DUTCH
SAFETY BOARD

Loss of separation over Uitgeest

Loss of separation over Uitgeest

The Hague, May 2013

The reports issued by the Dutch Safety Board are open to the public.
All reports are also available on the Safety Board's website www.safetyboard.nl

Cover photograph: Runway 18R seen southwards. Source: Amsterdam Airport Schiphol

Dutch Safety Board

The aim in the Netherlands is to limit the risk of accidents and incidents as much as possible. If accidents or near accidents nevertheless occur, a thorough investigation into the causes, irrespective of who are to blame, may help to prevent similar problems from occurring in the future. It is important to ensure that the investigation is carried out independently from the parties involved. This is why the Dutch Safety Board itself selects the issues it wishes to investigate, mindful of citizens' position of independence with respect to authorities and businesses. In some cases the Dutch Safety Board is required by law to conduct an investigation.

	Dutch Safety Board		
Chairman:	T.H.J. Joustra E.R. Muller P.L. Meurs		
General Secretary:	M. Visser		
Visiting address:	Anna van Saksenlaan 50 2593 HT The Hague The Netherlands	Postal address:	PO Box 95404 2509 CK The Hague The Netherlands
Telephone:	+31 (0)70 333 7000	Fax:	+31 (0)70 333 7077
Website:	www.safetyboard.nl		

General information

On 13 November 2012, two parallel runways were used for approach and landing at Amsterdam Airport Schiphol (Schiphol): Zwanenburg (18C) and Polder (18R). A Boeing B737-800 (approaching from the west) and an Airbus A330-200 (approaching from the east) turned to final at the same altitude, the Boeing aircraft for the approach to runway 18R, the Airbus for runway 18C. While on final, the distance between the two aircraft came below the published separation minima. When the distance between aircraft is below minima, there is talk of loss of separation.

Shortly after, the Dutch Air Traffic Control Agency (Luchtverkeersleiding Nederland, LVNL), responsible for air traffic control over Schiphol airport, reported the occurrence to the Dutch Safety Board (OVV). The public arousal caused by this occurrence was reason for the OVV to start an investigation into the event. The focus of the investigation was put on the performance of LVNL.

This report[1] gives a description of the event, a general view of the procedures used, and which safety features are in place. Furthermore, the report describes the effectiveness of the safety features and closes with a conclusion and recommendations.

1 This report is written in English and Dutch language. When differences in interpretation exist, Dutch version prevails.

The incident

Schiphol Airport has three (3) parallel runways, positioned north-south: 18 right (18R), 18 centre (18C) and 18 left (18L, Aalsmeer, see figure 1). The two most westerly runways 18R and 18C are used simultaneously for incoming traffic, so called parallel approaches. 18L is used for departing traffic. Because of infrastructure north of the runway, and noise abatement for the nearby city of Aalsmeer, 18L is not used for landings.

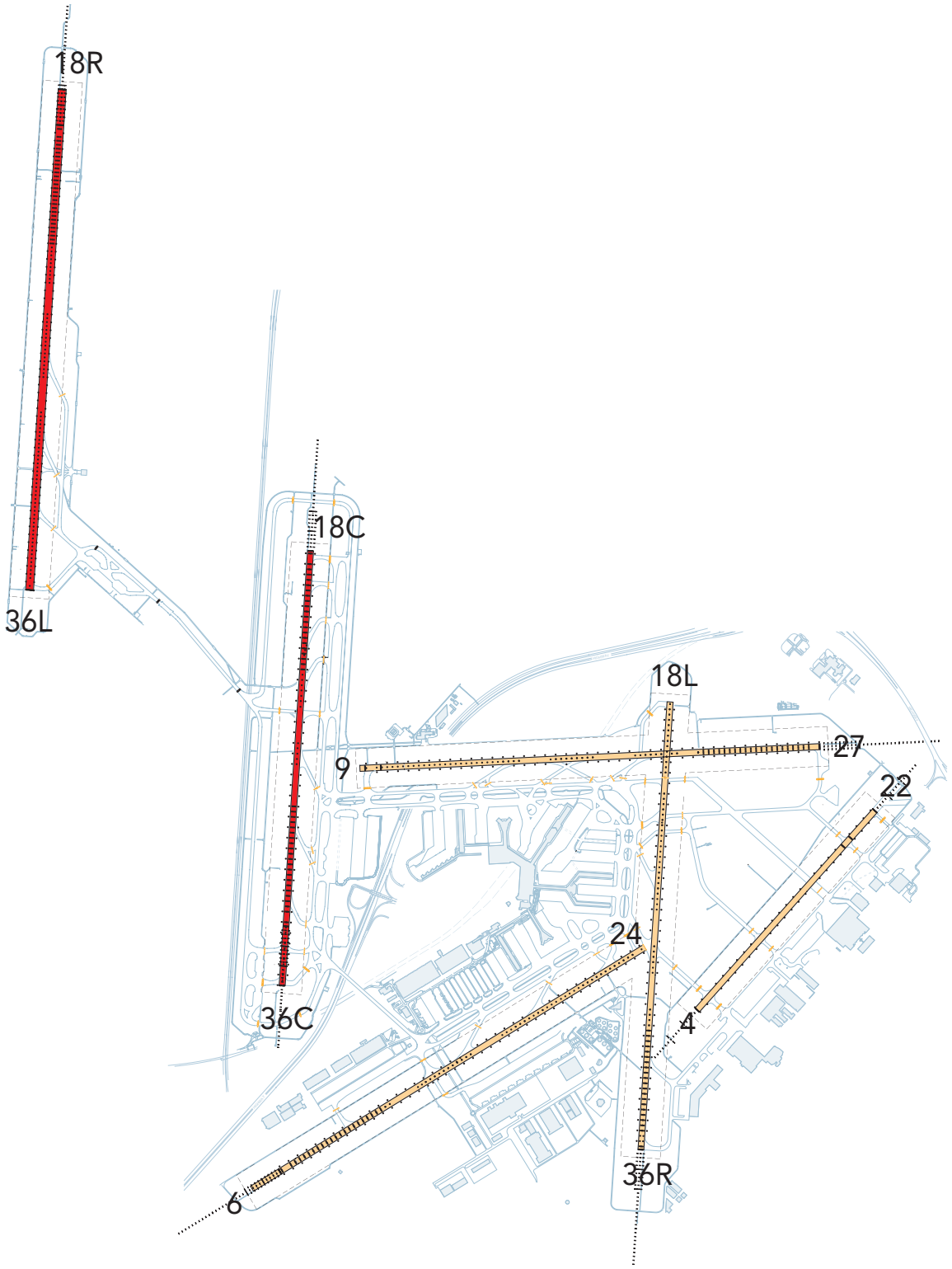


Figure 1: Airfield layout of Amsterdam Airport Schiphol, runways 18 C and 18R are situated at the top left.

