

4. Safety recommendations

The following safety recommendations were made during the course of the investigation.

- 4.1 That the CAA consider increasing the frequency of existing engine inspections and engine health monitoring on Boeing 737-300 and Boeing 737-400 aircraft until the causes of the engine failure(s) are established. (Precautionary Recommendation made 11 January 1989.)
- 4.2 That the CAA call for an examination of the Boeing 737-300 and Boeing 737-400 engine Fire/Overheat and Vibration monitoring circuitry for left/right engine sense. (Precautionary Recommendation made 11 January 1989.)
- 4.3 The Civil Aviation Authority, in conjunction with the engine manufacturer, consider instituting inspection procedures for the examination of the fan stage of CFM56 engines to ensure the early detection of damage that could lead to the failure of a blade. (Made 10 February 1989)
- 4.4 The Civil Aviation Authority review the advice given in the Boeing 737-400 Maintenance Manual concerning the excessive generation of heat during blending operations with power grinding and blending tools. (Made 10 February 1989).
- 4.5 The CAA should take action to advise pilots of Boeing 737-300/400 aircraft, and of other types with engines which have similar characteristics, that where instances of engine-induced high vibration occur, they may be accompanied by associated smoke and /or smells of burning entering the flight deck and/or cabin through the air-conditioning system, due merely to blade tip contact between fan/compressor rotating assemblies and the associated abradable seals. (Made 23 February 1989)
- 4.6 The CAA should review the current attitude of pilots to the engine vibration indicators on Boeing 737-300/400 aircraft, and other applicable types with turbofan engines, with a view towards providing flight crews with an indication of the pertinence of such vibration instruments when engine malfunctions or failures occur. (Made 23 February 1989)
- 4.7 The CAA should require that pilot training associated with aircraft which are equipped with modern vibration systems¹⁶, and particularly those aircraft which are fitted with high by-pass turbofan engines, should include specific instruction on the potential value of engine vibration indicators in assisting the identification of an engine which has suffered a failure associated with its rotating assemblies. (Made 30 March 1990)

¹⁶ Excluding those aircraft fitted with a computerised engine warning system which includes engine vibration as an alerting parameter.

- 4.8 The regulatory requirements concerning the certification of new instrument presentations should be amended to include a standardized method of assessing the effectiveness of such displays in transmitting the associated information to flight crew, under normal and abnormal parameter conditions. In addition, line pilots should be used in such evaluations. (Made 30 March 1990)
- 4.9 The CAA should require that the engine instrument system on the Boeing 737-400, and other applicable public transport aircraft, be modified to include an attention-getting facility to draw attention to each vibration indicator when it indicates maximum vibration. (Made 30 March 1990)
- 4.10 The CAA should request the Boeing Commercial Airplane Company to produce amendments to the existing aircraft Flight Manuals to indicate what actions should be taken when engine-induced high vibration occurs, accompanied by smoke and/or the smell of burning entering the flight deck and/or cabin. (Made 23 February 1989)
- 4.11 The CAA should ensure that flight crew currency training in simulators includes practice reprogramming of flight management systems, or any other such systems which control key approach and landing display format, during unplanned diversions so that they remain practised in the expeditious use of such systems. (Made 30 March 1990).
- 4.12 The CAA should review the current guidance to air traffic controllers on the subject of offering a discrete RT frequency to the commander of a public transport aircraft in an emergency situation, with a view towards the merits of positively offering this important option. (Made 30 March 1990).
- 4.13 The CAA should review current airline transport pilot training requirements to ensure that pilots, who lack experience of electronic flight displays, are provided with familiarisation of such displays in a flight simulator, before flying public transport aircraft that are so equipped. (Made 30 March 1990).
- 4.14 Training exercises for pilots and cabin crew should be introduced to improve co-ordination between technical and cabin crews in response to an emergency. (Made 30 March 1990).
- 4.15 The CAA should review current airline transport pilot training requirements with a view towards considering the need to restore the balance in flight crew technical appreciation of aircraft systems, including systems response under abnormal conditions, and to evaluate the potential of additional simulator training in flight deck decision making. (Made 30 March 1990).

