



Australian Government

Australian Transport Safety Bureau

Uncontrolled pressurisation change involving Boeing 737, VH-XMO

near Melbourne Airport, Victoria, 6 July 2021



ATSB Transport Safety Report

Aviation Occurrence Investigation (Short)

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Addendum

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Safety summary

What happened

On 6 July 2021, a Boeing Company 737-376SF (B737), registered VH-XMO and operated by Express Freighters Australia, was operating a freight flight from Perth, Western Australia, to Melbourne, Victoria. While passing 8,000 ft on descent the flight crew received pressurisation system cautions and the cabin depressurised. The flight crew performed the non-normal checklist and continued to Melbourne for an uneventful landing.

What the ATSB found

The ATSB found that an aft cargo bay insulation blanket had not been secured correctly during a previous maintenance activity. During the descent, the unsecured blanket became lodged in the main pressurisation outflow valve, inhibiting its ability to control aircraft pressurisation.

What has been done as a result

The operator conducted an inspection of aft cargo compartment pressurisation components and insulation blankets in their B737 fleet resulting in multiple unserviceabilities being discovered and rectified. Following these inspections, Express Freighters Australia implemented a 4,000 hour or 36 month insulation blanket visual inspection task for the B737-300 and a 4,000 hour or 18 month visual inspection task for the B737-400.

Safety message

Aircraft periodic inspection tasks often require equipment or covering removal to access inspection areas. Maintenance crews are reminded of the importance of ensuring that any items removed for access are thoroughly inspected for serviceability and securely reinstalled. Items must be refitted in accordance with the maintenance manual to prevent unsecured items inhibiting flight critical systems such as the aircraft pressurisation system.

The investigation

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope investigation was conducted in order to produce a short investigation report, and allow for greater industry awareness of findings that affect safety and potential learning opportunities.

The occurrence

On 6 July 2021, a Boeing 737-376 Special Freighter, registered VH-XMO and operated by Express Freighters Australia, was conducting a night freight flight from Perth Airport, Western Australia to Melbourne Airport, Victoria. The operating flight crew comprised of a captain and a first officer. There were no passengers. The aircraft departed Perth at 1206 Coordinated Universal Time (UTC)¹ (2006 local time) and climbed to a cruising altitude of Flight Level (FL) 370.²

At about 1453, the flight crew commenced their planned descent to Melbourne Airport. While descending through 8,000 ft, the AUTO FAIL and STANDBY annunciator lights illuminated on the pressurisation panel (see the section titled *Pressurisation system* and Figure 5). The flight crew reported feeling a rush of cold air and a soreness in their ears. The flight crew also observed the cabin differential pressure³ gauge reading zero and the main outflow valve position indication gauge reading approximately 50 per cent open.

The flight crew consulted the quick reference handbook (QRH)⁴ and conducted the non-normal checklist⁵ procedure for an 'AUTO FAIL or Unscheduled Pressurization Change' (Figure 1). The flight crew conducted the non-normal checklist up to and including step four and noted that the AUTO FAIL light had extinguished but the cabin pressure was not controllable.

¹ Coordinated Universal Time (UTC): Eastern Standard Time (EST) –10 hours. UTC has been used throughout this report as the flight crossed several Australian time zones.

