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AIRBORNE COLLISION AVOIDANCE SYSTEM (ACAS) HIGH VERTICAL RATE (HVR) ENCOUNTERS.

1 Introduction

1.1 ACAS was introduced by the International Civil Aviation Organization (ICAO) as a standard to help reduce the probability of airborne collisions. It was specified in ICAO Annex 10 to provide pilots with a system, independent of Air Traffic Control (ATC), to detect the presence of other aircraft that may present a threat of collision. When the system identifies a high risk of collision it provides guidance for the pilot to manoeuvre such that the risk of collision is reduced.

1.2 The purpose of this Circular is to raise awareness of the characteristics and limitations of ACAS equipment with particular regard to HVR encounters. Data collected by ACAS monitoring programmes continue to show that a large percentage of ACAS Resolution Advisories (RAs) are a result of climbing or descending aircraft maintaining a high vertical speed while approaching their ATC-assigned altitude. Changes made to ICAO Standards and Recommended Practices (SARPs) and guidance material relating to ACAS have been effective in reducing the frequency of occurrence of RAs caused by HVR encounters. It has been determined that no further changes are feasible within ACAS to address this issue without resulting in an unacceptable degradation of the safety provided by ACAS.

1.3 The only system that satisfies the current ICAO ACAS standards is version 7.0 of TCAS II (Traffic Alert and Collision Avoidance System). EU-OPS 1.668 mandates that all aircraft with a certificated take-off mass in excess of 5700 kg or a maximum passenger seating configuration of more than 19 seats are equipped with ACAS with a minimum performance level of TCAS II.

2 Modern Flight Guidance Systems

2.1 Modern aircraft and their flight guidance systems are designed to fly specific flight profiles that provide fuel-efficient and time-efficient flight paths. An integral element of these designs commands the aircraft to quickly climb to more efficient operating altitudes and then remain at these altitudes until fuel-efficient idle thrust descents can be achieved.

2.2 The design of these flight guidance systems can result in vertical speeds in excess of 3000 ft per minute until the aircraft is within 500 ft of the ATC-assigned altitude. When an aircraft maintains a vertical speed in excess of 3000 ft per minute until it is within 500 ft of the assigned altitude it is less than 30 seconds away from being at the adjacent Instrument Flight Rules (IFR) altitude, which may be occupied by an ACAS-equipped aircraft flying level at that altitude. If the intruder aircraft is horizontally within the protected area provided by ACAS, there is a high probability that an RA against the climbing or descending aircraft will be generated just as the intruder aircraft begins to reduce its vertical speed to capture the assigned altitude.

3 Airspace Environment

3.1 HVR RAs have been observing in both terminal and en-route airspace. The likelihood of this type of RA occurring above FL 290 has increased since the introduction of Reduced Vertical Separation Minimum airspace.

3.2 Many HVR RAs occur in the proximity of large airports where departures are kept below arriving aircraft until some distance from the airport before being allowed to climb to higher altitudes, and a large percentage of these RAs occur in geographic areas where there is a concentration of climbing and descending aircraft.

4 ACAS Operation with HVR Encounters

4.1 ACAS with version 7.0 TCAS II equipment recognises HVR encounters and can, when an HVR encounter is detected, delay the issuance of RAs by up to 10 seconds. This delay allows additional time for the intruder aircraft to initiate a level-off and for ACAS to detect this level-off. However, when the intruder aircraft maintains a vertical speed in excess of 3000 ft per minute until it is within 500 ft of its assigned altitude, even this 10-second delay may be insufficient for ACAS to detect the level-off, and an RA may be issued.

4.2 When the operational response to the RA requires the pilot of the intruder aircraft to disconnect the autopilot the planned automatic acquisition of the assigned altitude will not occur. Therefore there is a greatly increased probability that the intruder aircraft will not level off at the assigned altitude resulting in a loss of standard ATC separation. Equally an RA response by the aircraft in level flight, in the direction away from the intruder aircraft, also may result in a loss of separation with another aircraft not involved in the original RA.

4.3 Consideration has been given to providing ACAS information regarding the intruder aircraft's intent. However, this is not considered to be a viable approach to reducing these types of RAs while retaining the existing level of safety provided by ACAS. Currently, it has not been possible to identify any additional changes to ACAS that will provide a further reduction in the frequency of these potentially disruptive RAs.

5 Emergency Descent

5.1 HVR encounters can be triggered in the event of an emergency descent; the descending aeroplane will inevitably develop a high rate of descent during the manoeuvre. This high rate of descent may generate possible ACAS encounters as the aeroplane descends through occupied levels prior to the descent being co-ordinated by ATC. When these encounters generate an RA the crew should consider manoeuvring in the direction of the ACAS demand, even if the magnitude of the demand is not fully satisfied. This action will reduce the risk of collision without unduly reducing the efficacy of the emergency descent.

5.2 Crews should be aware that manoeuvring in opposition to an ACAS RA demand during an emergency descent is likely to increase the risk of collision.

5.3 When initiating an emergency descent crews should make full use of the traffic information provided by ACAS when deciding whether to turn, and in which direction.

5.4 In UK Airspace, when there is no traffic indicated, it is recommended to maintain the heading or track as cleared previously by ATC until ATC are able to give further instructions with regard to heading requirements during an emergency descent.

6 ACAS Demands that Exceed Aeroplane Performance

6.1 In the great majority of cases the climb demand during an ACAS encounter requires the pilot to initiate a climb that is well within the aeroplane's normal performance. However, in some circumstances an ACAS climb demand, during an RA, may exceed an aeroplane's performance capabilities. This situation may occur when the aeroplane is operating at, or close to, its maximum operating altitude, or when the TCAS demand exceeds the aeroplane's best performance.

6.2 When an aeroplane's performance limitations do not allow full compliance with an ACAS climb demand, the pilot should still initiate a climb, albeit within the performance limitations of the aeroplane. This action, although not fully achieving the calculated ACAS separation, will result in a reduction in the risk of collision.

6.3 Crews should be aware that manoeuvring in opposition (descent) to an ACAS climb demand is liable to increase the risk of collision.

7 Operational Considerations

7.1 HVR encounters remain a significant cause of 'disruptive' RAs, ie: those that can cause unexpected loss of standard separation with operational impacts for both pilots and controllers. Operators should therefore consider specifying operational procedures that reduce the likelihood of the issuance of this type of HVR-generated RA.

7.2 Amongst the procedures that might be considered the following should be reviewed:

a Limiting the vertical speed to 1500 ft per minute when within 1000 ft of the aircraft's assigned altitude, particularly in airspace with a high traffic density;

b using only moderate values of vertical speed when climbing or descending through small altitude changes;

c avoiding the use of zoom climbs and high rates of descent within airspace with a high traffic density.

7.3 Operators should ensure that crews appreciate both how ACAS can increase situations awareness when initiating an emergency descent, and that manoeuvring in the correct sense when in receipt of an RA, should an ACAS encounter occur during an emergency descent, will reduce the risk of collision.

7.4 Operators should ensure that crews are made aware of how they should respond to an ACAS climb demand that exceeds the performance capabilities of the aeroplane.

7.5 When reviewing the procedures in paragraph 7.2 operators should ensure that any change in procedures does not result in an increased risk of altitude busts. These may occur due to the limitations of the autopilot mode being changed when the autopilot is in the altitude capture mode that the assigned altitude capture function is lost.