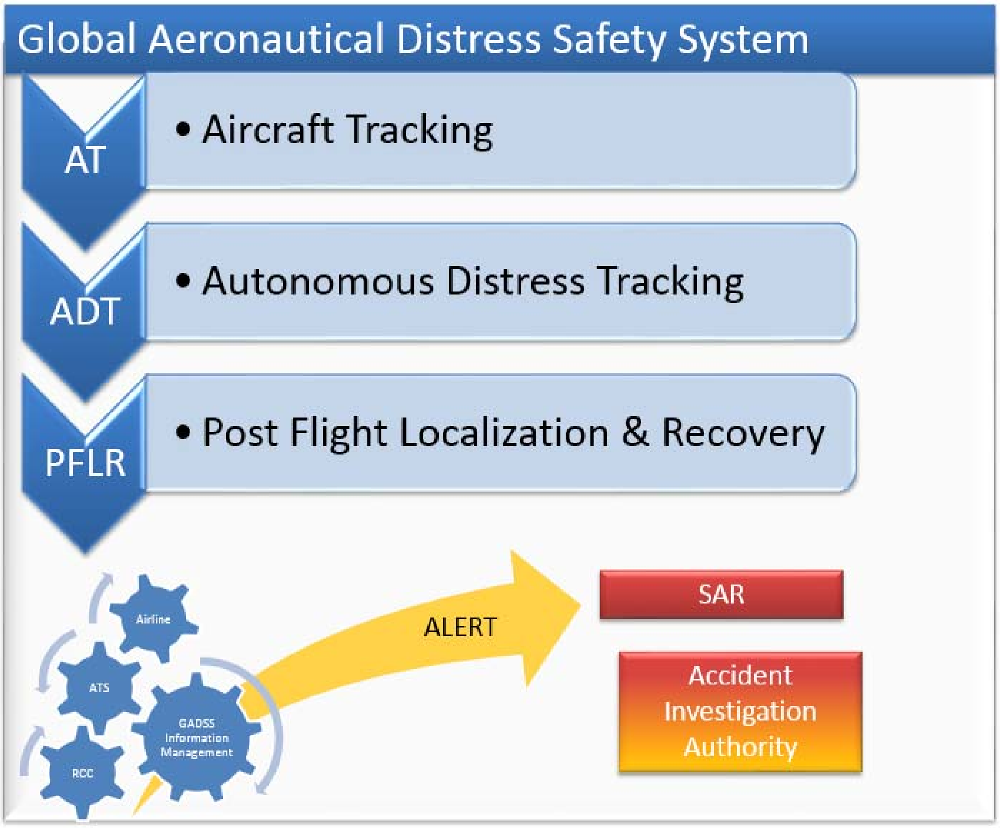


Figure B: high level overview of the GADSS identifying the main functions

3.0.4 This chapter is structured to first detail the target concept for the aircraft-centric functions and then the ground-centric procedures, recognising that all are interdependent when fulfilling the overall requirements of the GADSS. While the GADSS concept may apply to all aircraft, it is intended that the aircraft-centric provisions will only apply to commercial air transport in the shorter term.

3.1 Aircraft Tracking Function

3.1.1 The aircraft tracking function will leverage existing technologies to support SAR by:

- Assisting in the timely identification and location of aircraft;
- Reducing the reliance on the procedural methods used for determining aircraft position;
- Helping to ensure the availability and sharing of aircraft position data (with the relevant entities); and
- Helping to improve the effectiveness, efficiency and performance of ATS Unit Alerting.

To achieve these aims, the Aircraft Tracking function will provide an automated 4 dimensional position (4D – latitude, longitude, altitude and time) at a reporting interval of 15 minutes or less (recommended in all areas of operation and required in oceanic areas). This reporting interval will ultimately reduce the time necessary to resolve the status of an aircraft or when necessary, help to locate an aircraft. The State of the operator may, based on the results of an approved risk assessment process implemented by the operator, allow for variations to the minimum automated reporting intervals. The process will demonstrate how risks to the operation resulting from such variations can be managed.

3.1.2 Aircraft operators may meet the requirements of the Aircraft Tracking function using available and planned technologies as deemed effective.

In general terms the Aircraft Tracking function:

- Does not introduce any change to current ATC Alerting procedures;
- Establishes operator responsibilities for tracking based on areas of operation;
- is not technology-specific;
- Establishes communication protocols between operator and ATC.

3.1.3 The aircraft tracking function requires the aircraft operator to ensure that the aircraft is tracked when ATS surveillance services obtain an aircraft position at greater than 15 minute intervals. Having confirmed the air traffic services obtain an aircraft position at 15 minute intervals or less, an aircraft operator does not need to track the aircraft.

3.1.4 To enable aircraft operators to determine where they need to track their aircraft, ANSPs will make available details of the air traffic services surveillance capabilities provided in their area of responsibility. For aircraft a) operating in areas where there is no aircraft tracking function availability, b) for temporary operations outside the normal area of operation or c) for specific flights where the aircraft tracking capability may be unserviceable; an aircraft operator may conduct the flight based on a risk assessment acceptable to the State of Operator.

3.1.5 When the tracking is performed by the aircraft operator and the specific technology utilised by the aircraft operator has the capability, the reporting rate could be increased in response to abnormal events.

3.1.6 Aircraft operators who receive tracking information directly from the aircraft will ensure that procedures, including communications with ANSP and SAR as per ICAO Annex 11, are in place to respond to instances of missed reporting.

Aircraft Tracking Service Providers

3.1.7 The responsibility to track an aircraft lies with the aircraft operator, however, the service can be provided by a third party contracted by the aircraft operator through a formal agreement. The formal agreement will not allow the transfer of responsibility.

3.1.8 The aircraft operator is responsible for ensuring the aircraft tracking service provider records the aircraft tracking information. The full record will be kept for a duration defined by the State of the operator.

3.1.9 During any identified emergency phase the service provider makes available, at defined intervals, a log with the position of the aircraft and other information relevant to the emergency phase.

3.2 Autonomous Distress Tracking Function

3.2.1 The Autonomous Distress Tracking (ADT) function will be 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 aircraft position (latitude and longitude), or distinctive distress signals from which the aircraft position and time can be derived. The aircraft position information will 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.

Note: it is desirable that the aircraft position provided by the ADT also include altitude information. Likewise, the ability to identify the location of the accident site to within 6 NM may be further improved by increasing the frequency of transmission of aircraft position information.

3.2.3 In terms of the autonomy, the ADT function will 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. The on-board component of the ADT function will be designed such that, in the event of aircraft electrical power loss, it will continue transmitting for the expected duration of the remaining flight.

3.2.4 The operator will be notified (directly or indirectly) when one of their aircraft is in a distress condition. The ADT function will need to include the capability to deliver the distress tracking information to SAR Agencies.

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 aircraft position information), or to notify a distress condition and also commence transmitting of aircraft position information. Distress tracking manually initiated by the flight crew should also generate a notification.

3.2.5.1 The triggering criteria may include analysis of unusual attitudes, 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.

3.2.5.2 In the case of an on-board triggered transmission system (distinctive distress signal), initial transmission of aircraft position information shall commence immediately or no later than five seconds after the detection of the distress condition.

Note: Further guidance regarding in-flight event detection and triggering criteria may be found in the EUROCAE ED-237 Minimum Aviation Performance Specification (MASPS) for Criteria to Detect In-Flight Aircraft Distress Events to Trigger Transmission of Flight Information.

3.2.8 In case of recovery from the distress condition, distress tracking and any distress signal will be de-activated. However, the deactivation will only be possible using the activating mechanism.

3.2.9 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.

3.2.10 The ADT function will be approved by the State of the Operator, considering high-level performance criteria such as:

a) Quality and integrity of data being transmitted
b) Robustness of the communication link, including timely receipt of information and recovery after link-loss during unusual attitudes
c) Cyber security considerations
d) Robustness of the system performing the transmission
e) Global coverage
f) Accurate and timely information provided to the RCCs and operators.
g) Minimisation of False Alerts.

3.3 Post Flight Localization and Recovery Function

3.3.1 When an accident occurs there is a phase beginning immediately at the end of flight where the rescue of possible survivors has the immediate and highest priority. Accurate aircraft position information (1 NM or better) is provided through the Post Flight Localization function by means of ELT and/or homing signals to guide SAR services on site.

3.3.2 It is beneficial for the accident investigation authority to recover aircraft structure, components and critical flight data in a timely manner. When the accident occurs over oceanic areas the task of localizing the aircraft structure and particularly its flight recorders can be difficult. To assist the localization of the wreckage and recovery of flight recorder data after an accident, the post flight localization and recovery function specifies a number of requirements for, ELTs, ULDs and flight recorders; incorporated in ICAO Annex 6 provisions.

Emergency Locator Transmitters

3.3.3 The primary purpose of an ELT installed on an aircraft is to locate survivors, however, it may also aid the localization and recovery of wreckage. The types of ELTs and carriage requirements on aircraft are specified in ICAO Annex 6 provisions.

Underwater Locating Devices

3.3.4 To aid the location of an aircraft wreckage under water in oceanic areas, large aeroplanes performing long-range over-water flights are required to contain a securely attached underwater locating device operating at a frequency of 8.8 kHz (reference ICAO Annex 6, Part I). This automatically activated underwater locating device emits a signal which can be detected from a distance of several NMs and shall operate for a minimum of 30 days. Likewise, flight recorders are required to have, securely attached, an automatically activated underwater locating device operating at a frequency of 37.5 kHz and capable of operating for a minimum of 90 days.

Flight Recorder Data Recovery

3.3.5 To ensure accident investigation authorities obtain timely access to the flight recorder information the aircraft will be equipped with a means, approved by the State of the Operator, to recover the flight recorder data and make it available in a timely manner. The requirements for approving the means to make flight recorder data available in a timely manner are detailed in ICAO Annex 6 provisions.

3.3.6 Of particular importance to accident investigation authorities is the prompt recovery of flight recorder data. The retrieval of flight recorder information contributes to, and often accelerates, a determination of the probable cause of the accident. Requirements for flight data, cockpit voice and image recorders have existed for some time and are detailed in ICAO Annex 6 provisions.

3.3.7 There have been instances in which the search for recorders has been very long, or flight data has never been recovered; or where data was lost due to damage from exposure to severe fire or underwater conditions.

3.4 Information sharing and Processes for the Notification of a Distress Condition

3.4.1 When it is identified that an aircraft is experiencing a distress condition, the RCC will be alerted. The effectiveness and efficiency of any subsequent RCC and SAR action will rely on timely notification. The alerting process is consistent with the current provisions in ICAO Annex 11, which is:

- If an ATS unit detects a distress condition they will notify the RCC and the operator;
- If the operator detects a distress condition they will notify the ATS unit who will in turn notify the RCC;
- If an ELT or ELT-DT is activated the RCC will be notified via the Cospas-Sarsat system;
- The RCC may receive notification directly from outside sources.

3.4.2 Appendix A provides high-level examples of how the process for the notification of a distress condition and information sharing will occur when the emergency phase is identified by various sources. Specifically it deals with cases where the aircraft operator, an ATSU, Cospas-Sarsat or an ADT service provider identify an emergency phase.

3.4.2 Irrespective of the method of alert, the RCC will have access to aircraft position information. The minimum information that will be required, at an interval rate of at least once per minute, are:

- Latitude
- Longitude
- Time stamp
- Aircraft identification (i.e. registration)
- Information source (e.g. ELT-DT)

3.4.3 The aircraft position information will be available to RCC, ATS units and the aircraft operator by means of a distress tracking data repository which they can access through an identified access point that will be continuously available. The repository will be SWIM compliant and will serve as the SWIM entry point for additional information such as:

- Last known position:
  - Latitude/Longitude
  - Altitude
  - Time stamp
  - 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

3.4.4 When an aircraft operator becomes aware that any of their aircraft is in a distress condition they will have the responsibility to ensure that the aircraft position information is submitted to the distress tracking data repository in a timely manner. This will allow RCCs, ATS units and other entities identified by the State of the Operator to have access to the most recent location information for that aircraft. The operator may delegate this function to a third party (e.g. Cospas-Sarsat) so long as there are agreed policy and procedures in place.

