ACCIDENT

Aircraft Type and Registration:	1) Boeing 737-8AS, EI-ENL 2) Boeing 737-8AS, EI-DLJ
No & Type of Engines:	1) 2 CFM56-7B turbofan engines 2) 2 CFM56-7B26 turbofan engines
Year of Manufacture:	1) 2011 (Serial no: 35037) 2) 2005 (Serial no: 34177)
Date & Time (UTC):	28 June 2014 at 0546 hrs
Location:	London Stansted Airport
Type of Flight:	1) Commercial Air Transport (Passenger) 2) Commercial Air Transport (Passenger)
Persons on Board:	1) Crew - 6 Passengers - 161 2) Crew - 6 Passengers - 178
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Nature of Damage:	1) Right winglet detached 2) Right tailplane damaged and severe damage to APU installation
Commander's Licence:	1) Airline Transport Pilot's Licence 2) Airline Transport Pilot's Licence
Commander's Age:	1) 39 years 2) 49 years
Commander's Flying Experience:	1) 12,200 hours (of which 6,200 were on type) Last 90 days - 264 hours Last 28 days - 80 hours 2) 16,408 hours (of which 12,857 were on type) Last 90 days - 232 hours Last 28 days - 62 hours
Information Source:	AAIB Field Investigation

Synopsis

The right winglet of a taxiing Boeing 737-8AS detached when it collided with the tail of another Boeing 737-8AS being pushed back from the apron at London Stansted Airport. Both aircraft were manoeuvring in accordance with ATC instructions. The APU of the aircraft being pushed back was severely damaged and some fuel leaked onto the apron. There was no fire and all persons onboard later disembarked without injury.

The controller had not appreciated that the pushback approval he had issued conflicted with his earlier instruction to another aircraft and there was no monitoring or warning system to alert him. The pilots of the taxiing aircraft did not discern that the controller's instructions caused confliction and only noticed the other aircraft's movement at the last moment. Hand signals were used as the pushback team had no headset to communicate with the pilots on

the flight deck. There was no guide person to check for hazards to the rear and right of the aircraft that was being pushed.

Since the accident, safety actions have been taken by the operator, the air traffic control agency, the regulator and the ground handling company. There are therefore no AAIB Safety Recommendations.

History of the flight

EI-ENL had been flown from its base at Hahn Airport, Germany and had landed on Runway 22 at London Stansted Airport. It was a dry morning, visibility was good, and the wind was from 230º at 5 kt. After vacating the runway via the high speed link NR (Figure 1) the co-pilot checked in on the Ground radio frequency and the aircraft was instructed to take the second left turning onto Taxiway J and to hold short of Taxiway C. Later the Ground controller instructed EI-ENL to proceed via the 'C West' line to park on Stand 43R.

Figure 1

Partial taxiway diagram for London Stansted Airport

After passing Taxiway Z, the co-pilot shut down the right engine in accordance with the operator's Standard Operating Procedures (SOP). While he was doing this, EI-DLJ requested permission to "push and start" from Stand 44R. The Ground controller approved this request and in so doing repeated the stand number clearly and instructed EI-DLJ to push onto the 'C West' line. He then added that engine start could be delayed until the aircraft was established on the 'C West' line. The crew of EI-ENL did not discern that another aircraft was being given a pushback instruction that conflicted with their own routing. Onboard EI-DLJ, the crew were completing their pre-flight preparations and therefore they were not monitoring taxi instructions given on the Ground frequency when EI-ENL received parking instructions.

The pushback crew for EI-DLJ comprised a tug driver and a headset operator[1]. There was no headset immediately available, so the headset operator informed the commander, who opened his side window so that he might be able to supplement his hand signals with verbal instructions. The headset operator remained on the left side of the aircraft to maintain visual contact with the commander. When the tug driver was passed the '*brakes released*' signal, he saw EI-ENL on Taxiway J but lost contact with it as he started the pushback. The APU generator remained the prime source of electrical power for EI-DLJ.

A pier obscured the controller's view of Stands 43 and 44 and only the fins of aircraft on the 'C West' line could be seen from the Visual Control Room (VCR) (Figure 2). The crew of EI-ENL saw a B737 on Stand 44R as they turned onto the 'C West' line but they did not appreciate that it was commencing pushback. After completing the turn, the co-pilot looked to his right and realised that the tail cone of the other B737, was now moving towards him. He told the commander to stop and the commander started to turn left, away from the conflict, and to apply the brakes. Three and a half seconds after the co-pilot started speaking, the winglet of EI-ENL impacted the leading edge of the right horizontal stabiliser on EI-DLJ. The winglet was forced under the tail cone of EI-DLJ where it penetrated the APU bay and fragmented. The pilots of EI-ENL felt the aircraft "touch" before they brought it to a halt a few metres further on.

Figure 2

A view from the VCR looking towards Stands 43 and 44 with a Boeing 737 parked on Stand 44R and another taxiing along the 'C West' line

Footnote

[1] Although there was no headset available the ground crew member in charge of the pushback was referred to as the headset operator.

The tug driver had seen EI-ENL re-appear behind EI-DLJ and braked hard but could not prevent the collision. The impact of the winglet caused the APU on EI-DLJ to fail and a small amount of fuel to leak onto the ground. Onboard, the crew felt a thump, the aircraft stopped suddenly and some electrical services failed. The headset operator shouted to the commander that another aircraft had hit the tail and the pilots heard a radio call from an Operations vehicle (Ranger 2), which had followed EI-ENL onto C West. Seven seconds after the collision, Ranger 2 announced, "EMERGENCY, AGI[2] IN THE CHARLIES, AIRCRAFT AGAINST AIRCRAFT". The commander of EI-DLJ made a Public Address (PA) instructing the passengers to remain seated. He ascertained from the headset operator that a quantity of fluid had leaked onto the ground but he understood that the flow had ceased and that there was no sign of fire.

In response to the radio call from Ranger 2, the Ground controller looked towards C West but he only saw the fins of the two stationary aircraft in close proximity to each other. He then initiated the airport's AGI procedures using a landline and after that he instructed other aircraft on his frequency to stand by, so that fire vehicles would have a clear route to the incident. Approximately three minutes after the collision he was relieved of the Ground position by another controller.

The pilots on EI-ENL also heard Ranger 2 declare the emergency. Two attempts to speak to the Ground controller were made, but no reply was received.[3] The commander then called the No 1 cabin crew member by interphone and said "...WE HIT SOMEBODY. COULD YOU TELL THE PASSENGERS TO PLEASE REMAIN IN THEIR SEATS."

