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
PB2009-910401

National
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Notation 7943B
Adopted January 28, 2009

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National Transportation Safety Board. 2009. ***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.**

Abstract: This report explains the July 10, 2007, accident involving a Cessna 310R, N501N, operated by the National Association for Stock Car Auto Racing corporate aviation division as a personal flight. The airplane crashed while performing an emergency diversion to Orlando Sanford International Airport, Orlando, Florida, after an in-flight fire. The flight had been released despite a known unresolved maintenance discrepancy. Safety issues discussed in this report relate to the resetting of circuit breakers, the inspection and maintenance of electrical systems in general aviation aircraft, and the establishment of safety management systems in general aviation corporate operations. Safety recommendations regarding these issues are addressed to the Federal Aviation Administration.

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Abbreviations

A&P	airframe and powerplant
AC	advisory circular
agl	above ground level
AOPA	Airplane Owners and Pilots Association
ATP	airline transport pilot
CFR	*Code of Federal Regulations*
DAB	Daytona Beach International Airport
DOM	director of maintenance
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
IS-BAO	International Standard for Business Aircraft Operations
NASCAR	National Association for Stock Car Auto Racing
NBAA	National Business Aviation Association
PIC	pilot-in-command
PVC	polyvinyl chloride
SAFO	safety alert for operators
SFB	Orlando Sanford International Airport
SMS	Safety Management System
SOP	standard operating procedures

Executive Summary

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, Orlando, Florida. The two pilots on board the airplane (a commercial pilot and an airline transport pilot) 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* Part 91 on an instrument flight rules flight plan. Visual meteorological conditions prevailed at the time of the accident.

The National Transportation Safety Board determines 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.

This report discusses safety issues related to the resetting of circuit breakers, the inspection and maintenance of electrical systems in general aviation aircraft, and the establishment of Safety Management Systems in general aviation corporate operations.

1. The Accident

1.1 History of Flight

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. 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.

According to NASCAR corporate aviation division personnel, the commercial pilot was acting as pilot-in-command (PIC) for the personal flight, with the ATP acting as a "safety pilot."[1] The airplane departed Daytona Beach International Airport (DAB), Daytona Beach, Florida, about 0822, destined for Lakeland Linder Regional Airport, Lakeland, Florida.

According to Federal Aviation Administration (FAA) air traffic control records, about 0832:49, shortly after reaching a cruise altitude of 6,000 feet mean sea level, the ATP contacted air traffic control to declare an emergency, stating, "smoke in the cockpit we need…to land at Sanford."[2] The air traffic controller cleared the flight to proceed directly to SFB and descend to 2,000 feet. DAB airport surveillance radar data indicated that the airplane subsequently turned toward SFB and began to descend. The last radio transmission from the airplane was received about 0833:15. This transmission terminated midsentence and seemed to include the phrase, "shutoff all radios, elec[trical]."[3]

The Safety Board's aircraft performance radar study indicated that the last transponder signal[4] from the accident airplane was received about the time of the last radio transmission. At

[1] According to NASCAR policies, a pilot acting as PIC on a NASCAR airplane must hold an ATP certificate. However, NASCAR personnel stated that the commercial pilot was allowed to fly the Cessna 310 as long as the ATP was on board, acting as a "safety pilot."

[2] The airplane was not equipped with a built-in fire extinguishing system, nor was it required to be so equipped. NASCAR personnel stated that a handheld fire extinguisher was installed in the airplane, as required by regulations, and was mounted on the cockpit floor just forward of the right side pilot's seat. Investigators were unable to locate the airplane's handheld fire extinguisher in the wreckage and, therefore, could not determine if the pilots engaged in any smoke- or fire-fighting efforts.

[3] This phrase was consistent with the checklist guidance for an in-flight fire or smoke emergency in the Cessna 310R Pilot Operating Handbook, which stated – "Electrical load – REDUCE to minimum required."

[4] Transponders are electronic devices, installed on aircraft, which transmit unique aircraft-identifying codes and, often, other information, such as aircraft altitude, in response to radio-frequency interrogations from ground-based equipment. Transponders operate using airplane-provided electrical power.

that time, the airplane was about 8 nautical miles northwest of SFB and was turning toward the airport while rapidly descending. Primary radar returns[5] that were recorded for about another 1 minute 30 seconds showed the airplane maintaining a heading of about 150° towards SFB. The last of these primary radar returns was recorded about 0834:45; the Board's study estimated that, at that time, the accident airplane was about 3 miles northwest of SFB and descending through about 1,200 feet above ground level (agl). The airplane subsequently crashed in a residential area about 0.7 nautical miles west of the last primary radar return.

