CIVIL AVIATION AUTHORITY
OF VIETNAM

ADVISORY CIRCULAR
AC-10-016

OPERATIONAL PROCEDURES AND TRAINING REQUIREMENTS OF AIRBORNE COLLISION AVOIDANCE SYSTEM (ACAS)

SECTION 1 GENERAL

ACAS indications are intended to assist pilots in the avoidance of potential collisions and the active search for, and visual acquisition of, conflicting traffic. For ACAS to work as designed, immediate and correct crew response to ACAS advisories is essential. Delayed flight crew response to an RA or reluctance to maneuver the aircraft in response to an RA for whatever reason, can significantly decrease or negate the protection afforded by ACAS.

1.1 PURPOSE

The purpose of this Advisory Circular is to highlight the ACAS operational procedures and performance-based training requirements. More detailed information is provided in the documents outlined below.

1.2 STATUS OF THIS AC

This is the original version of this AC.

1.3 APPLICABILITY

This advisory circular is applicable to all operators or owners operating turbine-powered aeroplanes of a maximum certificated take-off mass more than 5 700 kg or authorized to carry more than 19 passengers.

Note: Any other aircraft category and class that intends to use the services of ATC should be equipped with an ACAS I.

- Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative, and explanatory material.
- Where an AC is referred to in a 'Note' below the regulation, the AC remains as guidance material,
- ACs should always be read in conjunction with the referenced regulations.

1.4 RELATED REGULATIONS

This advisory circular provides guidance regarding airworthiness reliability that is applicable to compliance with—

- VAR Part 6, Required Instruments and Equipment's
- VAR Part 10, Operations of Aircraft
- VAR Part 12, Air Operators Certification and Administration

1.5 RELATED PUBLICATIONS

The following publications also contain pertinent technical background regarding repairs and modifications—

1) International Civil Aviation Organization (ICAO)
   - Annex 6, Part 1, International Commercial Air Transport – Aeroplanes
   - Annex 6, Part 2, International General Aviation – Aeroplanes.
   - Annex 6, Part 3, International Operations – Helicopters
   - Annex 10, Vol 4, Surveillance and Collision Avoidance System
   - Document 9863 – Airborne Collision Avoidance System Manual
   - Document 8168 – Procedure for Air Navigation Services Volume III "Aircraft Operating Procedures"
2) Other publications
   - Eurocontrol – ACAS Guide
   - FAA Advisory Circular AC 120-55 – Air Carrier Operational Approval and use of TCASII

1.6 ACRONYMS

The following acronyms are used in this document—

1) **ACAS –** Airborne Collision Avoidance System
2) **ACAS X –** Airborne Collision Avoidance System X. ACAS X systems include a default logic for all intruders (ACAS Xa) and optionally include a specific logic (ACAS Xo) that can apply specific modes of collision avoidance to crew-designated intruders.
3) **ADS-B –** Automatic dependent surveillance-broadcast
4) **AGL –** Above ground level
5) **AHRS –** Attitude and heading reference system
6) **AOTO –** ADS-B only TA-only
7) **ATC –** Air Traffic Control
8) **CBT –** Computer-Based Training
9) **CPA –** Closest point of approach
10) **HVR –** High Vertical Rate
11) **RA –** Resolution advisory: an indication given to the flight crew recommending a maneuver or a maneuver restriction to avoid collision.
12) **RVSM –** Reduction Vertical Separation Minimum
13) **TA -** Traffic advisory: an indication given to the flight crew that a certain intruder is a potential threat.

