

ACCIDENT

Aircraft Type and Registration:	Jetstream 4100, G-MAJJ
No & Type of Engines:	2 Garrett Airesearch TPE331-14GR-807H turboprop engines
Year of Manufacture:	1993 (Serial no: 41024)
Date & Time (UTC):	28 May 2012 at 1456 hrs
Location:	Brussels National Airport, Belgium
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Rear pressure bulkhead of nose landing gear bay, lower fuselage skin and keel plate aft of nose landing gear bay
Commander's Licence:	Air Transport Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	5,638 hours (of which 1,700 were on type) Last 90 days - 70 hours Last 28 days - 15 hours
Information Source:	AAIB Field Investigation

Synopsis

During pushback, the aircraft came to an abrupt halt and the shear pin on the towbar broke. Subsequently damage to the keel area of the aircraft and to the pressure bulkhead at the rear of the nose landing gear bay was discovered. The aircraft had operated for eight sectors since the pushback.

History of the flights

At approximately 1455 hrs on 28 May 2012 G-MAJJ was pushed back from Stand 209 on Apron 2 South at Brussels National Airport. The pushback proceeded normally until the aircraft came to an abrupt halt and the shear pin on the towbar broke. The captain asked

the ground agent to look to see if there were any signs of damage and, when the agent said that he could see none, the captain decided to continue with the flight.

The aircraft flew uneventfully to Southampton Airport and later operated to Aberdeen Airport, its last sector of the day. During the climb out of Southampton Airport, the crew experienced a "low, steady thumping" below the cockpit after the landing gear was raised, which continued until the aircraft climbed through approximately FL70. After landing at Aberdeen Airport, the captain reported to the engineer "a clunking sound from the nosewheel after take off." The engineer

recorded this defect in the aircraft's Technical Log and on investigation found the nosewheel misaligned, which he corrected in accordance with the maintenance manual¹. A 5-Day Service Check was completed during the evening of 28 May 2012.

On 29 May 2012, G-MAJJ operated five sectors. On the second and third sectors, the crew noticed a "clunk" in the climb between FL50 and FL100 that sounded like "metal stretching" beneath their feet or "crushing a beer can". On the fourth sector of the day, a new crew felt a clunk through their feet as the aircraft climbed between FL50 and FL60 although they did not hear anything. On landing at Aberdeen Airport, the captain carried out a visual inspection to look for obvious signs of damage but saw none. On the return leg to Southampton Airport, the crew heard a clunking sound as the nose landing gear lowered. The captain reported this to Line Maintenance Control (LMC) after landing. No defects were reported in the Technical Log following any of the flights on 29 May 2012.

The aircraft's next flight was from Southampton Airport to Aberdeen Airport on 30 May 2012. At approximately 5,000 feet during the climb, a clunking noise was heard by the crew. As with all the preceding sectors flown since the pushback at Brussels, there were no other indications or handling difficulties and the aircraft continued and landed normally at Aberdeen. After landing it was discovered that the aircraft had suffered damage to its forward keel and to the pressure bulkhead at the rear of the nose landing gear bay.

Information from witnesses

Pilot of the aircraft during the pushback

The captain of the aircraft during the pushback at Brussels reported that he and his co-pilot were running through the after-start checks during the pushback. The pushback was normal until the aircraft came to a halt "almost as if we had pushed back onto chocks." He spoke to the ground agent on the headset and asked him to look for any signs of damage but the ground agent said he could not see any. The pilot decided to continue with the flight because the event did not feel serious at the time. He reported that there were no steering problems during the taxi out to the runway and no other symptoms during the flight to Southampton Airport. He believed that neither he nor his co-pilot had applied the brakes. A video of the event, obtained from a CCTV camera at the airport, showed no evidence of an external cause for the abrupt stop.