In the morning of 13 November 2012 all parallel runways 18R, 18C and 18L were in use simultaneously: runways 18R and 18C for landing traffic, 18L for departing traffic. There was a southerly wind and visibility at 2000 feet was almost unlimited.[2] Traffic was busy during the morning rush hour at Schiphol Airport (inbound peak, figure 2) and the flow of traffic for landing was significant. Traffic approaching from the west started final approach for runway 18R at an altitude of 2000 feet, traffic from the east started their approach for runway 18C at 3000 feet.

For all approaches to runways 18R and 18C Air traffic control was conducted by two ATC controllers. Their guided traffic by giving instructions for headings and altitudes to the crews of approaching aircraft.

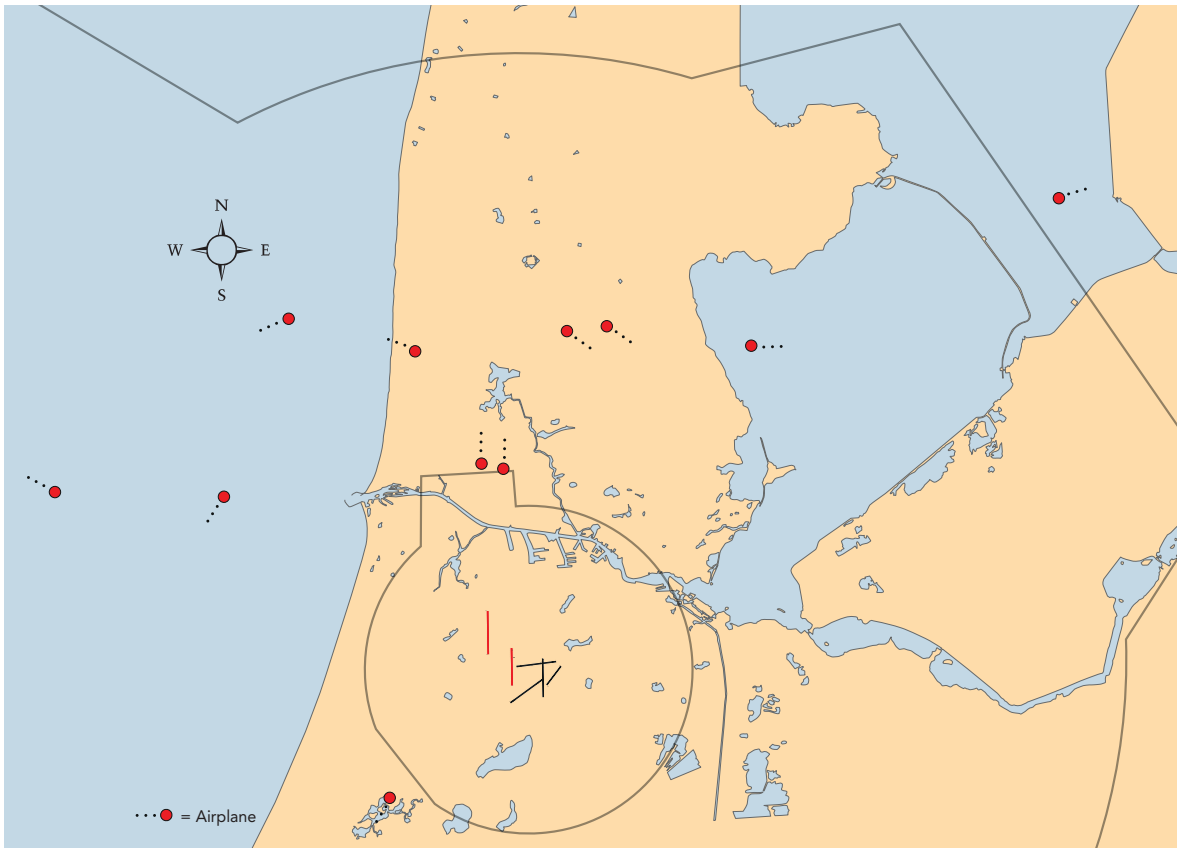


Figure 2: Example of a random morning rush hour for runways 18R and 18C (source LVNL)

At one point during the morning rush, there was a pause in traffic approaching from the west. The so called gap in traffic from the west eventually lasted for about 15 minutes. This gap in traffic from the west made it possible for the ATC controller responsible for the easterly traffic heading for runway 18C, to handle his traffic more efficient. By letting traffic descend to 2000 feet instead of 3000 feet before entering final approach, he hoped to establish a more fluent flow in traffic. Starting at 06.35:11, he let three aircraft fly the altered approach from 2000 feet for runway 18C.

