ESTONIAN SAFETY INVESTIGATION BUREAU

INVESTIGATION REPORT

SERIOUS INCIDENT, LOSS OF SEPARATION BETWEEN BOEING 777-200 AND DASSAULT FALCON 900 NEAR KIHNU ISLAND ON 17.10.2013

TALLINN 2015

Contents

Abbreviations used in this report

ACC	Area Control Centre
ADS-B	Automatic Dependent Surveillance - Broadcast
AP	Autopilot
ASEL	Altitude Preselect Mode, AP function
ATC	Air Traffic Control
ESIB	Estonian Safety Investigation Bureau
FIR	Flight Information Area
FL	Flight level
GS	Ground speed
kts	knots
PIC	Pilot in command
RA	Resolution Advisory
STCA	Short-Term Conflict Alert
TA	Traffic Advisory
TCAS	Traffic alert and Collision Avoidance System

Synopsis

On 17th Oct. 2013 at 15:05 UTC near Kihnu island, Estonia, on flight level 340 in the Tallinn flight information area (FIR), in a class C controlled airspace, minimum allowable separation between two aircraft – Boeing 777-200 and Dassault Falcon 900, was violated. The separation of two crossing aircraft tracks was reduced to a minimum of 853 feet vertically and 0.1 - 0.2 nm horizontally.

Both aircraft were equipped with TCAS II. The TCAS RA "ADJUST VERTICAL SPEED, ADJUST!" was activated on one of the aircraft, causing the crew to resume climb hence decreasing the vertical separation and compromising the safety of both aircraft even more.

The Estonian Safety Investigation Bureau (ESIB) initiated an investigation to determine the causes of this serious incident accordingly to EU regulation 996/2010 and ICAO annex 13. The conflicting flight IAM3116, Italian Air Force aircraft F900, belonged to state aviation and did not fall under the scope of civil accident investigation authorities neither in Estonia nor in Italy. However, the ESIB received full and valuable support from Italian Air Force Flight Safety Inspectorate during this investigation.

ESIB determined erroneous interpretation of the TCAS RA by the crew as a cause of the serious incident. The vague wording of the RA can be considered as contributing factor to the incident.

1 Factual information

1.1 History of the flight

At 14:51 UTC Italian Air Force aircraft Dassault Falcon 900, flight IAM3116, took off from Tallinn Airport (EETN), with the destination to Rome Ciampino Airport (LIRA). The aircraft was to join the route L729 (192.9°$_{true}$) from ORTAX to LUTAL (575358N, 0235453E). At 14.56 the aircraft was handed over by Tallinn ACC West sector to East sector and was cleared to climb to FL340. The GS of IAM3116 was 419 kts, variations in vertical speed are indicated on figure 2.

FL340 clearance limit was set to IAM3116 due to crossing traffic, a British Airways flight BAW17, Boeing 777-200, flying from London Heathrow Airport (EGGL) to Incheon International Airport (RKSI) on route P862 at FL350. The airways L729 and P862 are crossing over the north end of Kihnu island. BAW17 contacted Tallinn ACC at 14.59 and crossed point NETNA (575232N, 0224722E) at 15:00, cruising on P862 (066.5°$_{true}$) to LIMAK (585036N 0272804E) on FL 350 with the GS of 507 kts.

Both aircraft, IAM3116 and BAW17 were equipped with TCAS II version 7.0 system.

The TCAS alerts the crew to the air traffic that may present a collision threat. The TCAS system is independent of on the ground systems. It uses a transponder located on board of the aircraft to interrogate with other aircraft in its vicinity. TCAS generates a Traffic Advisory (TA) when another aircraft becomes close, posing a potential risk, but no manoeuvres are required. Resolution Advisory (RA) signal is generated when a threat becomes imminent and pilot action is inevitable to avoid collision.

If a pilot receives a RA, he or she is obligated to follow it, even if RAs are contrary to ATC clearances or instructions.