3.4.5 Aircraft position information normally retained by the operator (i.e. normal aircraft tracking information) can be requested by the RCC. This information, if requested, will be sent to the distress tracking data repository.

3.4.6 The sharing of distress tracking information requires global coverage and a global interoperable system approach. The service needs to be subject to a quality/maintenance process that ensures that the information is accurate and complete to the maximum extent possible and practical.

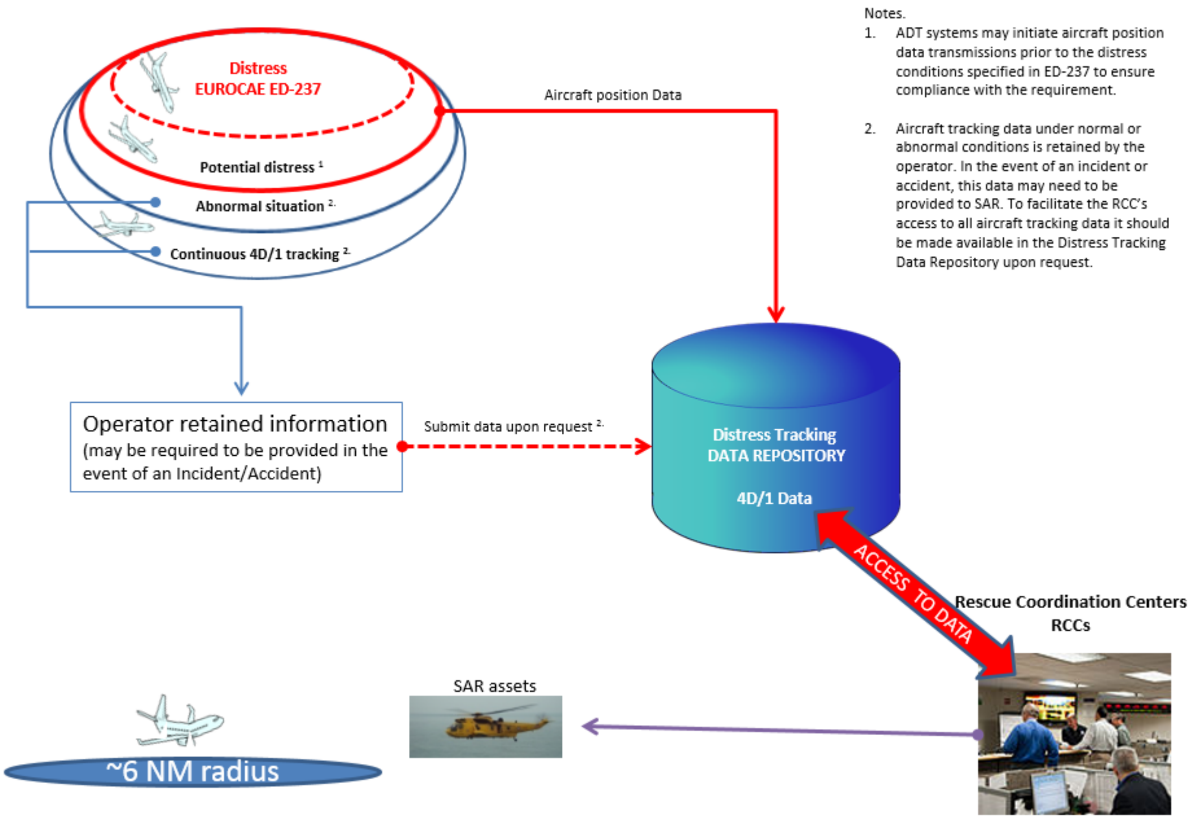


Figure C: Distress Tracking Data Repository

3.5 Point of contact repository services

3.5.1 An operator that detects a potential problem with an aircraft such as a missed report or suspected distress, will need to communicate it to the appropriate ATS unit. The operator will first identify the probable position of the aircraft and subsequently identify which ATS unit needs to be notified. The appropriate FIR and ATS unit will be ascertained by consulting information systems such as the ICAO GIS map services which is an electronic database based on the geographical (FIR's) from around the world.

3.5.2 To enable timely notification of the appropriate ATS unit and in turn the RCC, a point of contact repository will be populated with ATS unit's current contact information.

3.5.3 Likewise, ATS units that become aware of an aircraft in distress within their area of responsibility may not be familiar with the contact details of specific and foreign operators. The point of contact database repository will be populated with operator's current contact information.

3.5.4 GADSS Information Management including the information repositories is subject to a governance and maintenance process that ensures that the information is available and up-to-date to the maximum extent possible and practical. The point of contact repositories contain information such as:

- aeronautical field telecommunication network (AFTN) address;
- international fax and telephone numbers (complete with country codes and area codes); and
- email address.

3.6 Frequency Spectrum Considerations

3.6.1 In order to ensure global interoperability and lawful operation of radio equipment on-board aircraft, the equipment will conform to agreed performance standards, will operate in correct frequency bands, must be licensed by appropriate authorities, and be operated by licensed personnel if appropriate.

The below table shows which types of frequency bands could be considered for the various categories of functions specified under the GADSS

Function	**Spectrum Category**
Aircraft Tracking system	A
ATC Surveillance systems	B
Distress Tracking systems	C
Post Flight Localization and Recovery – Localization systems Post Flight Localization and Recovery - Flight Recorder Data Recovery system	C A

A: any type of spectrum properly allocated, on a primary basis, for the function being performed.
B: only protected aeronautical safety spectrum can be used.
C: only protected aeronautical safety spectrum, or protected distress spectrum (e.g., 406.1 MHz), can be used.
*This chart is not intended to imply that any new spectrum allocations are necessary to support GADSS.

4.0 GADSS Operation

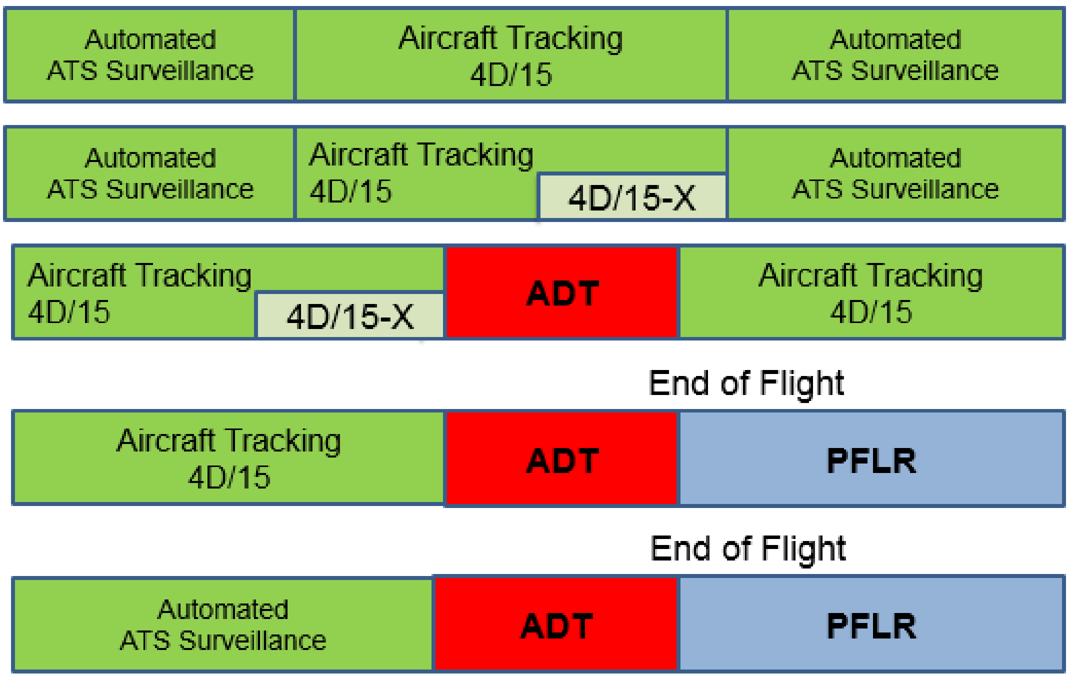
4.1 General

4.1.1 Before any active flight the aircraft operator identifies its point of contact for emergency phases who will be continuously contactable during the execution of the flight. This information is made available to relevant ATS units (ATS units involved in the execution of the flight). The aircraft operator will have the capability to determine and contact the appropriate ATS unit in relation to the aircraft position, if necessary, using the point of contact repository.

Detection of aircraft in distress takes place through direct communication between crew and ATS unit/operator and/or through automatic detection and communication of a distress signal and/or confirmed loss of position update information and communication.

4.1.2 During normal operations, aircraft position information needs to be updated and is available (through ATS surveillance) for ATS unit Alerting Services at least once per 15 min. Where necessary (i.e. automatic position updates of at least once per 15 min cannot be achieved) aircraft operators make use of Aircraft Tracking capabilities. Loss of position updates and communication is detected by the ATS unit and/or the operator. In case the operator detects a loss of position updates it will contact and provide relevant information to the ATS unit to activate and inform the Alerting Service.

4.1.3 The operator may programme its aircraft tracking function to increase its reporting rate based on various triggers detectable on the specific aircraft. These triggers will be identified by the operator as it deems appropriate. This will lead to increased reporting rates and information from the aircraft tracking function and if necessary enhanced distribution of information to enable early execution of procedures as defined in ICAO Annex 11. Figure D below shows some (non-exhaustive) examples of types of aircraft tracking progression:



ADT: Autonomous Distress Tracking
PFLR: Post Flight Localisation and Recovery
4D/15: latitude, longitude, altitude and time stamp at least once every fifteen minutes

4D/15-X: latitude, longitude, altitude and time stamp at an interval of less than 15 minutes

Figure D: Example of GADSS Progression

4.1.4 Figure D above illustrates the possible sequence of activation of GADSS functions. Example A starts with an aircraft operating in any area with ATS surveillance; however, the operator has also implemented a tracking capability on the aircraft which will start transmitting 4D position, at a 15 minute interval or less, when for example the aircraft is about to fly into an airspace where an ATS unit obtains position information at greater than 15 min intervals. Example B shows an increase to a higher aircraft tracking reporting rate based on operator defined parameters.

4.1.5 In example C the Autonomous Distress Tracking (ADT) function is activated as a last resort upon detection of a distress phase but ceases on the cessation of the activating event

4.1.6 Examples D and E show examples involving an end of flight. In example D Autonomous Distress Tracking (ADT) function is activated upon detection of a distress phase, with the Post Flight Localisation and Recovery function commencing at the end of flight. Example E starts with an aircraft operating in any area with ATS surveillance and shows a direct activation of the ADT function and subsequent post flight localisation and recovery functions.

4.1.7 It should be noted that communication of the escalation of an emergency phase to the Rescue coordination centre (RCC) is performed by the ATS unit and not by the aircraft operator. Where an ADT function uses a distinctive distress signal broadcast by an aircraft the distress notification will be forwarded directly from a Mission Control Centre (MCC) to the RCC. In that case, the ATS unit will be contacted by the RCC.

4.2 Procedures for declaring an emergency phase

4.2.1 In an Emergency phase, aircraft tracking information will be available to all relevant agencies.

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.

4.2.2.1 When the ATS unit becomes aware that an aircraft is in distress it will act in accordance with the provisions in ICAO Annex 11. The ATS unit will contact the aircraft operator to seek additional information and assist with the emergency phase.

4.2.2.2 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. If not already done, the ATS unit will initiate the appropriate emergency phase and will attempt to establish contact with the aircraft.

4.2.2.3 When an RCC detects an aircraft in distress it will contact the ATS unit and the aircraft operator.

4.3 Procedures for the emergency phase

4.3.1 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.

