SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 757-236, G-TCBC
No & Type of Engines:	2 Rolls-Royce RB211-535E4-37 turbofan engines
Year of Manufacture:	1999 (Serial no: 29946)
Date & Time (UTC):	17 August 2013 at 1610 hrs
Location:	During go-around at Newcastle International Airport, and diversion to Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 235
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nil
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	13,374 hours (of which 1,380 were on type) Last 90 days - 212 hours Last 28 days - 48 hours
Information Source:	AAIB Field Investigation

Synopsis

During an ILS approach to Newcastle International Airport (NCL), ATC instructed the crew to conduct a go-around. This manoeuvre was mishandled and it led to a slat and flap overspeed with an associated caution message. The Quick Reference Handbook (QRH) actions in response to this message were not followed correctly. Consequently the crew assumed that they would have to make a flapless landing and they decided to divert to an airport with a longer runway. They realised they would have to use some of the final reserve fuel but, when a low fuel caution light came on, the appropriate QRH checklist was not actioned. The crew continued to try to resolve the flap problem and, despite straying from the QRH instructions, they did ultimately regain normal flap control. When the aircraft arrived on stand at Manchester Airport (MAN), the total fuel was 700 kg below the final reserve figure and there was an imbalance of 500 kg between the tanks.

History of the flight

The crew of G-TCBC reported for duty at 0500 hrs, for a return flight from NCL to Fuerteventura (FUE). The commander was the pilot flying (PF) for the return sector to NCL. The flight was uneventful until, on a radar vector and with a relatively high groundspeed, the aircraft overshot the centreline whilst capturing the ILS for Runway 23. The localiser (LOC) and the glideslope (GS) were captured subsequently from a revised intercept heading but the commander was unsettled because he thought the aircraft had not performed normally.

He mentioned the matter to the co-pilot several times as the aircraft was configured with landing gear down and FLAP 20. The intention was to land with FLAP 25, in accordance with the operator's Standard Operating Procedures (SOPs). The weather, as copied from the ATIS, indicated a wind from 210º at 13 kt varying between 170º and 250º, visibility of 10 km or more, scattered cloud at 2,300 ft aal, temperature 19ºC, dew point 14ºC and pressure 999 hPa. The ATIS included a windshear report from an aircraft that landed at 1525 hrs, with an apparent loss of airspeed of 15 kt at 500 ft aal. The runway was wet.

After the preceding aircraft had landed, its crew informed ATC of a possible birdstrike on the runway. In response to this, at 1600 hrs, ATC instructed G-TCBC to 'GO AROUND'. The aircraft was at 1,500 ft amsl, 3.8 nm from the threshold and at a speed of approximately 140 kt. The commander's response was to say "GO-AROUND" three times, to select maximum thrust and then to disconnect the autothrottle (A/T). The autopilot (A/P) however, remained engaged in the 'LOC' and 'GS' modes causing the aircraft to accelerate as it continued its descent. A few seconds later the commander disengaged the A/P, without informing the co-pilot, and started to pitch the aircraft nose-up. The speed was now 187 kt and increasing.

Shortly after instructing G-TCBC to go around, ATC amended the missed approach clearance and instructed a climb straight ahead to 3,500 ft amsl[1]. The co-pilot was selecting this altitude in the Mode Control Panel (MCP), when the master warning alert sounded. He was distracted while he cancelled the warning and assessed that it had been caused by disengagement of the A/P.

Initially the commander pitched the aircraft to 10° nose-up[2] but the airspeed continued to increase. The co-pilot announced "POSITIVE CLIMB" and the commander called for "GEAR UP" and for "V_{REF} +80, CLIMB THRUST" and then for "FLAPS 5" and subsequently "FLAPS UP". The co-pilot tried to input the V_{REF} +80 speed (205 kt)[3] into the MCP, but was unable to set it. The FLAP 20 limiting speed of 195 kt was exceeded by 18 kt before the flaps started to retract.

The commander had to ignore the Flight Director (F/D) as he tried to level the aircraft at 3,500 ft amsl as it had remained in the LOC and GS modes. At 1602 hrs he asked for the F/D to be turned OFF. The speed reached 287 kt before the thrust levers were moved from the maximum thrust to the idle position. Although the limiting speed for FLAP 1 was 240 kt, the trailing edge (TE) flaps retracted successfully. However, the leading edge (LE) slats remained partly extended. The caution message LE SLAT DISAGREE was displayed on the EICAS but there was a delay before it was acknowledged. The co-pilot experienced difficulty trying to engage the A/P and A/T. On three occasions the A/P disengaged after a short period and it was six minutes after the go-around (G/A) manoeuvre before both systems were successfully reinstated. The aircraft had by then been vectored downwind under radar control and the altitude had deviated almost 500 ft below the cleared altitude.

Footnote

1 The promulgated missed approach procedure was to climb to 2,500 ft amsl.
2 With the A/P disengaged the SOP was to select an initial attitude of approximately 15º nose-up.
3 V_{REF}+80 means V_{REF} for FLAP 30, plus 80 kt and is the safe manoeuvre speed with FLAP UP. Setting this speed with speed mode engaged commands an acceleration to permit flap retraction.

The co-pilot suggested that they enter a holding pattern but the commander elected to extend the downwind leg and ATC were informed of a slight technical problem. The commander asked the co-pilot how much fuel was remaining and was told that they had 3,600 kg.[4]

Once the A/P and A/T were engaged, the co-pilot started to action the QRH checklist for the LE SLAT DISAGREE message. He also continued to operate the radio. Steps 1 to 4 in the QRH checklist (see QRH procedures), were followed correctly but, when step 5 called for the '*ALTN* [alternate] *FLAPS selector*' to be set to agree with the '*FLAP lever*', the co-pilot incorrectly set it to FLAP 1 instead of UP. Step 6 then called for the '*LE* [leading edge] *ALTN FLAPS switch*' to be set to '*ALTN*'. When this was done the LE flaps (ie the slats), ran to the commanded FLAP 1 position and the LE SLAT DISAGREE message cleared; shortly after that the TE FLAP DISAGREE message illuminated[5]. This was noticed by the crew and the commander said they should change to the '*Trailing Edge Flap Disagree*' checklist. This was started by the co-pilot and he got as far as step three in this checklist, which called for the alternate flaps selector to be set to agree with the flap lever, when he was interrupted by a radio call from ATC. ATC told them that they had left controlled airspace and were now in receipt of a Deconfliction Service.

After acknowledging this, the co-pilot tried to resume the checklist, but the commander interrupted by saying "SO CAN WE GET SOME MORE FLAP?...LET'S GO FOR FLAP 5". In a departure from the prescribed drill, the co-pilot selected both the flap lever and the alternate flaps selector to the FLAP 5 position. Shortly afterwards the co-pilot again tried to follow the QRH, but he was again interrupted when the commander stated "THAT'S ALL THE FLAP WE HAVE GOT; WE NEED A LONGER RUNWAY, DON'T WE?" The co-pilot responded "YEAH WE NEED MANCHESTER, DON'T WE?" After checking that 2,000 kg of fuel was required to fly to MAN, the commander stated that they should divert immediately.

The co-pilot agreed and told ATC that they could not get the flaps down and that they needed to divert to MAN for a longer runway. ATC instructed them to turn onto 230º and climb to FL100 and asked what level they would like. The co-pilot conferred with the commander, saying "WE DON'T WANT TO GO TOO HIGH, DO WE?", and they agreed to stop their climb at FL100. Before starting the climb, the commander asked for FLAP UP. In response, the co-pilot selected the flap lever to UP, without referring to the unfinished QRH checklist. The alternate flaps selector remained at FLAP 5 with the LE slats partially extended under alternate control and in agreement with the alternate flaps selector.

G-TCBC was approximately 25 nm east of NCL when the climb was commenced. The time was now 1612 hrs and the crew observed that 3,200 kg of fuel remained[6]. A few seconds later, a forward fuel pump low pressure light on the fuel panel illuminated, along with an associated EICAS advisory message. The co-pilot mentioned this, but no action was taken. The commander then gave the cabin manager a face-to-face briefing about the flap problem and the diversion to MAN.

Footnote

4 The required fuel on the flight plan for a diversion to the primary alternate, Edinburgh, was 3,280 kg.
5 The trailing edge flaps were UP but now in disagreement with the alternate flaps selector. See *Flap system.*
6 The Pilot's Flight Log (PLOG), indicated that 1,999 kg of fuel would be burnt on a diversion from NCL to MAN in the clean configuration, thus a minimum of 3,626 kg was needed, including a final reserve of 1,627 kg.

Although the aircraft had been cleared to FL100 the QNH of 999 hPa was still set when the aircraft levelled at 1614 hrs, 420 ft above the cleared level. A direct clearance to Pole Hill VOR was accepted, but the co-pilot could not manage to input this into the Flight Management Computer (FMC) and subsequently the commander used HDG SEL (heading select) as the lateral F/D mode in conjunction with raw navigational data. At this point the commander suggested that they declare a MAYDAY and the co-pilot told ATC "WE WANT TO DECLARE A MAYDAY". ATC acknowledged by saying "ROGER" but shortly afterwards they asked "HAVE YOU GOT ANY MORE DETAILS FOR THE PARAMEDIC?" The co-pilot said that they didn't need a paramedic but that they would be making a flapless landing at MAN.

One minute later a LOW FUEL caution illuminated on the EICAS and the FUEL CONFIG light showed on the fuel panel.[7] Without any crew discussion about this development, the co-pilot told ATC that they were requesting a priority landing due to a low fuel warning. Newcastle ATC said this message would be passed on and asked if an emergency was being declared. When this was replied to in the affirmative, the crew were asked to squawk 7700.

The TE FLAP DISAGREE caution remained illuminated throughout the climb and level off. At 1617 hrs the co-pilot suggested that they resume the '*Trailing Edge Flap Disagree*' checklist but the commander said that they should make preparations for the approach to MAN. A few moments later, without reference to the QRH, the co-pilot selected the TE alternate flaps switch to ALTN. This caused the TE FLAP DISAGREE caution to clear and the TE flaps to run slowly towards FLAP 5, under control of the alternate flaps selector. The crew noticed that the caution had cleared and the commander suggested they put the systems back to normal.

Both alternate flaps switches were turned OFF but, when the crew observed no immediate movement, they were re-selected ON. Various selections were then made, without use of the QRH checklists, over the course of a three-minute period. This resulted in both the LE and the TE flaps reaching FLAP 1 under normal control and without a caution message. The crew concluded that they could control the flaps normally and they retracted the flaps to conserve fuel. The commander now advised the passengers that they were diverting to MAN as a result of a flap problem.

After several attempts the co-pilot managed to programme the FMC by use of the alternate routing option, Route 2. While doing this he attempted to contact the next ATC radio frequency (Scottish Control) but no MAYDAY prefix was used and the crew did not notice when ATC failed to respond. Shortly afterwards the crew realised that the After Take-Off Checks had been overlooked. As a result, the altimeters were re-set to 1013 hPa and the aircraft was descended to FL100.

