Federal Public Service
Mobility and Transport
Air Accident Investigation Unit

Air Accident Investigation Unit
(Belgium)
City Atrium
Rue du Progrès 56
1210 Brussels

Safety Investigation Report

Ref. AAIU-2013-25

Issue date: 31 May 2015

Classification: Serious incident

Level of investigation: Standard

Date and hour: 24 November 2013 at 09:46 UTC

Aircraft type: Boeing 757-200

Year of manufacture: 2000

Total flight time: 43125:13 FH

Type of engine: 2 Rolls-Royce RB211-535E4, high-bypass turbofan engines

Operator: US Airways[1]

Accident location: EBBR - Brussels Airport, Belgium

Type of flight: Commercial Air Transport - Passengers

Phase: Pushback/towing

Persons on board: Crew: 9 Passengers: 58

Injuries: Cabin crew slightly injured

Abstract

When the pushback was done, the ramp operator instructed the flight crew to set the brakes. Subsequently the pilot gave permission to disconnect the steering by-pass pin and the chord of the headset. When this was done, the ramp operator was walking back to his tug when suddenly he heard the engines spooling up and saw the aircraft came in to movement. The nose gear of the aircraft collided with the lifting mechanism of the tow tug. The tug was pushed forward several meters before the aircraft came to an abrupt stop.

Occurrence category:
Ground handling (RAMP)

Cause:
Starting taxi when pushback procedure not completed

Contributing factors:
Lack of visible cues and not harmonised procedures

[1] As from December 2013, US Airways merged with American Airlines. The combined entity carries the brand name 'American Airlines', which will be used in the rest of this report.

Factual Information

History of the flight

At 09:41 UTC, flight US751 to Philadelphia (KPHL), scheduled to depart at 09:55, started pushback from stand 204. The aircraft was pushed back on taxiway R4 and then towed on taxiway S. This was done by a single operator from Swissport driving a towbarless tug Goldhofer nose wheel lifter.
At position 210 the ramp operator was told to stop the aircraft whereupon he instructed the flight crew to set the brake. Subsequently the pilot gave permission to disconnect the steering by-pass pin and the chord of the headset.
When this was done, the ramp operator was walking back to his tug when suddenly he heard the engines spooling up and saw the aircraft starting to move. He immediately ran to the right hand side of the aircraft trying to catch the attention of the pilots by hand signals. But meanwhile the nose gear of the aircraft collided with the lifting mechanism of the tow tug. The tug was pushed forward several meters before the aircraft came to an abrupt stop, resulting in a bouncing movement of the aircraft nose.
The tug continued moving for a few meters after the aircraft had stopped. The ramp operator reconnected the headset and informed the flight crew about what happened. The flight crew further notified ATC about the event. A maintenance crew arrived at the scene and confirmed that the aircraft was able to taxi to a parking stand. Passengers and crew remained on board while aircraft was inspected. At 13:55 UTC passengers disembarked and flight was cancelled.
The collision caused some cabin crew to fall over with several of them being slightly injured. However, none of them wanted to see a doctor. No injuries were reported among the passengers. The ground operator also didn't suffer any injury.

Statements of personnel involved

Ramp operator (ROP)

After having done the pushback from position 204 to the Sierra line and having towed the aircraft to position 210, the ramp operator gave the pilot the order to set the brakes. Normally the aircraft is towed a bit further but the tower told to stop over there upon flight crew instructions. After the brakes were set, the pilot gave permission to disconnect everything. After disconnection and removal of the steering pin and headset cable from the aircraft, the ramp operator wanted to return to the tug when he suddenly heard the engines accelerating and even saw the aircraft driving forward. He immediately ran to the right side of the aircraft and made signs to the crew to make them clear that they had to stop. But meanwhile the aircraft already smashed into the tractor which was catapulted backwards over several meters. The ramp operator immediately informed the flight crew through the headset and asked the ground handling dispatch to call the Airport inspection.

Flight crew

While the first officer was starting the engines, the captain was in communication with the pushback driver. The captain told the driver the breaks were set and he was clear to disconnect. After the engines were started neither the captain nor the first officer saw the pushback or any ground personnel. The captain contacted the tower, who he felt had a clear view of the aircraft, and requested permission to taxi. At that time they began to taxi. They felt a bump that according to the first officer was more than rolling on a taxi light.felt larger than a taxi light. They then felt a larger bump. At that time the captain applied the brakes. The ground crew reestablished communication via the headset to inform the pilots they had hit the tug. After the incident, the airplane was brought back to the gate for an inspection. According to the flight crew it is not uncommon for the push tug to leave without providing any communication.

