ACCIDENT

Aircraft Type and Registration:	Airbus A321-211, G-DHJH
No & Type of Engines:	2 CFM56-5B3 turbofan engines
Year of Manufacture:	2000
Date & Time (UTC):	17 February 2008 at 1527 hrs
Location:	Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 220
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gear damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	18,000 hours (of which 7,000 were on type) Last 90 days - 150 hours Last 28 days - Not known
Information Source:	AAIB Field Investigation

Synopsis

Whilst manouvering the aircraft using a towbarless tug, the aircraft's nosewheels became disengaged from the tug's hydraulic powered 'grab and retention' mechanism, which allowed the tyres to contact the ground. The nosewheel steering motors, which are mounted on the nose landing gear leg, contacted the structure of the tug.

History of the flight

At the start of the pushback everything appeared to be normal to the cockpit crew but, as the aircraft started to turn, tail moving to the left, 'clonking' noises could be heard from the area of the nose landing gear. The crew likened the noises to those associated with a loose pin on a tug-and-towbar arrangement. The tug in use was a towbarless unit. As the pushback progressed the noises increased in magnitude and frequency, which culminated in a loud bang and the pushback stopped. The cockpit crew saw that the towbarless tug was at an acute angle to the aircraft. The tug crew asked the cockpit crew to set the aircraft's park brake, informed them that considerable damage had been caused to the aircraft and asked if they could call their engineering department to send someone to inspect the damage. The passengers and crew deplaned using external steps and were transported back to the terminal.

Engineering examination

The operator's engineers found that the nosewheels had fallen from the towbarless tug's hydraulic-powered

'grab and retention' mechanism and were in contact with the apron surface (Figure 1). Both of the nosewheel steering motors mounted on the landing gear leg had been damaged by the tug's structure, which required the complete nose landing gear to be changed prior to the next flight.

Examination and testing of the towbarless tug by the operator, in the presence of AAIB and a manufacturer's representative, could find no fault with the equipment and it has not been possible to reproduce the problem.

Courtesy of Thomas Cook

Figure 1

Nosewheels after falling from the 'grab and retention' mechanism (looking forward)

Other information

The aircraft operator had performed a ramp maintenance task on the aircraft just prior to the pushback. Part of this maintenance task was to change one of the two nose landing gear wheels. This was undertaken and both tyres were inflated to the specified pressure. Following the accident the tyre pressures were not checked but the engineer, who deflated them to enable the tug to be separated from the aircraft, stated that both tyres appeared to be pressurised normally.

Previous occurrences

During the investigation AAIB were informed by the airport authorities that there had been four previous nosewheel damage events involving this particular towbarless tug with four different tug operatives. Two of the events were as a result of human error and equipment failure. No reasons could be found for the other two events.

Design of towbarless tugs

Inspection of another manufacturer's towbarless tug found that it had a safety feature that would not allow the aircraft nosewheel tyres to contact the ground if the hydraulic 'grab and retention' mechanism released the tyres whilst manouvering an aircraft (Figure 2).

There are a number of national and international guideline and 'recommended practice' documents that relate to aircraft towbarless tugs, although none of them refer directly to requiring a safety mechanism to prevent the nosewheel tyres from contacting the ground whilst manouvering the aircraft. Extracts from these are reproduced below.

In the UK and EU, BS EN 12312-7:2005 Part 7 titled '*Aircraft movement equipment*'.

Para 5.6.3:

> *'The aircraft pick-up point (eg wheels, towbar attachment point) shall be designed in such a way that unintended disengagement of the aircraft from the aircraft holding device of the movement equipment is prevented by positive mechanical locking eg a latch.'*

Figure 2

Another manufacturer's towbarless tug

Para 5.6.4:

> *'The geometry of the aircraft holding device shall be designed to prevent interference with the aircraft.'*

In the EU, Directive 98/37/EC titled '*Mechanical Equipment'*.

Para 3.4.6:

> *'Towing devices'. 'All machinery used to tow or to be towed must be fitted with towing or coupling devices designed, constructed and arranged to ensure easy and safe connection disconnection, and to prevent accidental disconnection during use.'*

In the USA, SAE ('*The Engineering Society For Advancing Mobility Land Sea Air and Space'*) ARP (Aerospace Recommended Practice) 4852 Revision B titled '*Design Specifications for Towbarless Push-Back Tow Vehicles.*'.

Para 5.15.3:

> *'While in the fully engaged position, the nose wheel must remain stabilized in the locking mechanism under all dynamic conditions. The nose wheel must be retained above the axle to prevent escape in the upwards direction.'*

SAE ARP 5283 titled '*Nose Gear Towbarless Tow Vehicle Basic Test Requirements'*.

Para 4.2 titled '*Retention Features*':

> *'The nose wheels shall be held by the vehicle in such a way that pitch-up of the aircraft shall not cause the wheel to disengage from the pickup device at any nose gear steering angle. A positive wheel retaining feature must be provided. If the nose gear is "canted", a turning maneuver will cause uneven loading on the nose gear (i.e., for an aft canted gear, the vertical load on the inboard nose wheel will tend to increase and conversely, the vertical load on the outboard nose wheel will tend to decrease). The retention feature must allow for uneven tire displacement without imposing additional loads on the nose gear.*
>
> *The geometry of the holding device shall be such that no interference with aircraft structure may occur (e.g., torque links, weight and balance sensors, tires, water spray deflector, etc.) at all wheel steering angles up to the limits defined by the airframe manufacturer's documentation, and the full range of shock strut extensions and tire deflections. Surface contact area between pick-up device and tire surface should be sufficient to preclude unacceptable tire loading (refer to tire manufacturer for bearing pressure specifications).'*

International Standard ISO 20683-1 titled '*Aircraft ground equipment – Design, test and maintenance for towbarless towing vehicles (TLTV) interfaced with nose landing gear*.' Part 1 titled '*Main-line aircraft*'.

Para 4.3 titled '*Nose wheels retention*':

Para 4.3.1:

> *'The nose wheels shall be held by the vehicle in such a way that pitch-up of the aircraft shall not cause the wheel to disengage from the pick-up device at any nose gear steering angle. A positive wheel retaining feature must be provided. If the nose gear is "canted", a turning maneuver will cause uneven loading on the nose gear (ie for an aft-canted gear, the vertical load on the inboard nose wheel will tend to increase and conversely, the vertical load on the outboard nose wheel will tend to decrease). The retention feature must allow for uneven tire displacement without imposing additional loads on the nose gear.'*

Conclusion

In summary, during this investigation it was established that there are a number of technical specification documents defining standards regarding the design, manufacture, operation or maintenance of aircraft ground support equipment generally, and specifically aircraft towbarless tugs. These are not, however, matched by national or international aviation regulatory requirements.