



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: July 22, 2008

In reply refer to: A-08-56 through -58

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The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The Safety Board is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

This recommendation letter addresses the in-flight loss of flight displays and various aircraft systems on Airbus A319 and A320 airplanes. This recommendation is derived from the Safety Board's ongoing investigation of a January 25, 2008, incident in which the flight crew of an Airbus A320 had to return to the departure airport following the loss of half of its flight displays and several aircraft systems and is consistent with the evidence we found and the analysis we performed. As a result of its investigation thus far, the Safety Board has issued six safety recommendations, three of which are addressed to the European Aviation Safety Agency (EASA). Information supporting these recommendations is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

On January 25, 2008, about 0945, an Airbus A320, N462UA, operated by United Airlines as flight 731, returned to Newark Liberty International Airport (EWR), Newark, New Jersey, shortly after departure from runway 22R because three of the six electronic displays¹ providing information to the flight crew went blank and several aircraft systems became inoperative. The flight crew landed the airplane without further incident, and no injuries were reported for anyone on board the flight. Visual meteorological conditions (VMC) prevailed at the time of the incident

¹ The flight instruments in an Airbus A320 include the captain's primary flight display (PFD) and navigational display (ND), the first officer's PFD and ND, and the upper and lower electronic centralized aircraft monitoring displays.

for the 14 *Code of Federal Regulations* Part 121 scheduled domestic flight, which was operating on an instrument flight rules flight plan.

According to the flight crew, shortly after takeoff, the captain's primary flight display (PFD) and navigational display (ND), along with the upper electronic centralized aircraft monitoring (ECAM)² display, went blank. The ND for the first officer remained functional, as did the lower ECAM display; however, the first officer reported that the attitude information on his PFD was initially not usable but that the information appeared to be reliable later in the flight. In addition, although the handle that controls the landing gear had been moved to the retract position after takeoff, the landing gear did not retract. According to the crew, all radios were inoperative and the overhead panel was blank. The pilots leveled the aircraft at their first assigned altitude of 2,500 feet, elected to return to the field, and landed at EWR³ with several aircraft systems inoperative, including the airplane's transponder, the traffic alert and collision avoidance system, and the standby attitude indicator.⁴ The crew later reported that the indicator (which, according to Airbus, is designed to function for about 5 minutes after it loses power) stopped functioning while the aircraft was on the downwind leg of the approach for landing.

After landing, the flight crewmembers observed that the "AC ESS FEED" pushbutton on the overhead panel had an illuminated fault indication for the AC 1 electrical bus.⁵ Both crewmembers stated that this fault indication was not illuminated in flight. They then manually selected the AC essential electrical bus feed to "alternate,"⁶ which reconfigured the power supply. After this selection, the captain's instruments, as well as most of the failed aircraft systems resumed functioning.

The National Transportation Safety Board's investigation of this incident is ongoing; however, preliminary findings indicate that a fault occurred in the airplane's AC 1 electrical bus, one of the two primary electrical distribution systems for the airplane, which in turn caused a number of other electrical busses on the aircraft to lose power. The loss of this electrical power led to the loss of a number of aircraft displays and systems.

² The ECAM system automatically displays messages and system diagrams to pilots. It provides operational assistance for both normal and abnormal airplane operational situations.

³ Because the pilots were not able to communicate with air traffic control (ATC) when they returned to EWR, they began flying a regular landing pattern and hoped ATC would recognize what they were doing. ATC did notice and cleared a path allowing the airplane to land.

⁴ The standby attitude indicator is designed to provide aircraft attitude information to the crew in the event that the primary attitude indicators are inoperative. This indicator is normally powered by the DC essential bus, which in turn is supplied by the AC essential bus.

⁵ The primary sources of electrical power for the A320, AC 1 and AC 2 use several electrical busses to distribute power throughout the airplane. In its normal configuration, the AC 1 electrical bus provides power to the AC essential bus, the DC essential bus, and DC 1 bus (power is provided to the DC electrical busses after first passing through a transformer-rectifier unit.) The auxiliary power unit and air driven emergency generator can also provide limited aircraft electrical power under some conditions.

⁶ When a fault is detected in the AC 1 electrical bus (or it stops providing power), the other busses can be powered by an alternate configuration, which entails selecting the AC 2 electrical bus to provide power. The alternate reconfiguration of the electrical system must be performed manually by the flight crew and is accomplished by activating a pushbutton switch located on the overhead panel.

