

AAIU Synoptic Report No.2002-015
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Aircraft Type and Registration	Jetstream 41 G-MAJA
No. and Type of Engines	Two, type TPE 331-14HR/GR
Aircraft Serial No.	41032
Year of Manufacture	1994
Date and Time(UTC)	26 July 2002, 07.50 hrs
Location:	Dublin Airport, Stand 12
Type of Flight	Public Transport
Persons on Board	23
Injuries	Nil
Nature of Damage	Nose gear damaged by towbar
Commanders Licence	UK ATPL
Information Source	Aer Rianta Duty Office

SYNOPSIS.

This incident, involving the above aircraft and a push-back tug, was notified to the Chief Inspector of Accidents, Air Accident Investigation Unit (AAIU) by the Aer Rianta Apron Manager at Dublin Airport at 10.30 hours on the morning of the incident.

The aircraft was being pushed back from Stand 12 at Dublin Airport and the towbar and tug were about to be disconnected from the aircraft. The ground engineer removed the towing pin connecting the tug to the towbar but it was let slip back in again just as the tug moved. The aircraft parking brake was on at the time and as a consequence the nose undercarriage was damaged. Fittings on the lower aircraft skin, adjacent to the undercarriage, were also damaged.

1. FACTUAL INFORMATION

1.1 History of the Flight.

The aircraft had arrived from Newcastle on to Stand 12 at Dublin Airport and was being pushed back from the stand for the return flight. The ground crew, who were members of a contracted aircraft maintenance organisation consisted of an engineer with a headset in contact with the Captain, a tug driver and a driving instructor.

They had completed the push-back and were in the process of disconnecting the towbar from the tug. The Captain had set the aircraft's parking brake "On". As the towing pin between the tug lugs and the towbar was being removed it partly slipped back in again at the same time as the tug went into reverse.

The nose undercarriage strut was pulled forward breaking the forked mounting which holds the down lock roller. The down-lock roller was found between the forward pressure bulkhead and the damaged undercarriage door clip fixture.

1.1.1 Captains Comments

The Captain said that he was advised by the ground engineer that the push was complete and to set the "brakes to park". He applied the park brake and the FO replied "brakes set to park, pressure good". After three or four seconds the Captain said he felt a jolt and at that instant the stick shaker device came on together with the stall warning and unsafe landing gear warning. The Captain said that the passengers could also feel the jolt as the tug was being disconnected. There were no reported injuries and the Captain shut down the engines and ordered the evacuation of the aircraft using normal exits. The Captain said that, on this occasion, he was fortunate to have had an engineer who wore a headset.

1.1.2 Instructors Comments

The mechanic who was driving the tug had just successfully completed five days of training on tug driving and was being observed by the training instructor. The instructor has a policy of monitoring recently trained drivers to observe their level of competence. He was totally satisfied with the driver and felt that his actions did not contribute to the incident.

The driving instructor said that on completion of the pushback he got out of the tug cab to assist the engineer in removing the towing pin. He said that as the engineer was removing the pin it slipped back in again as the tug was starting to move.

1.1.3 Engineers Comments

The engineer said that having confirmed that the aircraft's parking brake was on and the "pressure good" he went to disconnect the tug from the towbar. On removal of the towing pin it immediately slipped back in again at the same time as the tug was starting to move.

1.1.4 Drivers Comments

The engines had started up on ground power. The driver said that they had reached the end of pushback and the aircraft was stopped with parking brake on. The tug, which has an automatic drive, also had its hand brake on, in addition to the foot-brake. He said that the engineer approached the towing pin in order to withdraw it from the tug and decouple the towbar. He said that he put the tug into 1st gear and gradually released pressure on the foot brake in order to slowly move the tug so that the pin could be removed. The driving instructor got out of the vehicle in order to help the engineer. The driver said that he saw the complete pin through the windscreen. However, as he engaged “reverse” on the tug the pin slipped back in again. He said that the towing pin was not all the way through the forward tug lugs at the instant the tug was being reversed but that it had engaged the towbar.

He said that on this occasion the engineer had a headset. This did not always occur.

1.1.5 Aircraft Pushback Procedure

An extract from the aircraft pushback procedure as published in the Line Maintenance Manual states:

4. Remove tow bar.

4.1 Centralise the nose wheels in the last ten feet of the push

4.2 Instruct Captain to “Set Parking Brake” when aircraft has stopped and tug driver has signalled push is complete.

4.3 Disconnect tow bar when the Captain has acknowledged that the “Brakes are Set”

4.4 Remove steering pin when tow bar is clear of nose wheel..

Note: A steering pin is not applicable to this aircraft.

