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GENERAL

LEGISLATION MATTERS

INTRODUCTION OF TECHNICAL STANDARDS

The following technical standards are herewith published:

TS 43.02.22(ACAS MAINTENANCE)- introduced into Document SA-CATS-GMR;

TS91.04.31(AIRBORNE COLLISION AVOIDANCE SYSTEM)- introduced into Document SA- CATS-OPS 91;

TS 91.07.30 (AIRBORNE COLLISION AVOIDANCE SYSTEM OPERATIONS)- introduced into Document SA-CATS- OPS 91;

TS 121.03.9(ACAS TRAINING)- introduced into Document SA-CATS- OPS 121; and

TS 121.05.17 (AIRBORNE COLLISION AVOIDANCE SYSTEM)- introduced into Document SA-CATS- OPS 121.

The relevant technical standards(including Appendix 1 to TS 121.03.9) were contained in a document" Guidance Material- Requirements for and operation of Airborne Collision Avoidance System (ACAS 11) that was discussed at the CARCOM meeting of 25 June 2003. The meeting in principle recommended the introduction of the relevant technical standards. As to the requirement relating to the publishing of the proposals relating to the introduction thereof as contained in regulation 11.03.2 I have decided that compliance therewith will be impractical and contrary to public interest Copies of the above-mentioned document have already been provided to the operators concerned. The date of implementation of both the amended regulations and technical standards shall be 1 October 2003.

TS 43.02.22 ACAS MAINTENANCE

1. **ACAS maintenance and testing procedures**

(Under development. See also FAA AC 20-131)

2. **Maintenance personnel reports**

Maintenance personnel must report ACAS problems that relate to system performance, manufacturers, or vendors to the owner/operator and to the Commissioner.

TS 91.04.31 AIRBORNE COLLISION AVOIDANCE SYSTEM

1. **Definitions**

"ACAS instructor" means an appropriately rated flight instructor who is an ACAS-current pilot;

"ACAS syllabus" means a syllabus of training in the use of ACAS II, as published in Appendix 1 to TS 121.03.9;

"altitude limit" means the specified projected amount of vertical separation that ACAS is designed to provide between aircraft. It is also the altitude threshold for the issuance of a corrective RA. The value of altitude limit varies with aircraft barometric altitude;

"altitude threshold" means the projected minimum altitude threshold for the issuance of a preventive RA. The altitude threshold varies with aircraft altitude;

"approved ACAS" means an airborne collision avoidance system meeting ICAO specifications for ACAS II;

"check pilot" in the context of ACAS means an ACAS-current pilot who conducts ACAS II cyclic training for an approved ATO;

“closest point of approach” means the occurrence of minimum range between an ACAS-equipped aircraft and an intruder;

“co-ordination” in relation to ACAS means the process by which ACAS units in conflicting aircraft communicate with one another to select complementary RA's to resolve an encounter;

“intruder” means an aircraft that has satisfied ACAS traffic advisory detection criteria;

“other traffic” in relation to ACAS means aircraft \pm 1 200 feet vertical and six nautical mile from an ACAS-equipped aircraft that are neither an RA nor a TA;

“proximate traffic” in relation to ACAS means aircraft within six nautical mile in range and \pm 1 200 feet vertically from an ACAS-equipped aircraft, but does not meet the ACAS thresholds of a TA or RA;

“resolution advisory (RA)” means a message to a flight crew, generated by ACAS II, alerting the crew of hazardous conflicting traffic and advising it what action should be taken immediately;

“tau” is the Greek symbol representing the time to closest point of approach;

“threat” in relation to ACAS means an intruder that has satisfied the threat detection criteria and thus requires an RA;

“traffic” in relation to ACAS means any aircraft with an operating transponder capable of being tracked and displayed by an ACAS-equipped aircraft;

“traffic advisory (TA)” means a message to a flight crew, alerting the crew of hazardous conflicting traffic but without providing the crew with advice as to what action should be taken.

Abbreviations

ALIM - means altitude limit;

ATMS - means air traffic management system;

CPA - means closest point of approach;

LOFT - means line-orientated flight training;

PF - means pilot flying;

TAS - means avoidance system;

TCAS - means traffic alert and collision system (USA/New Zealand);

TCAS - means ACAS 1 equipment meeting FAA TSO C118 specifications;

TCAS 11 - means ACAS equipment meeting FAA TSO-Cii9 specifications; the equipment comes in two versions, namely 'version 6.04A' meeting TSO-c119a specifications, and 'version 7' meeting both TSO-C119b and ICAO and ACAS 11 specifications; and ZTHR means altitude threshold.

2. Terminology

(1) The term 'airborne collision avoidance system' (ACAS) is used by the International Civil Aviation Organisation (ICAO) in Annex 6 to the Convention on Civil Aviation to describe a system that provides an automatic warning to the pilots when the system detects other aircraft in potentially hazardous proximity. Annex 6 prescribe a version of ACAS known as ACAS II.

(2) The US Federal Aviation Administration (FAA) uses the term 'traffic alert and collision avoidance system' (TCAS) to describe the US-developed equipment that provides the functions of ACAS. There are two versions of TCAS: TCAS I and TCAS II. TCAS I provides traffic alert (TA) messages but not resolution advisory (RA) messages to pilots. TCAS II provides both TA and TR. New Zealand also uses the term 'traffic alert and collision avoidance system'.

3. Specifications

(1) The ICAO definitions and technical specifications for ACAS and its variants are contained in Annex 10, Volume IV.

