



Air Accident Investigation Unit Ireland

SYNOPTIC REPORT

SERIOUS INCIDENT
Airbus A320, EC-LVQ
Dublin Airport

27 September 2017



**An Roinn Iompair
Turasóireachta agus Spóirt**
Department of Transport,
Tourism and Sport

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13¹ to the Convention on International Civil Aviation, Regulation (EU) No 996/2010² and Statutory Instrument No. 460 of 2009³, safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

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¹ **Annex 13:** International Civil Aviation Organization (ICAO), Annex 13, Aircraft Accident and Incident Investigation.

² **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.

³ **Statutory Instrument (SI) No. 460 of 2009:** Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.



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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010 and the provisions of SI No. 460 of 2009, the Chief Inspector of Air Accidents on 27 September 2017, appointed Howard Hughes as the Investigator-in-Charge to carry out an Investigation into this Serious Incident and prepare a Report.

Aircraft Type and Registration:	Airbus A320-216, EC-LVQ	
No. and Type of Engines:	2 x CFM56-5B6/3	
Aircraft Serial Number:	5590	
Year of Manufacture:	2012	
Date and Time (UTC)⁴:	27 September 2017 @ 17.26 hrs	
Location:	Abeam Stand 318R, Dublin Airport (EIDW)	
Type of Operation:	Commercial Air Transport	
Persons on Board:	Crew - 6	Passengers - 179
Injuries:	Crew - Nil	Passengers - Nil
Nature of Damage:	Substantial to Engine Cowling	
Commander's Licence:	ATPL issued by AESA ⁵	
Commander's Age:	32 years	
Commander's Flying Experience:	6,082 hours, of which 5,882 were on type	
Notification Source:	Dublin Airport Authority (DAA)	
Information Source:	AAIU Field Investigation	

⁴UTC: Co-ordinated Universal Time. All timings in this Report are quoted in UTC. Local time is UTC + 1 hour.

⁵AESA: Agencia Estatal de Seguridad Aérea, the national aviation authority of Spain.

SYNOPSIS

A pushback and pull forward manoeuvre, using a tractor and towbar, was being performed on an Airbus A320 aircraft from parking Stand 318R at Dublin Airport (EIDW), in preparation for departure to Madrid Barajas Airport (LEMD), Spain. The aircraft's starboard engine was being started by the Flight Crew as the aircraft was being pulled forward onto Apron Taxiway 5. As it was being aligned with the apron taxiway, the nose of the aircraft overtook the tractor which remained attached to the aircraft by the towbar. The aircraft continued to move forward, coming to rest with the tractor wedged against the right hand side of the starboard engine cowling. There were no injuries.

NOTIFICATION

The AAIU was notified of the occurrence by the Airport Authority.

1. FACTUAL INFORMATION

1.1 History of the Occurrence

Having obtained Air Traffic Control approval "*to push and start to Tug⁶ Release Point November* [TRP 'N']", EC-LVQ was pushed off stand at 17.21 hrs. The manoeuvre involved an initial pushback, followed by a pull forward onto Apron Taxiway 5, to TRP 'N'.

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Following the initial pushback, and in order to bring the aircraft onto the taxiway, the tractor pulled the aircraft forward through the taxiway centreline to the south east of the line, prior to turning right to align the aircraft with the taxiway.

During the pull forward the flight crew obtained clearance from the headset operator to start the starboard engine.

As the tractor turned right to align the aircraft onto the taxiway, the aircraft nose began to overtake the tractor. The headset operator immediately instructed the Flight Crew to shut down the starboard engine. Although the tractor driver attempted to stop the tractor, it was pulled and rotated as the aircraft continued to move forward. The aircraft then turned slightly to the right as it remained attached to the tractor via the towbar and came to rest with the tractor wedged against the right hand side of the starboard engine cowling.

A diagram showing the path followed by the aircraft during pushback and pull forward is shown in **Figure No. 1**.

⁶ **Tug:** A vehicle used for ground manoeuvring of aircraft, also known as a tractor; referred to as 'Tractor' in this Report.