1.2 Damage To Aircraft

The nose undercarriage strut was pulled forward by the action of the tug. This force was such as to separate the down-lock roller from its forked mounting, fracturing the fork lugs. Under pressure from the down lock ram, the steel housing moved rearwards towards the forward pressure bulkhead. As the tug was stopped, the fractured lugs and the leg moved rearwards and embedded the dislocated roller between the front pressure bulkhead and the lower aircraft skin. The down-lock roller was found held by the forward pressure bulkhead and the damaged undercarriage door clip fixture. (See Appendix A).

1.3 Aircraft Information

1.3.1 Aircraft Details

Maximum authorised take-off weight	10835 kg
Actual Take off weight	10450 kg
Estimated weight at time of incident	10450 kg
Centre of Gravity limits (at incident weight)	11% to 30% MAC
Centre of gravity at time of incident	24% MAC

1.3.2 Tugs, Towbars and Attachments

The towbar recommended by the towbar manufacturer for this aircraft is Towbar, Multihead (2.125 in./5.4 cm eyebolt) Part No. 01-1201-0010 with Attachment Head Part No. 01-0575-0011. The towbar design does not allow the head to separate from the towbar in the event of an overload. In such event, a shearpin will shear and the head will move 0.44 inches in an elongated slot before it contacts a design stop. When the designed stop is contacted, the towbar will operate without the shear facility and damage may result if tug movement is not stopped immediately.

The towbar has 10 inch diameter wheels adjustable for towing with castors. The maximum capacity is 75,000 lbs. MTOW. It has a large vertical handle at the eye bolt end for ease of lifting and removal of the towbar from the towing vehicle. This towbar is recommended for a multiplicity of aircraft including the following:

<u>AIRCRAFT TYPE.</u>	<u>MAX. TAKE-OFF WEIGHT</u>
Jetstream 41	23,891 lbs.
ATR 42	41,005 lbs.
ATR 72	47,400 lbs.
Dash 8-400	63,250 lbs.
Gulfstream GIV	74,600 lbs.

The towbar houses within itself a spring “*shock absorber which protects the nose gear during towing operations*”.

The recommended attachment head for use with this towbar on the Jetstream 41 is 11 inches in length and has a “dual shear” capability (See Appendix A) The manufacturer states that dual shear attachment heads are made to break a shearpin, should maximum turning radius or straight overload limits be exceeded - without the head separating from the towbar. When the shearpin breaks there is relative movement between the head and the towbar of 0.44 inches before the shock absorber is again engaged.

The Aircraft Illustrated Tool and Equipment Manual details the following towbars for use with the Jetstream 41:

Heavy Duty Version	Part No. 01-1201-0000
Standard Version	Part No. 01-1202-0000

Either of these may be used with the above Attachment Head Part No. 01-0575-0011. The towbar version in use at the time of the incident was Part No: 01-1201-0000. (indicating heavy duty)

The towbar manufacturer indicates that Part No.01-1201-0010 is an improved version of towbar Part No.01-1201-0000 having a new shock absorber (capacity 75,000 lbs) and a longer lifting handle. The reason why the 01-1201-0010 is recommended is that this “Multi-Head Towbar” may be used by fixed base operators (FBO’s) for different and larger aircraft by just changing the attachment head. They also indicate, however, that towbar Part No.01-1202-0000 is sufficient for the Jetstream 41.

The towbar in use had an eyebolt of 2.1335 inches internal diameter. The three top lugs on the tug had an internal diameter of 2.020 inches and the towing pin used had an external diameter of 2.001 inches. This leaves a clearance of 20 thousandths of an inch in diameter between the pin and the lugs and a clearance of just over one tenth of an inch in diameter between the pin and the eyebolt.

The tug in use at the time is capable of pushing a wide range of aircraft. It has a weight of 25 Tons and an engine of 160 HP at 2800 RPM.

Some attachment head towing brackets in use separate from the head in the event that the shearpin is overloaded. The Boeing 737-3/4/500 has a towbar where the head bracket separates. The A320/321 has a towbar where the bracket does not separate and either a Type 1 or Type 2 can be used with the A330, the latter having a bracket that separates.

1.4 Meteorological Information

1.4.1 Conditions were dry at the time and the Captain reported the following weather conditions:

Wind Direction and Speed	270/13kt
Visibility	10 km
Significant Weather	Nil
Cloud	8 few 0900 ft
Temp	14°C

1.5 Management Information

The procedure for aircraft push-back is published in the maintenance organisation’s Company Manual. There were two further push-back incidents, involving this aircraft type and towbar type, within a month of this incident (4 & 22 August 2002).

2. ANALYSIS

The pushback crew said that part of their problem with the tug, towing pin and towbar hook combination was the close tolerance fitting between the three of these. They were finding it difficult to fit the towing pin in on assembly and again, at the end of the pushback procedure, the pin was difficult to remove.