(2) Technical specifications for TCAS I equipment are contained in FAA Technical Standard Order (TSO) TSO-C118 series. Technical specifications for TCAS II equipment are contained in TSA-C119 series. Earlier equipment, meeting TSO-C119a, is known as "version 6.04A". The latest specification for TCAS II equipment is contained in TSO-C119b and is known as "version 7" equipment. Only the latter equipment meets the ICAO ACAS II specifications contained in Annex 10, Volume IV.

4. **Prescribed equipment**

- (1) *From 1 July 2003, all turbine-engine aeroplanes of a maximum certificated mass in excess of 15 000 kg or with a maximum approved passenger seating configuration in excess of thirty (30) passengers, used in commercial air transport operations, shall be fitted and operated with serviceable equipment meeting ACAS II specifications.*
- (2) ***From 1 January 2005, all turbine-engine aeroplanes of a maximum certificated mass in excess of 5 700 kg or with a maximum approved passenger seating configuration in excess of nineteen (19) passengers, used in commercial air transport operations, shall be fitted and operated with serviceable equipment meeting ACAS II specifications.***
- (3) ***In the case of aeroplanes, referred to in sub-regulation (2), that - at the time of regulation 91.04.31 having been put into operation, or of aeroplanes that are put on the South African civil aircraft register between such date and 31 December 2004 - are fitted with any ACAS equipment, owners or operators thereof shall retain such equipment in an operative condition. Where applicable, upgrading of such equipment to ACAS II specification shall only be required after 31 December 2004 when the equipment becomes unserviceable beyond reasonable repair.***
- (4) *Owners of aeroplanes, not required in terms of the Regulations to carry ACAS, are encouraged to have such equipment fitted or specified in respect of newly ordered aircraft notwithstanding. In this respect it is pointed out that lower-performance systems such as TCAS I or TA'S (Traffic Avoidance Systems) do not provide RA information to pilots. TCAS I systems, furthermore, have a much reduced surveillance capability than the ACAS II-based surveillance systems and are particularly prone to reduced range and interference effects when there are a number of other TCAS I or ACAS II aircraft in the area.*

ACAS II provides RA advice automatically co-ordinated with an intruder aeroplane if the intruder is also ACAS II equipped. If encountering a Mode C transponder-equipped aircraft, RA advice is also provided, based on the projected flight path of the Mode C transponder-equipped intruder.

5. **Certification and operational approval**

- (1) *The installation of ACAS equipment requires CAA airworthiness certification in terms of an amendment to the aeroplane's type certificate in the issuance of a supplementary type certificate.*
- (2) *The operation of ACAS equipment requires CAA approval of the relevant changes to maintenance programmes, manuals, operational procedures, Minimum Equipment List (MEL) and other areas necessary for safe and effective ACAS use, and the qualification of aircrews through approved training programmes.*

TS 91.07.30 AIRBORNE COLLISION AVOIDANCE SYSTEM OPERATIONS

1. **Operational use**

- (1) *Pilot responsibilities*

ACAS is intended to serve as a support to visual collision avoidance, application of right-of-way rules, and air traffic separation services. For ACAS to work as designed, immediate and correct crew response to ACAS advisories is essential. Delayed crew response or reluctance of a flight crew to adjust the aircraft's flight path, as advised by ACAS, due to air traffic control (ATC) clearance provisions, fear of later CAA scrutiny, or other factors could significantly decrease or negate the protection afforded by ACAS. Flight crews are expected to respond to ACAS in accordance with the following guidelines:

- (a) *Respond to TA's by attempting to establish visual contact with the intruder aircraft and other aircraft that may be in the vicinity. Co-ordinate to the degree possible with other crew members and ATC to assist in searching for traffic. Do not deviate from an assigned clearance based only on TA information. For any traffic that is acquired visually, continue to maintain or attain a safe separation in accordance with current regulations and accepted operating practices.*
- (b) *When an RA occurs, the pilot flying (PF) should respond immediately by direct attention to RA displays and manoeuvre as indicated, unless doing so would jeopardise the safe operation of the flight, or the flight crew can assure separation with the help of definitive visual acquisition of the aircraft causing the RA. By not responding to an RA, the flight crew effectively takes responsibility for achieving safe operation. In so choosing, the following cautions should be considered:*
 - (i) *The traffic acquired visually may also be equipped with ACAS and it may manoeuvre in response to an RA that has been automatically co-ordinated with your own ACAS.*

- (ii) *The traffic acquired visually may not be the same traffic causing the RA.*
- (iii) *Visual perception of the encounter may be misleading. Unless it is unequivocally clear that the target acquired visually or confirmed by ATC is the one generating the RA and there are no other complicating circumstances, the pilot's instinctive reaction should always be to respond to RA's in the direction and to the degree displayed.*

(c) *Satisfy RA's by disconnecting the autopilot, if necessary, using prompt, positive control inputs in the direction and with the magnitude ACAS advises. To achieve the required vertical rate (normally 1 500 feet-per-minute (fpm) climb or descent), first adjust the aircraft's pitch using the suggested guidelines shown in the table below. Then refer to the vertical speed indicator (VSI) and make all necessary pitch adjustments to place the VSI in the green arc.*

| SPEED | PITCH ADJUSTMENT |
|-----------------------------------|-------------------------|
| <i>.80 MACH</i> | <i>2°</i> |
| <i>250 KIAS below 10 000 feet</i> | <i>4°</i> |
| <i>APPROACH below 200 KIAS</i> | <i>5° to 7°</i> |

