

3.3 HIGH VERTICAL RATE (HVR) ENCOUNTERS

Pilots should use appropriate procedures by which an aeroplane climbing or descending to an assigned altitude or flight level, especially with an autopilot engaged, may do so at a rate less than 8 m/s (or 1 500 ft/min) throughout the last 300 m (or 1 000 ft) of climb or descent to the assigned altitude or flight level when the pilot is made aware of another aircraft at or approaching an adjacent altitude or flight level, unless otherwise instructed by ATC. Some aircraft have auto-flight systems with the capability to detect the presence of such aircraft and adjust their vertical rate accordingly. These procedures are intended to avoid unnecessary ACAS II resolution advisories in aircraft at or approaching adjacent altitudes or flight levels. For commercial operations, these procedures should be specified by the operator. Detailed information on HVR encounters and guidance material concerning the development of appropriate procedures is contained in Attachment B to this chapter.

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Attachment A to Section 4, Chapter 3

ACAS TRAINING GUIDELINES FOR PILOTS

Note.— The acronym “ACAS” is used in this attachment to indicate “ACAS II”.

1. INTRODUCTION

1.1 During the implementation of ACAS and the operational evaluations conducted by States, several operational issues were identified that were attributed to deficiencies in pilot training programmes. To address these deficiencies, a set of performance-based training objectives for ACAS pilot training was developed. The training objectives cover: theory of operation; pre-flight operations; general in-flight operations; response to traffic advisories (TAs); and response to resolution advisories (RAs). The training objectives are further divided into the areas of: ACAS academic training; ACAS manoeuvre training; ACAS initial evaluation; and ACAS recurrent qualification.

1.2 ACAS academic training material has been divided into items that are considered essential training and those that are considered desirable. Those items that are deemed to be essential are a requirement for each ACAS operator. In each area, a list of objectives and acceptable performance criteria is defined. All manoeuvre training is considered essential.

1.3 In developing this material, no attempt was made to define how the training programme should be implemented. Instead, objectives were established that define the knowledge a pilot operating ACAS is expected to possess and the performance expected from a pilot who has completed ACAS training. Therefore, all pilots who operate ACAS equipment should receive the ACAS training described below.

2. ACAS ACADEMIC TRAINING

2.1 General

This training is typically conducted in a classroom environment. The knowledge demonstrations specified in this section may be achieved through the successful completion of written tests or providing correct responses to non-real-time computer-based training (CBT) questions.

2.2 Essential items

2.2.1 *Theory of operation.* The pilot must demonstrate an understanding of ACAS operation and the criteria used for issuing TAs and RAs. This training should address the following topics:

2.2.1.1 System operation

OBJECTIVE: Demonstrate knowledge of how ACAS functions.

CRITERIA: The pilot must demonstrate an understanding of the following functions:

a) Surveillance:

- 1) ACAS interrogates other transponder-equipped aircraft within a nominal range of 26 km (14 NM); and
- 2) ACAS surveillance range can be reduced in geographic areas with a large number of ground interrogators and/or ACAS-equipped aircraft. A minimum surveillance range of 8.5 km (4.5 NM) is guaranteed for ACAS aircraft that are airborne.

Note.— If the operator's ACAS installation provides for the use of the Mode S extended squitter, the normal surveillance range may be increased beyond the nominal 14 NM. However, this information is not used for collision avoidance purposes.

b) Collision avoidance:

- 1) TAs can be issued against any transponder-equipped aircraft that responds to the ICAO Mode C interrogations, even if the aircraft does not have altitude-reporting capability;

Note.— SSR transponders having only Mode A capability do not generate TAs. ACAS does not use Mode A interrogations; therefore, the Mode A transponder codes of nearby aircraft are not known to ACAS. In ICAO SARPs, Mode C minus the altitude is not considered Mode A because of the difference in the pulse intervals. ACAS uses the framing pulses of replies to Mode C interrogations and will track and may display aircraft equipped with an operating Mode A/C transponder whether or not the altitude-reporting function has been enabled.