There was a third pilot on the flight deck sitting on the jumpseat. When the aircraft began to taxi he saw the pushback driver on the right side of the aircraft. When he did, he attempted to bring it to the captain's attention.

Airfield information

The Brussels airport is located at 6.5 Nautical Miles (12km) NE of the city of Brussels, on the coordinates 50°54'05''N 004°29'04''E. The elevation is 56m ASL.

The airport is exploited by the Brussels Airport Company and certified (certificate N° A-POR\2012\Annex14_001) to be compliant with the requirements of ICAO Annex 14 and the Belgian Law (AR/KB 15 March 1954).

Pilot information

Captain

Age:	58
Nationality:	American
Flight hours on type:	2,076

First Officer

Age:	60
Nationality:	American
Flight hours on type:	9,004

Ground handler information

Swissport is a ground handling company that has been granted a licence by Brussels Airport Company in 2011 for a period of 7 years to supply the following handling services: Ramp handling for passenger aircraft, ramp handling for full-freighter aircraft, baggage handling and freight and mail handling.

The concerned ramp operator (ROP) has been working for the company as a ground handler since 2001.

Pushback equipment information

The equipment used to perform the pushback was a towbarless (TBL) aircraft tractor Goldhofer AST-3 L 140 (S/N 1896), for medium speed towing and ramp operation with aircraft range from AVRO RJ70 up to B767/A300. It has a 2 men cabin with 2 steering wheels and is fitted with two amber flashing lights which were lit at the time of the collision.

Specifications

Total length:	6,99 m
Height cabin:	1,65 m
Empty weight:	9000 kg
Aircraft weight up to:	160 000 kg
Pushback speed 2% rolling resistance:	5 km/h

Figure 1: Goldhofer AST-3 L 140 tractor

Aircraft information

Type:	Boeing 757-200
Maximum take-off weight (MTOW):	115680 kg
Height from ground to bottom fuselage:	2,24 m
Distance from nose tip to nose gear axis:	5,89 m

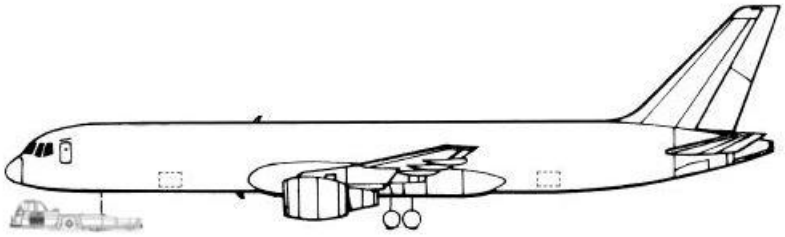


Figure 2: Sketch (not to scale) showing the position of the tug when nose is lifted

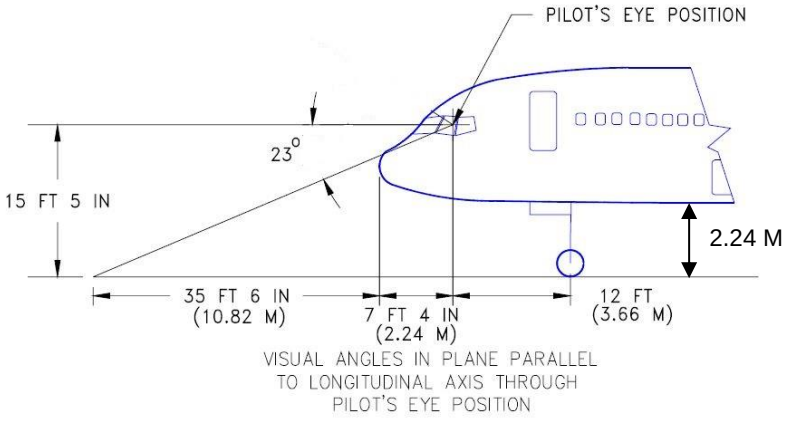


Figure 3: The visual angle from pilot's eye position

The tug with a height of 1,65 m would become visible when approximately 6,5 m in front of the aircraft nose.

