



# Incidents in Air Transport

Number 3 - April 2005

## Editorial

**T**he Überlingen disaster and various spectacular air traffic incidents involved TCAS, perhaps leading to some doubts in the aviation community as to the maturity of the system. TCAS is, however, an effective tool for prevention in an increasingly complex and busy airspace and is now essential for collision avoidance. In fact, it is not only a new type of warning but also a powerful detection system, using data updated every second, which takes over when ATC tools are not precise enough and then offers a consistent solution to the crews involved.

However, as with any new system, its introduction has been accompanied by new types of problems that it is essential to learn to master through the analysis of and treatment of the greatest number of incidents possible. Since each event concerns at least two aircraft and an ATC organization, questions relating to TCAS are of concern to all.

With this in mind, the French DGAC has set up a specific group whose analyses are forwarded to Eurocontrol, which centralizes and studies all of these events. Equally, on the operators' side, events reported are studied and some specific tools have been developed for this purpose<sup>(1)</sup>.

Within the scope of its investigative mission, the BEA has collected data concerning several of these events. Detailed reports on some of these events will be published shortly. In addition a selection of cases linked to TCAS and its use are presented here.

<sup>(1)</sup> Air France's Flight Safety and Prevention service has, for example, been able to detect and understand some inverse corrections to resolution advisories thanks to flight analysis software. It proposes to supply the algorithm to any operators who request it (contact: [mail.securite.des.vols@airfrance.fr](mailto:mail.securite.des.vols@airfrance.fr)).

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# Visual avoidance maneuver following clearances leading to conflict

## History of the flights

Shortly after sunrise, two transport aircraft were flying in the upper airspace: a B737, which had taken off from the south on a short-haul flight, was climbing towards FL270 and an A330 arriving from across the Atlantic that was descending towards FL330. The two aircraft were being handled by two different control centre positions, on two different radio frequencies.

The position controlling the A330 was handling an elementary sector, whereas the position controlling the B737 was handling two grouped sectors whose limit was at FL315 (see picture). The latter control position was manned by two trainees, each under the supervision of an instructor.

At 6 h 40 min, the two sectors controlled by the latter position were separated, the lower sector being kept by the position, with the same team. The trainee radar associate controller was busy with the separation of the two sectors. His

instructor asked him to coordinate the descent of the A330 to FL310 with the preceding sector, in order to avoid it going into the upper sector. The trainee radar associate controller did so and modified the strip. The trainee radar controller was at this time transmitting a message on

the radio and his instructor was focused on the exchange, so the change in A330 level clearance was not formally passed on to them.

At 6 h 41 min, after resolving a conflict that prevented the

B737 from climbing, the trainee radar controller cleared it to FL320. In his representation of the situation, he still had the configuration with the two sectors grouped together, which led him to clear the aircraft to a level that was outside his control sector and to not transfer it to the upper sector controller. In his mind, the A330

was expected at FL330. The trainee radar associate controller and his instructor, busy with the separation of the sectors, did not hear the clearance given to the B737.

At 6 h 42 min 46 s, the safeguard system triggered an alarm related to the two aircraft. The trainee radar controller and instructor analyzed the situation with the data they had in hand. As they considered that one aircraft was climbing towards FL320 and that the other was descending toward FL330 and that they were a minute and a half away from a crossing, the safeguard alarm appeared consistent to them. There was thus no further action taken to clarify any doubt.

At 6 h 43 min 41 s, the B737 was passing through FL308 in climb and the A330 was passing through FL312 in descent. Using terminology applicable in an emergency situation, the radar controller's instructor ordered the B737 to descend immediately to FL290. The crew read back, initiated a descent maneuver and announced having the traffic in sight at the same level at eleven o'clock. It was precisely at this moment that the A330 crew switched to the new sector's frequency. At 6 h 43 min 52 s, still using emergency terminology, the radar controller's instructor ordered the A330 to climb to FL320. The pilot read back, and then immediately stated "and negative we are descending due to TCAS". The TCAS on both aircraft in fact triggered at 6 h 43 min 58 s. The B737's TCAS issued a "Climb crossing climb" RA but the pilot, who had begun his descent maneuver, chose not to follow it. In the A330 cockpit, a "Descend crossing descend" alert was triggered.

The controller, in accordance with the procedures, did not intervene until the end of the conflict.

