Chapter 6

CONTROLLER TRAINING GUIDELINES

6.1 OBJECTIVE

Based on the experience gained with ACAS operations, it is strongly recommended that air traffic controllers be provided with formal training programmes. The objective of these training programmes is to enable air traffic controllers to better manage advisories by:

a) understanding how ACAS works;

b) anticipating ACAS behaviour in their ATM environment;

c) understanding the responsibilities of pilots and air traffic controllers during an ACAS event; and

d) evaluating the effectiveness and necessity of ACAS events.

6.2 ACAS TRAINING PROGRAMMES

6.2.1 ACAS training should be included in all phases of air traffic controller training, starting as a part of the initial training for student air traffic controllers and ending in specific safety briefings after major incidents. Continuous training should be provided either by using regular ATC simulator runs or with special computer-based training tools like RITA (Replay Interface for TCAS Alerts), a dynamic graphical tool showing TCAS events from both the pilots' and controllers' perspectives.

6.2.2 The initial ACAS training should include the following theoretical material:

a) History — a chronological overview of ACAS development;

b) Definitions — ICAO and RTCA definitions (or differences) for ACAS and TCAS;

c) System overview and functionality — structure, functionality capabilities, limitations and the sequence of an ACAS event;

d) ACAS mandates — summary of the international and national equipage requirements;

e) ACAS operational procedures and provisions — for pilots and controllers, including the material contained in PANS-OPS, PANS-ATM and other national requirements;

f) ACAS behaviour in the operational ATM environment — technical and operational experience and problem areas; and

g) Developments — future aspects, outlook.
6.2.3 This theoretical training material may be useful for events such as ACAS information meetings, special briefing sessions or combined controller/pilot experience discussion groups at the local ATC facility.

6.2.4 Following the theoretical instruction, initial practical exercises should be conducted (e.g. ATC simulator runs or replays of specific ACAS events). The benefit of performing specific ACAS simulator training is that controllers will not be surprised when they have a real ACAS event in their operational environment.

6.2.5 In addition to the initial training described above, ACAS events should be incorporated in the practical simulator training of controllers. The choice of events should be designed to show controllers the different types of ACAS events and the variations in the responses of pilots. Additionally the controllers should practice the correct procedures and appropriate communication with the pilot. Once the ACAS event has finished, the controller should demonstrate the transition of the affected aircraft to the original clearance or instruction, or the integration into the new traffic scenario.

6.2.6 It is important for controllers to maintain their knowledge about ACAS. Therefore, ACAS should be integrated as a part of the safety or unusual incident content in the regular refresher or CBT-training courses for all active controllers. This will ensure that the controllers stay familiar with the ACAS procedures and regulatory requirements.

6.2.7 Whenever a major incident or safety issue occurs, air navigation service providers (ANSP) should develop a safety briefing or presentation, which includes all operational and technical aspects related to this particular event. The briefing should be held as soon as possible after the event to clarify this specific situation and should have mandatory participation.

6.2.8 Due to the incorporation of ACAS into the airspace and operational procedure development, specific ACAS training may be necessary before a new airspace design or ATC procedure can be introduced. The scope of this training will depend on the complexity and size of the planned implementation and can have a major influence on the entire development, even if there was initially no obvious connection to ACAS.

6.2.9 The ANSP is responsible for training controllers and other ATC specialists on ACAS and on expected flight crew responses to ACAS advisories. Familiarization flights for such specialists on ACAS-equipped aircraft should be made available.

6.3 RECOMMENDED CONTENT OF CONTROLLER TRAINING PROGRAMMES

6.3.1 Pilot operating procedures

6.3.1.1 Controllers should be aware of the types of information provided to the pilot by ACAS and the guidance provided to pilots during their ACAS training.

6.3.1.2 The pilot procedures for the use of ACAS are contained in Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS, Doc 8168), Volume I, Part VIII, Chapter 3.