4.3.2 Figure E below illustrates the main information links for an emergency requiring the sharing of aircraft tracking information. As a result of triggers the ADT function will be activated and the information forwarded by the ADT provider to the aircraft operator and/or RCC. The ATS unit may make use of additional sources of information and share this with relevant agencies. 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.

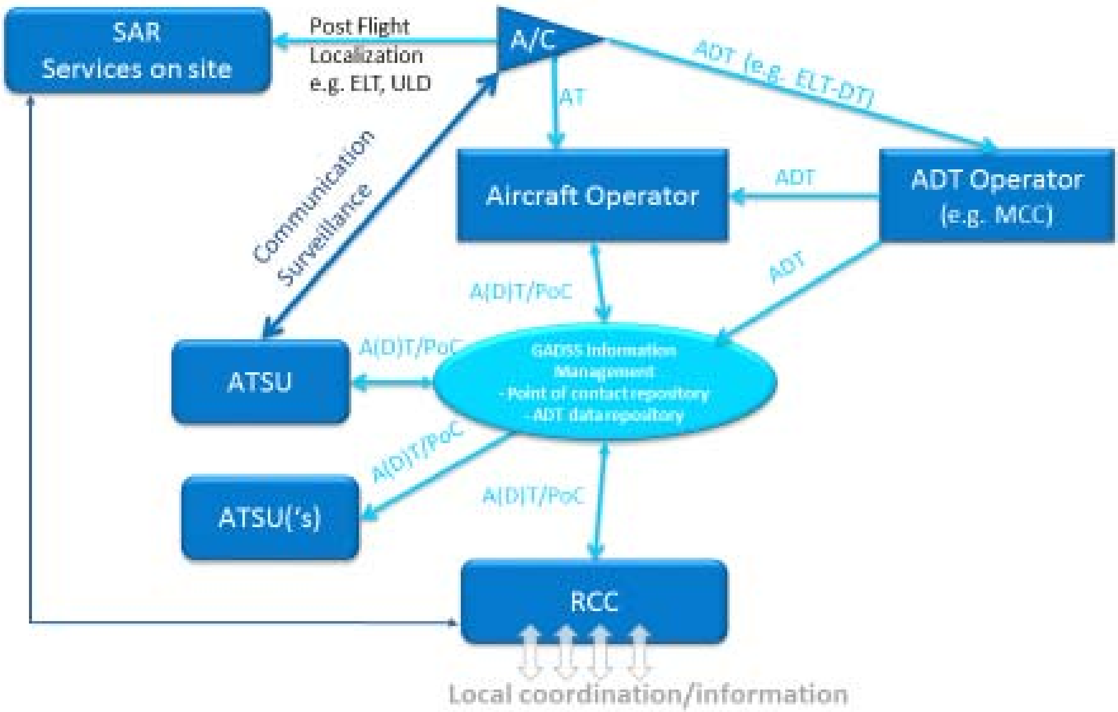


Figure E: main information links for an emergency

4.3.3 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 ICAO 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.

4.3.4 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* ICAO *Annex 11 and the IAMSAR Manual)*

a) **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; and

j) other pertinent remarks.

4.3.5 Flight information centres or area control centres are the first responsible to act as central point for collecting all information relevant to the state of emergency of an aircraft operating in its area of jurisdiction (ref ICAO Annex 11, 5.1.2). Coordination and information sharing agreements and procedures will be established between civil and military authorities to ensure that all possible means and information can be made available without delay in case of emergency situations.

4.3.6 Information, which is not available at the time the notification is made to an RCC, should be sought by an ATS unit prior to the declaration of a distress phase when there is reasonable certainty that this phase will eventuate. ATS units will provide further notification to the RCC, without delay, with:

a) any useful additional information, especially on the development of the state of emergency through subsequent phases; or

b) information that the emergency situation no longer exists.

Note - The cancellation of action initiated by the RCC is the responsibility of that centre.

4.3.7 During emergency phases, additional sources of information for locating and tracking aircraft may be used. Any relevant information will be made available as needed.

RCC Actions during Emergency Phases

4.3.8 Basic procedures may be adopted for each phase of emergency by RCCs. These procedures are not meant to be restrictive to RCCs who will act with flexibility as required to suit specific circumstances. A full description of procedures is outlined within the ICAO/IMO IAMSAR Manual, however, the level of RCC response is guided by the current emergency phase.

4.3.9 **At the Uncertainty phase,** RCCs will normally engage in actions such as conducting basic notifications, gathering basic information on the aircraft and its flight, plotting the aircraft information on a chart and commencing a communication search to attempt contact with the aircraft by all available means, including via the aircraft operator in case the operator is not already involved (e.g. loss of tracking). A communications search is supplementary to the initial communications checks which should have been completed by ATS or the operator prior to phase declaration. Departure, destination and alternate aerodromes will also normally be alerted.

4.3.10 **At the Alert phase,** RCCs will start to escalate SAR actions which may include alerting SAR resources such as SAR aircraft and vessels, in case of loss of communications conducting wider enquiries with communications stations which may have received transmissions from the aircraft, checking of potential airports where the aircraft may have diverted, plotting its most probable position and maximum range from the last known position, plotting known aircraft and ships known to be in the vicinity and initiating search planning and calculations.

4.3.11 **At the Distress phase,** RCCs undertake actions with the aim of rapidly locating, assisted by A(D)T information and homing signals, and rescuing survivors. Many concurrent actions will be undertaken including detailed search action planning and dispatch of SAR aircraft and vessels to the planned search area. The search action plan will include on-going development of search plans, allocation and coordination of search assets, a rescue plan, communications plan, intelligence-gathering plan, media response plan and so on, commensurate with the requirements appropriate to the situation.

4.3.12 Note that on the initial alert, RCCs may go directly to the Alert or Distress phase if appropriate to the situation and initiate a SAR response accordingly. For example, a MAYDAY call will immediately trigger a Distress phase and the dispatch of SAR units.

ATS and RCC relationship with Aircraft Operators

4.3.13 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 should collaborate for emergency planning or exercise purposes.

ATS information to the aircraft operator (ICAO Annex 11, 5.5)

4.3.14 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.

4.4 Procedures for cancellation of an emergency phase

4.4.1 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.

5.0 GADSS Implementation

5.0.1 This chapter provides an overview of relevant tasks necessary to complete the implementation of the GADSS concept. Some of the key functions of the GADSS are already defined in ICAO annex provisions while other new provisions, necessary to complete the GADSS, have applicability as shown below.

There are a number of interdependencies between tasks which require each task to be fully completed before the high-level objectives of the GADSS Conops can be realised.

5.1 ICAO annex provisions with applicability 2018 - 2021

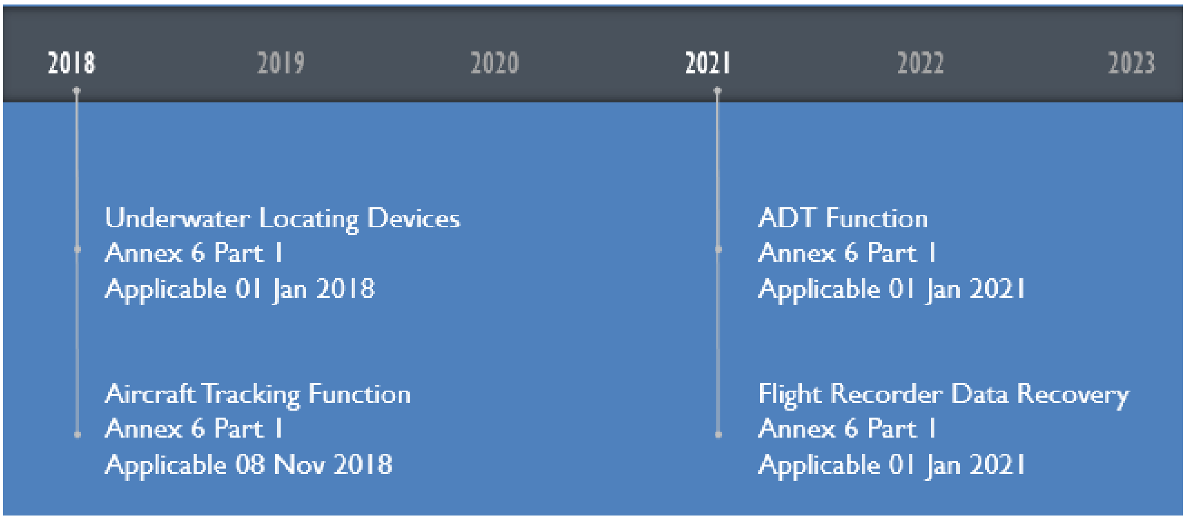


Figure F: ICAO Annex Provisions with initial applicability in 2018-2021

Underwater Locating Devices

5.1.1 ICAO Annex 6, Part 1, provision 6.5.3.1c requires, at the earliest practicable date but not later than 1 January 2018, on all aeroplanes of a maximum certificated takeoff mass of over 27 000 kg, a securely attached underwater locating device operating at a frequency of 8.8 kHz. This automatically activated underwater locating device must operate for a minimum of 30 days and must not be installed in wings or empennage.

Aircraft Tracking Function

5.1.2 ICAO Annex 6 Part 1, section 3.5 titled ‘Aircraft Tracking’, applicable on the 08 Nov 2018 requires the operator to establish an aircraft tracking capability to track aeroplanes throughout its area of operations.

5.1.3 More specifically, paragraph 3.5.3 requires that the operator shall track the position of an aeroplane, with a maximum certificated take-off mass of over 45 500 kg and a seating capacity greater than 19, through automated reporting at least every 15 minutes for the portion(s) of the in-flight operation(s) that is planned in an oceanic area(s) where an ATS unit obtains aeroplane position information at greater than 15 minute intervals.

Autonomous Distress Tracking Function

5.1.4 ICAO Annex 6 Part 1, section 6.18 titled 'Location of an Aeroplane in Distress' requires that 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.

Flight Recorder Data Recovery

5.1.5 ICAO Annex 6 Part 1, section 6.3.5 titled 'Flight Recorder Data Recovery' requires that all aeroplanes of a maximum certificated take-off mass of over 27 000 kg and authorized to carry more than nineteen passengers for which the application for type certification is submitted to a Contracting State on or after 1 January 2021, shall be equipped with a means approved by the State of the Operator, to recover flight recorder data and make it available in a timely manner.

5.2 GADSS Implementation Work Programme

5.2.1 All the necessary tasks identified, to fully implement the GADSS system, have been incorporated into the ICAO air navigation work programme. The tasks are being completed by the specialist panels established by the air navigation commission, adhoc working groups managed by the ICAO Secretariat and by the ICAO secretariat within their own resources.

5.2.2 The ICAO air navigation work programme is available through the ICAO website at: XXXX. Tasks specifically related to the GADSS, with a progress status, can also be viewed on the ICAO website at:

http://www.icao.int/safety/globaltracking/Pages/Homepage.aspx

6.0 Concept Scenarios

6.0.1 An important element of any ConOps is to analyse how the target concept will operate from the user's perspective. To do this, various operational scenarios are developed that will test the proposed solution and help identify any shortcomings.

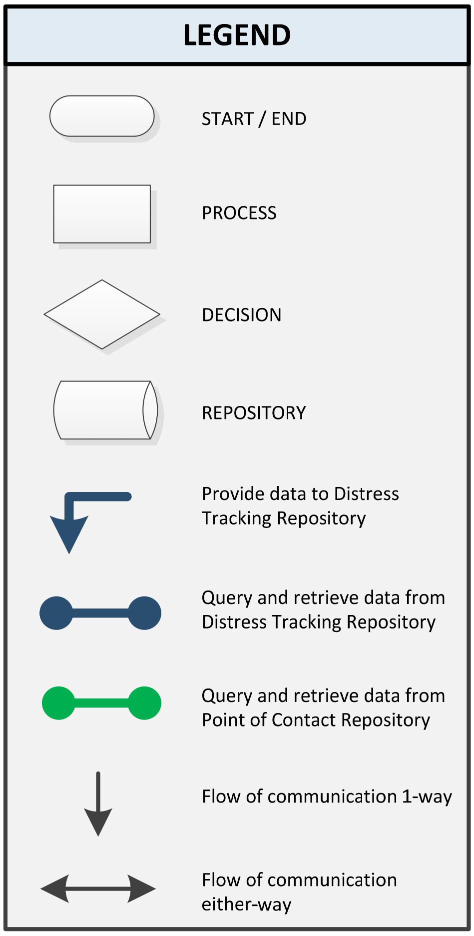
6.0.2 Scenarios may also be used to validate and further develop the target concept and to test possible solutions. The set of scenarios used should be designed to test all elements of the system including equipment design, human interface and operational processes.

