SERIOUS INCIDENT

Aircraft Type and Registration:	Fokker F.28 Mark 0070, PH-KZB
No & Type of Engines:	2 Rolls-Royce Tay 620-15 turbofan engines
Year of Manufacture:	1996
Date & Time (UTC):	29 September 2008 at 1705 hrs
Location:	Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 70
Injuries:	Crew - None Passengers - 2 (Minor)
Nature of Damage:	Emergency inverter cooling fan capacitor burnt out
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43
Commander's Flying Experience:	9,820 hours (of which 3,908 were on type) Last 90 days - 153 hours Last 28 days - 54 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was taxied onto Stand 214C (centre) using the right engine with the left engine shut down and the APU running. As soon as the right engine was shut down, there was a strong smell of electrical burning and smoke began to accumulate on the flight deck. Following a brief discussion between the commander and the Cabin Service Supervisor, the aircraft was evacuated.

An engineering investigation identified that the emergency inverter cooling fan capacitor, was completely burnt out. This had released smoke and fumes into the flight deck area.

History of the flight

The aircraft had completed an uneventful flight from Amsterdam, Schiphol Airport to Manchester Airport. Having landed on Runway 23R the aircraft was taxied to parking Stand 214 (centre) using the right engine with the left engine shut down and the Auxiliary Power Unit (APU) running. After arrival on stand, the parking brake was set and the right engine shut down. The cabin crew were instructed to open the airstair door at the front left side of the aircraft. The flight crew remained in their seats on the flight deck with the Cabin Service Supervisor (CSS) at the front left door and the second cabin attendant stood at the rear of the aircraft.

Immediately after the right engine was shut down, the pilots noticed a strong smell of electrical burning. Both

pilots noticed wisps of smoke and the co-pilot opened his sliding window to try and clear it. The commander called the CSS on the interphone and asked if there was any sign of smoke or a smell of burning in the cabin. She did not detect either and was asked to go onto the flight deck. As she opened the flight deck door, the smoke increased and she was immediately aware of the significant presence of smoke and the smell of burning. The flight crew believed the smoke was coming from multiple sources including behind the co-pilot, various vents and behind the instrument panel.

The commander firmly instructed the CSS to get the passengers off as quickly as possible. He then contacted ATC on the ground frequency and informed them that his aircraft had smoke on the flight deck and requested the immediate attendance of the Airport Fire Service (AFS).

The CSS left the flight deck, stood on the aircraft steps and told the Dispatcher that the aircraft had smoke in the cockpit and that the passengers would be disembarking immediately. She then used the cabin public address system to tell the passengers to:

> *'get off the aircraft now. Hurry, evacuate the aircraft.'*

The passengers were stood up retrieving their personal belongings and appeared not to react to the CSS's instructions. She then added:

> *'evacuate the aircraft but leave your luggage behind'*

to which the passengers responded appropriately. The cabin attendant in the rear of the aircraft saw a lady at the right side overwing exit release the door and throw it through the opening onto the wing. Passengers were leaving the aircraft quickly by the forward left door and the right side overwing exit.

The cabin crew member at the rear of the aircraft, realising that an emergency evacuation was in progress, kept the passengers moving forward. As the last passengers vacated the aircraft, both cabin attendants met near the overwing exit and confirmed all the passengers had left. The rear cabin attendant exited through the overwing exit and the CSS, having informed the commander that all the passengers were off, vacated the aircraft though the airstair door.

The flight crew attempted to locate the source of the smoke but given the imminent arrival of the AFS and not wishing to prolong the problem, shut down the APU and switched OFF the electrical power. The co-pilot completed the 'Termination' checklist and exited the aircraft. The commander made a final check of the cabin area and toilets to confirm that there were no persons still onboard. He then left the aircraft through the airstair door and joined the passengers and crew on the parking area.

When all passengers were accounted for, they were directed by ground staff into the terminal building. Two of the passengers were treated by the ambulance service for minor injuries sustained when moving off the aircraft wing.

