National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 18, 2009

In reply refer to: A-09-12 through -16

Ms. Lynne A. Osmus
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On July 10, 2007, about 0835 eastern daylight time, a Cessna Aircraft Company 310R, N501N, part of the fleet operated by the National Association for Stock Car Auto Racing (NASCAR) corporate aviation division, crashed while performing an emergency diversion to Orlando Sanford International Airport (SFB), Orlando, Florida.[1] The two pilots on board the airplane (a commercial pilot and an airline transport pilot [ATP]) and three people on the ground were killed. Four people on the ground received serious injuries. The airplane and two homes were destroyed by impact forces and a postcrash fire. The personal flight was operating under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91 on an instrument flight rules flight plan. Visual meteorological conditions prevailed at the time of the accident.

The National Transportation Safety Board determined that the probable causes of this accident were the actions and decisions by NASCAR's corporate aviation division's management and maintenance personnel to allow the accident airplane to be released for flight with a known and unresolved discrepancy, and the accident pilots' decision to operate the airplane with that known discrepancy, a discrepancy that likely resulted in an in-flight fire.

Background

On a flight in the accident airplane the day before the accident, another company pilot experienced a weather radar system malfunction and a "burning smell" in the airplane. In response, he turned off the weather radar and manually pulled the related circuit breaker, cutting electrical power to the system. The burning smell subsequently "went away," according to the pilot's entry in the airplane's maintenance discrepancy binder. The pilot flew the airplane for more than an hour without further incident before landing.

[1] For more information, see *In-flight Fire, Emergency Descent, and Crash in a Residential Area, Cessna 310R, N501N, Sanford, Florida, July 10, 2007*, Aircraft Accident Summary Report NTSB/AAR-09/01/SUM (Washington, DC: NTSB, 2008), which is available on the Safety Board's website at <http://www.ntsb.gov/publictn/2008/AAR0901.pdf>.

The events on the day before the accident indicate that an electrical problem existed in the weather radar components or related wiring. Pulling the circuit breaker for the weather radar stopped a symptom (the burning smell) of the problem by removing electrical power from the circuit; however, it did not correct the underlying problem. The heat, smoke, fumes, and restrictions to visibility associated with airplane electrical system anomalies can result in an in-flight fire; these conditions can also represent a significant hazard to airplane occupants and adversely affect an airplane's airworthiness. Therefore, the Safety Board concludes that the weather radar system anomaly that was experienced and formally documented by the NASCAR company pilot the day before the accident could have developed at that time into a significant in-flight smoke and fire event; however, the anomaly was temporarily alleviated when the company pilot pulled the related circuit breaker.

Upon landing, the company pilot left the weather radar circuit breaker pulled, placed the maintenance binder with the white copy[2] of the discrepancy report on the throttle quadrant, and provided the yellow copy and a verbal briefing of the incident to the director of maintenance. He also reported the maintenance discrepancy to the maintenance technician who had primary responsibility for the accident airplane.

According to 14 CFR 91.213, general aviation operations like NASCAR's aviation division may operate nonturbine-powered airplanes (such as the Cessna 310), with noncritical inoperative equipment if the inoperative item is not required for flight and is either 1) removed from the airplane, the cockpit control placarded, and the maintenance recorded, or 2) deactivated and placarded as inoperative. Further, Federal regulations state that an appropriately rated pilot or mechanic must determine that the inoperative equipment does not constitute a hazard to flight.

Postaccident interviews indicate that NASCAR's aviation director, director of maintenance, and chief pilot discussed the weather radar discrepancy on July 9—the day before the accident, after the company pilot reported it. However, no one examined the airplane to investigate the discrepancy; no maintenance personnel stated that they had been in the airplane since the discrepancy was reported; and no company personnel ensured that Section 91.213 had been complied with. The Safety Board concludes that without examining the weather radar system, and then either removing the airplane from service or placarding the airplane and collaring the circuit breaker, as well as making a maintenance records entry, it was not permissible to fly the airplane under Federal regulations.

