

## Podcast 32 – TCAS

Hello everyone and welcome to another Talk. This week we'll keep it a little shorter than the mammoth performance episode but we'd again like to say thank you to Thiago for joining us and for offering that great prize for one of our lucky listeners. A big thank you to everyone who entered and without further ado, although we will have the compulsory drumroll for dramatic effect, please Ian. The winner of the digital version of Thiago's book is... (drum roll) Arthur Dietrich who gave us a fantastically detailed answer. Congratulations and we'll be in touch shortly with your personal code, it's a great prize and we're sure you'll find it very interesting and useful. The correct answer was of course that in using auto brakes on a dry runway the use of reverse will not affect stopping distance as the auto brake system will target a deceleration rate and will therefore modulate the brake pressure to maintain that rate if reverse was applied.

So, on to today's topic and that's a look at the 737 TCAS system. The Traffic Collision Avoidance System is designed to enhance crew awareness of nearby traffic and issues advisories for timely visual acquisition or appropriate vertical flight path manoeuvres to avoid potential collisions. It is intended as a back-up to visual avoidance, application of right-of-way rules and ATC separation. Depending on the version TCAS can track 30-50 airplanes within its surveillance area.

The responsibility for avoiding collisions remains with the flight crew and ATC and we as pilots shouldn't become preoccupied with TCAS advisories and displays at the expense of basic airplane control, normal visual lookout and other crew duties.

Our TCAS system interrogates operating transponders in other aircraft, tracks them by analysing replies, and predicts the flight paths and positions. TCAS should be initiated just before takeoff and continue until just after landing. It provides advisory and traffic displays of the other airplanes to us, the flight crew, and is independent of ground-based ATC. One thing to remember is that we will not get advisory, guidance, nor traffic display for other aircraft without operating transponders.

Starting with the least intrusive we'll take a look at the various TCAS symbols. "Other traffic" is shown as a white, hollow diamond on the ND is beyond 6nm and 1200ft vertically where as "proximate traffic" shows as a solid white diamond and is not expected to cause an alert but is within 6nm and 1200ft vertically.

A Traffic Alert or TA will be indicated by the "Traffic, Traffic" aural alert which sounds once and is then reset until the next TA occurs. A TA is generated when the other aircraft is approximately 40 seconds from the point of closest approach. TA's show as a solid yellow or amber circle on the ND, at the proper range and relative bearing. Altitude and vertical motion are included as long as the other aircraft has a mode C or S transponder. Vertical motion information is indicated by an arrow depicting a climb or descent if a change is greater than 500fpm. Symbols will show on the ND within the 40-80NM range depending on the version with traffic showing that is  $\pm 8700$ ft from current airplane altitude. If the range of the ND does not permit the display of a TA or RA an OFFSCALE annunciation appears on the ND.

RA's are depicted as a red square and are accompanied by one of various aural warnings. An RA is generated when the intruder is approximately 25 seconds from the point of closest approach. As well as the aural warning we also get manoeuvre guidance to maintain or increase separation. This appears to us on the PFD attitude display as red trapezoids and, on some versions, the vertical speed indicator. For the attitude display we are to keep the airplane symbol outside the TCAS pitch command area to ensure traffic avoidance. The vertical speed display, if fitted, turns red to indicate values to avoid or exit during an RA. The vertical speed pointer itself will be red if it is within the vertical speed tape range.

We won't list all the RA aural call outs possible, or it would get a little boring, but we'll recap a few of the more interesting ones. The "monitor vertical speed", "maintain vertical speed" or Maintain vertical speed, crossing maintain" indicate that present pitch attitude is outside the RA pitch command area so the only action is to keep it that way. The "Climb, crossing climb, climb, crossing climb" aural alert indicates for us to climb at the displayed pitch and we will climb through the traffic's altitude and the final one we'll recap is the "Climb – Climb now, Climb – Climb now" alert which is a reversal manoeuvre from an initial descent RA.

On airplanes equipped with TCAS 7.0 and earlier there have been reports of incorrect responses to the ADJUST VERTICAL SPEED ADJUST or AVSA by increasing rather than decreasing vertical speed. AVSA warnings always require a reduction in vertical speed.

This was remedied in TCAS 7.1 and later with the AVSA warning changed to LEVEL OFF, LEVEL OFF.

RVSM airspace gives rise to a higher proportion of RA events and although climb and descent profiles shouldn't be modified in anticipation unless specifically requested by ATC you will find guidance in the Gens; Aeroplane Operating Procedures for Rates of Climb and Descent where it recommends. Unless otherwise specified in an ATC instruction, to avoid unnecessary ACAS II resolution advisories in aircraft at or approaching adjacent altitudes or flight levels, 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 1500ft per minute throughout the last 1,000ft of climb or descent when the pilot is made aware of another aircraft at or approaching an adjacent altitude or flight level.

Your operator should have its own procedures here so please make sure you are aware of them.

TA or RA traffic detected which do not provide a bearing generate a no-bearing text block beneath the TRAFFIC text on the ND. The text block will still give distance, altitude and vertical motion information.

A TCAS display will automatically show when all the following conditions are met:

- 1 the transponder mode selector is in TA ONLY or TA/RA
- 2 a TCAS TA or RA occurs
- 3 neither pilot has the TCAS (TFC) display selected, and

4 in MAP, centre MAP, VOR, or APP modes.