2 Source: weather report KNMI

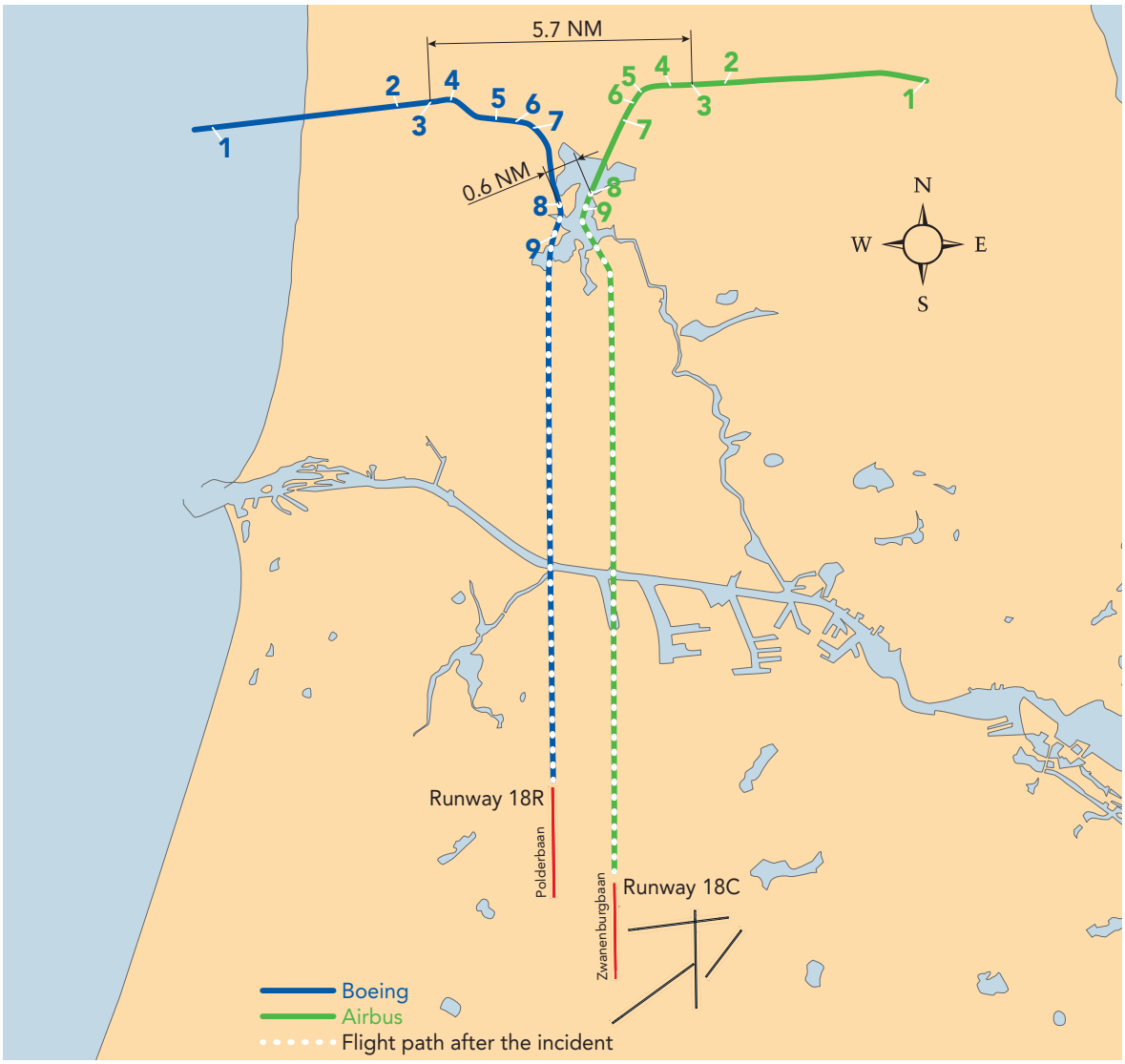
At 06.41:39 the crew of an Airbus approaching from the east received a clearance to descend to 2000 feet. The moment the aircraft arrived at 2000 feet, the gap in westerly traffic ended and traffic started reporting for the approach to 18R. A Boeing aircraft was the first to approach, also at 2000 feet, to make a landing at 18R. The ATC controller handling the Airbus, warned the ATC controller handling the Boeing, that the Airbus was also flying at 2000 feet (figure 3, **3**). At that moment, both aircraft were flying at 2000 feet and were separated 5,7NM (10,6 km) from each other. The Boeing was flying at a speed of 216 knots[3], the Airbus was flying 208 knots.

The ATC controller handling the Boeing had just before cleared the aircraft for the approach to runway 18R, and given the crew directions to fly a heading of 160.[4] The controller reacted immediately by ordering the Boeing crew to start a left turn to a heading of 360, to steer the aircraft away from a potential conflict with the Airbus (figure 3, **3**). The ATC controller for runway 18C gave orders to the Airbus crew to start a left turn to a heading of 210 with the intention to intercept the final radial for the approach to runway 18C (figure 3, **4**). He forgot however, to give the actual final clearance, and thereby the intercept of the final radial.

The ATC controller for 18R, ordered the Boeing crew to steer back to a heading of 160, and continue the approach for runway 18R (figure 3, **5**).

The Airbus continued on heading 210. The ATC controller for runway 18C warned the Airbus crew of the presence of the Boeing. The Airbus crew stated they had the Boeing in sight (figure 3, **6**). At that time the Airbus was approaching the final radial[5] for runway 18C. When the ATC controller asked the crew whether they had the Boeing in sight, the crew confirmed again and asked if they could start the approach to runway 18C (figure 3, **7**). The ATC controller then gave the crew a new heading of 160 to bring them back to centreline and cleared them for the approach (figure 3, **9**).

3 Knot is the standard unit for speed in aviation, 1 knot is 1 Nautical Mile per hours. One knot equals to 1,852 kilometre per hour (kmh).
4 Headings in aviation are given in degrees. One full circle is 360 degrees, whereby 360 is North, 090 is East and so on.
5 For aircraft operating under Instrument flight Rules (IFR), fixed approach procedures are laid down. The final approach to a runway is a straight line in space where both lateral (localizer) and vertical (glide path) positions are fixed.



Position	Time	Boeing	Position	Airbus
1	06.41:39		1	Airbus is given a heading of 270 and cleared to descend to 2000 feet
2	06.42:51	Boeing is given a heading of 160	2	
3	06.42:55	Air traffic controllers recognize the conflict. Distance aircrafts 5.7 NM, altitude difference 100 feet. Boeing is given a heading of 360	3	
4	06.43:01		4	Airbus is given a heading of 210
5	06.43:15	Boeing is given a heading of 160	5	
6	06.43:29	Boeing confirms visual contact with Airbus	6	
7	06.43:34		7	Airbus confirms visual contact with Boeing
8	06.44:08		8	Minimum distance between Boeing and Airbus 0.6 NM 0 feet.
9	06.44:12		9	Airbus is given a heading of 160

Figure 3: Overview of the approaches of both aircraft to Schiphol Airport

(Note: South of point **8**, the moment when the distance between the Boeing and Airbus is least, the flight paths are closest but the aircraft do not pass this point at the same time. Point **9** shows the Boeing is further in the approach than the Airbus.)

Parallel use of runways at Amsterdam Airport Schiphol

The use of parallel runways for starts and landing enhances the capacity and flexibility when traffic is busy. Schiphol is not unique in the use of simultaneous parallel approaches. Various international airports use these approaches, e.g. Heathrow (2 parallel runways), Frankfurt am Main (2 parallel runways), Atlanta (4 parallel runways) and New York/John F. Kennedy (2 parallel runways).

