

INCIDENT

Aircraft Type and Registration:	Embraer EMB-145EP, G-ERJG
No & Type of Engines:	2 Allison AE 3007/A1/1 turbofan engines
Category:	1.1
Year of Manufacture:	2001
Date & Time (UTC):	20 February 2005 at 0900 hrs
Location:	West of Coulommiers VOR Beacon, France
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 28
Injuries:	Crew - None Passengers - None
Nature of Damage:	Heat damage to electrical component
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	5,000 hours (of which 1,500 were on type) Last 90 days - 100 hours Last 28 days - 50 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the climb, the pilots were unable to keep the autopilot engaged, and later became aware of smoke and fumes in the cockpit. Shortly afterwards the commander's flight displays and the Engine Instrument and Crew Alerting System failed. Smoke was evident briefly in the passenger cabin and the aircraft diverted to Paris Charles de Gaulle Airport. After landing, disembarkation was delayed whilst the crew attempted to follow complex taxi instructions. The source of the smoke was identified as the number 1 IC-600 avionics integrated computer.

The investigation found that the procedure for recovering information to cockpit displays in the event of failure of an IC-600 had been omitted during a previous revision of the Quick Reference Handbook (QRH). One safety recommendation was made concerning restoration of the appropriate procedure in the QRH.

History of the flight

The aircraft was being flown by the co-pilot on a scheduled passenger flight from Manchester to Venice. While climbing through FL100, the autopilot disengaged but was successfully re-engaged by the co-pilot. The autopilot disengaged again as the aircraft climbed

through FL200, but could not be re-engaged, restricting the aircraft to flight below airspace in which Reduced Vertical Separation Minima (RVSM) apply. Later, whilst cruising at FL270 west of the Coulommiers VOR Beacon, an unusual smell became apparent in the flight deck. The senior cabin crew member who was asked to check the cabin reported to the commander that the smell was of nail varnish, although both pilots considered that it was similar to electrical burning. Shortly afterwards, smoke was seen beneath the commander's seat. Simultaneously, the commander's Primary Flight Display, Multi-function Display (MFD), Radio Management Unit and the Engine Instrument and Crew Alerting System (EICAS) all failed. The pilots carried out the emergency actions for smoke on the flight deck, donned oxygen masks and smoke goggles, and declared a MAYDAY, requesting a diversion to Paris Charles de Gaulle Airport. Smoke was also evident briefly in the passenger cabin but, according to the commander, the pilots were not made aware of this at the time. Nevertheless, the cabin crew were told to prepare for an immediate diversion and the passengers were informed of this intention.

As the aircraft descended through FL090, the co-pilot deployed the speed brakes in order to reduce indicated airspeed to below 250 kt. The speed brakes were not stowed prior to the subsequent approach and landing on Runway 27L and the commander noticed that they remained deployed after the aircraft was shut down, but no adverse handling or performance characteristics were reported.

After landing, the pilots received lengthy taxiing instructions to a remote stand in an area of Paris Charles de Gaulle Airport with which they were not familiar. Consequently, disembarkation did not start until five minutes after touchdown, despite advice from ATC that the aircraft could stop at any time, if disembarkation became necessary.

Engineering investigation

The source of the smoke was identified by the operator's maintenance personnel as the number 1 IC-600 avionics integrated computer, which collates data from a variety of aircraft systems and presents them on the number 1 cockpit displays.

Subsequent investigation by the manufacturer of the IC-600, found that a transistor on the A5 Autopilot Circuit Card Assembly had failed. Failure of this transistor caused the Yaw Damper Clutch line to short to ground. This caused excessive current to flow in the Yaw Damper Clutch line circuit, which resulted in overheating and some charring of the circuit card and other components located in the area of the failed transistor. The computer manufacturer concluded that this was an isolated incident. The aircraft manufacturer supports this view, stating that the IC-600 has been a very reliable component on the ERJ family of aircraft, with a mean time between failures of over 100,000 flight hours.

Reversionary procedures

The presentation of information on an electronic flight instrument can be lost either by interruption of the information source or by failure of the display itself. The former is identified by a red "X" on the affected display, the latter by a blank screen. Neither of the pilots recalled seeing anything displayed on the affected screens, but the investigation found that failure of an IC-600 would cause a loss of information to all of the screens normally associated with it and the display of a red "X" on each. The red "X" symbol is generated by the display unit itself in the absence of any other information, and thus is independent of the normal function of the symbol generator (SG) associated with each IC-600.

In normal operation, the number 1 IC-600 presents information on the commander's (left hand) cockpit displays and EICAS, and the number 2 IC-600 presents information on the right hand cockpit displays. In the case of a single display failure, the information that would normally be presented on that display can be shown instead on one of the other screens on that side, and the procedure to be followed is described in the quick reference handbook (QRH). If an IC-600 should fail, however, information from the opposite IC-600 can be presented on both sets of cockpit displays by pressing the "SG" pushbutton on the reversionary panel of the affected side. This simple procedure was absent from the QRH.