6.3.1.3 Every pilot operating an ACAS-equipped aircraft should have received training in the operation of ACAS, the interpretation of the ACAS-displayed information, and the proper response to TAs and RAs. Experience has shown that not all pilots will respond exactly the same, given the same ACAS encounter. As a result, controllers can expect some variation in the response of pilots, even between pilots from the same operator.
6.3.1.4 When a TA is issued, pilots are instructed to initiate a visual search for the traffic causing the TA. If the traffic is visually acquired, pilots are instructed to maintain visual separation from the traffic. The pilot training programmes also indicate that no horizontal manoeuvres are to be made based solely on information shown on the traffic display. Slight adjustments in vertical speed while climbing or descending, or slight adjustments in airspeed while still complying with the ATC clearance are acceptable.

6.3.1.5 When an RA is issued, pilots are expected to respond immediately to the RA unless doing so would jeopardize the safe operation of the flight. This means that aircraft will at times manoeuvre contrary to ATC instructions or disregard ATC instructions. The following points receive emphasis during pilot training:

a) do not manoeuvre in a direction opposite to that indicated by the RA because this may result in a collision;

b) inform the controller of the RA as soon as permitted by flight crew workload after responding to the RA. There is no requirement to make this notification prior to initiating the RA response;

c) be alert for the removal of RAs or the weakening of RAs so that deviations from a cleared altitude are minimized;

d) if possible, comply with the controller’s clearance, e.g. turn to intercept an airway or localizer, at the same time as responding to an RA; and

e) when the RA event is completed, promptly return to the previous ATC clearance or instruction or comply with a revised ATC clearance or instruction.

6.3.2 Controller responsibility during an RA

6.3.2.1 The procedures to be applied for the provision of air traffic services to aircraft equipped with ACAS shall be identical to those applicable to non-ACAS-equipped aircraft. In particular, the prevention of collisions, the establishment of appropriate separation and the information which might be provided in relation to conflicting traffic and to possible avoiding action should conform with the normal air traffic services procedures and should exclude consideration of aircraft capabilities dependent on ACAS equipment.

6.3.2.2 The controller procedures used during an RA are defined in the Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444).

6.3.2.3 Controller training programmes should include the following guidance. When a pilot reports a manoeuvre induced by an ACAS RA, the controller:

a) shall acknowledge pilots’ reports of RAs using the phrase “ROGER”;

b) shall not attempt to modify the flight path of any aircraft involved in the RA;

c) shall not issue any clearance or instruction to any aircraft involved until the pilot reports returning to the terms of the assigned air traffic control clearance or instruction; and

d) should provide traffic information if deemed necessary.
6.3.2.4 Once an aircraft departs from its clearance or instruction in compliance with an RA, the controller ceases to be responsible for providing separation between that aircraft and any other aircraft affected as a direct consequence of the manoeuvre induced by the RA. The controller shall resume responsibility for providing separation for all the affected aircraft when:

a) the controller acknowledges a report from the pilot that the aircraft is resuming the assigned clearance or instruction and issues an alternative clearance or instruction, which is acknowledged by the pilot; or

b) the controller acknowledges a report from the pilot that the aircraft has resumed the assigned clearance or instruction.

6.3.2.5 Controller training should emphasize that the use of ACAS does not alter the respective responsibility of pilots and controllers.

6.3.2.6 It is technically possible to provide controllers with information about ACAS RAs as they occur. In spite of the guidance given to flight crew, controllers should not assume that the pilot is obeying the RA. Nor should controllers assume that the RA information presented to them is current and correct, because ACAS can modify, and even reverse, the RAs, and there is an unavoidable delay in conveying RA information to controllers. The magnitude of the delay is dependent on the technical implementation of the system used for downlinking RAs.

6.3.2.7 Table 6-1 outlines the interactions that should occur between pilots and controllers during an ACAS event.

6.3.3 Phraseology

6.3.3.1 To provide a concise means of communication between pilots and controllers when an RA occurs, phraseology has been developed and implemented by States and operators.

6.3.3.2 The phraseology to be used during an RA is contained in PANS-ATM, Doc 4444. When an RA requires a deviation from an ATC clearance, pilots are expected to notify the controller that an RA has occurred and then of the termination of the RA.

6.3.4 Independence of ACAS thresholds and ATC separation standards

6.3.4.1 Controller training programmes should ensure that controllers understand the relationship and differences between ACAS advisory thresholds and ATC separation standards.