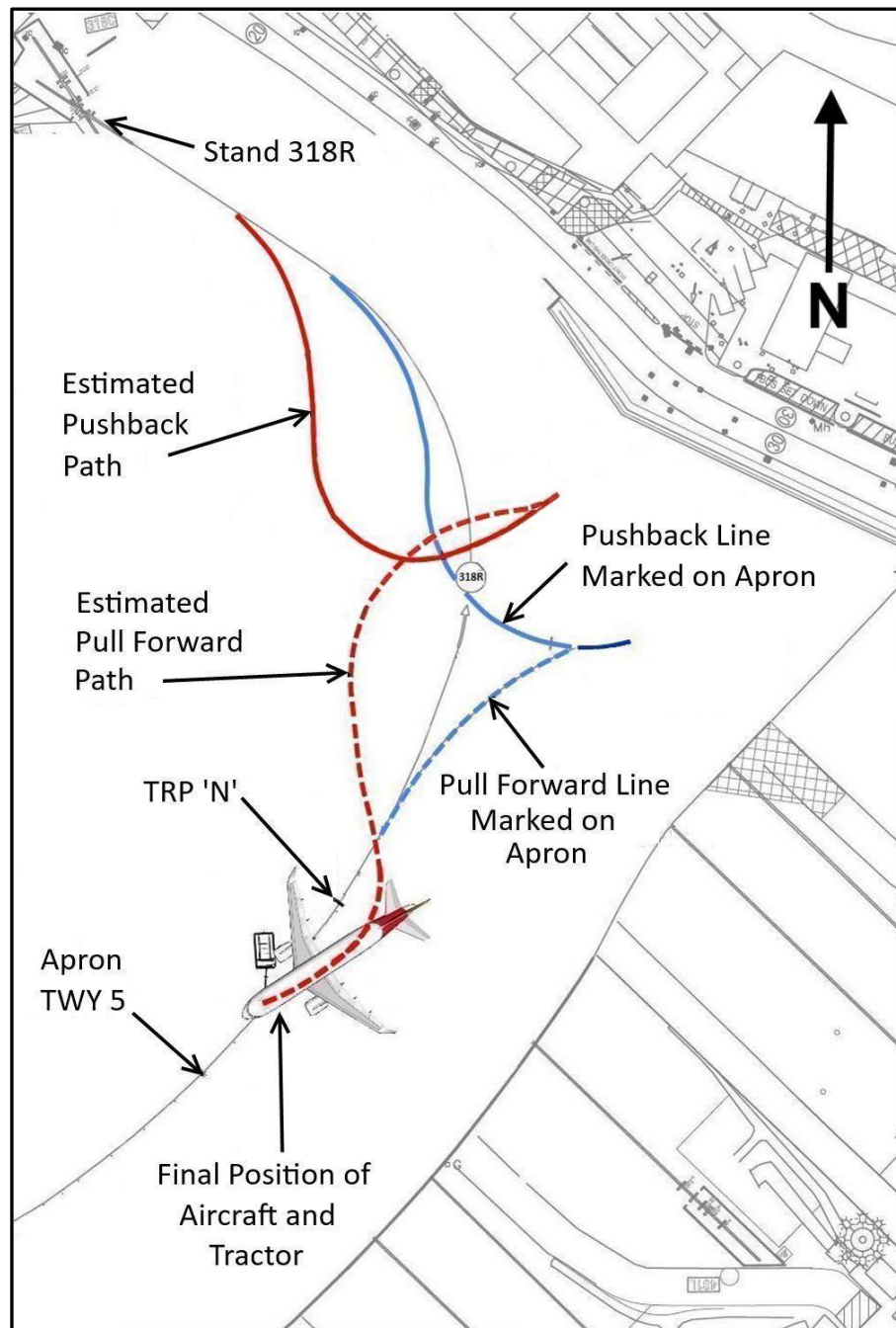


Figure No. 1: Path taken by the Aircraft as it was pushed off Stand 318R and pulled towards TRP 'N'

Once the aircraft had stopped, the headset operator instructed the Flight Crew to set the aircraft brakes, and informed them of the collision.

1.2 Injuries to Persons

No injuries were reported to the Investigation.

1.3 Damage to Aircraft

The aircraft's starboard engine cowling sustained damage (**Photo Nos. 1 & 2**). No other damage to the aircraft or engines was reported.



Photo Nos. 1 & 2: Damage to starboard engine cowling

1.4 Other Damage

No damage to the tractor was reported.

The shear-pin⁷ in the head of the towbar was found to have sheared, leaving just the head of the pin in place (**Photo No. 3**).