The commander reported that no reversionary procedure was attempted because of the high workload involved in diverting to Paris Charles de Gaulle. He conceded, however, that had such an attempt been made, the crew would not have been able to identify the appropriate procedure by reference to the QRH alone. The co-pilot added that he made a reversionary selection in order to present EICAS information on his MFD, but this action would not have altered the presentation of information on screens affected by failure of the number 1 IC-600.

Recorded information

The cockpit voice recorder was replayed successfully. The two solid-state flight recorders recorded information throughout the event, and the flight data recorder (FDR) operated normally until 0837 hrs. After that time parameters associated with the number 1 IC-600 were no longer recorded, whereas others not associated with it were recorded. These included the tri-axis accelerometer, control column and control wheel position transducers, rudder pedal position transducers, brake pressures and the clock. From these parameters it was deduced that the aircraft landed at 0853 hrs.

All of the missing parameters were routed through the failed IC-600 integrated computer. The architecture of the data capture system was such that failure of the number 1 IC-600 prevented data from reaching the FDR, with no possibility of reversion to alternative data sources.

Speed brake deployment

It is likely that the speed brakes were deployed (or selected) throughout the approach and landing. However, they are designed to stow automatically, regardless of the cockpit selection, when flaps are extended by 22° or more, or when the thrust levers are advanced, both of which conditions would be met during an approach. On the ground, with flaps selected up and thrust levers retarded, the speed brakes would have redeployed, as observed by the commander.

If the speed brakes were not in the selected position (for example, because they had stowed automatically in the circumstances described above) a "SPEED BRAKE LEVER DISAGREE" message should have appeared on the EICAS. However, since the EICAS itself was not displaying any information, this message would not have been presented to the crew in the normal way. The co-pilot did not recall seeing any such warning on the "reverted" EICAS display presented on his MFD. The manufacturer and operator consider that it would not have been possible to carry out a normal approach had the speed brakes remained deployed.

Follow up action

Quick Reference Handbook

The QRH current at the time of the incident did not contain a procedure to be followed in the event of failure of an IC-600. The simplicity of the correct reversionary procedure (pressing one button) suggests that adequate

crew knowledge alone should have been sufficient to address this failure. Also, the QRH described a procedure for dealing with an “IC bus failure”, the symptoms of which would be essentially the same as failure of the IC-600 computer itself. Completion of this procedure would restore information to the affected displays. Nevertheless, the commander of the incident aircraft and senior pilots on the operator’s ERJ fleet expressed surprise that a clearly identifiable procedure was not available. The AAIB supports this view. Although sufficient flight instrumentation remained for the co-pilot to carry out a successful approach and landing, easy access to a straightforward remedy would have reduced crew uncertainty and assisted the commander with monitoring of the flight.

quickly before taxiing clear. Stopping the aircraft expeditiously is of prime importance. If required, an evacuation must be initiated promptly’.

Elsewhere, it cautions:

‘fire or smoke warnings... may either be false or indicate an overheat condition rather than a fire. The immediate action - to carry out the appropriate emergency checklist - does not automatically include evacuating the aircraft. The primary objective is passengers’ safety, and it may be undesirable to carry out an unnecessary emergency evacuation with the attendant risks to passengers’.

The aircraft manufacturer discovered that the relevant reversionary procedure had previously been included in the published QRH but had then been omitted in a subsequent revision. The aircraft operating manual contains advice on reversionary procedures, and the operator has distributed this advice in a notice to its pilots. The manufacturer has undertaken to reinstate the procedure in the QRH.

FDR data acquisition

All of the parameters missing from the FDR are routed via the number 1 IC-600, the system having been certified on the basis that a single IC-600 is considered a reliable unit. Most aircraft have similar single source architecture, as it is not considered practical or desirable to duplicate the system.

Disembarkation following fire

The company Operations Manual advises

‘After a rejected take-off or an emergency landing the aircraft should normally be brought to a halt on the runway and the emergency evaluated

Weather conditions at the time of the incident were such that a disembarkation on or near the runway would have been an uncomfortable experience for the passengers. Nevertheless, a timely disembarkation or evacuation should be the highest priority following evidence of fire or smoke generation on board an aircraft. Previous accidents have demonstrated that any delay after landing can seriously prejudice the survival of those on board in the event of an actual fire. However, in this incident, the commander decided that evacuation was unnecessary. Discretion to make such a judgement was permissible within the operator’s flight crew orders.

On 8 September 2005 it was recommended that:

Safety Recommendation 2005-080

Empresa Brasileira De Aeronautica SA (Embraer) should publish a readily identifiable procedure in the quick reference handbook of all ERJ135/140/145 series aircraft which restores information to flight instruments affected by the failure of either IC-600 avionics integrated computer.

Response to Safety Recommendation 2005-080

On 14 October 2005 Embraer notified the AAIB in writing that:

‘Embraer is at present in the process of revising the current QRH to incorporate the suggested recommendation. Embraer expects to have this revision available for operators by the end of this calendar year’.