SECTION 2 OPERATIONAL USE AND TRAINING

For the system to achieve its designed safety benefits, flight crews must operate the system and respond to ACAS alerts in a manner compatible with the system design. Many ACAS alerts will involve more than one ACAS-equipped aircraft. In these coordinated encounters, it is essential that each flight crew respond in a predictable manner. This Advisory Circular defines the knowledge of the system and its operation that should be included in pilot training programs and includes information on system performance, proper use of ACAS controls, and proper responses to ACAS alerts. The guidelines require both academic training and maneuver training conducted in either aircraft simulators or other computer-based trainers. Flight crews must be tested to ensure they are wholly familiar with ACAS procedures, capabilities, and limitations and are able to respond correctly to ACAS indications. Moreover, regularly scheduled recurrent training sessions shall include ACAS training

2.1 USE OF ACAS INDICATIONS

A. The information provided by an airborne collision avoidance system (ACAS) are intended to assist pilots in the safe operation of aircraft by providing advice on appropriate action to reduce the risk of collision. This is achieved through resolution advisories (RAs), which propose maneuvers, and through traffic advisories (TAs), which are intended to prompt visual acquisition and to act as a warning that an RA may follow. Traffic advisories (TAs) indicate the approximate positions of intruding aircraft that may later cause resolution advisories. Resolution advisories (RAs) propose vertical maneuvers that are predicted to increase or maintain separation from threatening aircraft. ACAS I equipment is only capable of providing TAs, while ACAS II can provide both TAs and RAs. In this chapter, reference to ACAS means ACAS II.

B. Airborne collision avoidance system (ACAS) indications shall be used by pilots in the avoidance of potential collisions, the enhancement of situational awareness, and the active search for, and visual acquisition of, conflicting traffic. ACAS procedures outlined in “Use of ACAS indicators”, shall not prevent pilots-in-commands from exercising their best judgement and full authority in the choice of the best course of action to resolve a traffic conflict or avert a potential collision.

C. The indications generated by ACAS shall be used by pilots in conformity with the following safety considerations:

1) Pilots shall not maneuver their aircraft in response to traffic advisories (TAs) only;

Note: TAs are intended to alert pilots to the possibility of a resolution advisory (RA), to enhance situational awareness, and to assist in visual acquisition of conflicting traffic. However, visually acquired traffic may not be the same traffic causing a TA. Visual perception of an encounter may be misleading, particularly at night.

Note: The above restriction in the use of TAs is due to the limited bearing accuracy and to the difficulty in interpreting altitude rate from displayed traffic information.

2) On receipt of a TA, pilots shall use all available information to prepare for appropriate action if an RA occurs; and

3) In the event of an RA, pilots shall:

(a) Respond immediately by following the RA as indicated, unless doing so would jeopardize the safety of the aeroplane;

Note: — Stall warning, wind shear, and ground proximity warning system alerts have precedence over ACAS.

Note: — Visually acquired traffic may not be the same traffic causing an RA. Visual perception of an encounter may be misleading, particularly at night.

(b) Follow the RA even if there is a conflict between the RA and an ATC instruction to maneuver;

(c) Not maneuver in the opposite sense to an RA;

Note. — In the case of an ACAS-ACAS coordinated encounter, the RAs complement each other to reduce the potential for collision. Maneuvers, or lack of maneuvers, that result in vertical rates opposite to the sense of an RA could result in a collision with the threat aircraft.

(d) As soon as possible, as permitted by flight crew workload, notify the appropriate ATC unit of the RA, including the direction of any deviation from the current ATC instruction or clearance;

Note. — Unless informed by the pilot, ATC does not know when ACAS issues RAs. It is possible for ATC to issue instructions that are unknowingly contrary to ACAS RA

indications. Therefore, it is important that ATC be notified when an ATC instruction or clearance is not being followed because it conflicts with an RA.

(e) Promptly comply with any modified RAs;

(f) Limit the alterations of the flight path to the minimum extent necessary to comply with the RAs;

(g) Promptly return to the terms of the ATC instruction or clearance when the conflict is resolved;

(h) Notify ATC when returning to the current clearance.

Note: Procedures regarding ACAS-equipped aircraft and the phraseology to be used for the notification of maneuvers in response to an RA are contained in the PANS-ATM (ICAO Doc 4444), Chapters 12 and 15.