Damage

Upon visual inspection in Brussels no damage was identified and the AC was cleared to ferry to Philadelphia (KPHL). After further inspection in KPHL, abrasions were found to the left hand outboard nose tire.

The towing truck sustained severe damage and was taken out of service for repair by the operator.

General description of pushback with TBL

Before the nose is lifted by the tug, brakes are set and the ground operator installs a steering bypass pin into the nose gear and connects the headset to the aircraft when not cordless. This bypass pin disconnects the hydraulic steering system so that the nose wheel cannot be steered with the tillers or rudder pedals in the cockpit. The brakes are released during pushback/towing and set again when done. Finally the nose gear is lowered and the pin and headset connection are removed by the ground operator. Depending on company procedures start-up of one or more engines is already done during the pushback.

Towing procedures Brussels Airport

Every aircraft moving on the movement area must turn on its anti-collision lights, as an aircraft being towed (engines on or off) is considered to be operating. As defined in the Brussels Airport Airside Traffic Rules, no-one may approach an aircraft when the anti-collision lights are activated and consequently wing walking operations are thereby not allowed during push back and towing operations, even with aircraft engines off. This procedure is based upon a risk analysis, and the fact that no obstacle causative push back incidents were reported in the last 10 years.

However, when conventional tugs (with a towbar) are used for pushback and towing operations at Brussels Airport, the communication on the ground is done by an extra headset agent who walks next to the truck and always stays in visual contact with the flight deck.

In 2012 the Brussels Airport Safety Management Unit (SMU) issued a safety alert (see annex) towards the airlines representatives to remind them on the correct procedures to be applied during pushback and towing operations. The main message of this alert is that under no circumstances taxi may be initiated before the crew has received a clear ‘OK-to-taxi-hand signal’ from the ground crew. If in doubt the ground handler has to be contacted via air-ground frequency.

ICAO Standard phraseologies for pushback

ICAO Doc 4444, Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM) specifies the actual procedures to be applied by air traffic services units. Chapter 12 contains the phraseologies to be used in accordance with ICAO Annex 10 – Aeronautical Telecommunications.

Under paragraph 12.7.1.2 the standard phraseologies for pushback procedures between ground crew and cockpit can be found;

a) ARE YOU READY FOR PUSHBACK?;
*b) READY FOR PUSHBACK;
c) CONFIRM BRAKES RELEASED;
*d) BRAKES RELEASED;
e) COMMENCING PUSHBACK;
f) PUSHBACK COMPLETED;
*g) STOP PUSHBACK;
h) CONFIRM BRAKES SET;
*i) BRAKES SET;
*j) DISCONNECT;
k) DISCONNECTING STAND BY FOR VISUAL AT YOUR LEFT (or RIGHT).
Note.— This exchange is followed by a visual signal to the pilot to indicate that disconnect is completed and all is clear for taxiing.

* Denotes pilot transmission.

IATA Ground Operations Manual

Unlike ICAO, the International Air Transport Association (IATA) is a private trade association for the world's airlines, representing 84% of total air traffic. It was founded in 1945 to promote safe, regular and economical air transportation. The IATA Ground Operations Manual (IGOM), which is part of the IATA Airport Handling Manual (AHM), defines ground handling standards for both airlines and ground service providers for enhanced ground operational safety and damage reduction.