International Civil Aviation Organisation (ICAO)[6] gives guidance for the use of parallel runways. ICAO Document 4444 gives minimum distances between parallel runways, minimum radar support when conduction parallel approaches, and states that at least one ATC approach controller is appointed for each runway. When operating parallel runways, Schiphol confirms to the minima as given by Document 4444, and ATC controllers are working on one approach each, according guidance given. Each ATC controller handles traffic for 'their' own runway.

Each runway at Schiphol has its own procedure for the approach to the airport (approach procedure). According to the procedure, traffic approaching from the east is guided to the easterly runway (18C) for landing, traffic from the west is guided to the westerly runway (18R). Both runways are not situated precisely next to each other, there is a longitudinal shift whereby the beginning of runway 18C is positioned 1,8 NM (3,3 km) south of the beginning of 18R. Traffic for 18R flies the base leg at least 11 NM (20 km) north of threshold, traffic for 18C flies base leg at least 13 NM (24 km) from threshold.[7] If minimum distance from threshold for both runways is used, traffic will fly their base legs at the same distance from the Aerodrome Reference Point and will fly opposite tracks before starting their turns to final.

Crews flying to Schiphol are informed that they can expect to fly parallel approaches, so they can anticipate on the presence of other traffic in the traffic pattern. A note saying that parallel approaches are possible is printed on the published IFR approach plates and, closer to the airport, ATIS states if parallel approaches are conducted at that moment.

6 International Civil Aviation Organization (ICAO) was founded in 1947 as a body of the United Nations, which purpose was to make flying safer by giving guidelines for general aviation.
7 Local Dutch ATC regulations (Voorschriften Dienst Verkeersleiding 4.02) page 8.

Air trafic separation

Horizontal or vertical distance between aircraft during flight is called 'separation'. Minimum separation is used to make air traffic safer and at the mean time make best use of airspace available. ATC is responsible for maintaining minimum safe distances between aircraft under their control. ATC controllers give directions to crews stating heading, altitude and speed to fly in order to maintain minimum separation.

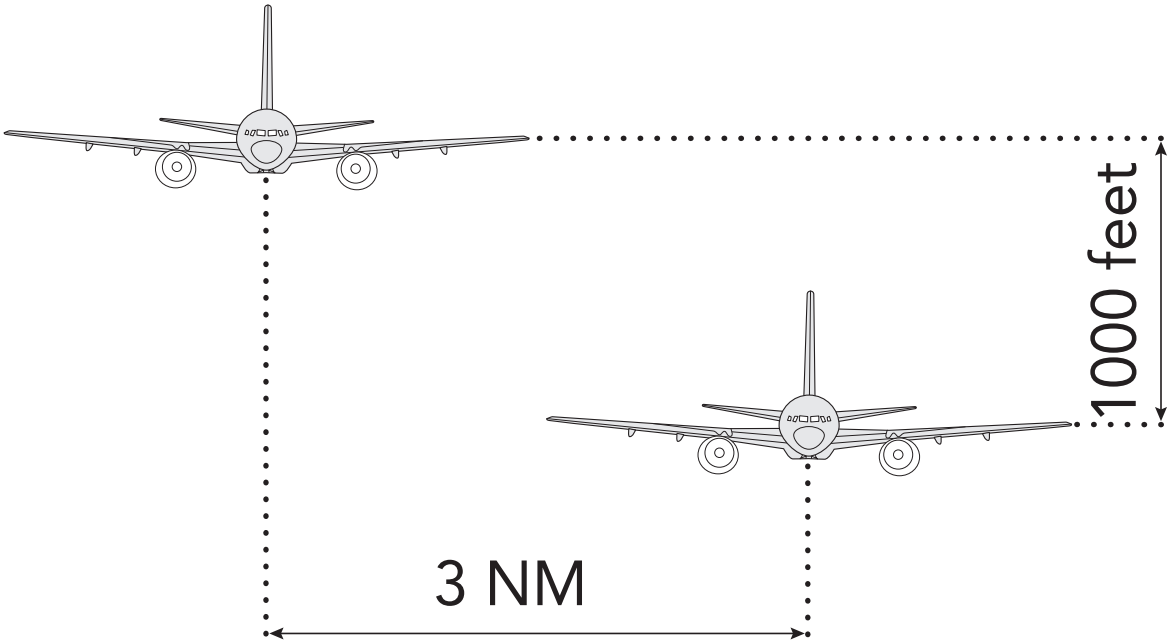


Figure 4: Minimum distance between aircraft, separation minima

When using parallel runways for landing, the minimum distance between aircraft in the approach is 3NM[8] (circa 5,5 km) horizontally *or* 1000 feet[9] (circa 305 m) vertically (figure 4).[10] Minimum separation is maintained until both aircraft in the approach intercept the final radial[11] to the runway, guiding them to the threshold.[12] LVNL has translated ICAO Document 4444 in their own procedure, written down in "Voorschriften Dienst Verkeersleiding" (VDV).

VDV describes standard procedures and relevant focus points for simultaneous parallel approaches, using 18R and 18C for landing and 18L for departure. Standard altitude for the beginning of the approach for 18R is 2000 feet and 3000 feet for runway 18C. The procedure in VDV describes that "*deviation from these altitudes is permitted, but only if a minimum altitude difference of 1000 feet exists between the altered approach altitudes for the parallel approaches*".

8 1 Nautical mile (NM) is 1852 meter.
9 Feet are used as unit for altitude in aviation, 1 foot is 0.3048 meter.
10 Published in ICAO Document 4444.
11 The Instrument Landing System (ILS) gives pilots a precise position of the aircraft in relation to the optimum glide path on final, both vertically and horizontally.
12 So called "independent runway use".

The distance between the centre lines of runways 18C and 18R at Schiphol is 2060 meter[13] (1.28 NM). This means that the altitude difference of 1000 feet is needed at all times since a horizontal separation of 3 NM (circa 5,5 km) is not possible when conduction simultaneous parallel approaches. Traffic approaching from the west shall normally be at 2000 feet, traffic from the east at 3000 feet, before starting the approach. The extra 1000 feet for the approach to runway 18C will be lost in the longer distance between the beginning of the final approach and the runway threshold.