Some three and a half minutes after the collision, the crew of EI-ENL started the APU and the commander made a PA in which he reiterated his instruction for the passengers to remain seated. On completion of the PA, the pilots responded to a radio call from the replacement Ground controller, who asked if any aircraft was evacuating. They transmitted that they were not evacuating passengers. They were then instructed to monitor the RFFS frequency (121.6 MHz), and to shut down their engines. The left engine was shut down some five minutes after the collision and, just over a minute later, the No 1 cabin crew called the commander on the interphone. He told the commander that he had a good view of what had happened but there was no exchange of information between them concerning the aftermath of the collision or damage that was apparent.

At the time of the accident a watch handover was taking place in the fire station. The oncoming Fire Station Manager had heard the AGI announced over the tannoy system. He reached the scene of the accident along with the first fire tender within two minutes of the collision. He saw what he initially thought to be hydraulic fluid beneath the tail of EI-DLJ but the leak had ceased. After assessing the damage to both aircraft, he upgraded the incident to an accident. This entailed an enhanced response from the local emergency services.

The two B737s were later towed onto their respective stands and all persons onboard disembarked without injury.

Footnote

[2] AGI – Aircraft Ground Incident.

[3] These transmissions were not heard by the Ground Controller as he was having a conversation on the land line.

Recorded information

The FDR and CVR from EI-ENL contained a complete record of the accident. The CVR from EI-DLJ recorded the period of the crew's pre-departure preparations, ATC instructions and pushback up until the collision, at which time the CVR system stopped recording when electrical power provided by the APU was lost. The FDR on EI-DLJ was not operating at the time of the pushback as neither engine had been started. Salient parameters from EI-ENL's FDR included groundspeed.

CCTV footage of the collision was available from a camera located at the far end of the adjacent terminal building near to Stand 53, which is about 180 m from Stand 44R. The position of the camera meant that the vertical stabiliser of EI-DLJ could be observed as EI-ENL taxied along Taxiway J before turning right to follow the 'C West' line. The CCTV images provided the relative positions of both aircraft when the pushback of EI-DLJ commenced, and through alignment with the CVR, the point that the crew of EI-ENL became aware that EI-DLJ was moving. Figures 3 and 4 are composite images, illustrating the relative positions at two points. The CCTV was used to corroborate the recorded groundspeed of EI-ENL. ATC recordings and ground surface movement radar records were also available.

The maximum groundspeed of EI-ENL was just less than 30 kt as it proceeded along Taxiway J. Approaching Apron Z, speed began to reduce and was about 10 kt at the start of the turn onto the 'C West' line. It was at this point that EI-DLJ's pushback manoeuvre started. A left turn by EI-ENL was evident just after the cockpit passed abeam the tail of EI-DLJ, which extended approximately 9 m beyond the stand parking limit line when the aircraft collided. The application of EI-ENL's brakes was not a recorded parameter but the aircraft's speed did not reduce until after the collision. The aircraft stopped with its empennage almost abeam that of EI-DLJ and displaced approximately 1.5 m to the left of the 'C West' line (away from Stand 44R).

The FDR record for EI-ENL continued for five minutes after the collision, ending when the left engine was shut down and about 90 seconds after the APU had been started. Flight deck and cabin crew communications, along with PA announcements from the flight deck and radio communications with ATC and RFFS, were recorded by the CVR until it was manually stopped 10 minutes after the accident[4].

Analysis of the CCTV footage, in conjunction with stand and aircraft dimensions and final position of EI-DLJ at impact, indicated that the aircraft had been pushed back approximately 22 m from its parked position at an average ground speed of about 1.3 m per second (2.9 mph).

Footnote

[4] The CVR circuit breaker was pulled by the crew in accordance with the operator's procedures in order to preserve the recorded data.

Figure 3

Relative position of EI-ENL when EI-DLJ push back commenced (composite image)

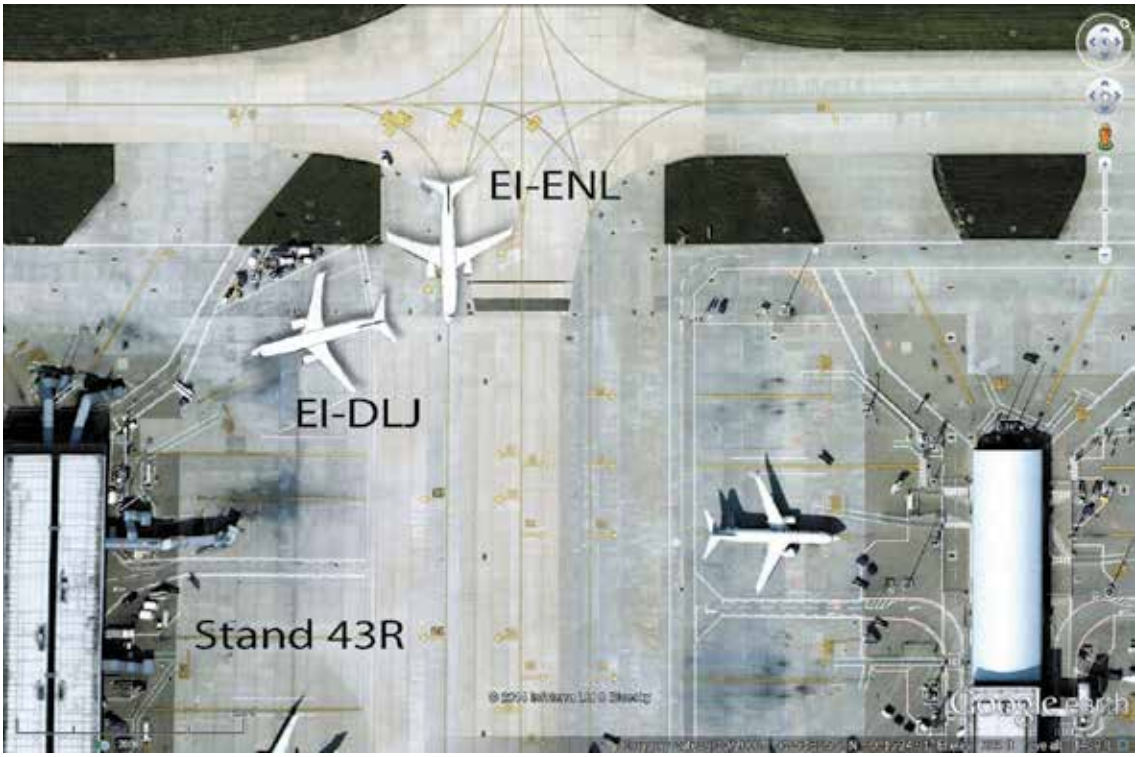

Figure 4

Position of EI-ENL when co-pilot observed EI-DLJ moving (composite image)

Damage to the aircraft

The right winglet of EI-ENL had struck the right tailplane of EI-DLJ before piercing its APU bay and severely damaging the APU. The winglet detached and remained embedded in the bay (Figure 5). The APU's automatic shutdown[5] process operated and closed the fuel shut-off valve on the forward bulkhead of the APU bay, preventing a fuel leak which would have been substantial.