- 2) RAs can be issued only against aircraft that are reporting altitude and in the vertical plane only;
- 3) RAs issued against an ACAS-equipped intruder are coordinated to ensure that complementary RAs are issued;
- 4) failure to respond to an RA deprives the aircraft of the collision protection provided by its ACAS. Additionally, in ACAS-ACAS encounters, it also restricts the choices available to the other aircraft's ACAS and thus renders the other aircraft's ACAS less effective than if the first aircraft were not ACAS-equipped; and
- 5) manoeuvring in a direction opposite to that indicated by an RA is likely to result in further reduction in separation. This is particularly true in the case of an ACAS-ACAS coordinated encounter.

2.2.1.2 Advisory thresholds

OBJECTIVE: Demonstrate knowledge of the criteria for issuing TAs and RAs.

CRITERIA: The pilot must be able to demonstrate an understanding of the methodology used by ACAS to issue TAs and RAs and the general criteria for the issuance of these advisories to include:

- a) ACAS advisories are based on time to closest point of approach (CPA) rather than distance. The time must be short and vertical separation must be small, or projected to be small, before an advisory can be issued. The separation standards provided by air traffic services are different from those against which ACAS issues alerts;
- b) thresholds for issuing a TA or RA vary with altitude. The thresholds are larger at higher altitudes;
- c) TAs generally occur from 20 to 48 seconds prior to CPA. When ACAS is operated in TA-only mode, RAs will be inhibited;
- d) RAs occur from 15 to 35 seconds before the projected CPA; and
- e) RAs are chosen to provide the desired vertical separation at CPA. As a result, RAs can instruct a climb or descent through the intruder aircraft's altitude.

2.2.1.3 ACAS limitations

OBJECTIVE: To verify that the pilot is aware of the limitations of ACAS.

CRITERIA: The pilot must demonstrate a knowledge and understanding of the ACAS limitations including:

- a) ACAS will neither track nor display non-transponder-equipped aircraft, nor aircraft with an inoperable transponder, nor aircraft with a Mode A transponder;
- b) ACAS will automatically fail if the input from the aircraft's barometric altimeter, radio altimeter, or transponder is lost;

Note.— In some installations, the loss of information from other on-board systems such as an inertial reference system (IRS) or attitude and heading reference system (AHRS) may result in an ACAS failure. Individual operators should ensure that their pilots are aware of what types of aircraft system failures will result in an ACAS failure.

- c) some aircraft within 116 m (380 ft) above ground level (AGL) (nominal value) will not be displayed. If ACAS is able to determine that an aircraft below this altitude is airborne, it will be displayed;
- d) ACAS may not display all proximate transponder-equipped aircraft in areas of high-density traffic; however, it will still issue RAs as necessary;
- e) because of design limitations, the bearing displayed by ACAS is not sufficiently accurate to support the initiation of horizontal manoeuvres based solely on the traffic display;
- f) because of design limitations, ACAS will neither display nor give alerts against intruders with a vertical speed in excess of 3 048 m/min (10 000 ft/min). In addition, the design implementation may result in some short-term errors in the tracked vertical speed of an intruder during periods of high vertical acceleration by the intruder; and
- g) stall warnings, ground proximity warning system (GPWS) warnings and wind shear warnings take precedence over ACAS advisories. When either a GPWS or wind shear warning is active, ACAS will automatically switch to the TA-only mode of operation except that ACAS aural annunciations will be inhibited. ACAS will remain in TA-only mode for 10 seconds after the GPWS or wind shear warning is removed.

2.2.1.4 ACAS inhibits

OBJECTIVE: To verify that the pilot is aware of the conditions under which certain functions of ACAS are inhibited.

CRITERIA: The pilot must demonstrate a knowledge and understanding of the various ACAS inhibits including:

- a) increase descent RAs are inhibited below 442 (± 30) m (1 450 (± 100) ft) AGL;
- b) descend RAs are inhibited below 335 (± 30) m (1 100 (± 100) ft) AGL;
- c) all RAs are inhibited below 305 (± 30) m (1 000 (± 100) ft) AGL;
- d) all ACAS aural annunciations are inhibited below 152 (± 30) m (500 (± 100) ft) AGL. This includes the aural annunciation for TAs; and
- e) altitude and configuration under which climb and increase climb RAs are inhibited. ACAS can still issue climb and increase climb RAs when operating at the aircraft's maximum altitude or certified ceiling. However, if aeroplane performance at maximum altitude is not sufficient to enable compliance with the climb rate required by a climb RA, the response should still be in the required sense but not beyond the extent permitted by aeroplane performance limitations.