According to several witnesses near the accident site, the airplane was traveling "extremely fast," was "very low," and its wings were "rocking" as it descended. Just before impact, the airplane entered a "steep bank" and made a sharp turn to the west. Several witnesses reported seeing smoke trailing from the airplane, and one witness stated, "Smoke was trailing from the port side."

1.2 Wreckage and Impact Information

The primary debris path was about 300 feet long and oriented on a westerly (about 255°) heading. The airplane first struck a north-south line of trees in a right-wing-low attitude at a height of about 65 feet agl. About 270 feet beyond the first tree strikes, the airplane struck a palm tree at a height of about 20 feet agl. The airplane then grazed the northeast corner of a house and subsequently impacted the next two houses along the street. A postcrash fire ensued, destroying the airplane and the second- and third-impacted homes.

Airplane debris was found along the wreckage path, beginning near the impacted north-south line of trees and continuing to the impacted houses. (See figures 1 and 2.) The instrument panel glare shield[6] was located on the roof of the first house. Most of the fuselage, the wings, the instrument panel, some avionics, seats, and the right engine were found in and around the second- and third-impacted homes.

[5] Primary radar signals occur when a radio signal reaches and returns from the skin of an aircraft or other target. There are no unique identifiers for airplanes, and, typically, no altitude information is associated with primary radar returns.

[6] The glare shield is a molded foam component that protrudes slightly aft of the instrument panel to reduce glare for pilots viewing the flight instruments.

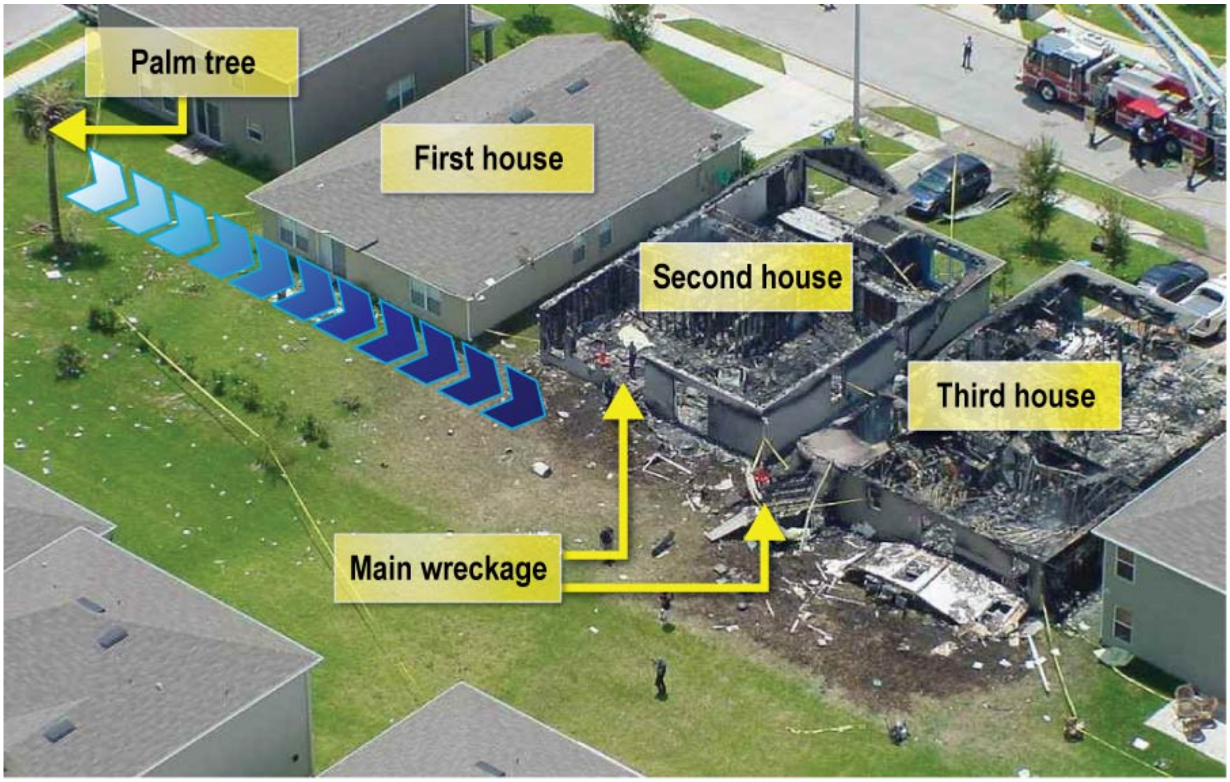

Figure 1. Aerial photograph of main wreckage and impacted homes. The blue arrows show the general westerly direction of the airplane's travel at impact.

