ACCIDENT

Aircraft Type and Registration:	Airbus A320-214, G-EZTV
No & Type of Engines:	2 CFM CFM56-5B4/3 turbofan engines
Year of Manufacture:	2010 (Serial no: 4234)
Date & Time (UTC):	3 March 2017 at 1825 hrs
Location:	Stand 1, Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 172
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to forward lower fuselage and nose landing gear assembly
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	7,729 hours (of which 7,510 were on type) Last 90 days - 194 hours Last 28 days - 74 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and reports from: the ground handling company, the airfield operator, the aircraft operator and the manufacturer

Synopsis

During pushback the shear pins[1] on the towbar fractured. The ground crew heard a noise and checked the towbar, but did not discover the broken shear pins, so the pushback continued and the left engine was started.

As the aircraft was subsequently pulled forward, it gained momentum and began to deviate to the right of the direction in which the tug was moving. The tug driver assumed the towbar had separated and tried to move away but a retaining pin, that was subsequently found intact, had prevented tow bar separation, and the aircraft was pulled towards the tug. Before the aircraft could be halted by the pilot the tug collided with the lower left fuselage. The engines were shut down and the passengers disembarked from the rear of the aircraft without injury.

Investigations by the ground handling company, the airport operator and the aircraft operator highlighted maintenance and training issues and a range of safety actions have been taken.

Footnote

[1] Shear pins act as weak links to prevent damage to the aircraft or the ground equipment if a pre-determined force is exceeded.

Description of the accident

During the pushback from Stand 1 at Manchester Airport, in dark and wet conditions, the flight deck crew felt a fore and aft jolt and heard a mechanical "clunk". The commander informed the headset operator who conferred with the tug driver, and then visually checked the towbar and its attachment to the tug and to the aircraft. The ground crew saw nothing abnormal and they assumed the clunk was due to the tow hitch shifting[2], which is a familiar occurrence. The headset operator informed the commander that all was well, and the pushback continued. In response to a request from the commander, the headset operator indicated the left engine could be started, although the aircraft had not reached the designated engine start positon for that stand.

As the aircraft was halted, in preparation for being pulled forward to the release point, the headset operator approved a request from the flight deck crew to start the right engine. The commander was conscious of the aircraft beginning to move gently forward, while he was concentrating on starting the right engine. Both the tug and the headset operator were concealed from his field of view and he was not surprised when the aircraft's nose turned first to the right and then to the left, as if it was being lined-up on the taxiway centreline. He then heard an urgent instruction from the headset operator for the brakes to be applied, so he responded by pressing on the toe brakes before setting the park brake. The headset operator then informed him that the tug and aircraft had collided, but that nobody was injured. Both engines were then shut down.

Ground crew from adjacent stands came to assist and found the towbar was still connected to both the tug and to the aircraft. The nose gear leg was rotated approximately 90º to the left and the tow bar was bent around the front corner of the tug (Figure 1). The shear pins on the towbar had fractured (Figure 2), and pieces were later found within the boundary of the stand, but the central retaining pin remained intact. The passengers and crew disembarked without injury from the rear right exit door.

Figure 1

Position of the tug and the towbar after the accident

Footnote

[2] The tow hitch is the connection interface between the tug and the towbar.

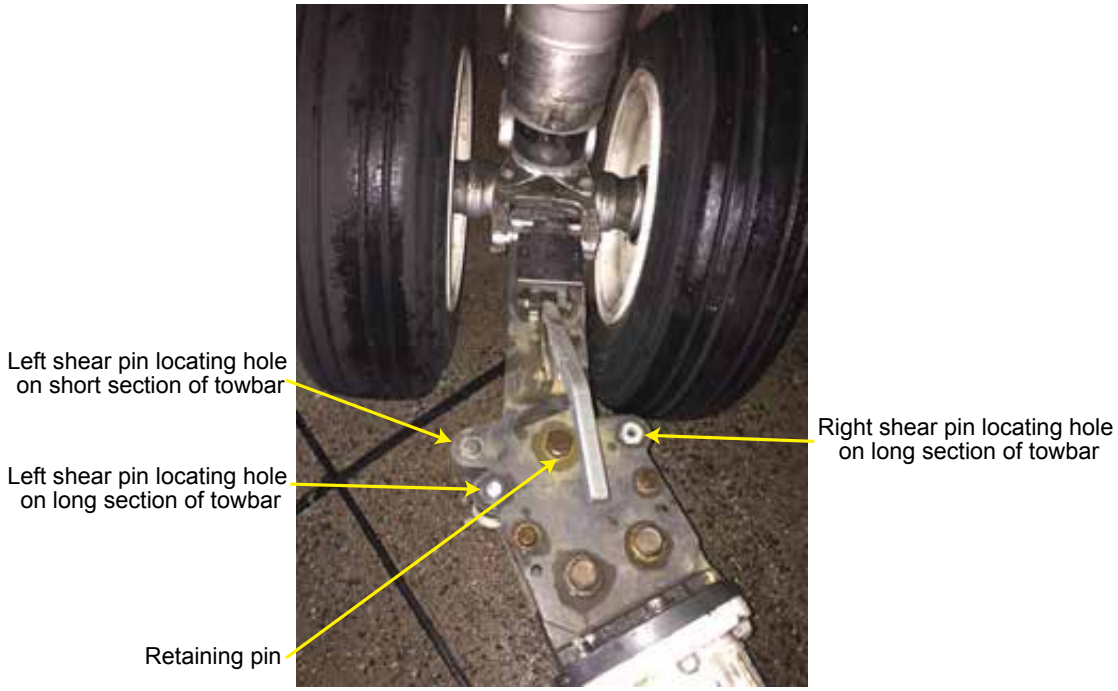

Figure 2

Image showing head of retaining pin and locating holes for failed shear pins

Ground handling investigation

The ground handling company, the airport operator and the aircraft operator investigated the accident and produced their own internal reports.