- (i) *On aircraft with pitch guidance for ACAS RA displays, follow the RA pitch command for initial, increase, and weakening RA's.*
 - (ii) *For ACAS to provide safe vertical separation, initial vertical speed response is expected within five seconds of when the RA is first displayed. Excursions from assigned altitude, when responding to an RA, typically should not be more than 300 to 500 feet to satisfy the conflict. Vertical speed responses should be made to avoid red arcs or outlined pitch avoidance areas and, if applicable, to accurately fly to the green arc or outlined pitch guidance area.*
- (d) *Respond immediately to any "increase" or "reversal" RA manoeuvre advisories. Initial vertical speed response to an increase or reversal RA is expected by ACAS within 2½ seconds after issuance of the advisory. Again, avoid red arcs or outlined pitch avoidance areas and fly to the green arc or outlined pitch guidance area.*
- (e) *The pilot not flying (PNF) should advise the PF on the progress of achieving the vertical rates commanded by ACAS. The PNF and any on-board observers will assist in the visual search for the intruder and continue to cross-check the ACAS displayed information with other available traffic information and ATC to ensure the RA response is being flown correctly.*
- (f) *If an initial corrective RA is downgraded or weakened, such as a "climb" RA downgraded to an "do not descend" RA, pilots should respond to the weakening RA and adjust the aircraft's vertical speed accordingly, but still keep the needle or pitch guidance symbol out of the red arc or outlined pitch avoidance area. Pilots are reminded that attention to the RA display and prompt reaction to the weakened RA will minimise altitude excursions and potential disruptions to ATC. This will allow for proper ACAS-to-ACAS resolution of encounters and reduce the probability of additional RA's against the intruder or other traffic.*
- (g) *Excessive control inputs in response to ACAS RA's are inappropriate and may increase interference with other traffic and result in additional RA's.*
- (h) *In some instances, it may not be possible to respond to an ACAS RA and continue to satisfy an ATC clearance at the same time. Even if an ACAS RA manoeuvre is inconsistent with the current clearance, respond appropriately to the RA. Since ACAS tracks all transponder-equipped aircraft in the vicinity, responding to an RA for an intruder assures a safer avoidance manoeuvre from that intruder and from other Mode C transponder equipped aircraft. Guidance in this paragraph does not conflict with that in paragraph 2(2)(b). Exceptions noted in paragraph 2(2)(b) are meant to hold down obvious nuisance excursions and unsafe handling of the aircraft.*
- (i) *If an ACAS RA requires manoeuvring contrary to "right-of-way" rules, "cloud clearance" rules for visual flight rules (VFR), instrument flight rules (IFR), or other such criteria, pilots are expected to follow the ACAS RA's to resolve the immediate traffic conflict. Deviations from rules or clearances should be kept to a minimum necessary to satisfy an ACAS RA.*
- (j) *If an ACAS/TCAS response requires deviation from an ATC clearance, expeditiously return to the current ATC clearance when the traffic conflict is resolved, the ACAS "clear of conflict" message is heard, or follow any subsequent change to clearance as advised by ATC. In responding to an ACAS*

RA that directs a deviation from assigned altitude, communicate with ATC as soon as practicable after responding to the RA. When the RA is cleared, the flight crew should advise ATC that they are returning to their previously assigned clearance or should acknowledge any amended clearance issued. In addition, the flight crew's discretionary use of other types of reports may be desired. See AIC 41.6 for suggested phraseology.

- (k) *If an ACAS RA manoeuvre is contrary to other critical cockpit warnings, then those other critical cockpit warnings are respected as defined by ACAS certification and training (that is, responses to a stall warning, windshear and Ground Proximity Warning System (GPWS) take precedence over an ACAS RA, particularly when the aircraft is less than 2 500 feet above ground level (AGL)).*
 - (l) *Pilots should use ACAS traffic information displays to increase their awareness of nearby traffic and to assist in establishing visual contact with other aircraft. Certain Electronic Flight Information System (EFIS) ACAS installations operating in conjunction with "track up" mode may require the pilot to make allowances for the difference between the aircraft heading and track when visually sighting nearby aircraft.*
 - (m) *Pilots are expected to operate ACAS while in flight in all airspace, including oceanic, international, foreign and domestic airspace.*
 - (n) *When feasible, flight crews should use the same altitude data source that is being used by the PF to provide altitude information to ACAS and the ATC transponders. Using a common altitude source precludes unnecessary RA's due to differences between altitude data sources.*
 - (o) *Note and accurately report ACAS encounters and system anomalies in accordance with operator policies so that remedial improvements to ACAS or the Air Traffic Management System (ATMS) may be initiated.*
 - (p) *ACAS does not alter or diminish the pilot's basic authority and responsibility to ensure safe flight. Since ACAS does not respond to aircraft that are not transponder-equipped or aircraft with a transponder failure, ACAS alone does not ensure safe separation in every case. ACAS RA's may, in some cases, conflict with flight path requirements due to terrain, such as an obstacle-limited climb segment or an approach to rising terrain. Since many approved instrument procedures and IFR clearances are predicated on avoiding high terrain or obstacles, it is particularly important that pilots maintain situational awareness and continue to use accepted operating practices and judgement when following ACAS RA's. Maintain frequent outside visual scan, "see-and-avoid" vigilance, and continue to communicate as needed and as appropriate with ATC.*
- (2) *Potential Consequences. The potential consequences of improperly manoeuvring the aircraft in response to an RA include:*
- (a) *An aircraft seen visually may not necessarily be the aircraft causing the RA or may not be the only aircraft to which ACAS is responding.*
 - (b) *It is difficult to visually determine the vertical displacement of other aircraft especially when ground reference information is unreliable or at cruise altitudes where the earth's horizon is obscured. Therefore, disregarding RA information and manoeuvring vertically based solely on visual acquisition may result in a loss of safe separation.*
 - (c) *ATC may not know when ACAS issues RA's. It is possible for ATC to unknowingly issue instructions that are contrary to the ACAS RA indications. Safe vertical separation may be lost during ACAS co-ordination when one aircraft manoeuvres opposite the vertical direction indicated by ACAS and the other aircraft manoeuvres as indicated by ACAS. As a result, both aircraft may experience excessive altitude excursions in "vertical chase" scenarios due to the aircraft manoeuvring in the same vertical direction. Accordingly, during an RA, do not manoeuvre contrary to the RA based solely upon ATC instructions.*
 - (d) *ATC may not be providing separation service or be communicating with the aircraft causing the RA.*
 - (e) *Failure to manoeuvre during a co-ordinated encounter with another ACAS-equipped aircraft can result in loss of safe separation.*
- (3) *ACAS Accepted Operating Practices.*

