AC 121-2-10(Rev 1)
9 November 2021

Civil Aviation Authority of Singapore

Advisory Circular

Aircraft Tracking

GENERAL
Advisory Circulars (ACs) are issued by the Director-General of Civil Aviation (DGCA) from time to time to provide practical guidance or certainty in respect of the statutory requirements for aviation safety. ACs contain information about standards, practices, and procedures acceptable to CAAS. An AC may be used, in accordance with section 3C of the Air Navigation Act (Cap. 6) (ANA), to demonstrate compliance with a statutory requirement. The revision number of the AC is indicated in parenthesis in the suffix of the AC number.

PURPOSE
This AC provides to demonstrate compliance with, and information related to, the requirements of an AOC holder on aircraft tracking requirements as well as location of an aircraft in distress.

APPLICABILITY
This AC is applicable to an AOC holder operating an aeroplane in accordance with Air Navigation (121 – Commercial Air Transport by Large Aeroplanes) Regulations 2018 (“ANR-121”).

RELATED REGULATIONS
This Advisory Circular relates specifically to Regulations 51, 52 and 105 of ANR-121.

RELATED ADVISORY CIRCULARS
Nil.

CANCELLATION
This Revision 1 to AC 121-2-10 supersedes Revision 0. Revision 1 includes guidance on autonomous distress tracking.

EFFECTIVE DATE
This AC is effective from 09 November 2021.

OTHER REFERENCES
- ICAO DOC 10054 - Manual on Location of Aircraft in Distress and Flight Record Data Recovery
- ICAO Doc 10150 - Manual on the Functional Specifications for the Location of an Aircraft in Distress Repository (LADR)

DEFINITIONS

4D/15 Service. In the provision of Air Traffic Services (ATS), an ATS unit receives four-dimensional (latitude, longitude, altitude, time) position information at 15-minute intervals or less from suitably equipped aircraft.

4D/15 Tracking. The AOC holder obtains four-dimensional (latitude, longitude, altitude, time) aircraft position information at 15 minute-intervals or less.

1 BACKGROUND

1.1 CAAS' policy to enhance aircraft tracking and locating by AOC holders is based on the three main components of ICAO's Global Aeronautical Distress and Safety Systems (GADSS)[1]: Aircraft Tracking, Autonomous Distress Tracking (ADT) and Post Flight Localization and Recovery.

1.2 AOC holders operating an aeroplane in accordance with ANR-121 are required to track its aeroplanes during normal operations from December 2015. Requirements relating to locating an aeroplane in distress as well as autonomous location transmitting capability were also introduced in 2018.

2 REGULATORY REQUIREMENTS

2.1 Regulation 51 of ANR-121 contains the requirements regarding tracking of aircraft during normal operations. The requirements are applicable to an AOC holder operating any of the following:

(a) A passenger or cargo aeroplane that has a maximum certificated take-off mass of more than 45,500 kg; or
(b) A passenger aeroplane that has a maximum certificated take-off mass of more than 27,000 kg but not exceeding 45,500 kg, and a passenger seating capacity of more than 19 passengers.

2.3 Regulation 52 of ANR-121 contains the requirements regarding locating an aeroplane in distress.

2.4 Regulation 105 of ANR-121 contains the requirements regarding an aeroplane's autonomous location transmitting capability.

[1]GADSS refers to Global Aeronautical Distress and Safety Systems. It is a Concept of Operations (CONOPS) developed by ICAO Ad-hoc Working Group (AHWG) to address aircraft tracking and locating during all phases of flight by all relevant parties. Discussions are ongoing to condense the GADSS from four components to three components, i.e. Aircraft Tracking – Normal Operations and Aircraft Tracking – Abnormal Operations might be condensed into a single component – Aircraft Tracking.

3 AIRCRAFT TRACKING POLICY, SYSTEM, PROCESS AND PROCEDURE

3.1 To achieve sufficient organisational control over aircraft tracking activities, the AOC holder should:

(a) Establish an aircraft tracking policy;
(b) Address ground-based and airborne tracking requirements and capabilities;
(c) Establish and document all applicable policies, processes, and procedures, including policies and procedures for third parties that perform aircraft tracking activities on the AOC holder's behalf;
(d) Maintain up to date its operational contact details in the ICAO OPS Control Directory (OPS CTRL)
(e) Establish appropriate tasking of operational personnel; and
(f) Establish a training programme for all flight operations officers/flight dispatcher, or other personnel appointed by the AOC holder, for the control and supervision of flights, and on the policies and procedures for aircraft tracking.