2.2 ACAS TRAINING GENERAL

A. 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 programs. To address these deficiencies, a set of performance-based training objectives for ACAS pilot training was developed by ICAO.

B. 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).

C. The training objectives are further divided into the areas of: ACAS academic training; ACAS maneuvers training; ACAS initial evaluation; and ACAS recurrent qualification. Details concerning the Academic training and the maneuvers training are respectively contained in Appendices 1 and 2 to this AC.

2.3 ACAS INITIAL EVALUATION

A. The pilot's understanding of the academic training items should be assessed by means of a written test or interactive CBT that records correct and incorrect responses to questions.

B. The pilot's understanding of the maneuver training items should be assessed in a flight simulator equipped with an ACAS display and controls similar in appearance and operation to those in the aircraft the pilot will fly, and the results assessed by a qualified instructor, inspector, or check pilot. The range of scenarios should include:

1) Initial RAs requiring a change in vertical speed;

2) Initial RAs that do not require a change in vertical speed;

3) Maintain rate RAs;

4) Altitude crossing RAs;

5) Increase rate RAs;

6) RA reversals;

7) Weakening RAs;

8) RAs issued while the aircraft is at the maximum altitude, and multi-aircraft encounters.

C. 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 maneuvering opposite to the direction called for by the displayed RA.

D. 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, and a record should be made of whether or not each response was correct.

2.4 ACAS RECURENT TRAINING

A. ACAS recurrent training ensures that pilots maintain the appropriate ACAS knowledge and skills. ACAS recurrent training should be integrated into and/or conducted in conjunction with other established recurrent training programs. An essential item of recurrent training is the discussion of any significant issues and operational concerns that have been identified by the operator.

B. ACAS monitoring programs periodically publish findings from their analyses of ACAS events. The results of these analyses typically discuss technical and operational issues related to the use and operation of ACAS. Recurrent training programs should address the results of monitoring programs in both the academic and simulator portions of recurrent training visits.

C. Recurrent training shall include both academic and maneuver training and address any significant issues identified by line operating experience, system changes, procedural changes, or unique characteristics such as the introduction of new aircraft/display systems or operations in airspace where high numbers of TAs and RAs have been reported.

Note: Pilots should fly all scenarios once every four years.

Note: Pilots should complete all scenarios once every two years if CBT is used

2.5 HIGH VERTICAL RATE ENCOUNTERS

Operators should specify 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/sec (1500 ft/min) throughout the last 300 m (1000 ft) of climb or descent to the assigned level. These procedures are intended to avoid unnecessary airborne collision avoidance system resolution advisories in aircraft at adjacent levels. Detailed information on HVR encounters and guidance material concerning the development of appropriate procedures is contained in Appendix 3 to this AC.

2.6 APPLICABILITY

Air operators shall review their ACAS operations procedures and training programs to ensure that they are current with the requirements of Vietnam Aviation regulations/standards and the relevant ICAO Documents.

APPENDIX A ACAS ACADEMIC TRAINING

1. INTRODUCTION

A. 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 maneuver training is considered essential.

B. In developing this material, no attempt was made to define how the training program 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.

2. GENERAL

A. This training is typically conducted in a classroom environment. The knowledge demonstrations specified in this section may be met by successfully completing written tests or providing correct responses to non-real-time computer-based training (CBT) questions.

3. ESSENTIAL ITEMS

4. 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:

A. System operation

Objective: Demonstrate knowledge of how ACAS functions.

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

1) Surveillance:

(a) ACAS interrogates other transponder-equipped aircraft within a nominal range of 14 NM; and

(b) ACAS surveillance range will be reduced in geographic areas with a large number of ground interrogators and/or ACAS II-equipped aircraft. A minimum surveillance range of 4.5 NM is guaranteed for ACAS aircraft that are airborne.

Note: If the operator's ACAS implementation 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.