At 1627 hrs, after further discussion about the flaps, the crew agreed that they should be able to make a normal FLAP 30 landing but they would slow up early in case they needed to use the alternate system. The pilots also talked about earlier events. They were unsure if

Footnote

7 A LOW FUEL caution along with a FUEL CONFIG light on the fuel panel indicates that the fuel level in either main tank has fallen below 1,000 kg (see *Fuel system).*

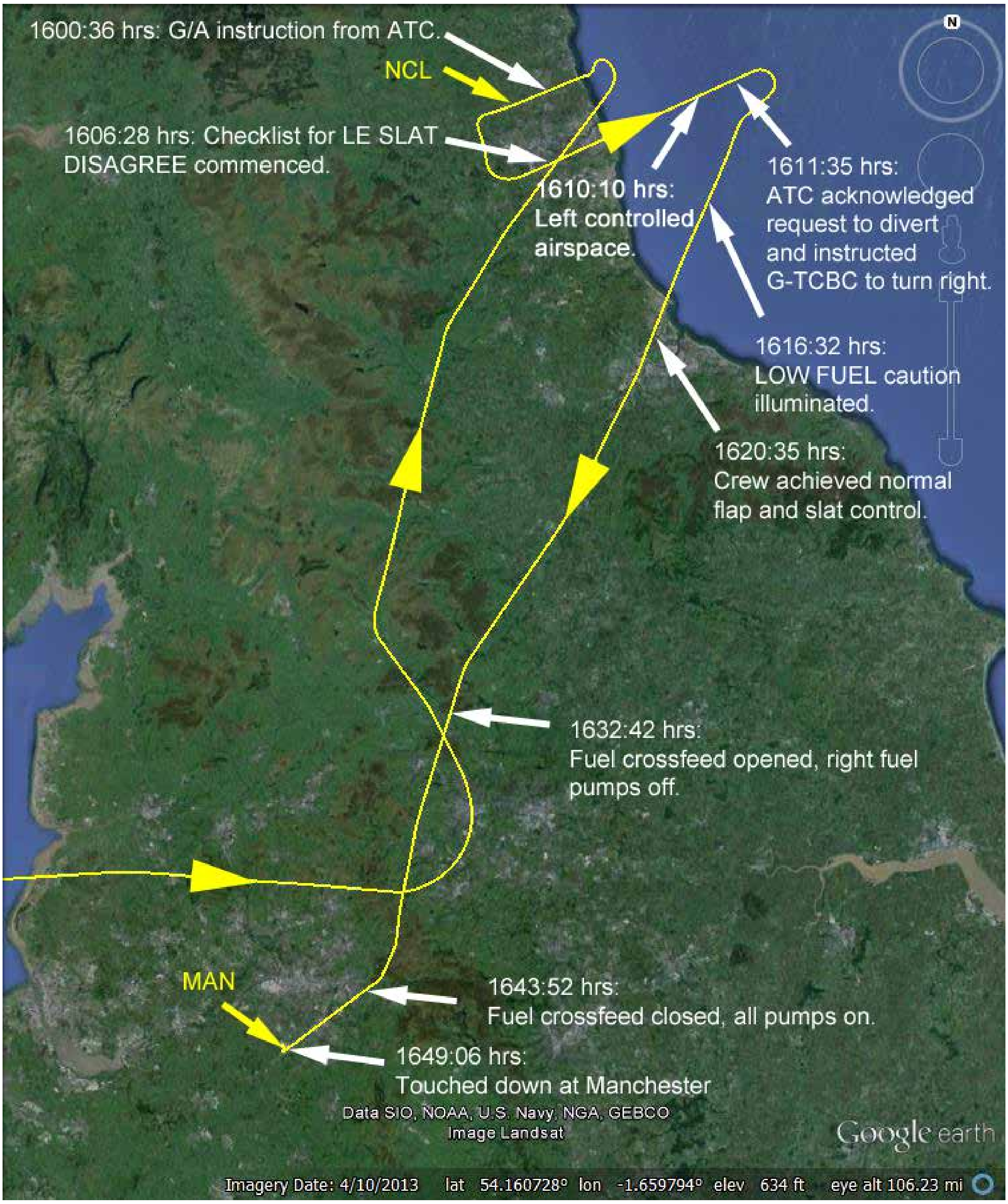

Figure 1

Plot of the track for G-TCBC showing inbound and outbound tracks from NCL and the diversion to MAN

there had been a flap overspeed or not and they were perplexed as to why the automatic systems had not worked as expected.

Five minutes after changing frequency, two-way communications were regained with ATC and clearance was given direct to a 10 nm final for Runway 23R at MAN. Immediately after this the commander observed that they needed to do something about the fuel and that they should use the fuel in the left tank. Fifteen minutes had passed since the LOW FUEL caution had illuminated and this was the first reference to a fuel imbalance. However, the co-pilot did not respond because ATC started to pass the MAN weather, followed by a descent clearance.

At 1632 hrs the commander asked for the fuel to be balanced. The co-pilot opened the fuel crossfeed and turned off the right fuel pumps without referring to the QRH. One minute later, idle thrust was selected and the descent was commenced. At 1643 hrs, at a range of 10 nm from touchdown, the fuel crossfeed was closed and the fuel pumps were turned back on. The commander commented "WE'RE COMMITTED TO LAND NOW, WE HAVE TO LAND", and later "WE DON'T WANT TO GO-AROUND…WE CAN'T". The co-pilot acknowledged these remarks.

The aircraft made a FLAP 30 landing at 1649 hrs and taxied to stand with the RFFS in attendance. The fuel recorded on shutdown was 700 kg in the left tank and 200 kg in the right tank. The commander noted in the technical log that they could not select a speed in the speed window following the G/A and that EICAS messages for LE SLAT ASYMMETRY[8] and TE FLAPS DISAGREE had been displayed.

During his journey home it occurred to the commander that he had not told the engineers about a possible flap overspeed, so he telephoned them and a further technical log entry was made relating to a suspected flap overspeed of 18 kt at FLAP 20. Overnight analysis of the flight data verified this figure and as a result of further maintenance checks it was apparent that the FLAP 1 speed limit had been exceeded by 46 kt. An internal investigation was commenced and the AAIB informed.

Crew information

Commander's background

The commander had been flying the Boeing 757 (B757) for about two and a half years before this incident. Prior to that he had operated Airbus types for over 13 years, but he was now at a stage where he "felt comfortable" with the B757. When he reported for this duty at 0500 hrs, he believed he was as well rested as could be expected for that time in the morning. Although he had not flown in the preceding week, he felt that in the previous few months he had experienced more technical problems than was usual. He stated that he had had in excess of 48 hours rest prior to reporting. Examination of his roster indicated that on the day before the incident he had been on home standby from 0900 hrs to 1500 hrs but had not been called to work.

He sensed that the airline was in turmoil due to a major internal re-organisation programme. The direct effect for him was that he had been told that he would be one of several captains who would be demoted to first officer in March 2014 and that his salary would reduce significantly. He was unhappy about this impending change and the matter weighed heavily on his mind at work, despite his best efforts to ignore it.

Footnote

[8] This was an erroneous entry due to incorrect recollections by the crew immediately after the flight.

Co-pilot's background

Like the commander, the co-pilot had not flown for several days before the incident and he stated that he felt well rested when he reported for duty. Although he had been rated on the B757 for over five years, he felt he had little experience of two engine G/As. He recalled one instance, about three years previously, when he had flown a G/A on the line but he could not remember having much practice of such a manoeuvre during simulator training. He had been the Pilot Monitoring (PM) on a flight into NCL around six weeks before when another commander executed a G/A, in accordance with SOPs, from an altitude of between 1,500 ft and 2,000 ft.

Pilots' comments

In the commander's opinion, he and the co-pilot had operated the flight from NCL to FUE in a professional manner. He said that a full approach brief was given by the co-pilot and recalled that this included the techniques that would be employed in the event of a G/A. On the way back to NCL, the commander gave a shortened approach brief, in accordance with SOPs. He did not discuss the manner in which a normal G/A would be flown but he did use the QRH to brief the procedures in the event of a windshear encounter and G/A.

On the flight to FUE, the co-pilot recalled briefing the missed approach procedure from the instrument plate but he said that it was not his habit to brief the handling actions in the event of a G/A. He said that it was unusual for someone to brief this and it had not been advocated to him as being a good practice. He had no recollection of receiving any training on the handling of G/As from well above the decision altitude.

Both pilots said that the return flight proceeded smoothly until the start of the ILS approach when the aircraft had not seemed to capture the LOC as well as normal. This compounded the commander's concerns regarding technical reliability. The instruction to commence the G/A was given when he was visual with the runway and was expecting to land. He remarked that he was in the habit of mentally reviewing his actions in the event of a G/A at or about 500 ft aal, but this G/A came at an earlier stage. He remembered that he called "GO-AROUND", but did not state "FLAPS 20" and that he advanced the thrust levers. He knew that he needed to do something with his thumb, but instead of pressing the G/A switch, he said he must have disconnected the A/T. In retrospect he believed that he had reverted instinctively to his Airbus training[9] and that he had then failed to employ the mnemonic "GAGL"[10]. At his last simulator check he recalled that he had practised a two engine G/A from decision altitude, but he noted that in the simulator you "know they are coming". After realising that something was wrong with the G/A, the commander disengaged the A/P but did not tell the co-pilot. He thought that he had pitched up to around 12º and was conscious of a speed increase.

Footnote

[9] On the Airbus aircraft flown previously by the commander a G/A was initiated by advancing the thrust levers to the takeoff position.
[10] See report section headed Operator's Operations Manual, *Go-arounds.*

When the G/A was initiated, the co-pilot heard the commander call "GO-AROUND" but no flap setting was mentioned. He was not aware of the A/T being switched off but when he cancelled the master warning he realised that the A/P had been disconnected. He was surprised to see that the G/A was being flown manually and he looked across to make sure that the commander was all right. At this stage he was not aware that the G/A switch had not been pressed and he did not check to see 'GA' (go-around mode) indications on the Flight Mode Annunciations (FMA) panel of the Attitude Director Indicator (ADI). In retrospect he realised that his thought processes were confused by the breakdown in SOPs.

Because the commander called for a target speed of V_{REF} +80 and climb thrust, the co-pilot tried to select the relevant speed on the MCP. However, he was unable to open the speed window to do so. He recalled that before the departure from NCL, an engineer had said the previous commander had mentioned having difficulty in viewing one of the digits in the speed window, so the co-pilot wondered if there was a technical malfunction. Meanwhile, although he was aware that the speed was increasing rapidly, he was trying to retract the flaps and failed to monitor the speed adequately.

While the co-pilot tried to re-engage the automatics, the commander did his best to climb and maintain 3,500 ft amsl. The commander felt that his scan had broken down as a consequence of the unusual situation but he also felt that the co-pilot appeared "stunned" and did not offer the support that he was capable of. The co-pilot acknowledged that he ought to have realised that the speed was excessive and brought it to the attention of the commander but his situational awareness and his scan had broken down.

When the aircraft levelled at around 3,500 ft amsl, the commander was still flying manually and the A/T and the A/P did not remain engaged when selected by the co-pilot. Eventually the speed window did function normally and the A/T and the A/P remained engaged. At some point the co-pilot was aware that the commander had asked for the F/D to be switched OFF and back ON again.

The co-pilot recalled that when he started the '*Leading Edge Slat Disagree'* checklist he felt frustrated and agitated because of his previous difficulties. As he progressed through the checks, he knew the flap lever was UP but he saw that the indicator was between FLAP 0 and FLAP 1. In retrospect he thought that this caused him to select the alternate flaps selector to FLAP 1 in error. After he had pressed the LE alternate flaps switch, the TE FLAP DISAGREE caution illuminated. He saw both it and the LE SLAT DISAGREE message illuminated together at one stage but the commander suggested that he transfer his attention to the '*Trailing Edge Flap Disagree'* checklist. His recollection of the sequence of events after this was unclear but he thought that he did turn the alternate flaps selector to FLAP 5 and he did move the flap lever by mistake at one point. Neither of the checklists were completed and he was convinced that the flaps would not extend and that they would be committed to a flapless landing.

The commander did not recall hearing the co-pilot say that the QRH checklist was completed. In retrospect he felt that he ought to have had the co-pilot pause and action the checklist more slowly. The commander felt his own thought processes were distracted by worries about the paperwork and the other potential repercussions of the mishandled G/A.

During the actioning of the checklist the commander was looking at the flap position indicator for movement. He knew it would take time in alternate mode but he also knew he was running out of options. He had a "ballpark" landing distance of 1,600 m in his head for a flapless landing but, the previous week, he had seen an aircraft make an abnormal landing at NCL with FLAP 20 and it had appeared to use much more than this. In addition, he was aware that there was no stopway on Runway 25 at NCL. Another concern was that the ATIS had included a windshear report from a previously landing aircraft and with a wet runway and the crosswind he "was reeling" at the idea of a flapless landing at NCL. He discounted Edinburgh (EDI) because the runway there was not much longer, so he considered only MAN where the runway was definitely longer, plus there were other airfields in that direction. These thoughts were not verbalised but he believed that the co-pilot felt the same way.