Considering pilot response time and perceptions on the vertical axis, the B737 reached an altitude that was higher than that of the A330 before starting its descent.

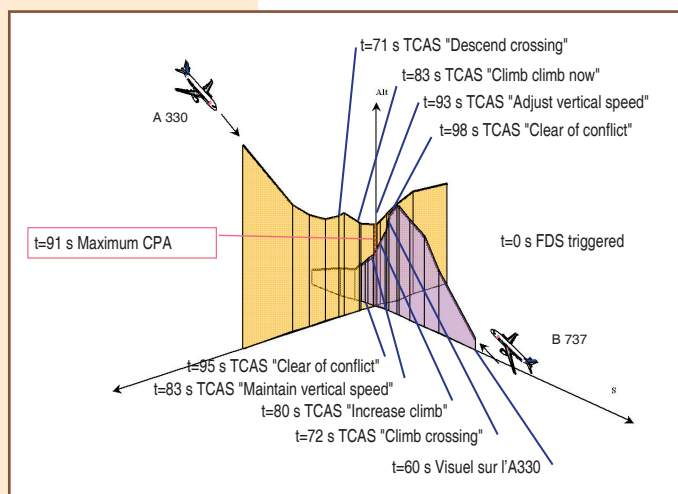
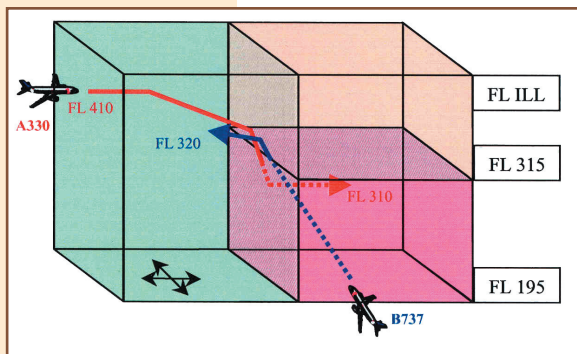
For their part, the A330 crew, who did not have the other airplane in sight, was disturbed to note that the vertical separation was still zero.

A few seconds later, the airplanes crossed again in the vertical axis, the B737 passing less than one NM in front of the A330 while making a left turn. The TCAS reacted by modifying the RA: the A330 received the "Climb climb now" order and the B737 the "Maintain vertical speed" order.

## Additional information

### Safeguard system

The safeguard system is a software tool available to controllers that warns them of an imminent

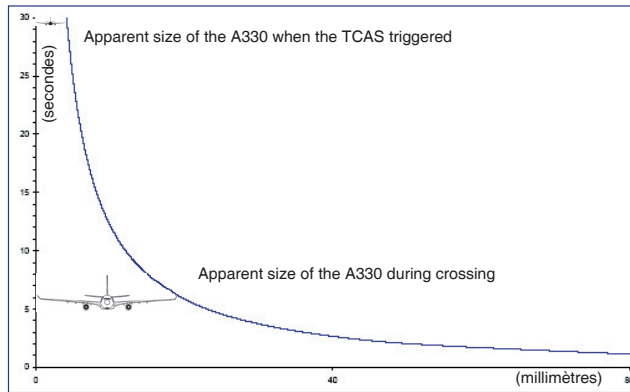


crossing of two airplanes with separation lower than the nominal levels. For each pair of aircraft the software computes a prediction of the flight paths with the data from the radar data processing system and compares them to verify that the nominal separation is respected. If this is not the case, a visual warning is displayed on the tag of the two conflicting aircraft (red flashing "ALRT" warning). This alarm gives about two minutes warning, but this can be shortened, depending on the configuration of the conflict. The trajectories predicted by the system do not take into account information from the flight plan or clearances given by controllers. Consequently, it can happen that the safeguard system is triggered even though the clearances given by the controllers are not generating conflicts and the clearances are respected by both crews. As an example, an aircraft climbing to FL140 maintaining a high vertical speed approaching its level, in front of an aircraft stable at FL150, is a situation where the safeguard system may generate an alarm.

### Visual avoidance maneuver

As we saw, the B737 pilot started the descent maneuver after the controller instructed him to do so, before the TCAS was triggered. He decided not to reverse his maneuver mainly because he had the other aircraft in sight, at about 6 NM, and he had the impression that the TCAS order would bring him closer. It should be noted that under these conditions the size

of the A330 seen from the B737 cockpit was equivalent to a 5 mm object held at arm's length (see illustration).