Note.— In some aircraft types, climb or increase climb RAs are never inhibited.

2.2.2 *Operating procedures.* The pilot must demonstrate the knowledge required to operate ACAS and interpret the information presented by ACAS. This training should address the following topics:

2.2.2.1 Use of controls

OBJECTIVE: To verify that the pilot can properly operate all ACAS and display controls.

CRITERIA: Demonstrate the proper use of controls including:

- a) aircraft configuration required to initiate a self-test;
- b) steps required to initiate a self-test;
- c) recognizing when the self-test is successful and when it is unsuccessful. When the self-test is unsuccessful, recognizing the reason for the failure, and, if possible, correcting the problem;
- d) recommended usage of traffic display range selection. Low ranges are used in the terminal area, and the higher display ranges are used in the en-route environment and in the transition between the terminal and en-route environment;
- e) if available, recommended usage of the *Above/Below* mode selector. *Above* mode should be used during climb, and *Below* mode should be used during descent;
- f) recognition that the configuration of the traffic display, i.e. range and *Above/Below* selection, does not affect the ACAS surveillance volume;

- g) selection of lower ranges on the traffic display to increase display resolution when an advisory is issued;
- h) if available, proper selection of the display of absolute or relative altitude and the limitations of using the absolute display option if a barometric correction is not provided to ACAS; and
- i) proper configuration to display the appropriate ACAS information without eliminating the display of other needed information.

Note.— The wide variety of display implementations makes it difficult to establish more definitive criteria. When the training programme is developed, these general criteria should be expanded to cover specific details for an operator's specific display implementation.

2.2.2.2 Display interpretation

OBJECTIVE: To verify that a pilot understands the meaning of all information that can be displayed by ACAS.

CRITERIA: The pilot must demonstrate the ability to properly interpret information displayed by ACAS including:

- a) other traffic, i.e. traffic within the selected display range that is not proximate traffic, or causing a TA or RA to be issued;
- b) proximate traffic, i.e. traffic that is within 11 km (6 NM) and ∇ 366 m (1 200 ft);
- c) non-altitude reporting traffic;
- d) no bearing TAs and RAs;
- e) off-scale TAs and RAs. The selected range should be changed to ensure that all available information on the intruder is displayed;
- f) traffic advisories. The minimum available display range that allows the traffic to be displayed should be selected to provide the maximum display resolution;
- g) resolution advisories (traffic display). The minimum available display range of the traffic display that allows the traffic to be displayed should be selected to provide the maximum display resolution;
- h) resolution advisories (RA display). Pilots should demonstrate knowledge of the meaning of the red and green areas or the meaning of pitch or flight path angle cues displayed on the RA display. For displays using red and green areas, pilots should demonstrate knowledge of when the green areas will and will not be displayed. Pilots should also demonstrate an understanding of the RA display limitations, i.e. if a vertical speed tape is used and the range of the tape is less than 762 m/min (2 500 ft/min), how an increase rate RA will be displayed; and
- i) if appropriate, awareness that navigation displays oriented Δ Track-Up@ may require a pilot to make a mental adjustment for drift angle when assessing the bearing of proximate traffic.

Note.— The wide variety of display implementations will require the tailoring of some criteria. When the training programme is developed, these criteria should be expanded to cover details for an operator's specific display implementation.

2.2.2.3 Use of the TA-only mode

OBJECTIVE: To verify that a pilot understands the appropriate times to select the TA-only mode of operation and the limitations associated with using this mode.

CRITERIA: The pilot must demonstrate the following:

- a) knowledge of the operator's guidance for the use of TA-only mode;
- b) reasons for using this mode and situations in which its use may be desirable. These include operating in known close proximity to other aircraft such as when visual approaches are being used to closely spaced parallel runways or taking off towards aircraft operating in a VFR corridor. If TA-only mode is not selected when an airport is conducting simultaneous operations from parallel runways separated by less than 366 m (1 200 ft), and to some intersecting runways, RAs can be expected. If an RA is received in these situations, the response should comply with the operator's approved procedures; and
- c) the TA aural annunciation is inhibited below 152 m (∇ 30) m (500 ft (∇ 100 ft)) AGL. As a result, TAs issued below 152 m (500 ft) AGL may not be noticed unless the TA display is included in the routine instrument scan.

