Boeing 747-286B, EP-IAH

AAIB Bulletin No: 5/2003	**Ref: EW/ C2002/06/09**	**Category: 1.1**
INCIDENT		
Aircraft Type and Registration:	Boeing 747-286B, EP-IAH	
No & Type of Engines:	4 Pratt & Whitney JT9D-7F turbofan engines	
Year of Manufacture:	1977	
Date & Time (UTC):	20 June 2002 at 1900 hrs	
Location:	London Heathrow Airport, Stand M30 (Terminal 3)	
Type of Flight:	Public Transport	
Persons on Board:	Crew - 25 (approx)	Passengers - 295 (approx)
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Puncture of pressure hull skin below Door 2L	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	55 years	
Commander's Flying Experience:	19,000 hours (of which 8,000 were on type)	
	Last 90 days - 120 hours	
	Last 28 days - 40 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The aircraft was ready to depart and the handling agent's airbridge operator, who was qualified according to the Airport Authority's requirements but not familiar with this specific type of airbridge, attempted to back it away from the aircraft door. In her concern to avoid damage to the wing root, without an axle position indicator, to which she was accustomed, the operator applied an excessive steering command and when reverse drive was applied, the airbridge head started to move to the left, along the fuselage side. Although she obtained assistance from an airbridge training officer, during the subsequent attempt to retract the airbridge, the aircraft's pressure hull was punctured by the front of the airbridge. The damage to the hull resulted in the aircraft having to be withdrawn from service. Five safety recommendations are made relating to airbridge operator training, airbridge equipment and limit stop adjustment.

The incident

Boarding had been completed and the aircraft was ready to depart from the stand. The handling agent's airbridge controller was qualified according to the Airport operator's requirements but she was not very familiar with the type of airbridge installed at Stand M30. When she attempted to back it away from aircraft Door 2 Left, she was conscious of how near the airbridge head was to the aircraft's

wing root. Consequently, before starting to back away from the door, she turned the drive axle to ensure that the airbridge head did not hit the wing. However, when reverse drive was applied to the drive axle, the airbridge head started to move to the left, parallel to the fuselage side.

A member of the ramp crew, observing that the drive axle was aligned with the side marked 'BACK' facing towards the front of the aircraft, told the controller not to operate the airbridge and to ask for assistance from the Airport operator's engineering department. At this point, an inspection showed there to be some scratches on the aircraft paintwork below Door 2 Left.

The airbridge controller, however, believing that the operator wished to get their aircraft clear of the ramp as soon as possible, made a further attempt to realign the drive axle and retract the airbridge. This was also unsuccessful and resulted in the fuselage skin being dented. The airbridge controller then asked for, and obtained, assistance from the handling agent's airbridge training officer but during the subsequent attempt to retract the airbridge, the aircraft's pressure hull was punctured by the front of the airbridge. At this point the Airport operator's engineers arrived but declined to assist in separating the airbridge from the aircraft as they might then be responsible for causing further damage.

The damage to the hull resulted in the aircraft having to be withdrawn from service and a substitute aircraft flown into Heathrow.

At the time of the incident, the sun was very bright and shining directly through the sideways facing window in the airbridge head into the face of the operator when she faced the airbridge control panel. The significance of this factor will be discussed later in this report.

Qualification of airbridge operating staff

The moving embarkation airbridges at Heathrow fall into two categories. The simpler type, known as 'Rail Drive' airbridges and a variety of more complex types, generically known as 'Apron-drive' airbridges.

Airbridge controllers are generally employed by airline operators or their handling agents and trained by them to pass a competency test, required by the Airport operator, qualifying them to become authorised airbridge controllers. Normally a new controller would gain experience under supervision, initially on the 'Rail Drive' type progressing to the more manoeuvrable 'Apron-drive' types before being put forward for competency testing. Once they had passed the competency test, an airbridge controller would be considered qualified to operate any airbridge unsupervised.