6.3.4.2 ACAS thresholds are independent from ATC separation standards because ACAS does not strive to ensure separation (which is ATC’s role) but tries to avoid collision as a last resort. The main ACAS thresholds are time-based, not distance-based like most ATC separation standards. An ACAS with distance thresholds for collision avoidance purposes would be less safe in some encounter configurations. The alerting thresholds used by ACAS were developed to ensure that errors in altimetry and delays in pilot responses would not compromise the safety provided by ACAS. The following considerations elaborate on these views.

6.3.4.3 The main objective of ATC is to ensure safe separation between aircraft. In most controlled airspaces, two aircraft are considered safely separated if the vertical distance between them is greater than a vertical separation standard or if the horizontal distance between them is greater than a horizontal separation standard. Both separation standards depend mostly on the accuracy of the aircraft position.
Table 6-1. Controller/pilot interaction during an ACAS event

<table>
<thead>
<tr>
<th>ACAS Event Interaction</th>
<th>AIRCREW</th>
<th>CONTROLLER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traffic Advisory TA</strong></td>
<td>Shall not manoeuvre their aircraft in response to traffic advisories (TAs) only</td>
<td>Remains responsible for ATC separation</td>
</tr>
<tr>
<td></td>
<td>Should prepare for appropriate action if an RA occurs; but as far as practicable, pilots should not request traffic information</td>
<td>If requested by the aircrew, shall give traffic information</td>
</tr>
<tr>
<td><strong>Resolution Advisory RA</strong></td>
<td>Shall respond immediately and manoeuvre as indicated, unless doing so would jeopardize the safety of the aeroplane</td>
<td>Shall not attempt to modify the flight path of an aircraft responding to an RA</td>
</tr>
<tr>
<td></td>
<td>Shall follow the RA even if there is a conflict between the RA and an Air Traffic Control (ATC) instruction to manoeuvre</td>
<td>Shall not issue any clearance or instruction to the aircraft involved until the pilot reports returning to the terms of the assigned ATC clearance or instruction</td>
</tr>
<tr>
<td></td>
<td>Shall never manoeuvre in the opposite sense to an RA, nor maintain a vertical rate in the opposite sense to an RA</td>
<td>Shall acknowledge the report by using the phrase ROGER</td>
</tr>
<tr>
<td></td>
<td>When deviating from an air traffic control instruction or clearance in response to any RA, shall:</td>
<td>If requested by the aircrew, shall give traffic information</td>
</tr>
<tr>
<td></td>
<td>— as soon as permitted by flight crew workload, notify the appropriate ATC unit of the deviation;</td>
<td></td>
</tr>
</tbody>
</table>
provided to the controller. In practice, the vertical separation standard varies from 1 000 ft to 2 000 ft, and
the horizontal separation varies from 3 NM (in Traffic Management Areas [TMAs]) to 80 NM (oceanic tracks).
Once the distance between two aircraft falls below one of the standards, the controller no longer has a
safety margin, and the controller’s certainty of the aircraft relative positions decreases rapidly.

6.3.4.4 ACAS collision avoidance is based on the time before a possible collision between the
ACAS-equipped aircraft and the altitude-reporting intruder. Depending on the configuration of the encounter
and the speed of both aircraft, the ACAS time threshold corresponds to different distances. For example,
consider two aircraft leveled at FL 180 with a speed of 330 kt. In a head-on encounter, the distance at which
an RA could occur would be 5.5 NM, while in a 90-degree crossing, it would be only 3.9 NM. Depending on
circumstances, an RA can be triggered well within the ATC separation standards or can be triggered well
beyond the ATC separation standards.

6.3.4.5 In operation, the geometry that most frequently highlights the independence of ACAS
thresholds from ATC separation standards is the 1 000 ft level-off geometry. In this configuration, one
aircraft manoeuvres in the vertical plane with the intent of leveling-off on a FL 1 000 ft apart from a level
aircraft. When both aircraft are also in close horizontal proximity, and since the CAS logic does not know any
pilot’s intent, the vertical speed of the first aircraft can be sufficient to trigger a resolution advisory. In cases
of altitude busts, this improves a hazardous situation. However, frequently both aircraft are (and should
remain) separated in the view of ATC, and this behaviour causes many RAs where there is no loss of
separation. The number of such unnecessary RAs for 1 000 ft level-offs can be reduced by separating
vertical convergence from horizontal convergence through airspace changes or by slowing the vertical rates
of leveling-off aircraft either through procedural changes or through FMS flight profile changes.

