

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):	18 October 2023 at 0017 hrs	
Location:	Belfast International Airport	
Type of Flight:	Commercial Air Transport (Cargo)	
Persons on Board:	Crew – 2	Passengers – None
Injuries:	Crew – None	Passengers – N/A
Nature of Damage:	Melted R61 contactor	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	40 years	
Commander's Flying Experience:	4,951 hours (of which 2,173 were on type) Last 90 days – 55 hours Last 28 days – 19 hours	
Information Source:	Aircraft Accident Report Form submitted by the commander and further enquiries by the AAIB	

Synopsis

After landing the crew started the APU and transferred the aircraft systems to be powered by the APU generator. When the APU generator was transferred to the right bus, the R61 contactor for the forward galley failed, emitting a noise, a flash and fumes. The crew discharged a fire extinguisher towards the source. The associated circuit breaker (CB) had opened, isolating the R61 contactor.

Assessment of the contactor did not determine the cause of its failure, but it is likely that either loose connectors on the input terminals, or loss of hermetic sealing of the unit caused the event. As the associated CB opened after the failure, it is considered that protection systems operated normally on the aircraft. The use of the fire extinguisher by the crew was an appropriate response based on the information available to them at the time, although the failure was contained without this intervention.

History of the flight

The crew reported for duty at Belfast International Airport at 2030 hrs and operated one sector to East Midlands Airport. The return sector to Belfast was the end of the rostered duty and the airborne flight was uneventful. The commander who was PF, flew a VOR approach to Runway 07 after which the aircraft vacated the runway at A1. ATC instructed the crew to hold at position L1 to allow another aircraft to taxi out of their planned parking position (Figure 1).

The crew performed the after landing checks and started the APU as normal, in preparation for engine shut down. The aircraft was stationary at the L1 position when the APU became available to provide electrical power.