At the time of this incident, authorisation was not specific to a particular 'Apron-drive' type but was valid for all types. However, it was accepted practice that controllers who had worked exclusively at Terminal 4, where all the airbridges are from a single manufacturer, would have familiarisation training on the variety of types found in the Central Area, if they were transferred there, but would not have to undergo another competency test. There was a similar policy for controllers transferred from the Central Area to Terminal 4 receiving familiarisation training on the type encountered there.

Types of airbridge used at London Heathrow

a) Rail-drive (see Figure 1 Plate 1)

Figure 1

Illustrations showing relevant features of types of airbridge in use in Terminals 2 and 3 at London Heathrow, Central Area.

Plate 1 Rail-drive airbridge

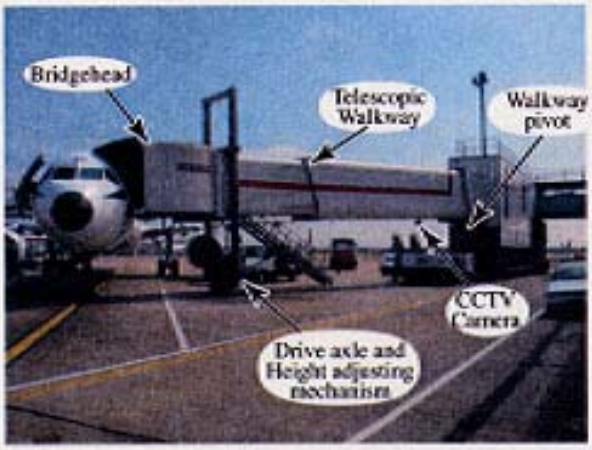

Plate 2 Older type apron-drive airbridge

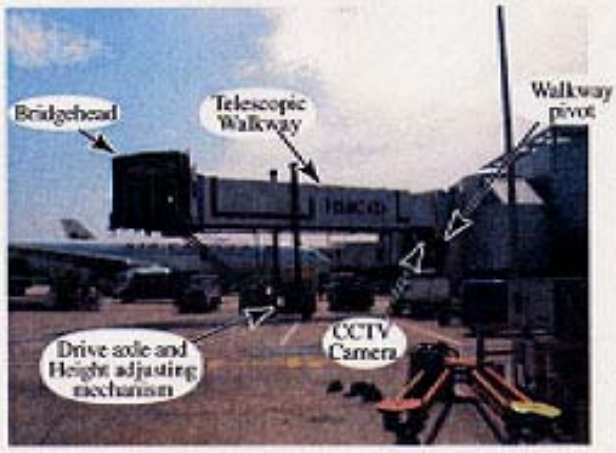

Plate 3 Latest type apron-drive airbridge

Plate 2a Control console on older type apron-drive airbridge (faces forwards)

Plate 3a Control console on new type apron-drive airbridge

Plate 3b Console in alcove facing side window

These have all been supplied by one manufacturer and have subsequently been updated to a common standard. They are in use at all the terminals in the Heathrow Central Area.

This type consists of a relatively short, telescopic pedestrian tunnel which projects from a fixed access walkway and is orientated at right angles to the centreline of the aircraft stand which it serves. The inner end of the airbridge is hinged on the fixed walkway to allow the airbridge head, which abuts the aircraft, to be raised or lowered to suit the door sill height of any aircraft type permitted to use the particular stand. The telescopic portion extends beyond the height adjusting mechanism, which is mounted on a fixed base on the apron, and, when fully retracted, is well clear of the fuselage of an aircraft on the stand. This type of airbridge cannot be moved laterally relative to the aircraft's side and so, on stands with this type of airbridge, aircraft must park in a precise position, according to their specific type and model. The airbridge extension and head height are controlled from a console at the airbridge head which is orientated in the same direction as the airbridge.

b) Apron-drive (see Figure 1 Plates 2 & 3)