The final safeguard against the operation of an airplane with an unresolved maintenance discrepancy is a thorough pilot preflight inspection. In this case, the Safety Board's investigation showed that both pilots had access to information that could have alerted them that the accident airplane had an unresolved maintenance discrepancy on the morning of the accident and could have led them to take appropriate actions to ensure that the discrepancy was addressed before flight. Postaccident interviews indicated that the ATP was specifically advised of the weather radar discrepancy by a telephone call from NASCAR's chief pilot the night before the accident

[2] NASCAR pilots documented airplane maintenance discrepancies on nonserialized, duplicate reporting forms in binders on each airplane. After the accident, the yellow copy could not be located by the director of maintenance.

flight and in person by the maintenance technician who was responsible for the accident airplane the morning of the accident flight.

There is no indication that anyone specifically advised the commercial pilot of the weather radar discrepancy, but he was the designated pilot-in-command for the accident flight and, as such, had primary responsibility for determining the airplane's airworthiness. The Safety Board concludes that the ATP and the commercial pilot had sufficient information about the weather radar discrepancy and the burning smell to determine that the condition constituted a hazard to flight and to refuse the airplane unless and until additional actions were performed by maintenance personnel. The Safety Board further concludes that the pilots accepted the airplane as made available by NASCAR management and maintenance personnel, despite the fact that no diagnostic, corrective, or interim maintenance action had been taken to address the discrepancy.

On the day before the accident, the airplane was flown uneventfully for at least 1 hour after the pilot pulled the weather radar circuit breaker. In contrast, on the accident flight, the airplane was only airborne for about 10 minutes before the pilots reported a problem. The airplane crashed about 2 minutes later. The most likely reason for the rapid onset of the problem is that one of the pilots reset the radar circuit breaker, thus reinitiating the development of the problem encountered on the previous flight. The circuit breakers would have been difficult for the ATP to reach and were next to the left leg of the commercial pilot, but nothing was found to indicate which pilot reset the circuit breaker or when. Examination of the wreckage also indicated that the heat of the in-flight fire was most intense in the area above the left-side instruments, where wiring (including weather radar wiring) and other combustible materials were located. However, impact and fire damage to the airplane prevented physical confirmation that the circuit breaker was reset.

Examination of heat and soot evidence on the instrument panel deck skin, which was not exposed to the intense postimpact fire, indicated that there had been a fire in the area forward of the left-side instrument panel. Given the previous day's events, the weather radar system and/or its associated wiring was most likely the source of the fire. The flammable fluid lines located near that system's wiring may have provided additional fuel for the fire; the Safety Board could identify no other likely sources of smoke or fire. Although the weather radar system and/or its wiring is the most likely source of the fire, the Safety Board concludes that there was insufficient evidence to conclusively determine the origin of the in-flight fire.

Circuit Breaker Reset Hazards

Circuit breakers are installed on aircraft to protect wiring. When current flowing through a system exceeds a predetermined value for a period of time, the circuit breaker activates or "trips" to stop current flow through that system by breaking the electrical circuit. To use the system after a circuit breaker trips, a pilot must reset that circuit breaker manually.

General aviation pilots often reset circuit breakers during preflight preparations unless the circuit breakers are placarded or collared to show that the associated system is to remain unpowered. Further, the accident airplane's "Before Starting Engines" checklist included an item

stating "Circuit Breakers—IN." Therefore, the Safety Board concludes that it is likely that one of the pilots, consistent with routine and/or the "Before Starting Engines" checklist for the accident airplane, reset the weather radar circuit breaker, which restored electrical power to the weather radar system's wiring and resulted in the in-flight fire.

Historically, it has been common practice to reset a circuit breaker on an airplane one time after the breaker trips. The rationale behind this one-time reset practice is that if the circuit breaker tripped because of anything other than a transient or nuisance event and if the triggering condition was still present, the circuit breaker would trip again shortly after being reset. Consistent with historical guidance related to circuit breakers, page 7-24 of the accident airplane's pilot operating handbook states, in part:

> All electrical systems in the airplane are protected by push-to-reset type circuit breakers…. Should an overload occur in any circuit, the resulting heat rise will cause the controlling circuit breaker to "pop" out, opening the circuit….After allowing to cool for approximately three minutes, the circuit breaker may be pushed in…to reenergize the circuit. However, the circuit breaker should not be held in…if it opens the circuit a second time as this indicates a short circuit.