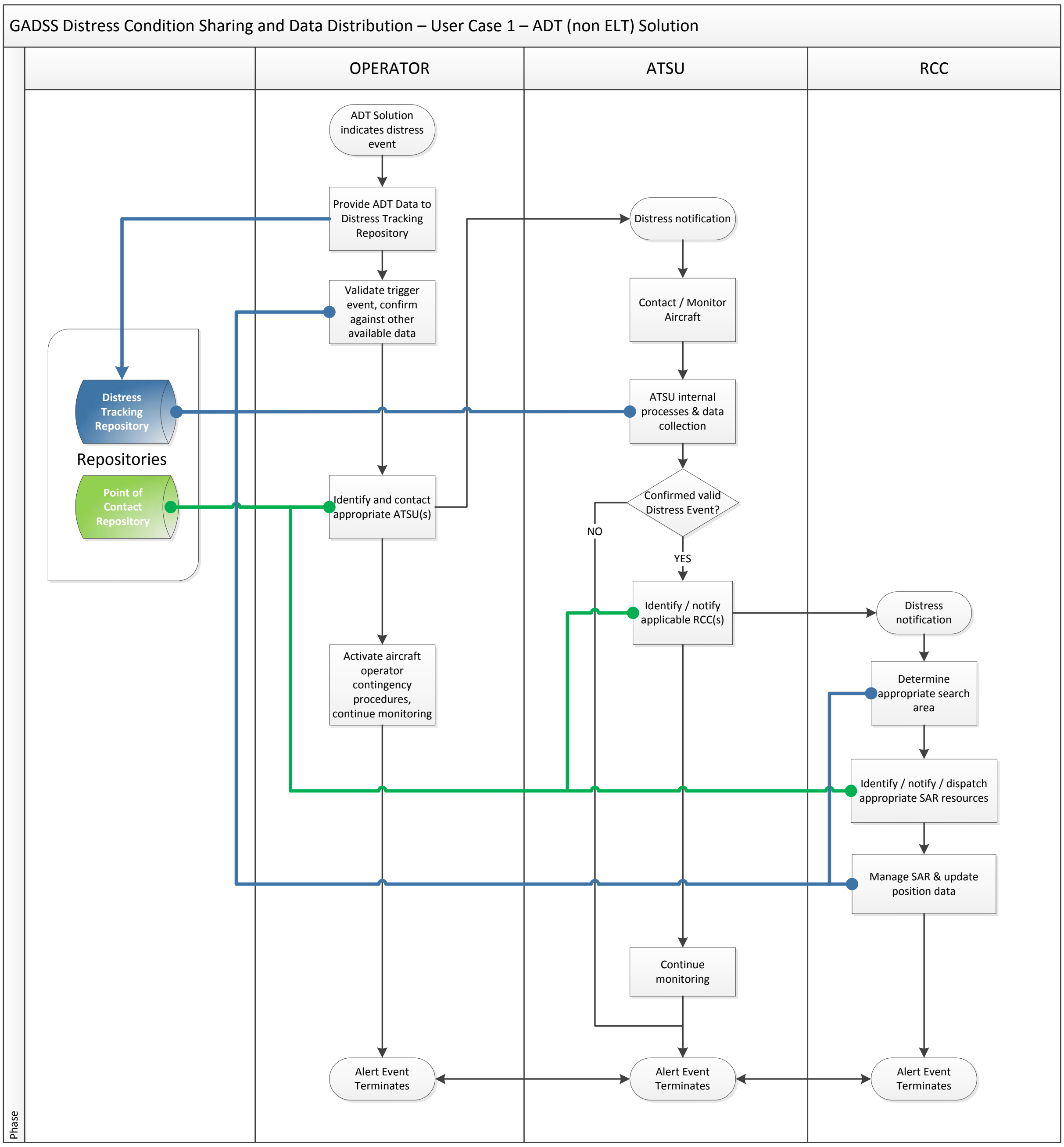
6.0.3 Appendix C provides some typical example scenarios. It provides a matrix outlining the expected level of redundancy (the number of independent opportunities to ensure the location of end of flight is known) based on the GADSS functionality.

6.0.4 It also includes a basic analysis of four of the scenarios, provided as guidance on how to document the analysis of a proposed solution against each scenario.

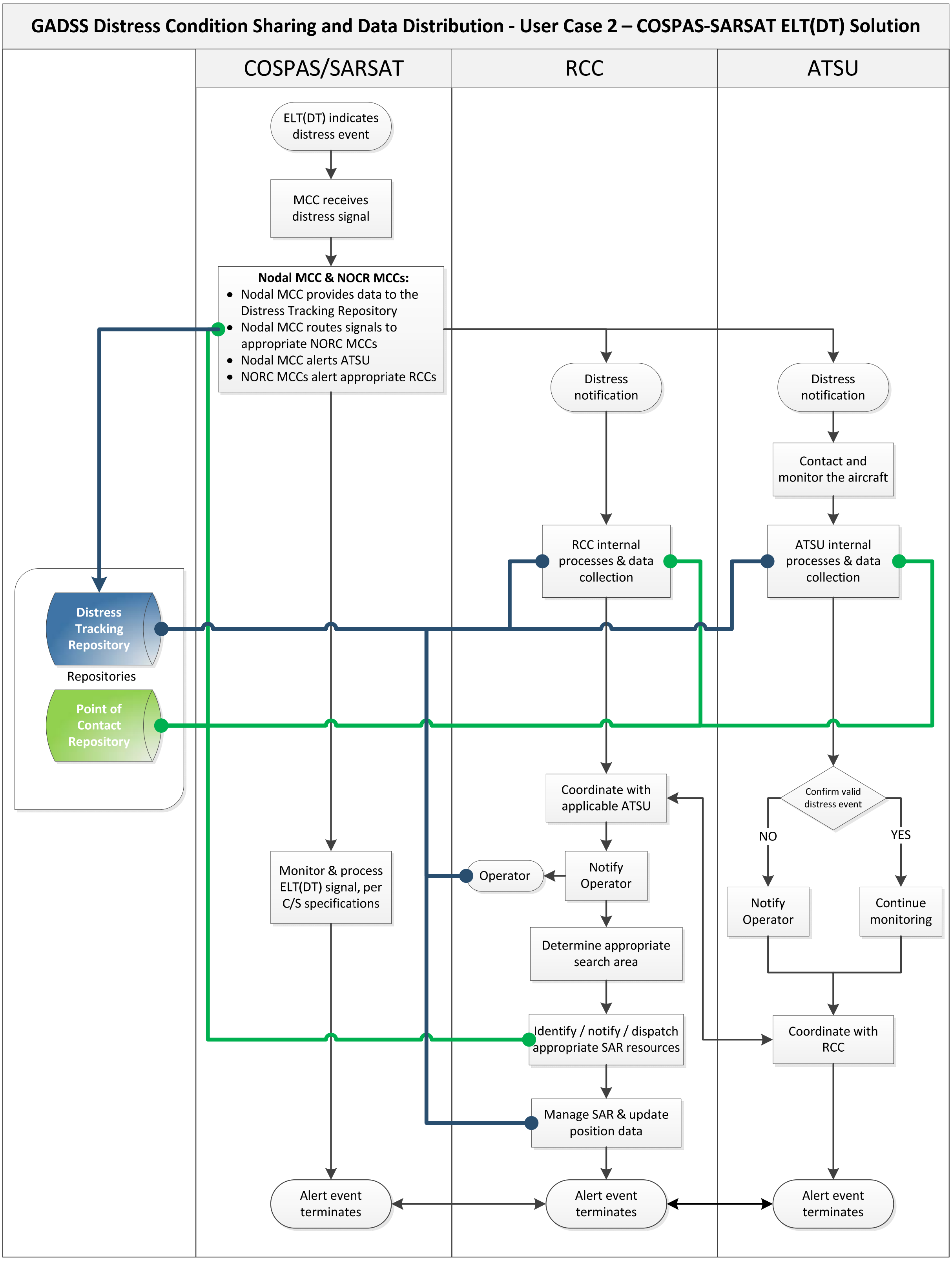
Appendix A: Information sharing and Processes for the Notification of a Distress Condition

The following diagrams are provided to outline the high-level process for notification of an emergency phase including the sharing of related data. Each scenario outlines the notification and data flow when an aircraft operator, an ATSU, an ADT provider or Cospas-Sarsat identify the emergency phase.