2.2.2.4 Crew coordination

OBJECTIVE: To verify that pilots adequately brief other crew members on how ACAS advisories will be handled.

CRITERIA: Pilots must demonstrate that their pre-flight briefing addresses the procedures that will be used in responding to TAs and RAs including:

- a) division of duties between the pilot flying and the pilot not flying, including a clear definition of whether the pilot flying or the pilot-in-command will fly the aircraft during a response to an RA;
- b) expected call-outs;
- c) communications with ATC; and
- d) conditions under which an RA may not be followed and who will make this decision.

Note 1.— Different operators have different procedures for conducting pre-flight briefings and for responding to ACAS advisories. These factors should be taken into consideration when implementing the training programme.

Note 2.— The operator must specify the conditions under which an RA need not be followed, reflecting advice published by States' Civil Aviation Authorities. This should not be an item left to the discretion of a crew.

Note 3.— This portion of the training may be combined with other training such as crew resource management (CRM).

2.2.2.5 Reporting requirements

OBJECTIVE: To verify that the pilot is aware of the requirements for reporting RAs to the controller and other authorities.

CRITERIA: The pilot must demonstrate the following:

- a) the use of the phraseology contained in the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444); and
- b) where information can be obtained regarding the need for making written reports to various States when an RA is issued. Various States have different reporting requirements and the material available to the pilot should be tailored to the airline's operating environment.

2.3 Desirable items

2.3.1 Advisory thresholds

OBJECTIVE: Demonstrate knowledge of the criteria for issuing TAs and RAs.

CRITERIA: The pilot must be able to demonstrate an understanding of the methodology used by ACAS to issue TAs and RAs and the general criteria for the issuance of these advisories to include:

- a) the TA altitude threshold is 259 m (850 ft) below FL 420 and 366 m (1 200 ft) above FL 420;
- b) when the vertical separation at CPA is projected to be less than the ACAS-desired separation, an RA requiring a change to the existing vertical speed will be issued. The ACAS-desired separation varies from 91 m (300 ft) at low altitude to a maximum of 213 m (700 ft) above FL 300;
- c) when the vertical separation at CPA is projected to be greater than the ACAS-desired separation, an RA that does not require a change to the existing vertical speed will be issued. This separation varies from 183 to 244 m (600 to 800 ft); and
- d) RA fixed-range thresholds vary between 0.4 km (0.2 NM) at low altitude and 2 km (1.1 NM) at high altitude. These fixed-range thresholds are used to issue RAs in encounters with slow closure rates.

3. ACAS MANOEUVRE TRAINING

3.1 When training pilots to properly respond to ACAS-displayed information, TAs and RAs are most effective when accomplished in a flight simulator equipped with an ACAS display and controls similar in appearance and operation to those in the aircraft. If a simulator is utilized, CRM aspects of responding to TAs and RAs should be practised during this training.

3.2 If an operator does not have access to an ACAS-equipped simulator, the initial ACAS evaluation should be conducted by means of an interactive CBT with an ACAS display and controls similar in appearance and operation to those in the aircraft the pilot will fly. This interactive CBT should depict scenarios in which real-time responses must be made. The pilot should be informed whether or not the responses made were correct. If the response was incorrect or inappropriate, the CBT should show what the correct response should be.

3.3 The scenarios in the manoeuvre training should include initial RAs that require a change in vertical speed; initial RAs not requiring a change in vertical speed; maintain rate RAs; altitude crossing RAs; increase rate RAs; RA reversals; weakening RAs; RAs issued while the aircraft is at a maximum altitude, and multi-aircraft encounters. In all scenarios, excursions should be limited to the extent required by the RA. The scenarios should be concluded with a return to the original flight profile. The scenarios should also include demonstrations of the consequences of not responding to RAs, slow or late responses, and manoeuvring opposite to the direction called for by the displayed RA as follows:

3.3.1 *TA responses*

OBJECTIVE: To verify that the pilot properly interprets and responds to TAs.