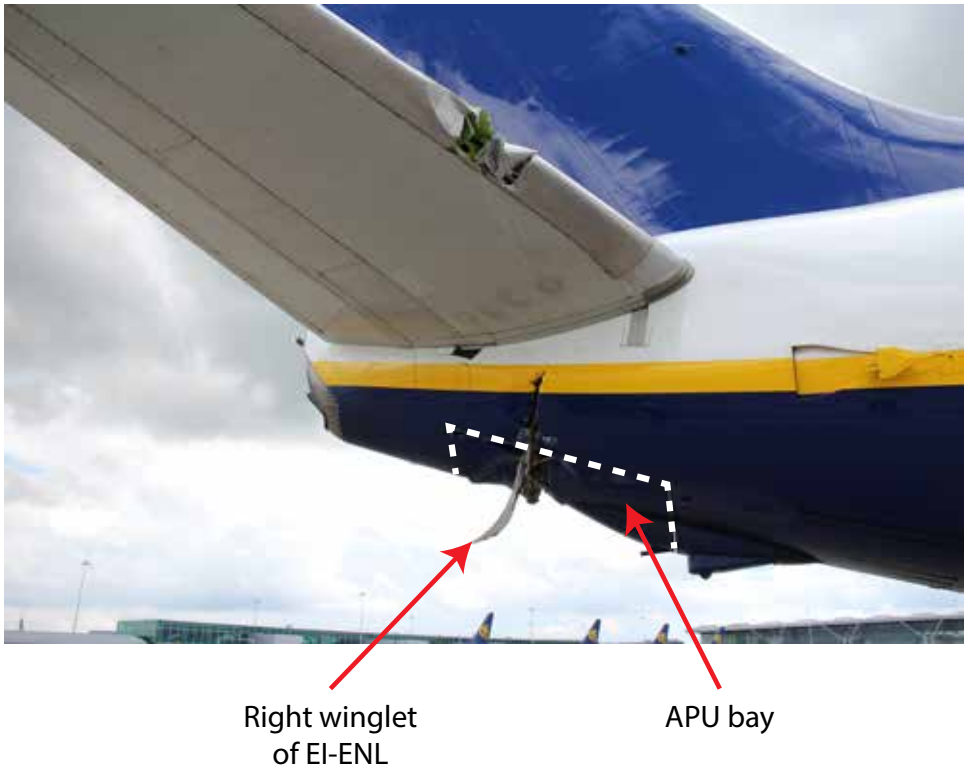

Figure 5

Right winglet of EI-ENL embedded in the APU bay of EI-DLJ

The APU was significantly damaged by the winglet (Figure 6). The impact severed main casings, fuel and oil pipes as well as causing damage to its mountings and bay. A small quantity of fuel and lubricating oil escaped, but there was no fire.

Footnote

[5] The APU has fully automatic shutdown protection provided for overspeed, low oil pressure, high oil temperature, APU fire, fuel control unit failure, EGT exceedence and other system faults monitored by the electronic control unit.

Figure 6

Underside of APU after removal, showing extent of the damage

ATC environment

The ATC Watch in the VCR consisted of five people. The Ground controller began work at 0455 hrs alongside the previous Watch. The other four members of his own Watch were due to start at 0600 hrs, although they had all reported to the VCR by 0546 hrs. In addition to the Watch Manager, there was one controller assigned to the Air position (Tower frequency), one who was about to open the Delivery position[6] and an additional person who later took control of the Ground position after the accident.

The Ground controller was responsible for Delivery and Ground control, providing ATC departure clearances as well as controlling aircraft from the start of pushback until they approached the runway and arriving aircraft that had vacated the runway. His responsibilities[7] included the issue of information and instructions to aircraft under his control to prevent collisions with vehicles, obstructions and other aircraft on the manoeuvring area and, on the apron, to assist in preventing collisions between aircraft[8]. It is not common practice at UK airports for the actions of a Ground controller to be continuously monitored by anyone else.

Footnote

[6] On weekdays the Delivery position had to be opened by 0530 hrs but there was no such constraint at weekends as traffic levels were lighter.

[7] The Manual of Air Traffic Services Part 1 (CAP 493) lays down ATC responsibilities in the UK.

[8] The 'C West' line at Stansted was on the manoeuvring area and the parking stands were on the apron. A line on the ground, known as the 'tail of stand line' separated Stand 44R from the manoeuvring area.

Aids available to the Ground controller included a monitor for the Advanced Surface Movement Guidance and Control System (A-SMGCS)[9] and two screens that displayed Electronic Flight Progress Strips (EFPS)[10] (Figure 7). Transponding aircraft and vehicles were displayed on the A-SMGCS by a secondary return that showed their callsign. However, within the confines of a parking stand the A-SMGCS showed only primary radar returns, making it difficult to differentiate aircraft from ground vehicles or fixed objects. On the EFPS, each strip carried details for a particular aircraft and the controller used an interactive pen to control the strips. The left screen (Figure 7) showed all the aircraft that had been issued with ATC clearances or were under the authority of the Ground controller.