- (a) *To preclude unnecessary transponder interrogations and possible interference with ground radar surveillance systems, ACAS should not be activated in either TA or TA/RA mode until taking the active runway for departure. The standby mode for a Mode S transponder is adequate in order for ATC to “see” the aircraft while taxiing on the aerodrome surface.*
- (b) *Following landing and clearing of the runway, ACAS should be selected to the “standby” mode as specified by the operator’s operating procedures or local aerodrome surveillance requirements.*
- (c) *During flight, ACAS displays should be used to enhance situational awareness. Displays, that have a range selection capability, should be used in an appropriate range setting for the phase of flight and area of operation. For example, use minimum range settings in the terminal and longer ranges for climb/descent and cruise, as appropriate.*
- (d) *It is appropriate to operate ACAS in the TA-only mode in circumstances where unnecessary RA’s frequently occur and where such RA’s are disruptive to the operation of the aircraft. These circumstances may include:*
 - (i) *During take-off towards known nearby traffic that is in visual contact and which could cause an unwanted RA during initial climb, such as a visually identified helicopter passing near the departure end of the runway. The TA/RA mode should be selected after the potential for an unwanted RA cease to exist, such as after climbing above a known VFR corridor.*
 - (ii) *In instrument or visual conditions during approached to closely-spaced parallel runways.*
 - (iii) *in visual conditions, when flying in close proximity of other aircraft.*
 - (iv) *In the vicinity of an aerodrome where separation standards may have been reduced, during particular procedures, or in circumstances identified by the operator as having a significant potential for unwanted or inappropriate RA’s.*
 - (v) *In the event of particular in-flight failures, such as engine failure, as specified by the flight manual or the operator.*
 - (vi) *During take-offs or landings outside of the nominal ACAS reference performance envelope for RA’s, as designated by the flight manual or operator. ACAS reference performance for RA’s is typically attainable during take-offs and landings at aerodromes within the envelope of ISA ± -4° C, sea level to 5 300 feet MSL. When take-offs or landings are outside this envelope, use of “TA only” may be appropriate during the limited period when ACAS reference performance cannot be achieved. This typically occurs when the aircraft is at low speed in specified limiting configurations during take-off or landing at “hot day” high-altitude aerodromes.*
 - (vii) *When participating in Parallel Runway Monitoring (PRM) Operations.*
- (e) *When safe, practical, and in accordance with the operator’s approved operating procedures, pilots should limit vertical speeds to 1 500 ft/min or less within 2 000 feet of assigned altitudes. This procedure will reduce the frequency of unnecessary RA’s and be in conformance with the Aeronautical Information Manual (AIM) and ICAO guidance.*

2. **ACAS event reporting**

(1) *Pilot reports*

- (a) ACAS-specific reports. *Pilots should make the following reports for ACAS TA’s and RA’s as necessary:*
 - (i) *Upon query from ATC, or after deviation from an ATC clearance, make radio communications as appropriate to report a response to an ACAS advisory. Refer to AIC 41.6 for recommended phraseology.*
 - (ii) *Reports, as specified by the operator, concerning ACAS anomalies, procedural difficulties, or system failures typically are made by pilots through one or more of the following methods:*

- (aa) Pilot/observer questionnaire;
- (bb) Logbook entry ;
- (cc) Other record used by the operator, such as a captain's report. An example of a typical reporting form for ACAS event information is shown in AIC 16.3.

(b) Other reports incidental to ACAS

- (i) AIRPROX reports. Flight crews should continue to submit AIRPROX reports in accordance with existing policies and procedures. Crews should be aware that there is no requirement to submit an AIRPROX report solely due to an ACAS event and that an ACAS report does not constitute an AIRPROX report.
- (ii) Compliance with ATC Clearances and Instructions reports. Unless required due to other circumstances, reports regarding emergency deviation from an ATC clearance are not necessary solely as a result of an ACAS manoeuvre.
- (iii) Aviation Safety Reporting System (ASRS) reports. ASRS reports may be filed at the discretion of the flight crew.

TS 121.03.9 ACAS TRAINING

1. General

- (1) Any ACAS training programme shall ensure that on completion the pilot is able to demonstrate proficiency in the following:
 - (a) Knowledge of ACAS II concepts, systems and procedures; and
 - (b) cognitive, procedural, and motor skills necessary to properly respond to ACAS advisories.
- (2) There are no formal ACAS evaluation requirements for flight testing and examination. An ACAS instructor shall accomplish evaluation of ACAS objectives during training.