Aircraft operating procedures

The procedure for an emergency evacuation is contained in the operator's Abnormal Checklist and is set out in Table 1.

ON GROUND EMERGENCY/EVACUATION	
When aircraft is stationary	
• ... Captain commands	ON GROUND EMERGENCY. TAKE ACTION
• PARK BRAKE (PF).....	SET

PILOT LH SEAT	PILOT RH SEAT
• Inform ATC	• Flaps.....42
	• Thrust levers ..... IDLE
	• Reverse levers ..... FULL DOWN
	• Lift dumpers..... DISARM
	• Both fuel levers ..... SHUT
	• Both fire handles .....PULL ROTATE OUTWARDS
	• APU DISCH switch .....ON
• PAS..... COMMAND 'EVACUATE AIRCRAFT'	
• EMER lights .....ON	
When leaving cockpit	
• BATTERIES ..... OFF	

NOTE: Use VHF1 to notify ATC

Table 1

Abnormal Checklist

The principles of the procedure are to facilitate a safe evacuation of the aircraft with the main engines and APU shut down, fire extinguishant discharged into the engine/APU bays and electrical system switched OFF. The flaps are lowered to allow passengers and crew to slide down the flap surface reducing the height they have to descend to the ground and increasing the distance of the flap trailing edge from the engine inlets.

Flaps are lowered by hydraulic actuators which are pressurised using engine driven pumps located on the main engines. The APU does not have a hydraulic pump and therefore, with both engines shut down hydraulic power is not available. An alternative method of lowering the flaps in flight is provided by an electrical motor which can be used as a backup means of lowering the flaps in the event of the loss of hydraulic pressure. On the ground, it is possible to pressurise the system with an electric pump which then allows normal flap selection. The APU generates sufficient electrical power to operate this backup system. To lower the flaps fully, using the hydraulic system takes 14 to 18 seconds and using the electrical backup system takes approximately 90 seconds.

Safety and survival

Manchester Airport has a comprehensive set of Standard Operating Procedures (SOPs) included in their Manual of Air Traffic Services (MATS) Part 2. These cover both aircraft arriving with an emergency situation and aircraft developing an emergency whilst on the ground. Aircraft arriving with an emergency will either be dealt with on the runway or allocated a remote stand, depending on the severity of the situation. A ground response team will be assembled which comprises assets from the emergency services and coaches to transport passengers and crew with specific reception areas made available in the terminal. The airport SOP covering aircraft evacuations is set out below:

*'**Aircraft Evacuations***

During the emergency evacuation of an aircraft, it is impossible to account for all passengers and crew until a head count has been carried out. People may be some distance from the aircraft until they have all been marshalled together. Manchester Airport and NATS have therefore agreed a procedure to cater for this scenario.

Whenever there is an emergency evacuation of an aircraft at Manchester Airport, regardless of where the aircraft is situated on the airfield, all aircraft movements are to be immediately suspended until the Airport Duty Manager (ADM) confirms that all evacuees have been accounted for. This means that no further departures are to commence their take-off roll, aircraft on final approach are to be instructed to commence a missed approach and aircraft on the ground are to be instructed to hold position.

Normal operations may re-commence when the ADM is satisfied that all evacuees have been accounted for. Experience shows that this normally takes a maximum of 6 to 7 minutes to achieve.'

The incident occurred at 1705 hrs and airfield operations were immediately suspended by the ADM. All evacuees were accounted for and airfield operations were re-instated at 1711 hrs. An aircraft due to park on the stand adjacent to the incident aircraft was redirected to another stand by ATC.

