

Serious Incident

Aircraft Type and Registration:	Boeing 737-4K5, G-JMCZ
No & Type of Engines:	2 CFM56-3C1 turbofan engines
Year of Manufacture:	1989 (Serial no: 24126)
Date & Time (UTC):	26 April 2024 at 0030 hrs
Location:	En-route to Edinburgh Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to liner tape and paint on forward bulkhead
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	9,045 hours (of which 2,365 were on type) Last 90 days - 70 hours Last 28 days - 33 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

At the start of the descent for Edinburgh Airport the cargo shifted in the main deck and came into contact with the forward bulkhead. The aircraft landed safely at Edinburgh without further incident. The crew were notified of the movement after the cargo had already been unloaded so it was not possible to ascertain whether the locks had not been engaged or had malfunctioned in some way. The operator took a number of safety actions to address the risks of unsecured cargo moving during flight.

History of the flight

When the crew began their descent on the flight from London Stansted Airport to Edinburgh Airport, they heard what they described as a "dull double bang." All the engine indications were normal except a momentary higher vibration indication on the right engine. There had been previous reports of sporadic indications on this engine and the crew considered the possibility that the engine had surged but there were no further indications. The crew also considered that there may have been a cargo shift on the main deck. Having completed their decision-making process, they elected to continue to Edinburgh where the aircraft landed safely without further incident.

Once the aircraft was parked on the stand, the main cargo door was opened and cargo unloading began immediately. The crew were informed by the ground crew that a unit load device (ULD) that had been loaded in Bay B in the aircraft was found in Bay A.

Aircraft information

G-JMCZ is a Boeing 737-400 built in 1989 as a passenger aircraft. It was converted into a cargo aircraft in 2010 with the addition of a large side cargo door and a cargo handling system inside the cabin. The aircraft is fitted with a bulkhead at the front of the cargo cabin between the large cargo door and the forward aircraft door. This bulkhead has a small sliding door to allow the crew to enter the main cargo deck when not blocked by any loaded cargo. There is a small porthole window in the door. The aircraft can be loaded with both 108 inch and 125 inch pallets or ULDs that can be placed in one of 11 (named A to L) bays within the main deck. Bay A is at the front of the aircraft. The aircraft holds are also available for cargo.

All cargo carried in the aircraft must be secured to prevent movement during aircraft operations such as takeoff, turbulence, landing or during an emergency. For the main deck, ULDs are secured using the aircraft palletisation side rails and floor locks, whilst pallets are secured using floor locks and by straps or cargo nets.

Aircraft examination

Examination of the forward bulkhead revealed some minor damage to the liner tape and paint. There was no damage to the main door bulkhead, door, or the cargo handling system.

Aircraft cargo load

The aircraft was loaded with items in Bays B to L, leaving Bay A empty. This is described as a void bay. The weight of the item in Bay B was 695 kg and the total weight of the cargo on the main deck was 8,944 kg.

Weight and balance

One of the many risks for a cargo shift in flight is a change in the aircraft centre of gravity that can lead to issues with controlling the aircraft. During the flight the crew experienced no control or handling difficulties. Calculations by the operator after the incident demonstrated that even with the cargo shift, the aircraft centre of gravity remained well inside the manufacturer's limits and the change was insignificant.

Organisational information

Cargo loading and security

Prior to loading the commander will receive a load instruction form (LIR). This will either be for the crew to plan the load positions or they will already have been planned using a computer based tool. In either case, the crew must check that the loading plan is correct and meets regulatory requirements. The loading can then be completed by the ground crew.

The operator's Operations Manual Part B (OMB) states that:

'The aircraft commander is responsible for all loading and off-loading of cargo although he may defer this responsibility to other suitably qualified company personnel. The loading and off-loading of the aircraft by handling agents and/or ground crew will be supervised at all times by the aircraft crew or other suitably qualified company personnel.'

Once loading is complete the cargo handling person responsible for loading must sign the LIR. In doing so they are signing to say that the cargo is loaded in accordance with the load instruction and secured in accordance with the current company regulations. As a result of a review into a number of incidents, the operator developed and launched a new LIR, which makes clearer what the load supervisor and commander are signing for.

Visual inspection of cargo security by the crew

As each pallet or ULD is loaded onto the main deck, the volume of the cabin is obstructed and it is not possible to move past or look at the locks of either the new load or any previously loaded item beyond the locks visible from in front of the load. A crew member cannot inspect the load for security beyond what they can see from the front of the load. Whilst they can attempt to move the foremost pallet or ULD to give them some indication of its security, such items can weigh a significant amount and may not move easily even if they are unlocked.