The co-pilot remembered the windshear report at NCL, so readily accepted the commander's suggestion to divert to a longer runway, which he assumed to mean MAN. A fuel emergency was not declared immediately because the co-pilot thought this was required only when the level in either main tank fell below 1,000 kg. He knew that the final reserve fuel for the flight was 1,627 kg and that they were likely to land with less than this.

This was the commander's first experience of being low on fuel but he decided that on balance it was better to go to MAN and land with less than final reserve fuel. He knew that a MAYDAY call should be made when it was evident that the final reserve fuel would be encroached, so he could not explain why there was a delay in making this declaration. Once the decision to divert was made, he felt things were normalising, albeit that he expected to land with a low fuel state. He said he was concerned about the fuel throughout, though he accepted that the imbalance was not dealt with as soon as he noticed it. He remarked that it would be SOP to rebalance fuel once a split of 400 to 500 kg developed but he was not sure if this had been done on the way from FUE towards NCL. His recollection was that the fuel crossfeed had been opened with about 1,700 kg in the left tank and about 600 kg in the right and that it had stayed open, with the right pumps off, until after they landed.

The co-pilot accepted that, as the flight progressed towards MAN, his awareness of the fuel situation decreased. His attention was focussed on trying to programme the FMC and in communicating with ATC. When the LOW FUEL message appeared, his belief was that it was mentioned but not addressed. He felt that he did not react to the message because he had been subconsciously prepared for it from the start of the diversion. He could not remember if there was an imbalanced fuel state at this point. (He thought some fuel balancing was conducted between FUE and NCL, after an imbalance of around 300 kg had developed.) Later in the flight towards MAN, he was aware of an imbalance but the co-pilot recalled that the commander dealt with it. This was also the first time that the co-pilot had been involved in a low fuel scenario.

Once they had climbed to 10,000 ft, the co-pilot suggested going back to the '*Trailing Edge Flap Disagree'* checklist but the commander asked him to get out the MAN instrument charts instead. Later he was asked to put the flap controls back to normal. After the co-pilot made various selections the flaps appeared to work normally but the pilots still prepared for the possibility of using the alternate system or a flapless landing.

When it became evident that the flaps were working again, the commander realised that NCL was still the nearest airport. However, a decision to divert had been made and he did not believe that the co-pilot would contemplate a return to NCL. En-route to MAN, the commander felt there was little time available to conduct a joint review of the situation but that he did mentally review things himself. He also remarked that the situation had felt unreal and that it seemed to get out of control very easily. He recalled that on a couple of occasions he had tried to offer the co-pilot some reassurance.

The co-pilot could not recall any discussion concerning actions in the event of a G/A from the approach at MAN. The cloud was reported as being broken at 1,500 ft aal with rain and he believed that they could have flown a visual circuit if necessary.

After the flight, the commander wrote up the technical defects that he remembered. He thought that this was a serious incident but he was unaware of any responsibility to isolate the CVR or to ensure that FDR data was preserved. He saw no need to review or debrief the incident with other crew members before dispersing. The ASR was not filled in immediately because he was in the habit of leaving these reports for a couple of days. He did try to contact the Duty Flight Operations Manager as soon as he could but was unable to reach anyone until two days later.

Recalling the event, the co-pilot considered that the problems caused by the G/A made him agitated and this was one reason why he did not handle the QRH correctly. He felt that if he had been made to sit and compose himself prior to starting the non-normal checklists then he might have performed better. He also remarked that he and the commander ought to have communicated more, and that they had not reviewed their actions as advocated during company training and laid down in Part A of the operator's Operations Manual (OM) [11].

QRH procedures

The Boeing QRH includes the following instruction on the use of non-normal checklists:

> *'Try to do checklists before or after high work load times. The crew may need to stop a checklist for a short time to do other tasks. If the interruption is short, continue the checklist with the next step. If a pilot is not sure where the checklist was stopped, do the checklist from the start. If the checklist is stopped for a long time, also do the checklist from the start. After completion of each checklist, the pilot reading the checklist calls, "________ CHECKLIST COMPLETE."'*

The end of a checklist is indicated by four solid black squares positioned in a horizontal line. The QRH instructions also state that:

> *'troubleshooting i.e. taking steps beyond published non-normal checklist steps, may cause further loss of system function or system failure. Troubleshooting should only be considered when completion of the published non-normal checklist results in an unacceptable situation.'*

Footnote

[11] See the '*TDODAR*' section of *'Operator's Operations Manual'*.

A section of the OM concerning emergencies after V_1 stated that the PF should be responsible for radio communications when the PM was carrying out QRH drills. This division of tasks was not explicitly associated with any other procedure.

Non-normal checklists

The '*Leading Edge Slat Disagree*' checklist from the Boeing 757 QRH is shown at Figure 2.

The second non-normal checklist to be referred to was titled '*Trailing Edge Flap Disagree'.* This was presented on pages 9.18 to 9.20 of the QRH. It was similar to the previous checklist but it had only nine numbered steps.

Performance

Landing distance

Reference to the '*Non-Normal Configuration Landing Distance tables'* in the QRH would have indicated that a minimum landing distance of around 1,455 m was needed to land with the flaps retracted at NCL. Alternatively the electronic flight bag, (Boeing's EFRAS tool[12]), was available on the flight deck. This would have calculated that a landing distance of 1,465 m was required. These distances were unfactored in accordance with the operator's guidance regarding the calculation of Operational Landing Distance (OLD) in the event of a technical emergency. A technical emergency was defined as '*a situation where there has been, or likely to be, a significant impact on the safety of continued flight. Normally this is the result of system failure.*' The OM said:

> ***'Diversion due to Technical Emergency:*** *In the event of a technical emergency the crew must confirm that the planned landing runway distance available is equal to or greater than the Operational Landing Distance required for the aircraft in the configuration that it will be landing in. However, pilots are reminded that this distance has no margin for pilot technique. As a result, whenever possible, pilots should attempt to land on runways which offer a greater margin of landing distance. In determining the best options available the Commander must consider the severity of the situation and compare the risk of continued flight to a more appropriate runway versus the risks inherent in landing on a limiting runway.'*

Where no technical emergency existed, the operator's policy was to increase the safety margin by adding 15% to the OLD. This would increase an unfactored landing distance of 1,465 m to 1,685 m. Runway 25 at NCL had a declared LDA of 2,125 m. The LDA of Runway 24 at EDI, the first alternate, was 2,347 m and Runway 23R at MAN had an LDA of 2,714m.

Footnote

[12] Two hand held computers on the flight deck provided access to publications, the electronic technical log and a tool for performance calculations known as EFRAS (Electronic Flight Report and Runway Weight Chart System). This tool interrogates Boeing Standard Computerised Aeroplane Performance (SCAP) data to derive takeoff and landing performance values.

9.10 BOEING 757 Flight Crew Operations Manual

LEADING EDGE SLAT DISAGREE

Message: LE SLAT DISAGREE

Condition: The leading edge slats are not in the commanded position.

Caution! Limit airspeed to 240 knots maximum.

1 GND PROX FLAP OVRD switch . . . . OVRD

2 Choose one:

◆Indicated flap position **greater than** 20:

Use current flaps and VREF 20 for landing.

►►**Go to step 10**

◆Indicated flap position **20 or less**:

►►**Go to step 3**

3 Use flaps 20 and VREF 20 for landing.

4 Choose one:

◆FLAP lever position **greater than** 20:

ALTN FLAPS selector. 20

►►**Go to step 6**

◆FLAP lever position **20 or less**:

►►**Go to step 5**

5 ALTN FLAPS selector . . . . Position to agree with FLAP lever

6 LE ALTN FLAPS switch . . . . ALTN

▼ Continued on next page ▼

9.10 D632N001-62.IMA Nov 2009

9.11 BOEING 757 Flight Crew Operations Manual

▼ LEADING EDGE SLAT DISAGREE continued ▼

7 TE ALTN FLAPS switch. . . . . ALTN

8 Choose one:

◆LEADING EDGE light is **illuminated:**

LE ALTN FLAPS switch . . . . Off

►►**Go to the LEADING EDGE SLAT ASYMMETRY checklist on page 9.6**

■ ■ ■ ■

◆LEADING EDGE light **extinguishes**:

►►**Go to step 9**

9 ALTN FLAPS selector . . . Extend or retract leading edge slats and trailing edge flaps as needed

10 Check the Non-Normal Configuration Landing Distance tables in the Performance Inflight-QRH chapter.

11 Checklist Complete Except Deferred Items

▼ Continued on next page ▼

Nov 2009 D632N001-62.IMA 9.11

9.12 BOEING 757 Flight Crew Operations Manual

▼ LEADING EDGE SLAT DISAGREE continued ▼

Deferred Items

Descent Checklist

Pressurization . . . . LDG ALT

Recall . . . . Checked

Autobrake . . . . ___

Landing data . . . . **VREF 20, Minimums**___

Approach briefing . . . . Completed

Approach Checklist

Altimeters . . . .

Nav Aids . . . . IDENTIFIED, COURSE SET

Landing Checklist

Speedbrake . . . . ARMED

Landing gear . . . . Down

Flaps. . . . . **As directed**

Cabin . . . . **SECURE/WARNED**

■ ■ ■ ■

9.12 D632N001-62.IMA May 2009

Figure 2

Leading Edge Slat Disagree checklist

Fuel

At FUE the aircraft was fuelled to 20,000 kg. The Pilots' Flight Log (PLOG) showed that this was 295 kg in excess of the minimum required. The taxi fuel was predicted as 306 kg, with a trip fuel of 15,650 kg, a contingency allowance of 469 kg and a final reserve figure of 1,627 kg. The PLOG indicated that to divert to EDI, 3,280 kg of fuel would be needed to land with final reserve fuel. MAN was listed as the second alternate option with a minimum of 3,626 kg required, including a predicted burn of 1,999 kg. The PLOG gave a cruise level of FL170 from NCL to MAN and a track distance of 132 nm. The quoted burn presumed a clean configuration and a normal speed profile.

System information

Automatic systems

The Autopilot Flight Director System includes the Flight Control Computers and the MCP. The A/P, F/D, altitude alert, and A/T parameters are controlled using the MCP on the glareshield and by the thrust mode select panel.

F/D steering indications normally display on the ADIs any time the related F/D switch is ON. The manufacturer's Flight Crew Training Manual (FCTM) notes that when establishing on a localiser with a large intercept angle, some overshoot can be expected. After the LOC and GS modes are captured they can only be disengaged by pressing a G/A switch or by firstly disconnecting the A/P and then turning both F/D switches off.

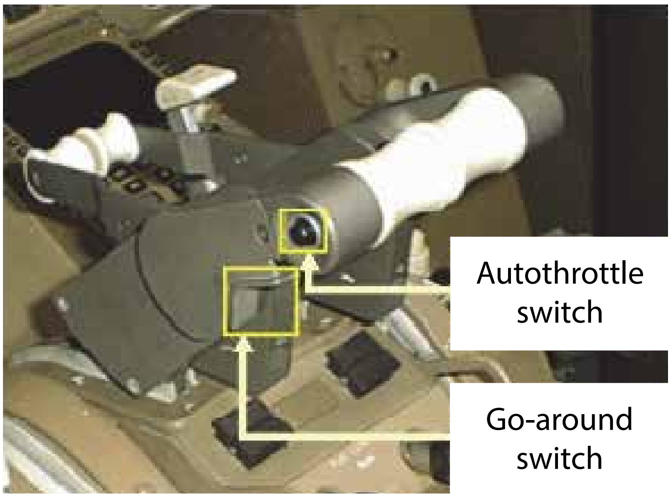

Figure 3
Thrust levers and associated switches

Each thrust lever has a G/A switch and an A/T disconnect switch (Figure 3). Pressing a G/A switch activates the GA modes using the A/P or, in manual flight, the F/D only. GA roll mode will command existing ground track at the time of mode engagement. GA pitch mode will command a pitch to achieve the existing speed or MCP speed if this is higher.