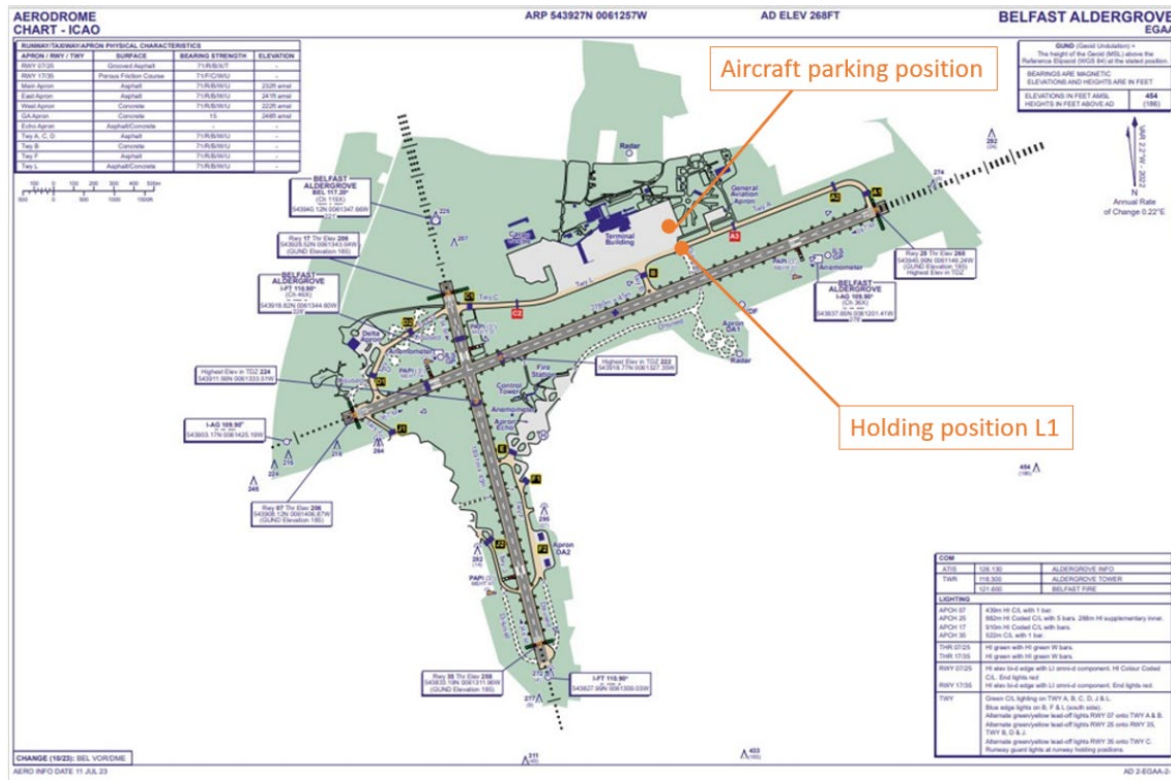


Figure 1
 Belfast International Aerodrome Chart

The PM transferred the left bus to the APU generator and when the right side was selected ON there was a loud ‘clunk and a flash’. The crew turned around and saw the CB panel behind the co-pilots seat was glowing orange. They reported a strong smell of burning. The co-pilot recalled that after a closer look, he could see what looked like flames coming from behind the CB panel. The commander transferred the electrical power back to the engines while the co-pilot left his seat, removed the fire extinguisher from its stowage position and discharged it behind the CB panel. The commander spoke to ATC and requested the fire service attended the aircraft.

After the extinguisher was discharged, the co-pilot returned to his seat and the crew agreed there was no longer any evidence of fire or burning. They elected to continue to their parking position which was close by. The fire crew attended the aircraft after it was parked on stand and found no evidence of fire.

Aircraft information

G-JMCZ is a Boeing 737-400 series aircraft converted, under Supplemental Type Certificate, to become a freighter.

When converting the aircraft, the electrical systems remained essentially the same, with the wiring remaining in situ for the devices that had been removed, such as the galleys.

Primary electrical power is supplied by two engine driven generators which provide 115 V AC. In normal operation each generator supplies its own bus system but can supply essential loads of the opposite side bus system if one generator was inoperative. The APU operates a generator which can supply power to either or both AC generator busses on the ground or one AC generator bus in flight. The electrical system is designed such that it is not possible to provide power to a device from multiple sources, known as 'paralleling', and when a source of power is being connected to a generator bus, the system automatically disconnects the existing source.

To provide power to the aircraft systems when on the ground the APU can be started and its generator transferred to power the two generator busses. This unloads the engine generators and allows the aircraft to remain electrically powered when the engines are shut down.

Contactors are used to switch the 115 V AC power and are activated by 28 V DC coils within them. To suppress arcing within the contactor unit the armature housing is hermetically sealed.

Circuit breakers are used to protect and isolate systems when an over current is experienced. When an over current is detected a circuit breaker will open, isolating the affected circuit. If a circuit or system is not required or has malfunctioned and is not in the minimum equipment list, its circuit breaker can be 'pulled and tagged' to manually isolate the system. Tagging the circuit breaker prevents the circuit breaker from being closed and gives a visual indication that a circuit breaker has been intentionally pulled.

Aircraft examination

After the incident, the aircraft was shut down and batteries disconnected. The fire was identified as having been behind the P6-2 circuit breaker panel, behind the co-pilot's seat. The panel was lowered and the R61 contactor (Figure 2), was found to be melted. This contactor which, when the galley switches were set to ON, switched power to the forward galley from the left 115 V AC bus. Molten material and debris from the contactor had fallen from it and came to rest in the bottom of the compartment. Paint on the underside of the compartment floor had blistered.

The FWD GALLEY circuit breaker had 'tripped'.