However, this practice does not consider the cumulative nature of wiring damage and that the removal of power only temporarily stops the progression of the damage. The aviation industry has begun to recognize the potential hazards of resetting noncritical circuit breakers even once. For example, the Transportation Safety Board of Canada report on the September 2, 1998, accident involving an in-flight fire on a SwissAir McDonnell Douglas MD-11[3] documented the importance of not resetting noncritical circuit breakers and recommended that "[r]egulatory authorities establish the requirements and industry standard for circuit breaker resetting." In addition, the Safety Board conducted a review of commercial aviation accidents involving in-flight fires and, based on its findings, issued several similar safety recommendations. In Safety Recommendation A-01-83, the Board recommended that the Federal Aviation Administration (FAA) develop and issue an advisory circular (AC) to address in-flight fire issues.[4] On January 8, 2004, the FAA issued AC 120-80,[5] "In-Flight Fires," which stated, in part:

> Crewmembers may create a potentially hazardous situation if they reset a CB [circuit breaker] without knowing what caused it to trip. A tripped CB should not be reset in flight unless doing so is consistent with explicit procedures specified in

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[3] For additional information, see Transportation Safety Board of Canada, *In-flight Fire Leading to Collision with Water, SwissAir Transport Limited Flight 111, McDonnell Douglas MD-11, HB-1WF, Peggy's Cove, Nova Scotia, 2 September 1998,* Aviation Investigation Report A98H0003.

[4] The Safety Board issued Safety Recommendations A-01-83 through -87 on January 4, 2002. The full text of the recommendation letter is available online at <http://www.ntsb.gov/recs/letters/2001/A01_83_87.pdf>. Based on the FAA's issuance of AC 120-80, the Board classified Safety Recommendation A-01-83 as "Closed—Acceptable Action" on April 15, 2004.

[5] The full text of AC 120-80 is available online at <http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/ed51f1681e9d8c5e86256e4a00744607/$FILE/AC120-80.pdf>.

> the approved operating manual used by the flight crew or unless, in the judgment of the captain, resetting the CB is necessary for the safe completion of the flight.
>
> Air carrier manuals and training programs should contain company policies and explicit procedures regarding resetting tripped CBs, both during flight and on the ground. The procedures shown in the manuals used by the air carrier's crewmembers, maintenance personnel, and airplane ground servicing personnel should be consistent with the airplane manufacturer's guidance.[6]

Many 14 CFR Part 121 (transport-category) operators provide their pilots with and follow procedures based on the AC guidance and have revised their operating handbooks and checklists to contain written instructions regarding which circuit breakers are considered essential and may be reset. Moreover, aircraft operated under Part 121 commonly have indicators, such as circuit breaker markings or coloring, or segregated placement of specific circuit breakers in the cockpit, showing which circuit breakers are critical.

Although many 14 CFR Part 121 operators have made changes that reflect current guidance regarding the resetting of tripped circuit breakers, evidence from this investigation indicates that many Part 91 pilots and operators have not yet made changes to address current guidance about circuit-breaker resets. One reason might be that individuals operating airplanes under Part 91 are less likely to have a formal system for addressing AC guidance. As a result, many general aviation pilots, mechanics, and operators may not have reviewed AC 120-80. Even if general aviation personnel have reviewed the AC, the guidance contained in manuals provided by general aviation airplane manufacturers often directly conflicts with the guidance contained in AC 120-80. Additionally, because the guidance in that AC focused more on transport-category operations, airplanes, and systems, general aviation pilots, mechanics, or operators who did review the AC might not have perceived its relevance to their operations.