Dialogue between Ground Staff and Flight Crew

Phase	Ground Staff		Flight Crew	
Preparation	Call:	CONFIRM PARKING BRAKES ARE SET.	Reply:	PARKING BRAKES SET.
			Call:	CONFIRM BYPASS PIN INSTALLED. (except main gear pushback)
	Reply:	BYPASS PIN INSTALLED & CLEARED TO PRESSURIZE (IF APPLICABLE)		
			Reply:	ROGER BYPASS PIN INSTALLED, PRESSURIZING (IF APPLICABLE)
After completion of the pre-departure servicing checks				ROGER.
	Call:	PRE-DEPARTURE CHECKS COMPLETED, GROUND READY FOR "PUSHBACK" or "LIFTING" (TOWBARLESS)		STANDBY FOR PUSHBACK or
			Reply:	YOU MAY LIFT THE AIRCRAFT.
		CLEAR TO START ENGINE(S) (FOR OPEN RAMP DEPARTURE ONLY)		(TOWBARLESS) or
				STARTING ENGINE(S)...]
Pushback [and engine start]				Request pushback [and engine start] clearance from ground control. After clearance received:
			Call:	READY FOR PUSHBACK
	Call:	RELEASE PARKING BRAKES or LIFTING COMPLETED, RELEASE PARKING BRAKES (TOWBARLESS)		
				When brakes are released:
	Call:	COMMENCING PUSHBACK [AND CLEAR TO START ENGINE(S)...]	Reply:	PARKING BRAKES RELEASED
			[Reply:	STARTING ENGINE(S)...]
Pushback completed	Call:	PUSHBACK COMPLETED, SET PARKING BRAKES.		When parking brakes are set:
			Reply:	PARKING BRAKES SET
		Tractor is disconnected and positioned in view of the flight deck.		
			Call:	YOU MAY DISCONNECT.
Clearance to Taxi	Reply:	DISCONNECTING, HOLD POSITION AND WAIT FOR VISUAL SIGNAL ON YOUR LEFT/RIGHT.	Reply:	HOLDING POSITION AND STANDING BY FOR VISUAL SIGNAL TO MY LEFT/RIGHT.
	Disconnect headset and give the 'All Clear' hand signal. ('All Clear' signal includes showing the steering bypass pin)			Acknowledges "All Clear" signal.
			(Taxi clearance may only be requested after the 'All Clear' signal is received)	

Communication procedures Swissport

In the Ramp Operator training manual of Swissport is described how the communication between ROP and flight crew has to go. The last actions to be performed are shown here below. 'G' means the ROP and 'P' stands for pilot or the flight crew.

Lorsque le pushback est terminé :

G: Pushback completed, set parking brakes.

P: Brakes set.

G: Disconnecting nosegear lifter.

Après que l'avion sera déchargé.

G: Nosegear lifter disconnect

P: Roger

Lorsque le start-up est terminé :

P: Clear to disconnect and give a handsignal on the left side.

G: Disconnecting, wait for handsignal on the left side.

US Airways/American Airlines procedures and comments

Towing procedures vary from airport to airport. In the USA it is a common practice to make use of so-called wing walkers. In many other airports there is at least a second person besides the driver, who provides visual cues to the flight deck. The crew felt the lack of a second person may have led to the event. Also they felt the addition of a flag on the tug would have been a help in identifying the location of the pushback tractor.

The 'Before Taxi' expanded checklist of the company starts with the following item;

Captain	First Officer
After the Guideman has disconnected the tractor and interphone, the Captain will flash the nose gear taxi light once when ready to taxi. The Guideman will give the departure salute when clear to taxi. The Captain will advise the First Officer, "I have a salute."	

The last item of this checklist consists of the following;

Captain	First Officer
Just Prior to Taxi	
Check that left wing is clear and callout – "Clear Left."	Check that right wing is clear and callout – "Clear Right."

Analysis

As shown in Figure 2, the cabin of the tractor disappears behind the nose of the aircraft when the nose is lifted. Even when the tractor moves forward in front of the aircraft, it has to cross the 23 degrees angle in order to become visible for the flight crew. The amber flashing lights on the tug were illuminated but were not effective as it was daylight and the lights were covered by the belly of the aircraft.

The reasons why Swissport doesn't use a second ramp operator - acting as a headset agent - is because it is not necessary for the operation with a towbarless tug, it can constitute additional risks and it is less cost efficient. However the advantage of eliminating the need for a manual connection against the operation with a conventional tractor is not fully exploited as the ground operator is still required to walk under the aircraft when the tug isn't moved yet to disconnect the headset chord.

When comparing the different standards and procedures used, it can be concluded that according to both ICAO and IATA standards the ground personnel must initially instruct the flight crew to stand by and wait for visual hand signal, whereas the Swissport training manual gives the impression that the 'wait for hand signal' instruction is more a read back on a call from the flight crew. However this flight crew was not very familiarized with single operator pushback procedures and they - as well as the ground operator - couldn't recall if the instruction to wait for the hand signal was given. When having performed the other actions on the 'Before taxi' checklist, seeing no obstacles and finally having checked that both wings were clear, the flight crew probably wrongly believed that everything was clear and taxi could be initiated.

Both US Airways/American Airlines as Swissport made the safety suggestion to add a flag on the tug to make it visible to the flight deck. However as shown in figure 2, a flag on a vertical extended aerial isn't possible as it could scratch the fuselage of the 757. An horizontal extended flag introduces other safety risks with it.