Airport Fire Service (AFS) response

The AFS were notified of the incident by ATC and immediately deployed four major foam tenders, a domestic appliance and the emergency tender directly to the scene. They arrived within one minute of the initial response and the AFS Incident Commander (I/C) established that the evacuation was virtually complete. Two fire fighters entered the aircraft and established that although there was a smell of burning, there were no visible signs of smoke or flames and there were no persons onboard. A thermal camera was used to inspect the flight deck area and a fuse panel behind the co-pilot's seat was correctly identified as being the source of the smoke and burning smell. The aircraft commander and a maintenance engineer assisted the AFS by ensuring that the aircraft was in a safe condition with the electrical system OFF.

The AFS I/C liaised with the ADM to establish the best method of keeping the site secure. There had been a number of approaches by ground personnel to gain access to the aircraft in order to remove the baggage. At 1845 hrs it was agreed that the fire risk to the aircraft was minimal and the scene was handed over to the police.

The AFS I/C summarised his assessment of the incident and his recommendations in his report as:

> *'A successful conclusion to this incident was in my opinion down to the excellent communication links and liaison that I, the I/C had with the ADM and his team. A concern of mine during the incident was of the amount of non-essential personnel trying to gain access to the A/C. Not only is this a dangerous occurrence for these persons entering a risk area, but it is also removing my fire personnel away from their tasks to shepherd ground staff away. A recommendation of Manchester Airport Security or Greater Manchester Police to cordon the area off until approval to enter is given by the Fire I/C or ADM.'*

Following the incident, Manchester Airport Emergency Planning Committee reviewed their response to the incident and in particular the issue of persons entering a risk area. The airport intends to establish that the airport police and security team leader attend ground incidents. The police will be asked to assist the AFS I/C to manage the inner cordon to ensure that only authorised staff attend the inner scene.

Aircraft examination

Although the aircraft was inspected 18 hours after the incident, the smell of electrical burning remained very strong on the flight deck. The crew had reported that the smoke initially appeared from the circuit breaker panels behind the co-pilot's seat and the fire service attending the incident had opened these panels to identify the source. Inspection of the wiring behind both the upper and lower panels did not identify any evidence of overheat or burning. The maintenance provider had reported a similar recent incident on another of their Fokker 70 aircraft, where the emergency inverter was suspected as being at fault. The inverter is located behind the panel adjacent to the upper circuit breaker panel and the inverter's cooling fan vents directly through a hole in the dividing wall into the area behind the circuit breaker panel. Again no evidence of burning or overheat was immediately obvious around the inverter or on its connector and external wiring. However, when the unit itself was removed, there was a similar strong electrical burning smell around the exit of the cooling fan.

A serviceable spare emergency inverter was fitted and the aircraft was electrically powered up using ground power and subsequently all the on-board power sources including the battery, APU and engines. The aircraft was left for an extended period of time with power on, but there was no re-occurrence of the smoke. No failure codes were evident on the maintenance display and all electrically powered systems were functioning correctly. On this basis the removed emergency inverter was retained for further investigation and the aircraft returned to service without reported incident.

The right overwing emergency exit had been used during the emergency evacuation. The exit door was of the type which is completely removed by pulling the release handle down and then pushing the door out of the aircraft. Inspection of the removed door showed that it had operated correctly. No damage was found on the wing top surface as a result of the door landing on it.

Detailed examination

The emergency inverter was taken to an overhaul facility for further disassembly and investigation. Initially when the cover was removed there was no obvious sign of burning or overheat, although the strong electrical burning smell was again present. It was decided that the unit should be tested using the

test bench power supply. As soon as electrical power was applied, smoke emanated from the area around the cooling fan. Further disassembly of the unit identified that a capacitor in the cooling fan power supply circuit was completely burnt out. (Figure 1) The capacitor was too badly damaged to allow any further analysis of why it had failed. The inverter was then repaired and tested, with no further anomalies identified.

Emergency inverter

The emergency inverter converts a 28V dc supply into a 115V ac supply to maintain electrical power to the aircraft's emergency busbar in the event of a loss of normal ac supply. The inverter is continually powered while the aircraft is electrically powered and as its operation is completely autonomous, the only means of isolating it is to pull the 28 V supply circuit breaker or to completely de-power the aircraft. The overheated capacitor which caused the smoke was part of a modification to the unit installed during aircraft development, to reduce the fan speed and therefore the level of noise which it generated on the flight deck. Should the cooling fan fail to operate, a thermistor within the inverter isolates the power supply when the temperature reaches 110ºC.

