**SERIOUS INCIDENT**

| | | |
|---|---|---|
| **Aircraft Type and Registration:** | Socata TBM 850, N850TV | |
| **No & Type of Engines:** | 1 P&W Canada PT6A-66 SER turboprop engine | |
| **Year of Manufacture:** | 2009 | |
| **Date & Time (UTC):** | 12 January 2011 at 1535 hrs | |
| **Location:** | Birmingham Airport | |
| **Type of Flight:** | Private | |
| **Persons on Board:** | Crew - 1 | Passengers - 3 |
| **Injuries:** | Crew - None | Passengers - None |
| **Nature of Damage:** | None | |
| **Commander's Licence:** | FAA Private Pilot's Licence | |
| **Commander's Age:** | 51 years | |
| **Commander's Flying Experience:** | 1,100 hours (of which 180 were on type)<br>Last 90 days - 30 hours<br>Last 28 days - 12 hours | |
| **Information Source:** | AAIB Field Investigation | |

**Synopsis**

Following a loss of communications on approach due to a frequency mis-selection by the pilot, the TBM 850 passed over the top of an aircraft holding on the Birmingham Airport Runway 15 starter extension and landed. No injuries or damage occurred. Four Safety Recommendations are made.

**History of the flight**

The history of the flight has been derived from interviews with the personnel involved, data recorded on the TBM 850, surface movement radar and air traffic recordings. Figure 1 shows the TBM flightpath and radio communications for the last nine minutes of the flight. Figure 2 shows relevant recorded data for the last four minutes.

The aircraft was on a private flight from Voghera, Italy to Birmingham Airport. It was being flown by the chairman of a business with the intention of attending a meeting in Birmingham; he departed Voghera at 0843 hrs. En-route he stopped at Angers, France and Antwerp, Belgium to collect members of his staff who were also to attend the meeting. There were NOTAMs in force at Birmingham Airport in respect of the replacement of the Runway 15 ILS and availability of navigation aids; these were not noted by the pilot prior to commencing the flight to Birmingham. The flight was routine until the arrival at Birmingham.

During the cruise the pilot had received the Birmingham ATIS which reported that the ILS for the runway in

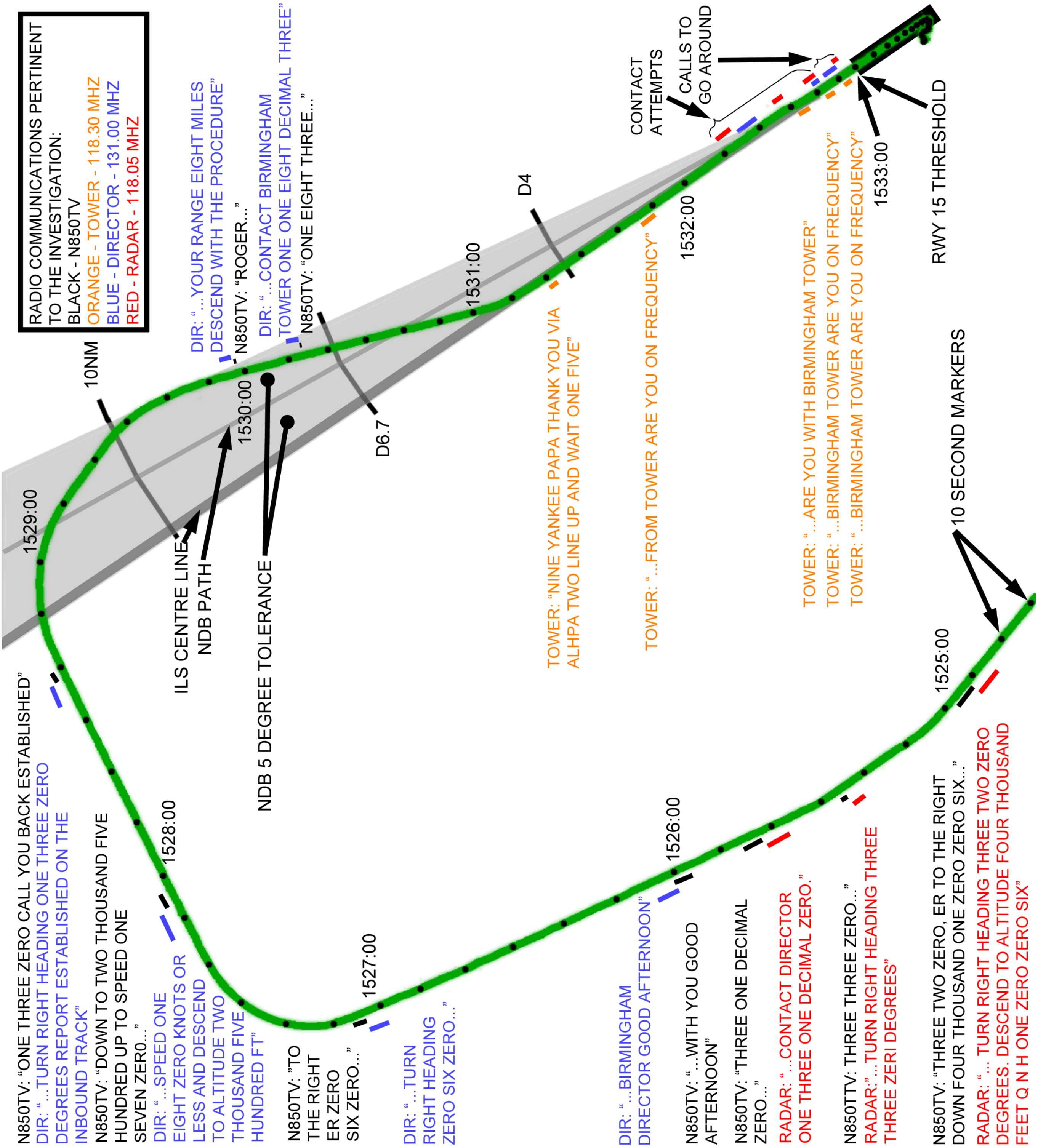


**Figure 1**

Aircraft track and radio communications, with pertinent procedural track information