TCAS II software version 7.0 that was installed on IAM3116 has the following RA aural warnings:

- Climb, climb / descend, descend;
- Climb, crossing climb; Climb, crossing climb/ descend, crossing descend; crossing descend;
- Maintain vertical speed, maintain;
- Maintain vertical speed, crossing maintain;
- Adjust vertical speed adjust;
- Climb, climb NOW; Climb, climb NOW / descend, descend NOW, descend, descend NOW;
- Increase climb, increase climb/ increase descent, increase descent;
- Monitor vertical speed;
- Clear of conflict.

At 15.00 was a scheduled change of the ACC West executive controller. The relieving controller was briefed about the IAM3116 and BAW17 situation.

To alert air traffic controllers to potential conflicts involving at least one aircraft under control, a ground based safety net system is used. The system uses radars, ADS-B or multilateration that predict the movement of aircraft and it generates an automated STCA (short-term conflict alert) on potential or actual infringement of separation minima. Alerting aircraft are identified on air traffic controllers` radar display by flashing target labels in colours to denote the severity of the conflict. Low severity alerts are shown white and high severity in red.

At 15:05 while IAM3116 was approaching FL339, both aircraft (IAM3116 and BAW17) received a TCAS TA. IAM3116 crew identified BAW17 immediately at about 2 o`clock to their position and BAW17 identified IAM3116 at 11 o`clock to their position. Two seconds later IAM3116 reduced vertical speed and started to level off on FL340. Two second before reaching the FL340 the crew of IAM3116 received TCAS RA. After descending approximately 80 feet the aircraft resumed climb, reaching FL343 (figure 1). After short verbal information exchange with ATC controller IAM3116 descended back to designated flight level (table 1).

The radar recordings indicate that the conflict on airways L729 and UP862 between IAM3116 and BAW17 flights were displayed red (figure 1) to the ACC - indicating unsafe condition.

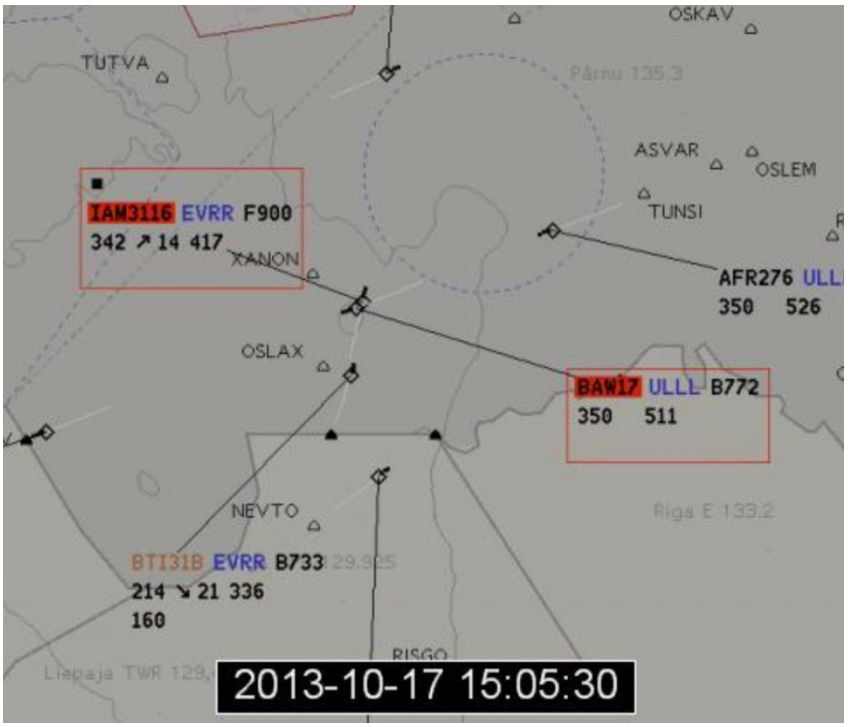

Figure 1: BAW17 and IAM3116 tracks and alerts on ATC radar screen

According to IAM3116 Captains statements, after receiving the RA "*the crew applied the relevant procedure for the TCAS RA"*.