3.2 Tracking Capability. The AOC holder must establish an aircraft tracking system that is capable of 4D/15 Tracking.

(a) Position report through HF voice, for the purpose of tracking, is not permitted, as HF transmissions are susceptible to atmospheric interference, and voice position reporting creates additional workload and distraction for the flight crew.
(b) Only automated reporting is permitted. This means that the reporting of an aircraft's location is to be conducted automatically via the aeroplane's data link, without the need for pilot intervention. Automated reporting reduces flight deck workload and would minimise any uncertainty in the accuracy of the report.

3.3 Areas of Coverage. The AOC holder is to maintain 4D/15 tracking of its aeroplanes throughout the entire duration of the flight, except for portions of the flight where there is an Air Traffic Services (ATS) unit doing so. Following the confirmation that the ATS is providing this 4D/15 Service, the AOC holder does not need to independently track its aeroplanes.

Note: ICAO has published 4D/15 ATS service areas in the Operations Control Directory (OPS CTRL) https://applications.icao.int/ops-map/flight-tracking.htm

3.4 Retention of Tracking Data. The AOC holder should retain the 4D/15 Tracking data of each flight until the aeroplane has landed safely. In the event of an accident or missing aircraft, the AOC holder should ensure that the data is retained for the period necessary to assist search and rescue entities in determining the last known position of the flight.

3.5 In order to practically fulfil its aircraft tracking responsibilities, the AOC holder would need to analyse its routes to determine which route would be reliant on 4D/15 Service and which would require 4D/15 Tracking. For areas where the availability of 4D/15 Service cannot be determined, the AOC holder will be responsible for tracking its aeroplanes. The AOC holder should therefore have specific policies and procedures that:

(a) Identify the duties, tasks, and actions necessary to track a specific flight;
(b) Ensure the duties, tasks and actions related to the tracking of each flight are assigned to the appropriate personnel;

(c) Ensure planned routes are reviewed to determine whether a 4D/15 Service is available along an intended route;
(d) Ensure aircraft equipage matches the 4D/15 Service in use;
(e) Identify the areas, routes, or route segments when 4D/15 Tracking is required; and
(f) Implement appropriate mitigating measures for areas or routes where 4D/15 Service and 4D/15 Tracking are not available due to operational constraints (refer to paragraph 4).

4 TEMPORARY OPERATIONAL CONSTRAINTS

4.1 Possible Scenarios. It is noted that there would be operational situations where aircraft tracking may not be practically achieved for a particular flight or route. Some examples are:

(a) **Aircraft equipment failure at dispatch** – Aircraft tracking equipment (e.g., Satellite Communications (SATCOM)) could fail during pre-departure, rendering total or partial loss of tracking capability.
(b) **Outage of communications service providers/ground equipment/ground system** – Scheduled maintenance or unforeseen interruptions of satellite network, Very High Frequency (VHF) station, ground systems could cause temporary loss of tracking.
(c) **Re-routing of flights** – Flight which was originally routed over areas where 4D/15 Service was available, might need to be re-routed over certain areas where 4D/15 Service is not available due to various reasons such as airspace closure, volcanic ash, security issues, etc.
(d) **Re-deployment of aircraft** – Due to operational or technical reasons, an aircraft originally deployed only for routes over areas where 4D/15 Service is available, might need to be re-deployed to routes over areas whereby 4D/15 Service is not always available.
(e) **Operations over polar regions** – There might be temporary loss of tracking of aircraft over the polar regions of aircraft due to limitations of the satellite network.

In these situations, the AOC holder may continue to operate the affected aeroplane or flight provided a risk assessment is conducted and the dispatch is done in accordance with approved procedures (see paragraph 4.3).