6.3.5 Relationship between ACAS and short-term conflict alert

6.3.5.1 ACAS and short-term conflict alert (STCA) algorithms were developed and operate
independently of each other. ACAS has more frequent surveillance updates (once per second) than STCA,
while STCA has more information than ACAS regarding an aircraft’s intended flight path.

6.3.5.2 Operational experience has shown that there will be encounters in which the ACAS RA will
be issued without an STCA alarm and that there will be encounters in which STCA alarms occur without an
RA being issued. Controllers should consider ACAS and STCA as separate, independent systems.

6.3.5.3 Controller training programmes should address the interaction between ACAS and the
STCA implementation at their workplace. This portion of the controller training should include replays and
analyses of actual events where STCA, ACAS or both were triggered.

6.3.6 ACAS capabilities, limitations and operation

6.3.6.1 While not direct users, controllers are directly affected by the capabilities, limitations and
operation of ACAS. As such, controller training programmes should ensure that controllers are aware of the
following ACAS characteristics.

6.3.6.1.1 The thresholds used by ACAS for issuing RAs

6.3.6.1.2 ACAS has the ability to modify the initially issued RA as the encounter geometry changes.
The modified RAs can call for a weakening of the initial RA to minimize clearance deviations once the
ACAS-desired vertical miss distance is obtained, or there has been an increase in vertical speed or a
reversal of the direction of the initial RA.
6.3.6.1.3 The initial RA will be modified if the response to the RA results in another aircraft becoming a threat.

6.3.6.1.4 In some encounter geometries, ACAS will issue an RA that requires the ACAS-equipped aircraft to cross through the intruder aircraft’s altitude. This manoeuvre is selected only when the non-altitude crossing RA will not provide the desired separation.

6.3.6.1.5 ACAS will neither detect nor issue advisories against aircraft that are not equipped with an operating transponder.

6.3.6.1.6 ACAS will issue TAs against altitude reporting and non-altitude reporting intruders but will not issue RAs against non-altitude reporting intruders.

6.3.6.1.7 ACAS will track multiple aircraft and if two or more intruders meet the criteria for the issuance of an RA simultaneously, the RA issued will provide separation from all intruders.

6.3.6.1.8 In an encounter with another ACAS-equipped aircraft, the aircraft will coordinate their RAs to ensure they are complementary.

6.3.6.1.9 Current systems may display targets to the pilot at long ranges, e.g. 30-40 NM. However, reliable ACAS surveillance is only guaranteed out to 14 NM in en route airspace with low traffic density. As traffic density increases, reliable ACAS surveillance progressively diminishes to a guaranteed minimum of 4.5 NM.

6.3.6.1.10 The response to an RA can result in a loss of standard ATC separation with either the aircraft causing the RA or a third aircraft. If the third aircraft becomes a threat while the RA is still displayed, the RA will be modified to provide the ACAS-desired vertical miss distance from both aircraft. However, because of the differences in the RA thresholds and ATC separation standards, the modification to the RA is likely to occur after ATC separation is lost.

6.3.6.1.11 ACAS can detect and discard short-term, spurious errors in Mode C replies. However, no techniques exist that allow it to detect a constant bias error or offset. Thus, ACAS will accept Mode C replies that are erroneous, and it is possible to issue an RA based on these inputs. PANS-ATM contains procedures that permit a controller to request that the altitude reporting function of the transponder be disabled. To prevent RAs caused by erroneous Mode C reports, it is essential that this procedure be implemented and followed. Controller training programmes should emphasize the danger of allowing erroneous Mode C reports to continue. In view of the 150 m (500 ft) separation between VFR and IFR aircraft in some States, it is recommended that the tolerance for requesting the discontinuance of altitude reporting be reduced from 90 m (300 ft) to 60 m (200 ft).