The main safety issue of these pushback operations is that the ground operator has to walk under the fuselage close to the nose gear with the tug still below the belly and thus without any visual cues to the flight deck, exposing him to injuries if the aircraft inadvertently moves. If the communication would be done by means of a cordless headset or an extended cable, the tug could be disconnected from the aircraft and placed in sight of the flight crew before removing the bypass pin (and headset).

Conclusion

The collision occurred because the aircraft started to taxi whilst the pushback was not completed. Contributing factors were the lack of any visible cue to the flight crew inherent to the current operation with a towbarless tug and due to procedures not harmonised between the ground operator and the airliner.

Safety actions

Safety issue: lack of visible cues to flight crew

Safety action taken by Swissport

Swissport makes/made a study to investigate the possibility to install flags on the tugs which would be fixed on an extendable horizontal arm.

Safety recommendation 2014-C-7 to Swissport

AAIU(Be) recommends that Swissport investigates the possibility to change to cordless headsets for their ground operations. This in order to eliminate the need for the disconnection of the headset near the nose landing gear whilst the tug is still under the aircraft and out of the flight crew's sight.

Response to this recommendation:

"Swissport agrees with the recommendation and is already working on the implementation thereof. The implementation of the wireless headsets is foreseen for June 2015."

Safety issue: not harmonised procedures

Safety actions taken by American Airlines

The American Airlines International Chief Pilot debriefed/interviewed this crew concerning this event. As a result of his interview, the Captain and First Officer were given Line Checks, and these Line Checks were completed satisfactorily.

AA has also reemphasized to all of the pilots in their recurrent training the importance of not starting to taxi an aircraft until the pilots have received an 'OK to Taxi' hand signal from the ground crew.

Safety recommendation 2014-C-8 to Swissport

AAIU(Be) recommends that Swissport changes their communication procedures in their training manual so that the ground operator is aware that he always has to instruct the flight crew "to wait for hand signal". By doing that, as the most vulnerable crew in this procedure, he reminds the flight crew who might be busy and perhaps not familiar with the single operator pushback procedure.

Response to this recommendation:

"Swissport agrees with the recommendation. The training manual related to the headset communication should be reviewed by the end of June 2015."

About this report

As per Annex 13 and EU regulation EU 996/2010, each safety investigation shall be concluded with a report in a form appropriate to the type and seriousness of the accident and serious incident. For this occurrence, a limited-scope, fact-gathering investigation and analysis was conducted in order to produce a short summary report.

It is not the purpose of the Air Accident Investigation Unit to apportion blame or liability. The sole objective of the investigation and the reports produced is the determination of the causes, and, where appropriate define recommendations in order to prevent future accidents and incidents.

Annex: Safety Alert Brussels Airport SMU

Brussels Airport
Welcome to Europe

2012-08-22

"Safety Alert"

"Pushback Ops -Tractor/Towbar/Towbarless/Power Push"

Dear Crew, Station Manager, Airline Representative,

Following recent incidents we want to remind you of the correct and safe applicable procedures during pushback and towing operations. Please respect these procedures in order to prevent human suffering and to avoid damage to ground support equipment and aircraft.

UNDER NO CIRCUMSTANCES START TO TAXI BEFORE YOU HAVE RECEIVED A CLEAR OK-TO-TAXI-HANDSIGNAL FROM THE GROUND CREW. IF IN DOUBT CONTACT YOUR GROUND HANDLER VIA AIR GROUND FREQ.

Nose- & Maingear controlled (Tractor & towbar + towbarless + Power Push)

At the end of the pushback sequence and before the towbar or tractor is disconnected, the flight deck should be instructed to set the aircraft brakes and hold position until receipt of visual signals for final clearance to taxi. Note: Brakes set must be confirmed to ground staff.
Before the aircraft commences taxiing under its own power, all equipment and personnel must be moved clear of the aircraft. Ground staff shall then give the final clearance signal once they are clear of the taxiway and display of the steering bypass pin (if applicable) to the flight deck crew. This indicates that all equipment and staff are clear of the aircraft and that it is safe to commence taxiing. An acknowledgement of the signal must be received from the flight deck crew.