4.2 Risk Assessment Process. Regulation 51(3) of ANR-121 provides for the AOC holder to continue operations in situations where the required tracking is not available provided certain conditions are met. To determine the appropriate level of mitigating measures required, the AOC holder should establish a risk assessment process to identify any hazards and risks associated with the lack of tracking. It should be noted that the intent is not to conduct a specific risk assessment on a tactical basis by operational personnel and/or the flight crew. Rather, the risk assessment process would be used by the AOC holder to develop mitigations that would be embedded in policies and procedures that would in turn allow for flight dispatches in accordance with the outcome of the process. The risk assessment process should consider at least the following elements:

(a) **Capability of the AOC holder's system and processes** – This refers to the demonstrable capabilities of the AOC holder's ground-based systems and processes that should be assessed. This would include the tracking capability to determine the position of an aircraft based on any available data sources, the flight monitoring capability of the ground-based systems to detect and resolve missed-position reports,

the appropriate training of relevant personnel to cope with lapses in 4D/15 Tracking, and any other ground-based system that aids in the timely resolution of missed reports.

(b) **Capability of the aircraft's tracking and locating systems** – This refers to the equipage of the aeroplane to support position reporting (e.g., Aircraft Communications Addressing and Reporting System (ACARS), ADS-B, ADS-C, SATCOM / VHF / HF, Engine condition monitoring system, etc.) that should be assessed to determine the available (remaining) tracking capability. Also, capabilities of locating technologies (e.g., Emergency Locator Transmitter (ELT), Underwater Locating Device (ULD), etc.) should be fully assessed in the context of planned areas of operations to determine the aircraft location capabilities afforded by such technologies. Lastly, the available communication technologies (e.g., VHF, HF, SATCOM, SATVOICE, etc.) should be considered as well.

Note: Unserviceable aircraft system(s) with aircraft tracking implications may not be immediately obvious (e.g., ELT inoperative) and should be identified in the MEL or other operational documentation.

(c) **Available means to determine the position of and communicate with the aircraft** – This refers to the demonstrable capability of an AOC holder to rapidly and reliably communicate with an aircraft. The capabilities available to support aircraft/AOC holder/ATS communications and surveillance should also be assessed (e.g., to support/update ground-based tracking, resolve missed-position reports, determine flight status, etc.). ANSPs may have access to surveillance information beyond the range of VHF communications which could be used to monitor flights.

(d) **Frequency and duration of gaps in 4D/15 tracking capability** – This refers to the exposure of a given operation or series of operations to gaps in 4D/15 Service or 4D/15 Tracking, and consequently the likelihood that an undesirable outcome might occur during such gaps considering the number of planned flights, the length of each flight and the duration of the gap(s). This may affect the need for mitigation strategies and would also help in quantifying the risk associated to exempting flights from tracking.

(e) **Specific mitigation measures and contingency procedures** – This refers to risk management mitigation strategies based on an assessment of relevant hazards, their probability and the severity of the consequences. These hazards may adversely affect a planned operation; as well as the contingency procedures for use by operational personnel and flight crew that address the gaps and maximize remaining aircraft tracking capabilities.

(f) **Human factors consequences resulting from changes to flight crew procedures** – This refers to the impact on flight crew workload, from a human factors perspective, of any existing or proposed procedures implemented to mitigate the risk associated with gaps in 4D/15 Service or 4D/15 Tracking. For example, manual reporting should be avoided as a viable mitigation strategy as the additional workload required to meet 4D/15 Tracking requirements would distract the flight crew from other operational duties and have a negative impact on the safety of the operation.

The above considerations ensure that risk assessment activities would be sufficiently robust to quantify the risk associated with a lack of 4D/15 tracking. They also ensure an AOC holder's aircraft tracking capability can be critically assessed to determine if existing risk controls and mitigations are sufficient or if additional mitigation is required.

*Note: Refer to **Appendix A** for a sample risk assessment process and scenario. An AOC holder may also make use of its existing risk assessment process for aircraft tracking purposes.*

4.3 Procedures. AOC holder procedures for allowing the continuation of a flight when 4D/15 Tracking and 4D/15 Service are not available must be approved by CAAS. It should be incorporated in the Operations Manual, or other operational manuals with references made to the Operations Manual. The procedures should describe:

(a) The process to assess the risks of commencing planned operations with a known 4D/15 Tracking deficiency;
(b) Appropriate tasking of personnel with the necessary knowledge or expertise to participate in risk assessment activities;
(c) Risk elements that should be considered during risk assessment in accordance with paragraph 4.2;
(d) Determination of the risk level and risk acceptability; and
(e) Implementation of the risk mitigation strategies.