2) Collision avoidance:

(a) TAs can be issued against any transponder-equipped aircraft even if the aircraft does not have altitude-reporting capability;

(b) RAs can be issued only in the vertical plane and only against aircraft that are reporting altitude;

(c) RAs issued against an ACAS-equipped intruder are coordinated to ensure complementary RAs are issued;

(d) Failure to respond to an RA deprives own aircraft of the collision protection provided by its ACAS. Additionally, in 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 were own aircraft not ACAS equipped; and

(e) For ACAS X compliant systems, special operational modes (Xo) can be selected against a designated intruder. In this case, timing of RAs and types of RAs can be different from those operating in normal Xa mode. This functionality is not implemented in all ACAS X installations.

B. 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 typically based on time to closest point of approach (CPA). 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) In encounters with a slow closure rate, ACAS advisories will be issued based on distance.

(c) Thresholds for issuing a TA or RA vary with altitude. The thresholds are longer at higher altitudes;

(d) TAs generally occur 8 to 15 seconds prior to an RA;

(e) RAs occur from 15 to 35 seconds before the projected CPA; and

(f) RAs are chosen to provide the desired vertical miss distance at CPA. As a result, Ras can instruct a climb or descent through the intruder aircraft's altitude.

C. ACAS limitations

Objective: To verify 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.

(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 heading reference system (AHRS) may result in an ACAS failure. Individual operators should ensure their pilots are aware of what types of aircraft system failures will result in an ACAS failure.

(c) Some aircraft within 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 display it;

(d) ACAS may not display all proximate, transponder-equipped aircraft in areas of high density traffic;

(e) Because of design limitations, the bearing displayed by ACAS is not sufficiently accurate to support the initiation of horizontal maneuvers 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 10 000 ft/min (50.8 m:s). 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 systems/terrain avoidance warning systems (GPWS/TAWS) warnings, and windshear warnings take precedence over ACAS advisories. When either a GPWS/TAWS or windshear warning is active, ACAS aural annunciations will be inhibited, and ACAS will automatically switch to the TA only mode of operation. ACAS will remain in TA Only mode for 10 seconds after the GPWS/TAWS or windshear warning is removed.

D. ACAS inhibits

Objective: To verify 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 1 450 (±100) ft AGL;

(b) Descend RAs are inhibited below 1 100 (± 100) ft AGL;

(c) All RAs are inhibited below 1 000 (± 100) ft;

(d) All ACAS aural annunciations are inhibited below 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. Responses to climb RAs while operating at the maximum altitude or certified ceiling are expected to be complied with in the normal manner.

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

5. OPERATING PROCEDURE

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

A. Use of controls

Objective: To verify 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 was successful and when it was 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 the 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) 7) 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;

(i) Proper configuration to display the appropriate ACAS information without eliminating the display of other needed information; and

(j) Selection of various ACAS and transponder operating modes.

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

B. Display interpretation

Objective: To verify 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 6 NM and ± 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, 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 2500 ft/min, how an Increase Rate RA and a Maintain Rate RA will be displayed;

(i) AOTO TAs (for ACAS X compliant systems). If enabled on their aircraft, pilots should demonstrate knowledge about the AOTO (ADS-B only — TA-only) TA, which is depicted with a symbol different from that of a normal TA. Pilots need to be aware of the fact that AOTO Tas will not turn into an RA if the threat increases; and

(j) If appropriate, awareness that navigation displays oriented “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 program is developed, these criteria should be expanded to cover details for an operator's specific display implementation.

C. 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;

(b) Reasons for using this mode and situations in which its use may be desirable. These include operating in known 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 is not selected when an airport is conducting simultaneous operations from parallel runways separated by less than 1 200 ft, and to some intersecting runways, RAs can be expected. If an RA is received in these situations, the pilot should follow the RA, and

(c) The TA aural annunciation is inhibited below 500 ft (±100 ft) AGL. As a result, Tas issued below 500 ft AGL may not be noticed unless the TA display is included in the routine instrument scan;

D. Crew coordination

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

Criteria: Pilots must demonstrate during their preflight briefing the procedures that will be used in responding to TAs and RAs including:

(a) Division of duties between pilot flying and pilot not flying, including a clear definition of who will fly the aircraft during a response to an RA;

(b) Expected call-outs;

(c) Conditions under which an RA may not be followed and who will make this decision; and

(d) Communications with ATC.