If a G/A switch is pressed with the A/T and A/P engaged, thrust is increased to a maximum of G/A thrust, to establish a climb rate of at least 2,000 ft/min. Once a climb rate of

2,000 ft/min is established, thrust is adjusted to maintain that climb rate. If the A/P and the F/D are both off, the A/T will provide a reference thrust that protects flap and VMO speed limits.

Normal A/P disengagement is by means of either of the control wheel A/P disengage switches. Alternatively there is an A/P disengage bar on the MCP. Movement of the manual trim switches on the control wheel can also cause disengagement while large control wheel movements or large or rapid control surface movement can prevent the A/P from engaging when commanded. Disconnection of the A/P illuminates the A/P DISC light and the EICAS warning message AUTOPILOT DISC. The A/T can be operated independently of the A/P or F/D.

Figure 4

Left portion of the MCP on the glareshield panel

With the A/T Arm switch set to ARM, the system will engage when any one of the adjacent EPR, SPD, VNAV or FL CH switches or the G/A switch (Figure 3) is pressed. With EPR pressed, thrust is controlled according to which selection is made on the Thrust Mode Select Panel. With SPD pressed, the white speed selector knob to the right of it can be used to set a target airspeed in the speed window (labelled IAS/MACH in Figure 4). The small select switch (labeled SEL) can be pressed to alternate between IAS and MACH. The speed set in the window during an approach will become the initial target speed if SPD mode is engaged after a G/A. To command acceleration, the speed selector can be rotated clockwise to a higher speed, typically V_{REF} +80.

When an A/T disconnect switch is pressed during an approach, the SPD mode annunciation on each ADI will clear but the speed window should still indicate the speed that was last targeted. To re-instate the A/T, the arm switch must stay in the ARM position and an A/T mode then engaged. For SPD mode, the speed switch must be pressed and the selector rotated to adjust the reference speed if required. If the selector was accidentally pressed instead of the switch, the speed window would close. A second press of the end of the selector would re-open the speed window. This was investigated in a simulator detail and it was found that if pressure was applied obliquely to the end of the selector then it might not open the window. The selector is normally pressed squarely towards the panel but when the pilot in the right seat leant across the flight deck, it was possible to apply pressure obliquely so that the window remained blank. No technical irregularity was found when the system was checked on G-TCBC immediately after the incident.

Flap systems

The primary control for the flaps and slats is the flap lever on the control stand and their primary power source is hydraulic. The flaps can be selected to one of seven detent positions. The slats only have three positions. When FLAP UP is selected the slats are commanded to retract. When the flap lever is moved to FLAP 1, the slats should move to a mid-range position and when the flap lever is moved past FLAP 20, the slats should fully extend. The position of the control surfaces and the associated limit speed is indicated on the centre instrument panel. If the flap and slat positions selected by the crew are not reached within an appropriate time, a DISAGREE is recorded by the FDR and a caution is generated on the EICAS, along with an amber LEADING EDGE or TRAILING EDGE light on the centre instrument panel.

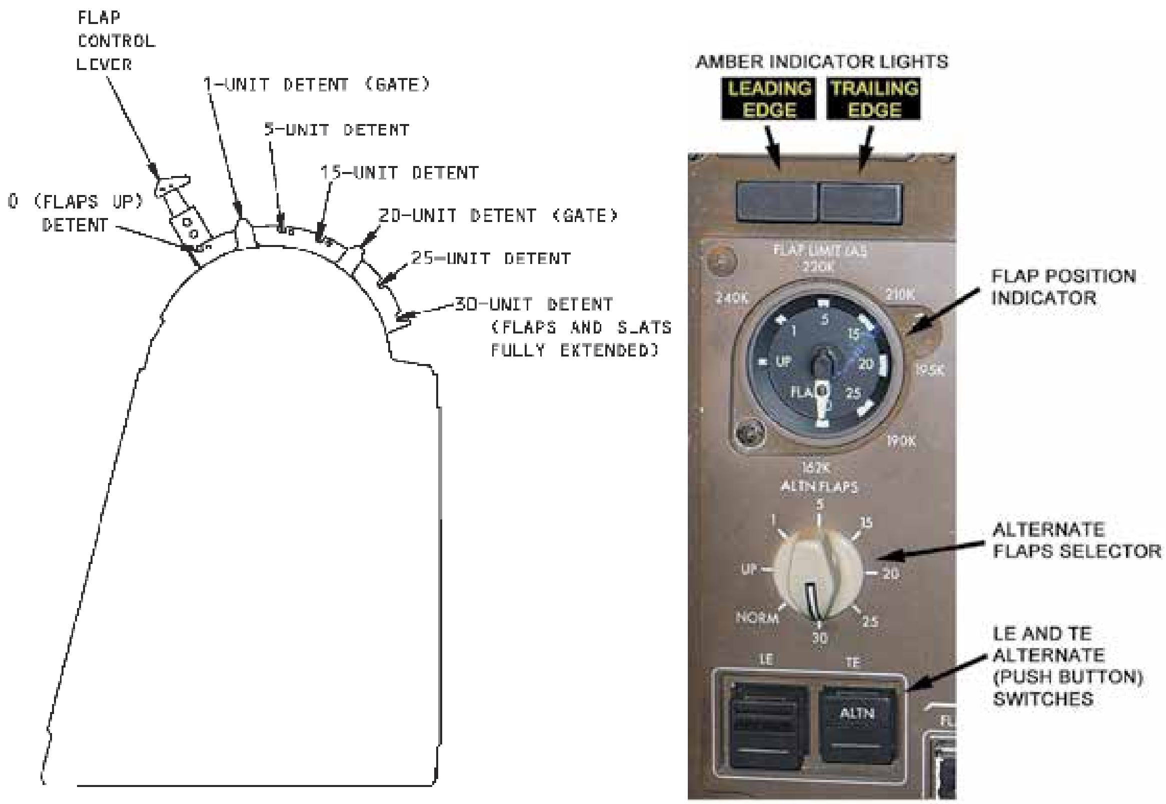

Figure 5

The main flap/slat control on the control stand (left diagram), the flap position indicator with associated alternate controls and indicators on the centre instrument panel (right diagram)

There is an alternate control and power system for the flaps and slats and two alternate flaps switches (labelled LE ALTN and TE ALTN). Note that although the LE devices are generally referred to as slats, their associated alternate switch is known as the LE or TE alternate flaps switch. Selecting either alternate switch will isolate hydraulic power from both the LE and TE systems. Selecting either alternate switch will also switch the DISAGREE warning logic of both LE and TE devices from the control stand flap lever to the alternate flaps selector on the centre instrument panel. However, the electrical power for driving the surfaces will only be connected if the appropriate alternate flaps switch for that system has been pressed. This means that arming only one of the alternate switches, results in the other system being unable to respond to selections made via either the flap lever or the alternate flaps selector. Under this condition, if the alternate flaps selector does not match the position of one surface, a DISAGREE condition will exist and this will cause the associated amber indicator, at the top of the flap panel, to illuminate and an EICAS LE SLAT DISAGREE or TE FLAP DISAGREE message will be presented. Note that a DISAGREE condition can also exist under normal control (with neither alternate flaps switch pressed), should one surface disagree with the position commanded by the flap lever.

The flap position indicator also shows the limit speeds for that configuration. Exceeding that limit can result in damage or an inability for the system to reach the selected position. If a system does not reach the position commanded by the flap lever within the appropriate time, the hydraulic power is shut off, freezing the system at its achieved position and causing a DISAGREE condition to exist. The Operator's SOP Manual states that any incident of a flap limit speed exceedence with flap extended must be recorded in the technical log.

Fuel system

The B757 has a centre fuel tank as well as left and right main tanks located in the wings. Each tank has a forward and aft fuel pump. The two centre tank fuel pumps have greater output pressure than the left and right main tank fuel pumps. When all six pumps are operating, the centre tank pumps override the left and right main tank pumps, so that the centre tank fuel is used before left or right main tank fuel. If any pump has low output pressure, the appropriate switch PRESS light illuminates on the fuel panel and an advisory message is displayed on the EICAS.

When total usable fuel in the left or right main tank drops below approximately 1,000 kg, a FUEL CONFIG light on the fuel control panel illuminates and the EICAS caution message LOW FUEL is displayed. If the fuel quantities in the main tanks differ by 800 kg or centre fuel pump switches are OFF with more than 600 kg in the centre tank, the FUEL CONFIG light illuminates and an EICAS advisory message FUEL CONFIG is displayed. This operator's SOP was for the QRH to be used in response to EICAS messages. The SOP Manual included a maximum imbalance limitation of 880 kg.

Figure 6 shows the layout of the fuel panel on the overhead console. Each fuel pump switch has an integral low pressure indication (PRESS). The crossfeed valve switch controls two valves operating in parallel. Below this switch is the FUEL CONFIG light.

The fuel manifolds are arranged so that any fuel tank pump can supply either engine. The crossfeed valves isolate the left fuel manifold from the right. These valves are normally closed to provide fuel feed from tank to engine. Fuel balancing is accomplished by opening the crossfeed and turning off the fuel pumps for the main tank that has the lowest quantity.

The OM permitted fuel balancing to be done at any stage in flight, whilst the FCTM included the following notes:

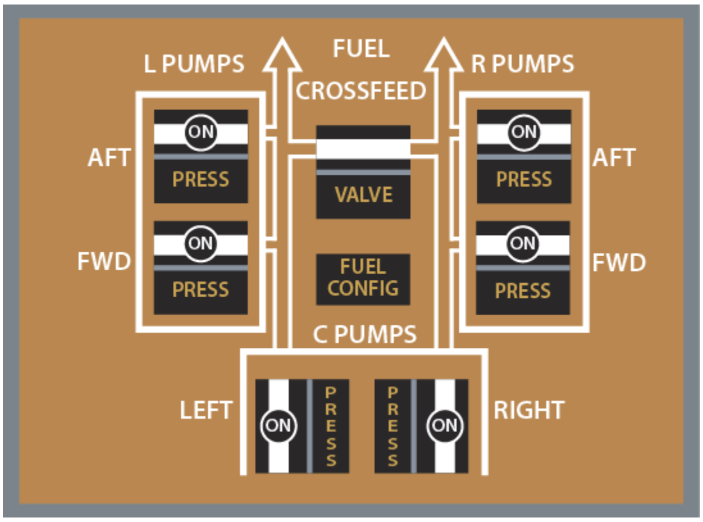

Figure 6

Diagrammatic representation of the fuel panel situated on the overhead instrument console

> ***'Fuel Balancing Considerations***
>
> *The crew should consider the following when performing fuel balancing procedures*
>
> - *use of the Fuel Balancing Supplementary Procedure in conjunction with good crew coordination reduces the possibility of crew errors*
> - *routine fuel balancing when not near the imbalance limit increases the possibility of crew errors and does not significantly improve fuel consumption*
> - *during critical phases of flight, fuel balancing should be delayed until workload permits. This reduces the possibility of crew errors and allows crew attention to be focused on flight path control*
> - *fuel imbalances that occur during approach need not be addressed if the reason for the imbalance is obvious (e.g. engine failure or thrust asymmetry, etc.).'*

The Fuel Balancing Supplementary Procedure mentioned above stated that when the fuel quantities in the main tanks differed 'by an appreciable amount', the crossfeed switches should be turned on and the fuel pump switches in the low quantity tank turned off until the fuel load balanced. The FCTM also offered guidance for flight with the LOW FUEL message displayed. For approach and landing it said:

> *'In a low fuel condition, the clean configuration should be maintained as long as possible during the descent and approach to conserve fuel. However, initiate configuration changes early enough to provide a smooth, slow deceleration to final approach speed to prevent fuel from running forward in the tanks. A*

> *normal landing configuration and airspeed appropriate for the wind conditions are recommended. Runway conditions permitting, heavy braking and high levels of reverse thrust should be avoided to prevent uncovering all fuel pumps and possible engine flameout during landing roll.'........... 'If a go-around is necessary, apply thrust slowly and smoothly and maintain the minimum nose-up body attitude required for a safe climb gradient. Avoid rapid acceleration of the airplane. If any wing tank fuel pump low pressure light illuminates, do not turn the fuel pump switches off.'*

The QRH actions for a LOW FUEL caution involve opening the crossfeed valves but leaving all pumps on. This ensures that both engines receive fuel, even if one tank is empty but the other still has fuel. The QRH actions for a FUEL CONFIG message are to open the crossfeed valves and turn off the fuel pumps to the low tank until fuel is balanced. There is also an instruction in this checklist to refer to the '*Low Fuel*' checklist if the fuel quantity in either main tank is low.