4.4 Reporting to CAAS. As per Regulation 52(3) of ANR-121, the AOC holder is required to make a report when 4D/15 tracking of a particular flight in an emergency phase existed within 72 hours after the termination of the affected flight. This written notification should contain the following details and be submitted to CAAS via email through caas_dfirs@caas.gov.sg.

(a) Airline, Aircraft Type, Aircraft Registration, Flight Number, Sector;
(b) Date, Time;
(c) Affected area(s); and
(d) Brief description of the reason(s) for the non-tracking situation.

5 AIRCRAFT TRACKING DURING ABNORMAL OPERATIONS

5.1 Using existing aircraft tracking systems, technologies and related resources, the AOC holder could expand its flight monitoring capabilities to identify and monitor more closely a flight that is experiencing an abnormal event. The AOC holder should identify an event as abnormal if the event has the potential to develop into a condition of distress which could be in the interest of the AOC holder to monitor.

5.2 An AOC holder that tracks abnormal events should clearly define the criterion that qualifies an event as abnormal to reduce false alerts. Abnormal events should include, but is not limited to, the following:

(a) Lateral deviation of 100 NM from the flight plan position
(b) Vertical deviation of 10,000 feet from flight plan altitude
(c) Initiation of emergency or distress calls by the pilot to airline operations centre
(d) Receipt of immediate or projected safety and/or security threats against the flight (e.g., sabotage threat, operations in conflict zones, etc.)

5.3 In addition, the AOC holder may stipulate other occurrences that have potential significant safety implications as abnormal events. These include engine failure, ground proximity warning, cabin altitude warning, fire or smoke warning, reversion of flight control modes to direct law or direct mode, or any event that is considered a reportable safety matter in accordance with the Third Schedule of ANR-91.

5.4 When a flight experiences an abnormal event, the automated position reporting interval should be shortened to once every minute or less, i.e., 4D/1. The purpose is to provide the relevant ATS units with the most practicably available position data should an escalation to an emergency phase occur. At the same time, the AOC holder should establish communication with the flight by any available means to determine its operational status, failing which the AOC holder should notify the appropriate ATS unit with the latest known position of the aeroplane and its expected track. When the abnormal event is resolved, the automated position reporting interval may revert to once every 15 minutes or less, i.e., 4D/15.

5.5 An abnormal event that may not be a reportable safety matter should also be reported to CAAS through the Singapore Aviation Accident Incident Reporting System (SAIRS).

6 ALERTING PROCESS FOR MISSED POSITION REPORT

6.1 The AOC holder must establish a process to monitor its flights throughout their entire duration when under 4D/15 Tracking. In event of a missed position report, the AOC holder should assess and determine whether it is the result of a system outage, equipment failure or other causes. The flight operations personnel or flight dispatcher, in conjunction with the AOC holder's method of control and supervision of flight operations, must verify the relevant communication links and attempt to establish communication with the aeroplane by any available means. When such attempts are unsuccessful, the appropriate ATS unit must be notified in the most expeditious manner with the latest known position of the aeroplane and its expected track.

6.2 The aircraft tracking missed position report message template in Appendix B should be used when information regarding a missed position report is required to be transmitted to an ATS unit.

Note: The ICAO OPS Control Directory (OPS CTRL) has been established to facilitate contact between AOC holders and ATS units when responding to a tracking related event. The OPS CTRL can be accessed at: www.icao.int/safety/global tracking

6.3 It is not required to alert the appropriate ATS unit when the missed-position report occurred within 4D/15 Service areas. Service areas can be found in ICAOs OPS CTRL https://applications.icao.int/ops-map/flight-tracking.htm

6.4 When a missed position report is resolved by the AOC holder and/or ATS unit and contact is re-established, the AOC holder should reset and resume 4D/15 Tracking. It is important to clearly identify the reset point to avoid the unnecessary initiation of missed report procedures.

7 AUTONOMOUS DISTRESS TRACKING

7.1 For purpose of Regulations 52 and 105 of ANR-121, the AOC holder should establish and document:

(a) A training programme for flight operations officers/flight dispatchers, or other personnel nominated by the AOC holder for the control and supervision of flights, on the use of the autonomous distress tracking (ADT) services and functionalities;

(b) Procedures for the monitoring of information received from the ADT system, including actions to be taken in the event of a notification of a distress condition; and
(c) Policy and procedures for the flight crew manual activation function.