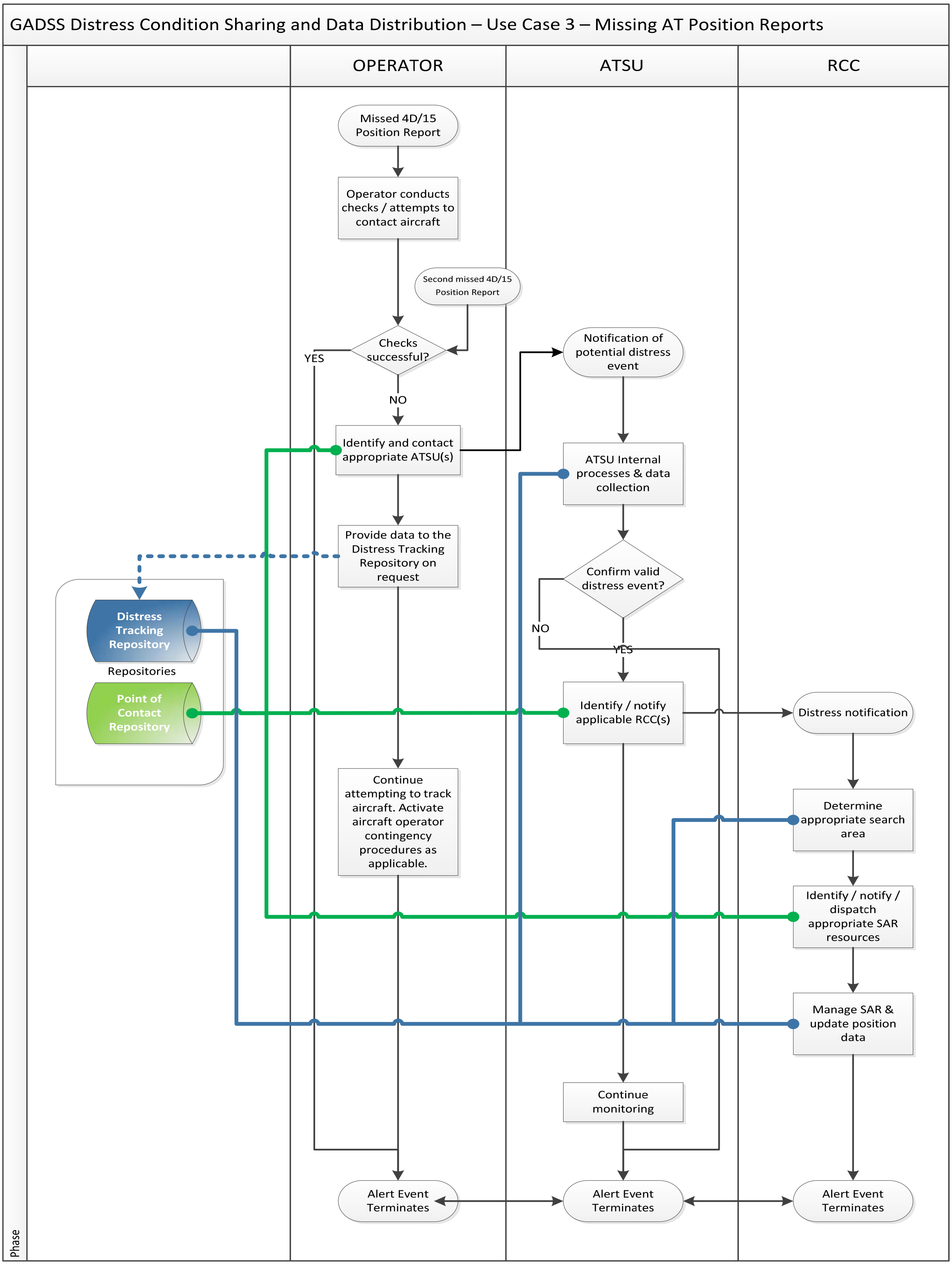


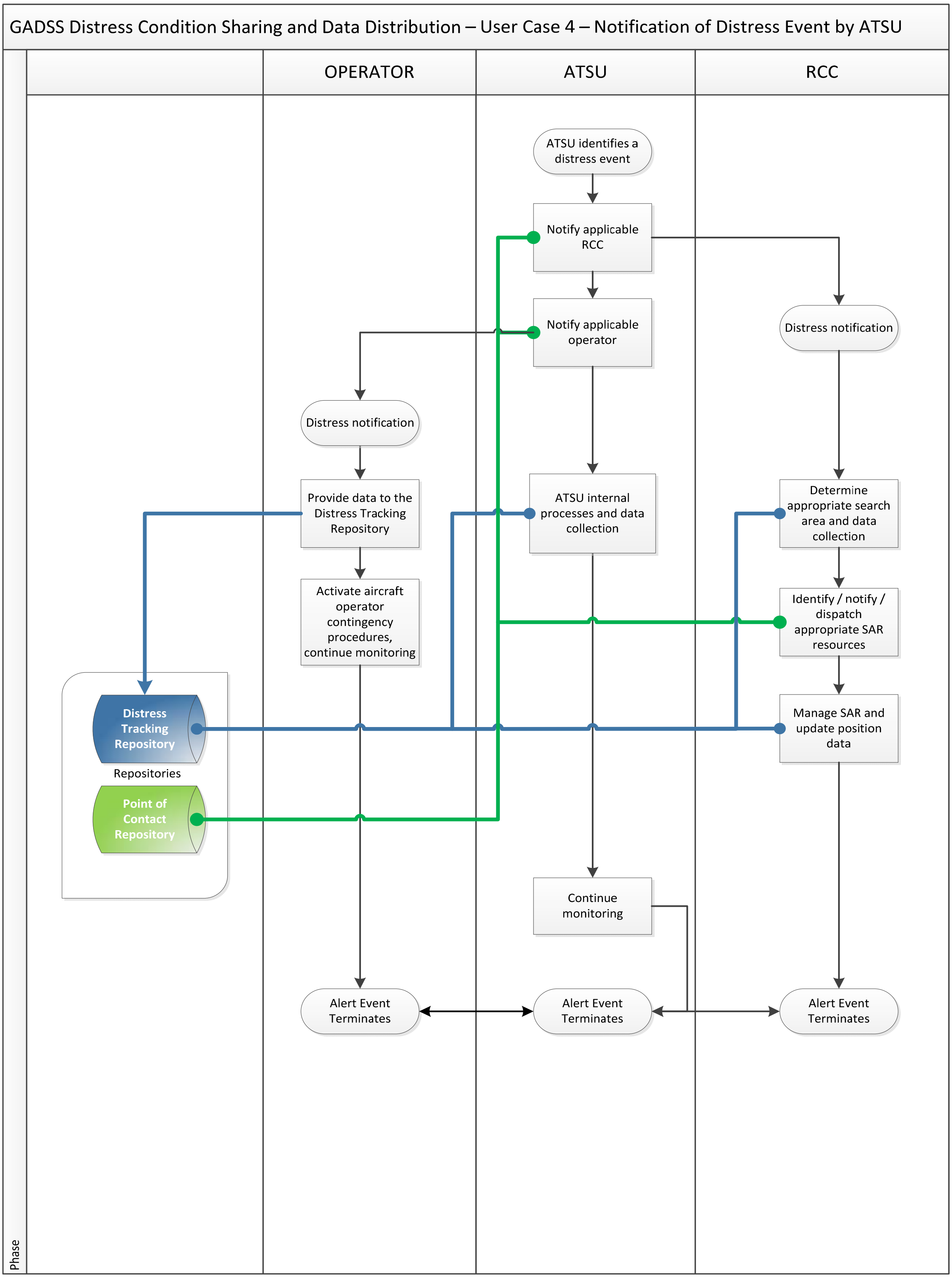


GADSS Distress Condition Sharing and Data Distribution – User Case 1 – ADT (non ELT) Solution
OPERATOR
ATSU
RCC
Phase
ADT Solution indicates distress event
Provide ADT Data to Distress Tracking Repository
Validate trigger event, confirm against other available data
Identify and contact appropriate ATSU(s)
Activate aircraft operator contingency procedures, continue monitoring
Alert Event Terminates
Distress notification
Contact / Monitor Aircraft
ATSU internal processes & data collection
Confirmed valid Distress Event?
NO
YES
Identify / notify applicable RCC(s)
Continue monitoring
Alert Event Terminates
Distress notification
Determine appropriate search area
Identify / notify / dispatch appropriate SAR resources
Manage SAR & update position data
Alert Event Terminates
Distress Tracking Repository
Repositories
Point of Contact Repository



GADSS Distress Condition Sharing and Data Distribution - User Case 2 – COSPAS-SARSAT ELT(DT) Solution
COSPAS/SARSAT
RCC
ATSU
ELT(DT) indicates distress event
MCC receives distress signal
Nodal MCC & NOCR MCCs:
Nodal MCC provides data to the Distress Tracking Repository
Nodal MCC routes signals to appropriate NORC MCCs
Nodal MCC alerts ATSU
NORC MCCs alert appropriate RCCs
Distress notification
Distress notification
Contact and monitor the aircraft
RCC internal processes & data collection
ATSU internal processes & data collection
Distress Tracking Repository
Repositories
Point of Contact Repository
Coordinate with applicable ATSU
Confirm valid distress event
NO
YES
Monitor & process ELT(DT) signal, per C/S specifications
Operator
Notify Operator
Notify Operator
Continue monitoring
Determine appropriate search area
Identify / notify / dispatch appropriate SAR resources
Coordinate with RCC
Manage SAR & update position data
Alert event terminates
Alert event terminates
Alert event terminates


GADSS Distress Condition Sharing and Data Distribution – Use Case 3 – Missing AT Position Reports
OPERATOR
ATSU
RCC
Phase
Missed 4D/15 Position Report
Operator conducts checks / attempts to contact aircraft
Second missed 4D/15 Position Report
Checks successful?
YES
NO
Identify and contact appropriate ATSU(s)
Provide data to the Distress Tracking Repository on request
Continue attempting to track aircraft. Activate aircraft operator contingency procedures as applicable.
Alert Event Terminates
Notification of potential distress event
ATSU Internal processes & data collection
Confirm valid distress event?
NO
YES
Identify / notify applicable RCC(s)
Continue monitoring
Alert Event Terminates
Distress notification
Determine appropriate search area
Identify / notify / dispatch appropriate SAR resources
Manage SAR & update position data
Alert Event Terminates
Distress Tracking Repository
Repositories
Point of Contact Repository


GADSS Distress Condition Sharing and Data Distribution – User Case 4 – Notification of Distress Event by ATSU
OPERATOR
ATSU
RCC
Phase
ATSU identifies a distress event
Notify applicable RCC
Notify applicable operator
Distress notification
Distress notification
Provide data to the Distress Tracking Repository
ATSU internal processes and data collection
Determine appropriate search area and data collection
Activate aircraft operator contingency procedures, continue monitoring
Identify / notify / dispatch appropriate SAR resources
Distress Tracking Repository
Repositories
Point of Contact Repository
Manage SAR and update position data
Continue monitoring
Alert Event Terminates
Alert Event Terminates
Alert Event Terminates

Appendix B: Improvement Areas in Current Operating Environment

In developing the GADSS the AHWG identified a number of areas where improvements could be made to support the overall objectives of the GADSSS CONOPS in the current operating environment. This appendix lists the issues identified as detailed in the GADSS CONOPs version 5.0 and are provided in this version for reference.

The issues are grouped under four headings: Aircraft Systems, Air Traffic Services, the Search and Rescue system and Information Management. It is recognised that other areas for improvement may exist, particularly in the area of equipment usage.

B.1 Aircraft Systems

B.1.1 The main areas for potential improvement identified are:

	Improvement Areas	**Analysis**
a	Reduction in the reliance on Emergency Locator Transmitters (ELT) (lack of system redundancy) to identify accident site	In regions where no surveillance is available and the aircraft is not using an aircraft tracking system the only source of accident location will be the ELT when it activates correctly. ELTs were not designed to operate in non-survivable accidents and are largely ineffective in locating crashes over water.
b	Improvement in the (timely) activation of ELTs	From analysis of large transport aircraft accidents, there is a low activation rate of ELTs. Typically, they are damaged in the crash and/or are not activated either automatically or manually prior to or post an impact.
c	Ensure operators are meeting the 406MHz ELT equipage requirement.	Aircraft may still be using just 121.5MHz ELTs. These are no longer detected by Cospas-Sarsat and will only be detected by VHF radios tuned to the frequency and within range.
d	Improvement in the robustness and range of location devices	Wreckage and flight recorders can be difficult to locate and retrieve, particularly in remote and oceanic regions.
e	Improvement in the existing systems to ensure the accident investigation authority can always retrieve adequate data to allow determination of probable causes.	Current technology limited in ability to trigger and download FDR data. Civilian applications of deployable flight recorders not currently available.

	Improvement Areas	Analysis
f	Ensure existing Emergency and Abnormal operating procedures maximise the potential of the ELT to perform effectively and provide a distress signal.	Some SOPs only call for activation of ELTs after the accident e.g. ditching procedure.
g	Improvement in the overall registration of 406MHz ELTs	Distress beacon registration allows RCCs to determine beacon identification details including emergency contacts. This allows RCCs to contact beacon owners or their emergency contacts when a beacon is activated to obtain further details. The distress beacon registration emergency contact information for the owner/operator of an aircraft subject to an ELT alert may be different to the actual operator for that flight. To avoid delays in RCC response, it is essential to enable RCCs to readily identify the operator of the aircraft at the time of the distress alert.
h	Improvement in the level of carriage of 406MHz survival ELTs (ELT(S)) for overwater operations	Although not mandated by ICAO SARPs many aircraft may still carry legacy 121.5/243 MHz ELT(S) beacons as part of their emergency equipment, such as slide rafts, which are no longer detected by the Cospas-Sarsat system.
i	Increase aircraft equipage for transmitting their 4D position and identity.	Not all aircraft overflying remote or oceanic airspace are equipped with long range communication systems for regular transmission of 4D position. However, most transport category aircraft are equipped with Mode S transponders which are, in accordance with ICAO Annex 10, ADS-B out capable. If that ADS-B out signal can be received and processed via Satellite, no additional equipage would be required.
j	Increase the use of current aircraft capability to transmit their 4D position and identity for aircraft tracking purposes.	Aircraft operators are not using ADS-C capability to the degree possible.
k	Expansion of space- and ground-based infrastructure to achieve global coverage during all phases of flight.	The ADS-B ground infrastructure could be supplemented with space-based ADS-B to provide global tracking capability. Spaced based ADS-B is scheduled to be available in 2017. Non-Geostationary satellite systems have complete coverage of the Globe, a particular benefit for polar route operations.