Given the fact that both runways are not precisely next to each other, and distances between the beginning of final approach and threshold vary, traffic will fly opposite with an altitude difference of 1000 feet before commencing their turn to final.

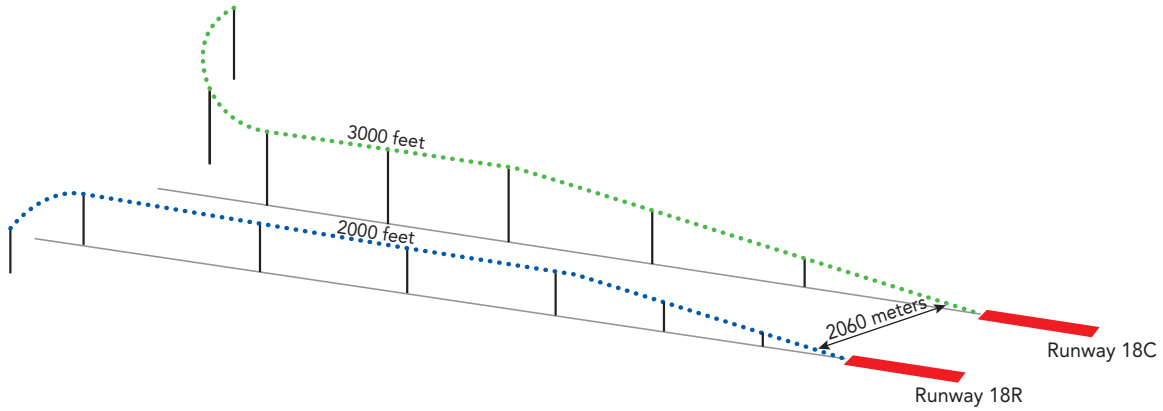


Figure 5: 3D image of approaches for both runways, note the runway offset

13 This distance must be at least 1035 meter if runways are used simultaneously (ICAO, PANS-ATM doc. 444, chapter 6 en PANS OPS doc. 8168, volume 1).

Safety features during loss of separation

When aircraft in flight are closer than the minimum published distance from each other, a situation called loss of separation exists. To prevent loss of separation conditions, a number of safety features are in place:

Air Traffic Control (ATC)
ATC is responsible for maintaining minimum separation between aircraft under their control. Whenever a (potential) loss of separation condition develops, ATC controllers give orders to aircrew to alter their heading, altitude or speed to recover the separation. These instructions are based upon the information given to the ATC controllers by radar imagery stating position, altitude, heading and speed of all aircraft under their control.

TCAS
Traffic Collision Avoidance System (TCAS) is installed on board of commercial airliners to give warning signals to the crew whenever two aircraft are getting too close, to prevent possible collisions. TCAS or Airborne Collision Avoidance System ACAS, works autonomously from other systems on board of the aircraft and gives two sequential warnings to the crew. These warnings include 'traffic advisory' (TA) and 'resolution advisory' (RA) that are activated depending on the calculated time until a possible collision.

TA warns the crew that other traffic is in the vicinity. Responsibility for separation lies at that point still with the ATC controller. RA gives the crew a warning for a possible collision and requires action from the crew. RA warnings include altitude instructions (climb, descend) to them that HAVE to be met. Apart from these audio warnings, TCAS also gives the crew a visual picture of the positions of other traffic, depicted on one of the displays in the cockpit.

The Crew
Crews are warned by ATC controllers or onboard TCAS devices of any potential danger in the air. It is mandatory for crews to respond to the instructions given by ATC controllers, and RA warnings from TCAS devices. TCAS RA warnings have a higher priority than ATC instructions and need to be followed, independent of ATC instructions.

Pilots are obliged to look outside the cockpit for other traffic whenever the weather permits them to do so. This is especially important in uncontrolled airspace where no guidance is given to traffic and crews are responsible for their own separation. This principle is known as 'See and Avoid'. All traffic flying to Schiphol under IFR is controlled traffic under direct control of ATC.

Effectiveness of safety features on 13 november 2012

When flying simultaneous parallel approaches, LVNL uses published minima whenever traffic is approaching from the west and the east, and both runways are used.

On 13 November a period of no traffic from the west was present during the 15 minutes prior to the event. Because of the pause in westerly traffic, during these 15 minutes there were no simultaneous approaches, and, according to LVNL, there were no separation minima in place since there was no traffic to separate. The ATC controller for runway 18C took the initiative and let his traffic descend to 2000 feet earlier than published. His colleague handling traffic for 18R was aware of that.

When traffic was again approaching from the west , the ATC controller for 18C did not stop descending his traffic from 3000 feet to maintain 1000 feet separation between the two traffic flows. Not until he noticed the Boeing approaching from the west appearing on his radar screen, did he understand that his traffic was too low. The ATC controller for 18R did not warn the 18C controller that traffic was approaching from the west again, and that traffic from the east should stay at 3000 feet to meet the separation criteria.

By separating east and west traffic by 1000 feet in altitude, ATC controllers can independently handle traffic for both parallel runways. On 13 November the 1000 feet separation was lost by allowing traffic from the east to descend to 2000 feet early in the approach. By doing so, opposite traffic from arriving from the west and east for landing at two parallel runways were flying at the same altitude. ATC controllers must be aware that leaving published altitudes, and thus leaving 1000 feet separation, they become dependent of each other. They must then be alert to the end of the traffic gap and inform each other of new traffic to be able to reinstall separation minima.

In this case no information was shared. The ATC controller for 18C expected his colleague to give him a warning when westerly traffic was approaching again. The ATC controller for 18R was convinced that his colleague would notice new traffic appearing on his radar screen and therefore did not notify him of the Boeing approaching from the west. There are no agreements between controllers on how to re-establish separation after a traffic gap.

Letting traffic descend early in the approach for runway 18C give the possibility for ATC controllers to also have aircraft fly a shorter route. This saves time, especially for traffic coming from the south that can shortcut the route by as much as 10 NM. In this case however, traffic came from the east and there was hardly any possibility to save time or distance. The only thing gained when descending traffic early, is the possibility to use the 3000 feet altitude band for other incoming traffic, but no such traffic existed at the time.