- 4.16 The type certification requirements for gas turbine engines should be amended so that it is mandatory to perform instrumented flight tests to demonstrate freedom from damaging vibratory stresses at all altitude conditions and powers which an engine will encounter in service (Made 30 March 1990).
- 4.17 The potential for fuel and oil system leakage within the fan case area of high by-pass turbofan engines, during conditions of excessive vibration, should be reviewed by the engine manufacturers and the CAA with a view towards modifying such systems to minimise such leakage, and the associated fire risk (Made 30 March 1990).
- 4.18 The CAA should review the existing Joint Airworthiness Requirements concerning fuel tank protection from the effects of main landing gear and engine detachment during ground impact and include specific design requirements to protect the fuel tank integrity of those designs of aircraft with wing-mounted engines (Made 30 March 1990).
- 4.19 The CAA should expedite current research into methods of providing flight deck crews of public transport aircraft with visual information on the status of their aircraft by means of external and internal closed circuit television monitoring and the recording/recall of such monitoring, including that associated with flight deck presentations, with a view towards producing a requirement for all UK public transport aircraft to be so equipped (Made 30 March 1990).
- 4.20 The manufacturers of existing flight data recorders which use buffering techniques should give consideration to making the buffers non-volatile and hence recoverable after loss of power, and EUROCAE and the CAA should reconsider the concept of allowing volatile memory buffering in flight data recorders (Made 30 March 1990).
- 4.21 Where engine vibration is an available parameter for flight data recording, the CAA should consider making a requirement for it to be recorded at a sampling rate of once every second (Made 30 March 1990).
- 4.22 The CAA should actively seek further improvement in the standards of JAR 25.561/.562 and the level of such standards should not be constrained by the current FAA requirements (Made 30 March 1990).
- 4.23 The CAA should require that, for aircraft passenger seats, the current loading and dynamic testing requirements of JAR 25.561 and .562 be applied to newly manufactured aircraft coming onto the UK register and, with the minimum of delay, to aircraft already on the UK register (Made 30 March 1990).
- 4.24 In addition to the dynamic test requirements, the CAA should seek to modify the JARs associated with detailed seat design to ensure that such seats are safety-engineered to minimise occupant injury in an impact (Made 30 March 1990).

- 4.25 The CAA should initiate and expedite a structured programme of research, in conjunction with the European airworthiness authorities, into passenger seat design, with particular emphasis on:
- (i) Effective upper torso restraint.
 - (ii) Aft-facing passenger seats. (Made 30 March 1990)
- 4.26 The certification requirements for cabin floors of new aircraft types should be modified to require that dynamic impulse and distortion be taken into account and these criteria should be applied to future production of existing designs (Made 30 March 1990).
- 4.27 The CAA should initiate research, in conjunction with the European airworthiness authorities, into the feasibility of a significant increase in cabin floor toughness beyond the level of the current JAR/FAR seat requirements (Made 30 March 1990).
- 4.28 The CAA implement a programme to require that all infants and young children, who would not be safely restrained by supplementary or standard lap belts, be placed in child-seats for take-off, landing and flight in turbulence (Made 30 March 1990, amended 8 August 1990).
- 4.29 The CAA expedite the publication of a specification for child seat designs (Made 30 March 1990).
- 4.30 The certification requirements for cabin stowage bins, and other cabin items of mass, should be modified to ensure the retention of these items to fuselage structure when subjected to dynamic crash pulses substantially beyond the static load factors currently required (Made 30 March 1990).
- 4.31 The CAA consider improving the airworthiness requirements for public transport aircraft to require some form of improved latching to be fitted to overhead stowage bins and this should also apply to new stowage bins fitted to existing aircraft. (Made 30 March 1990)

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August 1990