Note: 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 program.

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

E. Reporting requirements

Objective: To verify 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 PANS-ATM, Doc 4444; and

(b) Where information can be obtained regarding the need for making written reports when an RA is issued. Various States have different reporting requirements and the material available to the pilot should be tailored to the operator's operating environment.

6. NON-ESSENTIAL ITEM

A. Advisory thresholds

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

Criteria: The pilot needs to understand 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 850 ft below FL 420 and 1 200 ft above FL 420;

(b) When the vertical miss distance is projected to be less than the ACAS target, an RA requiring a change to the existing vertical speed will be issued. The ACAS-desired separation varies from 300 ft at low altitude to a maximum of 700 ft above FL 300;

(c) When the vertical miss distance is projected to be just outside the ACAS goal, an RA which does not require a change to the existing vertical speed will be issued. This separation varies from 600 to 800 ft.; and

(d) RA fixed range thresholds vary between 0.2 at low altitude and 1.1 NM at high altitude. These fixed range thresholds are used to issue RAs in encounters with slow closure rates.

APPENDIX B ACAS MANEUVER TRAINING

1. GENERAL

A. Training pilots to properly respond to ACAS displayed information, TAs, and RAs is 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, crew resource management (CRM) aspects of responding to TAs and RAs should be practiced during this training.

B. Alternatively, the required maneuver can be carried out by means of an inter-active CBT with an ACAS display and controls similar in appearance and operation to those in the aircraft. This interactive CBT should depict scenarios in which real-time responses must be made. The pilot should be informed whether the responses made were correct. If the response was incorrect or inappropriate, the CBT should show what the correct response should be.

C. The scenarios included in the maneuver training should include:

1) initial RAs that require a change in vertical speed;

2) initial RAs not requiring a change in vertical speed;

3) maintain rate RAs;

4) altitude crossing Ras;

5) increase rate RAs;

6) RA reversals;

7) weakening RAs;

8) RAs issued while the aircraft is at a maximum altitude, and

9) multi-aircraft encounters. The scenarios should also include demonstrations of the consequences of not responding to RAs, slow or late responses, and maneuvering opposite to the direction called for by the displayed RA as follows:

D. The scenarios should also include demonstrations of the consequences of not responding to RAs, slow or late responses, and maneuvering opposite to the direction called for by the displayed RA as follows:

2. TA RESPONSE

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

Criteria: The pilot must demonstrate:

(a) Proper division of responsibilities between the PF and PM. PF should continue to fly the aeroplane and be prepared to respond to any RA that might follow. PM 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. Both pilots confirm that the aircraft they have visually acquired is that which has caused the TA to be issued. 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) Unnecessary requests for traffic information are not made following TAs;

(e) Because of the limitations described in attachment I § 3.1(C), that no maneuvers are made based solely on the information shown on the ACAS display; and

(f) When visual acquisition is attained, right of way rules are used to maintain or attain safe separation. No unnecessary maneuvers are initiated. The limitations of making maneuvers based solely on visual acquisition are understood; and

(g) For ACAS X compliant systems, recognition of AOTO TA (if enabled on aircraft) and demonstrating appropriate actions.

3. RA RESPONSE

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

Criteria: The pilot must demonstrate:

(a) Proper division of responsibilities between the PF and PM. PF should respond to the RA with positive control inputs, when required, while the PM 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 (red square on the traffic display) and responds appropriately; and

(c) For RAs requiring a change in vertical speed, initiation of a response in the proper direction is made within 5 s of the RA being displayed. The change in vertical speed is accomplished with an acceleration of approximately 1/4 g to obtain the required vertical rate. ATC is notified of the RA response without delay after initiating the maneuver using the standard phraseology.