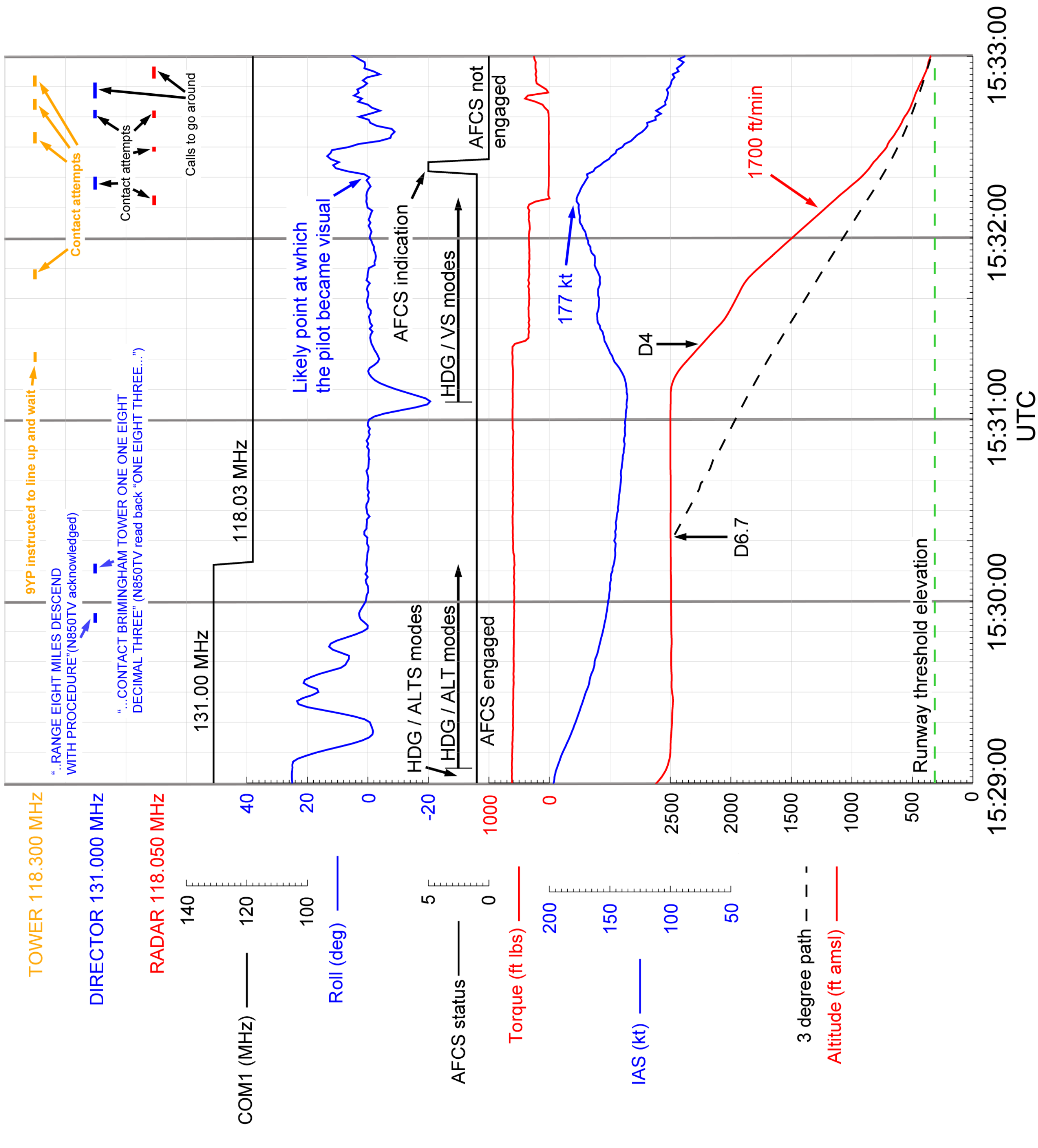


**Figure 2**

Pertinent recorded data for the four minutes prior to crossing the runway threshold use was "TRANSMITTING FOR TEST PURPOSES ONLY". When he contacted Birmingham Approach at 1514 hrs, the pilot was advised to expect a "NDB/DME RUNWAY 15" approach. He tuned the ADF for the approach and reviewed the approach plate on the aircraft's built-in Electronic Flight Bag (EFB). This EFB was displayed on the aircraft's central Multi-Function Display (MFD). MFD selections are not recorded and it is unclear if the pilot used other functions between this initial review and finally selecting the relevant plate to be displayed when conducting the approach. The aircraft was being operated with the autopilot engaged with the pilot manually selecting heading and vertical speed.

The pilot was given radar vectors to downwind right at 4,000 ft and handed over from Approach Radar on 118.050 MHz to Director on 131.000 MHz. The Tower controller had requested that, in order to allow a DHC-8-402 (Q400), which was just leaving the terminal, to depart, Director achieve 6 nm spacing between arrivals. Director therefore vectored the TBM behind a B737-700 (737) with a gap of about 6 nm[1]. At 1527:50 hrs Director instructed N850TV to slow to less than 180 kt and descend to 2,500 ft.

Director vectored the TBM towards the Final Approach Track (FAT) for the NDB with the instruction "NOVEMBER ZERO TANGO VICTOR TURN RIGHT HEADING ONE THREE ZERO DEGREES REPORT ESTABLISHED ON THE INBOUND TRACK." The pilot acknowledged, replying with "ONE THREE ZERO CALL YOU BACK ESTABLISHED TANGO VICTOR." The FAT for the NDB approach is 154° which is offset 5° from that of the track for an ILS approach (149°) and the runway extended centreline.

**Footnote**

[1] Spacing was to be achieved at 4 nm from the runway, the last point at which speed control normally applies.

The pilot later reported disconnecting the autopilot at or near this point. However, the recorded data indicates that the aircraft continued with the autopilot engaged until the aircraft became visual.

The turn took the TBM through the final approach track of 154°. The pilot adjusted the heading on to an intercept heading (closing the track from the east), still at the platform altitude of 2,500 ft. The pilot did not report established on the FAT and at the time the TBM completed the turn Director was talking with another aircraft.

At 8 nm Director passed a range check and cleared the TBM to "DESCEND WITH THE PROCEDURE." This was acknowledged by the TBM pilot.

As the TBM reached 7 nm the Director instructed the pilot to contact "BIRMINGHAM TOWER ONE ONE EIGHT DECIMAL THREE" which the pilot acknowledged saying "ONE EIGHT THREE TANGO VICTOR, THANK YOU."

This occurred about 10 seconds before the aircraft reached the FAT and about five seconds before the final descent point. However, the aircraft did not turn to track the FAT inbound, nor did it commence descent at the final descent point of 6.7 nm DME from the Runway 15 threshold.

The pilot believed he had pre-selected 118.300 MHz on the #1 radio standby position and pressed the frequency transfer button to move it to the active position. The recorded data shows that, at this point, 118.030 MHz became the active frequency. He then attempted to call the tower but received no reply. He decided to wait before calling again in case the tower controller was on the telephone. About 30 seconds later the pilot attempted to call the tower but again received no reply. The press to transmit (PTT) switch activations were not recorded and it is unclear exactly where on the approach these calls were made. Due to the lack of response from the tower, the pilot decided that his radio had failed and did not attempt to analyse this further. The pilot later stated that he had considered selecting 7600 on the transponder but, due to the position of the selectors being behind the control yoke, had felt unable to do so.

As the 737 was landing the tower controller checked the air traffic monitor[2] and, with the TBM about 5 nm from the airfield, cleared the Q400 to "VIA ALPHA TWO, LINE UP AND WAIT" on Runway 15. The controller then waited for the 737 to vacate the runway at Charlie, a 75° exit, in order to clear the Q400 for takeoff.

The TBM continued in level flight until intercepting the track of the extended runway centreline (149°) at about 4.7 nm from the threshold. Based on a nominal 3° glidepath the TBM was about 700 ft high at this point. The pilot selected a vertical descent speed of about 1,400 fpm while continuing to track approximately along the runway centreline. Shortly after starting the final descent the engine torque reduced from approximately 610 ft lbs to approximately 340 ft lbs.