The driver of the tug

The driver of the tug was a qualified pushback operator but was working on this type of aircraft for the first time. He did not notice any defects with the towbar while coupling it to the aircraft nose gear. He stated that he kept the aircraft in a substantially straight line, with only minor corrections, while pushing it backwards at slow speed. After about 100 m, he saw the nosewheel of the aircraft lift up and almost immediately drop back downwards with the nose towards the right. The shear pin on the towbar head had broken leaving the towbar head to pivot freely horizontally. The nosewheel was turned completely to one side as were the towbar and the towbar head. There were no obstacles in the path of the aircraft and the driver had no idea why it had come to such an abrupt halt.

Footnote

¹ The nosewheels rotate together with the axle and any misalignment of the wheels can cause a strong vibration when the wheels lift off the ground during takeoff.

The ground agent on the headset

During the pushback, the ground agent was in contact with the pilot through his headset. One engine was started with the aircraft on the stand and the other was started during the pushback. He reported that he was watching the engine start when suddenly the nose of the aircraft moved to his right, the nosewheel turned and the towbar was no longer aligned with the aircraft. The shear pin on the towbar had broken and the towbar head had pivoted.

The ground agent told the pilot what had happened and had a look at the nose gear himself but did not notice any damage. The pilot decided that it would not be necessary to return to stand for further investigation.

Pushback equipment

The pushback tractor was a SchopfMaschinenbau GmbH F100 Tug, which has an empty weight of 14,000 kg. The towbar was of a type approved for this aircraft and was fitted with the appropriate connecting head. The towbar incorporated a shear pin to protect the aircraft from excessive loads. The shear pin is designed to transmit normal loads but will break if a pre-determined load value is exceeded (Figure 1). If the shear pin breaks due to an excessive load in line with the towbar, the load will initially be removed but it will be reapplied as soon as the pivot bolt reaches the end of its slot in the towbar head.