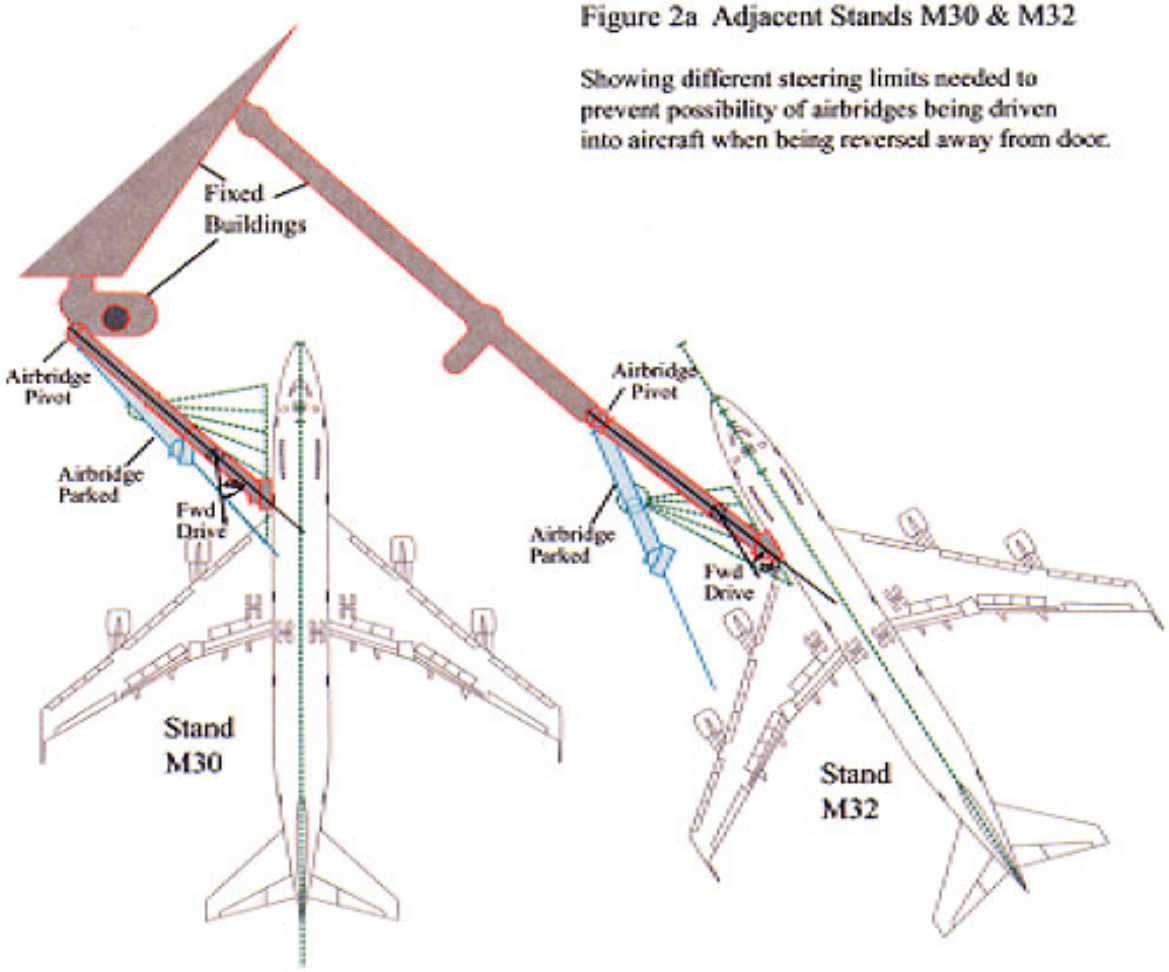

Figure 2a Adjacent Stands M30 & M32

Showing different steering limits needed to prevent possibility of airbridges being driven into aircraft when being reversed away from door.

