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ENGINE MALFUNCTION CAUSED BY LIGHTNING STRIKES

1 Introduction

1.1 A recent lightning strike to an Embraer 145 aircraft has highlighted the possibility of such an occurrence causing an engine shut-down. In this incident the aircraft was passing FL 70 in descent to Manchester Airport when the strike occurred. The first indication of an engine problem was a high temperature indication on the left engine. Within 5 to 10 seconds of the strike, both crew members noted that the left engine operating parameters were decreasing rapidly. The engine went to a sub-idle condition and was shut down by the Full Authority Digital Engine Control (FADEC). The crew were not aware of any warning or caution indications prior to engine shut-down.

1.2 At the time the aircraft had just entered cloud, but there was no significant turbulence or precipitation. Some cumulo-nimbus returns were noted on the radar display, but the aircraft had been manoeuvred to avoid these.

1.3 A single engine approach and landing was carried out in accordance with checklist procedures.

1.4 The cause of the auto shut-down was determined to be an engine surge induced by the aero-thermal effects of the lightning strike. The engine installed in the incident aircraft features an Inter Turbine Temperature limiter (ITT) in the FADEC. The combination of the surge and the increase in temperature of the air entering the engine caused a high ITT, which reduced fuel flow as the ITT limit was reached. The engine then entered a sub-idle condition and eventually the FADEC shut down the engine.

2 Other Information

2.1 Data supplied by the aircraft manufacturer during their investigation revealed that some information existed on apparently similar events occurring to other types.

2.2 It is understood that a survey of 40 aircraft lightning strike events during the 1970s was carried out, covering three types of aft-engined business jet types (ie those having small lateral spacing between their engine axes). Twenty of these reportedly resulted in engine flame-outs, most being relightable. One dual flame-out reportedly occurred at 35,000 ft. A number of events were reported on military aircraft, such as F111 and F4, both having fuselage side engine intake configurations. The severity of the latter events is not known.

2.3 It has since come to light that a North American NA 265-80 (Sabreliner) business jet type suffered a fatal accident recently in the USA after a lightning strike event at night. This led to a double engine flame-out, followed by progressive loss of battery power (accelerated by failure to carry out electrical load-shedding), which prevented a restart of either engine. The engine type was not FADEC equipped.

2.4 Data obtained from the UK MOR data base has identified 14 incidents where engine malfunction has occurred after a lightning strike. Whilst a number were small rear-engined jets there were also other types affected including large trijets, underslung twinjets and turboprops.

2.5 In practice, aircraft are frequently struck by lightning. Unfortunately, reliable data on lightning events is difficult to obtain, particularly when little or no physical damage has occurred. In the Embraer 145 incident the physical damage presented no identifiable hazard.

3 Lightning Behaviour

3.1 Discussion with leading lightning specialists has confirmed that a risk exists of lightning effects sweeping longitudinally down both sides of a narrow fuselage. This could therefore affect the intake flows of both engines of narrow-bodied aircraft, where the engines are necessarily mounted close to the fuselage sides (ie typical of many combat aircraft and all aft-engined business jet and airliner types). A study of aft-engined commercial aircraft revealed that fuselage diameters range from approximately 5 ft for typical small business jets to nearly 11 ft for aft-engined airliners.

3.2 A risk therefore exists of a single lightning strike causing both engines to flame-out as a result of aero-thermal effects.

4 Safety Recommendation

4.1 There is a potential hazard of a lightning strike affecting both intake airflows on narrow-bodied aircraft equipped with FADEC controlled, fuselage mounted engines, with the associated potential for a double engine flame-out.

4.2 The CAA therefore makes the following recommendations:

- (a) Crews should be aware of the potential of an engine malfunction caused by lightning strikes.
- (b) Operators and owners of small twin jets with a narrow fuselage should review their operating procedures to ensure, for example, that where an APU is available, it is started when approaching an area where the potential for lightning strikes exists. Then, in the unlikely event of a double engine failure the aircraft will maintain power and hydraulics whilst a rapid engine relight is attempted.

This Circular is issued for information, guidance and necessary action.