In fact, general aviation pilots still receive information indicating that it is acceptable to reset circuit breakers one time, even for nonessential systems. For example, a May 2007 article in *Flight Training*, a periodical published by the Aircraft Owners and Pilots Association provided pilots the following advice:

> Circuit breakers can be reset simply by pushing in the black button. Wait a few moments to allow the breaker to cool before resetting. Also, don't try to reset a breaker more than once. If it pops again after the first reset, it's a good indication that a serious problem exists somewhere in the circuit that demands professional attention.[7]

The Safety Board concludes that existing guidance in manuals provided by general aviation airplane manufacturers regarding the resetting of circuit breakers often does not

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[6] According to the AC, this guidance was directed to crewmembers operating transport-category airplanes under 14 CFR Part 121 and also to crewmembers of passenger-carrying airplanes operating under other parts, including Part 135 and Part 91.

[7] This quote is from "Training Notes and News: Popped circuit breaker" in the May 2007 issue of *Flight Training*.

consider the cumulative nature of wiring damage and that the removal of power only temporarily stops the progression of such damage. The Safety Board further concludes that if general aviation pilots, maintenance personnel, and operators had a more thorough understanding of the potential hazards of a reset circuit breaker (as outlined in AC 120-80), they would be less likely to reset a tripped circuit breaker without knowing what caused that circuit breaker to trip. Therefore, the Safety Board believes that the FAA should develop a safety alert for operators (SAFO) informing general aviation pilots and maintenance personnel of the circuit breaker policy contained in AC 120-80. The Safety Board believes the FAA should require that the contents of the SAFO requested in the previous safety recommendation be included in initial and required biennial training for general aviation pilots and maintenance personnel.

Although 14 CFR Part 91 operators do not operate under FAA-approved operations specifications and are subject to less FAA scrutiny than Part 135 and 121 operators, information describing the hazards associated with resetting nonessential circuit breakers could easily be made available to general aviation operators, pilots, and mechanics. Some of the options available to the FAA for dissemination of this information, other than the previously recommended training, include publishing the information on the FAA's safety-related websites and providing the information to pilots directly via e-mail or regular mail.

Critical Circuit Breaker Identification

Although resetting a circuit breaker can pose a hazard, some systems must remain powered to ensure safe flight. FAA AC 23-17 and its subsequent revisions provide guidance for aircraft manufacturers related to limiting unnecessary circuit breaker resets by identifying circuit breakers associated with critical systems. The AC states, in part:

> The FAA recognizes that some required circuit protection devices are associated with circuits that can have no significant impact on safety in flight. Therefore, the responsible Aircraft Certification Office…and [the manufacturer] should identify which circuits and circuit protection devices are essential to safety in flight.

On February 23, 2004, the FAA issued Policy Statement ACE100-2002-005 to clarify guidance issued in AC 23-17 regarding the identification of critical and noncritical systems and their circuit breakers in general aviation aircraft.[8] This policy statement acknowledged that the criticality of an electrical system depends on certain variables, such as the equipment on board the airplane and the flight conditions for any given flight. As a result, the need to reset circuit breakers associated with these systems varies with operational circumstances. Applying this analysis to the accident flight, which was a relatively short flight conducted in visual meteorological conditions, the weather radar would not be considered a critical system; the weather radar system was not needed for safe flight.

The FAA's guidance indicated that the airplane manufacturers were to work with the FAA to identify an airplane's critical systems during the certification process and develop related

[8] The full text of FAA Policy Statement ACE100-2002-005 is available online at <http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgPolicy.nsf/0/23080994EFAD2D0A86256E44004BE9B3?OpenDocument>.

procedures to keep those critical systems powered. However, although this FAA guidance might have successfully addressed issues related to critical systems and resetting of critical circuit breakers in newly certificated airplanes, it did not address those issues for older airplanes that are currently being manufactured under existing certifications. Pilots who are unaware that circuit breakers should be reset only if the associated system is critical may unwittingly reset a noncritical circuit breaker and, in doing so, unnecessarily introduce a hazard.