Examination of a number of towbars and their servicing records identified that past failures of a single shear pin had been resolved by replacement of that pin only, whereas they both need to be replaced because the unbroken pin may have been subjected to extra stress. One of the pins on this towbar had failed 16 days before the accident and only that pin had been replaced. It was also established that other maintenance procedures for the shear pins had not been followed. They had not been lubricated correctly and the training given to ground crews did not prepare them for conducting adequate serviceability checks on the pins. Additionally, the retaining pin (fitted between the two shear pins) was found to have been over-tightened and this might, over time, have contributed to the failure of the shear pins. The towbar comprised two sections, a short, forward section that connects to the aircraft and a longer section that connects to the tug. The shear pins and the retaining pin join the two sections through locating holes. The retaining pin that was fitted was intact and was found not to have the correct part number. However the loads in this event were probably not sufficiently high to cause a correctly fitted retaining pin with the correct part number to fail.

When the pull forward manoeuvre commenced, the two sections of the towbar pivoted around the retaining pin, allowing the aircraft to turn right, possibly influenced by thrust from the idling left engine and a slight downslope. This was not noticed initially by the headset operator who was looking forwards in the intended direction of movement. When

the tug driver realised the aircraft was deviating from the intended path, he assumed the towbar sections had separated close to the aircraft's nosewheel, as designed, and tried to reverse the tug away. Because the towbar had not separated, the nose of the aircraft was pulled left, towards the tug. Although the headset operator had realised by this time that the aircraft was deviating from its intended route, he was unable to get the pilots to stop the aircraft before the collision occurred.

Many of the stands at Manchester have specific pushback procedures, but because of the number of variations they are not listed in the Aeronautical Information Publication. Hence flight crew rely on the ground crews' knowledge of stand-specific pushback and engine start procedures. These are documented on laminated sheets placed in each tug, but they were not referred to before this pushback. The headset operator believed it was permissible for the engines to be started when the aircraft was clear of Stand 1 but the tug should have been pulled forward to the release point before the engines were started.

Tug conspicuity

The commander noted that some ground handling services equip their tugs with flags on an extended aerial to increase their conspicuity to pilots. In this instance, flags might have alerted the crew that the tug had become misaligned with the aircraft and, possibly, given the crew additional time to react to the event before the collision occurred.

Aircraft manufacturer's comments

The aircraft manufacturer studied the accident and noted that the towbar used was not fitted with a damping system as recommended in the '*Aircraft Characteristics Manual*'[3]. This damping device is aimed at reducing the impulse loads generated at the connection interface between the towbar and the tug. Such a damping device is also requested by the latest industry standards for towbar design (eg SAE ARP1915E and ISO 9667).

Tables are provided in the *Aircraft Characteristics Manual* to enable operators to calculate the minimum weight of tug required to move an aircraft, depending on the aircraft's weight and local conditions. In this instance the aircraft manufacturer calculated that an 8 tonne tug would have been adequate, but the tug used was approximately three times heavier than this and consequently it was capable of loading the towbar above the minimum required load. The aircraft manufacturer stated that when the tug used is heavier than the minimum required, larger forces will be transmitted to the shear pins and this can increase the possibility of the pins breaking.

The manufacturer also warns that extra caution should be exercised when using tugs that are a lot heavier than the required minimum, in order to prevent damage to the aircraft or the towbar, particularly when the tug is pushing an aircraft rather than pulling it. If a shear pin fails when the tug is pushing, there is an increased likelihood of it colliding with the aircraft.

Footnote

[3] Ref Section 5-8-0, '*Ground Towing Requirements: A conventional type towbar is required which should be equipped with a damping system (to protect the nose gear against jerks) and with towing shear pins.*'

The aircraft manufacturer has recently published an amendment to the Aircraft Characteristics Manual for the Airbus 320 and this states '*Use a tractor with a limited drawbar pull to prevent loads above the tow-bar shear-pin capacity*'.

Safety actions

There have been several safety actions made by three organisations as a result of this accident. These are outlined below.

The ground handling company has instigated several changes to its procedures and to personnel training, including:

- Improvements to towbar maintenance and inspection procedures.
- A training aid has been developed to help ground crew recognise when shear pins are unserviceable.
- A standard fault-finding procedure has been introduced for ground crews when they hear an unusual sound or suspect a shear pin has broken while pushing or pulling an aircraft.
- Improvements have been made to ground crew training to ensure that correct procedures for aircraft engine start are followed for each stand at Manchester.

The airfield operator has issued safety alerts to airfield users regarding inspections and maintenance of pushback equipment and also regarding stand-specific pushback procedures.

The aircraft operator has reviewed its pushback procedures in response to the aircraft manufacturer's comments.