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WORKING PAPER

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TECHNICAL COMMISSION

Agenda Item 31: Aviation Safety- Emerging Issues

FALSE AIRCRAFT PROXIMITY

(Presented by the Islamic Republic of Iran)

EXECUTIVE SUMMARY

This working paper has been prepared to be tabled in the 38th Session of the ICAO Assembly under Agenda Item 31.

It introduces the paper as "False Aircraft Proximity" (False Airprox) and provides the results of the studies and researches have been conducted concerning the occurred serious incidents. Actually, the transmission of incorrect level data by the aircraft, which is received by TCAS II equipped one, violates the set separation minima, compromises safety of air traffic and causes difficulties to air traffic management (ATM), particularly to the provision of air traffic control service and relevant processes.

Action: The Assembly is invited to consider this working paper and its conclusion and provide directives for the enhancement of global aviation safety.

Strategic Objectives:	This working paper relates to the Safety Strategic Objective.
Financial implications:	Not applicable.
References:	ICAO Annex 10 — *Aeronautical Telecommunications*, Volume IV — *Surveillance and Collision Avoidance Systems* ICAO Annex 13 — *Accident and Incident Investigation* ICAO Annex 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport — Aeroplanes* PANS-OPS, Doc 8168 — *Procedures for Air Navigation Services — Aircraft Operations*, Volume I — *Flight Procedures*

(5 pages)

1. INTRODUCTION

1.1 There have been some incidents in which an aircraft faces with an airprox; whereas, there has not been any aircraft flying at a proximity below the set minimum standard separation to the aircraft. Although, the aircraft was flying safely, its TCAS II detected a threat and predicted that a critical airprox is going to happen. These incidents indicate that TCAS II of the aircraft detected a threat wrongly and issued resolution advisory (false advisory) because the other aircraft has transmitted its altitude incorrectly.

1.2 TCAS II fully relies on the altitude (level) transmitted by the intruder's Air Traffic Control (ATC) Transponder and issues resolution advisory when required. The calculation performed by TCAS Computer is based on the received altitude and other existing data, no matter whether the received altitude has been right or wrong. In this context, “altitude” means the actual altitude and level broadly means height, altitude and flight level.

1.3 Each false airprox is a serious incident regardless of the classification provided in Doc 4444 and they should be reported and investigated just like a real airprox.

1.4 The wrong transmission of aircraft altitude may involve risk of collision, compromise safety of aircraft and disturb the air traffic management (ATM) processes.

1.5 Some false airproxes have already occurred; therefore, the risk of occurrence of them should be decreased to very minimum one way or another.

1.6 False airprox incidents can be fully analyzed as demonstrated in the Appendix to this working paper.

2. DISCUSSION

2.1 Under false airprox, one aircraft transmits its altitude (level) incorrectly. For this reason, two scenarios may be introduced for each given false airprox.

2.2 Based on the analysis and along with those scenarios, it can be found that what had really happened that has led to the incident.

2.3 In fact, what happens upon transmission of incorrect altitude data depends on the relative position and situation of the aircraft and the transmitted altitude. If the trajectories of the aircraft are not close enough laterally, nothing will happen. If the transmitted altitude is wrong and the aircraft are flying far enough, then no advisory will be issued by TCAS II. In addition, if the transmitted altitude is wrong, but it is not close enough to the altitude of the other aircraft, in such a case, no advisory will be issued.

2.4 False airprox incidents occur as follows.

2.4.1 The trajectories of the aircraft are close enough when TCAS II issues traffic advisory.

2.4.2 The required altitude differences between the aircraft provide them with safe and minimum standard separation. On the other hand, standard separation is achieved because of altitude differences between the aircraft.

2.4.3 The wrong level, which is transmitted by one aircraft, is close to the actual altitude of other aircraft that is equipped with TCAS II; thus, TCAS II issues traffic alert and then resolution advisories; whereas, the aircraft are flying safely and complying with the standard separation. (the Appendix refers).

2.5 There are two types of false airprox incidents: False airprox with one TCAS II equipped aircraft, and false airprox with two TCAS II equipped aircraft. The analysis of false airprox with two TCAS II equipped aircraft is extremely complicated. The analysis consists of initiation and continuation of the event. Initiation means the traffic and resolution advisories and the vertical manoeuvre of the aircraft initiated in a false airprox. Continuation means what happens after the accomplishment of the vertical manoeuvre that is commanded by TCAS II. When discussing the false airprox in which both aircraft are equipped with TCAS II, the continuation of the event is very important. Theoretically, a scenario justifies the incident when it would be is possible to explain and justify the initiation and continuation of the event.