The driver said he witnessed the removal of the pin in full and that the pin slipped back in again. However, a tight fit should have militated against this happening. At the same time, a looser fit should allow easier insertion and extraction of the pin in operation. Eyebolts are also available with a 3 inch internal diameter. Adequate pushback training seems to have been given and monitored. However, the Investigation feels that in relation to the removal of the towbar, the written instruction should be more specific.

The built-in shock absorber protects the nose gear during towing operations. However, in this incident the shock absorber, a single spring, was designed to include a load at least three times the maximum weight of the aircraft (i.e. for larger aircraft). The shock absorber would appear almost as a solid device to the aircraft and would be, under the circumstances, ineffective in protecting the nose gear. In this incident the tug used was too powerful, inflexible and cumbersome for the job and, combined with the towbar, left the nose gear vulnerable once the attachment pin sheared.

On gear extension, prior to landing, the downlock actuator pushed the down lock hook which pivots about the front bulkhead fixture. The down lock roller engaged the hook before snapping into the down and locked position. At the time of the incident, the nose gear was down and locked in that position.

On completion of the pushback, the towing pin was inadvertently allowed to reinsert into the towbar eyebolt at the instant that the driver put the tug into reverse. As the aircraft's brakes were set, the initial instantaneous pull on the nose gear caused the fine shearpin on the attachment head to shear. The tug and towbar combination then continued to move rearwards, taking up the slack in the head, until the head contacted the designed stop. There was no further protection afforded to the nose gear and the impulsive force on the nose gear, coupled with the leverage of the nose leg, pulled at the down-lock roller and fractured the bracket holding it to the main body of the leg. An immediate reaction to this forward motion, as the tug was brought to a halt, was a force in the opposite direction which enabled the fractured bracket and the leg to move towards the rear of the aircraft and embed the dislocated roller between the front pressure bulkhead and the lower aircraft skin.

The fact that there were a further two incidents within a month would indicate that discussions between the aircraft operator, towbar manufacturer and the maintenance organisation are required.

3. CONCLUSIONS

3.1 Findings

3.1.1 The shock loading capacity of the towbar in use was not compatible with the rampweight of the aircraft.

3.1.2 The tug in use at the time was not compatible with the size and weight of the aircraft.

3.2 Causes

The damage to the aircraft was due to the inadvertent insertion of the towbar towing pin as the tug was moving in reverse and its continued movement after the attachment head shearpin had sheared.

4. SAFETY RECOMMENDATIONS

4.1 It is recommended that the Operator review with the aircraft manufacturer and towbar manufacturer the specifications of the required towing equipment which would be more compatible with the weight of this aircraft. **(SR 33 of 2002)**

4.2 The Maintenance Organisation should amend para.4.3 of their "Pushback Procedure" in order to make it more specific. **(SR 34 of 2002)**

Note:

Since the incident the Maintenance Organisation have promptly made necessary changes in order to prevent a reoccurrence of this type of incident and responded as follows:

Re 3.1.2 - Tug not compatible with size and weight of the aircraft

"The contracted maintenance organisation has sourced and is about to commence trials with a smaller tug to assess it's suitability for a range of aircraft sizes. Subject to a successful outcome to these trials, it is intended to procure a smaller tug for handling turboprop aircraft"

Re 4.2 The Maintenance Organisation should amend para 4.3 of their "pushback procedure" in order to make it more specific.

"The maintenance organisation is amending its pushback procedures to address the aircraft type differences that exist in relation to tow bar disconnection"

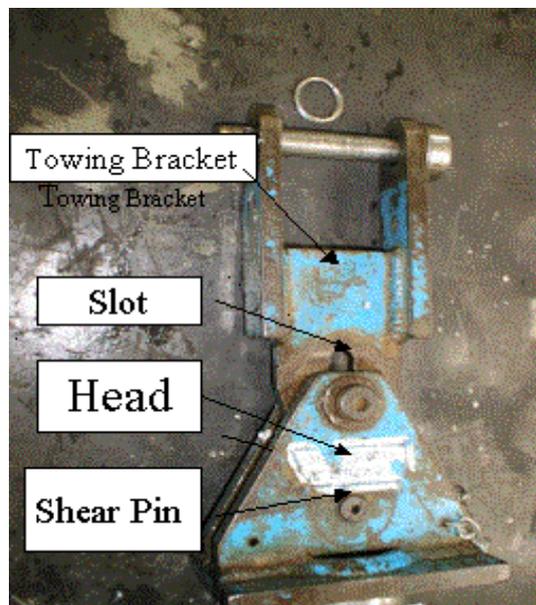
APPENDIX A



Top Picture: Position of nose gear roller following the incident.



Bottom Left: Tug and Towbar eyebolt attached.



Bottom Right: Head, with towing bracket elongated and with the shearpin removed, following the incident with aircraft G-MAJA.