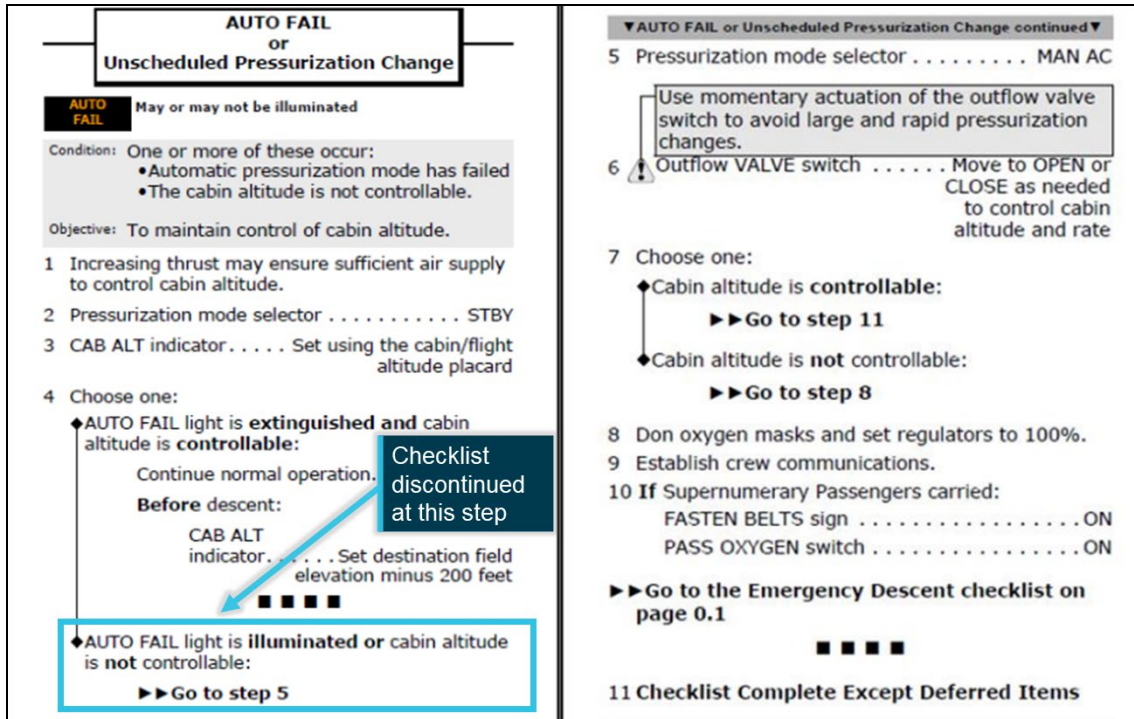
² Flight level: at altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 370 equates to about 37,000 ft.

³ Cabin differential pressure: the difference in pressure between inside the aircraft cabin and the local external atmosphere.

⁴ Quick Reference Handbook (QRH): an approved document for the flight crew that contains procedures for non-normal and emergency conditions for use in flight.

⁵ Non-normal checklist: A specific procedure to be carried out in response to a system annunciator light.

Figure 1: Non-normal checklist



Source: Express Freighter Australia, annotated by the ATSB

It was at about this time that Melbourne Air Traffic Control cleared the flight crew for approach to Melbourne Airport. The flight crew, noting that they were at 4,000 ft on descent and the aircraft was depressurised, elected to suspend any further troubleshooting on the pressurisation system. The aircraft landed without further incident at 1513 (0113 local time).

After landing, the captain contacted engineering control to discuss the occurrence and completed an entry in the aircraft’s technical log. Engineering personnel conducted internal and external inspections of the aircraft including the cargo compartments and the main outflow valve. The engineering inspections revealed multiple aft cargo bay insulation blankets were either missing (Figure 2), installed incorrectly or unsecured and one had been partially ejected from the main outflow valve (Figure 3).

Figure 2: Missing insulation blanket aft cargo bay



Source: Express Freighter Australia, annotated by the ATSB

Figure 3: Main outflow valve after occurrence



Source: Express Freighter Australia, annotated by the ATSB

A subsequent fleetwide inspection was carried out with unsecured or missing insulation blankets discovered in the aft cargo bays of four of the operator's five Boeing 737 Special Freighter aircraft.