The speed of each aircraft was about 450 kt and they were converging at an angle of 120°, which resulted in a relative approach speed of about 660 kt (11 NM/min). Transport pilots are not at all used to assessing distances and positions of other aircraft for

traffic avoidance maneuvers at this altitude and speed<sup>(2)</sup>. To the B737 pilot, it appeared that he would pass under the A330.

During this phase when the aircraft were on changing tracks, the B737 pilot, who was the only one to see the other aircraft, evaluated his relative track incorrectly, partly because the increase in the apparent size in relation to time of an approaching object is a hyperbolic curve.

### Operational Instructions

The A330 operator's instructions call for the TCAS RA to be followed in all situations. Regarding the B737, the operator's documentation gives the pilot more scope for assessment. In the TCAS chapter in the section on flight procedures, it is recommended to follow the RA even if it is in contradiction with an ATC instruction. But in the same section, in the chapter on collision avoidance, it is recommended to maintain a good look out and it states that collision avoidance cannot entirely rely on ATS and TCAS, given their limitations<sup>(3)</sup>.

(2) Perception in the vertical plane is problematic and is relative to the attitude of the two aircraft and the perception of the horizon. This makes it difficult to develop an avoidance strategy.

(3) These limitations relate to occasions when ATC and the TCAS cannot detect the conflict, in particular when one of the airplanes is not equipped with a transponder. When the TCAS is triggered, other means of detection are never as effective.

### What is a sector separation?

Several sectors can be attributed to the same control position in order to adapt the workload to the quantity of traffic. They are then grouped together. At the same position, and apart from instruction situations, two controllers work as a pair.

The elementary sector controller receives strips from a printer in his workstation. He ensures the compatibility of the tracks of airplanes entering his sector and plans their exit conditions by phone with the controllers of adjacent sectors.

The radar controller observes traffic movements and any conflicts and gives ATC instructions to crews by radio.

At the request of the controllers involved, the head of the control room initiates grouping together or separation of sectors. He has the necessary tools available to update the issuing of strips and redirect telephone links.

The selected radio frequencies are switched to the new position. Previously, airplanes that were going to be transferred to a new sector would have received a request to change frequency. A few moments before grouping together or separation, the controllers who are taking over a sector must update, via the previous controller, all information on the traffic that they are going to handle. This coordination allows the vital information to be transferred on possible conflicts and specific actions that need to be taken. The four controllers must also adjust their interfaces (adjust the radar image, select the charts displayed...) to the new volume that they are controlling.

## Lessons Learned

### *Clearances leading to conflict*

The conflict had two causes. The initial instruction to climb to FL320 was given to the B737 by the trainee radar controller, although this level was no longer in his sector after the separation. The radar controller's instructor did not notice this first error. When the trainee associate radar controller modified the A330's entry conditions by phone after his instructor had asked him to do so, there was no coordination with the two radar controllers, so that level changes were understood by neither party. Neither pair was aware of the other's actions, which can be explained by a lack of formal communication between the two pairs. The following factors aggravated this confusion:

- The recent separation from the upper sector, which generated both a need for a high level of communication with outside actors for the associate radar controller pair, as well as an increase in workload that led to the radar controllers failing to update their representation of the spatial organization of the airspace.
- The dual instruction context where the presence of four people around the same control position increased difficulties in coordination and in having a common perception of traffic, especially as access to information was physically more complicated for the instructors.

### *Reaction to the safeguard system*

As we have seen, the safeguard system can be triggered even though there is no conflict. Habituation to this warning can result and application of a clearance verification procedure is then not systematic. Moreover, this could be further complicated by frequency availability. On the day of the incident, the activation of the safeguard system did not lead to an immediate reaction since it was comprehensible for the radar controllers, given their representation of

the situation. Thus, almost a minute passed before the radar instructor realized that the alarm was valid and reacted to it.

### *Coordination between TCAS and the safeguard system*

The TCAS on both aircraft performed well. The B737 pilot's maneuver, contrary to the RA, led to a smaller separation than the one that would have been achieved with a strict compliance with the RA by both parties.

It is notable that when an urgent ATC clearance arrives a very short time before a TCAS RA, and where these orders are contradictory, the pilot's decision can be distorted.