2. ACAS initial training

- (1) A pilot must complete ACAS initial training in respect of each aeroplane type for which he or she is rated.
- (2) ACAS initial training may be provided as a stand-alone module of ground and flight training, or may be integrated with other initial, transition or upgrade ground and flight training programmes.
- (3) With the approval of the Commissioner, an operator may contract with another operator, or with an ATO approved to operate an aeroplane for instrument flight instruction, to provide the ACAS initial training to its flight crew, provided such ACAS initial training is conducted in aeroplanes and with ACAS equipment, and in accordance with procedures and other relevant factors or circumstances that are the same or equivalent to those of the particular operator.
- (4) A pilot completes ACAS initial training when –
 - (a) an ACAS instructor certifies in the pilot's logbook that the pilot has completed ACAS initial training conducted by an ATO approved to operate aircraft for instrument flying training; or
 - (b) a CAA flying inspector certifies in the pilot's logbook that the pilot has completed ACAS initial training conducted by the CAA; or
 - (c) on a day during the year 2003 the pilot completes ACAS renewal training.

3. ACAS renewal training

- (1) ACAS renewal training –
 - (a) shall be integrated with recurrent flight training during proficiency training or line-orientated flight training; while
 - (b) ground training shall be provided as a stand-alone module; and

should 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 traffic advisories (TA) and resolution advisories (RA) have been reported.

- (2) *Routine ACAS operations must be included in all evaluation environments and testing officers should include ACAS as a routine discussion item.*
- (3) *A pilot completes ACAS renewal training when –*
 - (a) *an ACAS instructor certifies in the pilot's logbook that the pilot has completed ACAS renewal training conducted by an ATO approved to operate aircraft for instrument flying training; or*
 - (b) *a CAA flying inspector certifies in the pilot's logbook that the pilot has completed ACAS renewal training conducted by the CAA.*
- (4) *An ACAS instructor is deemed to have completed ACAS renewal training when the instructor conducts ACAS initial training or ACAS renewal training.*

4. ACAS cyclic training

- (1) *A pilot completes a session of ACAS cyclic training when a check pilot certifies in the pilot's logbook that the pilot has successfully completed a training session.*
- (2) *A pilot is deemed to have completed –*
 - (a) *ACAS initial training on the first occasion that the pilot completes a session of ACAS cyclic training; and*
 - (b) *ACAS renewal training on the second or a subsequent occasion that the pilot completes a session of ACAS cyclic training.*
- (3) *A check pilot is deemed to have completed ACAS renewal training when the check pilot conducts ACAS cyclic training.*

5. ACAS training programme requirements

- (1) *Curriculum*

Appendix 1 contains the required areas of instruction for ground training for the ACAS initial training. For subsequent aeroplane types and for ACAS renewal training only the new, revised, or emphasised items needs to be addressed. Appendix 1 also contains the objectives and related simulation characteristics required for flight training.
- (2) *Evaluation*
 - (a) *ACAS theoretical knowledge shall be evaluated with written, oral or computer-based instructional tests. Combinations of these methods may be used if the required body of knowledge is completely covered. For any of these methods, a passing grade of 90 per cent must be achieved. Initial qualification in any type aeroplane must include evaluation of all knowledge areas. For renewal training and cycle training, complete coverage of the knowledge requirements must be completed every 36 months.*
 - (b) *ACAS skills (manoeuvres) must be evaluated by an ACAS instructor for initial qualification in each type aeroplane. This evaluation may be accomplished in a simulator, approved for the manoeuvres.*
 - (c) *For ACAS renewal training and cyclic training, all manoeuvres must be provided during training in any 36-month period. Renewal training is desirable in a simulator, approved for the manoeuvres.*
- (3) *Line-orientated flight training (LOFT)*

LOFT programmes, using simulators equipped with ACAS, should be enhanced by an interactive ACAS. In addition, LOFT programmes should consider proper crew vigilance for aircraft that may not be transponder- or Mode C transponder-equipped. ACAS advisories accomplished during LOFT are creditable toward initial or renewal qualification.

6. **ATO approval**

ATOs conducting training, such as contract training, or aircraft manufacturers may have ACAS elements of their training programmes approved by the Commissioner if curriculum requirements (ground and flight) provided in Appendix 1 are met.

7. **Crew resource management (CRM)**

CRM programmes should address effective teamwork in responding to ACAS events, with emphasis on the following areas:

- (a) The crew should conduct pre-flight briefings on how ACAS advisories will be handled; and
- (b) The proper reaction to a TA by the pilot-flying (PF) and the pilot-not-flying (PNF).

APPENDIX 1 TO TS 121.03.9 ACAS GROUND AND FLIGHT TRAINING REQUIREMENTS

1. **Introduction**

This appendix provides a set of training standards for ACAS II pilot training. The information contained in this appendix, related to TA's, is also applicable to TCAS I users. Training standards are divided into the areas of instruction required for ground training (theoretical knowledge) and the performance objectives for the manoeuvres required in flight training (skill).

2. **Theoretical knowledge**

Note: The theoretical knowledge training, as applied herein, is that part of any theoretical training course that exclusively addresses acquiring the required ACAS concepts, systems, limitations, or procedures knowledge (rather than skills), and demonstration of that knowledge. ACAS academic training generally is accomplished using a combination of classroom methods (stand-up instruction, slide/tapes, computer-based instruction, tutorial, etc.), flight manual, information bulletins, or self-study.

The theoretical knowledge training course must cover the following areas:

(1) General concepts of ACAS operation

The course should cover, in general terms, ACAS theory, to the extent appropriate, to ensure proper operational use. Flight crews should understand basic concepts of ACAS logic, CPA (closest point of approach), tau, altitude separation thresholds for the issuance of RA's, as well as the relationship between displayed traffic information and issuance of TA's and RA's. The theoretical training programme should address the following:

- (a) The meaning of TA's and preventive versus corrective RA's;
- (b) Increase, reversal, crossing and weakened RA's;
- (c) That ACAS II assures separation from Mode C transponder-equipped aircraft;
- (d) The detection and protection provided by ACAS against altitude-reporting and non-altitude-reporting intruders;
- (e) That the system detects multiple aircraft;
- (f) ACAS-to-ACAS co-ordination;
- (g) The potential impact of not following RA's;
- (h) ACAS surveillance range versus display range;
- (i) When an intruder will not be displayed;
- (j) ACAS on ground performance; and
- (k) The continued applicability of the see-and-avoid concept.