The Safety Board concludes that identification, by an aircraft's manufacturer or those responsible for postmanufacture modifications, of which of an aircraft's systems are critical to a flight (or to a realm of flight) would enable pilots to make better-informed decisions regarding which circuit breakers they should or should not attempt to reset before or during flight. Therefore, the Safety Board believes that the FAA should require aircraft manufacturers and those responsible for postmanufacture modifications to improve existing guidance, or create new guidance, regarding which circuit breakers pilots should and should not attempt to reset before or during flight and to disseminate the resultant guidance to airplane mechanics, pilots, and owners.

Electrical Systems

The accident airplane had been flown by various operators since it was manufactured in 1977 and was equipped with circuit breakers and wiring associated with both original equipment and modifications made during the 30 intervening years. The weather radar system, which was significant to this accident, was a postmanufacture equipment modification. Postaccident examination of Cessna 310R airplanes similar to the accident airplane revealed that the densest concentration of wiring in those airplanes is in the area where maintenance personnel would have been working during the weather radar system modification. Although postimpact damage precluded a definitive determination of the ignition source, this accident highlights an ongoing and as-yet unaddressed issue regarding wiring and circuit breakers in general aviation. Postmanufacture electrical system modifications and installations often result in general aviation maintenance personnel performing critical work among densely packed layers of wiring of different ages and materials; this work would be more safely performed if general aviation maintenance personnel were kept abreast of current industry concerns related to wiring.

The FAA regulations for maintenance of transport-category airplanes have been revised to address wiring-related concerns, such as 1) deteriorated (aging) wiring; 2) corrosion; 3) improper wire installation and repairs; and 4) contamination of wire bundles with metal shavings, dust, and fluids. The FAA also requires operators of transport-category airplanes to keep their maintenance personnel updated regarding current wiring-related concerns and best practices. Although electrical/wiring systems in general aviation airplanes are subject to hazards similar to those in transport-category airplanes, the FAA has not addressed similar issues with regard to maintenance personnel working on general aviation airplanes.

The Safety Board concludes that more thorough and continually updated guidance and information regarding maintenance and inspection of airplane electrical systems and wiring for general aviation maintenance personnel would increase the likelihood that they will be aware of current industry wiring-related concerns such as deteriorated (aging) wiring, corrosion, improper wire installation and repairs, and contamination of wire bundles with metal shavings, dust, and

fluids and would greatly increase the likelihood that their work will comply with current best practices. Therefore, the Safety Board believes that the FAA should require that initial and recurrent training for maintenance personnel working on general aviation aircraft include the most current "best practices" regarding inspection and maintenance of electrical systems, circuit breakers, and aging wiring.

Safety Management Systems

An operator's standard operating procedures (SOP) can provide useful procedural guidance if those SOPs are clear, detailed, readily available, and adhered to by company personnel. Although NASCAR's corporate aviation division had developed an SOP manual that established guidelines and procedures for its operations, those SOPs were not an integral part of the normal operating regimen and, in fact, were commonly disregarded by NASCAR personnel. Moreover, the SOPs were incomplete. For example, NASCAR's corporate aviation division's SOPs did not define a procedure for preventing the flight of an airplane with an unaddressed maintenance discrepancy and, thus, they did not prevent the release and acceptance of the accident airplane on the day of the accident, although pertinent NASCAR aviation flight, maintenance, and management personnel were aware of the discrepancy before the accident flight departed. Contrary to Federal regulations, company policy, and basic good operating practice, NASCAR maintenance and management personnel permitted the accident airplane to be released for flight with a significant maintenance discrepancy unaddressed. Therefore, the Safety Board concludes that, although NASCAR's corporate aviation division's SOPs included procedures designed to ensure that airplane maintenance discrepancies would be properly addressed and airplane airworthiness maintained, there was no formal method for determining and ensuring that an airplane was safe for flight; thus management, maintenance, and flight operations personnel allowed the operation of an airplane with a known and unaddressed discrepancy.