Note: PANS-OPS (Doc 8168) states that, in the event of an RA, pilots shall respond immediately and maneuver as indicated, unless doing so would jeopardize the safety of the aeroplane. Neither crossing RAs, which cause the flight crew to direct the aircraft towards the altitude of the other aircraft, nor RAs that are contrary to ATC instructions should be considered to jeopardize the safety of the aircraft; both are routine.

Note: Timely notification to ATC that an RA is in progress is essential to ensure that the controller is aware of the RA and will not issue conflicting clearances or instructions. The pilot's initial responsibility after receiving an RA is to modify the aircraft's vertical speed to comply with the RA. Once the required vertical speed is established, the next responsibility is to advise ATC of the RA.

(d) 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 s of the RA being displayed. The change in vertical speed is accomplished with an acceleration of approximately 1/3 g;

2) For RA reversals, the maneuver is initiated within 2 1/2 s of the RA being displayed. The change in vertical speed is accomplished with an acceleration of approximately 1/3 g;

3) For RA weakening's, the vertical speed is modified to initiate a return towards level flight within 2 1/2 s of the RA being displayed. The change in vertical speed is accomplished with an acceleration of approximately 1/4 g; and

4) For RAs that strengthen, the maneuver to comply with the revised RA is initiated within 2 1/2 s of the RA being displayed. The change in vertical speed is accomplished with an acceleration of approximately 1/4 g.

5) Recognition of altitude crossing encounters and the proper response to these RAs;

6) 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;

7) 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;

8) 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;

9) 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 using the standard phraseology as soon as permitted by flight crew workload after resuming the current clearance;

10) 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;

11) That when simultaneous, conflicting instructions to maneuver are received from ATC and an RA, the RA is followed and ATC is notified using the standard phraseology as soon as permitted by flight crew workload;

12) Awareness that ACAS is designed to cope with several simultaneous threats, and that ACAS can optimize separation from two aircraft by climbing or descending towards one of them. For example, ACAS only considers intruders that it considers 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 maneuver 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;

13) The consequences of not responding to an RA and maneuvering in the direction opposite to the RA; and

14) A prompt response is made when a climb RA is issued while the aircraft is at the maximum altitude.

APPENDIX C- ACAS PERFORMANCE DURING HVR ENCOUNTERS

1. GENERAL

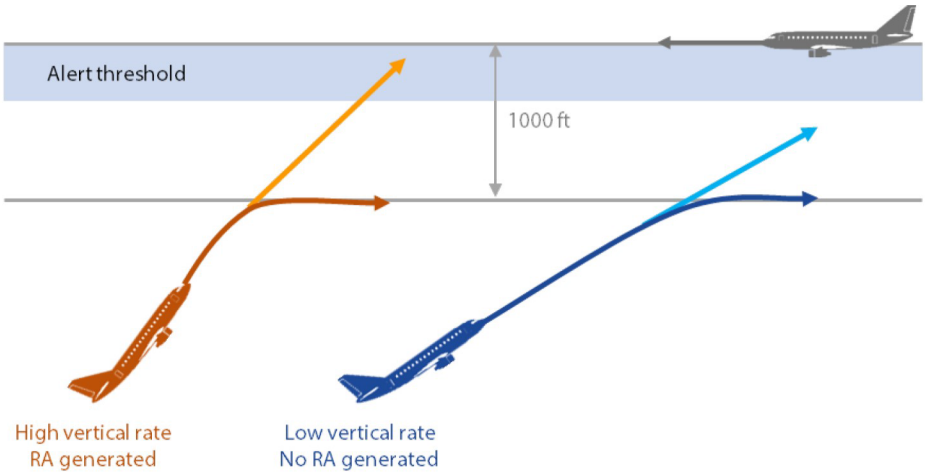
A. Data collected by ACAS monitoring programs continue to show that a large percentage of ACAS RAs are a result of climbing or descending aircraft maintaining a high vertical speed while approaching their ATC-assigned altitude. Changes have been made to the ACAS SARPs and guidance material (see Annex 10) that have been effective in reducing the frequency of occurrence for these types of RAs, but these types of RAs continue to occur with a high degree of regularity in airspace throughout the world. 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.