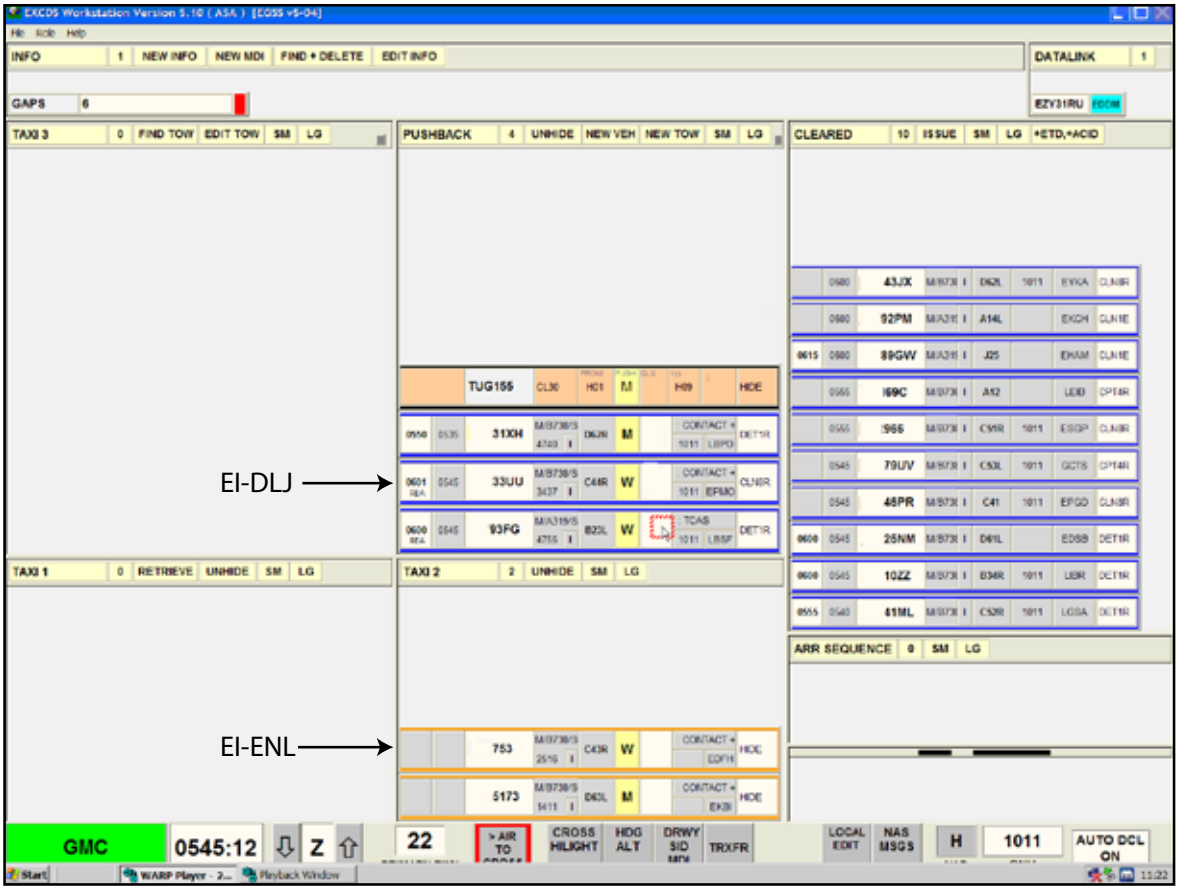

Figure 7

The left EFPS screen just before the collision (operators' identifiers removed)

When an aircraft requests push and start, the controller notes the aircraft's position and Calculated Takeoff Time (CTOT) from its progress strip. Before issuing his instructions the controller checks if there are any aircraft pushing or taxiing which could cause confliction. The interactive pen[11] is then used to move the strip from the 'Cleared' bay in the right column of the left EFPS screen into the 'Pushback' bay in the centre column.

Footnote

[9] A surface movement radar that incorporated transponder mode S information.
[10] A-SMGCS and EFPS are used at other UK ATC units and are not unique to London Stansted Airport.
[11] On Figure 7 the arrow inside a red box indicates the location of the interactive pen.

The controller's situational awareness relies on his integration of information gained by looking outside, by monitoring the A-SMGCS and by checking the EFPS. Figure 7 shows that as EI-ENL taxied in, its strip appeared along with that of one other aircraft in the 'Taxi 2[12]' bay of the left hand screen. The data on the strip included the radio callsign, the allocated stand (C43R) and a 'W' for the 'C West' line. Before EI-DLJ requested push and start, there were several progress strips in the 'Cleared' bay but only three other strips in the 'Pushback' bay. It was these three strips along with the two strips in the 'Taxi 2' bay that needed to be checked before EI-DLJ was given instructions. The right EFPS screen (not illustrated) showed the scheduled departures that had not yet been given a departure clearance. There was a steady stream of departure clearances to be given over the radio; the controller's workload was therefore almost continuous.

Shortly before EI-DLJ requested 'push and start', another operator's aircraft (in the 'B' cul-de-sac), had been given pushback instructions. This aircraft had the same scheduled departure time as EI-DLJ but had been allocated a CTOT that was one minute earlier. Because there was time to spare before the CTOT, the controller had offered this other aircraft the option to delay engine start until established on its taxi line. He told EI-DLJ to 'push and start' onto the 'C West' line and then made a separate transmission "IF YOU WANT TO DELAY YOUR START UNTIL YOU ARE ON THE LINE, THAT'S FINE." This offer was acknowledged by the co-pilot of EI-DLJ.

Automatic Dependent Surveillance Broadcast (ADS-B)

ADS-B technology allows the exchange of GPS-derived positional information using transponders. The integration of ADS-B with TCAS and EGPWS is currently at a development stage but it has the potential to warn pilots of impending collision with structures or other buildings when moving on the ground. ADS-B is likely to assist ATC through the creation of enhanced surface movement tools.

Ground controller

The Ground controller gained his validation in March 2012. He had a good night's rest and commented later that he felt alert and cheerful when he commenced his duty at 0455 hrs. He had worked the previous day from 0600 hrs until 1230 hrs but had been off the day before that. The traffic level on the Ground frequency had been busy but was below the level where he deemed it necessary for the Delivery position to be opened, for another person to provide the departure clearances on a separate frequency.

When EI-ENL began taxiing in, it followed an aircraft of a similar type which had been instructed to give way to an outbound aircraft routing through Taxiway C. All three aircraft belonged to the same operator, with EI-ENL's callsign ending 753, while the preceding one ended 5173. The controller's procedure when approving a pushback request was first to check the strips of incoming aircraft (in the 'Taxi 2' bay), but he considered it possible that, when EI-DLJ asked for pushback, he had confused EI-ENL with one of the other aircraft.

Footnote

[12] Taxi 2 was the bay used to show all arriving aircraft that were under control of the Ground controller.

The controller did not see the collision and it was the radio call from Ranger 2 that alerted him to the accident. He saw the tails of the aircraft close together but had no CCTV facility in the VCR to assist him. After acknowledging the call from Ranger 2, he immediately used the dedicated landline to inform the RFFS, airport operations and the combined control centre of the event.