During this investigation, the Safety Board learned of a similar event involving a British Airways A319 flight from London Heathrow Airport to Budapest, Hungary, on October 22, 2005. As the airplane climbed through 20,000 feet in night VMC with the autopilot and autothrust engaged, an electrical failure occurred, which resulted in five out of the six flight displays going blank. In addition, the autopilot and autothrust systems disconnected, the VHF radio and intercom became inoperative, and most of the cockpit lighting went off. After troubleshooting the problem, the flight crew was able to restore power to the displays and most of the affected systems by manually selecting the AC essential electrical bus feed to “alternate,” which reconfigured the electrical system to provide power from the AC 2 electrical bus. The United Kingdom Air Accidents Investigation Branch (AAIB) investigated this incident,⁷ but no definitive cause for the AC 1 bus fault could be determined.

According to Airbus, as of May 2007, 49 events similar to the United Airlines flight 731 and UK events had occurred in which the failure of electrical busses resulted in the loss of flight displays and various aircraft systems. Of these 49 events, roughly 37 were due to failures of the AC 1 bus. According to records provided by Airbus, 17 of the AC 1 bus failure events have resulted in the loss of either five or all six displays, and 7 of the AC 1 bus failures resulted in the loss of all six displays (generally, the number of displays lost related to AC 1 bus failures ranged from three to six).

The Safety Board notes that the multiple system losses associated with an AC 1 electrical bus failure can create a challenging situation for crews attempting to identify the nature of the fault and determine the best course of action for correcting the problem. For example, during the incident involving flight 731, the crewmembers noted that the multiple messages on the ECAM system, which provides information to the crew regarding failures that have occurred on the aircraft along with recommended corrective actions, were being displayed then removed by the ECAM system so quickly that they were unable to interpret and address the error messages.⁸

To mitigate the effects of any future AC 1 bus failures, Airbus has developed a service bulletin (SB) that modifies the airplane electrical system. In May 2007, Airbus published SB A320-24-1120,⁹ which contains a modification (number 37317) that incorporates into the airplane the ability to automatically reconfigure the power supply for the AC electrical bus in the event of an AC 1 electrical bus failure.¹⁰ To date, EASA has not mandated this SB.

The Safety Board is concerned that the blanking of electronic displays and failure of multiple aircraft systems can pose a significant safety risk during all phases of flight but

⁷ For more information, see UK Air Accidents Investigation Branch, *Report on the Serious Incident to Airbus A319-131, Registration G-EUOB, During the Climb After Departure From London Heathrow Airport on 22 October 2005*, AAIB Report Number 2/2008 (United Kingdom: AAIB, 2008) at <http://www.aaib.dft.gov.uk/sites/aaib/publications/formal_reports/2_2008_g_euob.cfm>.

⁸ The flight crewmembers of flight 731 later stated that, even though the weather was clear during the incident, they felt a very real sense of urgency to land the aircraft once the failure occurred because they were at low altitude, not in contact with ATC, had an inoperative transponder, and were heading roughly in the direction of downtown New York City. This sense of urgency may have led them to spend most of their efforts flying the aircraft and returning to EWR rather than spending more time troubleshooting the aircraft problems.

⁹ SB A320-24-1120 applies to A318, A319, A320, and A321 aircraft.

¹⁰ The modification contained in SB A320-24-1120 had not been incorporated on the United Airlines A320 involved in the January 2008 incident.

especially when an airplane is operating close to the ground (such as during takeoff and landing) or during approach operations under instrument conditions. The Board is especially concerned about a failure under such circumstances because of the increased pilot workload and potential for crew distraction associated with managing the failure. Therefore, to help ensure that electronic displays and aircraft systems remain functional in the event of an AC 1 electrical bus failure, the Safety Board believes that EASA should require all operators of Airbus A320 family aircraft to modify these aircraft in accordance with SB A320-24-1120 to provide the automatic reconfiguration of the AC essential bus power supply in the event that the AC 1 electrical bus fails.

The AAIB indicated that it has investigated 14 additional display-blanking events involving the failure of the AC 1 electrical bus. In two of these events, selecting the electrical bus feed to “alternate” did not have the intended result of supplying power from the AC 2 electrical bus. These incidents indicate that, even if a flight crew is able to effectively troubleshoot the malfunction,¹¹ the problem may not be resolved quickly. Moreover, increased flight crew workload resulting from the multiple system failures associated with this type of malfunction may impede crews’ ability to effectively troubleshoot the problem, especially under degraded environmental conditions (such as nighttime or instrument meteorological conditions).