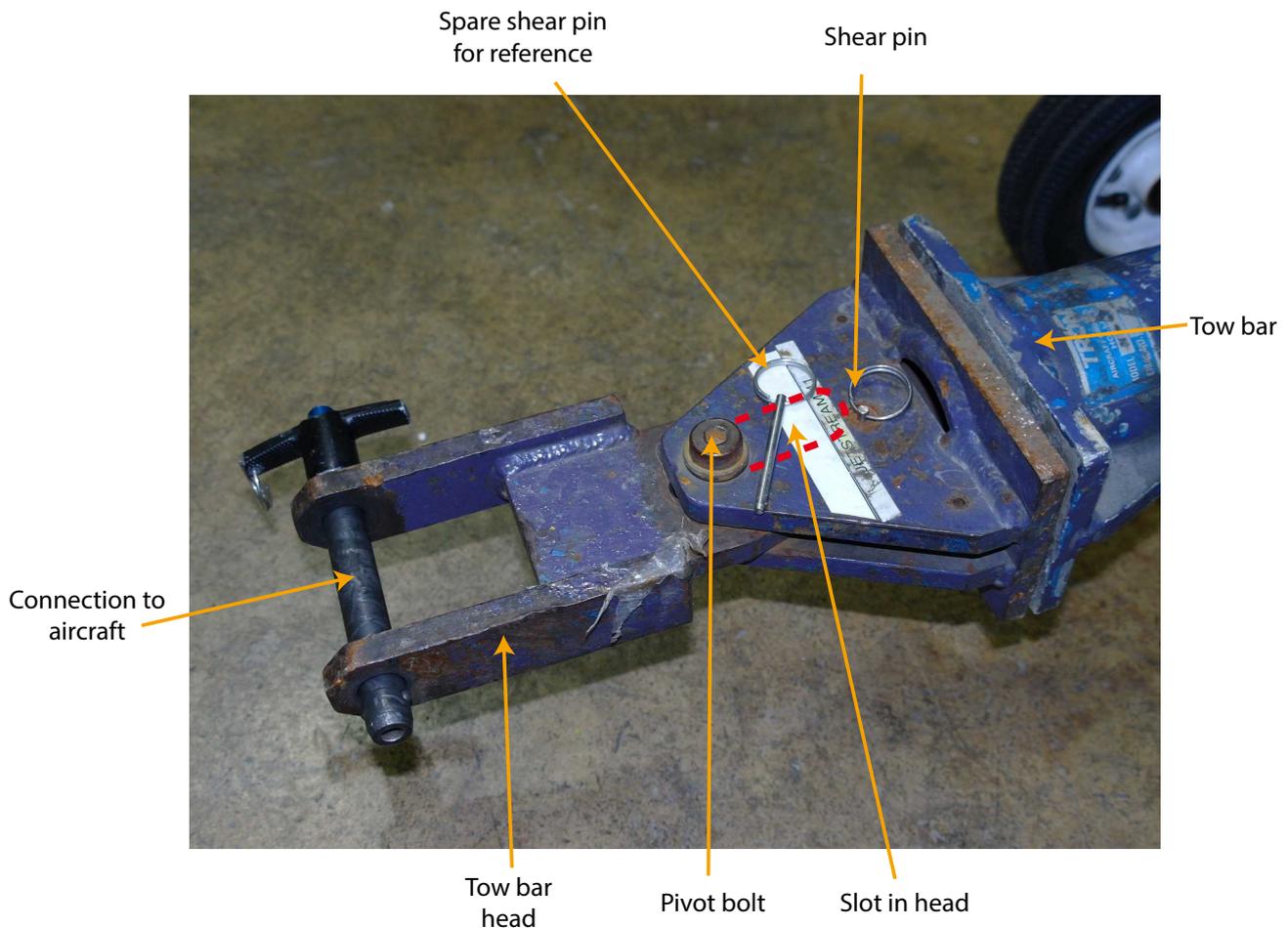


Figure 1

Detail of towbar head, shear pin and head attachment to towbar

The aircraft manufacturer's Aircraft Maintenance Manual (AMM), Towing and Taxiing, 09-10-00 page 209 states: *'The tractor used should weigh between 5000 lb and 10000 lb'* (approximately 2,300 kg and 4,500 kg). The ground handling agent did not have access to the AMM but followed the instructions laid down in the operator's Ground Operations Manual (GOM) and Ground Handling Instructions which, at the time of this event, did not refer to the type of tractor to be used.

Pushback procedures

The operator's GOM contains pushback procedures for ground handlers. It states:

'If a shear pin breaks on pushback and the towbar remains attached, the tug should be slowed and stopped, and the flight deck informed.'

Damage

When the damage was found, the aircraft was removed from service and moved to a hangar for a full inspection and evaluation. The aircraft was jacked and the nose gear and some of the cockpit equipment removed to allow access. The rear pressure bulkhead of the nose gear bay, the lower fuselage skin and keel plate immediately behind the nose gear bay and its supporting frames were found to be damaged (Figure 2).

Inspection schedule

Prior to each flight the commander is responsible for ensuring that a walk-around inspection is carried out, the requirements for which are detailed in the Operations Manual Part B1-BA41-2, 2.3 External Checks. Inspection requirements in the area of the nose gear and front fuselage are to check that the skin and antennas are undamaged.