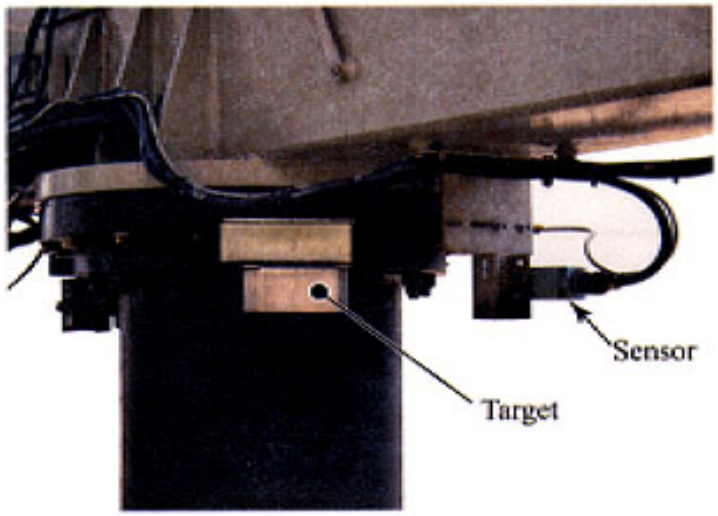

Figure 2b View showing accessibility of limit switches

At Heathrow, the 'Apron-drive' airbridges have been supplied by three different manufacturers and have differing detail characteristics. Examples from all three manufacturers are in service in the

Central Area, but the type used throughout Terminal 4 is used only in Terminal 1 of the Central Area. As the controller involved in this incident controls airbridge positioning only in Terminals 2 & 3 of the Central Area, this type is not illustrated and will not be described more fully.

Of the 'Apron-drive' airbridges in Terminals 2 & 3, where the controller involved in this incident worked, all of those in Terminal 2 and the majority in Terminal 3 are of one make and have been in service for several years (see Figure 1 Plates 2 & 2a). These are controlled from a console in the airbridge head and have the steerable drive axle and height adjusting mechanism just behind the airbridge head; the drive axle steering has limiting switches fitted in the mechanism. The control console faces forward, which gives the controller a direct view out of the front of the bridge towards an aircraft on the stand; there are no side windows. The drive and/or steering can be operated manually, from ground level, if power to the bridge is lost or disabled.

Airbridge movement across the apron is controlled by a joystick, which causes movement of the bridgehead in the same direction that the stick is deflected, and there are pushbutton controls for bridge head slew and height. There is an axle position indicator which shows, clearly, the orientation of the drive axle relative to the axis of the airbridge and the direction of 'forward' drive. There is a monitor with adjustable brightness and contrast, but no zoom, to view the image from an apron surveillance CCTV camera. This is mounted on the underside of the airbridge walkway, back near the pivot, and allows the controller to see any obstructions on the apron area around the drive axle and is used to position the airbridge wheels in their parking 'box' when it has been drawn back from an aircraft on the stand. This was the type of airbridge with which the controller involved in this incident was familiar.

The 'new' Apron-drive airbridge

The other type of 'Apron-drive' airbridge, of which three have been introduced into Terminal 3 relatively recently, whilst not radically different in concept from the more numerous older type, has significant detail differences (see Figure 1 Plates 3 & 3a). It is, similarly controlled from a console in the airbridge head but on this type the control console is located in an alcove on the left hand side of the head, directly below a sideways facing window. Therefore, if the controller wishes to look towards an aircraft on the stand, they must either face the console and look over their right shoulder or stand, facing the aircraft, beside the console and operate the controls with their left hand. Airbridge movement across the apron is similarly controlled by a joystick which causes movement of the bridgehead in the same direction that the stick is deflected. There are pushbutton controls, similar to those in the other type, for bridge head slew and height.

This type has the steerable drive axle and height adjusting mechanism a considerable distance back down the walkway from the airbridge head which results in a different movement geometry compared to that of the older type. There are similar steering limiting switches fitted in the mechanism as in the other type; they are externally mounted and readily accessible for adjustment. There is also a proximity sensing system in the bridgehead which, in the final stages of its approach to the aircraft, limit the speed of the bridgehead, stop it at the correct point and prevent forward drive being engaged when in this position. The sensor system does, however, permit reverse drive to be applied to disengage from the aircraft.

On the 'new' airbridge type there is no drive axle steering position indicator on the console and to determine the axle orientation visually, the controller would normally use the apron surveillance CCTV camera image. This is displayed on a monitor which is not adjustable for zoom, contrast or brightness and is situated directly below the window which has no blind on it. When the airbridge is considerably extended (as it is when serving Door 2 Left on a Boeing 747) the image of the drive axle is small and indistinct. Moreover, the legend, either 'FRONT' or 'BACK', painted in white on a grey axle beam, is not easily discernible. It has been observed that, with bright sunlight shining in through the window, the image on the monitor is barely visible and the definition of details at the distance of the drive axle with the airbridge extended is extremely poor. The possibility exists for a controller to

go through a secure door onto the outside of the bridgehead to view the axle directly, but this is not normal practice and has not been promoted in training.