At 1531:46 hrs, with the TBM approximately 3 nm from the threshold and the Q400 approaching A1, the controller called the TBM to establish communications and transmitted "NOVEMBER EIGHT FIVE ZERO TANGO VICTOR FROM TOWER ARE YOU ON FREQUENCY?" There was no reply to this call. The controller contacted Director by intercom to alert him to the developing situation. Tower called N850TV again with the same question at 1532:31 hrs, with the TBM now 0.8 nm from the runway, and twice more before the TBM landed, but in each case there was no reply. At no time did the tower controller transmit a go-around instruction. Both Approach and Director attempted to contact the TBM on their respective frequencies and transmitted go-around instructions.

The 737 had vacated the runway at 1532:10 hrs. The tower controller did not clear the Q400 to depart in front of N850TV and focused attention on trying to establish two-way contact with the TBM. The controller assessed that there was no option that would allow the Q400 to depart or safely clear the runway and that holding it in its current location on the Runway 15 starter extension posed the least risk.

Data recorded on the TBM suggests that the pilot became visual with the runway at about 600 ft aal (900 ft amsl) and at a range of about 1.3 nm from the threshold. When interviewed, he was unsure of the point at which he became visual but the position indicated by the data appears to be reasonable. He configured the aircraft for landing with the gear and first stage of flap, waited for the speed to reduce below the full flap limit speed of 122 kt and then selected landing flap. He visually checked that the runway was clear while correcting the aircraft's flightpath and then landed. The tower controller assessed that the TBM touched down abeam the Bravo intersection, about 270 m from the displaced threshold and 170 m short of the main touchdown markers. A 'follow me' vehicle was assigned to escort the TBM to its parking position. On vacating the runway the TBM pilot contacted Ground on the #1 radio without difficulty.

**Aircraft and Garmin G1000 description**

The TBM 850 is a single engine turboprop powered by an 850 hp engine. It is certified for single pilot operations and has a total of six seats. It is equipped with Garmin G1000 avionics comprising two 10.4 inch Primary Flying Displays (PFDs) and one central 15 inch

**Footnote**

[2] A simple radar display mounted in the tower.

Multi-function Display MFD. The G1000 is controlled by a combination of soft keys and dedicated controls. N850TV was equipped with an ADF, which is an optional fit.

The communication (COM) radios are integrated into the G1000 system. Information relating to the active and standby frequency of the #1 radio is displayed on the top right of the PFD with the active frequency being to the left of the standby frequency. The #2 radio is displayed immediately below the #1. The frequency in use is highlighted in green. Should the radio tuning system fail then the system will automatically tune 121.5 MHz. Depending on the failure mode a red 'X' may appear on the frequency display.

It is possible to load frequencies from the FMS database directly into the COM standby position using the 'nearest airport' function. This database held the correct tower frequency for Birmingham.

In March 2010, during an approach to Malaga, N850TV had a failure of the #1 COM radio. This failure was accompanied by an audible warning and the presentation of the red 'X' on the COM 1 display on the G1000. The pilot commented that on that occasion he was operating with another qualified pilot and it had been relatively straightforward to deal with the problem. The COM 1 radio was subsequently replaced.

The transponder Mode A code is altered by selecting the XPDR soft key on the PFD, then selecting CODE and entering the required code. The XPDR soft key is the eighth key from the left of the PFD and is therefore located behind the control yoke (shown in Figure 3 below).

The G1000 system is capable of flying autopilot coupled approaches. The MFD of the G1000 on the TBM850 can display electronic versions of paper approach charts. N850TV was using a database from a major international chart supplier. The G1000 overlays the aircraft position


**Figure 3**

Position of transponder controls

onto the electronic chart as an aid to situational awareness but this is not approved for primary navigation use. The charts are selected by pressing the SHW CHRT soft key then pressing the FMS knob to activate the cursor and entering the airfield identification. The FMS knob is then used to select an approach and a dropdown box with the chart options appears. Turning either FMS knob will scroll through the available charts and enter selects the chart. The electronic menu uses the same identifiers as the paper charts; the ILS for Runway 15 at Birmingham is therefore listed as the NDB ILS DME Rwy 15 (plate number 11-1), while the NDB approach is NDB DME Rwy 15 (plate number 16-1). The chart display can zoom into the chart at a user-set level. The default user-set level set for N850TV displays the top two-thirds of the chart but cuts off the vertical profile at the bottom (see Figure 4 below).

The pilot stated that, during the incident, he had placed a paper copy of the NDB chart in a chart holder which he used to follow the vertical profile of the approach. He also stated that he had selected, on the G1000, a NAV page which he used to monitor his lateral profile.

On the day following the incident the pilot was asked to demonstrate selecting the NDB approach chart for Runway 15 on the system. However, the chart he selected for display was the ILS chart for Runway 15.

## Recorded data

N850TV was not required to be equipped with flight recorders. However, the installed Garmin G1000 avionics system records flight parameters once a second to a file on a Secure Digital (SD) memory card if one is inserted in the top SD card slot of the central display. An SD card was found in the appropriate slot and it retained the recordings of three flights flown on the day of the incident. The otherwise comprehensive list of recorded parameters did not include flap or gear selections, data relating to the EFB or radio Push-To-Talk parameters.

Recorded radar returns from the aircraft, including some Mode S parameters, were provided as well as the ATC recordings active at the time of the event.

Birmingham ATC uses surface movement radar which is overlaid onto a display of the airport map along with

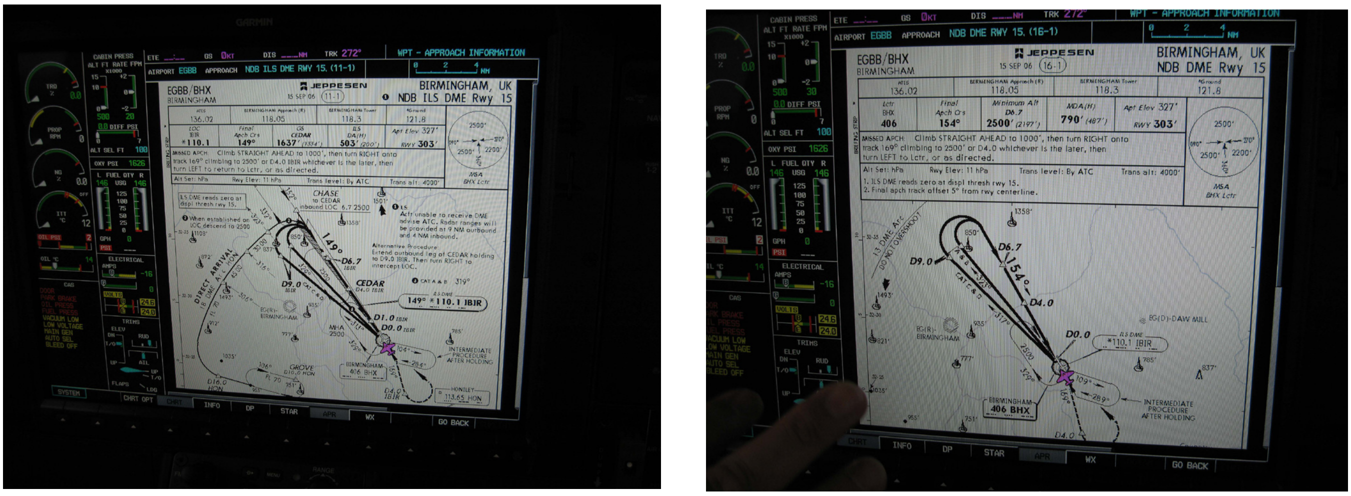


**Figure 4**

Presentation of ILS and NDB plate images on G1000

UTC and aircraft identifiers. The displayed image was recorded and subsequently analysed. The pertinent information from the recordings is given in Table 1.