	Improvement Areas	Analysis
l	Reduce reliance on HF as sole means of communications over remote and oceanic areas.	The unreliable nature of HF communications leads to relatively frequent occurrences of situations warranting the declaration of the uncertainty phase. The frequency of such occurrences may lead to complacency which can result in a delayed SAR response to a genuine emergency (e.g. AF447). Carriage of satellite communications equipment as a secondary means to HF will assist to confirm the safety of an aircraft, or otherwise. CPDLC and SATVOICE are potential options.

B.2 Air Traffic Services (ATS)

B.2.1 The main areas of potential improvement identified are:

	Improvement Areas	Analysis
a	Improvement in existing ATS capabilities where voice is the only means to ensure the timely identification of abnormal events experienced by aircraft, where voice is the only means of position reporting.	Outside ATS surveillance airspace the absence of position reports for a set period is the only indication of an abnormal event. Regular communication problems and related complacency may even extend this period in practice. Other than using ADS-C, there is no airborne and/or ground ATS capability to detect an abnormal event based on defined and measurable triggers.
b	Improvement in existing ATS procedures to ensure, on a worldwide basis, that the location of an accident site will be identified to a degree of accuracy, in a timeframe and to a level of confidence acceptable to the stakeholders	The current provisions for position reporting (frequency and information contents) in remote and oceanic areas are not based on the accuracy requirements for accident site location.
c	Improvements in Airspace coordination to prevent any compromise in the mechanism for ensuring receipt of overdue position reports	Lack of clarity on the responsibility to ensure all position reports including those from an aircraft that has exited the airspace or area of jurisdiction.
d	Improvements by ANSPs in consistently sharing data with other ANSPs and operators	There is currently no international requirement for sharing position data. Some ANSPs share this data with operators while others do not.
e	Increased experience in using emergency procedures preventing decreased proficiency when required	The extremely low frequency of emergency situations with an accident risk necessitates regular drills and exercises to be held to ensure that proficiency with applicable procedures, cooperation between all actors and use of systems is maintained.

	Improvement Areas	Analysis
f	Reduction in complacency due to 'normalised' lack of HF communications	Aircraft routinely unable to report their position (and be unreachable by the ATS unit) can lead to complacency and subsequent failure to follow the prescribed procedures
g	Improved civil / military coordination and information sharing in support of emergency situations	There is no consistent sharing of relevant information between civil /military.
h	Improved ICAO SARPs for raising of an INCERFA	ICAO SARPs which use a time based (waiting 30 minutes after scheduled reporting time before raising an INCERFA) gate mechanism to avoid spurious or unnecessary reports compromises the need for quick identification of an event. The period of 30 minutes has been set in 1960 and may no longer be adequate. Some States have reduced the 30 minutes period to 15 minutes.

B.3 The Search and Rescue (SAR) System

B.3.1 The main areas of potential improvement identified are:

	Improvement Areas	Analysis
a	Improvement by States to ensure Aeronautical Search and Rescue regions are always aligned with the FIRs.	Differences in boundaries increases coordination complexity and response time
b	Improvement by States to ensure Aeronautical Search and Rescue regions are always aligned with maritime SRRs.	Differences in boundaries increases coordination complexity and response time
c	Improved Compliance by States with ICAO Annex 12 obligations in relation to SAR.	Many States do not meet the requirements of ICAO Annex 12 to provide SAR capabilities in their State, and/or between States, often where there is high density overflight traffic. Existing deficiencies may result in: • Delayed and/or inadequate SAR response • Higher risk of loss of life Lack of coordination, cooperation and communication between RCCs, between ATS units and RCC, and between civil and military authorities and other stakeholders

	Improvement Areas	Analysis
d	Improved ability for RCCs to quickly determine the actual geographic air traffic picture within its area of responsibility.	RCCs with this facility would benefit from an enhanced situational awareness, not only for aircraft subject to an emergency, but also other aircraft in the area that may be able to assist (diversion, communications relay, etc). Integration of GIS information such as airspace, terrain, etc would enhance this.
e	Improved understanding of responsibilities and coordination for the transition of ICAO Annex 12 to Annex 13	In the existing SARPS of ICAO Annex 12 and Annex 13 transition from rescue to recovery responsibilities is not clearly defined. (i.e.: who is responsible for a rescue operation and when that phase ends, so it became primarily a recovery/investigation operation under ICAO Annex 13).
f	Increased experience in using SAR procedures preventing decreased proficiency when required.	The extremely low frequency of SAR situations in some SRRs necessitates regular drills and exercises to be held to ensure that proficiency with applicable procedures, cooperation between all actors and use of systems is maintained.
g	Improvement and definition of the co-ordination of In-Flight Emergency Response (IFER)	It is not clear in this situation whether an ATS unit or RCC has coordination responsibility of an emergency for an aircraft whilst it is still in flight, or where the coordination responsibility begins/ends. Management of In-Flight Emergency Response (IFER) and the interface between ATS and RCCs is an issue that will be affected by global tracking.

B.4 Information Management

B.4.1 The main areas of potential improvement identified are:

	Improvement Areas	Analysis
a	Improved abilities to identify the responsible RCC for the region in which the aircraft experiences the emergency.	There is no worldwide chart(s) publication of Aeronautical Search and Rescue Regions which allows stakeholders to quickly identify the relevant RCC(s) to contact. There is no automated system support in correlating the aircrafts position with the RCC area of responsibility

	Improvement Areas	Analysis
b	Improved ability to reach operational staff of ATS Centres/Units and RCC's.	There is no consolidated contact list of worldwide ATS Centres/Units or RCCs to enable rapid identification and contact between these stakeholders. There is no automated system support in providing contact details of operational staff
c	Improved ability to reach operations staff of aircraft operators.	There is no consolidated contact list of worldwide aircraft operators to enable rapid identification and contact between these stakeholders. There is no automated system support in providing contact details of operational staff
d	Improved ground communication capabilities	The Aeronautical Fixed Telecommunications Network is quite limited in its capabilities, especially in terms of interactivity and the exchange of large quantities of data. The AFTN is limited in its capabilities for future use in the context of the GADSS
e	Enhance provisions for effective use of English language by points of contact (ATS unit, RCC, Aircraft Operator)	Time may be lost due to language issues between the operational staff of aircraft operations centres, ATS units and RCCs. Stakeholder points of contact should be proficient in English.

Appendix C: Concept Scenario

The following are some typical example scenarios:

Event	Summary
1	***Aircraft experiences an in-flight abnormal event and recovers***
1.1	**Loss of control in-Flight (LOC-I) with recovery** The aircraft suddenly pitches nose down while in the cruise at Flight Level (FL) 330. Within 27 seconds, the aircraft lost 4,440 feet, before the self-protection system initiated a recovery back towards controlled flight. The aircraft diverted to an airport and lands safely. The resulting negative g forces are sufficient for almost all of the unrestrained passengers and crew to be thrown towards the ceiling, resulting in a number of minor injuries.
1.2	**Engine failure in flight** As the aircraft takes-off, the fan cowl doors from both engines detached, puncturing a fuel pipe on the right engine, damaging the airframe, and some aircraft systems. The flight crew elects to return to the departure airport. On the approach to land an external fire develops on the right engine. The left engine continues to perform normally throughout the flight. The right engine is shut down and the aircraft lands safely. The emergency services extinguish the fire in the right engine. The passengers and crew are evacuating the aircraft via the escape slides. Subsequent investigation revealed that the fan cowl doors on both engines were left unlatched during maintenance and this was not identified prior to aircraft departure.
1.3	**Failure of communication system, failure to report position or operational status** The aircraft was dispatched with VHF1 unserviceable for return to its main base. During the flight the aircraft experienced a communication systems fault which resulted in loss of all VHF communication, with no alternative voice communication system available. The aircraft followed standard procedures for loss of communications and landed safely.
1.4	**System Component Failure (non-powerplant)** While the aircraft is in cruise at 37,000 feet, one of the aircraft's three air data inertial reference units started outputting intermittent, incorrect values (spikes) on all flight parameters to other aircraft systems. Two minutes later, in response to spikes in angle of attack (AOA) data, the aircraft's flight control primary computers commanded the aircraft to pitch down. Many passengers and crew members were injured. The flight crew recovered the aircraft and landed safely
1.5	**Fuel related (FUEL)** While en-route at FL390 over oceanic area, the crew becomes aware of a fuel imbalance between the left and right-wing main fuel tanks. Five minutes later the crew is concerned about the lower-than-expected fuel quantity indication, and decides to divert to a diverting Airport. When the crew ascertains that a fuel leak could be the reason for the possible fuel loss, an emergency is declared to Oceanic Control. At 85 nm from diverting airport and at an altitude of about FL345, the second engine flames out. An engines-out visual approach is carried out and the aircraft landed safely.
2	***Aircraft experiences an in-flight abnormal event which leads to an accident***
2.1	**Loss of control in-Flight (LOC-I)** The aircraft is at its cruising altitude of FL330. The speed begins to steadily decrease. The horizontal stabilizer is moving nose up during this deceleration. The flight crew is discussing weather concerns that included possible icing conditions and the possible need to turn on engine and airfoil anti-ice. The flight crew requests permission to descend to FL310, which was approved. The autopilot is disconnected and the airplane starts to descend. As the airplane is descending past about FL315,

	the airspeed continued to decrease and the engine EPR decreased to about flight idle. A few minutes later a further descent to FL240 is requested. In the meantime, the altitude alert warning is activated, followed by the stick shaker and the aural stall warning alert. The airspeed is reaching a minimum of about 150 indicated air speed (IAS) knots at about FL250. The aircraft descends at 7000 ft/min, and finally crashed by impacting water. The entire descent from FL330 has taken approx. 3 minutes and 30 seconds.
2.2	**Mid-Air Collision (MAC)** Two aircraft are flying at the same altitude on the same route on opposite direction. The crews of both aircraft received a Resolution Advisory (RA)-command from their TCAS. One of the crew complies with the order and initiates a descent. At the same time the other crew is trying to deal with the conflicting descent (by ATC) and climb (TCAS) instructions. The crew then decided to follow the ATC controller's instructions. Just prior to the collision, both crews detected the other aircraft, and reacted to avoid the collision by attempting appropriate flight maneuvers. Nevertheless, both aircraft collide.
2.3	**In-flight break-up** The aircraft is flying at a cruising altitude of FL350. An explosion on board causes the aircraft to crash. The explosive device is located in the cargo hold. The device is most probably hidden in baggage.
2.4	**Powerplant system/component failure or malfunction (SCF-PP)** After take-off as the aircraft is reaching an altitude of 3000 feet the crew sees a formation of Canada geese. Several loud thuds are heard. The ingestion of large birds into each engine, results in an almost total loss of thrust in both engines. The crew decides that they would not be able to land safely. The crew descends over the river until it ditches.
2.5	**Fire (F)** The aircraft is flying in cruise over oceanic area. The pilots detect an unusual odor in the cockpit. They determine that some smoke is present in the cockpit. Four minutes later a Pan Pan radio call is made. The pilots report that there is smoke in the cockpit and request an immediate return to a convenient airport. The ATC controller immediately clears the aircraft to descend to FL310. At this time, the pilots are using their oxygen masks. The controller clears the aircraft to descend to 10000 feet. The aircraft is descending through approximately FL210 when the pilots decide to dump fuel. The flight is vectored to dump fuel. The pilots declare Emergency. Last radio contact is lost one minute later. The fire had propagated, causing severe disturbances of the electric system.
2.6	**CFIT** During an approach the aircraft descended below Minimum Descent Altitude (MDA), and the crew was losing visual contact with the airfield due to weather conditions. The crew then decided not to follow the published procedures, thus transgressing out of the protected airspace. The crew did not respond to more than 20 EGPWS warnings related to approaching rising terrain and pull up. The airplane flew into the side of a mountain.
2.7	**Aircraft communication system Failure** While on route at cruising altitude, all communication with the aircraft is lost. The aircraft never reaches its final destination and disappears from civilian and military radars.