Figure 1

Burnt out capacitor

Previous history

The inverter unit under investigation was only fitted two days prior to the incident. The unit which it replaced, although removed from service for a different reason, had evidence of overheat on the same capacitor though to a lesser extent. A review of the overhaul records for inverters since introduction of the aircraft in 1994, identified a further four instances where this capacitor was found to have overheated. The last of these had occurred 22 months previously, again on this aircraft. At the time of this event, the Fokker 70 fleet had accumulated 1,226,309 flight hours since entry into service.

The operator reviewed the aircraft's build standard and found it to be consistent with the rest of their Fokker 70 fleet. The capacitor was manufactured by a component supplier, who confirmed the part number had been out of production for the last 10 years and was not used in any other application.

Analysis

Operational matters

With both main engines shut down and the passengers standing retrieving their belongings, the situation was outside the circumstances which would normally exist in an emergency evacuation as set out in the abnormal checklist. There was no time to prepare the passengers and crew to carry out an evacuation.

The commander, seeing the smoke developing, wanted the passengers off the aircraft as his first priority and firmly instructed the CSS to do this. Her initial attempt to get the passengers to leave the aircraft by saying,

> *'get off the aircraft now. Hurry, evacuate the aircraft,'*

produced little response. Given the strength of the commander's instruction and the urgency of the situation, the CSS raised the assertiveness in her voice and carried out the evacuation drill. The evacuation proceeded rapidly whilst the flight crew alerted ATC, attempted to identify where the smoke was coming from and ultimately shut down the aircraft. Whilst he had not specifically ordered an 'evacuation', the commander fully supported the decision and actions of the CSS.

The movement of the passengers off the wing would have been made safer by lowering the flaps. Without the hydraulic system to power the flap actuators the electrical system would have been the only method of achieving this. Using this system would have either meant delaying the use of the overwing exits whilst the flaps were lowered or having the flaps travelling as passengers were on or possibly under them. Both of these options carried associated additional risk.

The airport Emergency Planning Committee has addressed the concerns of the Airport Fire Service, Officer in Charge regarding the entry of unauthorised persons into a risk area.

Engineering

During the incident, a cooling fan power supply capacitor, located adjacent to the fan within the emergency inverter unit, overheated and generated a significant quantity of smoke. The cooling fan continued to operate, drawing the smoke out of the inverter casing and through the hole in the dividing wall between the inverter equipment bay and the area behind the upper circuit breaker panel. As this space was completely enclosed, it then entered the flight deck via the gaps around the panel. The co-pilot opened his sliding window to allow the smoke to clear, but this most likely set up a circulation cell

within the flight deck which drew the smoke behind the equipment panels such that it then appeared to come from various sources around the flight deck. This may have contributed to the pilots' perception of the seriousness of the incident. As the pilots could not locate the source of the smoke and given that the inverter remained electrically powered as long as the aircraft did, they were not able to prevent the capacitor from continuing to overheat and generate smoke until the aircraft was completely electrically de-powered.

It has not been possible to isolate the reason for the capacitor overheating due to the severity of the damage. Previous failures of this component are low in number, although the recent frequency of failures may suggest that the failure rate is beginning to increase. Given the time since manufacture of the capacitors, the failure mode may potentially be a service life related issue. This event is the first recorded incident where smoke in the flight deck has been reported as a consequence of this capacitor overheating. No anomalies could be identified which might explain the number of overheat failures associated with this aircraft. Routine fleet airworthiness reviews between the inverter manufacturer and the Civil Aviation Authority (Netherlands) aim to identify any adverse trend in reliability and ensure mitigating action is taken if necessary.