AVIATION INVESTIGATION REPORT
A02P0010

CABIN ENTERTAINMENT SYSTEM FIRE

AIR CANADA
AIRBUS A-330-300 C-GFAF
VANCOUVER INTERNATIONAL AIRPORT,
BRITISH COLUMBIA
17 JANUARY 2002

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

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Summary

An Air Canada Airbus A330-300, C-GFAF, was parked at Vancouver International Airport while the crew prepared the aircraft for boarding. A fault in the cabin entertainment system had been reported and a technician was in the passenger cabin, resetting the system in accordance with normal procedures. Shortly thereafter, the in-charge flight attendant observed a fire in the video system management unit (SMU), located in the forward galley area of the cabin. The technician used the main power switch to remove power from the cabin entertainment system; however, smoke continued to emanate from the SMU. The technician then removed power from the entire aircraft and discharged a halon fire extinguisher into the SMU to extinguish the fire. Airport emergency response personnel were alerted and responded promptly. Fire damage was contained within the SMU and there were no injuries. Maintenance personnel removed the SMU and the aircraft departed without further incident.

Ce rapport est également disponible en français.

Other Factual Information

The P@ssport ™ cabin entertainment system on the aircraft was manufactured by Rockwell Collins Inc. The system comprised the video system management unit (SMU), part number RV 970-0029-005, and approximately 20 other main components. The subject SMU, serial number 2006, was installed in the occurrence aircraft on 04 January 2002 after being repaired by the manufacturer. It subsequently operated for approximately 169 hours before the occurrence.

The SMU was installed in the video control centre (VCC) in the forward galley area of the aircraft. The VCC received 115-volt aircraft power, and an internal power supply produced other voltages required by the system. The cabin entertainment system was normally turned on and off by cabin crew using a touch-sensitive screen. To turn off the system in an emergency, a main power switch located in the VCC is used. However, the SMU and two other components continued to be powered for up to 120 seconds by two 6-volt, 4.5 amp hour batteries, as the SMU completes a systematic software shutdown. Battery power is provided to these components regardless of the position of the cabin entertainment system main power switch or the availability of aircraft power.

The SMU was removed from the aircraft after the occurrence and inspected. The outside of the SMU case was not damaged. The tamper-proof seal was intact and the rear electrical connector pins were clean with no indication of pitting, arcing, or heat damage. Inside the SMU case, the fan assembly for the central processing unit (CPU), on the processor board, was detached from the CPU. One of two plastic locking tabs was thermally deformed, allowing the fan to separate from the CPU. Burn patterns on the back of the fan assembly were consistent with the fan being attached to the CPU while the fire was in progress.

Components on the processor board adjacent to the CPU, and both faces of the processor board itself, had extensive heat damage. One of these components, a switching regulator integrated circuit (U18), received 12-volt power via a copper trace on the processor board. The copper trace exhibited signs of overheating, which were consistent with exposure to a high electrical current, particularly in the vicinity of the U18 switching regulator. A resettable fuse and two small capacitors, originally mounted on the processor board, had fallen onto the SMU mother board. The solder that held these components to the processor board had melted and all three components exhibited heat damage. The resettable fuse had thermally tripped.

An integrated circuit (U19) on the processor board will detect a short circuit condition external to the U18 switching regulator and remove power from the component; however, an internal failure within the U18 switching regulator will not be detected. The SMU, including the processor board, is normally powered by the SMU power supply. The voltage output of the SMU power supply is monitored and the power supply will shut down if an over-voltage condition is detected. The SMU power supply was tested after the occurrence and functioned normally. The backup batteries and the copper trace that deliver 12-volt power to the U18 switching regulator are not protected against over-current conditions.
Burn tests were conducted on similar electrical components in an attempt to replicate the heat damage to components on the occurrence processor board. The components did not exhibit the extensive damage observed on the SMU processor board after being exposed to a direct flame for approximately one minute. According to

the manufacturer, a component failure on the processor board will typically produce high heat for less than one second.

The SMU had been repaired by Rockwell Collins on 01 October, 08 November and 06 December 2001. During the repairs in October the processor board, which includes the U18 switching regulator, was replaced. In November, the SMU was returned to Rockwell Collins after it had begun to smoke during installation. The SMU was again returned to Rockwell Collins in December, after it was installed in an aircraft but failed to operate. In December, repair technicians discovered that the U18 switching regulator was burnt. The processor board was again replaced and operated until the occurrence on 17 January 2002.