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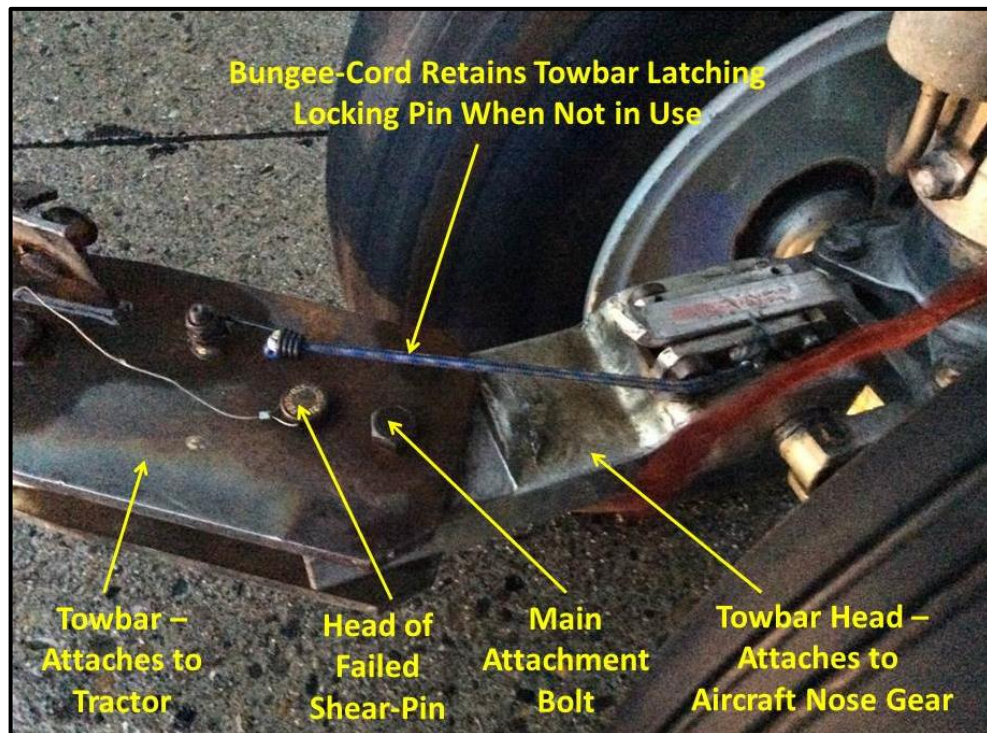


Photo No. 3: Towbar and towbar head as found following the occurrence

⁷ **Shear-pin:** This pin acts as a safeguard, such that, in the case of a mechanical overload, the pin is designed to shear, preventing other parts from being damaged.



1.5 Ground Handling Company

1.5.1 Personnel

Pushback of the Operator's aircraft at EIDW was performed by a ground handling company. The pushback crew consisted of a pushback tractor operated by one driver, one headset operator (in contact with the cockpit via a headset), and one observer or 'wing-walker'⁸.

1.5.2 Ground Handling Company Procedures Manual

The ground handling company's manual (dated 1 May 2017) titled, '*Standard Operating Procedure: Ramp-022: Aircraft Ground Movement*', 3.6.2 TOWING, Section 4, *Ready for Towing*, sub-section (i) states:

Towing with engine(s) running is prohibited

Section 5, '*Incidents during Tow*', includes, *inter alia*, the following:

- (b) *In the event of a ground service equipment malfunction during movement, the pushback operator shall instruct the flight deck to softly apply the aircraft brakes and bring the aircraft to a full stop.*
- (i) *[...] If the towbar fails and remains attached during a tow then the tug has lost direction control over the aircraft, the aircraft brake rider⁹ shall be requested to make gentle application of aircraft brakes.*

The company also provided guidance and training to its staff on ramp markings.

1.5.3 Pushback Equipment

The vehicle used for the pushback was a 14,000 kg, four-wheel-steerable tractor coupled to a tow bar designed for use with an A320 aircraft and fitted with an appropriate shear-pin. The usual orientation of the tractor during a pushback manoeuvre is for the front of the tractor to face the nose of the aircraft. Thus, during a pushback and pull forward manoeuvre, the tractor is normally driven in reverse, with the driver looking over his shoulder as the aircraft is pulled forward.

1.5.3.1 Tractor Specification

IATA Airport Handling Ground Support Equipment Specification AHM 955: '*Functional Specification for an Aircraft Tractor*', paragraph 1.4 states: '*There shall be four categories of tractors defined in accordance with the maximum aircraft weight*'.

⁸ **Wing-walker:** A person positioned at the aircraft wing tip, [to provide signals] to the pilot/marshaller/pushback operator, that the aircraft movement on/off a parking position would be unobstructed (ICAO Annex 2).