Context

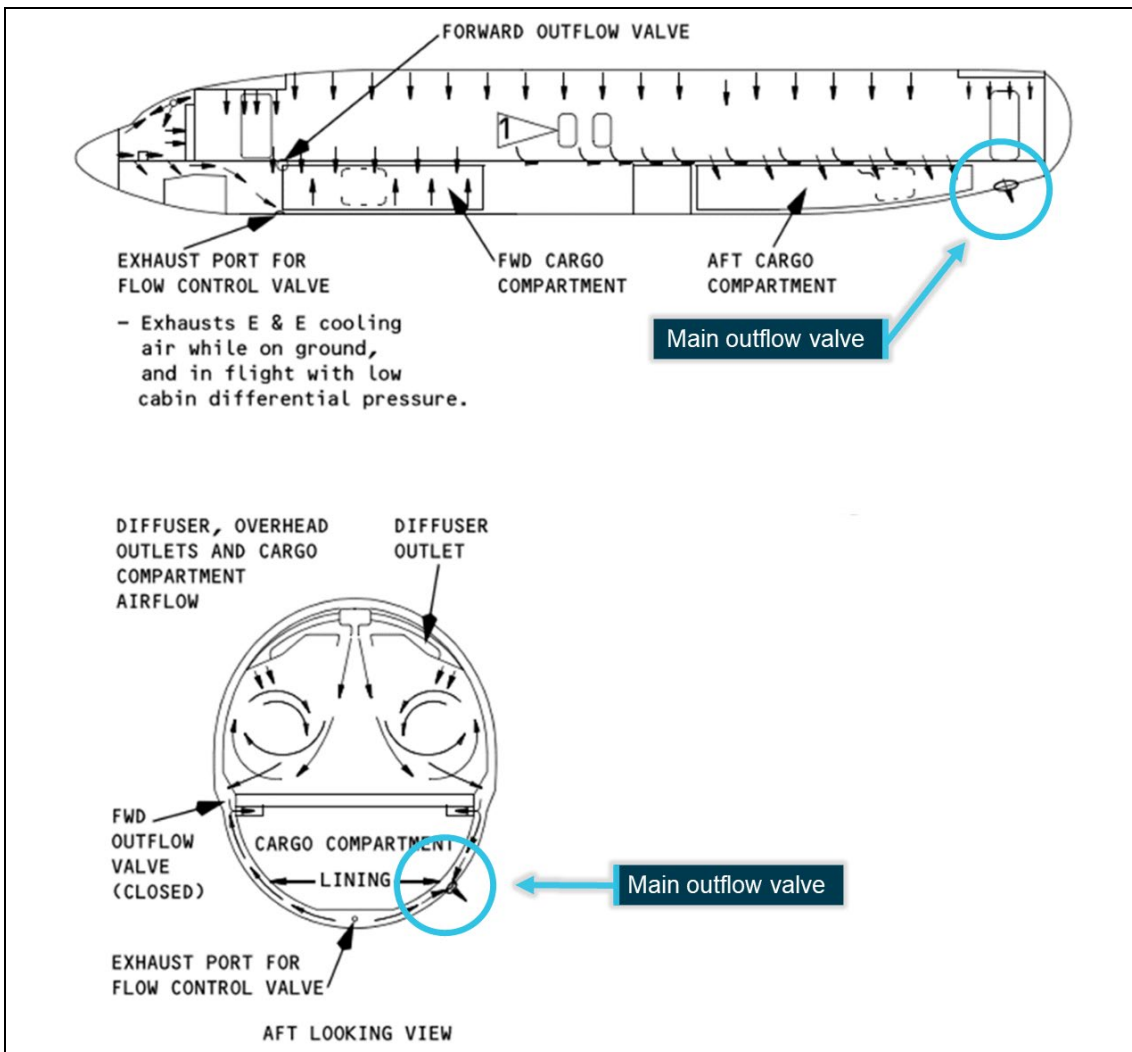
Aircraft information

VH-XMO was originally manufactured as a passenger aircraft in the United States in 1987, and later converted for air freight operations. At the time of the occurrence the aircraft had accrued a total of 74,408 flight hours. Express Freighters Australia operated four 737-300 Special Freighters and one 737-400 Freighter.

Pressurisation system

The aircraft's cabin is pressurised to maintain a safe and comfortable environment for the flight crew. This is achieved by the cabin pressure control system during all phases of operation. Engine bleed air is supplied to the cabin and the control system modulates a forward and a main outflow valve to maintain pressurisation within the aircraft's cabin (Figure 4). The cabin pressurisation panel (Figure 5) allows the flight crew to set and monitor cabin pressurisation.

Figure 4: Main outflow valve fuselage location



Source: Express Freighter Australia, annotated by the ATSB

The main outflow valve is operated electrically and has three modes of control: AUTO, STANDBY, and MANUAL.