2.6 The altitude data is transmitted in gray code or binary code, via ATC Transponders. ATC Mode-C Transponders transmit the altitude data in gray code, whereas ATC Mode-S Transponders transmit the altitude data in binary code or in gray code, depending on the type of altitude data received from Air Data Computer. Transmission of the altitude data in binary code is much more reliable and provides a high level of aviation safety.

3. CONCLUSION

3.1 Based on the conducted surveys of the false airprox incidents, in order to decrease occurrence of such incidents and to prevent the separation loss and not to compromise safety of aircraft operations, the following is recommended to be noted and implemented.

3.1.1 Each false airprox, as a serious incident, should be reported and investigated just like a real airprox.

3.1.2 All vehicles equipped with ATC Mode-C transponder should be periodically checked in order to ascertain that their altitude is correctly transmitted.

3.1.3 Upon occurring Resolution Advisory, the altitude of given aircraft and its relative altitude should be accurately noted down.

3.1.4 On any aircraft in which ARINC 429 or ARINC 575 altitude data is available (including almost all commercial aircraft), Gillham coded altitude data should not be used.

3.1.5 Gillham coded altitude data should not be used on TCAS II equipped aircraft as well as on any aircraft flying in RVSM airspace.

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APPENDIX

1. TCAS II is intended to detect the presence of nearby aircraft and determine if they are potential threats.

1.1. TCAS II interrogates the nearby aircraft's transponder and uses its replies to compute the predicted flight path for the aircraft. From this information, TCAS II determines the possibility conflict among existing air traffic.

1.2. TCAS directional antenna permits the system to determine the direction (bearing) of other aircraft that its reply consists of the altitude information. Receiving and processing of several transponder transmissions of other aircraft allows the TCAS Computer to compute the range and range rate.

1.3. TCAS Computer predicts the intruder's flight path and speed using its altitude, bearing, range and range rate. TCAS Computer outputs a traffic advisory and display of bearing, altitude and range of the nearby aircraft for the flight crew. If the computer determines that the other aircraft is an imminent threat and if it would maintain its present flight path, the computer issues a resolution advisory (command for vertical manoeuvre). The display (like RA/TA/VSI, EFIS DU, and Weather radar indicator) advises the flight crew of the recommended vertical manoeuvre to achieve defined safe separation.

1.4. In situations where both aircraft are TCAS II equipped, TCAS Computers transmit and receive messages over their Transponder's Mode-S data link to coordinate the advised vertical manoeuvres of each aircraft. This prevents each TCAS Computer from independently advising that which aircraft be in an avoidance climb and which could continue its path despite the traffic conflict.

1.5. TCAS Computer issues a resolution advisory (command for vertical manoeuvre) to achieve safe minimum separation - in other words, to prevent occurrence of critical airprox, and then:

$$\text{TCAS II risk ratio} = \frac{\text{Number of critical airprox induced by TCAS II} + \text{Number of critical airprox not resolved by TCAS II}}{\text{Number of critical airprox without TCAS II}}$$

1.6. TCAS Computer directly receives the altitude of the intruder, while the computer computes other data (bearing, range and range rate).

2. TCAS II relies fully on the altitude transmitted by the intruder's Transponder. This is the most important restriction of TCAS Computer, just like any other computer, which is unable to distinguish whether the input data is correct or not.

2.1. What will happen if the transmitted level is wrong? Of course, it depends on the situation of the aircraft.

2.2. False airprox incidents have occurred unexpectedly, due to incorrect altitude reporting, whereas the aircraft were flying at an assigned safe level.

2.3. The working paper “False airprox” is actually a 26-page article, but reduced and truncated to describe that how a wrong transmission of aircraft altitude may compromise aircraft safety, disrupt air traffic management processes and severely put at risk the aviation safety.

2.4. The paper “False Aircraft Proximity” with different examples and scenarios deals with the airproxes that have not really occurred. It introduces the analysis of false airprox incidents and talks about the scenarios in which the actual separation of the aircraft is sufficient (the aircraft have the safe separation); however, due to transmission of incorrect altitude by one aircraft, TCAS II recommends a vertical manoeuvre (false advisory).

2.5. False airprox incidents are analysed based on the justifiable scenarios that explain the incident. For each false airprox, two scenarios may be considered. Normally one of them is correct. Based on the scenarios, it could be found that what has really happened during such incidents. The analysis of false airprox is much complicated when both aircraft are equipped with TCAS II.

2.6. The justifiable scenario explains the initiation of the incident. When analyzing false airprox with two TCAS II equipped aircraft, it should be able to explain the initiation and the continuation of the event. Initiation means the traffic and resolution advisories and the vertical manoeuvre of the aircraft is initiated in a false airprox. Continuation means what happens after accomplishment of the first vertical manoeuvre of the aircraft that is certainly commanded by TCAS II.

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