Two minutes and eleven seconds elapsed between the first returns of the 737 and N850TV appearing on the surface movement radar display. The G1000 recordings show that N850TV was 5.7 nm away from threshold when the 737 landed.

**TBM pilot**

The TBM pilot had originally held an Italian PPL (A) and had an FAA private pilot certificate issued on the basis of that licence. However, his Italian licence lapsed and he gained a stand alone FAA Private Pilot's certificate in the USA in December 2006. He completed his Instrument Rating (IR) at the same time and last renewed it in June 2010 in Italy. He was required to fly an NDB approach during his initial flight test but was not required to fly one during his renewal test. The TBM pilot could not recall flying an NDB approach between his initial IR test and the incident.

No type rating is required to fly a TBM 850 on a FAA licence, nor is a specific endorsement for glass cockpit aircraft required. However, a pilot is expected to be proficient in the use of the equipment installed in the aircraft. In February/March 2010 the pilot completed

| Surface movement radar displayed time (UTC) | Comment |
|---|---|
| 1530:45 | First sign of 737 surface movement radar return on landing. |
| 1531:55 | Q400 radar return started crossing the A1 hold point. |
| 1531:57 | Box[3] popped up showing N850TV against a 60 second marker. |
| 1532:05 | N850TV ident moved to 45 second marker. |
| 1532:10 | 737 radar return cleared C1. |
| 1532:21 | N850TV ident moved to the 30 second marker and highlighted in amber[4]. Q400 also highlighted in amber and on the runway. |
| 1532:37 | N850TV ident moved to the 15 second marker and highlighted in red. Q400 also highlighted in red. |
| 1532:55 | N850TV ident and Q400 marker returned to normal colours. |
| 1532:56 | First sign of N850TV surface movement radar return, just behind Q400, ie while still airborne. |

**Table 1**

Pertinent information from the Birmingham surface movement radar recording

**Footnotes**

[3] The box has four times, 60, 45, 30 and 15 seconds. An approaching aircraft is shown against the 60 second marker 60 seconds before the estimated touch down time, and moves to the 45 second marker 45 seconds before the estimated touch down time and so on for 30 seconds and 15 seconds.

[4] Changes in colour indicate a change in the level of hazard predicted by the system.

a two-week ground and flying training course at the aircraft manufacturer. The manufacturer reported that:

> *'The aim* (of the course) *is neither to give nor to give again Instrument Rating (IR) training. The manufacturer requests from the pilot as prerequisites, a valid Instrument Rating certificate (IR), but it is not mandatory from FAA or JAA rules point of view.*
>
> *During the training this pilot flew 8.10 hours in 6 flights of which 2.20 hours* (were) *under IFR flight. He totalizes 20 landings, 4 go-around, 6 instrument approaches of which 2* (were) *NDB approaches.*
>
> *During training, to perform an instrument approach the instructor asks to use the autopilot (to teach the pilot to use it), but may also ask the pilot to perform instrument approaches without the autopilot to train for a possible system failure.*
>
> *There are no specific instructions for* (an) *NDB approach. The pilot can use or not use the autopilot.*
>
> *If the autopilot is chosen for* (an) *NDB approach, we advise (but the PIC remains the only one to decide and there are no written operational instructions):*
>
> - *for a DESCENT (approach or normal descent): to engage "heading -HDG" mode and, either "vertical speed - VS" mode or "pitch" mode*
> - *During CLIMB: to use "flight level change - FLC" mode to avoid all risks of stall*
>
> *While using the autopilot, the instructor emphasizes limitations given in POH section 2 - page 2.6.2 and particularly on:*
>
> - *the autopilot and yaw damper must be OFF during takeoff and landing*
> - *do not engage autopilot below 1000ft above ground level during cruise or climb*
> - *do not use autopilot below 200ft during approach*
> - *do not use autopilot with airspeeds below 85 KIAS'*

**Tower controller**

Three staff were on duty in the visual control room at the time of the incident. Two air traffic controllers (ATCO) in the Tower and Ground roles and an assistant. The ATCO in the Tower position had qualified as a controller in 2003, held current tower and radar validations, had been on shift since 1000 hrs and in position for 25 minutes before the incident.

**Meteorological conditions**

The METAR for Birmingham at the time of the incident reported a wind from 210° at 9 kt, visibility of greater than 10 km, light rain with cloud scattered at six hundred feet and broken at nine hundred feet temperature +11°C dewpoint +10°C and the QNH 1006 HPa.

**Airfield information**

Birmingham Airport is a major international airport located in the West Midlands. Runway 15 was in use which is of black coloured asphalt construction measuring 2,279 m from the displaced threshold. There is a starter extension of 290 m, the first 160 m of which is constructed of beige-coloured concrete. The runway is equipped with high intensity approach lights, runway lighting with 15 m spaced centreline lighting, touchdown zone lighting and PAPI set to 3°. Figure 5 below shows the area around the threshold of Runway 15 and identifies the holding points at that end.

The runway is normally equipped with an ILS certified to CAT III. However, because it was being tested after it had been replaced, the ILS was unserviceable; this fact was identified in NOTAMs. The NDB DME approach to Runway 15 was in use. The NDB is located on the airfield and the DME used is the same as for the ILS giving a reading of 0.0nm at the threshold. On the day of the incident the ILS was in the process of being re-commissioned which required calibration flights to be operated intermittently. The Air Navigation Service Provider (ANSP) responsible for the ILS stated that, at the time of the incident, it was believed that the ILS was switched off but no detailed records of power on and off times were available. Due to the calibration work ATC were using CAT II/III holding points for departing traffic. The aircraft being used for the ILS calibration was on the ground at the time of the incident and was not a factor in the event.

**ATIS**

*CAA CAP 493: Manual of Air Traffic Services (MATS) Part 1*, Section 3, Chapter 1 states that:

> *'The ATIS message is intended to provide a pilot with a range of information to enable him to make a definite decision about his approach and landing…The message should, whenever practicable, not exceed 30 seconds'*

and additionally in the same section:

> *'The ATIS should contain…Type of approach to be expected'*

In addition to the normal weather information, the ATIS being broadcast had four messages appended; that the ILS was transmitting for test purposes, that delays could be expected due to calibration work, that a ground stop bar had a fault and that there was increased bird activity, specifically wood pigeons. These messages alternated between human and synthetic voice, included the repetitive phrase "PILOTS ARE TO BE ADVISED THAT…". The total duration of the ATIS message was 56 seconds. The ATIS broadcast did not include the type of approach to be expected.