B. Modern aircraft and their flight guidance systems (autopilots, flight management systems, and autothrottles) are designed to fly specific flight profiles that provide fuel and time efficient flight paths. An integral concept of the design of the flight guidance systems includes allowing an aircraft to quickly climb to higher, more efficient operating altitudes and to remain at these altitudes as long as possible, which results in descents also being made with high vertical speeds. For economic benefits, the high vertical speeds used in a climb or descent are retained as long as feasible before initiating a smooth capture of the aircraft's assigned altitude.

C. The design of the flight guidance systems can result in vertical speeds in excess of 15 m/s (3000 ft/min) until they are within 150 m (500 ft) of the aircraft's assigned altitude. When a climbing or descending aircraft maintains a vertical speed in excess of 15 m/s (3000 ft/min) until it is within 150 m (500 ft) of the aircraft's assigned altitude, it is less than 30 seconds away from being at the adjacent 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 issued just as the intruder aircraft begins to reduce its vertical speed to capture its assigned altitude.

D. The following figure provides a representation of the encounter geometry of this scenario. ACAS typically issues a Climb RA, which calls for a climb at 8 m/sec (1500 ft/min). Depending on the altitude of the level aircraft, this RA will typically be issued when the intruder aircraft is approximately 500 feet below its assigned altitude and the vertical speed

of the intruder is in excess of 3000 ft/min



E. ACAS in the level aircraft is tracking a climbing/descending (intruder) aircraft and is using replies to its interrogations to determine the intruder's altitude and its vertical speed. The ACAS track is updated once per second. The intruding aircraft's track information, along with the track of the level ACAS aircraft (own aircraft), is used within ACAS to determine if the intruder aircraft is currently a threat or will be in the near future.

F. In determining whether the intruder aircraft will be a threat in the future, ACAS projects the existing vertical speed of the intruder and own aircraft, to estimate the vertical separation that will exist at the closest point of horizontal approach during the encounter. These projections use the current vertical speed of both aircraft, and ACAS is not aware of the intruder aircraft's intent to level at an adjacent altitude above or below its own aircraft's current altitude. Should this projection be less than the ACAS desired vertical separation, an RA will be issued.

G. Should the intruder aircraft continue to climb/descend with the high vertical speed until it is 15 to 25 seconds from being at the same altitude as the level ACAS aircraft (again depending on the ACAS aircraft's altitude), ACAS will issue an RA calling for the own aircraft to maneuver to increase vertical separation from the intruder aircraft.

2. OPERATIONAL IMPACT OF RAS FROM HVR ENCOUNTERS

A. Shortly after ACAS issues the RA (Climb RA for the encounter geometry shown in Figure of chapter 1.0-), the intruder aircraft begins reducing its vertical rate to capture its assigned altitude.

B. While the intruder aircraft is initiating its level off, the ACAS aircraft has started responding to its RA and may have left its assigned altitude. Both pilots and controllers agree that RAs issued in this encounter geometry are unwelcome. The RAs can be disruptive to a controller's current traffic flow and plans, and thus represent an increase in their workload. The response to the RA can also result in a loss of standard ATC separation if another aircraft is above the ACAS aircraft.

C. Pilots have reported that these types of RAs decrease their confidence in the performance of ACAS. These RAs typically occur repeatedly in the same geographic area and repeated RAs of this type result in pilots being reluctant to follow the RA. This can be potentially hazardous in the event that the intruder aircraft passes through its assigned altitude.