The question of the existence of two backup systems is thus raised when their respective warning times get closer. Indeed, the safeguard system, which is the first to be activated, can lead the controller to adopt a separation strategy that is at variance with that proposed by the TCAS. Thus, from the controller's point of view, it was logical to stop the B737's climb and the A330's descent so as to solve the conflict. The TCAS system processes RAs in order to minimize the proximity of the two airplanes and can propose maneuvers where the airplanes cross. The quasi-simultaneity of an urgent clearance and a TCAS RA is favored by habituation to the safeguard system's non-pertinent warnings that tend to slow down controllers' reactions.

### *Visual separation*

Operators' instructions concerning reactions to RA alerts are not harmonized. As soon as an RA is not followed, the risks of a collision are greatly increased. The maneuverability of aircraft, the limits of perception in the cockpit, the lack of training for visual avoidance maneuvers, and their rarity, make the chances of success in these maneuvers rather random.

## Precision of Radar Images

The uncertainty as to the position of airplanes between two radar screen sweeps has a direct effect on the choice of separation standards. It is basic for determining the strategy of the backup safety system when these standards have been breached. This uncertainty depends mainly on the airplane's speed and the speed of the antenna's rotation, that is to say the frequency with which the airplane is "seen" and the STR information updated. Depending, among other things, on the rotation speed of the radar in question, there can be refresh intervals of 4, 5, 8 or more seconds.

For example, a radar with a rotation speed of ten rpm will update the indicated position of an airplane every six seconds. If the airplane has a ground speed of 420 kt, it will have moved 1,300 meters between two refresh intervals and its position on the screen can be false by the same value. Equally, an airplane climbing at 3,000 ft/min can be three hundred feet above the altitude at which the controller sees it.

<sup>(4)</sup> The Überlingen accident demonstrated the great danger of actions contrary to TCAS RA's



The lag associated with data transmission between different items of radar equipment also occurs in relation to the precision of radar images. In practice, the distance between the airplane's displayed position and its real position is difficult to estimate.

## TCAS

ACAS and TCAS are terms used to designate onboard collision avoidance systems. The BEA uses the term ACAS for the standards relating to these systems and TCAS for the systems themselves. Onboard collision avoidance systems are based on predictive logic. Based on several successive responses from the transponder of another airplane, by dividing the distance by the closing speed, the TCAS calculates the time available before the closest point approach (CPA) is reached. This time is the main parameter for generating alerts. The transponder signal refresh interval is around one second. Resolution advisories are updated once a second.

The TCAS is capable of managing a situation with multiple risks. It can simultaneously handle up to thirty intruders with a nominal range of 14 NM for aircraft equipped with a mode A/C transponder and 30 NM for those in S mode.

# ADJUST VERTICAL SPEED on vertical speed indicator

## History of Flights

A CRJ, between Autun and Nevers, was descending towards Orly with a vertical speed of 2,500 ft/min. It was cleared to FL200. As it was descending through FL210, the controller informed the crew of traffic coming from the left to the right, one thousand feet below their clearance. A short time later, the TCAS triggered a resolution advisory (RA). The crew, who had heard "Descend Descend", disconnected the autopilot and, after a brief hesitation, increased the rate of descent to 4,000 ft/min, while informing the controller. At the "Clear of conflict" callout, the airplane was below its initial clearance level. It climbed to FL200 and continued its flight towards Orly.

The other airplane, a Beech 90, was stable at FL190 and was performing a flight between Orleans and Strasburg. Its pilot saw an airplane that was slightly higher that crossed in front of him at his flight level, then passed below it.

## Additional Information

### Examinations and simulations

The Beech 90, which is not obliged to carry TCAS, did not have it installed. The technical examinations, carried out on both the Beech's encoding altimeter and on the CRJ's TCAS and altimeter circuit, revealed no malfunctions.

According to the CRJ's QAR data, the separation was three nautical miles and zero feet at the closest point of approach of the two aircraft.

Based on the radar recordings, a simulation was carried out at the CENA using the OSCAR software. The resolution advisory thus reconstituted was "Adjust vertical speed" and not "Descend Descend".