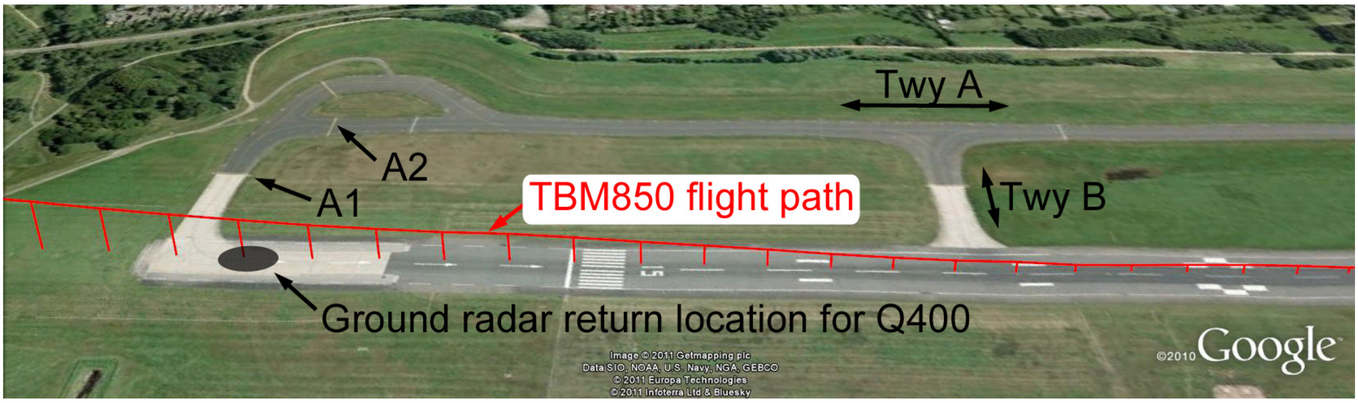


**Figure 5**

Runway 15 threshold

**Approach vectoring**

The *CAA MATS Part 1*, Section 3, Chapter 2 states that:

> *'9.3.3 Except when Continuous Descent Approach (CDA) procedures are in operation or in an emergency, aircraft shall be positioned so as to maintain a period of stabilised level flight before commencing descent on the glide path, on descent profile of a pilot interpreted approach…*
>
> *9.6.1 …Non-precision approaches rely on the pilot being in a position to cross the published Final Approach Fix at the specified altitude/height in order to safely complete the approach.*
>
> *9.6.2 Controllers shall vector aircraft onto the final approach track, or onto a heading to close the final approach track at an angle not greater than 40° offset from the final approach track. Whenever practicable, the aircraft is to be established on the final approach track before the Final Approach Fix to enable it to cross the Final Approach Fix at the altitude/height specified in the notified procedure.*
>
> *9.6.4 For procedures that are supported by DME, the controller shall pass a range check and clear the aircraft for the approach when the aircraft is established on the final approach track.'*

**Loss of communications**

*ICAO Doc 4444 Procedures for Air Navigation Services* - Air Traffic Management - Section 15.3.3 states that, following a loss of communications a pilot should, if in visual meteorological conditions:

> *'1) continue to fly in visual meteorological conditions; 2) land at the nearest suitable aerodrome…'*

If in instrument meteorological conditions a pilot should:

> *'.....complete a normal instrument approach procedure as specified for the designated navigation aid or fix; and land….'*

The *UK Aeronautical Information Package* (AIP), section ENR 1-1-3-4, paragraph 4.2.4 details the actions to be taken following radio failure. The procedures in ENR 1 state:

> *'4.2.4.1 A flight experiencing communication failure in IMC shall*
>
> *(a) Operate secondary radar transponder on Mode A, Code 7600 with Mode C.*
>
> …
>
> *(f) Carry out the notified instrument approach procedure as specified for the designated navigational … When practical, pilots should take account of visual landing aids and keep watch for instructions that may be issued by visual signals from the ground.'*

However, specific airfield instructions, detailed in AIP, section AD 2, may differ from or amplify those procedures. The charting system used by the pilot for Birmingham Airport accurately reflected the entry published in the *UK Aeronautical Information Package (AIP)* for Birmingham (on chart AD 2-EGBB 5-1) and stated, on plate 18-2, the loss of communication procedure as:

> *'Intermediate and Final Approach – Continue visually or by means of an appropriate final approach aid. If not possible follow the Missed Approach Procedure to Birmingham Lctr.'*

The procedure has been adopted as standard throughout the UK and reflects *ICAO Doc 4444* practice.

The *UK Air Navigation Order - The Rules of the Air Regulations 2007* (ANO) also address the issues of communications and communication failure and states under Rule 45 that:

> *'(6) The commander of an aircraft flying within the aerodrome traffic zone of an aerodrome shall:*
>
> *(a) cause a continuous watch to be maintained on the appropriate radio frequency notified for communications at the aerodrome; or*
>
> *(b) if this is not possible, cause a watch to be kept for such instructions as may be issued by visual means;'*

**Signal lamps**

The *UK Civil Aviation Publication (CAP) 670* requires[5] that:

> *'A signal lamp with interchangeable coloured lenses (white, red and green) and spare bulb shall be provided and must be accessible to the controller. The lamp must enable control of aerodrome traffic as laid down in the Rules of the Air Regulations 2007 (incorporating The Rules of the Air (amendment) Regulations 2009). The light must be visible from all points of the manoeuvring area and from all points within the aerodrome visual circuit. NOTE: Shining the lamp through tinted glass or blinds can affect the perceived colour of the signal.'*

The ANSP at Birmingham, in common with several other major UK airfields, had applied to the CAA to remove their signalling lamp approximately six to ten years before the incident. This application was supported by a study which showed that signal lamps had limited effectiveness at those airfields. The CAA acknowledged that they had given permission for the signal lamp to be removed but neither they nor the ANSP could locate a copy of the application, permission or the supporting study.

**Landing without clearance – previous events**

The UK CAA MOR database was interrogated for incidents relating to loss of communications on final approach which had resulted in landing without clearance. Although the database produced numerous examples, a considerable number of non-relevant results were returned as well. Where examples were highlighted, the database coding was not sufficiently robust to allow a quantitative analysis of events occurring over a wide date range to be conducted with any confidence. However, 17 occurrences were positively identified in the 12 months to March 2011. To ensure data validity the search was constrained to multi-pilot, public transport, passenger aircraft.

**ANSP safety notice**

Following a number of incidents at various airfields of aircraft landing without clearance, or aircraft not going-around when instructed, the ANSP issued *Safety Notice (SN001.10 NATS) Runway Safety – Landing without clearance* (Safety Notice) on 22 December 2010. Although titled *'Safety Notice'* it provided advice for controllers rather than a mandatory operating instruction. The Safety Notice stated that:

**Footnote**

[5] CAP 670 provides a detailed means of compliance with the ANO and EU Regulations that is acceptable to the CAA.