3. FREQUENCY OF OCURRENCES

A. ACAS monitoring shows that the frequency of occurrence is dependent on how airspace is structured and managed. Data collected during 2001 indicate that up to 70% of the RAs issued are caused by the intruder aircraft maintaining a high vertical speed while approaching its assigned altitude. Depending on the airspace structure and the flow of traffic, it is possible to have several of these RAs issued within one hour, although airspace containing a lower density of traffic will have relatively few RAs of this type. Some air traffic service providers have been able to change their traffic flows and/or operational procedures to reduce the occurrence of these types of RAs, but these types of RAs continue to occur with a high degree of regularity in airspace throughout the world.

B. HVR RAs have been observed in both terminal and en route airspace, although because of the previously higher vertical separation above FL 290 in non-RVSM airspace, very few RAs of this type have been observed above FL 290 in the past. With the current reduced separation, it is possible that HVR RAs may occur more frequently above FL 290 in RVSM airspace. Many HVR RAs occur near 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 FEATURES THAT REDUCE THE LIKEHOOD OF RAS BEING ISSUE IN THESE SITUATION OPERATIONAL IMPACTS OF RAS FROM HVR ENCOUNTERS

A. ACAS recognizes HVR encounters, such as that shown in Figure III-3-3-1. When this encounter geometry is detected, the issuance of RAs can be delayed by up to ten seconds. This delay allows additional time for the intruder aircraft to initiate a level off and for ACAS to then detect this level off. However, when the intruder aircraft maintains a vertical speed in excess of 15 m/s (3000 ft/min) until it is within 150 m (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. Safety studies have shown that further delays in issuing the RA result in unacceptable degradation in the safety provided by ACAS.

B. Consideration has also been given to providing ACAS with information regarding the intruder aircraft's intent. 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. OPERATOR SPECIFIED PROCEDURE

A. Because of the operational impacts to pilots and controllers caused by these types of RAs, the continued existence of these RAs, and the constraints on further modifications to ACAS, operators should specify procedures by which an aeroplane climbing or descending to an assigned altitude or flight level with an autopilot engaged may do so at a rate less than 8 m/ sec (1 500 ft/min) within 300 m (1000 ft) of the assigned level. Such procedural changes should provide an immediate operational benefit to both pilots and controllers by reducing the occurrence of HVR RAs.

B. The implementation of such procedures will not completely eliminate these RAs, but in the absence of other solutions such as the redesign of airspace, their implementation will reduce the frequency of these undesirable RAs until a technical solution can be developed. Options that operators should consider include flying the entire climb or descent at a pre-selected

rate, modifying the climb or descent in the latter stage, and employing use of less than economic climb thrust in lower airspace.

C. A recommended procedure would call for a climbing or descending aircraft to adjust its vertical rate when approaching an assigned altitude, and when the pilot is aware that there is an aircraft level at an adjacent altitude. The crew can be made aware of the presence of the level aircraft by several means, including information provided by a controller, an ACAS TA, or by visual acquisition. When a crew of an intruder aircraft becomes aware that another aircraft is at an adjacent altitude, it is recommended that the vertical speed of the intruder aircraft be reduced to less than 8 m/s (1500 ft/min) when approaching an altitude that is 300 m (1000 ft) above or below the assigned altitude.

Note: There is no intent in this recommendation to require a modification in vertical speed for every level off. This is not necessary and would introduce a significant increase in pilot workload.

D. Some autopilots may not properly capture the altitude if a mode change or vertical speed change is made after the altitude capture has started. Altitude deviations represent a significant percentage of pilot deviations and the performance of the autopilot during any altitude capture should be closely monitored in accordance with existing procedures.

E. Additional tasks may be required during some level off maneuvers. However, the procedure is a recommendation, not a requirement. Further, the procedure does not suggest that adjustments to the aircraft's vertical speed be made unless the pilot is aware that traffic is at an adjacent altitude.

F. The operator should specify procedures that the pilot may use to reduce vertical speed when an autopilot is engaged, as appropriate for the type of aircraft. Also, the operator should consider authorizing pilots to use a modest vertical speed throughout a climb or descent when the vertical interval is not large, such as a change of altitude in a holding pattern, specifying how this should be accomplished.

End of Advisory Circular