## CRJ Pilots' Testimony

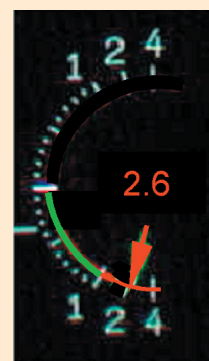
At the moment the alert was triggered, the CRJ's co-pilot was pilot flying. The Captain was picking up meteorological information from the destination aerodrome on his headphones. The co-pilot is sure that he heard the "Descend Descend" alert message. As that seemed to be in contradiction with the traffic information received, the crew tried to get confirmation from the displayed information that the TCAS was giving an order to descend. According to both pilots' recollections, the digital vertical speed indicator was completely red, with the exception of a small part of the arc that was green around the number 2, which corresponds to a vertical speed of 2,000 feet/min. They stated that they didn't understand "the maneuver ordered by the TCAS" and that they were "paralyzed by the situation, which was in total contradiction with good sense". They added "That situation created fear and enormous stress".

## TCAS Procedures

The CRJ operator's procedures make it imperative to follow all avoidance maneuvers ordered by the TCAS.

## Ergonomics

In the case of the CRJ, the TCAS visual alert is visible on the vertical speed indicator on the PFD via the appearance of a red arc and a green arc that superimpose over the graduated arc. The needle on the VSI adopts the color of the arc that it is in front of.



CRJ's digital VSI  
"Adjust vertical  
speed"

### Lessons Learned

The TCAS equipment functioned correctly. The “Adjust vertical speed” alert was triggered normally but the crew did not understand it. The alert in question is relatively rare in case of an initial RA and the pilots had not been faced with it during their training. The crew interpreted the indication on their VSI as an order to descend. They therefore obeyed their instruction to follow the TCAS RA, despite the inconsistency with the traffic information.

In fact, the RA ordered a decrease in vertical speed to 1,000 ft/min in descent, which is quite common when approaching the cleared level with a 1,000 ft separation.

During the pilots’ check on the PFD display, they were clearly subject to confirmation bias, in interpreting the information presented to them, as part of their erroneous mental representation of the situation. If the difficulty of reading the instrument is taken into account, due to its size and its non-linear scale, along with the necessity to interpret vertical speed information to convert it into pitch angle, added to the stress that is always generated when an alert sounds, it is easy to understand that an individual’s capacity to manage an urgent situation can be exceeded, especially where it has not been encountered in training. Constructing a new analysis, in case of an initial misrepresentation error, eats up resources and individuals often find themselves unable to take appropriate action. This is plain to see from the way in which the crew described this incident.

Further, since the aural warning was issued only once, it was difficult for the crew to realize that they had confused it with another one and that they had performed a corrective maneuver in the wrong direction.

Any contrary correction of an RA is particularly dangerous. This incident is, however, by no means unique. The BEA has issued a detailed report on an incident that was practically identical that occurred in March 2003. A brief summary follows.

*While on a Marseille-Paris Orly flight, an A319 climbed to FL260 in accordance with the ATC clearance. Its TCAS triggered a traffic advisory in relation to an airplane flying higher above it on an opposite route. Eighteen seconds later, an “Adjust vertical speed” RA was triggered, ordering the crew to reduce its vertical speed. The pilot increased the airplane’s pitch angle. The opposing traffic was an A320, stable at FL270 on the Paris Orly-Marseille route. Around ten seconds after the A319’s RA alert was triggered, a “Climb” RA was triggered on board the A320. This was acted on by the crew.*

*During crossing, each crew saw the other airplane. The pilot of the A 319 performed a left turn avoidance maneuver. The FDR recordings showed that the minimum lateral and vertical separations were respectively about 0.8 NM and 300 ft.*

## MONITOR VERTICAL SPEED on ADI

### History of Flight

While the airplane was stabilized on the downwind leg on the aerodrome circuit, the

TCAS “Monitor vertical speed” alert was triggered and the display (pictured left) appeared on the screen.

The crew neither received traffic information from the ATC nor did it note a traffic advisory. They immediately corrected the airplane’s pitch angle to follow the red pitch cue, which made the airplane descend. At the same time they located the intruding aircraft on the navigation screens and were surprised to find that it

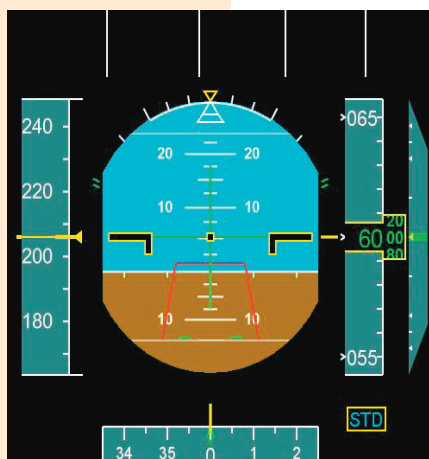
was below them and that the action they had undertaken reduced the separation. The crew submitted a feedback report to the operator, convinced that the TCAS had malfunctioned.