The ATC controllers
Even before the loss of separation was a fact, both ATC controllers involved realised that both airplanes were flying on converging flight paths at the same altitude and took measures. They did not warn the crews of both aircraft of the arising loss of separation, but did give course corrections to steer both aircraft away from each other and thus re-establish separation. Both ATC controllers work on adjacent desks and are trained for conflict situations and how to communicate and react under stress.

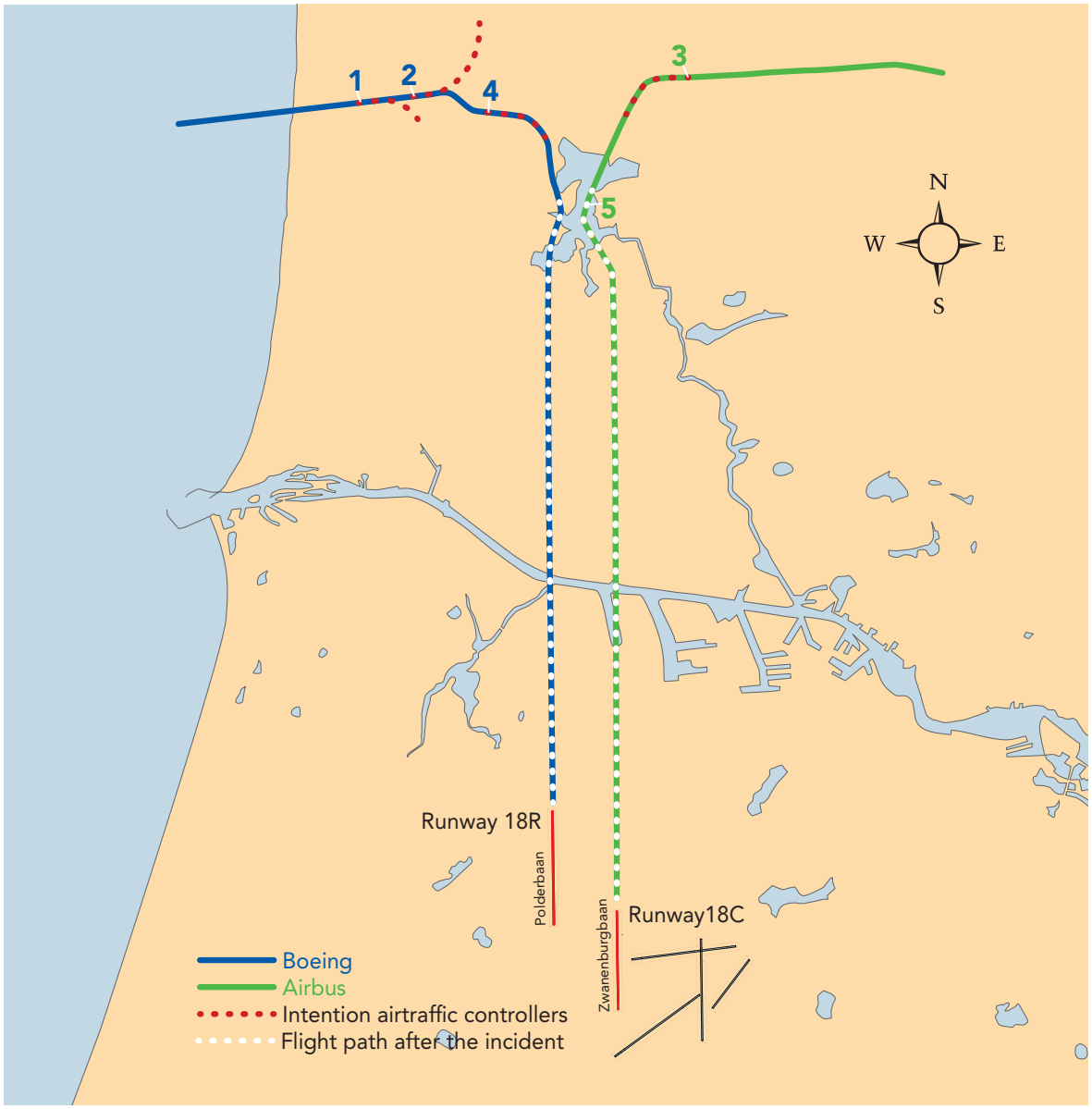
Nevertheless the situation on 13 November caused some stress with both ATC controllers, aggravating the situation:

ATC controller 18C
The ATC controller guiding the Airbus from the east, did not give the crew a final clearance for the approach to runway 18C. When given a final clearance, the crew is allowed to autonomously turn to the final heading and intercept finals. Because a clearance was not given, the crew persisted on the last given heading and crossed centreline. This caused them to fly west of the centreline of runway 18C.

ATC controller 18R
When the ATC controller for runway 18C told his colleague that the easterly traffic was also flying at 2000 feet, the ATC controller for runway 18R immediately ordered the Boeing aircraft to start a left hand turn to heading 360.

Moments later, the ATC controller 18R noticed that the course correction given to the Boeing crew resulted in the Boeing flying directly towards the Airbus. He then ordered the Boeing crew to start a right hand turn towards heading 160.

Heading changes from 160 to 360 and then to 160 again are considered extreme changes, especially during approaches. De crew was given heading changes to the south, followed by a turn to the north and then southbound again. The ATC controller did not expect the Boeing crew to turn as quickly as they did, and was already turning towards heading 160 when he told them to steer 360, and towards 360 when told to turn to 160 again. The radar images shown to the ATC controllers has a 5 seconds lag time. This lag is due to system design and is not preventable. Because of radar lag time and the short time between the given instructions the ATC controller was unaware of the fact the crew was already turning to the instructed headings. According to the ATC controller, there was a no, or very short time between the given instructions. The fact that there was little or no delay between the given instructions indicates the ATC controller was looking for a solution for the loss in separation between the two aircraft. The first heading correction did not give him the expected result. Interpreting the radar imagery he concluded the heading correction towards 360 would take too much time (a full 360 degree turn takes 2 minutes, a left turn towards 360 heading would take approximately 30 seconds), resulting in an even shorter distance between the two aircraft.