Airfield operations vehicle (Ranger 2)

An Airfield Operations vehicle, radio callsign "Ranger 2", was following EI-ENL towards Stand 44R, to conduct a routine audit of the aircraft's turnaround. The driver stated that he was in the vicinity of Stand 45R (on Taxiway J) when he heard a bang and saw debris and leaking fluid to the rear of EI-DLJ. He continued onto the 'C West' line and made the radio announcement that an AGI had occurred.

After parking his vehicle in front of EI-ENL, the driver tried to indicate to the pilots that they should shut down both engines. He did this by pointing at the right engine only and made a cutting motion with his other hand. He was unaware that the right engine had already been shut down during taxi-in and, as he did not perceive a response to his signal, he gained the impression that the pilots were ignoring his instruction. He then went over to EI-DLJ's tug to assess the situation there before closing the 'C' cul-de-sac to any traffic that was not responding to the emergency.

EI-ENL crew actions and comments

Prior to the collision

This was the first flight of the day for the crew of EI-ENL. Both the commander and the co-pilot said they had good quality sleep and felt well rested at the start of their duty. They both heard and understood the instructions given to them by the Ground controller after they had landed. Stand 43R was not where they were used to parking when inbound from Hahn Airport, Germany, but they had been told to anticipate this stand and had checked the routing on their charts.

While taxiing along Taxiway J, the co-pilot completed the After Landing Checks and the pilots engaged in intermittent conversation about an aircraft they saw which was leased to their operator and about other airport activity. They later commented that this was one of the busiest airports on their current schedule and in their conversation they had remarked how efficiently the traffic was controlled there. The co-pilot shut down the right engine, just as EI-DLJ requested pushback. Although neither pilot was talking when the controller approved the pushback from Stand 44R, they did not discern that the controller's instructions caused confliction.

Before they turned right into the 'C' cul-de-sac, the co-pilot noticed the B737 parked on Stand 44R but he did not see its red anti-collision beacon illuminated[13] or that it had a tug attached and was ready to push. He confirmed to the commander that they were

Footnote

[13] The co-pilot noted that anti-collision beacons on other aircraft are sometimes turned on before the aircraft is fully ready to push back.

turning on the correct taxi line and then transferred his attention towards Stand 43R. He saw that it was unobstructed and that ground crew were awaiting their arrival. It was then that he looked right and began to realise that the B737 on Stand 44R was pushing towards them.

He later observed that, because the aircraft on Stand 44R was not being pushed back at right angles to the taxi line[14], the perspective made it difficult for him to pick up relative movement of EI-DLJ against the pier behind it. He and the commander noted that, when there is no road behind the stand, the spacing between taxiing aircraft and parked aircraft can seem minimal and an aircraft being pushed back may quickly encroach the taxiway. With respect to ATC taxi instructions, they commented that once they received unconditional approval to taxi somewhere, their mindset was that the route would be clear. They likened it to a green traffic light but stressed that they were still vigilant for aircraft and vehicles which could cause conflict.

The collision

When the co-pilot told him to stop, the commander took evasive action by turning left away from the danger and braked sharply. The co-pilot saw the winglet hit the tail of the other aircraft but did not state what had happened. They both felt a small amount of movement as the two aircraft collided. After stopping and applying the park brake, they heard an emergency being declared over the radio. They realised they had collided with another aircraft but perceived the impact to be minor. There were no unusual cockpit indications so the commander and co-pilot took time to evaluate the situation. After two unsuccessful attempts to contact the Ground controller, the commander called the No 1 cabin crew, to ensure that the passengers remained seated. There was no discussion regarding the nature or whereabouts of any damage.

The cabin crew had sensed the aircraft braking sharply to a halt. The cabin crew at the rear of the aircraft heard a noise but the window in the right service door was misted-up so they unstrapped and looked out of a cabin window. They saw part of the winglet lying on the ground and some fluid under the tail of the other aircraft so they informed the No 1 crew member, who was at the front of the cabin. The No 1 crew member did not believe that the fluid was from EI-ENL and he had made a PA to reassure the passengers before the commander called him.

EI-ENL had stopped close to Stand 43R with the nose only marginally left of the ‘W’ line. The commander later said that because the impact had not been dramatic, he had deemed that an evacuation was not needed and his focus was on preventing panic by the passengers which might have led to injury. The commander later commented that the situation was akin to the routine scenario of having been halted just short of a stand and waiting for further instruction. This was not discussed with the co-pilot and the commander was not then aware of what damage there was.

Footnote

[14] See Figure 3 to view the angular difference between the lead-in line for Stand 44R and the ‘C West’ line.

One minute after the collision they saw a vehicle (Ranger 2) stop and the driver indicate that the right engine should be shut down[15]. As that engine had been shut down earlier, no action was taken but the co-pilot suggested starting the APU. The commander responded by asking if there was any fluid leaking and he was told that there was not. He was then informed (2.5 minutes after the collision), that the winglet had been cut off. There was no further exchange of information[16] about the damage although the commander did say "OK, WE'RE STOPPED. WHAT ELSE CAN WE DO?" He later observed that it did not "feel" like an emergency situation and, with no QRH drill to be carried out, their attention became focussed on activity outside the aircraft.

In reviewing the accident, the pilots agreed that they could have worked better together to agree a course of action. They felt that initially their reactions were affected by the lack of build-up to the accident and the startling effect that it had on them. The operator had an easy-to-remember mnemonic (PIOSEE[17]) to aid crews in their decision-making process; they believed that they covered the elements of it but that they could have done so more efficiently. The commander felt there was no need for an evacuation, therefore his priority was to reassure the passengers and make sure they remained seated. Discussion with the cabin crew, to gain their perspective of the event and the possibility of any damage, took place six minutes after the collision. By this time the APU had been started and contact had been made with the RFFS on 121.6 MHz. The pilots later commented that the RFFS told them to standby for a damage assessment but that they were then left to wait for a long time. It was around 30 minutes later that EI-ENL was towed onto Stand 43R and those onboard disembarked normally.

Rules of the air

The UK Rules of the Air Regulations 2007 apply to all aircraft within the UK. Rule 42 refers to right of way on the ground and states at paragraph 2:

> *'Notwithstanding any air traffic control clearance it shall remain the duty of the commander of a flying machine to take all possible measures to ensure that his flying machine does not collide with any other aircraft or vehicle.'*

Paragraph 4 then states:

> *'Vehicles and flying machines which are not taking off or landing shall give way to vehicles towing aircraft.'*

Footnote

[15] Ranger 2 was unaware that the right engine had been stopped before the collision.