### Additional Information

The TCAS procedure described in the Operations manual indicates “adjust pitch angle and thrust slowly so as to satisfy the RA’s orders”.

On the screen, the red goalpost indicates the no-fly zone. The symbolic airplane must then be positioned outside of this area. In practice, to limit the amplitude of the pitch angle changes, the pilot tries to place the symbolic airplane on the upper bar of the red goalpost.

There are nine types of TCAS resolution advisory. Seven require immediate action to pitch up or pitch down. Two, “Monitor Vertical



Type of advisory	Pitch down	Pitch up
Initial preventive	Monitor vertical speed	Monitor vertical speed
Corrective	Descend, descend	Climb, climb
Reinforcing	Increase descent, increase descent	Increase climb, increase climb
Decreasing	Adjust vertical speed, adjust	Adjust vertical speed, adjust
Reversing	Descend, descend NOW	Climb, climb NOW
With altitude crossing	Descend, crossing descend, crossing descend	Climb, crossing climb, crossing climb
Maintaining speed	Maintain vertical speed, maintain	Maintain vertical speed, maintain
Maintaining vertical speed and with altitude crossing	Maintain vertical speed, crossing maintain	Maintain vertical speed, crossing maintain
With vertical speed reduction	Adjust vertical speed, adjust	Adjust vertical speed, adjust

Speed” and “Maintain Vertical Speed”, which are by the way quite infrequent, are preventive and do not necessarily call for a modification of the trajectory. The above table summarizes these advisories.

## Lessons Learned

TCAS resolution advisories indicate the maneuver to be performed and the display allows the pilot to quantify the correction to be performed. In most cases, the pilot must move the airplane out of the red area: his action thus involves placing the symbolic airplane outside of the red goalpost overlaid on the horizon. However, in the case of the preventive “Monitor vertical speed” RA, the airplane is already outside of the red area, so nothing needs to be done. Nevertheless, since the display is the same for the other RA cases, the pilot would tend to react in the same way and move the symbolic airplane towards the upper bar of the goalpost.

In this case, the only consequence of this was to reduce the separation selected by the TCAS, though this event also led the crew to call into question how the TCAS functioned.

It is important that pilots be well informed about all of the possible TCAS alerts and that they be well-trained to respond to them. In fact, a fundamental principle of an emergency backup system is for those using it to have confidence in it. Any doubt or incomprehension with regard to its operation may lead to an inappropriate reaction that could have serious consequences.

## TCAS Alert with an Aircraft in VFR

### History of Flights

A Boeing 737 was on approach to Toulouse Blagnac. At 15 h 29 min 21 s, in contact with approach control, it was cleared to descend from FL70 to 3,000 ft, with radar vectoring for an ILS 14 procedure.

During this time, an instructor was performing a flight with two students pilots on board a DR 400. He had taken off from Castelsarrasin for Toulouse Labordes at about 15 h 55. At 16 h 00 min 07 s, one minute before entering the class D CTR and while stable at an altitude of 3,500 ft in a section of the class E TMA, the student at the controls contacted the Toulouse information frequency. He identified himself as “a DR 400 inbound from Agen and bound for Toulouse Labordes, seven minutes away from point E at 3,500 ft QNH squawking 7000”.

The controller in charge of the Toulouse information frequency did not see any plot displaying 7000 inbound from Agen. However, he detected a primary plot (thus without any identification code or altitude indication) at the edge of the CTR, with a track that was converging with that of the Boeing.

At 16 h 00 min 25 s, he assigned a transponder code to the DR 400 and asked his colleague handling approaches to stop the Boeing’s descent at 4,000 ft. The pilot of the DR 400 read back and selected the transponder code.

At 16 h 01 min 04 s, the approach controller asked the Boeing to stop its descent. The crew answered that they had just received a TCAS RA and that they were climbing.

The Boeing landed without further incident and the DR 400 continued its flight towards point E. The minimum separation of the two airplanes was 1.3 NM and 200 ft.