Conditions at the time of the incident

The weather, on the day of the incident, was very fine and at the time at which it occurred, 1900 hrs local, the sun was shining directly in through the window above the control console. This would have made it extremely difficult to discern any picture on the monitor and determination of the drive axle orientation, by means of the CCTV, unlikely. As the controller was unfamiliar with the physical layout of this type of airbridge, she did not attempt to view the drive axle directly from the platform outside the bridgehead secure door. Moreover, there was no evidence to indicate that she had been made aware of this possibility.

Following this incident, the Airport operator fixed a placard with a supporting photograph in the cabs of the new type airbridges with instructions emphasising the need to ensure that the drive axle is correctly orientated before each bridge movement. The placard draws attention to the existence of a yellow chevron on rear of the drive axle, to aid the determination of the orientation of the axle through the CCTV monitor. However, no contrast, brightness or zoom controls have been fitted to the monitors to enable airbridge controllers to adjust the picture so as to readily distinguish these legends in all lighting conditions.

Discussion

The damage caused to aircraft by vehicles and ground equipment during airport ground handling operations is a constant area of concern. Not only do such incidents cause delays and raise the probability that additional incidents will occur as a result of the generally increased workload, they also cause unnecessary damage to aircraft, frequently to the pressure hull. In the case of airbridges, their position relative to the aircraft make it most likely that if they do cause damage, it will be to the pressure hull or to the high lift devices on the wings.

Since damage to the pressure hull, even when repaired, will most probably degrade the local fatigue resistance of the hull, all reasonable steps should be taken to ensure that incidents causing such unnecessary damage are reduced to a minimum.

It is evident that, in her concern to avoid damage to the wing root of the aircraft, the airbridge controller applied an excessive steering command in the opposite sense. However, without the availability of an axle position indicator, to which she was accustomed, she was unaware of the degree of this excess and she remained unable to determine the orientation of the drive axle from that point onwards. Her company's training officer, who came to assist her, was also unsuccessful in turning the drive axle to an orientation which allowed him to retract the airbridge without causing further damage to the aircraft. This indicates both the degree of unfamiliarity of this handling agents' airbridge controllers with this newer type of airbridge, and the hazard to aircraft which can result from airbridges being operated by staff who are unfamiliar with all their characteristics.

Aerodrome Manuals

Under the terms of Article 103 of the Air Navigation Order, one of the conditions which must be met before the Civil Aviation Authority may grant a licence to an intending aerodrome licence holder is for them to submit an adequate aerodrome manual. The authority issues guidance to prospective licence holders in Civil Aviation Publication (CAP) 642 'Airside Safety Management'.

CAP 642 Airside Safety Management

CAP 642 was recently revised by the CAA and re-issued on 28 February 2003; the current version is available at no charge on the Internet at http://www.caa.co.uk/docs/33/CAP642.pdf

The current version states its purpose as follows:

'CAP 642 was produced to provide guidance on matters affecting the health and safety of individuals and the safety of aircraft to aerodrome operators, airlines and other organisations that undertake activities in airside areas of aerodromes. The document incorporates a brief overview of the legislative and regulatory arrangements and obligations that apply in airside areas and offers a number of model procedures demonstrating current industry best practice on which aerodrome operators and other organisations may base their local procedures'.

This report quotes from the previous version of CAP 642 that was extant at the time of the incident. Where appropriate, references to the relevant section of the current version of CAP 642 are included.

Airbridge operator training and authorisation

CAP 642, Part 5, Section 2 contained advice on airbridge operations, some of which was specific to operator training and licensing. (The current advice is in Chapter 2 Part 9.17 beginning on page 27; the differences between the versions are mainly editorial). The original advice is quoted, verbatim, below.