⁹ In this case the Commander of the aircraft, seated in the cockpit.

In this case the aircraft being manoeuvred by the tractor was within Category 2: 'aircraft less than 150,000 kg'. Paragraph 3.7 of this document lists the minimum tractor weight for each aircraft category as defined in paragraph 1.4, and states that aircraft of Category 2 should be towed by a tractor of minimum weight 12,000 kg.

1.6 The Aircraft

EC-LVQ was an A320-216, a single aisle, twin-engine aircraft manufactured by Airbus Industrie. It was powered by two CFM56-5B6/3 turbofan engines. The aircraft mass during the pushback was reported as 67,927 kg.

Examination of A320 cockpit visibility cut-off angles shows that it was unlikely that the Flight Crew would have seen the event unfold, or the impact of the tractor with the starboard engine cowling.

With the nose wheel steering system de-activated, the maximum steering angle is limited to plus or minus 95 degrees either side of centreline. Visual markings on the side of the aircraft act as a warning to pushback tractor operators when the maximum steering angle is reached.

1.6.1 Engine Start

The aircraft Operator informed the Investigation that the engine data available came from the FDIMU¹⁰ PCMCIA¹¹ card, and that the data timeframe available from this source is from engine start to engine shutdown. This data indicated that the starboard engine was being started during the pull forward manoeuvre. The maximum engine rotation speeds¹² reached during the start procedure were recorded as 54.9% N2 and 16.5% N1, at which point the engine start was aborted. The engine manufacturer was asked to provide an estimate of engine thrust at these rotational speeds. The engine manufacturer informed the Investigation that 'ground idle engine conditions are approximately N2 60% and N1 19%', which would produce a thrust 'expected to be below 800 Lbf¹³'. The engine manufacture went on to state 'so for the peak N1 and N2 listed, the actual max thrust for this engine should have been less than 700 pounds'.

1.7 Ramp Conditions

At the time of the occurrence it had been raining and the ramp conditions were wet. The Investigation asked the Airport Authority if there had been evidence of ramp surface contamination. The Airport Authority informed the Investigation that there was no evidence of surface contamination other than water.

The Airport Authority supplied the Investigation with a survey document of the area of ramp where the event occurred, from which it was determined that the slope on the ramp over which the aircraft was pulled forward was a down-hill slope of approximately 1%.

¹⁰ **FDIMU**: Flight Data Interface Management Unit.

¹¹ **PCMCIA**: Personal Computer Memory Card International Association.

¹² Usually expressed as percentage of a nominal value where N1 refers to the rotation speed of the low pressure compressor and N2 refers to the rotation speed of the high pressure compressor.

¹³ **Lbf**: A unit of force measured in Pounds.



1.7.1 Maximum Slope on Airport Aprons and Ramps

European Aviation Safety Agency (EASA) certification specifications & guidance material for aerodrome design (CS-ADR-DSN) Book 1, Chapter E – Aprons, ‘CS ADR-DSN.E.360 Slopes on Aprons’, states:

- (a) Slopes on an apron should be sufficient to prevent accumulation of water on the surface of the apron but should be kept to the minimum required to facilitate effective drainage.
- (b) On an aircraft stand the maximum slope should not exceed 1% in any direction.

1.8 Examination of Pushback Equipment

Following the occurrence, the Operator of the tractor and towbar quarantined the equipment and engaged the services of an independent engineer to examine the equipment and produce a report.

The engineer’s report stated, *inter alia*, that ‘*the tractor is in good working condition and within manufacturers’ specification and fit for service*’ and ‘*Towbar also checked and genuine [...] shear pin fitted, [...]*’.

The Investigation was informed by the engineer that ‘*it is just as likely that the pin could have sheared just before the incident, rather than being a direct result of the incident*’.

The Investigation was also informed that towbar shear-pins have been known to fail during pushback and pull forward manoeuvres whilst under normal load conditions.

1.9 Witness Interviews and Statements

The Investigation interviewed the tractor driver, the headset operator, and the wing-walker. The headset operator stated that the push and pull manoeuvres appeared “*normal until the last moment, when the jack-knife¹⁴ occurred*”. Upon realising that the aircraft was overtaking the tractor, his immediate concern was to have the starboard engine shut down as he felt this presented the “*greatest danger to the tractor driver*”. The headset operator stated that the “*Engine number 2 [starboard engine] had stopped before contact was made*”. He informed the Investigation, that had the engine not been starting, he would have most likely instructed the pilot to stop the aircraft when he saw the jack-knife develop. Once the collision had occurred he immediately told the Flight Crew to set the aircraft brakes, and he informed the Commander of the collision.