Rockwell Collins subsequently identified a manufacturing process deficiency for U18 components manufactured before July 2000. The manufacturing deficiency resulted in an incomplete seal around the U18 component, allowing contaminants to penetrate the plastic case and creating an environment conducive to premature component failure. The U18 component on the damaged processor board had been manufactured in 1999. U18 is common to 11 other processor boards in each P@ssport entertainment system. In total, 539 of these processor boards are in the P@ssport entertainment systems of 27 aircraft operating worldwide.

Most failures of electronic components occur within the first few weeks of operation. Manufacturers of aircraft electronics typically subject new components to a burn-in[1] period prior to installation, to increase the reliability of the finished product and identify any manufacturing deficiencies. The SMU was subject to a burn-in period when it was initially manufactured. Spare SMU electrical components, however, including the processor board, are not subject to a burn-in period.

On 27 August 2001, the Federal Aviation Administration (FAA) of the United States of America issued a series of airworthiness directives[2] (AD) that apply to aircraft with entertainment systems which cannot be completely powered off. The AD ensured that the main power switch in the VCC removes electrical power from all entertainment system components. This FAA AD series, however, does not apply to the P@ssport entertainment system and, with respect to Airbus aircraft, only to the A340-211 model.

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[1] Burn-in is the application of thermal and electrical stresses for the purpose of inducing the failure of electronic devices that have inherent defects resulting from manufacturing.

[2] Airworthiness directives are mandatory modifications to an in-service aircraft, engine, or component.

On 07 December 2001, Airbus issued a service bulletin (SB-A340-23-4119), similar to the FAA AD, modifying the in-flight entertainment systems on all A340-313 aircraft. This SB ensured that the main power switch in the VCC removes electrical power from all entertainment system components. This SB, however, applies only to the A340-313 model and one specific entertainment system: it does not apply to other Airbus aircraft or the P@ssport entertainment system.

Analysis

The high current condition on the SMU processor board 12-volt trace could have been caused by one of the following.

1. A mechanical short circuit – A mechanical short could have been caused by the dislodged CPU fan. However, the fan assembly did not exhibit signs of pitting or arcing, as it would have if it had contacted live electrical components. As well, the burn patterns on the fan assembly indicate that it remained properly attached to the CPU for some time after the fire started.

2. An over-voltage condition at the SMU power supply – It is unlikely that the SMU power supply produced an over-voltage condition sufficient to cause electrical heating on the 12-volt copper trace. The SMU power supply is protected against over-voltage conditions, and it functioned normally after the occurrence.

3. An internal failure of an electrical component on the processor board – The U18 switching regulator was replaced twice in the months prior to the occurrence. The U18 component was susceptible to premature failure and a manufacturing process deficiency was identified. Heat damage to U18 is consistent with an internal failure. Failure of the U18 switching regulator would not have been detected by the SMU and power would not have been removed from the component.

This investigation concluded that an internal failure of the U18 component on the processor board resulted in an excessive draw of current over the 12-volt trace, which produced excessive heat and caused the processor board to burn.

The duration and intensity of the fire was not characteristic of merely a component failure. When main power was removed from the SMU, the processor board continued to receive electrical energy from the backup batteries, likely contributing to the duration of the fire. There was no effective mechanism to disconnect the battery from the SMU, a deficiency not addressed in existing Airbus service bulletins or FAA airworthiness directives.

Findings as to Causes and Contributing Factors

1. Internal failure of the U18 switching regulator caused a high current draw and excessive heat on the 12-volt input trace, causing the processor board to ignite.

2. The main power switch does not remove battery power from the processor board and the 12-volt input trace is not protected. As a consequence, the over-current condition could not be interrupted, likely extending the duration of the fire.

Findings as to Risk

1. The absence of a burn-in process increases the likelihood of electrical component failure on in-service equipment.

2. The inability to remove all electrical power from the entertainment system, and potentially reduce the duration and intensity of a fire, is not addressed by the Federal Aviation Administration (FAA) airworthiness directives (AD) series, or the Airbus service bulletins (SB).

Safety Action

As a result of this occurrence, Rockwell Collins issued service bulletins 970-0029-005-23-02, 970-001-003-23-01, 970-0010-23-01 and 970-0002-003-23-01, which required the replacement of all U18 components manufactured before July 2000. These SBs, apply to all units in the P@assport system that contain the U18 component.

Airbus will issue SB A330-23-3109, SB A330-23-3122 and SB A340-23-4147 between January and April 2003. These SBs, in conjunction with Rockwell Collins SB A330-A340-23-02, will cover the installation of a main power switch to remove electrical power from all P@ssport entertainment system components installed on A330 and A340 aircraft.

Air Canada Technical Services will comply with all SBs issued by Airbus and Rockwell Collins involving the P@ssport entertainment system.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 30 January 2003.

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