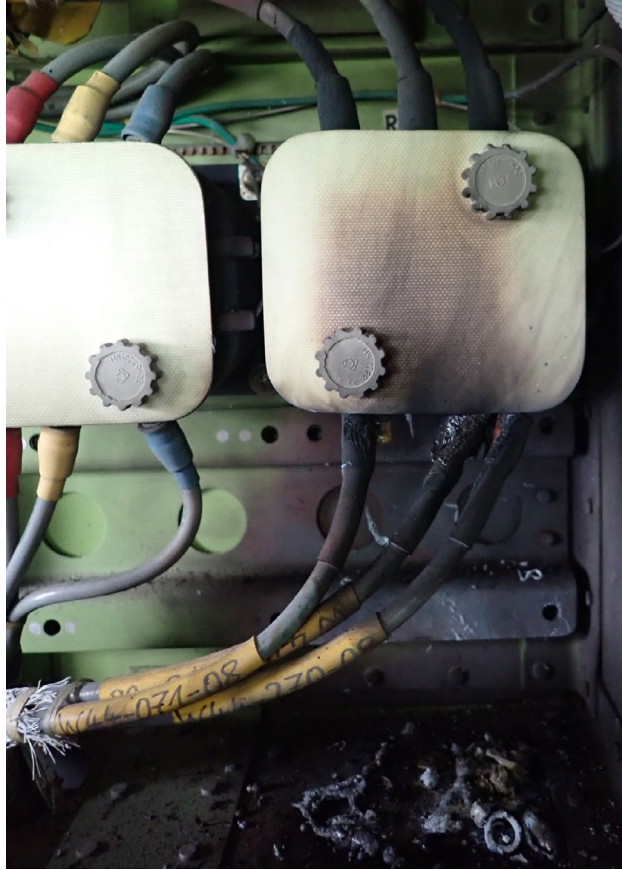


Figure 2

R61 forward galley contactor

When the contactor was removed it was evident that the contactor housing had been breached and the three input terminals had been destroyed during the fire. (Figure 3).



Figure 3

R61 Contactor, Part Number 9124-8073, after removal showing melted housing and loss of input terminals

Apart from some evidence of over current in the APU bus tie contactor associated with the contactor failure, troubleshooting of the electrical systems found no other issues.

Analysis

Due to the nature of the damage to the contactor, the cause of the failure could not be determined. It is possible that either the hermetically sealed contactor housing failed, allowing ambient conditions to enter the body resulting in the possibility of arcing within the unit, or the input terminal connectors had become loose, allowing external arcing and heat generation.

When the short circuit occurred, arcing generated heat and intense light, resulting in the melting of the contactor housing. This short circuit also reduced the circuit resistance and increased the current. The increased current was detected by the circuit breaker causing the circuit breaker to trip.

To avoid circuit breakers tripping due to momentary current spikes they are rated to trip when a sustained over current is sensed. When the circuit breaker trips, the system is isolated, as in this case, and stops the flow of current to the location of the short circuit.

Troubleshooting after the event found no issues with the aircraft that could have caused the short circuit and as such it is considered that the issue was isolated to the contactor. When the generators are transferred from one source to another momentary power spikes can occur, which may agitate the electrical systems. When the left bus was transferred to the APU power the R61 contactor was live. When APU power was transferred to the right bus, with the APU already connected to the left bus, a power spike may have agitated the R61 contactor allowing an arc to establish.

In the event, the crew were confronted by a noise followed by light and fumes from behind the CB panel. The dark cockpit will have exacerbated the intensity of the light generated during the failure. Although the safety systems isolated the failing contactor, the residual heat, fumes and glow of the hot components will have persisted so it is considered that the use of the fire extinguisher by the crew was appropriate in the circumstances.

Conclusion

The R61, forward galley, contactor failed, likely as a result of a loose connector or loss of sealing of the contactor housing. The failure resulted in arcing of the 115 V AC system, emitting light and fumes. The crew acted quickly to extinguish the perceived fire with a handheld fire extinguisher. At this time the associated circuit breaker tripped isolating the R61 contactor. The protection systems operated normally on the aircraft. The use of the fire extinguisher by the crew was an appropriate response based on the information available to them at the time.