Following the occurrence, the headset operator stated that he examined the head of the towbar, and confirmed that the shear-pin had indeed failed. He was of the opinion that the shear-pin most likely failed as the aircraft was being pulled towards Apron Taxiway 5. He stated that he formed this opinion as the bottom of the shear-pin could not be located in the vicinity of the aircraft, when he and the wing-walker searched for it following the event.

¹⁴ **Jack-knife:** This term is used in the Report to indicate that the nose of the aircraft overtook the tractor.

The wing-walker told the Investigation that the push and pull manoeuvres appeared normal until the jack-knife occurred. Due to his position during the pull forward manoeuvres he did not notice the shear-pin failing, neither could he signal to the headset operator that a jack-knife was occurring. He confirmed that he assisted the headset operator in the unsuccessful attempt to locate the bottom of the shear-pin.

The tractor driver told the Investigation that just prior to the jack-knife he was turning the tractor back towards Apron Taxiway 5. In order to maintain visual contact with the taxiway he was looking over his shoulder towards the rear of the tractor. He did not observe the failure of the shear-pin.

He stated that *“it [the jack-knife] just happened so quickly”*. As he realised the aircraft was overtaking the tractor he attempted to attract the attention of the headset operator, but was unsuccessful. He noted that at this time the headset operator appeared to be trying to contact the cockpit, and did not see his (the driver’s) hand signals to stop the aircraft.

The tractor driver informed the Investigation that he did not apply any braking prior to the jack-knife, but when the tractor began to skid he applied the brakes to no avail. The tractor kept skidding until it stopped abruptly against the side of the starboard engine. He stated that the engine was still rotating as the collision occurred.

Reports received from the Flight Crew indicate that they did not see the event unfold from the flight deck. They also reported that the impact between the engine cowling and the tractor was *‘hardly noticeable’*.

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The ground handling company informed the Investigation that they handle aircraft other than the A320. These aircraft would also have been manoeuvred off stand 318R, but would not have had to follow the guidance markings, as these were applicable to A320 aircraft only. All of those interviewed by the Investigation indicated that it was usual to push aircraft out of stand 318R in the manner that had been performed on this occurrence. See **Figure No. 1**.

1.10 CCTV Recordings

Following the occurrence the Investigation obtained copies of CCTV recordings from the Airport Authority from a number of cameras that recorded the event from different angles. These showed the movement of the aircraft during its pushback from stand 318R and its pull forward to TRP ‘N’. Examination of the videos confirmed the reported movement of the aircraft and ground personnel involved in the pushback. The video shows that the aircraft was manoeuvred at a slow walking pace throughout, and the towbar angles did not appear to exceed the limitations for manoeuvring an A320 aircraft whilst under tow (**Section 1.6**).

Close examination of the video in the latter stages of the pull forward manoeuvre, show the aircraft and tow truck moving in a manner that would be consistent with a failure of the shear-pin prior to the commencement of the jack-knife. It was estimated that the aircraft continued forward one full aircraft length following the point at which the shear-pin appears to fail.



1.11 Dublin Airport Authority (DAA) Operating Procedures

DUBLIN AIRPORT - AERODROME MANUAL Airport Direction D-O Aircraft Stand Allocation, Pushback and Flight Information, Part E – Operating procedures of the Aerodrome, its Equipment and Safety Measures, states:

- 10. Procedures for vacating stands,*
a) Pushback. All aircraft shall be pushed back in compliance with the procedures outlined in Appendix 1.

Appendix 1 of the Aerodrome Manual, Stand Vacation Procedures contains the following instructions and cautions for stand 318R:

Stand Number	Procedure	Conditions / Restrictions
318R	Push back to the right to TRP H or For aircraft type A320 only , push back, with the centre of the aircraft following the pushback guidance line and tow forward to TRP N	If Stand 400T is occupied there is no push back permitted. Do not push beyond stop marking provided

A survey document, provided by the DAA, showed the pushback guidance line to be followed by A320 aircraft pushing off parking stand 318R. See also **Figure No. 1, Section 1.1.**

2. ANALYSIS

2.1 General

During ground manoeuvring, as the aircraft was being pulled forward by the tow tractor, it is likely that the shear-pin failed. Video evidence showed that, as the tractor commenced the turn to the right, the aircraft continued straight ahead. This suggests that the shear-pin had failed at this point, allowing the aircraft to continue straight, and reducing the ability of the tractor to control the aircraft.