Position	Time	Boeing	Airbus
1	06.42:51	Boeing is given a heading of 160	
2	06.42:55	Boeing is given a heading of 360	
3	06.43:01		Airbus is given a heading of 210
4	06.43:15	Boeing is given a heading of 160	
5	06.44:12		Airbus is given a heading of 160

Figure 6: ATC heading instructions and crew confirmation (2,3 NM and 1,9 NM)

TCAS

TCAS generated a 'traffic advisory' at 06.43:35 (during 4 seconds) and again at 06.43:49 (during 5 seconds). The minimum distance between the two aircraft during the approach was 0,6 NM (1,1 km, figure 3, **8**). No collision warning (RA) was given by either system.

The Crew

The crew of both aircraft was fully aware of the position of the other aircraft in the approach. Radio communication with ATC indicated the Boeing crew were visual on the Airbus and vice versa. The distance between the two aircraft when asked if they were visual on each other was between 2,3 and 1,9 NM (4,2 and 3,5 km) .

The crew of both aircraft were given two TCAS 'traffic advisory'-warnings (figure 8). Crews were prepared to take the necessary actions if needed (evasive manoeuvre in case of 'resolution advisory'). Until the moment of the first TA warning, both crews were following ATC instructions.

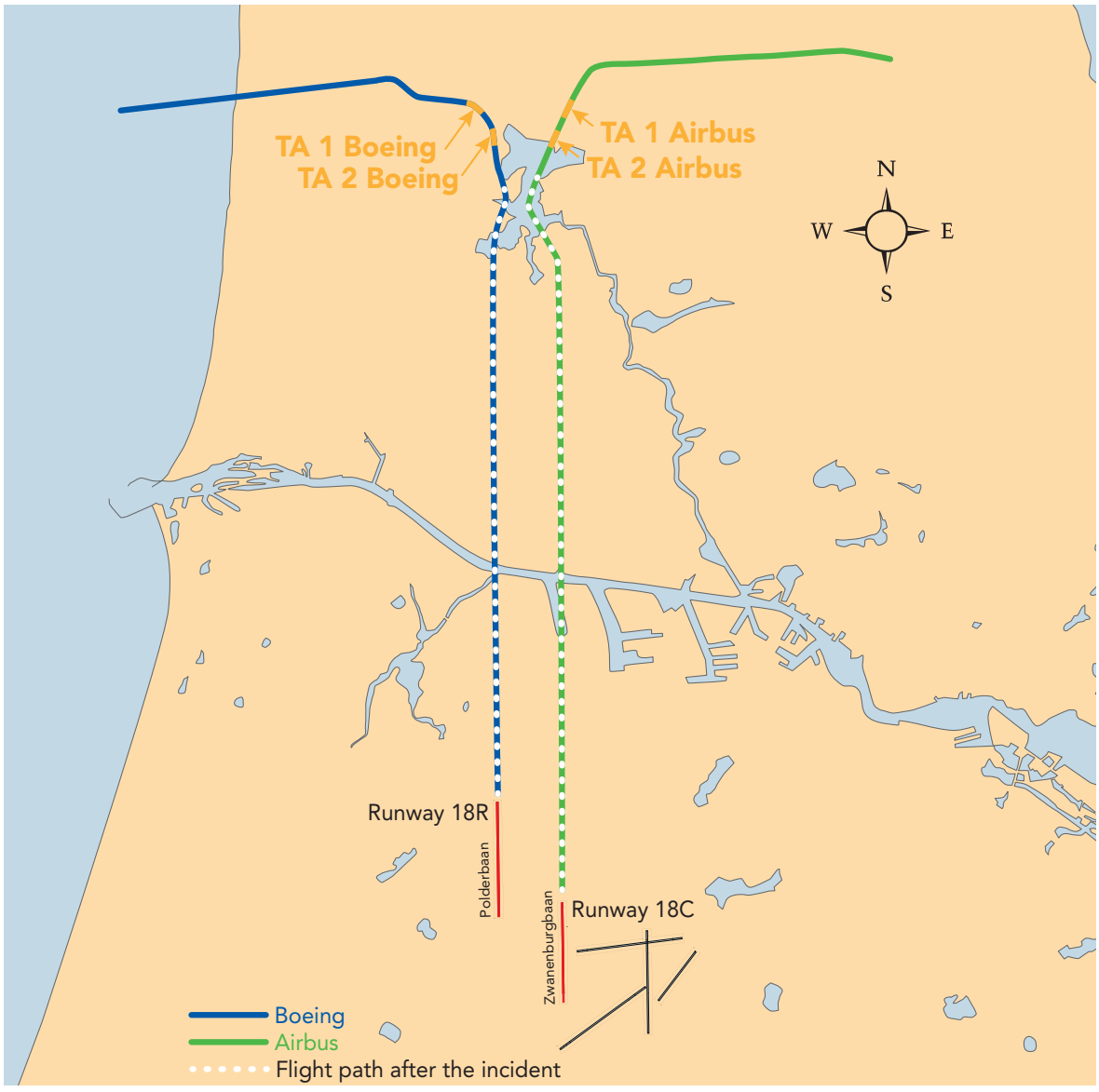


Figure 7: Position of aircraft during TA warnings

CONCLUSIONS

On 13 November two airliners in the approach towards Schiphol lost minimum separation. The public arousal caused by this occurrence was reason for the Dutch Safety Board to start an investigation into the event. On the basis of the investigation, the Board concludes that there was never any real danger during the event, and no immediate chance of a collision was present.

At Amsterdam Airport Schiphol, airplanes approaching on parallel approaches for runways 18C and 18R are separated in altitude and distance. Because of the lay-out of the runways, the minimum separation is 1000 feet .

The situation at 13 November started when ATC let the aircraft for the approach to 18C start its approach at 2000 feet instead of the usual 3000 feet. ATC changed the approach altitude because there was no other traffic on approach for 18R. At the time traffic reported for 18R again, traffic for 18C should have been brought to 3000 feet to maintain minimum separation. This was not done, causing the distance between two aircraft on approach to be below minimum. The Board considers this loss of separation minima to be an incident, causing a possible breach in flight safety.

The incident shows that deviating from published minima on own initiative brings safety risks. During earlier investigations in 2007 and 2013, the Board also concluded that ATC deviated from published procedures. Dutch Safety Board recognizes that ATC personnel should have a certain amount of freedom in handling traffic because of changing situations and the dynamics of the traffic flow. At the same time, this flexibility in handling traffic should be conducted in a safe and orderly manner, within written boundaries.