> *'Advice from UK based airline crew is that, normally commercial crews not in receipt of a landing clearance will execute a standard missed approach. Occasionally an aircraft will complete an approach and land without clearance….'*

The Safety Notice included advice relating to '*Aircraft failing to execute a missed approach when instructed.*'

It stated:

> *'A significantly more serious situation arises when an ATCO has issued the instruction for an aircraft to execute a missed approach and the aircraft crew fail to carry out/acknowledge the "go-around" instruction or they indicate their intention to land regardless. Controllers should be aware that the instruction to execute a missed approach represents a significant dislocation of the pilots' expectation that they will land, particularly if the instruction is issued when the aircraft is within 4 miles from touchdown.'*

The Safety Notice then observed that:

> *'the options available to mitigate the severity of this situation are extremely limited, but the following actions should be considered:*
>
> - *Continue to transmit the "go-around" instruction to the aircraft*
> - *Transmit essential aerodrome information relating to the hazard / reason for the "go-around"*
> - *Initiate an "aircraft accident imminent" in accordance with local procedures*
> - *Alert other controllers in the vicinity*
> - *Use an Aldis lamp to signal the aircraft*
> - *Alert the supervisor'*

The Tower controller was aware that an aircraft may land if its radio had failed and the runway was clear, but was not aware of this Safety Notice before the incident and thus had not read the advice that it contained.

**ATCO briefing process**

At Birmingham a group briefing was conducted for each ATC watch on the first afternoon shift of a week. Between these group briefings ATCOs were required to self-brief at the start of each shift, before commencing controlling. In common with all the ANSP's units, an electronic briefing system was provided which should have flagged any instructions, safety notices or similar documents that had been uploaded since the last time the ATCO logged on to the system. The ATCO could then read the document on the screen and/or print it. The ATCO could also electronically acknowledge the document as having been read. The system logs the amount of time a controller views each document and whether it is printed. The system also generates reports for managers to allow them to track that their staff have acknowledged the latest documents. If the electronic system was unavailable the ATCO could self-brief from hard copies of the relevant documents.

The Tower controller had logged onto the briefing system after the Safety Notice had been issued but had not seen or acknowledged it. It was subsequently determined that the Safety Notice had been removed in error and thus was not available for the controller to view or acknowledge at that time.

After it became apparent that the controller had not read the Safety Notice, the AAIB asked the unit air traffic manager to interrogate the system and provide a list of staff who also had not electronically signed as having read or printed it. The system generated a list that included this controller but also included members of staff who were not licensed controllers and were therefore not expected to have read it. It also listed controllers who for various reasons were no longer at the unit.

**UK controller – pilot mutual training**

To improve mutual understanding of the controller and pilot roles, several airlines conduct training with the ANSP involved in the incident. This training includes flight crew and controllers attending each others classroom and simulator training courses. For flight crew the ANSP encourages the observation of live operations involving tower, radar and the Swanwick and Prestwick Control Centres. Several airlines offer controllers the opportunity to observe flights from the jumpseat as a way of significantly improving controllers' understanding of flight procedures. In order to satisfy insurance requirements controllers may be issued with a flight ticket, although the ticket itself is normally provided by an operator at no cost. This mutual training has the full support of the CAA and the ANSP.

**UK Air Passenger Duty (APD)**

In the UK, APD is a duty of Excise which is levied on the carriage of chargeable passengers on chargeable aircraft from a UK airport. The duty is payable by the operator of the aircraft. Certain categories of persons are exempt from APD but it had been considered that Air Traffic Controllers on mutual training flights did not fit in one of these categories and so were not exempt. During the investigation a number of controllers and other safety staff commented that the costs, including APD, act as a discouragement from conducting familiarisation flights.

## Analysis

**Human Factors: operational context**

The TBM pilot had relatively limited total experience and low experience on type. The level of experience in a particular activity changes the likelihood of particular types of error being made. Low experience increases the probability of errors in skill and rule-based behaviour[6]. The pilot stated that he last flew an NDB approach four years before the incident and could not recall flying one in the TBM 850 even though he was reported to have accomplished two during his TBM course.

The TBM pilot was also subject to subtle pressures which may have reduced his probability of making good decisions. He had flown three sectors over seven hours and, with five and a half hours airborne as single pilot, may have been experiencing some fatigue. His passengers were his employees and they were all going to a business meeting. It is likely that the pilot felt a certain amount of pressure to land at Birmingham in order that he and his colleagues could attend the meeting on time.

**Plan continuation bias - explanation**

The theory of plan continuation bias is described in '*The Field Guide to Understanding Human Error*', (Dekker 2006) as *'sticking with the original plan while the situation has actually changed and calls for a different plan.'*[7] In it he goes on to suggest that amongst the reasons for this are that early cues

**Footnotes**

6 Reason- Human Error p57 section 2.4

7 Dekker – The field guide to understanding human error 2006

suggesting that the initial plan is correct are usually very strong. However, later cues suggesting the plan should be abandoned are less compelling. Stress and fatigue make it more difficult to project a situation into the future by mentally simulating possible outcomes. The evidence of a need to change the plan may not become compelling until seen in hindsight. Anyone, including pilots and ATCOs, can be affected by plan continuation bias.

**Approach vectoring**

The timing of Director's call to turn right to intercept the FAT would have enabled the TBM to become established at about 10 nm, albeit with a very short intercept leg, if the TBM had executed a similar rate of turn to that of the previous vectoring instruction. However, a reduced rate of turn resulted in the aircraft passing through the NDB inbound track while still heading south east. The aircraft continued for 1.5 nm before the pilot turned more southerly to intercept. Despite overshooting the FAT there remained sufficient distance and time to re-establish on the NDB final approach track before commencing descent at 6.7 nm. The effect of the late interception on pilot workload was further compounded by the frequency change from Director to Tower occurring at 7 nm.

The TBM passed through the NDB final approach track again at 5.9 nm. This position was already within the final descent point for the approach and thus an unstable approach became more likely. The aircraft eventually became established on the runway extended centreline at just less than 5 nm but still at the platform altitude of 2,500 ft.

Although the vast majority of instrument approaches flown in the UK involve radar vectors to an ILS, the NDB approach remains approved for use in the UK. The NDB lateral element is pilot-interpreted requiring a high cognitive demand to complete and the vertical element relies on a stable starting platform. As a consequence, it is considered likely that pilot-interpreted non-precision approaches require additional time to plan and execute.

**Approach**

The TBM pilot had maintained the platform altitude of 2,500 ft until intercepting the extended runway centreline at 4.7 miles. Based on the weather and pilot reports, it was unlikely that he would have been visual with the runway at this point and, with the ILS out of service, the pilot needed to use another navigation aid to achieve this track. While the pilot maintains that he was simply flying the NDB to the best of his ability, there is the possibility that he was flying the approach by using the G1000 aircraft position overlay to support his tracking. It is also possible that the pilot had displayed the ILS lateral profile on the MFD instead of that for the NDB.

The TBM's lateral track remained within the limits for the NDB procedure.