(2) Expected flight crew response and level of protection provided by ACAS

The theoretical knowledge course should explain the normal, expected pilot response to TA's, RA's, use of displayed traffic information to establish visual contact, and constraints on manoeuvring based solely on TA's.

(3) ACAS general limitation

There are several system, operational, and performance limitations that should be understood that apply to all aircraft types. System limitations include the inability of ACAS to detect non-transponder-equipped aircraft, no RA's issued for traffic without an altitude-reporting transponder, etc. Operational limitations include some RA-inhibit altitudes, certain RA's being inhibited by aircraft performance constraints, the inability to comply with an RA due to aircraft performance limitation after an engine failure, and appropriate response to RA's in

limiting performance conditions, such as during heavy-mass take-off or while en route at maximum altitude for a particular mass.

(4) ATC communication and co-ordination

Training should discuss communication and co-ordination with ATC, related to or following an ACAS event, when to contact ATC, and accepted ACAS phraseology. (See also AIC 41.6.)

(5) ACAS equipment components, controls, displays, audio alerts, and annunciations

Training should include a discussion of ACAS terminology, symbology, operation, and operational controls and display features, including any items particular to an operator's implementation or unique to his or her system.

(6) Interfaces and compatibility with other aircraft systems

Training should discuss the role of the Mode S transponder with a correct, discreet address installed, radar altimeter inputs to ACAS, and weather radar/EFIS interfaces, including any item particular to an operator's implementation or unique to his or her system.

(7) Aircraft flight manual (AFM) information

AFM provisions should be addressed, including information on ACAS modes of operation; normal and atypical flight crew operating procedures; and responses to TA's, RA's, and any AFM limitations.

(8) MEL operating provisions.

(9) Appropriate pilot response to ACAS RA's and TA's, ATC clearance compliance, nuisance alerts, and other such issues.

(10) The operator's ACAS-event reporting policies for flight crews.

(11) Flight crew procedures for reporting ACAS malfunctions or irregularities, if not otherwise addressed by routine maintenance procedures of the operator.

3. **Classroom training**

An understanding of ACAS operation and the criteria used for issuing TA's and RA's may be assessed using the following objectives and criteria. This training should address the following topics:

(1) System operation:

(a) Objective: Demonstrate knowledge of how ACAS functions.

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

(i) Surveillance:

(aa) ACAS interrogates other transponder-equipped aircraft within a nominal range of 1 nautical miles (NM).

(bb) ACAS surveillance range can be reduced in geographic areas with a large number of ground interrogators or ACAS II equipped aircraft.

- (ii) *Collision avoidance:*
 - (aa) *TA's 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.*
 - (bb) *RA's can be issued only against aircraft that are reporting altitude and in the vertical plane only.*
 - (cc) *RA's issued against an ACAS-equipped intruder are co-ordinated to ensure complementary RA's are issued.*

(2) *Advisory thresholds*

- (a) *Objective: Demonstrate knowledge of the criteria for issuing TA's and RA's.*
- (b) *Criteria: The pilot must be able to demonstrate an understanding of the methodology used by ACAS to issue TA's and RA's and the general criteria for the issuance of these advisories to include:*
 - (i) *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 ATC are different from the miss distances against which ACAS issues an alert.*
 - (ii) *Thresholds for issuing a TA or RA vary with altitude. The thresholds are larger at higher altitudes.*
 - (iii) *The TA tau threshold (trigger point) varies from 15 to 48 seconds before the projected CPA, and the RA tau threshold varies from 15 to 35 seconds.*
 - (iv) *RA's are chosen to provide the desired vertical miss distance at CPA. As a result, RA's can instruct to climb or descent through the intruder aircraft's altitude.*

(3) *ACAS limitations*

- (a) *Objective: To verify the pilot is aware of the limitations of ACAS.*
- (b) *Criteria: The pilot must demonstrate a knowledge and understanding of the ACAS limitations including:*
 - (i) *ACAS will neither track nor display non-transponder equipped aircraft, nor aircraft not responding to ACAS Mode C interrogations.*
 - (ii) *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 onboard systems, such as Inertial Reference System (IRS) or Attitude Heading Reference System (ARHS), may result in an ACAS failure. Individual operators should ensure that their pilots are aware of what types of failures will result in an ACAS failure.*
 - (iii) *An intruder aircraft within 380 feet AGL (nominal value) may or may not be displayed by your ACAS (i.e., declared to be airborne or on the ground respectively) depending upon whether the intruder is Mode S or ATCRBS Mode C equipped and whether your ACAS equipped aircraft is airborne or on the ground.*
 - (iv) *ACAS may not display all proximate transponder-equipped aircraft in areas of high-density traffic.*
 - (v) *Because of design limitation, the bearing displayed by ACAS is not sufficiently accurate to support the initiation of horizontal manoeuvres based solely on traffic display.*
 - (vi) *Because of design limitations, ACAS will not track intruders with a vertical speed in excess of 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.*
 - (vii) *Ground-proximity warning system (GPWS) warnings and windshear warnings take precedence over ACAS advisories. When either a GPWS or windshear warning is active, ACAS aural annunciations will be inhibited.*