The following table provides a basic analysis of the expected level of resilience in the GADSS system (the number of independent opportunities to ensure the location of end of flight is known) for each of the scenarios outlined above and is based on the defined GADSS functionality. The matrix considers four basic over-arching states:

Aircraft indication and communication systems operating normally with cooperative crew	A
Aircraft indication and communication systems operating normally with non-cooperative crew	B
Aircraft indication and communication systems not operating normally with cooperative crew	C
Aircraft indication and communication systems not operating normally with non-cooperative crew	D

It should be noted that AT is mandated to provide a 4D position every 15 minute which, on its own, will not allow identification of the end of flight location to a level of accuracy required. Likewise, voice communications on its own will rarely allow an accurate end of flight location to be determined.

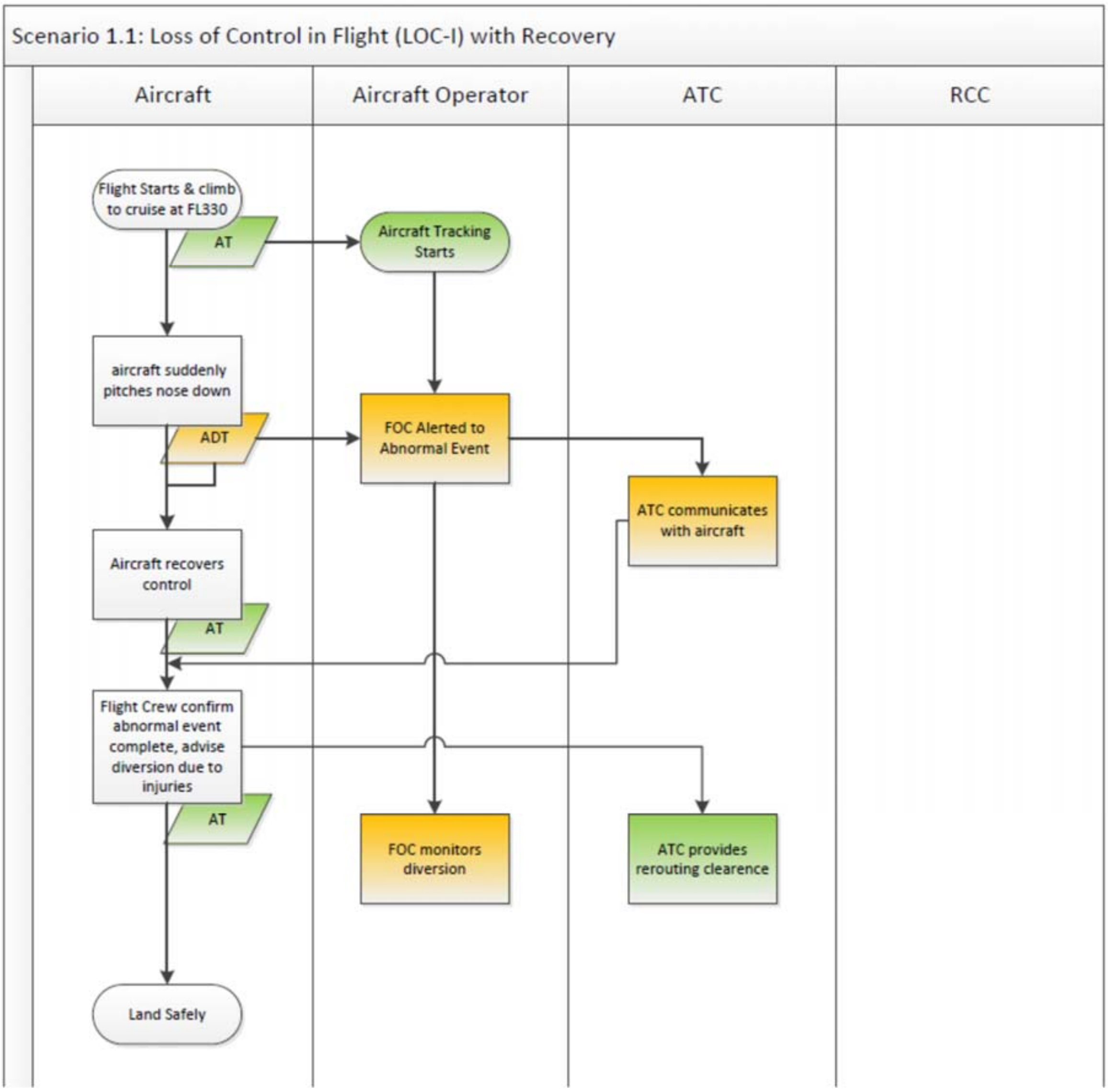
Scenario Reference		PRE-END OF FLIGHT			POST – END OF FLIGHT (Focus: Rescue and Recovery)		POST – END OF FLIGHT (Focus: Recovery)	
		VOICE COMMS	**AT / Surveillance**	**ADT automatically activated**	**ELT (LEGACY)**	**FRDR**	**FDR/CVR ULD**	**AIRFRAME ULD**
1.1 – Loss of control in-Flight (LOC-I) with recovery	A	Limitations[1]	YES	YES	N/A	TBD	N/A	N/A
1.2 - Engine failure in flight	A	YES	YES	NO	N/A	TBD	N/A	N/A
1.3 - Failure of communication system, failure to report position or operational status	C	NO	YES	NO	N/A	TBD	N/A	N/A
1.4 - System Component Failure (non-powerplant)	C	Limitations[1]	YES	NO	N/A	TBD	N/A	N/A
1.5 - Fuel related (FUEL)	A	YES	YES	YES	N/A	TBD	N/A	N/A
2.1 - Loss of control in-Flight (LOC-I), no recovery	A	Limitations[1]	YES	YES	NO	YES	YES	YES
2.2 - Mid-Air Collision (MAC)	A	NO	YES	NO	YES	TBD	Limitations[2]	Limitations[2]
2.3 - In-flight break-up	A	NO	YES	NO	YES	TBD	Limitations[2]	Limitations[2]
2.4 - Powerplant system/component failure or malfunction (SCF-PP)	A	YES	YES	YES[3]	YES[3]	TBD	YES	YES

[1] The crew would have limited time to communicate and depending on geographical location may have been outside voice communication coverage.
[2] Limited to surviving the initial impact and landing in water
[3] Subject to manual activation

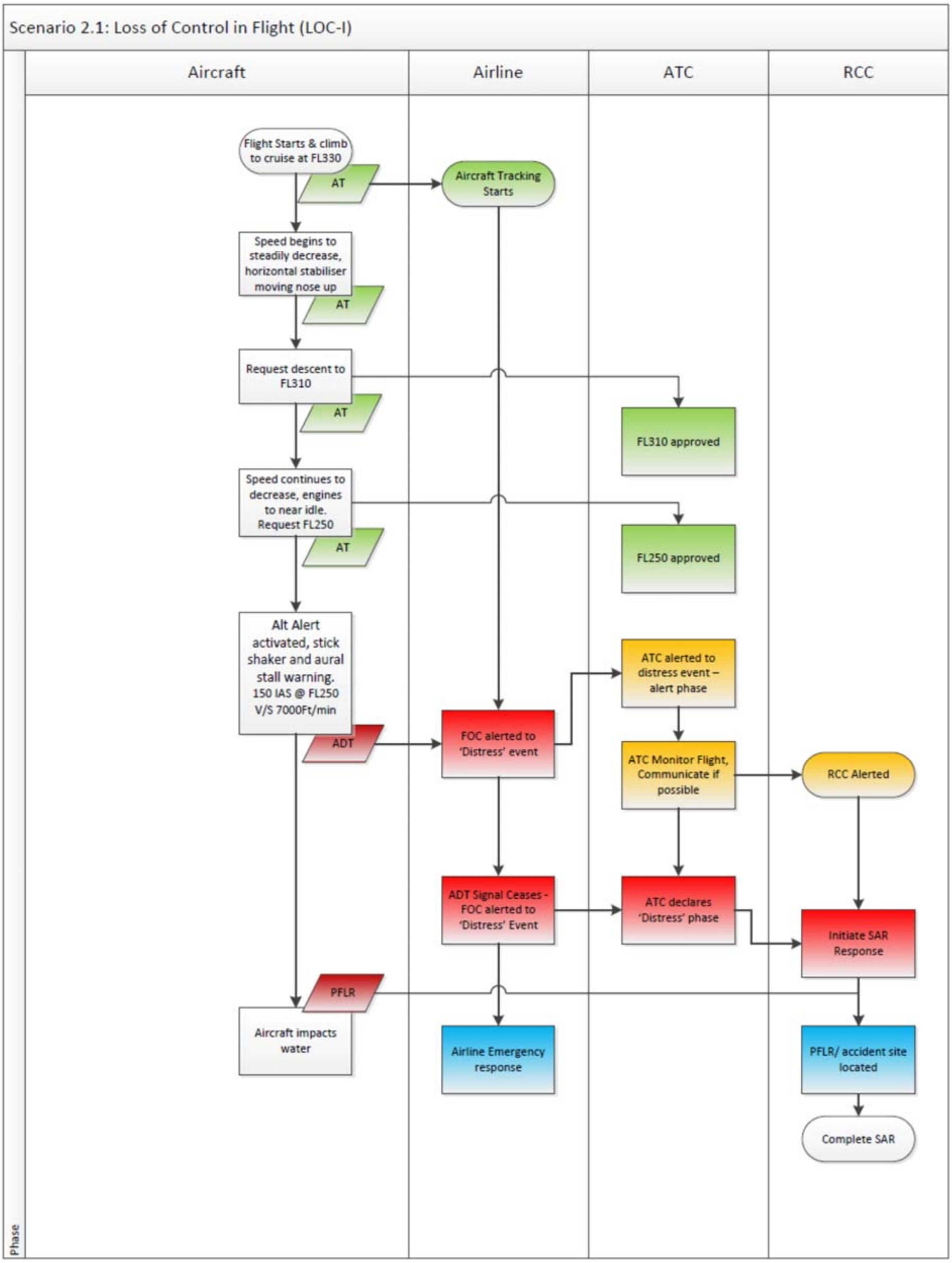
Scenario Reference		PRE-END OF FLIGHT			POST – END OF FLIGHT (Focus: Rescue and Recovery)		POST – END OF FLIGHT (Focus: Recovery)	
		VOICE COMMS	**AT / Surveillance**	**ADT automatically activated**	**ELT (LEGACY)**	**FRDR**	**FDR/CVR ULD**	**AIRFRAME ULD**
2.5- Fire (F)	A	YES	YES	YES[3]	YES[3]	YES	Limitations[2]	Limitations[2]
2.6 – Controlled Flight into Terrain (CFIT)	B	YES	YES	TBD	YES[4]	TBD	N/A	N/A
2.7 - Aircraft comm. system Failure	B/D	NO	NO	YES	YES[4]	NO	YES[5]	YES[5]

The analysis of the concept should be conducted in a consistent manner to allow objective comparison of alternative solutions. The 'swim-lane' methodology is one approach that may be appropriate for this ConOps and is used below for illustrative purposes.