[16] The pilots recollected that the commander climbed across the console to see out of the co-pilot's window at some stage and that the co-pilot took a photograph that he showed to the commander. However, they thought that these actions took place later, after the left engine had been shut down.

[17] See *Operator's procedures.*

EI-DLJ crew actions

The crew of EI-DLJ had reported for duty at 0500 hrs, for a 0545 hrs departure to Warsaw. They were completing their pre-flight preparations and did not hear EI-ENL being given taxi instructions to Stand 43R.

When pushback commenced, neither pilot was aware of EI-ENL's position. After moving a few metres the headset operator indicated that they could commence engine start but the commander declined this option. They then felt a "thump" and the aircraft stopped suddenly. The commander later said that he did not regard it as a dramatic event and thought that it was a tug-related problem, until some of the electrics failed. The headset operator shouted to tell him they had hit another aircraft. When this was reinforced by the radio call from Ranger 2, the commander made a PA to reassure the cabin occupants. Soon after that he unlocked the cockpit door in order to converse directly with the cabin crew.

The front door emergency slides were disarmed and the airstairs were lowered but the commander kept the rear doors armed because he was told there was fluid on the ground. He believed that the fluid had stopped leaking and that it had come from the other aircraft. With no signs of fire he saw no need to evacuate the aircraft but he wanted the rear slides to be available if circumstances deteriorated[18]. The APU and the Inertial Reference Systems[19] were then turned off and when the fire service arrived on the scene, the commander monitored frequency 121.6 MHz.

The cabin crew, who were standing at the time, felt a bump when the aircraft collided but it was not of sufficient force to cause them to stumble. They noticed an electrical power disruption but that was not unusual. The passengers were kept onboard for approximately 45 minutes but none of them seemed to be alarmed, even though damage to the other aircraft was visible.

Pushback procedures

The Operator stipulated in its Operator's Manual (OM), that headset communications were obligatory for all pushbacks, except where there was a ground intercom malfunction[20].

With no headset available, standard ICAO hand signals were used to communicate with the pushback crew. At Stansted there was a need to augment these so the pushback crew would know which line the aircraft should push to. The local practice was to make a 'W', using the thumb and index fingers of both hands together to indicate the 'W' line. There was no such signal for the 'E' line or the 'M' line so the practice was to raise one finger to indicate the 'first' line, two fingers for the 'second' line or three fingers for the 'third'. These non-standard signals were not published anywhere for the benefit of pilots unfamiliar with the airport.

Footnote

[18] The disarming of the front emergency slides would have impaired the use of the right front door as an emergency-exit had an evacuation been later initiated.

[19] The Inertial Reference System alarm in the nosebay could be heard because the commander's side window was open. The alarm indicated that the aircraft was being powered by the batteries only.

[20] The OM omitted to mention that a headset might not be used when there was a lightning risk.

The Operator's Ground Operations Manual (GOM) stated that three ramp personnel, including a 'wingman', were required for all pushbacks and that they must be correctly positioned before pushback commenced. The manual indicated that local procedures could apply at certain airports but there was no indication that the 'wingman'[21] might be dispensed with at Stansted.

The OM Part A informed aircraft commanders that, whilst they retained full command during pushback, the headset operator[22] was in charge of the pushback manoeuvre and was responsible for the safety of the aircraft, the tug and any other people or objects in the immediate vicinity. This was supported in presentations used by the ground handling company to train pushback personnel. These presentations also stressed that a 'guide person' had to be in position before a pushback commenced. The headset operator was instructed to:

> *'ALWAYS make a visual check around the aircraft and taxiway to ensure the intended pushback path is clear before giving the "brakes released" signal'*

to the tug driver. If the headset failed, the headset operator was instructed to stand on the left side of the aircraft, in line of sight of the captain, and to remain in this position to ensure no break in communication.

The ground handling company required a radio to be fitted and working in the pushback tug and that a pushback could not take place:

> *'without communication between the ground control tower and the pushback tug.'*[23]

However, tug drivers did not know an aircraft's radio callsign, hence they could only try to listen to instructions when the relevant stand number was quoted. The aim of having drivers monitor the radio was to enable them to hear any conditions issued by ATC when pushback instructions were given.

The training material used by the ground handling company addressed the need for tug drivers to be aware of other aircraft and the position of the pushback aircraft's tail and wingtips. A recent risk assessment by the company indicated that headset operators should crouch down to look under the wings to check that the route is clear. There was a stated intention by the company to audit this process and to train tug drivers to query ATC pushback instructions if necessary. The company did not provide guidance about what their staff should do if a ground collision occurred.

The handling company reported that, since December 2012, a verbal agreement with the operator had allowed pushbacks from stands, with no roadway behind, to be conducted by

Footnote

[21] The ground handling company referred to the 'wingman' as the 'guide person', 'roadman' or 'back of stands road person'. Throughout the remainder of this report the term used is 'guide person'.

[22] The headset operator was referred to in the OM Part A as the 'ground Crew Chief'.

[23] The presumed intent of this statement was that the tug driver had to be able to hear ATC communications.

only two people. Consequently the guide person had been dispensed with for Stand 44R and for several other stands. The operator stated that no such agreement had been made.

After the accident, pushback trials were conducted on Stand 44R using a guide person positioned to the right and rear of an aircraft. It was concluded that the geometry of this stand (Figure 3) meant the tug driver tended to lose sight of the guide person when the nose of the aircraft was moved left. To stay in sight of the tug driver, the guide person would have to move towards the front of the aircraft as the pushback proceeded.

The pushback team

The pushback team consisted of the tug driver and the headset operator. They reported to their team leader who was responsible for dispatching the aircraft but did not assist with the pushback. The team leader normally supplied the headset for use during a pushback but this team leader's headset had been taken away seven months previously as it was required for training purposes. He stated that he had been unable to obtain a replacement from the ground handling company.

The team leader normally goes to the next aircraft when a pushback commences. On this occasion, however, he was about to have a break, so he remained in his vehicle adjacent to the stand. He saw the other taxiing B737 (EI-ENL) and when it turned he realised there could be a collision. He saw the headset operator raise his arms and thought that he was signalling an emergency stop but the signal to the pilot was for clearance to start the left engine. The team leader pressed the horn of his car but failed to attract the attention of his team members and he witnessed the ensuing collision. He then ran to an emergency phone and asked for RFFS attendance. Airfield Operations and RFFS vehicles arrived promptly but he noted that the other aircraft kept an engine running for four or five minutes.