2.3 Operator Training and Licensing

2.3.1 A system should be established for the training, testing and licensing of airbridge operators in accordance with Part 6 of this publication. An Airbridge Operators Licence (or Permit), endorsed for the appropriate type of airbridge, should be issued by the airport authority when a satisfactory level of competence has been demonstrated by means of a practical test under the supervision of the airport authority.

2.3.2 Licences should only be issued to those staff who regularly operate airbridges as part of their job function, as it is these staff who remain fully familiar, in good operational practice and up to date with operational changes and airbridge modification states. Licence holders should be subject to regular re-validation. The airport authority should also establish an audit system for operator competency and adherence to standards, including the examination and recording of airbridge incidents and major faults. Following an accident or incident, airbridge operators should be subject to re-validation on request of the airport authority and it should be possible to suspend an operator's licence pending re-training.

In CAP 642, Part 5, Appendix A, was a model safety instruction for Passenger Airbridges. (Chapter 2 Appendix I in the current version - the differences between the versions are mainly editorial). The following example of what the CAA considered satisfactory is quoted, almost verbatim, below.

3 Airbridge operator licensing

3.1 Airbridges may be operated only by persons holding an Airbridge Operator's Licence, endorsed for the appropriate type of airbridge. Licences are restricted to those persons who operate airbridges regularly as an essential part of their job function. Licences will not normally be issued to employees of airlines who have nominated a handling agent to perform the dispatching function.

3.2 The issue of a licence is subject to a satisfactory course of training, followed by an airbridge driving test, where candidates must be able to demonstrate a high standard of safety proficiency in the operation of the airbridge.

3.3 Tests are carried out by a member of The Airport Airfield Safety Department. Applications for tests should be made by airline airbridge training officers approved by The Airport, direct to the Airfield Safety Department, telephone 1234-5678 during normal office hours. Licences must be re-validated every 2 years by the nominated airbridge training officer. The Airport may also require a licence holder to be submitted for a re-validation check on request. Operators must comply with any other requirements or conditions which may be determined from time to time by The Airport.

3.5 The airbridge licence remains the property of The Airport. In circumstances where, in the opinion of The Airport, the operator has acted negligently or recklessly in the operation of an airbridge, The Airport reserves the right to suspend unconditionally and immediately the licence for a specified period pending retraining or to withdraw the licence altogether.

In the introduction section of this model instruction however, it was implied that 'Apron-drive' airbridges are considered to be a specific rather than generic type.

1.1 All pier served stands at The Airport are equipped with passenger airbridges. There are two specific types of bridge in use, referred to as either rail-drive or apron-drive airbridges.

Although, generically, the 'Apron-drive' airbridges from the various manufacturers all work in a similar way, there are subtle differences in the design philosophies and physical layouts favoured by each. This had been accepted, in part by the Airport Authority at Heathrow, in that there was a requirement to undertake familiarisation training when an airbridge controller was moved from Terminal 4 to the Central Area terminals or vice-versa.

On the evidence gathered during this investigation, it was apparent that there were sufficient differences between the two types of 'Apron-drive' airbridge, in Terminal 3, to lead to the controller having difficulty with the steering of the type with which she was less familiar. Although the type of airbridge involved in this incident only constituted a very small proportion of those to which this controller was likely to be sent, it was always probable that she would ultimately encounter one. It was, however, probably largely as a result of the scarcity of this relatively new (in her area of working) type of 'Apron-drive' airbridge that both she and her Training Officer were unfamiliar with its control characteristics and the damage to this aircraft was occasioned.

The likelihood of controllers encountering types with which they are unfamiliar is influenced both by the size of the airport at which they are working and the introduction onto the airport of new airbridges. Therefore, at airports where there are 'Apron-drive' airbridges produced by a variety of manufacturers, there would appear to be a need to ensure that all airbridge controllers acquire and maintain an awareness of the characteristics and a current competency on all the specific airbridge types that they are likely to encounter during their normal duties. This is particularly the case for the Airbridge Training Officers. Accordingly, the following Safety Recommendations are made:-

Safety Recommendation No 2003-19

Within CAP 642 the Civil Aviation Authority should advise Licence Holders of Airports at which there is a variety of specific types of airbridge installed, to adopt a system which ensures that Airbridge Operators' Licences (or Permits) restrict the holder to operating only those specific airbridge types upon which they have been tested for competency.