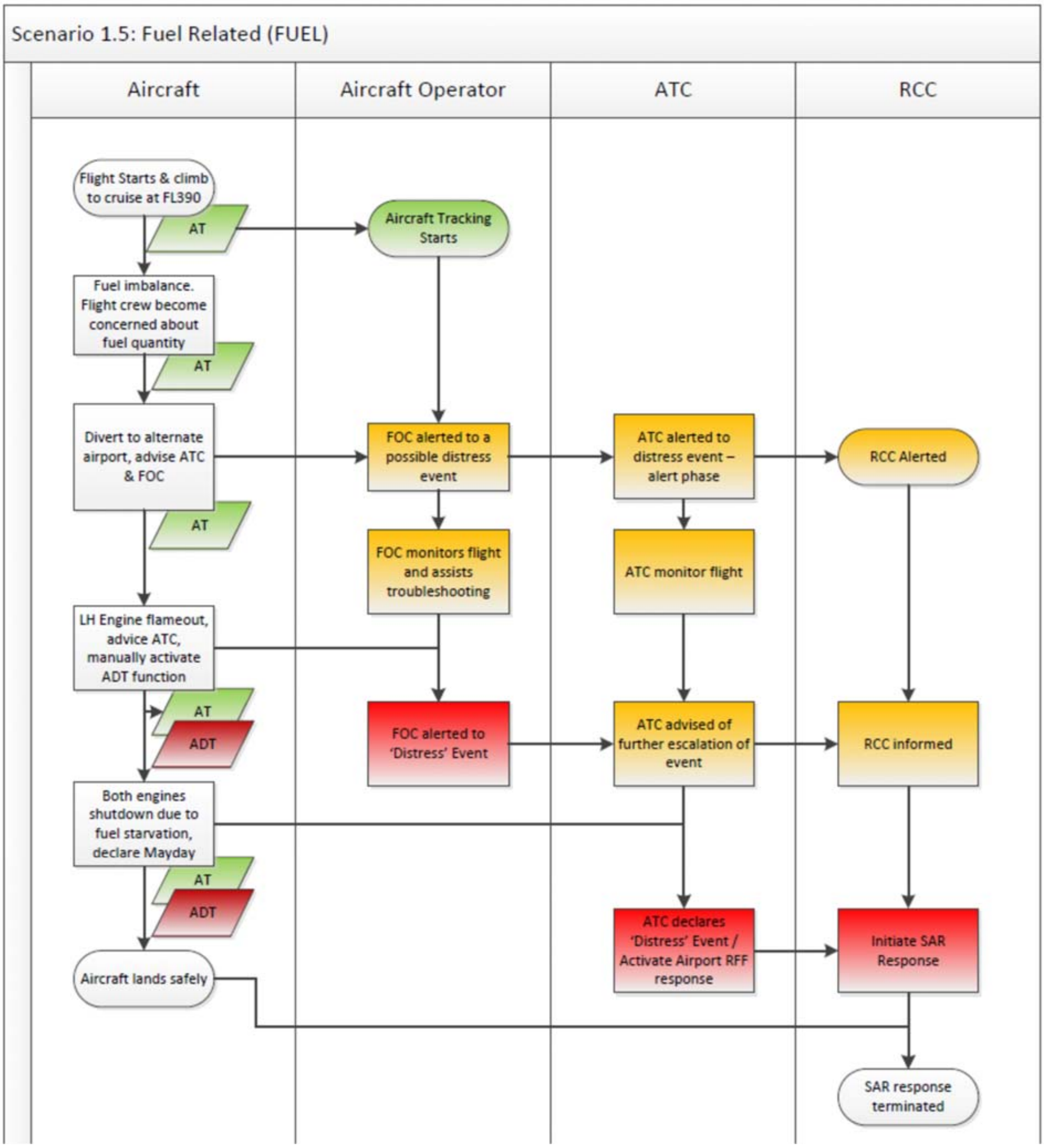
[4] Subject to the ELT system (including antenna) surviving the initial impact
[5] Subject to ADT working and providing location of end of flight in oceanic areas



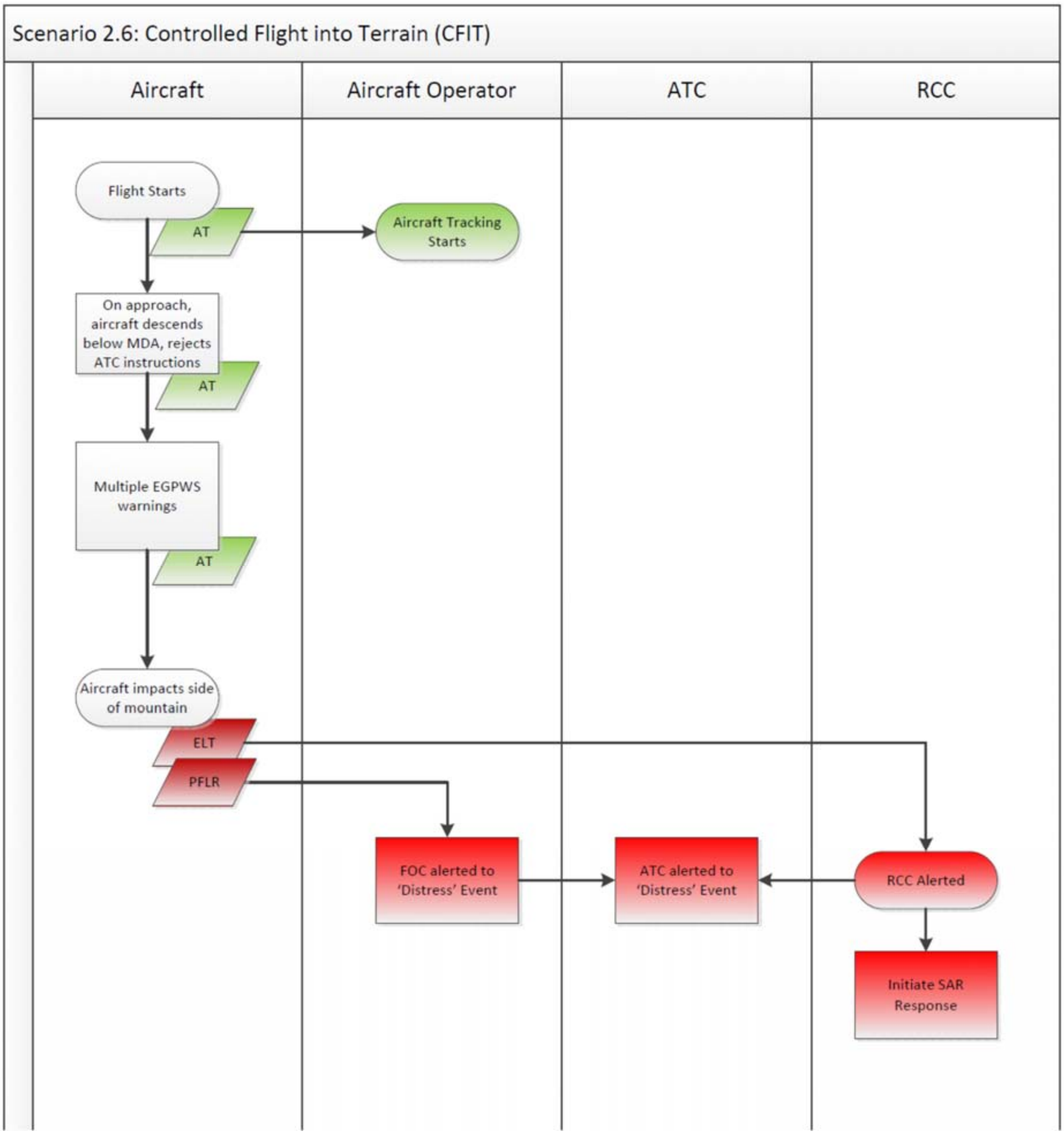
Scenario 1.1: Loss of Control in Flight (LOC-I) with Recovery
Aircraft
Aircraft Operator
ATC
RCC
Flight Starts & climb to cruise at FL330
AT
Aircraft Tracking Starts
aircraft suddenly pitches nose down
ADT
FOC Alerted to Abnormal Event
ATC communicates with aircraft
Aircraft recovers control
AT
Flight Crew confirm abnormal event complete, advise diversion due to injuries
AT
FOC monitors diversion
ATC provides rerouting clearence
Land Safely



Scenario 2.1: Loss of Control in Flight (LOC-I)
Aircraft
Airline
ATC
RCC
Flight Starts & climb to cruise at FL330
AT
Aircraft Tracking Starts
Speed begins to steadily decrease, horizontal stabiliser moving nose up
AT
Request descent to FL310
AT
FL310 approved
Speed continues to decrease, engines to near idle. Request FL250
AT
FL250 approved
Alt Alert activated, stick shaker and aural stall warning. 150 IAS @ FL250 V/S 7000Ft/min
ATC alerted to distress event – alert phase
ADT
FOC alerted to 'Distress' event
ATC Monitor Flight, Communicate if possible
RCC Alerted
ADT Signal Ceases - FOC alerted to 'Distress' Event
ATC declares 'Distress' phase
Initiate SAR Response
PFLR
Aircraft impacts water
Airline Emergency response
PFLR/ accident site located
Complete SAR
Phase



Scenario 1.5: Fuel Related (FUEL)
Aircraft
Aircraft Operator
ATC
RCC
Flight Starts & climb to cruise at FL390
AT
Aircraft Tracking Starts
Fuel imbalance. Flight crew become concerned about fuel quantity
AT
Divert to alternate airport, advise ATC & FOC
FOC alerted to a possible distress event
ATC alerted to distress event – alert phase
RCC Alerted
AT
FOC monitors flight and assists troubleshooting
ATC monitor flight
LH Engine flameout, advice ATC, manually activate ADT function
AT
ADT
FOC alerted to 'Distress' Event
ATC advised of further escalation of event
RCC informed
Both engines shutdown due to fuel starvation, declare Mayday
AT
ADT
ATC declares 'Distress' Event / Activate Airport RFF response
Initiate SAR Response
Aircraft lands safely
SAR response terminated



Scenario 2.6: Controlled Flight into Terrain (CFIT)
Aircraft
Aircraft Operator
ATC
RCC
Flight Starts
AT
Aircraft Tracking Starts
On approach, aircraft descends below MDA, rejects ATC instructions
AT
Multiple EGPWS warnings
AT
Aircraft impacts side of mountain
ELT
PFLR
FOC alerted to 'Distress' Event
ATC alerted to 'Distress' Event
RCC Alerted
Initiate SAR Response

Appendix D: Terms and abbreviations

The following list is provided to help explain terms and abbreviations used in this document.

TERM	Explanation
ADS-B	Automatic Dependent Surveillance - Broadcast
ADS-C	Automatic Dependent Surveillance - Contract
ADFR	Automatic Deployable Flight Recorder
ANC	Air Navigation Commission (of ICAO)
ANSP	Air navigation service provider
ADT	Autonomous Distress Tracking
AHWG	Ad-hoc Working Group on Aircraft Tracking
ARCC	Aeronautical rescue coordination centre
ASBU	Aeronautical System Block Upgrade
ATC	Air Traffic Control
ATM	Air Traffic Management
ATS	Air Traffic Services
ATS unit	Air Traffic Service Unit
BEA	Bureau d'Enquêtes et d'Analyses (pour la sécurité de l'aviation civile)
CPDLC	Controller–Pilot Data Link Communications
CVR	Cockpit Voice Recorder
ELT	Emergency Locator Transmitter
ELT(DT)	Emergency Locator Transmitter – Distress Tracking
EUROCAE	European Organisation for Civil Aviation Equipment
FDR	Flight Data Recorder
FF-ICE	Flight and Flow Information for a Collaborative Environment
FIC	Flight Information Centre
FIR	Flight Information Region
FIS	Flight Information Service
FOC	(Airline) Flight Operations Centre
FPL	Flight Plan
GADSS	Global Aeronautical Distress Safety System
GANP	Global Air Navigation Plan
GASP	Global Aviation Safety Plan
GEO	Geostationary orbit
GNSS	Global Navigation Satellite System
GPS	Global Positioning System

HF	High Frequency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFER	In-Flight Emergency Response
IMO	International Maritime Organisation
JRCC	Joint Rescue Coordination Centre
LEO	Low Earth Orbit
MCC	(Cospas-Sarsat) Mission Control Centre
MEO	Medium Earth Orbit
MRCC	Maritime rescue coordination centre
PANS-ATM	Procedures for Air Navigation Services – Air Traffic Management
PANS-OPS	Procedures for Air Navigation Services – Aircraft Operations
PFLR	Post Flight Localisation and Recovery
RCC	Rescue Coordination Centre
SAR	Search and Rescue
SARP	Standards and Recommended Practices
SOP	Standard Operating Procedures
SRR	Search and Rescue Region
SWIM	System wide information management
ULD	Underwater Locator Device
VHF	Very High Frequency