1.2 Injuries to persons, aircraft or other damage

No injuries

1.3 Damage to aircraft

No damage.

1.4 Other damage

No damage.

1.5 Personnel information

The personnel information is limited due to the nature of the incident.

IAM3116 PIC - experienced pilot rated as instructor in the Italian Air Force. Experienced with TCAS II.

BAW17, B772 – not relevant.

Tallinn tower planner - Male, aged 30. Operational experience 5 years. Time on duty 2,5 hrs

Tallinn tower controller - Male aged 46. Operational experience 16 years. Time on duty 2,5 hrs.

1.6 Aircraft information

IAM3116: Italian Air Force operated Dassault Falcon 900, French-built corporate jet aircraft made by Dassault Aviation. Equipped with TCAS II ver. 7.0, TCAS TTR920, Mode S 24-bit address 33FFFA.

BAW17: British Airways operated Boeing 777-200. Equipped with TCAS II ver. 7.0, Mode S 24-bit address 4007F7.

1.7 Meteorological information

Incident occurred during daytime with visibility more than 10 km, wind 65/260°.

1.8 Aids to navigation

Not relevant.

1.9 Communications

Communications were made on Tallinn FIR CTA East sector frequency 122.9 MHz. The quality of communication was good.

Transcript of relevant parts of communication:

Time	Unit	Content
15:04:31	ACC	*Italian Air Force, maintain FL340 when reaching, expect further climb in 1.5 minutes.*
	IAM3116	*Copied, maintain 340 and we advise you that we don't need to anymore climb, so 340 will be good final.*
	ACC	*Italian Air Force, roger, 340.*
	IAM3116	*Climb level 340, 311.*
15:05:43	IAM3116	*Control, IAM3116, we had a TCAS climb, now TCAS completely is ended, we continue descent FL340.*
	ACC	*IAM3116, flight level was 340.*
	IAM3116	*Yes, but we do had a TCAS conflict that commanded us to climb.*
	ACC	*Traffic was at FL350, above us … of you.*
	IAM3116	*It was maybe a problem of the wrong indication of the TCAS, but my rules say that I have to follow.*
	ACC	*Roger.*

Table 1: Transcripts of communication

1.10 Aerodrome information

Not relevant.

1.11 Flight recorders

Due to the nature of flight onboard data recorders were not retrieved. The flight reconstruction was made using Estonian Air Navigation Services recordings (secondary radar and voice communications) and ERGLI (Latvia) Mode-S radar data.

The Mode-S radar data was analysed by Eurocontrol using InCAS v2.10 simulation software. The graphics below represents the relative positions of the two aircraft during this incident.