The amount of fuel imbalance at the start of this diversion is unclear but it is known that the crossfeed valves were open for 11 minutes and 12 seconds, during which time 369 kg of fuel was used from the left tank. As the left tank was recorded as having 500 kg more fuel than the right tank at shutdown, it is probable that there was an imbalance of close to 800 kg when the crossfeed valves were opened.

Flight Management Computers

There were two FMCs on G-TCBC. Pilots input flight plan information as a route via their onside Control Display Unit (CDU) and the related FMC combines it with information from aircraft sensors and from its memory. The left FMC is usually the master system and the right is the slave. Once a route is input into the FMC, it is activated by pressing a Line Select Key adjacent to the command 'ACTIVATE>' on the CDU. The route in use is normally RTE 1 but there is an option to pre-load and activate an alternative route, RTE 2. When the end of a route is overflown or passed (eg when diverting but without a diversion route prepared), a new waypoint can be added to the route in use. It must then be activated before the FMC will provide relevant navigational information. When using RTE 1, there is a Line Select Key that provides a shortcut to RTE 2, which can be built up and activated in-flight if needed.

Recorded data

The aircraft was fitted with an FDR and a CVR. Pertinent extracts from the CVR are provided in the *History of the flight* section of this report. The FDR recorded pertinent data for the majority of the investigative needs.

The problems encountered during the flight relate to different systems over different periods so the following plots and descriptions cover overlapping periods.

Go-around

Figure 7 shows the pertinent parameters for the G/A sequence.

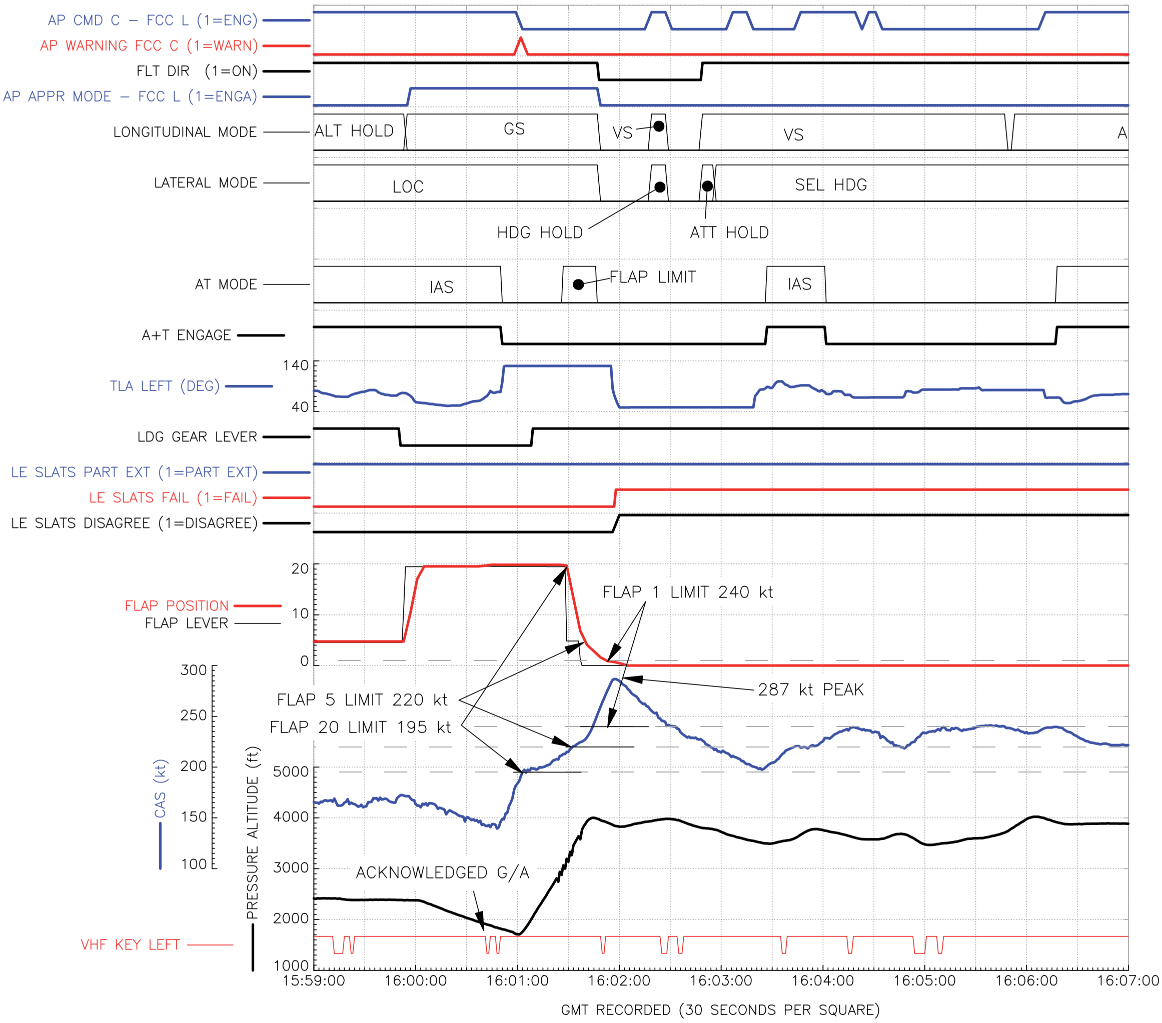

Figure 7

Go-around speeds, flap limits and automatics

The G/A call was acknowledged at approximately 1600:40 hrs. Soon after, the thrust levers were advanced and the A/T was disconnected. The A/P remained engaged and the aircraft followed the glideslope but accelerated due to additional thrust. It reached the FLAP 20 limit speed just after the A/P was disengaged and the aircraft was pitched up. This slowed the acceleration but FLAP 20 remained selected for a further 30 seconds. The subsequent flap retraction rates and aircraft accelerations were such that the aircraft speed remained above the relevant flap limit speeds until the flaps were fully retracted, soon after the speed peaked at 287 KCAS. At this point LE SLAT FAIL and LE SLAT DISAGREE conditions were recorded. 20 seconds prior to reaching the peak speed, the aircraft levelled at a pressure altitude of 4,000 ft (approx 3,580 ft barometric altitude), after which the F/Ds were switched off. The A/P and A/T went through a number of iterations of being engaged and then disengaged until the final engagement at approximately 1606 hrs.

Flaps and slats

The position of the alternate flaps selector is not recorded. This can be inferred or partially inferred when no failure or disagreement is recorded and either the LE or TE alternate flaps switch is selected, as this indicates the alternate flaps selector position matches the recorded surface positions.

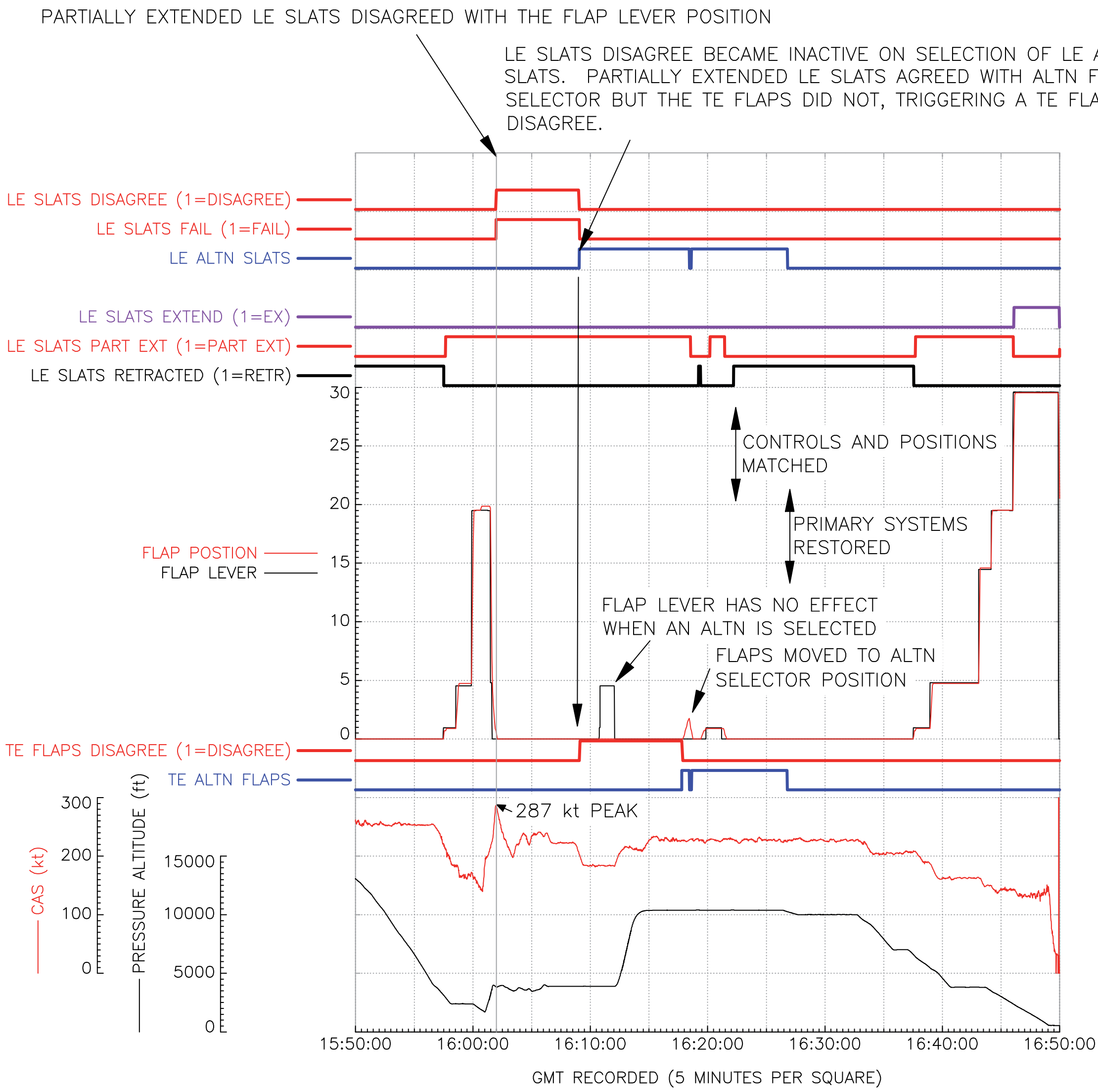

Figure 8

Flap and slat parameters for the G/A and remainder of the flight

The LE SLAT DISAGREE parameter, along with the partially extended state of the LE slats with the flap lever at 0, indicate that the slats could not reach the selected retracted state. This condition started when flaps retracted past FLAP 1, when the slats should have started retracting and the aircraft was above the FLAP 1 limit speed. The end of the LE SLAT DISAGREE condition coincided with the recorded selection of LE ALTN SLATS. This indicates that the LE alternate flaps switch had been pressed which:

- switched the DISAGREE logic from the flap lever to the alternate flaps selector
- removed hydraulic power from the flap and slat systems
- provided electrical power to the alternate slat system
- left the flap system without any motive power

This resolved the slat anomalies but triggered a TE FLAP DISAGREE. This indicates that the alternate flaps selector was now in agreement with the partially extended state of the LE slats but disagreed with the retracted position of the TE flaps. Approximately nine minutes later the TE alternate flaps system was armed, providing electrical motive power to the TE alternate flaps system. The flaps started moving and the TE FLAP DISAGREE parameter no longer indicated a problem. The flap movement initially continued past FLAP 1 then reversed and all surfaces were retracted before running back to FLAP 1 for a few minutes under alternate control. During this time the flap lever was also moved to FLAP 1. All surfaces were then retracted and approximately five minutes later both the alternate systems were disarmed and normal flap/slat control was established. The inference is that once the TE alternate flaps switch was pressed, the TE flaps ran under control of the alternate flaps selector (which must initially have been positioned beyond FLAP 1), until both alternate systems were disarmed.