**Vertical profile**

The TBM pilot was operating a private flight and was not obliged to operate to the stable approach criteria or continuous descent final approach used by commercial air transport operators. However, these techniques are referenced here as a benchmark for the approach profile. His approach would be legal so long as he did not go below minima without the appropriate visual references. While with Director, the TBM had been given a speed control of not more the 180 kt. Any speed control would normally cease to apply within four miles of landing.

The TBM did not cross the NDB final approach track until it was 6.1 nm from the threshold. Although the pilot could have commenced descent when within 5° of the inbound track he would be unlikely to do so until he had turned to track inbound. At 6.1 nm the aircraft was 212 ft above the profile.

The TBM continued in level flight until it was 5° right of the published FAT where it turned to track inbound on 149°. At this point it was 700 ft above the nominal approach path. The pilot flew a rate of descent of about 1,400 fpm, approximately double the rate required on a normal 3° approach. Just inside 4 nm, torque was reduced from approximately 610 ft lbs to approximately 310 ft lbs but the aircraft's speed continued to increase, peaking at 177 kt at 1,130 ft (1.6nm). This was 1 kt below the gear limiting speed.

The approach had become unstable; the aircraft was close to the ground with a high rate of descent and a high speed (almost 90 kt above its threshold speed). Landing clearance had not been received. The cloudbase was close to the approach minima and, as the approach had become destabilised, it is likely there would be an aversion to return to an uncomfortable environment. Likewise the runway represented an area of safety and thus the psychological 'push' from the cloud and the 'pull' from the airfield made a go-around, once visual, more unlikely. Plan continuation bias would also have reduced the likelihood of the pilot electing to go around.

At no point on the approach did the TBM's vertical profile exceed the limits of the NDB procedure.

**Loss of communications**

On being instructed to change to 118.300 MHz the pilot had selected 118.030 MHz. The number sequence is visually very similar and once the error had been made, detection of it without an additional cue would be highly unlikely. The cue provided by the failure to establish communications could have led the pilot back to the radio frequency selection. However, as discussed above, by the time the pilot had been alerted to the loss of communications, his task loading had increased significantly and it is possible that the need to establish communications was lost amongst the competing priorities of operating the aircraft. There is no evidence to suggest that the pilot tried to diagnose the apparent radio failure. A previous radio failure on the aircraft may have made the pilot more likely to assume that it had failed again, even when there was no evidence to support this assumption.

**Failure of visual search**

On becoming visual with the runway at about 600 ft aal the pilot stated that he looked at the runway but did not see the Q400. It is likely that he did look to check that the runway was clear before landing, with his probable area of focus having been the touchdown zone of Runway 15 (the point at which he was aiming).

Although the Q400 had a white strobe light on its tail, white strobes are sometimes used as location aids at European runways and as such may not have been as effective in attracting the pilot's attention. The approach lighting embedded into the surface of the starter extension created a brightly lit area which would have reduced the contrast between the white coloured Q400 and the runway surface. This, combined with the likelihood that any visual search would have been focused on the runway itself and not the different coloured concrete of the starter extension, would have reduced the probability of a successful detection of the Q400.

The approach ended in a cognitively busy situation and any pilot has limited attention to divide between all the necessary tasks. In this approach the required number of tasks at the point of breaking cloud had increased and, due to the high approach speed, the time available to complete those tasks was substantially shorter than normal. High workload can lead to a narrowing of the visual field, as well as reducing the time available for visual search.

Regardless of the reasons, the pilot did not see the Q400 and thus assumed that the runway was clear for him to land.

**Tower controller's options**

The tower controller had intended on using the 6 nm spacing between landing aircraft to allow the Q400 to line up and depart. After the landing 737 had passed the threshold, the Q400 was cleared to line up from holding point A2. Once the 737 had vacated the runway the controller planned to clear the Q400 to depart, before then clearing the TBM to land. There were four prospective outcomes that could have affected the controller's plan:

a if the 737 was slow to vacate the controller would have to keep the Q400 on the ground and send the TBM around,

b if, after the 737 vacated, the Q400, despite reporting ready for departure, was slow to commence its takeoff roll the controller would have to send the TBM around and then co-ordinate the departing Q400 and the TBM going around,

c if the Q400 conducted a rejected takeoff the controller would have to send the TBM around and,

d if the TBM had a higher groundspeed than the controller had anticipated then the controller would have to keep the Q400 on the ground and send the TBM around.

All the scenarios above are routine occurrences in the UK and require, in order to ensure a successful outcome, an effective channel of communication from the controller to the aircraft involved.

As stated during a subsequent interview, the controller would normally plan on a 6.5 nm spacing between arrivals, but with a light turboprop the spacing could be smaller as they tend to be much slower within 4 nm of the runway. At normal speeds the controller's plan would have allowed a small but workable gap to clear the Q400 to depart. The controller had reduced risk by confirming that the Q400 was "ready for departure" and so would be able to depart as soon as the 737 had vacated. If the plan did not work as intended, the contingency was for the TBM to go-around. Based on the controller's knowledge at that time and without the benefit of having seen the guidance in the Safety Notice, the expectation was that, in the event of a loss of communication, the TBM would be likely to go around.

However, instead of slowing down when within 4 nm, N850TV accelerated and was considerably faster than normal. This reduced the time available for the Q400 to depart by about 20 seconds. It is considered likely that the controller's first call to the TBM of "ARE YOU ON FREQUENCY?" was a confidence check that two-way communications with the TBM could be established and that the plan to depart the Q400 could still be achieved. This call occurred synchronously with the Q400 approaching the A1 holding point and entering the runway and a positive reply from the TBM might have given the controller confidence in the original plan. With the controller's focus of attention being on establishing contact with the TBM, the opportunity to allow the Q400 to depart, was lost.

The lack of response from the TBM presented the controller with a choice, to clear the Q400 to depart against non-communicating traffic of unknown intentions but which, based on the controller's expectations, would probably go-around, or to change the plan that had already been embarked upon. The controller's options for changing the plan were very limited. The Q400 was entering the runway and communications had already been lost with the TBM. There was no way for the Q400 to taxi clear of the runway before the TBM arrived so the controller's only option was to keep the Q400 obstructing the runway and rely on the TBM pilot either going around or seeing and avoiding the Q400.

The tower controller had not read the recent Safety Notice which contained specific advice for dealing with this type of situation, but did alert the other controllers on duty and the supervisor that N850TV had not checked in on the tower frequency and instructed them to try to call the aircraft to send it around. The tower controller called the TBM a total of four times in an attempt to make contact but at no time issued a 'blind' go-around instruction to N850TV. Blind go-around instructions were issued by Approach Radar and Director. Due to the specific nature of the loss of communications this did not alter the outcome of this event but, had N850TV simply had a transmitter failure, the pilot would have been alerted to the need to conduct a go-around and may have been prompted to do another visual search to determine the reason: the presence of the Q400.

One possible way to instruct the TBM to go-around would have been by visual signal using a signal lamp. However, as the lamp had been removed, this option was not available to the controller.