Based on the incidents in which alternating the electrical bus feed did not have the desired effect, the Safety Board is concerned that automatic bus switching, although a good and necessary step on the path to mitigating the effects of this type of failure, may not comprehensively address this issue. Because, in many cases, the cause of these failures is unknown and because of the multiple systems and display failures that accompany this type of malfunction, the effects of this failure may not be resolved quickly if either manual or automatic bus switching does not work or high workloads prevent the flight crew from troubleshooting the failure. The Board notes that, in such cases, the standby attitude indicator would remain unpowered and would no longer function if the condition lasts more than 5 minutes. Combined with a loss of primary attitude indication (due to the loss of the PFDs) and degraded environmental conditions, this situation could easily result in the loss of the aircraft.¹²

To address this issue, Airbus has developed an aircraft modification (number 27140) that includes a separate backup power source for the standby attitude indicator. This modification is currently being included on new A320 family aircraft but has not been made available for retrofit on older aircraft. Therefore, the Safety Board believes that EASA should require Airbus to develop a modification for in-service A320 family aircraft such that, in the event of an AC 1 electrical bus failure, the standby attitude indicator is powered by an additional power source that

¹¹ The Safety Board notes that in some cases, such as that encountered by United Airlines flight 731, the crew may not be able to actively troubleshoot the malfunction due to more pressing concerns, such as the aircraft not being visible on radar (because of losing the transponder) and the crew’s being unable to communicate its situation to ATC. Under such circumstances, a flight crew will have to focus on other tasks without being able to effectively troubleshoot this problem.

¹² According to the first officer of flight 731, the standby attitude indicator began to present false information about 3 minutes after takeoff, rolling about 45° and pitching up about 20°. It eventually failed, displaying an orange flag. He observed that, “if EWR had low ceilings and visibility that day and if my attitude indication on my PFD had not returned, the aircraft may have been lost as the attitude gyro failed.”

will last for a minimum of 30 minutes, and require operators to incorporate this modification as soon as possible after it is available.

The Safety Board's investigation also found that not all operators have informed their pilots or provided training regarding the symptoms and resolution for an AC 1 electrical bus failure.¹³ In some cases during these events, experienced A320 pilots were unable to rapidly identify the nature of the fault to initiate corrective action. For example, the captain of flight 731 stated that he had "never seen any problems like this [that is, problems without apparent solutions]" on this aircraft before.¹⁴ Crew attempts to troubleshoot unusual or unforeseen systems problems, especially during critical phases of flight, may lead to more serious problems or even loss of aircraft control. While the incorporation of automatic reconfiguration pursuant to SB A320-24-1120 may reduce the prevalence of such problems, it may not always be effective. In such cases, to facilitate timely crew response to this hazardous situation, the Safety Board considers it important to provide crews with information about AC 1 bus failures and the associated loss of flight displays and systems, the symptoms of such failures, and recommended procedures. Therefore, the Safety Board believes that EASA should require all operators of A320 aircraft to develop new procedures, if necessary, and to provide flight crews with guidance and simulator training regarding the symptoms and resolution procedures for the loss of flight displays and systems in conjunction with an AC 1 electrical bus failure.

Therefore, the National Transportation Safety Board recommends that the European Aviation Safety Agency:

Require all operators of Airbus A320 family aircraft to modify these aircraft in accordance with Airbus Service Bulletin A320-24-1120 to provide the automatic reconfiguration of the AC essential bus power supply in the event that the AC 1 electrical bus fails. (A-08-56)

Require Airbus to develop a modification for in-service A320 family aircraft such that, in the event of an AC 1 electrical bus failure, the standby attitude indicator is powered by an additional power source that will last for a minimum of 30 minutes, and require operators to incorporate this modification as soon as possible after it is available. (A-08-57)

Require all operators of A320 aircraft to develop new procedures, if necessary, and to provide flight crews with guidance and simulator training regarding the symptoms and resolution procedures for the loss of flight displays and systems in conjunction with an AC 1 electrical bus failure. (A-08-58)

The Safety Board also issued safety recommendations to the Federal Aviation Administration. In response to the recommendations in this letter, please refer to Safety Recommendations A-08-56 through -58. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address:

¹³ After the flight 731 event, United Airlines issued a notice on February 6, 2008, to its A320 pilots describing the event; however, the notice did not provide guidance about how to manage such an event.

¹⁴ The captain of flight 731 was type rated in the A320 and was also a pilot instructor, a standards captain, as well as a line check airman.

correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us asking for instructions on how to use our Tumbleweed secure mailbox procedures. To avoid confusion, please use only one method of submission (that is, do not submit both an electronic copy and a hardcopy of the same response letter).

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred with these recommendations.

[Original Signed]

By: Mark V. Rosenker
Chairman