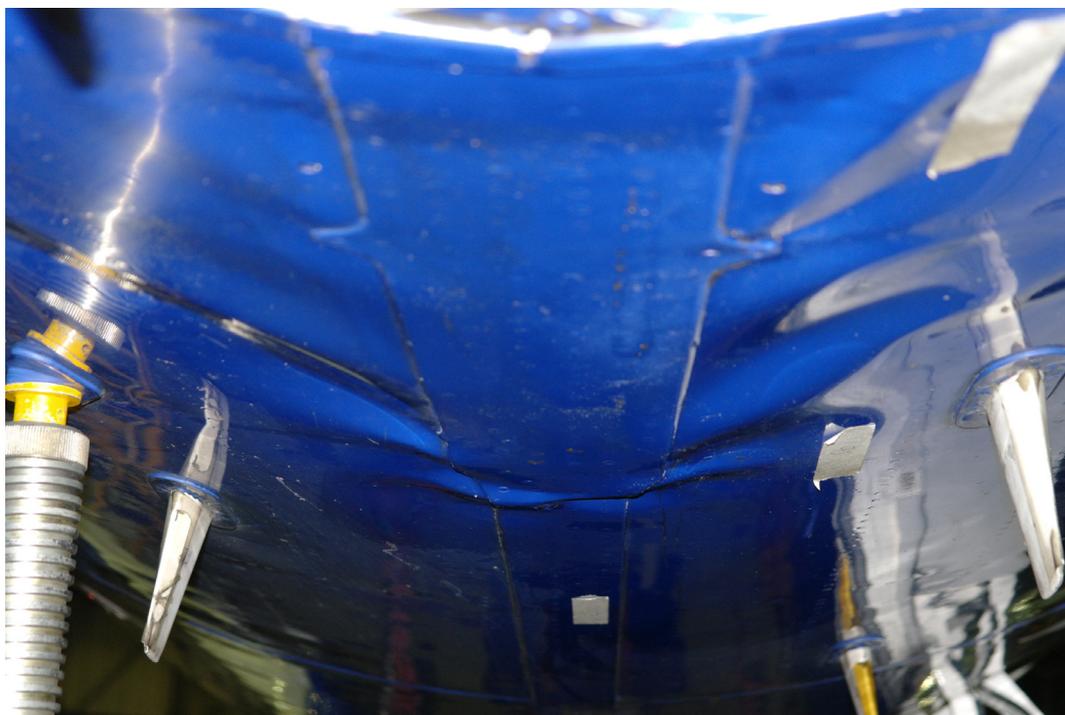


Figure 2

View, looking aft following removal of the nose leg, of damage to lower fuselage skin and keel plate aft of nose gear bay

Every five calendar days a 5-Day Service Check is completed by maintenance engineers in accordance with the aircraft maintenance programme, reference EA-41-01. This check includes a general visual inspection of all external fuselage areas including antennas.

Defect reporting

The operator has procedures contained in the Operations manual that require defects to be entered into the Technical Log.

Flight recorders

The aircraft was equipped with a 30-minute CVR and a Flight Data Recorder (FDR), which contained data from 44 flights. Because the aircraft flew eight sectors after the pushback event before any damage was discovered, the CVR record of the event itself was overwritten. The FDR did not record the position of the brake pedals or hydraulic brake pressure.

All the flights recorded on the FDR were analysed for evidence of the forward fuselage having been damaged during a heavy landing on the nose gear, or as a result of a rapid de-rotation of the nose gear onto the runway during a landing. No such evidence was found. During one landing on the 29 May 2012 at Brussels Airport, the normal acceleration at touchdown was 0.06g above the aircraft manufacturer's hard landing limit of 1.5g. However, the vertical descent rate at touchdown was below the landing gear load limit of 10 ft/sec and the aircraft had not touched down on the nose gear first.

Because the towbar shear pin had broken during pushback at Brussels Airport on the 28 May 2012, the relevant FDR data was analysed. The FDR started to record when the number one engine was started while the aircraft was stationary on the stand. About 40 seconds

later, the pushback began (refer to Figure 3 - Point A), followed several seconds later by the number two engine being started. During the initial 43 seconds of the pushback, the aircraft heading remained constant at 334° before turning slightly onto a heading of 330°. Over the following 19 seconds, the aircraft heading remained constant to within 1°, after which the aircraft was turned onto a heading of 338° over a period of 34 seconds (refer to Figure 3 - Point B). Three seconds later, the aircraft came to a stop with its nose briefly pitching up by just less than 2°, but sufficient to cause the weight-on-wheels switch to change state briefly (refer to Figure 3 - Point C). During this short period, aircraft heading changed by 3° to a heading of 335°.