(4) ACAS inhibits

- (a) *Objective: To verify that the pilot is aware of the conditions under which certain functions of ACAS are inhibited.*
- (b) *Criteria: The pilot must demonstrate a knowledge and understanding of the various ACAS inhibits including:*
- (i) *Increase Descent RA's are inhibited below 1 450 (± 100) feet AGL.*
 - (ii) *Descend RA's are inhibited below 1 100 (± 100) feet AGL.*
 - (iii) *All RA's are inhibited below 1000 (± 100) feet.*
 - (iv) *All ACAS aural annunciations are inhibited below 500 (± 100) feet AGL. This includes the aural annunciation for TA's.*
 - (v) *Altitude and configuration under which Climb and Increase Climb RA's are inhibited. Know if your aircraft type issues Climb and Increase Climb RA's when operating at the aircraft's certified ceiling. If your aircraft type provides RA Climb and Increase Climb commands at certified ceilings, the commands are to be followed.*

Note: *In some aircraft types, Climb or Increase Climb RA's are never inhibited.*

(5) Use of controls

- (a) *Objective: To verify that the pilot can properly operate all ACAS and display controls.*
- (b) *Criteria: Demonstrate the proper use of controls including:*
- (i) *Aircraft configuration required to initiate a self test.*
 - (ii) *Steps required to initiate a self test.*
 - (iii) *Recognition when the self test was successful and when it was unsuccessful. When the self test is unsuccessful, recognising the reasons for the failure, and if possible, correcting the problem.*
 - (iv) *Recommended usage of range selection. Low ranges are used in the terminal area and the higher display ranges are used in the en route environment.*
 - (v) *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.*
 - (vi) *Recognition that the configuration of the display does not affect ACAS surveillance volume.*
 - (vii) *Selection of lower ranges when an advisory is issued to increase display resolution.*
 - (viii) *If available, selection of the display of absolute altitude instead of relative altitude and the limitations of using this display if a barometric correction is not provided to ACAS.*
 - (ix) *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.*

(6) Display interpretation

- (a) *Objective: To verify that the pilot understands the meaning of all information that can be displayed by ACAS.*
- (b) *Criteria: The pilot must demonstrate the ability to properly interpret information displayed by ACAS including:*

- (i) *Other traffic, i.e., traffic within the selected display range that is not proximate traffic, or causing a TA or RA to be issued.*
- (ii) *Proximate traffic, i.e., traffic that is within 6 NM and $\pm 1\ 200$ feet.*
- (iii) *Non-altitude reporting traffic.*
- (iv) *No bearing TA's and RA's.*
- (v) *Off-scale TA's and RA's. The selected range should be changed to ensure that all available information on the intruder is displayed.*
- (vi) *Traffic advisories. The minimum available display range that allows the traffic to be displayed should be selected to provide the maximum display resolution.*
- (vii) *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.*
- (viii) *Resolution advisories (RA Display). Pilots should demonstrate knowledge of the meaning of red and green areas displayed on the RA display and 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 A cannot be properly displayed).*
- (ix) *If appropriate, awareness that Navigation Displays orientated on Track-Up may require a pilot to make a mental adjustment for drift angle when assessing the bearing of approximate traffic.*

Note: *The wide variety of display implementation 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.*

(7) *Use of the TA-Only mode*

- (a) *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.*
- (b) *Criteria: The pilot must demonstrate the following:*
 - (i) *Knowledge of the operator's guidance for the use of TA-only mode.*
 - (ii) *Reasons for using this mode and situations in which its use may be desirable. If TA-only is not selected when an aerodrome is conducting simultaneous operations from parallel runways separated by less than 1 200 feet, and to some intersecting runways, RA's can be expected.*
 - (iii) *The TA aural annunciation is inhibited below 500 feet AGL. As a result, TA's issued below 500 feet AGL may not be noticed unless the TA display is included in the routine instrument scan.*
 - (iv) *When the TA-only mode is selected, TA's will be issued at the time an RA is normally issued.*

(8) *Crew co-ordination*

- (a) *Objective: To verify that the pilot adequately briefs other crew members on how ACAS advisories will be handled.*
- (b) *Criteria: The pilot must demonstrate his or her pre-flight briefing addresses the procedures that will be used in responding to TA's and RA's including:*
 - (i) *Division of duties between PF and PNF.*
 - (ii) *Expected call-outs.*
 - (iii) *Communications with ATC.*
 - (iv) *Conditions under which an RA may not be followed and who will make this decision.*

Notes:

1. *Different operators have different procedures for conducting pre-flight briefings and for responding to ACAS advisories. These factors must be taken into consideration when implementing the training programme.*
2. *The operator must specify the conditions under which an RA need not be followed, reflecting advice published by the Commissioner. This should not be left to the discretion of a crew.*
3. *This portion of the training may be combined with other training, such as CRM training.*

(9) *Reporting requirements*

- (a) *Objective: To verify that the pilot is aware of the requirements for reporting RA's to ATC and other authorities.*
- (b) *Criteria: The pilot must demonstrate the following:*
 - (i) *The use of phraseology contained in PANS-RAC (ICAO DOC. 4444).*
 - (ii) *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 operator's operating environment.*

(10) *ACAS Flight Training (Manoeuvre)*

The scenarios included in the manoeuvre training should include corrective RA's, initial preventive RA's, maintain-rate RA's, altitude-crossing RA's, increase-rate RA's, RA reversals, weakening RA's, and multi-aircraft encounters.

Training must provide pilots the opportunity to reach the ACAS proficiency indicated in the following TA and RA response objectives. This proficiency may be assessed and certified by an ACAS-qualified instructor.