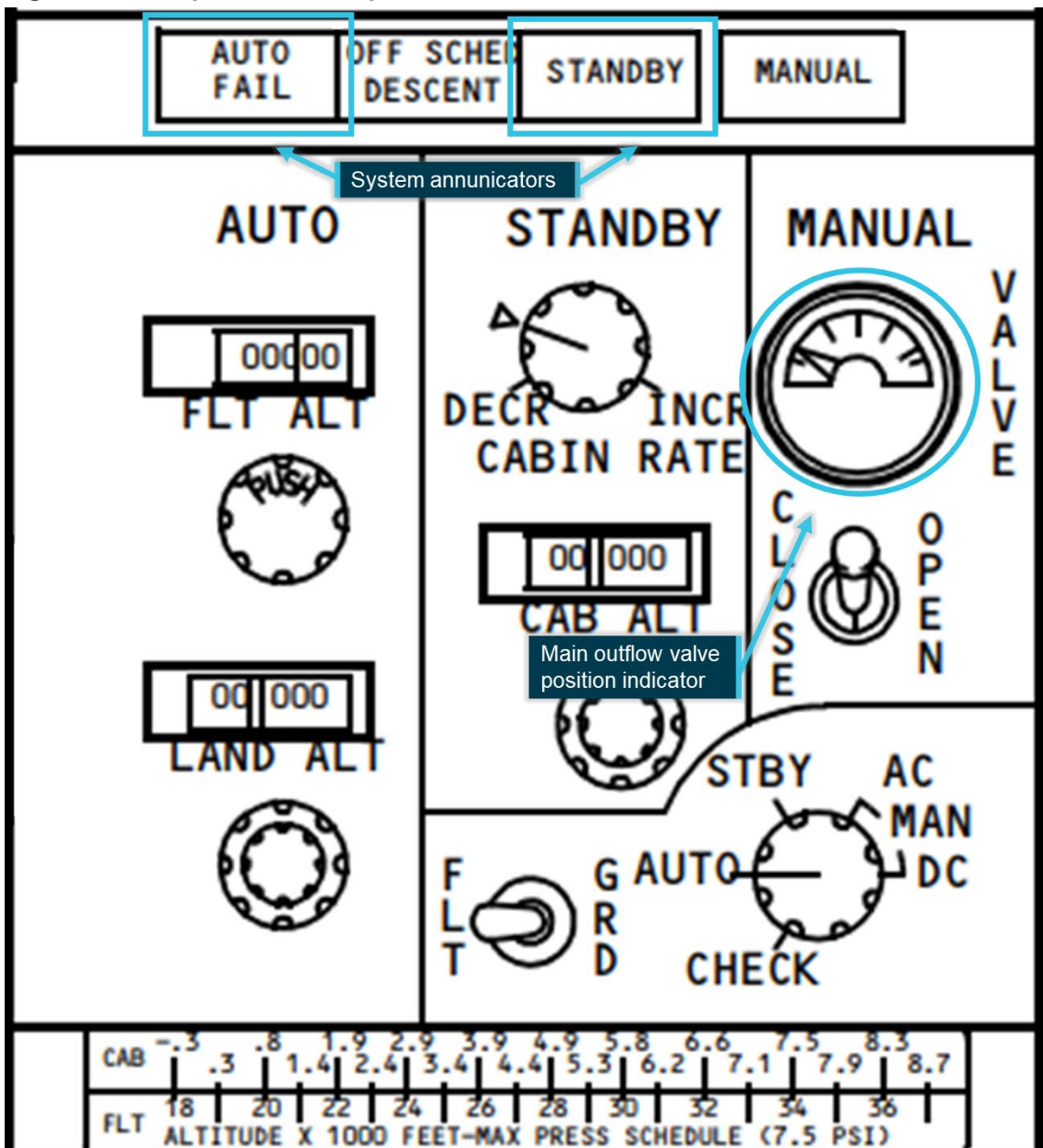
- AUTO, the flight crew set the planned cruising altitude along with the destination landing altitude. The cabin pressure control system then uses these parameters, along with ambient static pressure, to automatically control cabin pressurisation.

- STANDBY, the flight crew select a cabin altitude and the cabin rate of climb required for the flight.
- MANUAL, the flight crew directly control the opening and closing of the main outflow valve with a switch to control cabin pressurisation.

The AUTO FAIL annunciator light (Figure 5) illuminates on the panel if there is an AUTO pressurisation control failure. If that occurs, pressurisation control automatically transfers to the STANDBY mode and the green STANDBY annunciator illuminates. This occurs under any of the following conditions:

- loss of AUTO AC power
- excessive rate of cabin pressure change (greater than 1,890 sea level ft/min)
- excessive differential pressure
- high cabin altitude (13,875 ft).

Figure 5: Cabin pressurisation panel



Source: Express Freighter Australia, annotated by the ATSB

The main outflow valve incorporates an electrically heated gasket on its mounting surface to the fuselage skin. This gasket provides heat during flight at high altitudes to prevent the main outflow valve freezing in the closed position.

Non-normal checklist

Non-normal checklists are used by the flight crew to manage unexpected events. Illumination of a system annunciator light indicates a non-normal condition and are a cue to carry out the associated checklist.

The flight crew commenced the 'AUTO FAIL or Unscheduled Pressurization Change' non-normal checklist (Figure 1) as a response to the illumination of the AUTO FAIL annunciator. The objective of the checklist is to maintain control of the cabin altitude.

The flight crew completed the steps up to and including step four and determined that the cabin altitude was not controllable. The flight crew elected to discontinue the non-normal checklist at this stage due to the aircraft already having depressurised, and being at 4,000 ft on the approach to land.