System inhibits include the INCREASE DESCENT RA below approximately 1500ft RA, DESCEND RA below approximately 1,100ft RA and RAs below approximately 1,000ft RA. Below 1000ft rad alt when the TA/RA mode is selected on the transponder, TA only mode is enabled automatically and the TCAS message TA ONLY displays on the ND. All TCAS voice annunciations are inhibited below 500ft RA and lastly TCAS alerts are inhibited by both GPWS and windshear warnings.

The transponder panel has the TCAS controls on the left side labelled TCAS whereas the right side, is used for controlling the information your transponder sends to ATC.

Some transponders have an ABOVE, NORMAL and BELOW filter switch. In ABOVE you will get traffic from 2700ft below to 7000ft above you, in NORMAL your range will be 2700 below to 2700 above and in BELOW, yep you guessed it, from 7000ft below to 2700ft above.

Well, that's the technical side covered, how about the procedural. We'll start with the actions required for a TA. We are to look for the traffic using the traffic display as a guide and call out any conflicting traffic. If traffic is sighted, manoeuvre if needed. This statement comes with the rather important note that manoeuvres based solely on a TA potentially result in reduced separation. You would need to be very sure as a crew that manoeuvring based solely on a TA was the right thing to do.

For an RA, except a climb in the landing configuration, IF manoeuvring is needed you would disengage the AP and AT and then smoothly adjust pitch and thrust to satisfy the RA command. You would follow the lateral flight path unless visual contact with the conflicting traffic requires other action. Do not use FD pitch commands until clear of conflict. Use your company SOP call to ATC when you commence the manoeuvre and remember to call clear of conflict too.

During the RA manoeuvre, the crew attempt to establish visual contact with the target. However, visual perception of the encounter can be misleading, particularly at night. A strong word of caution is that the traffic acquired visually may not be the same traffic causing the RA.

A warning here from the manoeuvres section of the QRH states "Once an RA has been issued, safe separation could be compromised if current vertical speed is changed, except as needed to comply with the RA. This is because TCAS II to TCAS II coordination can be in progress with the intruder aircraft, and any change in vertical speed that does not comply with the RA can negate the effectiveness of the other aircrafts compliance with the RA.

Other important notes from the manoeuvre section include to immediately accomplish the approach to stall recovery if you get stick shaker or initial buffet during the RA manoeuvre and, to also relax pitch force to reduce buffet in the event high speed buffet occurs, but continue the manoeuvre.

Remember during this manoeuvre that you have disengaged the auto throttle so when climbing or descending the correct thrust inputs need to be applied or aircraft speed control will suffer. This is a very common error observed in the simulator. From experience, only a small thrust change will be required to maintain speed.

For a climb RA in the landing configuration PF will disengage the AP and AT, advance the thrust levers to ensure maximum thrust and call for flaps 15. Now PF would smoothly adjust pitch to satisfy the RA command and follow that planned lateral flight path unless visual contact requires other action.

PM would verify max thrust and position the flap lever to 15. A positive rate call should then lead to the gear coming up.

If you think of this as a maximum thrust manual Go around, you won't go far wrong, with acceleration delayed until clear of conflict.

You will then need to put the aircraft back into your desired state which we would suggest would involve a climb to MAA or MSA perhaps calling Go Around flap 15 once clear of conflict and setting normal Go-Around thrust if still climbing. If already levelling off just be careful with those flap limit speeds and reduce thrust accordingly to enable a clean-up profile to be achieved within limits, remembering to set desired airspeed in the open window in this case.

There are multiple threats associated with the execution of the RA manoeuvre and being aware of these will help you avoid them. Use the pilot competencies to deal with these threats using your knowledge, SA, FPM, communication and Teamwork to successfully navigate the event. Accurate and smooth control of the airplane is required. Stay ahead of the aircraft and anticipate control inputs. For example, if you put the aircraft into a climb or descent, make sure to keep the speed in your scan and adjust the thrust as necessary to maintain the required speed.

Once clear of the conflict, smooth and accurate flying is again required to return the aircraft to your desired state. Make sure you are in positive control by employing your basic airmanship of Aviate, Navigate, Communicate. You can now rebuild your MCP, checking your FMA's for correct mode engagement and FD guidance. Once settled on the FD and in trim you can then reengage the AP and Auto throttle and resume the desired flightpath. It's a good one to review come sim time too as we all know it's an examiner favourite.

And now for the return of... Talks Tech Ten

Q1: How many seconds from the point of closest approach will generate a TA?

Q2: Which system warnings take priority over a TCAS RA

Q3: What is displayed by the airspeed trend vector arrow on the speed tape?

Q4: Which Bus powers the standby attitude indicator?

Q5: Audio warnings for TCAS are heard through what?

Q6: How long can the cockpit voice recorder record for?

Q7: What is the maximum allowable fuel imbalance between no1 and no2 tanks?

Q8: After takeoff what height may the AP be engaged above?

Q9: What does an illuminated amber COWL ANTI-ICE light indicate?

Q10: Which tank does the fuel temperature indicator read the temperature of the fuel in?

Thanks again for listening and we hope this one has been a useful refresher of both the technical and procedural side of the TCAS system. We look at a couple of these events including a not too often seen RA on the approach over at [B737training.org](http://B737training.org) if you want more indepth briefs as well as simulator videos and debriefs. Take a look if you're interested or just continue the talk with us over on our social media pages @b737talk or contact us through the website [b737talk.com](http://b737talk.com) with any questions or suggestions for future podcasts. Until next time though, from Mark and I fly well and be safe.