Information based on IATA Ground Handling Manual—Airside Management and Safety—AHM 631

Prepared by SMU Brussels Airport - safetymanagement@brusselsairport.be

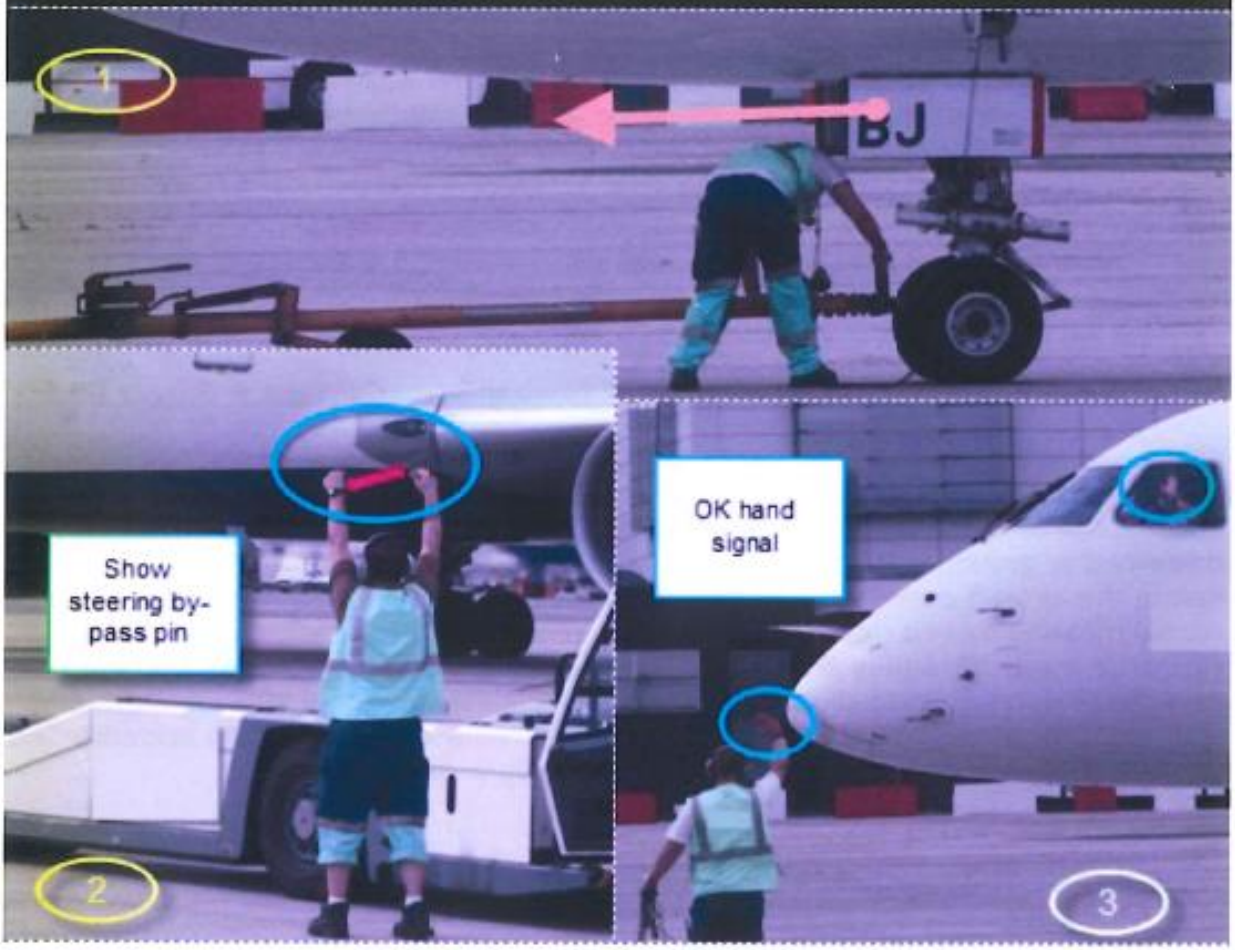
Brussels Airport
Welcome to Europe

2012-08-22

"Safety Alert"

"Pushback Ops -Tractor/Towbar/Towbarless/Power Push"

UNDER NO CIRCUMSTANCES START TO TAXI BEFORE YOU HAVE RECEIVED A CLEAR OK-TO-TAXI-HANDSIGNAL FROM THE GROUND CREW. IF IN DOUBT CONTACT YOUR GROUND HANDLER VIA AIR GROUND FREQ.



Information based on IATA Ground Handling Manual—Airside Management and Safety—AHM 631

Prepared by SMU Brussels Airport - safetymanagement@brusselsairport.be