The tug driver had started work at 0430 hrs and this was his second pushback of the day. He had worked an early shift the previous day but for the three preceding days he had been on a late shift. He found the transition from late shifts to early shifts difficult. He would normally be in the tug to listen out for mention of the relevant stand number on the radio so that he could hear the instructions that were given. However, prior to this pushback he had been busy preparing the aircraft and he was not in the tug when ATC gave the pushback instruction. This was not unusual as he often had to load last minute baggage. He had been trained to be vigilant before starting a pushback and it was his expectation that it was safe to pushback an aircraft once ATC had issued a "clearance".

When the anti-collision light on EI-DLJ came on, the pilot signalled 'W' to the headset operator and held up one finger to indicate the first taxiway. The tug driver looked left and saw an aircraft on Taxiway J but he later commented that he thought it was going too quickly to turn into the 'C' cul-de-sac. Due to the angle of the stand centreline he had to turn the tug right initially, to manoeuvre the tail of the aircraft towards the 'C West' line. He lost sight of the other aircraft at this point and did not see it again until it emerged to the right of EI-DLJ's tail. He rapidly applied his brakes but at the same time he felt the aircraft rock in reaction to the collision. The collision sent him into a state of shock such that he did not know what to do.

The headset operator had worked the same shift pattern as the tug driver. He stated that he conducted one or two pushbacks each week without a headset and that at the start of the pushback he was blind to the left side of the aircraft. He first saw the nose of the other B737 when it went past the tail of his aircraft, just before the collision. After EI-DLJ stopped, he remained in position. He could see oil and debris at the rear of his aircraft. His team leader re-appeared and they waited for assistance to arrive.

The trials conducted after the accident indicated that, even if there had been a guide person stationed to the rear of the aircraft on the right side, they would probably have been unsighted from the other two members of the pushback team and would have been unable to communicate visually with them in the event of an emergency.

Operator's procedures

The OM Part A instructed pilots to wear radio headsets from the start of pushback until the top of climb and from top of descent until engine shutdown on stand. During these periods a 'Sterile Cockpit' procedure was to be followed, with conversation restricted to matters directly relating to the safe operation of the aircraft, to allow both pilots to give maximum attention to the ATC frequency.

The Standard Operating Procedures (SOP) manual stated that the commander was always to be the Pilot Flying (PF) during ground operations and he was responsible for ground taxiing. The Flight Crew Operating Manual (FCOM) Vol 1 noted that the Pilot Monitoring (PM) was to monitor taxiing and the OM Part A stated that 10 kt was the maximum permitted taxi speed when turning through 45º or greater.

The Operator's SOP was to shut down the right engine before parking on stand. This was a standard fuel-saving practice and was subject to the pilots' familiarity with the airport and the complexity of the taxi procedures. The memo which explained this procedure stated that during engine-out taxi procedures, the crew's attention should be focussed on taxiing the aircraft and that sterile cockpit procedures must be observed during this critical phase.

Decision making

Many operators train their crews to use a particular mnemonic as an aid to their decision-making processes when they encounter difficult or unusual situations. The mnemonic advocated by this operator was P.I.O.S.E.E.: P - Problem (define the problem); I - Information (gather information); O - Options (identify options); S - Select (select the most appropriate option); E - Execute (implement the selected option) and E - Evaluate (establish if the problem has been solved). The Operator noted in its training material that:

> *'Unexpected events can impose a "startle factor" which may impose significantly in the decision making process. Unannunciated problems may not be identified as such and a P.I.O.S.E.E. process may not be carried out because the problem is subtle.'*

Interaction between flight deck and cabin crew during ground incidents

Both the OM Part A and the Safety and Emergency Procedures (SEP) manual provided guidance to crew regarding communication in the event of an incident in the cabin while taxiing. Cabin crew (normally the No 1), were instructed that if they needed to contact the flight crew urgently, because of an incident in the cabin, they should do so via the interphone. They were also instructed to report all '*abnormal incidents*' to the flight crew immediately.

The reference in OM Part A to the initiation by the flight crew of emergency communications with the cabin, came under the heading of '*Emergencies in Flight'*. Pilots were to make the PA call '*No 1 to the flight deck immediately.*' and the No 1 cabin crew was to respond by proceeding immediately to the cabin interphone and await a call from the flight deck. However, the SEP manual stated the No 1 was to go to the interphone and call the flight deck, saying *'Cabin to flight deck, No 1 standing by*'. The SEP manual also stated that if this call was given on the ground, both the No 1 and the No 2 should pick up an interphone and report that they were standing by. They would then expect to be given a NITS[24] briefing.

The OM did not specify any other drills relating to an aircraft which stopped unexpectedly while taxiing or being pushed back. In the event of a rejected take off, however, the SEP manual stated that once the aircraft had come to a complete halt or had taxied clear of the runway, the No 1 cabin crew member should make a specific PA before calling the commander on the interphone and saying *'Cabin to flight deck, No 1 standing by*'.

Analysis

During the investigation it became clear that the crews of both aircraft followed the instructions and taxi routes given to them by the Ground controller.

Air Traffic Control

The potential for a collision was created when the Ground controller inadvertently gave approval for EI-DLJ to push back from Stand 44R onto the 'C West' line, before the inbound taxiing aircraft, EI-ENL, had passed behind and parked on the adjacent stand.

When the crew of EI-DLJ requested pushback, the Ground controller did not check EI-ENL's progress strip on the EFPS, showing that EI-ENL was taxiing to Stand 43R. This may have been because the controller was confused by some callsign similarity between EI-ENL and another aircraft. Lack of monitoring of the Ground controller's actions and the inability of the EFPS to generate an alert when two aircraft are instructed to use the same portion of taxiway were contributory factors.

Footnote

[24] The NITS acronym is commonly used for communications between flight and cabin crew in emergency situations. The N stands for Nature of the emergency, the I for Intention, T for Time available and S for Special instructions.

The Ground controller can monitor aircraft movements visually but, in this case, his view of Stand 44R was obscured by an intervening pier and there was no CCTV available within the confines of the stand to assist. The A-SMGCS is a useful tool for the controller but only displays primary radar returns in parking areas, making it difficult to differentiate aircraft from ground vehicles and fixed objects.