Shortly after this, the tractor was observed to stop, but with the shear-pin broken it was unable to retard the aircraft, which continued forward, eventually coming to rest with its starboard engine against the tractor.

The Flight Crew did not see the event unfold, and were not aware of the collision with the tractor until informed by the headset operator.

Although the ground handling company's manual contains instructions on what action to take in the event of a towbar failure during a towing manoeuvre, the angle of the tow tractor, and the location of the headset operator, meant that he did not see the shear-pin fail, and only saw that a jack-knife had developed at the last moment.

At this point, with an engine starting, the headset operator's decision to request the Commander to stop the engine was understandable, as he perceived the greatest threat to the tractor driver was from the engine intake as it came into contact with the tractor.

Airport Authority ramp markings and guidance material indicate the pushback path to be taken by A320 aircraft when manoeuvring from stand 318R. Training material provided by the ground handling company indicate that ramp personnel are shown the different ramp markings to be found and their meaning. Although the pushback and pull forward paths did not follow the marked apron guidance line for A320 aircraft, the Investigation is of the opinion that the ground manoeuvring limitations for the aircraft were not exceeded, but did result in more acute turning angles by the tractor as it approached Apron Taxiway 5.

The ground handling company does handle aircraft types other than the A320 off this stand, which would not be required to follow the pushback guidance line marked on the apron from stand 318R. From information given to the Investigation, it appears to have become custom and practice for the ground handling company's ground crew to push all aircraft off stand 318R in the manner performed on this occasion.

However, given that the specific pushback instructions for A320 aircraft from Stand 318R were not followed in this case the Investigation makes the following Safety Recommendation to the ground handling company:

Safety Recommendation No. 1

Swissport Ground Handling should ensure that all ground crews are made aware of, and follow, the correct manoeuvring procedures at Dublin Airport. (IRLD2018008).

2.2 Equipment used during Pull Forward

The tractor, towbar, and shear-pin used in this case were all appropriate for use with an A320 aircraft.

Towbar shear-pins are designed to fail under certain load conditions, in order to prevent damage to an aircraft's nose landing gear and surrounding structure. On occasion shear-pins have been known to fail under normal load conditions.

In the case of the subject towbar, there is a main (non-shearing) bolt that attaches the towbar to the towbar head through a slot in the towbar head. A shear-pin then locks the towbar in line with the towbar head (**Appendix A**). The Investigation is of the opinion that it would not have been possible to perform the initial pushback manoeuvre with a sheared pin, and that the pin therefore sheared during the latter stages of the pull forward manoeuvre.



The bottom portion of the shear-pin was likely deposited on the ramp in an area behind where the aircraft finally came to rest but was not located. Given that the aircraft had continued forward some distance following the failure of the shear-pin it is understandable that it was not found subsequent to the event. The Airport Authority tasked a ramp surface cleaning vehicle to sweep the area immediately after EC-LVQ had been towed to another stand.

2.3 Ramp Conditions

The Investigation notes that the ramp surface was wet at the time of the event, and that there was a small downward incline during the pull forward manoeuvre. The Investigation considers that it is unlikely that either of these contributed to the failure of the shear-pin. However, once the shear-pin failed and control of the aircraft by the tractor was lost, the wet surface of the ramp and the slight downhill slope likely contributed to the severity of the outcome.

2.4 Engine Start

Witness statements and engine data show that the starboard engine was undergoing a start sequence at the time of the event. This is not in accordance with the ground handling company's procedures.

Engine data shows that the engine had not achieved its normal idle parameters before the start sequence was aborted. Thus, any thrust produced by the engine was less than idle thrust. Notwithstanding this, the ground handling company manual prohibits starting of aircraft engines during towing manoeuvres. The Investigation considers that it is unlikely that thrust from the starting engine contributed to the failure of the shear-pin.

However, the thrust that was generated may have contributed to the severity of the outcome, once the shear-pin failed and control of the aircraft by the tractor was lost.

Although the ground handling company's manual states that ground crew should instruct the flight crew to apply braking in the event of equipment failure, it is understandable in this case that priority was given to stopping the engine rather than stopping the aircraft, as that was perceived as the greater threat to the tractor driver.