Dutch Safety Board recommends LVNL to give extra attention to the circumstances under which ATC controllers are allowed to deviate from procedures in their safety program 'Duidelijkheid in Veiligheid'

Furthermore, ATC controllers must be aware that they cannot operate individually, but are dependent on each other, especially when deviating from procedures. Strict co-ordination and communication are needed to maintain separation during parallel approaches.

TCAS INFORMATION

The official name for the system is Airborne Collision Avoidance System (ACAS). An other term used is Traffic alert and Collision Avoidance System (TCAS), this is however a brand name. Both terms are used, but TCAS is the more common. This report uses the term TCAS. TCAS system is an electronic system on board of commercial airliners to mitigate the risk of airborne collisions between aircraft. The system works autonomously, separate from ATC and other aircraft systems, and thus works as a safety feature in case of a potential danger for a collision.

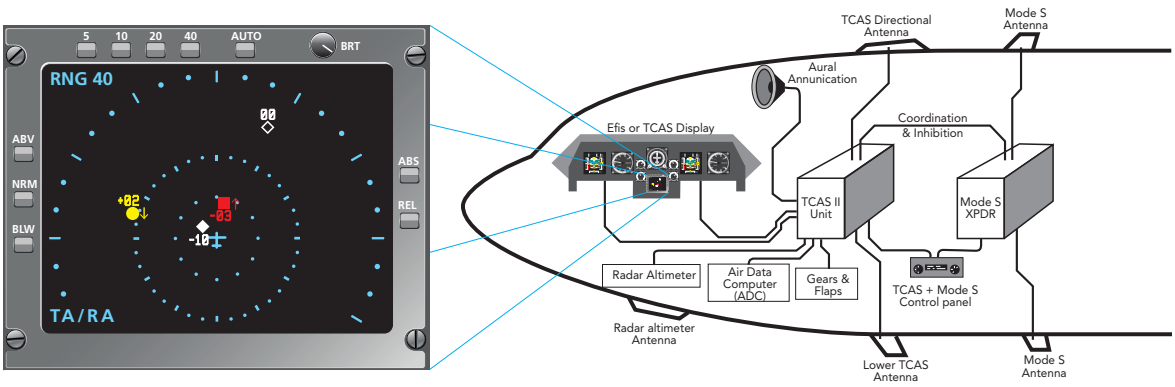


Figure 8: Schematic working of the system[14]

The TCAS system is active continuously and detects other traffic within a certain range from the aircraft. Traffic is depicted on a navigation display and is shown as a blue symbol.

Not to scale

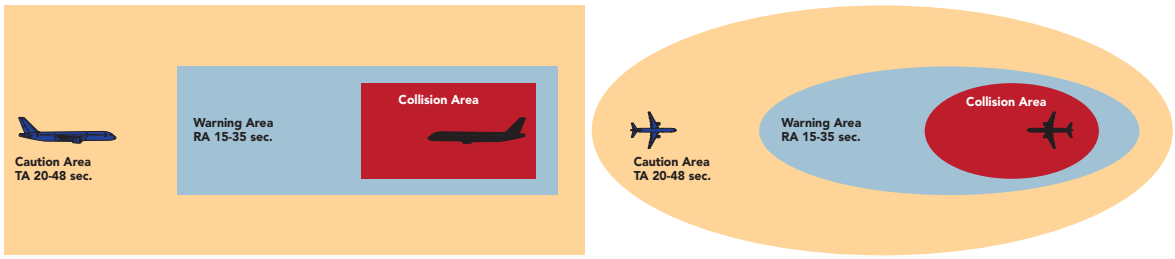


Figure 9: Schematic showing the vertical and horizontal plane, including the 'Traffic Advisory' and 'Resolution Advisory' regions[15]

14 Bron: ACAS II Guide, Airborne Collision Avoidance System II (incorperated version 7.1), January 2012.
15 Bron: ACAS II Guide, Airborne Collision Avoidance System II (incorperated version 7.1), January 2012.

The TCAS system analyses the identified traffic on the risk of a (possible) collision. Whenever a conflict arises, the system provides a pre-warning 'TA' (Traffic Advisory). This TCAS TA is shown on the navigation display as a yellow symbol and is accompanied by an audio signal 'Traffic Traffic'. The purpose of a TA is to help the crew identify any potential danger, but also to prepare the crew for any possible evasive actions. The responsibility for the separation in case of a 'TA' remains with ATC.

If the system calculates that there is a possibility of a collision and evasive action from the crew is required, a TCAS 'Resolution Advisory' (RA) warning is given. A TCAS RA warning is safety critical and requires action from the crew to prevent a collision. A red symbol is shown on the navigation display. A RA steering order is also displayed on the PFD (primary flight display). A RA manoeuvre is given in a vertical plane, the system will let the airplane steer up or down. The TCAS system has no influence on increasing the distance between aircraft in the horizontal plane (lateral separation). In case of a TCAS RA warning, separation is done by the TCAS system and ATC is no longer involved. Only when the system indicates the danger of a collision is no longer there, the crew will have report to the end of TCAS warning ATC, and ATC can take over responsibility of separation.

International rules and regulations indicate that the follow up of TCAS generated steering orders prevails over those given by ATC. Rules also indicate that ATC should be informed as soon as possible after reacting to the TCAS instructions. [ICAO doc. 8168 Aircraft operations: Communicate with ATC as soon as practicable after responding to the resolution Advisory (RA).]

ANNEX B

COMMENTS

A concept version of this report was given to all persons and organisations involved in the occurrence to contribute to the accuracy of the report, in line with 'Rijkswet Onderzoeksraad voor Veiligheid'. Persons and organisations shown below were asked to report any discrepancies or omissions in the draft report.

- LVNL
- Both Airlines involved
- AAIB Indonesia

All persons and parties responded to the request. AAIB Indonesia and one of the airlines had no comments. Two parties reacted after the given reaction time of four weeks. The reactions were incorporated in the report. Correction of factual omissions, detailed information and editorial comments were corrected as far as relevant for the report. The report was amended in the final report where necessary. Some of the reactions that were received but not incorporated in the report have a reaction from the Board. In the original Dutch report, the factual comments are given, together with the reactions from the Board.

DUTCH
SAFETY BOARD

Visiting Address
Anna van Saksenlaan 50
2593 HT The Hague
T +31(0)70 333 70 00
F +31(0)70 333 70 77

Postal Address
PO Box 95404
2509 CK The Hague

www.safetyboard.nl