Safety Recommendation No 2003-20

Within CAP 642 the Civil Aviation Authority should advise Licence Holders of Airports at which there is a variety of specific types of airbridge installed, to adopt a system which ensures that airbridge operators maintain an adequate familiarity with all the types that they are approved to operate.

Safety Recommendation No 2003-21

The Civil Aviation Authority should require Airport Licence Holders to have a training and audit system to ensure that the Airbridge Training Officers for all companies that operate airbridges are regularly tested for familiarity with and competency on all types of airbridge installed at their airport. This system should ensure that Airbridge Training Officers are fully acquainted with any new type of airbridge as soon as it is commissioned.

Safety Recommendation No 2003-22

The Civil Aviation Authority should inform all UK Airport Authorities of the revised advice and guidance regarding airbridge operator training and authorisation when such guidance is formally issued in CAP 642.

Amendment of CAP 642

Because the current (revised) version of CAP 642 is in the process of being published on paper, the CAA advised the AAIB that any changes which might arise from the recommendations above must be included in a future amendment. However, the CAA expects to notify aerodrome licensees of any proposed amendments through the medium of a NOTAL (Notice to Aerodrome Licence Holders) or in 'Reference Point', a CAA communication document sent to all aerodrome licensees.

Additional Factors

The fundamental reasons for the occurrence of this incident were the airbridge controller's inability to properly assess the orientation of the driving axle and the possibility which existed for the axle to be orientated in such a way that the bridge head could be driven towards the aircraft (albeit obliquely) whilst already in contact with it.

Without a drive axle orientation indicator on the bridgehead control console, the primary means of assessing axle orientation, on these most recently introduced Thyssen airbridges, is via the CCTV image. However, investigations have established that this image can be extremely poor in adverse lighting conditions and at long extensions of the airbridge. Added to this, the legends painted on the front and back of the axles were not radically different at the time of this incident, leading to a greater possibility of misidentification under these conditions. If the CCTV image is to remain the primary means for establishing axle orientation, the clarity of the monitor image should be considerably improved and the visual identification of the back face of the axle made unequivocal. Moreover, the utility of the CCTV camera could be improved if it were fitted with a zoom lens capability. Therefore, the following safety recommendation regarding airbridge facilities was made:-

Safety Recommendation No 2003-23

Heathrow Airport Limited, in consultation with Thyssen, the airbridge manufacturer, should improve the ease of use and accuracy of the means by which airbridge controllers can assess the orientation of the drive axles of the type of airbridge installed at Stand M30 of Heathrow Terminal 3.

Airbridge steering limits

Although the airbridge is fitted with a refined system for preventing a damaging approach of the bridgehead to an aircraft, this system is disabled whilst the airbridge is being driven in reverse. If the steering limit switches do not prevent the drive axle being turned to an orientation which, when reversing, will cause the bridgehead to move obliquely towards the fuselage of an aircraft on the stand when the airbridge is positioned most nearly parallel to the aircraft fuselage when serving a door, inadvertent damage to the aircraft will always be possible.

If steering limitation were to be used as an additional means of preventing airbridges from colliding with aircraft on the stand, the limits set would need to be unique to each stand. An examination of the geometry of Stand M30 showed that to avoid reversing into the side of an aircraft whilst retracting the airbridge from its furthest permitted extension, it would be necessary to limit the steering angle to the right to about 40° (see Figure 2 Diagram 1). On the adjacent stand, M32, the different relative alignments of the Stand centreline and airbridge pivot indicate that a much smaller steering angle to the right, of the order of 5°, would be all that was permissible.

As a result of these aspects of the investigation, therefore, the following additional Safety Recommendation is made:-

Safety Recommendation No 2003-24

Heathrow Airport Limited should consider determining and setting the steering limits of 'Apron-drive' type airbridges such that whilst the airbridge is being driven in reverse, it is not possible for the bridgehead to approach the fuselage side of a correctly positioned aircraft.