No other flap/slat issues were recorded for the remainder of the flight and the landing was made using FLAP 30. Other than the conditions associated with excessive speed and partial slat extension, the flap and slat parameters reacted as expected for the given crew selections.

Fuel

Figure 9 shows the pertinent fuel related parameters. The derived fuel weight figures are based on recorded gross weight and zero fuel weight parameters, recorded once every 64 seconds. The CVR captured the crew agreeing the remaining fuel at two points during the flight. These were approximately 150 kg more than the derived figures indicate. However, the final derived fuel figure of 871 kg is close to the reported 900 kg final fuel figure. Part of the mismatch may be associated with timing and the quality and resolution of the source values. The fuel figures quoted in the earlier *History of the flight* section are the figures that were acknowledged by the crew.

After the G/A a forward fuel pump low pressure condition was recorded for a period during the climb from 4,000 ft. This was probably associated with the geometry of the fuel tank and aircraft attitude during the climb. The low fuel quantity parameter started indicating LOW FUEL soon after the top of climb and remained in that state for the rest of the flight. The parameters relating to crossfeeding became active at 1632 hr for approximately 11 minutes. The majority of this time was in the descent with relatively low fuel flow. The fuel flow figures indicate that approximately 813 lb (369 kg) of fuel was used during this period.

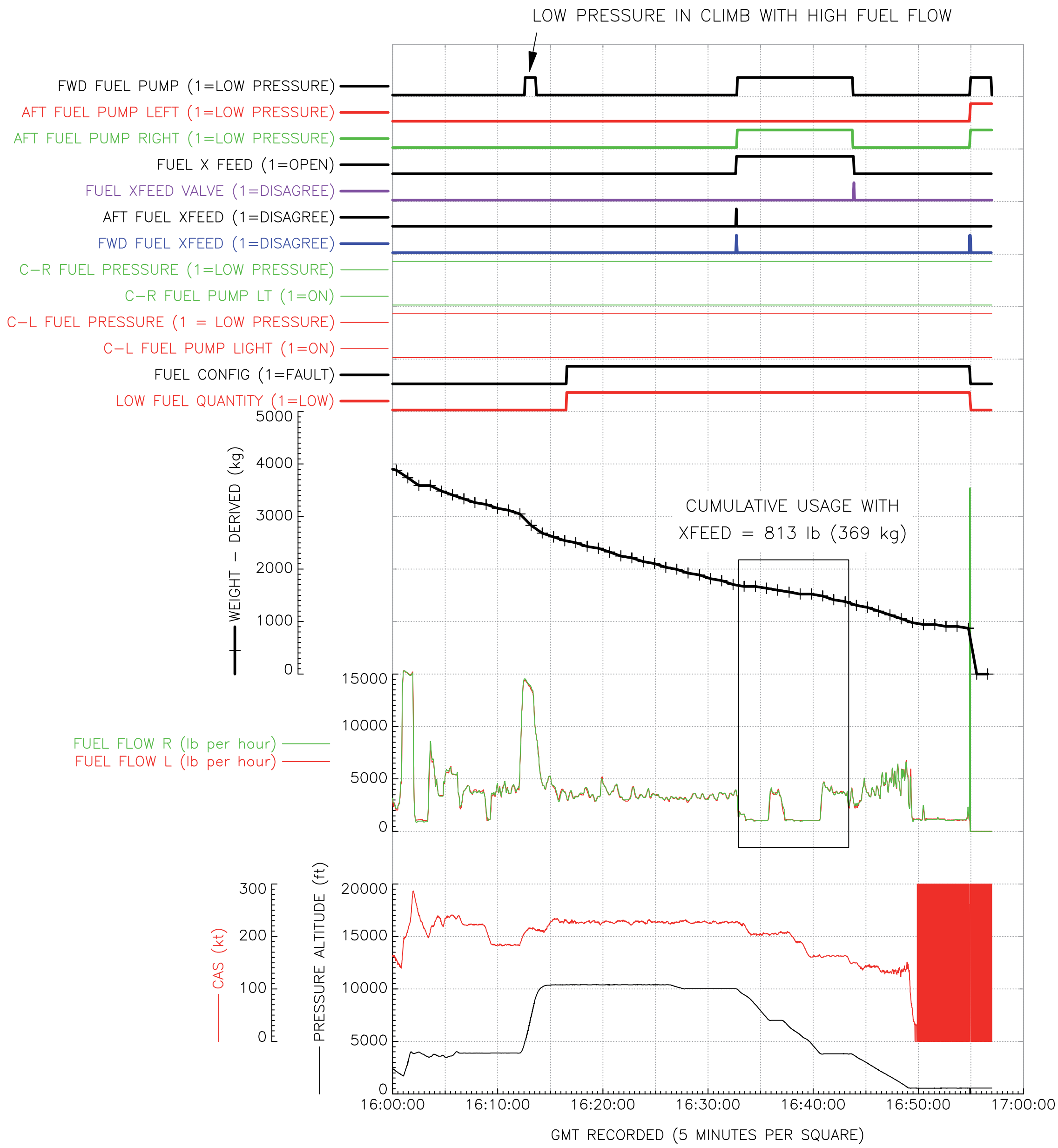

Figure 9

Fuel usage

Protection of CVR recordings

After reporting this occurrence the operator requested release of the FDR back to service, which was granted. It also accessed the CVR and used a transcription of the recording for its internal investigation, which is not permitted.

Regulation (EU) 996/2010, Article 14 states that cockpit voice recordings shall not be used for purposes other than safety investigation[13]. This protection exists whenever a safety investigation authority is conducting an investigation.

Footnote

[13] Regulation (EU) 996/2010 defines safety investigation as a process conducted by a safety investigation authority, such as the AAIB.

Operating procedures

Go-arounds

Regarding briefing prior to approach, the OM stated:

> *'When an approach briefing is conducted for the home base of both pilots then the brief may be abbreviated if both pilots agree they are fully familiar with the procedure.'*

A full briefing is expected to cover the '*Missed Approach Procedure – to include an engine inoperative scenario*'. No written guidance is offered as to whether or not the handling technique for an all engines operating G/A should be included within the briefing of the Missed Approach Procedure.

The guidance given in the manual for an approach made using the A/P was that it should normally remain engaged for the G/A. For a manually flown G/A the SOP was that, with both engines available, the aeroplane should initially be rotated to approximately 15º nose-up and the F/D pitch bar followed thereafter. To further enhance workload management and ensure that an appropriate level of automation was used during a G/A after manual flight, with or without F/D selected, the SOP was to use the mnemonic "GAGL". This was a reminder to press the G/A switch, engage the A/P, so that vertical speed and heading hold modes both functioned, before again pressing the G/A switch to engage GA modes, which would be checked on the FMA. When the climb was stabilised, an appropriate Lateral mode was expected to be used to follow the missed approach procedure.

The PM's duties during a G/A were to acknowledge the initial call of "GEAR UP, FLAPS 20" by moving the flap lever if necessary, check the engine thrust rating and confirm that GA was displayed on the FMA. When a positive climb was seen, it was announced and the gear selected up when commanded. After that the PM would inform ATC of the G/A and check again that GA was annunciated on the FMA. The A/P would be selected if requested, along with any modes stipulated. Above the acceleration altitude 'V_{REF} +80, climb thrust' would be called for and the PM would dial up the V_{REF} +80 figure in the speed window. As the speed increased the PF would call for the flaps to be retracted to FLAP 5, FLAP 1 and then UP and the PM would acknowledge each call, check the speed and retract each stage of flap. A section in the manual dealing with monitoring duties stated:

> *'In the event of an airspeed discrepancy of more than -5 kt or +10 kt from the required airspeed, PM should call 'SPEED.'*

Fuel emergency

The following paragraph appeared in the Part A of the Operator's OM:

> ***'Fuel Emergency (EU-OPS 1.375 b)***
>
> *The Commander shall declare an emergency when the calculated usable fuel on landing, at the nearest adequate aerodrome where a safe landing can be performed, is less than final reserve fuel.'*

TDODAR

The Part A of the OM gave detailed guidance about decision making processes. This included the way in which the pilots should deal with new or unfamiliar situations. It said:

> *'………..we recommend the use of the mnemonic* ***TDODAR****. It can also be useful as a mental checklist to ensure all eventualities have been covered. The most important element of the process is the last item, the review. Time for a review must always be found. A proper review will enable one to ensure the decision(s) you have made still fit the situation as it develops.'*

TDODAR is described as the following series of actions or considerations:

> ***'Time*** *How quickly must you get the aircraft on the ground? This will dictate how much time you can give to considering options and reaching a decision.*
> ***Diagnosis*** *What are the symptoms? ....Use all resources and senses available to you and your crew. What is the problem? ....Not what is the solution. Ask what, how, why, etc...............Time spent on diagnosis is rarely wasted.*
> ***Options*** *Is there more than one option? ....There often is. Consider the consequences of each. Has anyone else thought of an option? ....Consulting is not a sign of weakness and taps into others' situational awareness (crew SA).*
> ***Decision*** *There is not always a "perfect" decision but a thorough diagnosis (with all options and consequences considered) will probably be the best decision that can be made with the information and time available.*
> ***Assign Tasks*** *Consider workload and experience. Beware of overloading yourself or others. Ensure others' roles are understood.*
> ***Review*** *Is the decision still valid? Are tasks completed? Has everyone been updated? Time for the review must always be found and if the situation no longer fits the decision made then the process has to be repeated, hence this technique is also called the "Decision Making Loop.'*

Serious incident procedures

ICAO Annex 13 defines accidents and serious incidents and notes that the only difference between the two lies in the result. It gives examples of serious incidents and these are repeated in Regulation (EU) 996/2010 regarding the investigation and prevention of accidents and incidents in civil aviation. In the UK the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996 requires the commander of a UK registered aircraft or of an aircraft flying in the UK, to inform the AAIB if they are involved in an accident or serious incident.

Section 11.2 of Part A of the operator's OM dealt with accident reporting. It stated that it was the pilot's responsibility to ensure that relevant reporting procedures were followed without delay but that in the UK the company would be responsible for notifying the AAIB.

Serious incidents were not mentioned in this section although it was noted that if there was any doubt as to classification, then the captain should report an occurrence in the same way as an accident. There was no instruction in the OM to inform pilots that serious incidents should be reported to the AAIB.