Safety action taken by the operator

Shortly after this incident, the operator issued a Flight Crew Instruction (FCI) to try and reduce the likelihood of a similar event happening again. The FCI stated that crews were not to action the after-start checklist until the pushback was complete and the ground agent was clear of the aircraft. In the event of a shear pin breaking, inadvertent application of the brakes, or an unexplained jolt during the pushback, the FCI instructed crews to return to the stand so that the aircraft can be inspected.

The operator decided that this incident highlighted a need to improve its defect reporting systems. Subsequently a number of initiatives were introduced for pilots, engineers and staff within LMC to ensure that the passage of information improved with regard to technical issues on the aircraft:

An FCI was issued to remind crews of the requirement to record defects in the Technical Log.

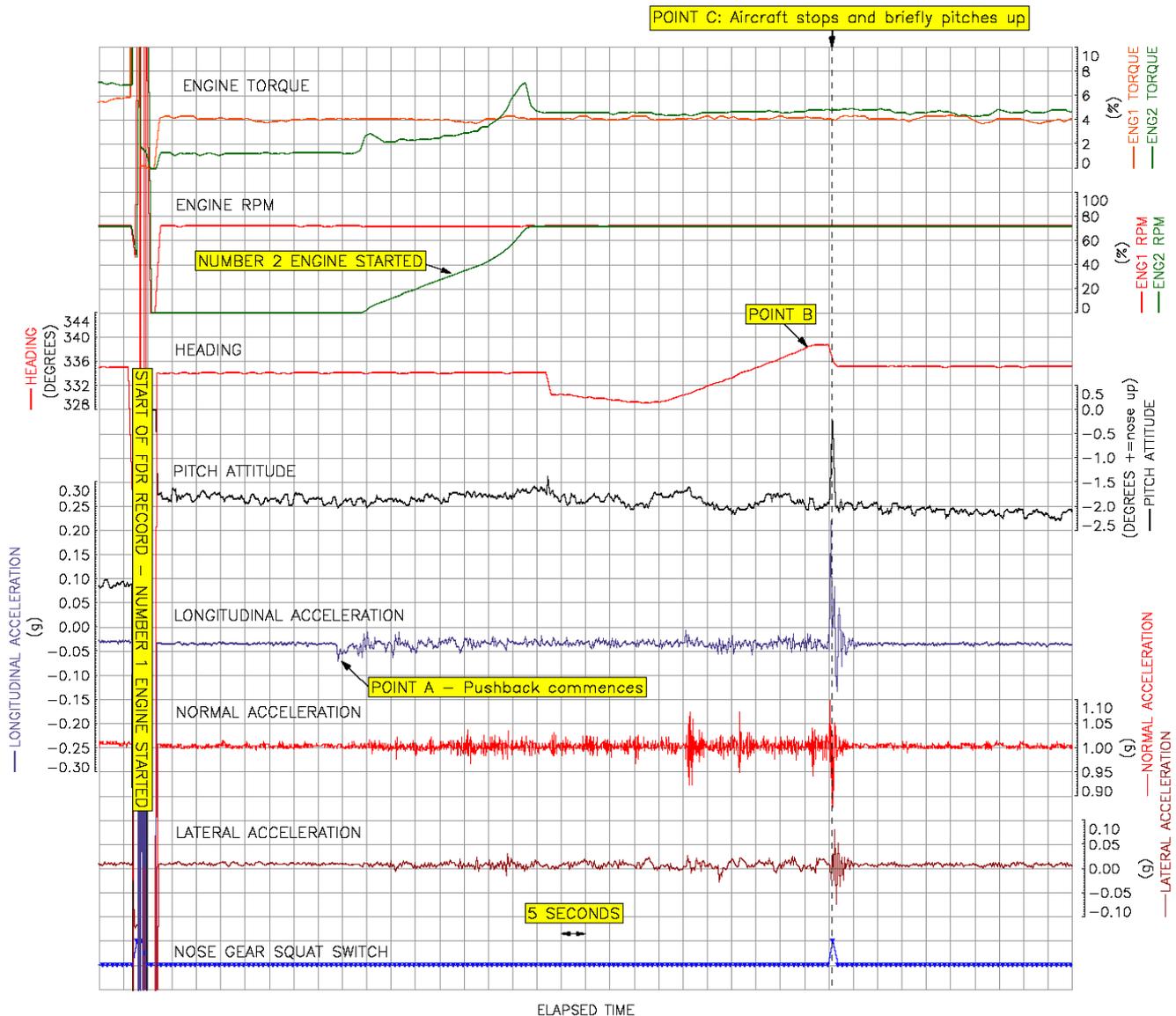


Figure 3

Pushback at Brussels Airport 28 May 2012

The operator discussed this event with its certifying staff during a regular ‘tool-box talk’ and reminded them of the need to be vigilant during service checks. In addition, the completion and certification of service checks was discussed at a Station Engineers meeting and all the attendees inspected the damaged aircraft. A notice to all certifying staff reminding them of their responsibilities was issued and displayed on notice boards.

The operator initiated a review of the entire Technical Log process but, following the review, decided that no changes were necessary.

A Ground Handling Instruction was issued to all Ground Handling Agents associated with this airline’s operation to ensure that suitable towing vehicles are used.

Analysis

It is highly likely that damage occurred during the pushback in Brussels on 28 May 2012. Witness evidence, recorded flight data and a video recording from a camera at the airport showed that the aircraft experienced a significant jolt that caused the towbar shear pin to fail. Further damage may have occurred as a consequence of operation with a weakened structure during subsequent flights.

The tug used for the pushback weighed 14,000 kg, which was much heavier than the 4,500 kg recommended in the AMM, and this would have given it much more momentum than a lighter tug when the towbar pin sheared. Consequently, the tug was capable of applying a large longitudinal force to the aircraft as the pivot bolt reached the end of its slot. The investigation did not determine whether or not the use of a lighter tug would have caused similar damage.