2.4.1 Safety Action Taken by Ground Handling Company

The ground handling company has taken the following safety action to ensure that all ground crews involved in aircraft manoeuvres are aware of the prohibition of engine starting during pull forward/towing manoeuvres. A Safety Notice issued 6 March 2018 stated:

Pushback Procedures:

In line with the standard SOP, please also ensure that you DO NOT give the PIC clearance to start up engines if you are in the process, or plan to tow the aircraft forward to the tug release point.

3. CONCLUSIONS

(a) Findings

1. The pushback equipment was appropriate for the aircraft being manoeuvred.
2. The pushback crew were suitably qualified for pushback operations.
3. During the pushback and pull forward the aircraft did not follow the manoeuvring line for Stand 318R.
4. The pushback and pull forward manoeuvres did not appear to exceed the limitations for manoeuvring an A320 aircraft whilst under tow.
5. The ramp conditions were wet.
6. There was a downhill slope of approximately 1% on the pull forward section of the manoeuvre, which was within aerodrome design specifications.
7. During the pull forward, the aircraft's starboard engine was started.
8. The estimated thrust from the engine did not exceed idle thrust.
9. The ground handling company's OPERATING PROCEDURE MANUAL - AIRCRAFT GROUND MOVEMENT states that towing with engine(s) running is prohibited.
10. The Shear-Pin failed during the latter stages of the pull forward manoeuvre as the tractor turned towards TRP 'N'.
11. Shear-Pins have been known to fail during normal pushback and pull forward manoeuvres, which likely occurred in this case.
12. Neither the pushback driver nor the headset operator saw when the shear-pin failed.
13. Once the Shear-Pin failed, the ability of the tractor to control the aircraft was lost.
14. Upon noticing the jack-knife developing, the headset operator's immediate reaction was to order the Flight Crew to shut down the starboard engine.
15. Although the slope on the ramp, engine start, or wet conditions did not cause the shear-pin to fail, once failed, these factors likely contributed to the severity of the outcome.
16. The ground handling company has taken safety actions relating to engine start during tow forward manoeuvres.



(b) Probable Cause

Failure of the towbar shear-pin during a pull forward manoeuvre.

4. SAFETY RECOMMENDATIONS

No.	It is Recommended that:	Recommendation Ref.
1.	Swissport Ground Handling should ensure that all ground crews are made aware of, and follow, the correct manoeuvring procedures at Dublin Airport.	IRLD2018008

[View Safety Recommendations for Report 2018-008](#)