Section 11.3 of Part A dealt separately with incidents and included the following notes about serious incidents:

> ***'11.3.2 Serious Incident***
>
> *A serious incident is defined as an incident which:*
>
> *(a) Has jeopardised the safety of passengers, crew or aircraft and narrowly avoids being an accident (by good handling, good luck, etc)*
>
> *(b) Has serious potential technical or operational implications, or*
>
> *(c) May result in formal disciplinary action against aircrew or engineers.*
>
> *The decision to classify an Incident as 'Serious' will normally be made by the Director of Flight Operations or the Flight Safety Manager. This decision must be made as soon as possible after the event and before the crew or aircraft fly again and the operations supervisor will contact the DFO or Flight Safety Manager as soon as notification of a potentially serious incident is received.'*

The Duty Flight Operations Manager was not mentioned in the above paragraph but his responsibilities were laid out in an earlier section of the Part A, where it stated:

> *'The Duty Flight Operations Manager (DFOM) roster gives 7-day, 24-hour cover to grade operational incidents and provides round the clock pilot management access for the Flight Crew. The DFOM is the first point of contact for Operations Control in the event of any accident, incident, security threat or issue that might attract unwanted publicity.'*

According to the operator's procedures, when the DFOM became aware of an accident or serious incident, he would contact the on-call safety manager who would then notify the AAIB. The OM Part A also stated:

> *'At all times where possible a manager should speak to the crew. Ideally this will be face to face but where necessary this may be with the DFOM over the telephone who as a pilot, will then exercise his discretion. The Captain should be encouraged to carry out a "crew post incident de-brief" to ensure that all aspects of the incident are captured for reporting purposes and to enhance CRM.'*

The requirement for a crew post-incident debrief was not included in the guidance given to commanders. However, there was an instruction that required a pilot who was involved in an incident to fill in an Air Safety Report within six hours of the occurrence or of landing.

Preservation of recorded data

The regulations for the preservation of FDR and CVR data are laid down in EU-OPS 1.160 and in JAR-OPS 3.160. In 2011 the CAA issued Safety Notice 2011/011 to reinforce the need for operators to have robust procedures to ensure protection of this data after both accidents and serious incidents. This operator's OM required that every effort should be made to preserve all forms of aircraft data unless advised to the contrary by the flight safety department. One of the commander's responsibilities according to Part A of the OM was not to permit recorded data to be erased after a flight when an accident or incident subject to mandatory reporting had occurred. Elsewhere in Part A pilots were instructed to ensure that after an '*incident*' the CVR was to be isolated to avoid over-writing and that they should ensure the security of the FDR and Quick Access Recorder until the data or the units were removed. No details were given as to how to accomplish this on the B757.

CAA guidance

As a result of reported incidents that arose from all-engines operating G/As, the CAA published a notice in 2008 (FODCOM 11/2008) which highlighted these occurrences. This guidance was later incorporated in CAP 789 (Requirements and Guidance Material for Operators). An extract from Chapter 24 relating to Flight Crew Training is shown below:

'4.1 ***Go-around Training***

4.1.1 Most go-arounds are flown from positions not normally practised during simulator training and checking. These include go-arounds from below decision height and from well above decision height close to the acceleration altitude. They may also take place when not in the final landing configuration and when not asymmetric as required by Licence Proficiency Checks (LPC) or OPC. There have been a number of incidents during which a go-around was carried out in a serviceable aircraft that resulted in the loss, or near-loss, of that aircraft. Two events that were frequently linked with go-arounds were:

a) altitude busts; and
b) flap and/or landing gear limit speed exceedance.

4.1.2 Go-arounds with all engines operating are part of the initial type rating training course for Multi-Pilot Aeroplanes (MPAs) but not a mandatory part of annual or six-monthly recurrent training. The practice of go-arounds with all engines operating from other than at DA should be carried out regularly. As a minimum, this should be included in the operator's three-year training programme but should not be too prescriptive in detail. Unplanned go-arounds should be included to verify pilot understanding of SOPs. This would enable operators to vary the training in order that it encompass a variety of circumstances including:

> a) *above DA and above the platform altitude in the Missed Approach Procedure;*
> b) *between DA and touchdown; and*
> c) *after touchdown.*
>
> *Briefing material should be produced to provide crews with guidance on appropriate autoflight modes relevant to the differing circumstances. Operators should ensure that sufficient training is provided to enable crews to execute go-arounds satisfactorily from various altitudes.'*

Since this incident took place, the CAA published Information Notice (IN-2013/198) which reiterated the guidance quoted above.

Operator's training

The operator of G-TCBC included all-engines operating G/As in its recurrent simulator training for pilots in early 2011, incorporating use of the mnemonic GAGL. This training package was undertaken by the co-pilot in July 2011. The commander undertook his type conversion during this period and did not experience the same scenario but his conversion training included all-engines operating G/As from other than decision altitude (DA).

The operator's recurrent training in early 2013 included briefing on the use of the mnemonic GAGL in association with a visually flown manual approach that resulted in a G/A. In this training scenario the all-engines operating G/A was initiated from above DA following a technical malfunction. The commander undertook this training in April 2013. The associated training record stated that this was *'very well handled and good decision made leading to a well flown G/A'*. It did not record from how far above DA the manoeuvre was commenced. During the co-pilot's recurrent training in July 2013, he acted as PM during a similar all-engines operating G/A from above DA.

Prior to the serious incident to G-TCBC, the operator had planned all-engines operating G/A training from above DA into its recurrent training scenario for the second half of 2013. This simulator training for all the operator's pilots was in accordance with the CAA's recommendations.

During 2014 the operator adjusted its guidance on G/As advising pilots to take time, discuss the intended actions and if necessary to re-engage the autopilot first.

Operator's response

The operator commenced an internal investigation when details of the occurrence became clear. Initially the operator accessed the CVR and FDR data. This was subsequently passed to the AAIB when the AAIB upgraded the level of its own enquiry. The operator also engaged an independent Human Factors (HF) specialist to interview the crew and to produce a report. The following remarks were made in this report with regard to the disengagement of the A/T by the commander:

> *'The Captain was visual with the runway on a coupled ILS final approach, with every expectation of continuing to land. After many times of experiencing this situation the captain's brain (unconsciously), brings to readiness a motor response to squeeze the right thumb in order to disconnect the A/T, because that is what normally happens at this point – in order to commence visual landing off the approach. This might also have been consciously anticipated (he was soon intending to do so). In the second after the go-around instruction, the captain is preparing the action and is only consciously aware that he "needs to do something with his thumb". Unfortunately his thumb is almost certainly covering or touching the right A/T button as well as being unconsciously primed to disengage the A/T. The primed response (disengaging the A/T), is extremely similar to the required response (pushing the GA buttons). Given the physical thumb position and the highly sensitized action of disengaging the A/T with the thumb (due to [contextual] priming), this error was relatively likely to occur….'*

The report also discussed the decision to divert and the crew's failure to refer to the QRH drill for LOW FUEL. Some pertinent extracts from this section of the report are quoted:

> *'The decision appeared to solve the problem caused by the flaps and suddenly gave the crew a welcome perception of regaining control over the situation……… It re-focused the crew with a clear joint plan……..It gave the impression that they were taking back control of the situation and hence they started to emerge from their discomfort. Furthermore it helped the cockpit dynamics (the crew relationship) because they had jointly agreed on a plan/goal (this is known to increase group cohesion, which improves relationships).*
>
> *An important point here is that both crew felt so much better about the situation after the decision was made, it made them reluctant to question it further (if unconsciously). The choice to go to Manchester 'felt' very good and this affect probably duped the crew into a false sense that the choice was better than it was in reality, and stopped them reviewing or scrutinising it.*
>
> *It is probable that the criticality of the fuel situation was never properly realised for a number of reasons; partly due to being consumed with a reflection on earlier mistakes, partly due to a reticence to discuss further problems during the flight (and therefore a tacit reassurance from each other), and partly due to unfamiliarity around diverting and what to expect. However the main reason is probably that the crew viewed the fuel state as being planned as part of the decision to divert.......Because below-minimum fuel was part of that 'very good' decision, and the fuel state progressed 'as planned' in line with that 'very good' decision, the actual criticality of the fuel situation did not make the impact upon the crew that it might have done. This even applied to the EICAS message and failure to run the low fuel QRH.'*

Safety actions

The operator's report proposed the following actions:

- A review of G/A training to include an external study of best practice.
- The role of the PM was to be addressed during recurrent ground and simulator training sessions.
- An internal newsletter for pilots was to focus on high workload issues, as an interim measure, pending the introduction of a revised HF training package.
- A review of the way that pilots use the QRH. Prior to this being completed, B757 pilots were to receive specific training to enhance their familiarity with checklists relating to slat and flap problems.
- A notice was circulated reminding pilots of the operator's fuel policies and of the need to declare an emergency with a low fuel state. The same notice explained how pilots should contact Operations Control or the DFOM in the event of an emergency and how CVR and FDR data should be secured.
- As part of a harmonisation programme, among several airlines in the same group, the Part A of the OM was to be amended to incorporate changes needed after this incident.

Analysis

Go-around training and briefing

The CAA recognises the need for pilots to regularly practise all-engines operating G/As and has issued guidance with a recommendation that, as a minimum standard, such training should take place every three years. The commander and co-pilot involved in this incident had experienced an all-engines operating G/A without use of the autopilot during training in April and July 2013 respectively. The commander's recollection was that this G/A took place at DA but the operator's records indicated that it was from above DA. The circumstances of this occurrence differed from that of training in that it was not a premeditated G/A and both the autopilot and the autothrottle were engaged when the G/A was initiated.

This incident highlights the need for pilots to be prepared for a G/A at any stage of an approach. The G/A technique was not discussed in the abbreviated approach briefing. The commander believed that the co-pilot had briefed this technique on the previous approach but this did not accord with the co-pilot's recollection. Moreover the co-pilot said that it was unusual for these G/A actions to be briefed. This incident indicates that such a briefing would be beneficial.

The go-around

On final approach, the commander was distracted by his perception that the aircraft had not captured the localiser “as well as normal”. There was no evidence of a system fault but with a slightly late turn onto the intercept heading and a high groundspeed, the aircraft did overshoot the centreline in the process of capturing. When ATC noticed the overshoot a new intercept heading was given and this gave the crew the impression that the aircraft was not performing correctly.

With the runway in sight the commander was mentally attuned to a landing and was in the habit of reviewing the G/A routine “at about 500 ft” on an approach. In this instance the instruction to G/A came at an earlier stage and he reverted to the G/A procedure relevant to a previous type. Consequently he advanced the thrust levers before realising that he needed to press something with his thumb. This should have been the G/A switch but instead he disengaged the A/T. The G/A switch was never pressed and the commander did not make the standard call ‘*Go Around, Flaps 20’.* One consequence of disengaging the A/T was that automatic protection against flap speed exceedence was lost.

The report commissioned by the operator noted that if the G/A had not been commanded, the next action that the commander was expecting to carry out with his right thumb was to disengage the A/T for landing. Even if he realised that he needed to press the G/A switch he was already primed for a very similar action and consequently the A/T disconnect switch was pressed as a reflexive action.

The commander observed the aircraft accelerating but still following the glideslope and this contradicted the actions that he thought he had taken. In order to rectify this situation he repeated “GO-AROUND” and eventually disconnected the A/P. He now had to adjust to an un-anticipated G/A whilst flying manually and disregarding the F/D commands. He was mentally stretched as he tried to work out what had happened and he only achieved 10º of pitch-up instead of the recommended 15º. In the short time that it took the fully powered aircraft to reach 3,500 ft amsl it accelerated quickly and several flap speed limits were exceeded.

The operator’s SOPs required the co-pilot, as PM, to verbalise any speed discrepancies. However, on this occasion the co-pilot’s monitoring ability was degraded and he did not provide this assistance. He, too, had to adjust his mental model from landing to G/A. This was hindered because the initiating call from the commander was incomplete (no flap setting was mentioned), and because he responded to the ATC call to climb straight ahead to 3,500 ft. This diverted his attention when he should have been looking for GA annunciations on the FMA. After that his eyes were drawn to the EICAS screen when the A/P was disengaged. Instead of following the mental GAGL routine, he struggled to put the new situation into context and this degraded his performance. When asked to select V_{REF} +80 and climb thrust, he experienced difficulties. He found the speed window was closed and he started to become frustrated when it would not open. The window may have been closed by accidentally pressing the end of the speed selector instead of the adjacent SPD switch and then would not work because oblique pressure was applied.