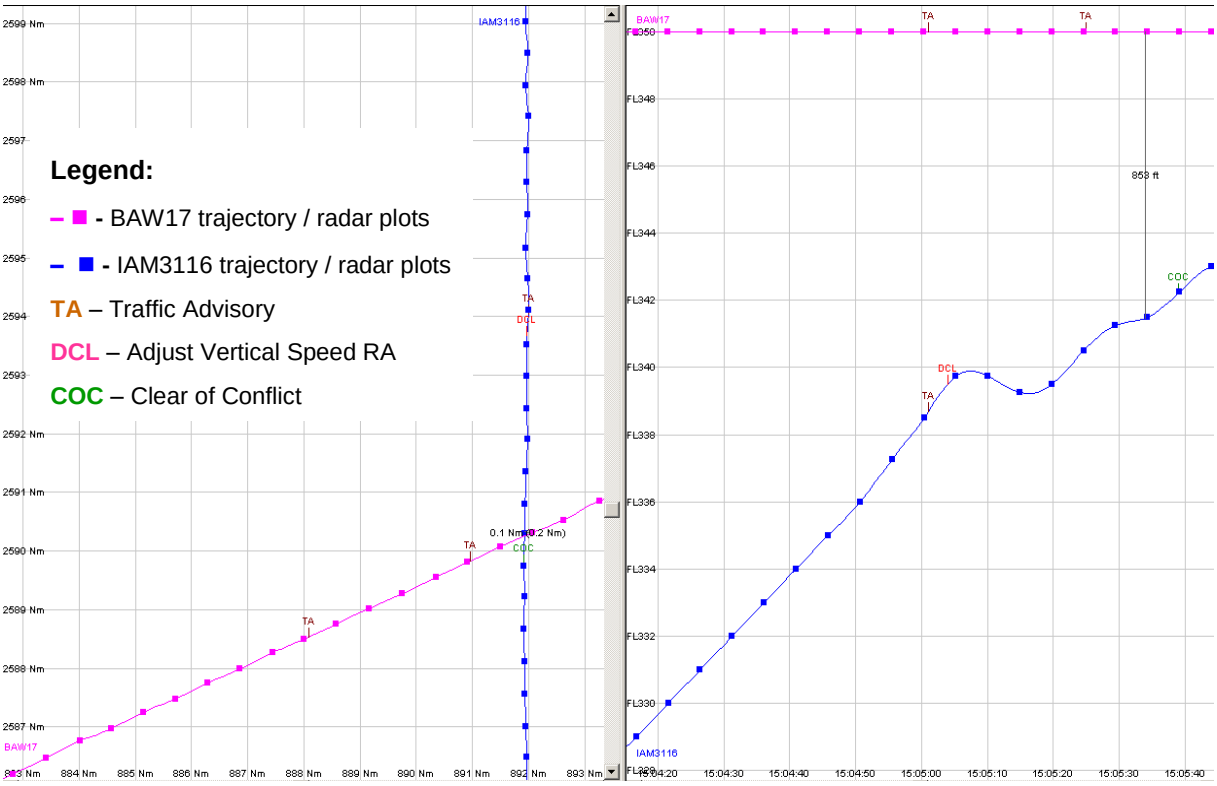

Figure 2: BAW17 and IAM3116 tracks. Source: ERGLI S-Mode Radar data, Eurocontrol InCAS 2.10

2 Analysis

2.1 General

The two aircraft (IAM3116 and BAW17) were converging laterally, however the IAM3116 was predicated to pass safely beneath BAW17. At 15:04 the climbing IAM3116 at FL333 got instructions from air traffic controller to maintain FL 340, which the PIC (pilot in command) read back correctly. The aircraft continued climb (figure 2) to reach designated altitude. At 15:05 due to crossing flightpaths both aircraft (IAM3116 and BAW17) received a TCAS TA. Two three later the climbing IAM3116 received a TCAS RA. BAW17 did not receive any TCAS RA instruction (figure 3).

According to the recordings of ACC and IAM3116 communication (table 1), the AIM3116 "*had a TCAS conflict that commanded us to climb".* The variations vertical speed and altitude of IAM3116 (figure 2) reflect the pilot action after receiving the RA. The flightpath indicates that immediately after receiving the RA, the AIM3116 reduces altitude from FL340 to 339 and then starts to climb again reaching FL343. According to ATC and radar information there was no other traffic below IAM3116, therefore ESIB considers it to be unlikely that TCAS generated an RA "Climb, climb; Climb, climb". The most likely RA received by the IAM3116 crew must have been "Adjust vertical speed adjust" which always require reduction of vertical speed, and which was firstly followed by correct pilot action (by the IAM3116 crew) - reduction of vertical speed (figure 2) and then followed by unintentionally incorrect pilot response causing the aircraft to climb instead of levelling off (figure 2). The mode S downlink data (Ergli radar) confirms that "Adjust vertical speed, adjust" was issued to IAM3116 crew.