(11) *TA responses*

- (a) *Objective: To verify that the pilot properly interprets and responds to TA's.*
- (b) *Criteria: The pilot must demonstrate the following:*
 - (i) *Proper division of responsibilities between the PF and PNF. The PF should continue to fly the aeroplane, and be prepared to respond to any RA that might follow. The PNF should provide updates on the traffic location shown on the ACAS display, using this information to help visually acquire the intruder.*
 - (ii) *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 bearing and range of the intruder (amber circle), whether it is above or below (data tag), and its vertical speed direction (trend arrow).*
 - (iii) *Other available information is used to assist in visual acquisition. This includes ATC party-line information, traffic flow in use, etc.*
 - (iv) *Because of the limitations that may exist with various display systems, the PF should not manoeuvre the aeroplane based solely on the information shown on the ACAS display. No attempts should be made to adjust the current flight path in anticipation of what an RA would advise.*
 - (v) *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, especially at high altitudes or without a definite horizon, are understood.*

(12) *RA responses*

- (a) *Objective: To verify that the pilot properly interprets and responds to RA's.*
- (b) *Criteria: The pilot must demonstrate the following:*

- (i) *Proper division of responsibilities between the PF and PNF. The PF responds to the RA with positive control inputs, when required, while the PNF provides updates on the traffic location and cross-checks between the traffic display and monitors the response to the RA. Proper CRM should be used.*
 - (ii) *Proper interpretation of the displayed information. The pilot recognises the intruder causing the RA to be issued (red square on display). Pilot responds appropriately.*
 - (iii) *For corrective RA's, the response is initiated in the proper direction within five seconds of the RA being issued..*
 - (iv) *Recognition of the initially RA being modified. Response to the modified RA is properly accomplished:*
 - (aa) *For Increase Rate RA's, the vertical speed is increased within 2½ seconds of the RA being displayed.*
 - (bb) *For RA reversals, the vertical speed is reversed within 2½ seconds of the RA being displayed.*
 - (cc) *For RA weakenings, the vertical speed is modified to initiate a return towards the original clearance within 2½ seconds of the RA being displayed.*
 - (dd) *For RA's which strengthen, the vertical speed is modified to comply with the revised RA within 2½ seconds of the RA being displayed.*
 - (v) *Recognition of altitude crossing encounters and the proper response to these RA's.*
 - (vi) *For preventive RA's, the vertical speed needle remains outside the red area on the RA display.*
 - (vii) *For Maintain Rate RA's, the vertical speed is not reduced. Pilots should recognise that a Maintain Rate RA may result in crossing through the intruder's altitude.*
 - (viii) *If a decision is made to not follow an RA, no changes in the existing vertical speed are made in a direction opposite to the sense of the displayed RA. Pilots should be aware that, if the intruder is also ACAS-equipped, the decision to not follow an RA may result in a decrease in separation at CPA because of the intruder's RA response.*
 - (ix) *When the RA weakened, pilot initiates a return towards the original clearance, and when Clear of Conflict is annunciated, pilot completes the return to the original clearance.*
 - (x) *ATC is informed of the RA as soon as time and workload permit, using the standard phraseology.*
 - (xi) *When possible, an ATC clearance is complied with while responding to an RA. For example, if the aeroplane can level at the assigned altitude while responding to a Reduce Climb or Reduce Descent RA, it should be done.*
 - (xii) *If pilots simultaneously receive instructions to manoeuvre from ATC and an RA that are in conflict, the pilot should follow the RA.*
 - (xiii) *Knowledge of the ACAS multi-aircraft logic and its limitations. For example, ACAS only considers intruders which it believes to be a threat when selecting an RA. As such, it is possible for ACAS to issue an RA against one intruder that 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.*
 - (xiv) *The consequences of both responding to, and not responding to, an RA.*
- (13) *Characteristics of training equipment suitable for manoeuvre training*
- (a) *Acceptable characteristics. Flight training devices, simulators and CBIs must have certain characteristics to be effective. This is due to the interactive nature of ACAS, the variety of encounter scenarios possible, the immediate and standardised pilot response required, and the instant and correct display interpretation that is necessary. Thus, training equipment used for ACAS flight training should have the following characteristics:*
 - (i) *The ability to functionally represent ACAS displays, controls, indications, and annunciations;*

- (ii) *Ability to depict selected traffic encounter scenarios, including ACAS display and audio advisories;*
 - (iii) *Ability to show proper ACAS reaction to depicted scenarios and advisories; and*
 - (iv) *Ability to interactively respond to pilot inputs regarding ACAS advisories, including responses to RA's displayed on relevant vertical speed and pith indicators.*
- (b) *Simulator and ACAS fidelity. For a particular ACAS, manoeuvre training may be accomplished in simulators or training devices that represent the specific aeroplane or an aeroplane that has similar characteristics. For the purposes of ACAS manoeuvre training, simulators or training devices may use simplified ACAS algorithms or displays and do not require ACAS logic or an ACAS processor. ACAS displays do not have to be identical, but must be functionally equivalent to the operator's specific aeroplane(s) in use.*
- (c) *Training device or simulator approval. Training devices or simulators meeting CAA approval are those that meet criteria qualified by the US National Simulator Evaluation Team and approved by the Commissioner. Any one or combination of the following devices or simulators that meet characteristics of paragraph (13)(a) may be used:*
- (i) *Level A through D simulators;*
 - (ii) *Level 2 through 7 flight training devices; or*
 - (iii) *Dedicated ACAS training devices acceptable to the Commissioner.*

TS 121.05.17

AIRBORNE COLLISION AVOIDANCE SYSTEM

1. Specification

The specifications for ACAS are those referred to in Technical Standard 91.04.31.

COMMISSIONER FOR CIVIL AVIATION