- END -

Appendix A
Schematic Diagram of Towbar and Shear-Pin

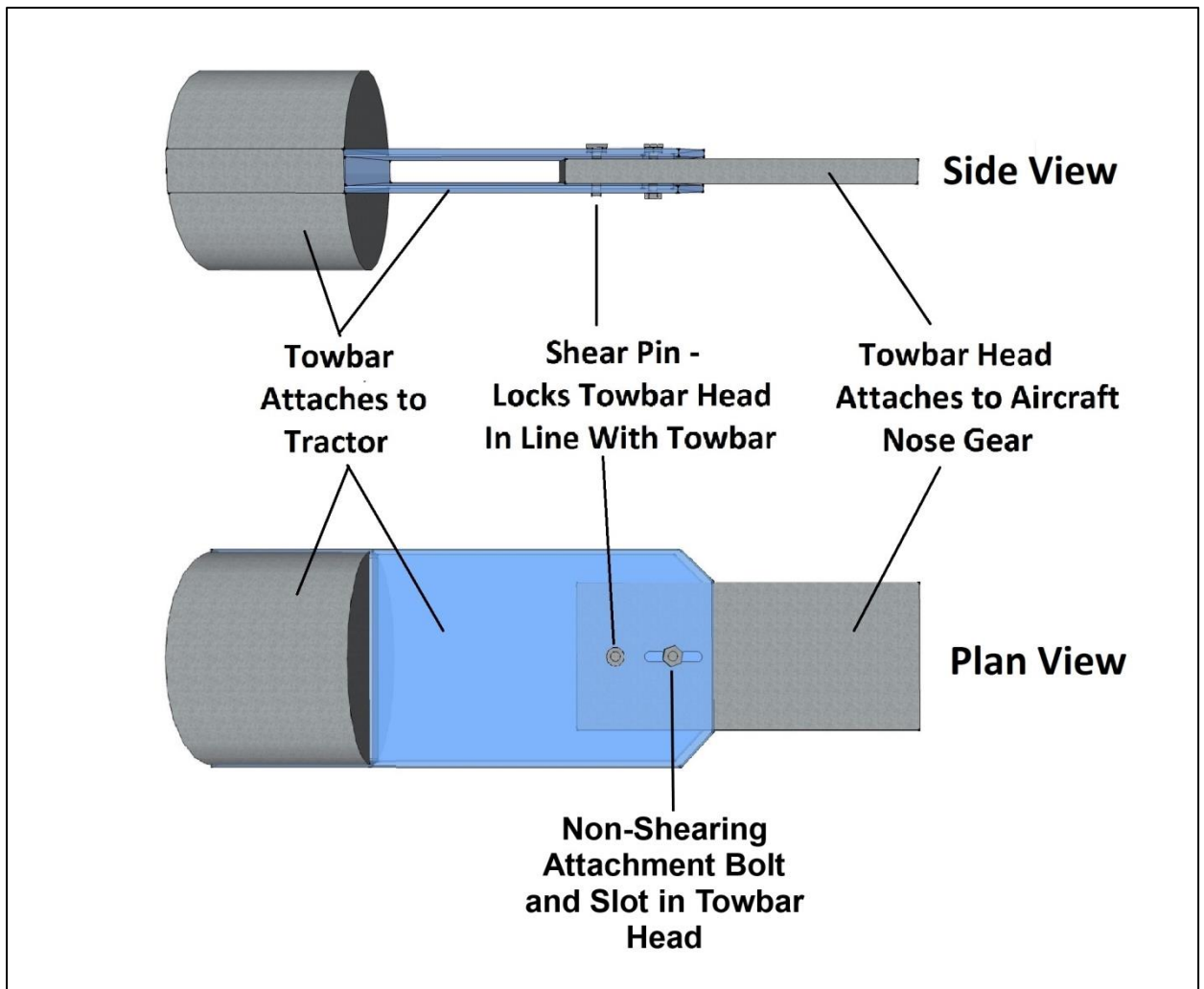


Figure 1: Towbar and towbar head in line as per normal operation

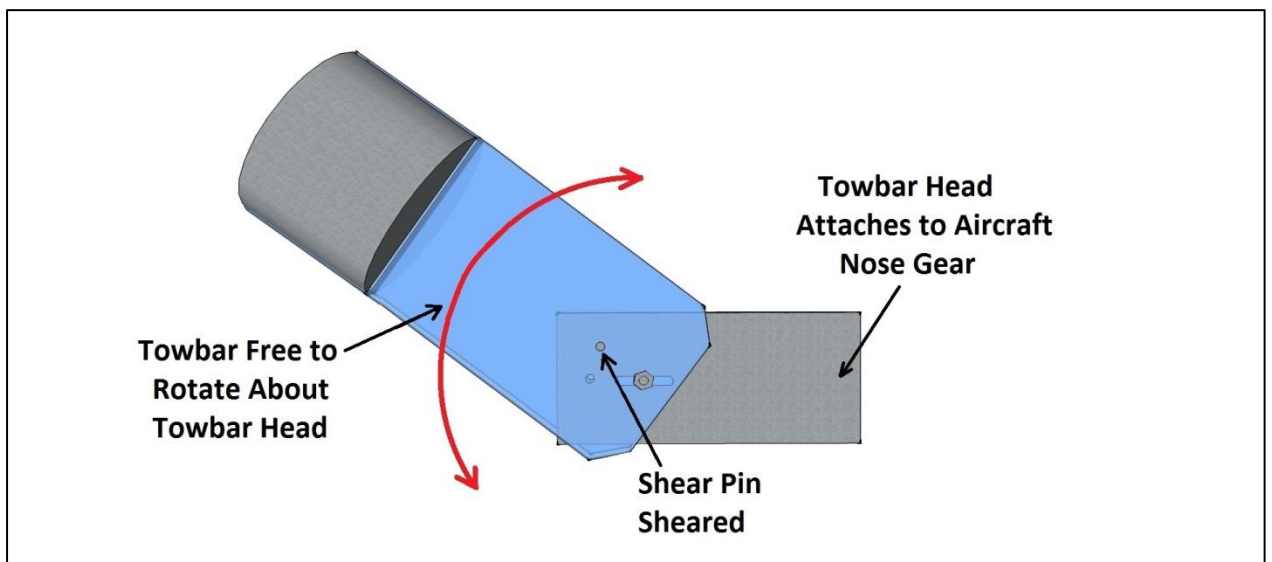


Figure 2: Towbar and towbar head out of line due shear-pin failure

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

Produced by the Air Accident Investigation Unit

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