The Safety Board notes that increasing numbers of operators in the aviation industry have been incorporating a Safety Management System (SMS) into their operations. An effective SMS program would formalize a company's SOPs and establish methods for ensuring that those SOPs are followed. Guidance issued in November 2006, by the International Civil Aviation Organization in Annex 6, "Operation of Aircraft," states that after January 1, 2009, "[Member] States shall require, as part of their safety program, that an operator implements a [SMS] acceptable to the State of the Operator…." It is generally agreed that a successful SMS program is one that incorporates proactive safety methods to evaluate a company's flight and maintenance operations to, at a minimum:

1. Identify safety hazards;
2. Ensure that remedial action necessary to maintain an acceptable level of safety is implemented;
3. Provide for continuous monitoring and regular assessment of the safety level achieved; and
4. Continuously improve the company's overall level of safety.

The continuous monitoring and regular assessments involved in a formal SMS program would have helped to ensure that NASCAR aviation division personnel adhered in practice to their established processes and procedures and likely would have prevented the accident airplane's release for flight without corrective maintenance or ensured the placarding and deactivation of the circuit breaker. After this accident, NASCAR's corporate aviation division established an SMS program in compliance with the International Standard for Business Aircraft Operations [IS-BAO].[9] NASCAR's SMS implementation involved extensive review of and changes to their procedures, manuals, safety systems, and culture. After implementation, the NASCAR aviation department successfully completed an extensive registration audit by IS-BAO SMS auditors. The National Business Aviation Association actively encourages its business aviation members to incorporate SMS programs into their operations and endorses the IS-BAO program.

Although the FAA is addressing the issue of SMS programs with 14 CFR Part 121 operators, it has not explicitly addressed the issue of SMS for Part 91 operators. In June 2006, the FAA published AC 120-92, "Introduction to Safety Management Systems for Air Operators," which states, in part, the following:

> An SMS is essentially a quality management approach to controlling risk. It also provides the organizational framework to support a sound safety culture. For general aviation operators, an SMS can form the core of the company's safety efforts.[10]

Although the FAA recognizes that general aviation operators, such as NASCAR's corporate aviation division, which operate under Part 91, would benefit from an SMS, the FAA has done nothing to ensure that corporate operators adopt SMS programs. The Safety Board concludes that SMS programs would provide corporate flight departments a formal system of risk management, safety methods, and internal oversight programs that could improve safety. Therefore, the Safety Board believes that the FAA should develop a SAFO encouraging all 14 CFR Part 91 business operators to adopt SMS programs that include sound risk management practices.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Develop a safety alert for operators informing general aviation pilots and maintenance personnel of the circuit breaker policy contained in Advisory Circular 120-80. (A-09-12)

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[9] The International Business Aviation Council, a council of business aviation associations from around the world, developed IS-BAO as a code of best practices designed to help business flight departments worldwide achieve high levels of safety and professionalism.

[10] The full text of AC 120-92 is available online at <http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/6485143d5ec81aae8625719b0055c9e5/$FILE/AC%20120-92.pdf>.

Require that the contents of the safety alert for operators requested in Safety Recommendation A-09-12 be included in initial and required biennial training for general aviation pilots and maintenance personnel. (A-09-13)

Require aircraft manufacturers and those responsible for postmanufacture modifications to improve existing guidance, or create new guidance, regarding which circuit breakers pilots should and should not attempt to reset before or during flight and to disseminate the resultant guidance to airplane mechanics, pilots, and owners. (A-09-14)

Require that initial and recurrent training for maintenance personnel working on general aviation aircraft include the most current "best practices" regarding inspection and maintenance of electrical systems, circuit breakers, and aging wiring. (A-09-15)

Develop a safety alert for operators encouraging all 14 *Code of Federal Regulations* Part 91 business operators to adopt Safety Management System programs that include sound risk management practices. (A-09-16)

In response to the recommendations in this letter, please refer to Safety Recommendations A-09-12 through -16. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address: 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 hard copy of the same response letter).

Acting Chairman ROSENKER and Members HERSMAN, HIGGINS, SUMWALT, and CHEALANDER concurred with these recommendations. Member Sumwalt filed a concurring statement, which is attached to the Aircraft Accident Summary Report for this accident.

[Original Signed]

By: Mark V. Rosenker
Acting Chairman