7.2 For an aeroplane so equipped in accordance with Regulation 105 of ANR-121, the AOC holder should also ensure that the Location of an Aircraft in Distress Repository (LADR) is automatically updated with position information if the aeroplane encounters a distress condition. Guidance on the means to validate the data is found in ICAO Doc 10150.

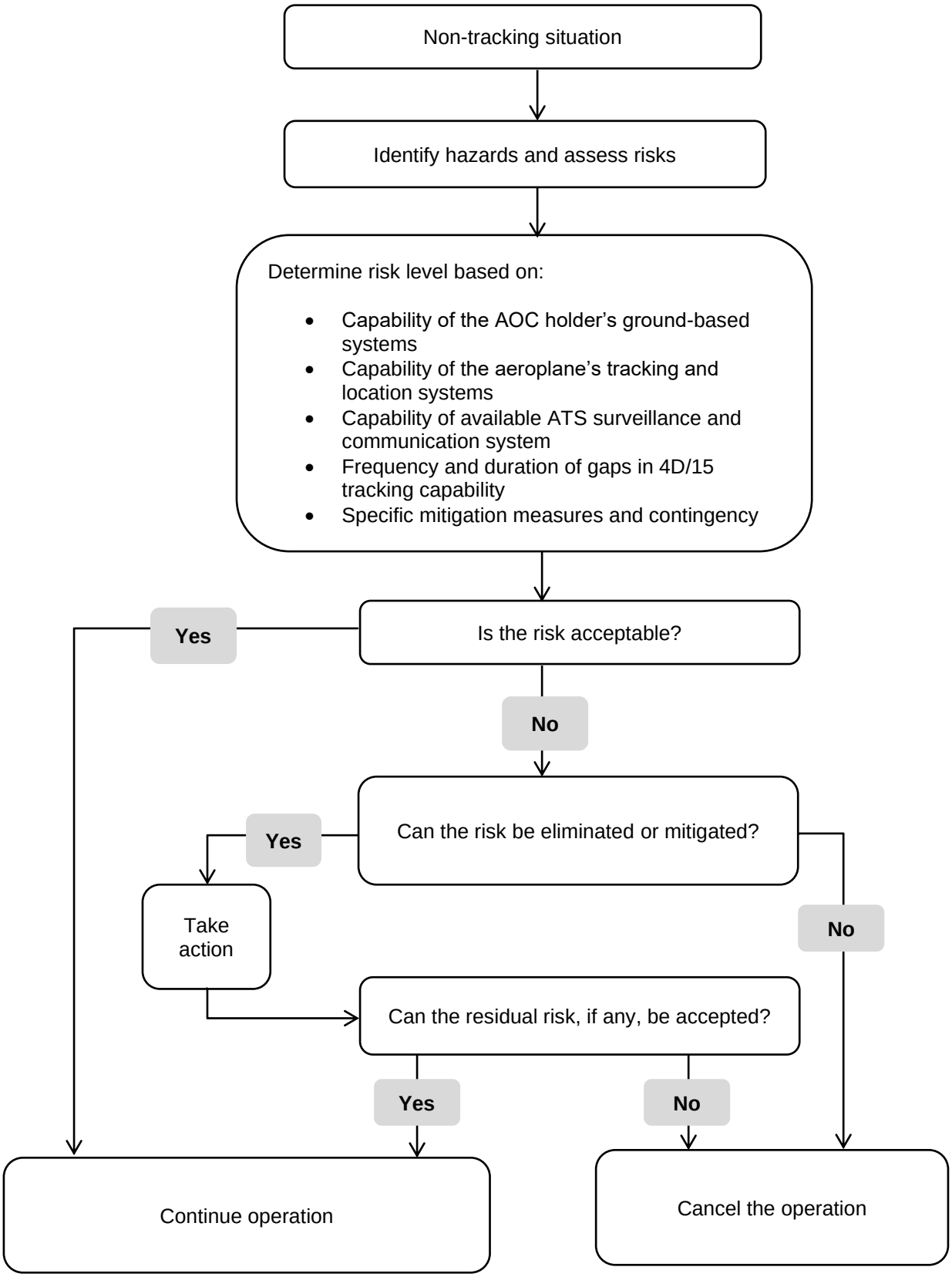
7.3 The AOC holder's system to be used for tracking an aircraft in distress should be approved by CAAS. The AOC holder should demonstrate that its system meets performance and functional requirements as listed in the Manual on Location of Aircraft in Distress and Flight Record Data Recovery (ICAO Doc 10054).