Once in flight, the crew can look through the small window in the bulkhead door but what they can see is limited both by the lack of lighting and the lack of space around the cargo load.

Risks of a void bay

Void bays are acknowledged as a risk for load security within the operator's OMB. For multiple void bays the operator requires that all floor locks are raised to the locked position to minimize movement in the event of a load shift. The operator originally preferred that any void bays should be at the front of the aircraft so that the floor locks could be inspected, if possible, by the crew through the bulkhead door or the main cargo door as required. The requirement for a single void bay to be Bay A for the B737-400 was changed by the operator after this incident by a notice to crew to state:

'A single void planned in B is considered the lowest risk despite being unable to inspect visually from the forward vestibule, because the human error exposure from the ground teams forgetting to raise floor locks on a single in A is higher than if in B due to load procedures. If a void is in B, a crew could push on the ULD in A via the bulkhead door which may give an indication of the security of that ULD.'

The new version of the LIR also contained a section where parties sign for the status of the floor locks in any void bays.

Unloading procedures

When the aircraft arrives on stand at the destination and has been shut down, one of the crew must open the main cargo door so that unloading can begin. The operator had no specific procedures for the ground crew to check the load and to notify the crew or the operator if the cargo had moved from its loaded position.

Other information

The Civil Aviation Authority (CAA) manages a number of forums to capture industry-wide issues and to share best practice between operators, and these forums include the Flight Operations Liaison Groups. They established a liaison group for larger cargo operators which includes the operator of G-JMCZ. The operator took the lead within this group on managing the threat of void bays.

Analysis

During the start of the descent into Edinburgh, the ULD loaded in Bay B moved forward into Bay A and struck the forward bulkhead. Although the crew initially considered that the noise might have been associated with an engine after they noted an abnormal vibration indication, they concluded that they may have had a cargo shift. Due to the cargo being unloaded before the crew had completed their post-flight actions, it was not possible to establish which locks, if any, had been secured on the ULD before the flight departed from Stansted or if the locks malfunctioned in some way. There was some minor damage to the bulkhead and no damage to the cargo loading system. The aircraft centre of gravity remained within limits and the crew experienced no limitations in control or handling. The aircraft landed at Edinburgh without further incident.

The cargo was loaded at Stansted leaving Bay A as a void. Given the lack of space within the main deck, it is not possible for anyone to check the security of the load or the position of the locks once the cargo is loaded. It is only possible to check the front locks of the forward most ULD and any void space in front of that. The check of the locks therefore must be done for each ULD or pallet as it is loaded. It is likely that during the loading of the ULD in Bay B, either some or all of the locks were not secured, and this allowed the ULD to move forward into Bay A when the aircraft pitched down for the descent.

The operator's procedures place the ultimate responsibility on the commander (or a delegated crew member) to ensure the security of the load, but it is difficult to see how this can be complied with unless each individual ULD or pallet is checked as it is loaded. The operator's procedures also require the cargo handling person responsible for the loading to sign to confirm that the load is secure. All these procedures were to be reviewed by the operator as part of the safety action group review. A new version of the LIR was already in use at the time of publication to make clear the responsibilities of all parties in ensuring the load is secure. It also required all the parties to acknowledge and sign for the security of void bays in that all floor locks have been raised.

The operator took action to address the risks posed by cargo shifts and particularly void bays within its operation. It was also leading an initiative within an industry-wide group established by the CAA on the specific threat of void bays.

Conclusion

During the start of the descent for landing at Edinburgh, the ULD loaded in Bay B shifted forwards, hitting the forward bulkhead wall. The ULD was found in Bay A when the cargo was unloaded on arrival. It is likely that the locks on the ULD loaded in Bay B were not secured as required, allowing the ULD to move during flight. The operator made a number of changes to address the risks of cargo shifts and of void bays in particular.

Safety actions/Recommendations

The operator took the following safety actions:

- Issued a notice to crew aimed at crew awareness and mitigation of load shift during flight, specifically relating to void bay awareness and management.
- Issued guidance to move a single void bay in the B737-400 from Bay A to Bay B as it was assessed to be lower risk and gave the crew some opportunity to check the security of Bay A from the bulkhead door.
- Convened a Safety Action Group to specifically look at the risk exposure and assess barrier strengths in cargo loading and security.
- Issued a new LIR which made the obligations of each party clear for load security and included a box requiring the signature of all parties for the locks in void bays should there be any on the flight.
- Engaged with the CAA safety forum, leading on the risks of void bays

The CAA also took action as a result of a number of cargo shift events in the industry:

- Established a medium-size-operator Flight Operations Liaison Group which captures the larger cargo operators to share events, risks and best practice