The aircraft was subject to a number of routine inspections by both flight crew and maintenance staff between the pushback incident and the time at which damage was identified. Damage was not discovered during these inspections even though the relevant check lists required the damaged skin area to be inspected. There were a number of factors that made identification more difficult. The damaged area was located at the bottom of the fuselage, which is approximately waist high above the ground. It is not visible from a standing position and to inspect the area effectively a person would have to crouch down and look up. The lower

fuselage is painted blue and in poor lighting conditions, such as a floodlit ramp at night (similar to when the service check was completed), identification of damage would be difficult, even when using a torch.

The FCI was issued by the airline to prevent an aircraft being flown following a similar pushback incident. However, the wider issue was that the resulting damage was not identified, and no action was taken, despite symptoms being experienced by a number of crews. The symptoms were entered into the Technical Log after the last flight on 28 May 2012. An engineer identified a fault with the nose landing gear that could give similar symptoms and this was rectified but damage to the pressure bulkhead and forward keel was not identified. Similar symptoms were experienced during four flights on 29 May 12 but no entries were made in the Technical Log. LMC was informed but this did not result in an inspection of the aircraft.

The Technical Log is the formal document relating to the airworthiness of the aircraft and there are procedures for clearing entries or deferring them in accordance with the Minimum Equipment List (MEL). Reporting problems in the Technical Log, perhaps after consultation with an engineer, facilitates good decision-making in relation to faults. Actions are being taken by the airline to improve the Technical Log and its use by pilots, engineers and staff within LMC. This is to ensure that problems identified by crews or line engineers will be reported promptly so that appropriate corrective action can be taken.