8 CONTACT PERSON AND INFORMATION

8.1 Should you have any queries relating to the above, please access the online forms available at Enquiries & Feedback (caas.gov.sg)

APPENDIX A SAMPLE RISK ASSESSMENT

Sample Risk Assessment Process - Flowchart



Sample Risk Assessment Process - Risk Mitigation Worksheet with Scenario to continue operation without additional mitigation

Non-tracking Event	Identified Hazard	Projected Risk	Risk Level	Additional Mitigation Actions	Resultant Risk Level
Loss of SATCOM. SATCOM was found inoperative during pre-departure. Aircraft (9V-*XXX*) was scheduled for *AAA*-*BBB* sector.	Loss of 4D/15 Tracking for up to 30 minutes over *ZZZ* Sea.	Loss of communications during the non-tracking duration could result in delayed search and rescue operations in times of distress.	6 - Acceptable (see table below for details)	Nil	6 - Acceptable

Item	Assessment Elements	Existing System / Mitigations	Risk Level
1	Capability of the AOC holder's ground-based systems	The AOC holder utilizes *ABC* ground-based system – a highly reliable and accurate tracking system, with automatic alerting functions. Adequate number of trained flight operations personnel is available to monitor the flights.	1
2	Capability of the aircraft's tracking and location systems	In absence of SATCOM, aircraft is capable of reporting its position through ADS-B (out), ACARS via VHF and waypoint reporting via HF voice (if required by Air Traffic Control). Aircraft is also equipped with two automatic 121.5/406 MHz ELTs, and two 90-day 37.5kHz ULDs. (Functional check was done at every pre-departure). (MEL allows SATCOM to be inoperative, except for flights departing from SIN and provided the stated operational procedures are used.)	2
3	Available means to determine the position of and communicate with the aircraft	The portion of flight over *ZZZ* sea is under *XYZ* air traffic control which uses SSR, ADS-B, ADS-C for surveillance. *XYZ* air traffic control has an established process to track the aircraft via HF voice at certain waypoints during the non-tracking duration. The AOC holder can also communicate with the aircraft through its service provider, when it is within HF/VHF range.	1
4	Frequency and duration of gaps in 4D/15 tracking capability	30-minute gap over *ZZZ* sea. Risk exposure is 10%. (30 minutes gap over entire flight duration of 5 hours)	1
5	Specific mitigation measures and contingency procedures	The AOC holder has an established contingency process for ground crew to contact the aircraft and coordinate with the relevant ATS units. Flight crew procedures during distress situation were also well established. The subject flight will be flying over the *ZZZ* sea on an established airway, where there is frequent activity.	1
Overall Risk Level - 6 (Acceptable)			

APPENDIX B REPORTING TEMPLATE

Aircraft tracking missed position report message template

Aircraft tracking missed position report message

From:_____

To:_____

This message provides information regarding potential uncertainty as to the safety of an aircraft. This is a request for action to resolve this uncertainty.

Please contact _____ at _____ with details of action taken.

Required information	
1. Initial or subsequent notification indication	
2. Aircraft identification in Field 7 of filed flight plan	
3. Aircraft type	
4. Last known position (Time, Latitude and Longitude or bearing and range)	
5. Time of last communication	
6. Last known flight level or altitude	
7. Next expected position (if known), and estimate	
8. Name of air traffic services unit notified	
9. Name of AOC holder	
10. Contact details of AOC holder primary point of contact for this event	
Supplementary information, if available	
11. Contact actions attempted, including frequency channels and SATCOM numbers	
12. Aircraft registration (if different from aircraft identification in 2 above)	
13. Information contained in Item 19 of the filed flight plan	
14. If not included in 13 above, fuel endurance or fuel endurance remaining at last known position	
15. Total persons on board	
16. Alternate or possible alternates	
17. Any other relevant information (e.g., dangerous goods on board, etc.)	

Note.— Contact details for ANSPs and AOC holders can be obtained from the OPS CTRL directory, accessed at www.icao.int/safety/globaltracking.