On reaching 3,500 ft amsl, the commander requested the A/P to be engaged but that proved problematic as well. It either failed to engage or did not remain engaged. It is possible that movements of the control wheel and control surfaces may have prevented A/P engagement, or the commander may have inadvertently disengaged it through use of the pitch trim before he appreciated that the A/P was working. It is also relevant that, because the G/A switch had not been pressed, the LOC and GS modes were still active. The only other way to remove these was by turning the F/D OFF and then back ON with the A/P disengaged. As the F/Ds were not turned OFF and ON before the first attempt to engage the A/P, the LOC and GS modes would have been active and the commander would have had to override the A/P.

Slat and flap problems

Eventually the automatics were successfully engaged but the slats remained partially extended due to an exceedence of the limiting speed by a significant margin. The co-pilot began the relevant QRH checklist but he was frustrated by his poor performance prior to that. Interruption caused him to lose his place in the checklist and instead of starting again, in accordance with SOPs, he struggled to find where he had got to. The similarity in presentation of steps 2 and 4 made this quite difficult. Step 5 required the alternate flaps selector to be positioned to agree with the flap lever. The flap lever was in the UP position but the co-pilot set the alternate flaps selector to FLAP 1, possibly as a result of his heightened anxiety.

Step 6 was to set the LE alternate flaps switch to ALTN. When this was done, the LE flaps, ie the slats, were powered by the alternate electric system and they ran towards the FLAP 1 position, as instructed by the alternate flaps selector. This caused the reference for both the LE and the TE flaps to shift from the flap lever to the alternate flaps selector, but the power source for the TE flaps had not been changed to the alternate system. This action was called for at step 7, at the top of the next page on the checklist, but the checklist was stopped before this was reached, when the TE FLAP DISAGREE caution illuminated. This appeared because the TE flaps were UP, as commanded by the flap lever, but their reference source had been switched to the alternate flaps selector, which was incorrectly set to FLAP 1. System knowledge and familiarity with this drill from training should have ensured that both systems were switched in quick succession.

When the TE FLAPS DISAGREE caption illuminated, the decision was made to prioritise this, even though there was no guidance to that effect. Instead of completing the first checklist, the pilots switched to the '*Trailing Edge Flap Disagree'* checklist. The crew only progressed this checklist to step 3. Had steps 4 and 5 been completed, then both the slats and the flaps would have been controlled and referenced to the alternate flaps selector. If either checklist had been finished, the crew would have been instructed to check the '*Non-Normal Configuration Landing Distance tables'* for the appropriate performance data.

The checklist was interrupted, first by ATC and then when the commander asked if they could get more flaps. The commander's attention had slipped from the checklist because he was becoming convinced that this was another technical failure (following problems on other aircraft and the issue at the start of the approach), and he wanted confirmation that they had a flap fault. The consequence was that the co-pilot diverged from the QRH and mistakenly tried to move the flaps with the flap lever. The commander did not notice this error but he did see that the flaps were not moving, which convinced him that there was a problem and that they would have to land without flap.

The commander stated that he had concerns about conducting a flapless landing at NCL. Calculation of the Operational Landing Distance indicates that Runway 23 at NCL offered sufficient length. The nearest planned alternate destination was EDI, but the commander did not consider this as he believed the runway there was not much longer than NCL. The pilots did not calculate the Operational Landing Distance or review the decision to divert to MAN.

The operator's report indicated that the pilots felt more in control of the situation having decided on a course of action. They knew that this entailed landing with less fuel than normal, but accepted this as part of the solution.

The QRH warned against troubleshooting by deviating from non-normal procedures, prior to completion of appropriate checklists. This crew ignored this instruction and made random flap system selections without completing either checklist. As it transpired, they did manage to regain normal control of the flaps, but if they had followed the QRH correctly they might not have had to consider a flapless landing or a diversion.

Fuel

When the diversion commenced the pilots observed that the remaining indicated fuel quantity was 3,200 kg. The PLOG showed a fuel burn to MAN of 1,999 kg but only 1,653 kg to go to EDI. The EDI option was not discussed and neither were the implications of landing at MAN with less than final reserve fuel of 1,627 kg. No attention was given to the extra track miles to be covered, from 25 nm east of NCL, or to the increased fuel burn that would result because of the non-normal flap configuration (although when they later re-gained flap control the pilots did raise the flaps to reduce fuel burn). The pilots decided to cruise at FL100 but the predicted burn was based on climbing to FL170. An emergency should have been declared as soon as it became evident that the aircraft would land with less than final reserve fuel but there was a delay before this was done.

The pilots did not refer to the QRH in response to EICAS indications of forward fuel pump low pressure or the LOW FUEL caption. They had accepted when they started the diversion that this would entail a landing in a low fuel situation, so may have considered these indications a consequence of the solution. Also, their ability to respond methodically may have been affected by the difficulties they had encountered earlier.

It was unclear if any balancing of fuel had been done on the flight from FUE to NCL, although the co-pilot thought that this had occurred. Both pilots said that they would routinely balance fuel when a difference of between 300 kg and 500 kg was seen. It is unclear what the exact imbalance was at the point that the fuel level in the right tank reduced to 1,000 kg and the LOW FUEL caution came on. The left tank had substantially more but the EICAS FUEL CONFIG had not illuminated, so the imbalance should have been less than 800 kg.

The imbalance was not discussed until 15 minutes later when fuel balancing was attempted without reference to the QRH. In this circumstance the '*Low Fuel'* checklist should have been used. Even if the '*Fuel Configuration*' checklist had been begun instead, it would have referred the crew back to the '*Low Fuel'* checklist because the fuel quantity in one tank was low. This would have meant the crossfeed was left open with all pumps on until landing. Instead, the crossfeed was only open for 11 minutes and as the thrust was at minimum for much of this period, there was not enough time to balance the tank levels.

The FCTM includes some important notes concerning an approach and landing with the LOW FUEL caption illuminated These ought to have been discussed prior to landing, along with the potential difficulties that could be encountered in the event of a further G/A. From comments made just before landing, the commander was aware just how critical the situation was but all he said was "WE DON'T WANT TO GO-AROUND…WE CAN'T".

ATC was not told how critical the fuel situation was. With around 200 kg in the right tank and the crossfeed valves closed, the right engine could have flamed-out during, or immediately after, a G/A.

ATC input

The instruction by ATC at the start of the G/A to climb straight ahead to 3,500 ft may have been made in order to simplify matters for the crew but the instruction came at a point of high workload when the crew were trying to initiate the G/A. The co-pilot had to reply to the instruction to climb to 3,500 ft and then had to input this on the MCP. This distracted his attention when he should first have been checking to see GA annunciations on the FMA. It would have been better if ATC had given the change of G/A procedure either in the same transmission as the G/A instruction or after observing the aircraft start to climb.

When G-TCBC was downwind, ATC knew the crew were dealing with a technical problem and provided assistance by giving extended downwind vectors. However, it could have been helpful for the crew if they had been warned before they reached the boundary of controlled airspace, rather than being told when they had left it. This would have given them the opportunity to opt to remain within controlled airspace so as to retain the best traffic separation service.

RTF discipline

A MAYDAY should have been declared, using standard phraseology, as soon as it became evident that the aircraft was going to land with less than final reserve fuel. Instead, a non-standard declaration of an emergency was made which only led to some confusion. The co-pilot used the phrase "AND WE WANT TO DECLARE A MAYDAY", but it became apparent later that ATC had interpreted this as a request for a paramedic. The confusion was only sorted out a little later when the crew reported that they wanted a priority landing because they were low on fuel. This prompted ATC to ask if they were declaring an emergency.

A MAYDAY prefix could then have been used for subsequent radio exchanges. This could have helped ATC to provide maximum assistance and it could have alerted other aircraft to their predicament. When the co-pilot first checked in with Scottish Control he did not notice that he received no reply. It is possible that if the MAYDAY prefix had been used, then ATC would not have missed that call. In the event, Scottish Control did not realise that the aircraft was on frequency until six minutes later when the co-pilot asked for a direct routing.

Altitude deviation and FMC difficulties

The After Take-Off Checks were overlooked because of the other problems created by the G/A. This led the crew to climb to, and cruise at, 10,000 ft on the QNH rather than at FL100. Consequently the aircraft was 420 ft higher than it should have been, but this was not brought to the crew's attention by ATC.

Following the G/A, the aircraft had passed the end of the route entered in RTE 1. The co-pilot was unable to re-programme RTE 1, so raw data was used to navigate towards Pole Hill VOR. The co-pilot repeatedly tried to re-programme the FMC, whilst also trying to sort out the flap/slat situation and deal with radio calls. However, his performance with these tasks was affected by the difficulties he had encountered during the G/A and with the QRH checklists. He had lost confidence in his own ability and he had probably reached an over-aroused mental state, where his capacity to think straight had started to deteriorate. Like the commander, he was now experiencing a low fuel scenario for the first time. At this point it is likely they were both task-saturated. This helps explain why the After Take-Off Checks were missed. It is most likely that a new waypoint could not be programmed because it was not activated. Eventually, when the option was taken to use RTE 2, this was activated and the FMC provided navigational assistance again.

Crew

There was no indication that the crew's performance was degraded by fatigue or medical reasons. However, the commander was affected by the major re-organisation that was taking place in the company. He tried to put worries about his pending demotion to one side when he was at work but inevitably these still intruded into his mind. Following the mishandled G/A he worried about the potential repercussions. Without this distraction he may have been able to pace the crew actions more effectively. Specifically he could have offloaded the co-pilot, by taking responsibility for radio transmissions while the QRH checklists were done.

Pilot type rating training as well as recurrent training is designed to ensure that pilots understand aircraft systems and are familiar with QRH checklists. This crew had difficulty applying their knowledge in an unexpected situation and did not use the QRH correctly. The checklists should have been run to completion, despite the interruptions.

The exchange of information and regular reviews of what has happened and what is planned are fundamental to the successful outcome of any occurrence. The operator's OM explains how tasks should be shared and states that time for a review must always be found. The mnemonic TDODAR is advocated as a tool to aid problem solving and decision making. These guidelines were not followed during this serious incident.

Post-flight actions

The operator's policy was that the DFOM should be told about all incidents and should give them a classification. In this case the DFOM did not categorise this as a serious incident and did not contact the commander to discuss it. The commander tried unsuccessfully to phone the DFOM. If the two had spoken, it is likely that the matter would have been treated as a serious incident and the commander would have been counselled to conduct a crew debrief. Had it been treated as a serious incident straightaway the DFOM would have set in train the process to alert the AAIB. The OM Part A was the pilot's prime point of reference and this ought to have emphasised that serious incidents and accidents are to be reported in a similar way.

Although the operator's OM indicated that the commander had a responsibility after an incident to preserve CVR and FDR data, no guidance was provided on how to accomplish this.

Details of the flap overspeed were not given to the engineers until sometime after the incident and this delayed the initiation of detailed technical checks. It was two days after the incident before the operator realised the severity of the fuel issue and the AAIB was contacted. When the AAIB began its investigation, the CVR data became protected under applicable regulations and should not have been used for any purpose other than the AAIB safety investigation.

Conclusion

This serious incident had its origin in an incorrectly executed G/A from well above decision altitude. The approach briefing had not mentioned the techniques that might be employed in such a circumstance. Initially the autothrottle disconnect switch was operated rather than the G/A switch and the thrust levers were advanced manually. In order to climb, the autopilot was disconnected but the flight director remained in approach mode and did not provide the pilots with appropriate guidance.

SOPs were not adhered to and consequently the pilots' situational awareness became degraded and their workload was increased. As a result there was a slat/flap overspeed which necessitated the use of the QRH to address a non-normal situation. The pilots became stressed and task-saturated and were unable to follow the checklists correctly in order to regain full use of the slats and flaps and then land at their destination.

When a decision was made to divert, it was accepted that the fuel in tanks would drop below the final reserve level before landing. However, fuel caution messages were overlooked because a low fuel state was seen as an integral part of the solution to the earlier difficulties. The low and imbalanced fuel state which developed could have had serious implications in the event of a further G/A.

The outcome could have been improved by greater adherence to SOPs along with better monitoring and workload management skills. One tool that was overlooked and which could have helped with decision making in these unfamiliar circumstances was the mnemonic TDODAR.