**Loss of communication – controller and pilot expectations**

The *Safety Notice (SN001.10 NATS)* states that '*normally, commercial crew not in receipt of a landing clearance will execute a standard missed approach*'. However, the instances of landing without clearance recorded in the CAA MOR database suggest that this is not always the case. ICAO Doc 4444, the UK AIP and the specific instructions for Birmingham, in common with most other UK airfields, require a crew having lost communications on intermediate or final approach to *continue visually or by means of an appropriate final approach aid*. As the pilot of N850TV had lost communications, albeit through a frequency mis-selection, this is the situation in which he found himself.

In summary it is likely that air traffic controllers assume that a loss of communications will probably result in a go-around while pilots are expecting that they will land if they are able. This disparity could lead to conflict between the controller and pilot mental models. Therefore:

**Safety Recommendation 2011-073**

It is recommended that the Civil Aviation Authority resolve the conflicting expectations of flight crews and air traffic controllers following a loss of communications during approach.

An expectation that aircraft without a landing clearance will probably go around will form the basis for any risk assessment associated with lining up an aircraft for departure ahead of it. In light of the fact that, contrary to controller expectation, some aircraft will land without having received clearance, it is possible that that risk assessment is flawed. Therefore:

**Safety Recommendation 2011-074**

It is recommended that the Civil Aviation Authority review the risk assessment of the hazards associated with clearing aircraft to line up ahead of landing traffic.

**Controller / pilot joint training**

Improving ATCO and pilot understanding of each other's operating environments would help improve mutual mental models. Several UK airlines conduct joint ATCO/pilot training, and pilot visits to local towers and en-route facilities are encouraged by the UKs major ANSPs. Several airlines welcome controllers on flight deck observation trips which are designed to improve this mutual understanding.

Controllers may be issued with a flight ticket for such trips. Although the tickets are free of charge, UK Air Passenger Duty is levied which, as these trips are generally arranged for short-haul multi-sector trips, can be required to be paid multiple times. This application of APD acts as a disincentive to conducting mutual training gained through flight deck visits.

With the assistance of the Department for Transport's Head of International Aviation Safety and Environment Division the issue was highlighted to HM Revenue and Customs (HMRC) - transport taxes team. After consideration HMRC stated that:

*'There is a provision in the Finance Act 1994 that exempts from APD passengers carried on board an aircraft who are not carried for reward and who are there for the sole purpose of inspecting the aircraft or flight crew (section 31(5)(b)). We consider that air traffic control officers on officially sanctioned operational training flights…. would fit this description provided they were not required to buy a ticket.'*

**ATIS**

The ATIS broadcast by Birmingham at the time of the incident did not include the type of approach to be expected by pilots, contrary to the information provided in MATS (Part 1). Furthermore the ATIS included repetitive phrases and a mix of human and automated voices that could make the ATIS difficult to receive over a radio and could be overly complex for non-native English speakers. The ATIS also significantly exceeds the recommended MATS (Part 1) length. Therefore:

**Safety Recommendation 2011-075**

It is recommended that NATS review the content of the Birmingham Airport Automated Terminal Information System to ensure that it is clear and concise, and includes the type of approach to be expected.

**Signal lamps**

CAP 670 requires the tower to have available a signal lamp capable of being visible from all points in the visual circuit. However, a study showed the lamps to be ineffective at some airfields (including Birmingham) and so their withdrawal from service was permitted by the CAA. The inability to provide the supporting paperwork for this withdrawal means that the considerations taken into account when making this decision are unavailable. However, Rule 45 of the ANO requires pilots to cause a watch to be kept for visual instructions. At Birmingham, at the time of the incident, a means for issuing visual instructions was not provided.

Given the weather conditions on the day and the workload of the TBM pilot it is considered unlikely that issuing a visual instruction by means of a signal lamp from the tower would have affected the outcome of this incident. However, as a means of providing visual signals is inferred to be required by the ANO, an effective alternative to the now-withdrawn signal lamp should be sought. Therefore:

**Safety Recommendation 2011-076**

It is recommended that the Civil Aviation Authority review the most appropriate means of providing the visual instructions for which pilots are required to maintain a watch in accordance with Rule 45(6)(b) of the UK Air Navigation Order.

**Conclusions**

The pilot met the currency requirements of his IR. However, lack of recent practice at NDB approaches combined with other factors, led to a short term peak in workload. Despite this, his approach was in compliance with the lateral and vertical limits for the NDB DME 15 but the high workload led to peripheral tasks being dropped and his decision-making process being degraded. This led, without further fault diagnosis, to the misidentification of a frequency selection error as a radio failure. From that point on, the pilot's actions from his perspective, although based on continuation bias, were in compliance with regulations. The same human factors that led to the misidentification of the radio problem probably also led to the failure of his visual search of the runway before he landed.

The air traffic control procedures in use were compliant with the appropriate MATS and are standard practice throughout the UK. The controller's planning assumption, supported by previous training, that aircraft should and probably will go around following a loss of communications, was widely shared throughout ATC management and the regulator. However, the controller's plan provided little room for manoeuvre and included a single point, albeit unlikely, that could lead to it being disrupted.

Following a loss of communications, ICAO Doc 4444 and the UK AIP require aircraft to continue visually and at least 17 multi-pilot public transport passenger flights have landed without clearance in the UK in the 12 months to March 2011. In those cases the runway was clear.

**Safety action**

*By the pilot*

The pilot commented that subsequent to this event he had reappraised the risk of both operating the aircraft and attending business meetings. As such, whenever travelling to meetings, he now operates with a safety pilot who is not involved with the business.

*By NATS*

The ANSP conducted a review of the central briefing process used to deliver the safety notice SN001.10. They reported that issues in the way the notice had been processed onto the electronic briefing system had meant it may not have been highlighted to all relevant members of staff, including the tower controller. This issue did not affect operating instructions and similar mandatory notices. The process for uploading safety notices has been altered to ensure appropriate distribution.

An ALDIS lamp was installed at Birmingham by the ANSP and tested in detail to determine its effectiveness. However, this study indicated that the ALDIS lamp is ineffective at the current tower location and its use could hinder rather than help pilots.

The trial concluded that, while a white lamp could be seen at a range of about 1 nm, a red or green filter would make the lamp impossible to detect. The study concluded:

> *'The effectiveness of an Aldis Lamp in being an aid to a controller at Birmingham to an aircraft flying at a range of more than a mile is probably nil.'*

The results of this study have been communicated to the CAA.

The ANSP is trialling modified arrival procedures at Birmingham: no traffic will be lined up ahead of any aircraft on a non-precision approach once it is within 6 nm unless it has established communications with the tower controller. Further, to provide a more predictable traffic flow for the tower controller; speed control of 160 kt to 4 nm will be mandatory; a standard gap of 6 nm between traffic will be used unless certain circumstances, such as wake vortex, require a different gap; and all traffic will be transferred to Tower by 6 nm.

*By HMRC*

During the investigation the AAIB made HMRC aware of the issues surrounding this incident. Having considered the matter HMRC stated that, on condition that the controller does not pay for a ticket, they will in future consider Air Traffic Controllers on officially organised mutual training flights to be exempt for the purpose of Air Passenger Duty.