### Additional Information

#### DR 400’s track

The secondary plot, displaying the code assigned to the DR 400, its altitude and its speed, appeared on the controller’s radar at the same time as the pilot of the 737 announced the TCAS maneuver.

The instructor stated that the transponder was on 7000 with altitude mode throughout the flight. By studying the radar plots and the radio communications of the outward flight, it was



established that the radar's reception of the DR 400's transponder was intermittent.

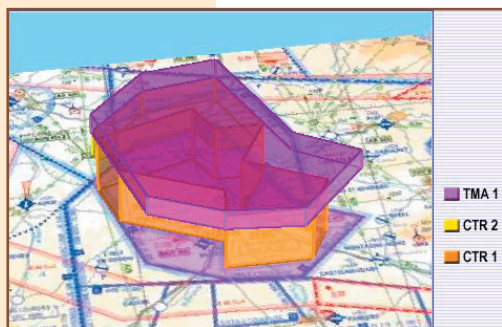
#### CTR entry conditions

The Toulouse Blagnac VAC chart indicates, "First contact must be established at least five minutes before overflying the entry points (for example N), while waiting for a clearance". The DR 400 did in fact call in about five minutes before point N but, due to its flight path, it was then on the point of entering class D airspace. The regulations state that "to enter and fly in class B, C, D or A airspace, if it has obtained an exemption, an aircraft in VFR flight must have obtained a clearance", without any further indications, for example on the anticipated time required.

The DR 400 did not formally receive a clearance before entering the class D airspace and the assignment of a transponder code was implicitly a clearance as far as both the controller and the pilot were concerned.

#### Airplane descent profiles

The airspace around Toulouse Blagnac, as is the case for many aerodromes, is organized in volumes with descending sizes as the ground is approached. As airplanes generally descend steadily instead of step by step during approach, it is possible that they may pass through class E 5 airspace. This is what happened for the 737.



(5) Note: in class E airspace, airplanes in VFR are not all known to the ATC.

#### Terminology

At 16 h 01 min 04 s, the controller asked the crew of the Boeing to "stop descent 4,000 feet, 4,000 feet". The crew replied "Negative stop descent 4,000 ... that's TCAS". The controller then issued traffic information "Copy an unknown traffic twelve o'clock from the right to the left", to which the crew replied "TCAS climb stand by" before stating, fifteen seconds later, "Clear of traffic".

#### Lessons Learned

The TCAS fulfilled its role of urgently recovering a situation at the edge of VFR and IFR areas. The terminology used by the pilot of the Boeing to notify the TCAS RA was not standard. Although the controller obeyed the instructions by relaying the traffic information, the pilot believed that he was intervening and then used the standard terminology "TCAS climb". This shows the importance both for pilots and for controllers of training in TCAS procedures, any incomprehension in this area being potentially dangerous.

This event also shows that, in areas with mixed VFR and IFR traffic, it is essential for controllers to know as early as possible of the presence of VFR flights, and it underlines the importance of the transponder. It was thanks to this piece of equipment that the Boeing received the TCAS RA. Checking correct operation of this equipment before a flight is fundamental.

The descent of the Boeing from FL70 towards 3,000 ft was carried out by touching the edge of a class E area. This shows that it is sometimes difficult for pilots in IFR to know what airspace they are in. The definition of the area is done in order to protect IFR tracks. In seeking to optimize tracks, the margins are reduced and segregation is no longer guaranteed.

#### References and Useful Links

[www.bfu-web.de/berichte/index.htm](http://www.bfu-web.de/berichte/index.htm)

Report on the collision that occurred over Überlingen on 1 July 2002

[www.caa.co.uk/docs/CAP717.pdf](http://www.caa.co.uk/docs/CAP717.pdf)

CAP717 document that summarizes the limitations on the effectiveness of emergency instructions given by controllers

[www.cena.fr/pages/4publ/div\\_sas.html](http://www.cena.fr/pages/4publ/div_sas.html)

[www.eurocontrol.int/acas/](http://www.eurocontrol.int/acas/)

Lots of information on legislation, training, ACAS bulletins...

[www.stna.aviation-civile.gouv.fr/actualites/revues/frrevues.html](http://www.stna.aviation-civile.gouv.fr/actualites/revues/frrevues.html)

Consult the technical reviews numbers 62 and 66 "Overflying a cluster of gliders" on the use of TCAS