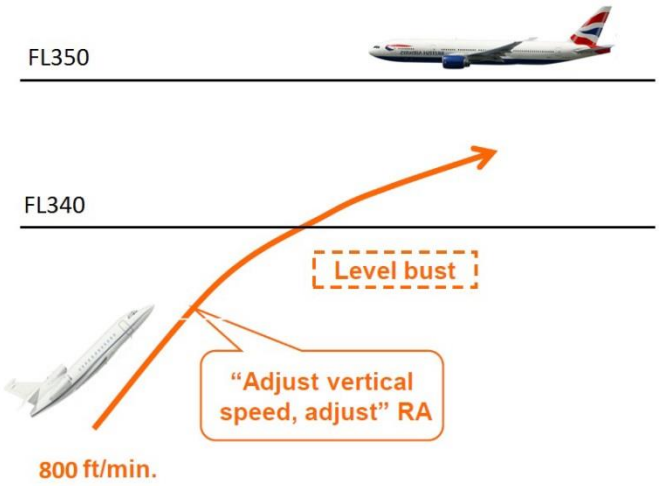

Figure 2: TCAS RA on IAM3116 climb

2.2 ATC aspects

At 15.00 there was a scheduled change of the ACC West executive controller. The relieving controller was briefed about the IAM3116 and BAW17 situation.

The ACC informed IAM3116 of crossing traffic.

The radar recordings indicate that the conflict on airways L729 and UP862 between IAM3116 and BAW17 flights was displayed red (figure 1) to the ACC - indicating unsafe condition and drawing the air

traffic controllers attention to the conflict, however in this instance the STCA provided little help to the controller to avoid this conflict.

3 Conclusion

(a) Findings

- Both aircraft were flying according to instrument flight rules (IFR) in category C airspace.
- The air traffic controller was in possession of necessary licence and procedures to perform his duties.
- Both aircraft were fitted with TCAS II Version 7.0.
- Both crews had received TCAS-TA alert.
- The IAM3116 crew was instructed by air traffic control to maintain FL340.
- The STCA conflict alert was displayed to the ACC.
- According to the radar recording, the two aircraft converged to an altitude difference of 853 feet and lateral separation of 0.1 - 0.2 nm.
- The IAM3116 crew received a TCAS RA "Adjust vertical speed adjust".
- The IAM3116 crew did not react correctly to the TCAS RA.

(b) Causal factors

This incident is attributable of the fact that the crew of IAM3116 misinterpreted TCAS RA "Adjust vertical speed, adjust", by increasing the rate of climb instead of levelling off.

(c) Contributory factors

The aural warning wordings of TCAS II Version 7.0 RA can be misleading. This might have contributed to the incorrect pilot response.

4 Safety Recommendations

EU 1332/2011 is mandating TCAS version 7.1 to be used in European airspace on civil aircraft. State aircraft are subject to National-jurisdiction and no mandatory action can be enforced at EU level. Since the State transport aircraft may operate in the same airspace as civil aircraft, the adoption of TCAS version 7.1 on transport-type State aircraft may not be seen as mandatory in regulatory terms, but it is strongly recommended to all ICAO and EASA member states, that for safety reasons, all State aircraft should be upgraded to version 7.1 as soon as possible, including when forward-fit opportunities arise. Taking in account that "The Convention of International Civil Aviation" Article 3 and EC 216/2008 Article I exclude State aircraft, ICAO and EASA cannot mandate the implementation of TCAS version 7.1 on State aircraft, which decision at the moment is on the separate member states. It is therefore recommended to ICAO, EASA and European Commission to consider promoting member states to take further actions in enforcing the adoption of TCAS version 7.1 on State aircraft, when operating in common airspace to mitigate the risks of loss of separation between civil and State aircraft.