The inbound aircraft

Rule 42 of the Rules of the Air places responsibility for preventing collision on the ground with the aircraft commander, irrespective of air traffic instructions. In this instance, with increased situational awareness, the crew of the EI-ENL might have prevented the collision if they had picked out the approval of EI-DLJ's pushback on the radio or if they had spotted that EI-DLJ was starting to move as they began to turn into the cul-de-sac. However, once the turn was underway, the geometry of the stands and the perspective view from their moving aircraft made it difficult for this crew to perceive the movement of EI-DLJ. Review of the flight data showed that the inbound aircraft was taxiing at approximately 10 kt at the time of the collision which was the maximum permitted speed for that part of the route.

After landing, the flight crew of EI-ENL did not adhere with the operator's 'Sterile Cockpit' policy. However, they were not conversing at the time pushback instructions were given to EI-DLJ and were in a position to identify the conflicting instructions given by the Ground controller. There was no clear reason why the crew did not identify the confliction but they did later observe that Stansted was busier than other airports on their schedule.

The pushback team

The effectiveness of the pushback team appears to have been limited in two principal areas. One was that the headset operator did not have a headset available, and thus needed to use hand signals to communicate with the pilots in EI-DLJ. If a headset had been used for the pushback of EI-DLJ, the headset operator would have been on the right side of that aircraft and the non-standard hand signals would not have been required. From this position he might have spotted EI-ENL's turn in time to halt EI-DLJ within the confines of its stand. Standing on the left side of the aircraft, he could only have seen EI-ENL's turn by regularly crouching down to look underneath the hull of EI-DLJ.

The other principal limitation was that the pushback team did not include a guide person. The exclusion of such a guide person had been the standard procedure at Stansted, for stands with no roadway, since December 2012. The ground handling company stated that a verbal agreement to this effect had been made with the operator but the operator disagreed. Trials conducted after the collision indicated that, had there been a guide person stationed to the rear of the aircraft on the right side, they may have been out of the line of sight of the other two members of the pushback team and unable to communicate visually with them.

It is possible that the tug driver and headset operator were suffering some effects of tiredness due to their recent transition from a late to an early shift pattern.

After the collision

The crews of both aircraft realised almost immediately that there had been a collision and the ground vehicle, Ranger 2, made a prompt radio declaration of an AGI. The airport's RFFS reacted in an appropriate and timely manner to reach the scene of the collision. A period of seven minutes then elapsed until the 'incident' was upgraded to 'accident' status.

In EI-ENL, the inbound aircraft, the commander did not seek information from the cabin crew about damage caused in the collision. He considered there was no need for an immediate evacuation and his priority was to reassure the passengers and ensure they remained seated. There was no QRH drill covering the situation and the pilots did not engage in a sustained dialogue to analyse the situation and assess their options; they did not make best use of the mnemonic P.I.O.S.E.E. to assist them in their thought processes. In reviewing the accident, the commander and co-pilot both commented that they were startled by the collision, as there had not been any build-up to the accident that might have prepared them for coping with its aftermath. This also appears to have led the crew to delay shutting down the left engine until they had started the APU, not appreciating at that stage that the idling left engine could be a hazard to personnel attending the incident.

In EI-DLJ, the aircraft that pushed back, the commander was aware there was spilled fluid at the rear of the aircraft but, with no sign of fire, an evacuation was not needed. However, when the forward door emergency evacuation slides were disarmed to allow deployment of the integral airstairs, the slides on the rear doors remained armed for around 45 minutes, until passengers disembarked.

Safety actions

As a result of this accident, a number of organisations have taken safety actions:

The operator

The operator decided to introduce a "Cabin Crew Standby" call, to be used when flight crew become aware of something of concern on the ground that is not immediately life-threatening. The use of this call will alert the cabin crew to the fact that the flight crew are dealing with an unusual situation and that an evacuation may become necessary.

Pilot training for ground incidents has been enhanced and an event of this nature was included in the Winter 2014-15 recurrent simulator training scenario.

The OM has been changed to indicate that hand signals, for pushback, are only to be used if the headset breaks immediately prior to pushback or when thunderstorms or lightning are forecast.

The OM now refers to the ground personnel involved in a pushback manoeuvre as the Headset Operator, the Tug Driver and the Guide Person. The operator is committed to pass this information to the ground handling companies which it employs.

Air Traffic Control

NATS (National Air Traffic Services) Stansted conducted a unit investigation and the controller involved received further training before returning to normal duties.

The report produced by NATS Stansted recommended that development of EFPS should be explored, to find out if it could highlight when more than one aircraft has been given an instruction to use the same cul-de-sac taxi line. This idea has since been incorporated into a nationwide project to evaluate surface management tools at UK airports. NATS is reviewing available technology, and methods for monitoring and checking the instructions given by Ground controllers, with the aim of quickly resolving any errors that are made. The project encompasses the control of aircraft pushbacks and the extra difficulties that exist when there is no headset communication between the flight crew and the ground team. Consideration is being given to the concept of having "Standard Pushback" procedures for each stand and to the idea of passing radio instructions for pushback directly to the tug driver. The project aims to identify an enhanced surface management tool which will provide conflict resolution and for this to be trialled at a major UK airport.

NATS Stansted has now mandated that the Delivery position be opened at 0530 hrs at weekends as well as on weekdays, subject to periodic review and a proviso regarding traffic levels.

A range of local initiatives have been put in place to highlight the lessons from this accident to controllers and to try to ensure that ATC and the ground handling companies have a common understanding of how pushback manoeuvres should take place.

The regulator (Civil Aviation Authority)

The Ground Handling Operational Safety Team (GHOST) is a multi-disciplined CAA and industry group that is set up to address and share lessons that arise from ground handling issues. At a meeting in October 2014, the team acknowledged the need for better standardisation of pushback procedures and terminology and for tug drivers to receive thorough RTF training and to be made aware of the callsign of the aircraft that they are to push back.

The Ground Handling Company

Following the accident the ground handling company changed its procedures to ensure that a guide person is employed for all pushbacks at London Stansted Airport. The guide person is to be on the opposite side of the aircraft from the headset operator, who is to remain in view of the tug driver.

The company issued an '*Airside Notice*' which emphasised the requirement for headsets to be used at all times (unless lightning is forecast). However, the shift manager may provide specific approval for a single pushback operation to take place following failure of a headset.

The same '*Airside Notice*' stated that the tug driver should be in the tug and listen to the radio from five minutes before the expected pushback time. Since the notice was issued, the company has concluded that this practice may be difficult to implement at all times and it is under review.

The company intends to ensure that pushback team members are trained on the actions to take in the event of a ground collision.