Post occurrence maintenance

After the occurrence, engineers conducted external and internal inspections of XMO. This included inspections of the aft cargo compartment and main outflow valve. A pressurisation control system test, a cabin depressurisation conditional inspection, and an automatic rate check pressurisation run were also carried out. As a result, the following unserviceability's were recorded in the aircraft's maintenance log:

- insulation blanket found liberated out of the outflow valve and jamming the valve
- insulation blankets in the aft cargo equipment area appear not to be secured as viewed via the outflow valve opening
- aft equipment bay insulation blankets found to be missing frame cap insulation blankets in several locations
- frame blankets installed over the top of frames in several locations
- one blanket missing from location, located in upper right aft corner of compartment
- one insulation blanket found damaged and partially missing forward of outflow valve
- strip cap frame blankets found adrift
- the main outflow valve heater gasket found unserviceable
- inspections carried out on insulation blankets and attachment stand-offs

Prior to XMO's return to service, engineers replaced the main outflow valve assembly, the main outflow valve heater gasket, multiple insulation blankets, and multiple insulation blanket stand-offs. Correct orientation of the aft cargo bay insulation blankets was also carried out as required.

Engineering requirements

Over the service life of the Boeing 737 airframe, the Boeing Company have issued two service bulletins directly relating to the insulation blankets in the aft cargo compartment. These service bulletins were applicable to the Express Freighters Australia's four 737-300 aircraft. They were not applicable to the 737-400 due to the bulletins being incorporated at the time of manufacture.

- 14 July 1988, Boeing service bulletin 737-25-1227 - Cargo compartments – cabin pressurisation outflow valve area insulation blanket replacement:
 - This service bulletin stated that six operators reported being unable to maintain cabin pressure due to a detached insulation blanket inhibiting pressurisation outflow valve operation. The incorporation of this service bulletin reduced the likelihood of loose insulation blankets interfering with the operation of the cabin pressurisation outflow valve by installing insulation retaining studs, replacing the insulation blankets with a heavier cover material,

and using wider hook and loop (Velcro) fasteners. Express Freighters Australia confirmed that this service bulletin was applicable to the four Express Freighters Australia's Boeing 737-300's and was incorporated on all four aircraft between 1989 and 1991.

- 30 July 2008, Boeing service bulletin 737-25-1572 - Replace fuselage and environmental control system insulation blankets with new insulation blankets:
 - This service bulletin required the replacement of all of the fuselage insulation blankets and the environmental control system duct insulation blankets in the pressurised areas of the aircraft with new, less flammable blankets. On the 24 November 2008 the Civil Aviation Safety Authority (CASA) issued Airworthiness Directive AD/B737/348 for Australian operators to incorporate this Boeing service bulletin. This included the replacement of the blankets installed during service bulletin 737-25-1227 and was applicable to all four Express Freighters Australia's Boeing 737-300s. This service bulletin was incorporated on XMO on the 01 August 2014.

Scheduled inspections

Aft cargo bay structural and component inspections are an ongoing requirement on the Boeing 737-300/400 aircraft. These scheduled inspections require the disturbance or removal (partial or complete) of insulation blankets. Instructions are included in these inspections to inspect the blankets for serviceability prior to reinstallation.

The following inspections were carried out on XMO prior to the occurrence:

- On 12 November 2016, an Aft Cargo Lower Lobe scheduled inspection was carried out by Singapore Technologies Engineering Aerospace. This inspection is scheduled for every 5 years or 8,000 flying hours.
- On 26 April 2020, a heavy maintenance check was carried out by Singapore Technologies Engineering Aerospace. This included multiple tasks in and around the aft cargo bay and rear pressure bulkhead. This also included an inspection of the aft cargo bay pressurisation components which consist of the main outflow valve and surrounds.

During these inspections there were no subsequent faults or non-routine tasks raised in the maintenance documentation for damaged or missing blankets.

The insulation blankets in the aft cargo bay are not readily accessible due to the interior lining and the cargo bay floor, therefore, removal of the lining and floor is required prior to access and inspection of the area. Following the heavy maintenance check in April 2020, and prior to the occurrence, there were no other maintenance activities documented within the aft cargo bay area that would necessitate the disturbance of the insulation blankets.

Safety analysis

The flight crew reported that passing through 8,000 ft on descent into Melbourne, the AUTO FAIL and STANDBY annunciator lights illuminated and they felt a rush of cold air and a soreness in their ears. The flight crew also observed the cabin differential pressure gauge reading zero and the main outflow valve position indication gauge reading approximately 50 per cent open.