CRITERIA: The pilot must demonstrate:

- a) proper division of responsibilities between the pilot flying and the pilot not flying. The pilot flying should continue to fly the aeroplane and be prepared to respond to any RA that might follow. The pilot not flying should provide updates on the traffic location shown on the ACAS traffic display and use this information to help visually acquire the intruder;
- b) proper interpretation of the displayed information. Visually search for the traffic causing the TA at a location shown on the traffic display. Use should be made of all information shown on the display, note being taken of the bearing and range of the intruder (amber circle), whether it is above or below (data tag), and its vertical speed direction (trend arrow);
- c) other available information is used to assist in visual acquisition. This includes ATC “party-line” information, traffic flow in use, etc.;
- d) because of the limitations described in 2.2.1.3 e), that no manoeuvres are made based solely on the information shown on the ACAS display; and
- e) when visual acquisition is attained, right of way rules are used to maintain or attain safe separation. No unnecessary manoeuvres are initiated. The limitations of making manoeuvres based solely on visual acquisition are understood.

3.3.2 *RA responses*

OBJECTIVE: To verify that the pilot properly interprets and responds to RAs.

CRITERIA: The pilot must demonstrate:

- a) proper division of responsibilities between the pilot flying and the pilot not flying. The pilot flying should respond to the RA with positive control inputs, when required, while the pilot not flying is providing updates on the traffic location, checking the traffic display and monitoring the response to the RA. Proper CRM should be used. If the operator’s procedures require the pilot-in-command to fly all RAs, transfer of aircraft control should be demonstrated;
- b) proper interpretation of the displayed information. The pilot recognizes the intruder causing the RA to be issued (red square on display). The pilot responds appropriately;
- c) for RAs requiring a change in vertical speed, initiation of a response in the proper direction within five seconds of the RA being displayed. Pilot actions must focus on tasks related to manoeuvring the aeroplane in

response to the RA and flight crew coordination, avoiding distractions that may interfere with a correct and timely response. After initiating the manoeuvre, and as soon as possible, as permitted by flight workload, ATC is notified using the standard phraseology if the manoeuvre requires a deviation from the current ATC instruction or clearance;

Note.— Chapter 3, 3.2 c) 1), states that in the event of an RA, pilots should respond immediately and manoeuvre as indicated, unless doing so would jeopardize the safety of the aeroplane.

- d) for RAs not requiring a change in vertical speed, focus on tasks associated with following the RA, including preparedness for a modification to the initially displayed RA where a change in vertical speed may be required. Distractions that may interfere with a correct and timely response must be avoided;
- e) recognition of and the proper response to modifications to the initially displayed RA:
 - 1) for increase rate RAs, the vertical speed is increased within 2 1/2 seconds of the RA being displayed;
 - 2) for RA reversals, the manoeuvre is initiated within 2 1/2 seconds of the RA being displayed;
 - 3) for RA weakenings, the vertical speed is modified to initiate a return towards level flight within 2 1/2 seconds of the RA being displayed; and
 - 4) for RAs that strengthen, the manoeuvre to comply with the revised RA is initiated within 2 1/2 seconds of the RA being displayed;
- f) recognition of altitude crossing encounters and the proper response to these RAs;
- g) for RAs that do not require a change in vertical speed, the vertical speed needle or pitch angle remains outside the red area on the RA display;
- h) for maintain rate RAs, the vertical speed is not reduced. Pilots should recognize that a maintain rate RA may result in crossing through the intruder's altitude;
- i) that if a justified decision is made to not follow an RA, the resulting vertical rate is not in a direction opposite to the sense of the displayed RA;
- j) that the deviation from the current clearance is minimized by levelling the aircraft when the RA weakens and when "Clear of Conflict" is annunciated, executing a prompt return to the current clearance; and notifying ATC as soon as possible, as permitted by flight crew workload;
- k) that when possible, an ATC clearance is complied with while responding to an RA. For example, if the aircraft can level at the assigned altitude while responding to a reduce climb or reduce descent RA, it should be done;
- l) that when simultaneous conflicting instructions to manoeuvre are received from ATC and an RA, the RA is followed and, as soon as possible, as permitted by flight crew workload, ATC is notified using the standard phraseology;
- m) a knowledge of the ACAS multi-aircraft logic and its limitations, and that ACAS can optimize separation from two aircraft by climbing or descending towards one of them. For example, ACAS considers as intruders only aircraft that it finds to be a threat when selecting an RA. As such, it is possible for ACAS to issue an RA against one intruder, which results in a manoeuvre towards another intruder that is not classified as a threat. If the second intruder becomes a threat, the RA will be modified to provide separation from that intruder;