During descent, the main outflow valve modulates increasing cabin pressure as ambient air pressure increases. It is possible that the failure of the main outflow valve heater gasket, identified by engineering personnel after the occurrence, resulted in the valve freezing in the closed position. As the aircraft descended into warmer air, the valve may have thawed resulting in its sudden opening and observed ingestion of the unsecured insulation blanket.

However, with the main outflow valve operation inhibited, it was unable to modulate allowing an unrestricted venting of pressurised cabin air. This resulted in the inability to control the aircraft's cabin pressure reported by the flight crew.

One of four conditions is required to illuminate the AUTO FAIL annunciator on the pressurisation panel. The pilots reported a rush of air and a soreness in their ears, indicating that an ‘excessive rate of cabin pressure change (1,890 sea level ft/min)’ was probably detected by the cabin pressure control system resulting in the illumination of the AUTO FAIL annunciator. The STANDBY annunciator illuminated due to the pressurisation system unable to automatically operate and switching to the STANDBY mode of operation.

The ATSB assessed that the decision by the flight crew to suspend the non-normal checklist at 4,000 ft was appropriate due to the aircraft being already depressurised and on approach to land.

During post occurrence troubleshooting and inspections, the engineers discovered multiple aft cargo bay insulation blankets either installed incorrectly, damaged, unsecured or missing. This included an insulation blanket protruding from the main outflow valve, inhibiting its operation. As part of the post occurrence rectifications, the engineers correctly orientated and installed new blankets where required.

The incorrect installation of some of the blankets along with an inadequate inspection of their condition occurred at some point prior to the occurrence. A heavy maintenance check was carried out on 26 April 2020, 15 months prior to the occurrence. This inspection and maintenance activity included multiple tasks within the aft cargo bay which necessitated the disturbance and partial or complete removal of the insulation blankets. After this date, and prior to the occurrence on 6 July 2021, there was no documented evidence of maintenance carried out in the aft cargo bay which would require access or disturbance of the insulation blankets.

It is unlikely that undocumented maintenance occurred in this area due to the requirement to remove multiple interior linings and the cargo floor to gain access to the insulation blankets. Therefore, it is probable that during the heavy maintenance check that was completed on the 26 April 2020, the insulation blankets were installed incorrectly, and an inadequate area inspection was carried out.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include ‘contributing factors’ and ‘other factors that increased risk’ (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition ‘other findings’ may be included to provide important information about topics other than safety factors.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to the unscheduled pressurisation change involving a Boeing 737, VH-XMO that occurred on 6 July 2021.

Contributing factors

- An insulation blanket in the aft cargo bay was incorrectly secured leading to it coming adrift and inhibiting the main outflow valve operation. This resulted in uncontrolled pressurisation changes in the aircraft.

Safety actions

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence

Safety action by Express Freighters Australia

Following this occurrence Express Freighters Australia advised that an inspection of aft cargo compartment equipment and insulation blankets were conducted on the four other Boeing company 737 freighter aircraft within the Express Freighters fleet. Multiple unserviceabilities were discovered during this inspection and subsequently rectified.

As a result of the outcome of these inspections, Express Freighters Australia have implemented a 4,000 hour or 36 month insulation blanket visual inspection task for the B737-300 and a 4,000 hour or 18 month inspection task for the B737-400.

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- the operator (Express Freighters Australia)

Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the following directly involved parties:

- the operator (Express Freighters Australia)
- Civil Aviation Safety Authority

No draft report submissions were received.

General details

Occurrence details

Date and time:	7 July 2021 0104 EST	
Occurrence class:	Incident	
Occurrence categories:	Depressurisation, Warning devices, Air / Pressurisation	
Location:	Ballarat Aerodrome, 161° T 37Km (FR24)	
	Latitude: 37° 49.632' S	Longitude: 143° 55.680 E

Aircraft details

Manufacturer and model:	THE BOEING COMPANY 737-376	
Registration:	VH-XMO	
Operator:	EXPRESS FREIGHTERS AUSTRALIA PTY LIMITED	
Serial number:	23488	
Type of operation:	Air Transport High Capacity-Freight - (Air Transport High Capacity)	
Activity:	Commercial air transport-Scheduled-Scheduled freight only	
Departure:	Perth Aerodrome	
Destination:	Melbourne Aerodrome	
Persons on board:	Crew – 2	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Minor	