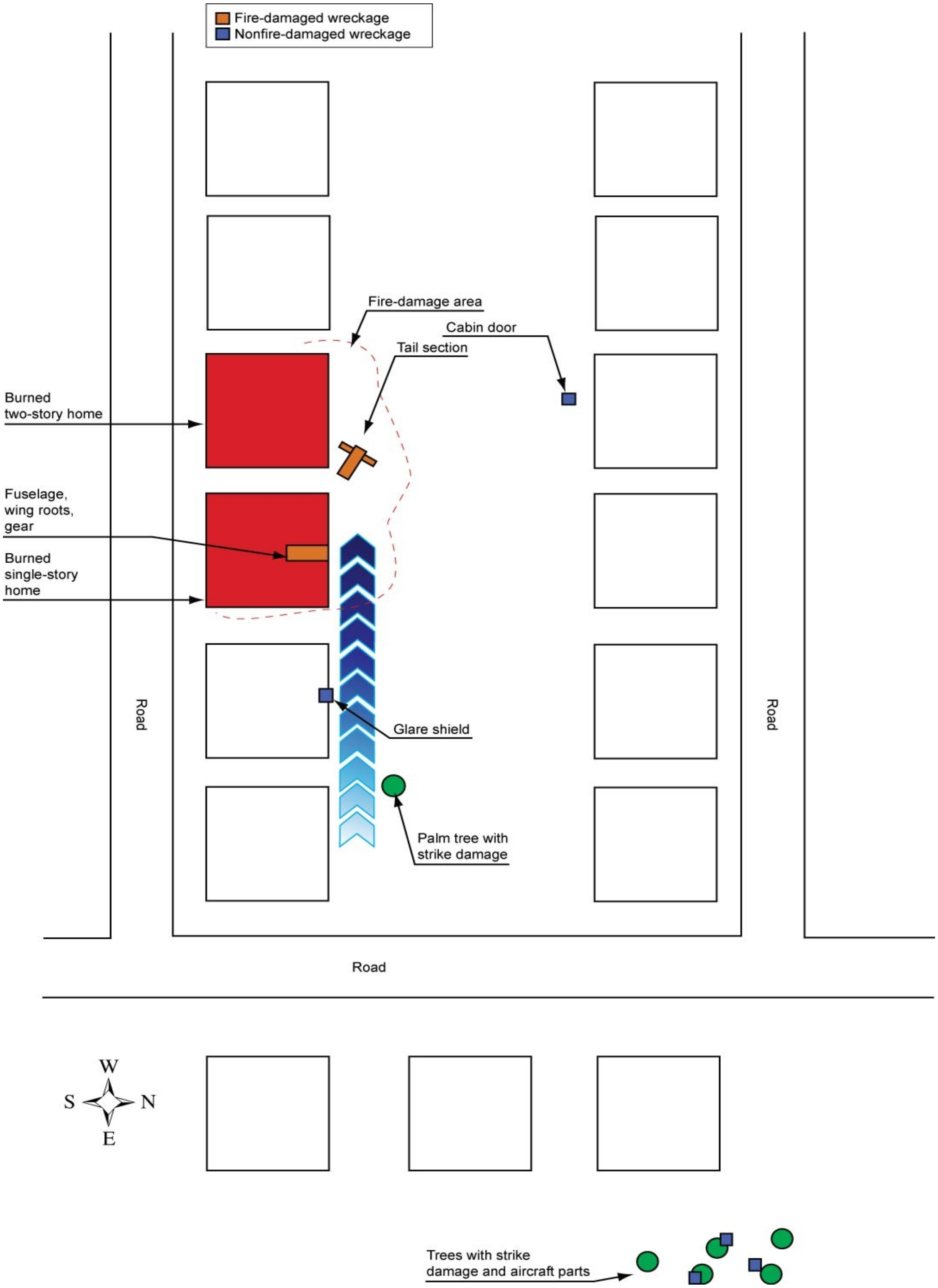

Figure 2. Diagram showing the location of impacted homes and trees and pertinent wreckage. The blue arrows show the general westerly direction of the airplane's travel at impact. (Diagram not to scale.)

The airplane was fragmented and severely burned; however, there was no indication of preimpact structural failure. Flight control cable continuity for the rudder and elevators was verified from the cable separation points (about the mid-cabin area) to the control surfaces in the empennage. Aileron control cable continuity was verified from the left wing root outboard to the left aileron bellcrank. Numerous separations in the control cables in the right wing and forward fuselage exhibited signatures consistent with tensile overload.

Although much of the airplane was destroyed during the postimpact fire, investigators observed some discolorations and/or soot deposits on airplane parts that were not directly exposed to the postcrash fire. For example, the instrument panel deck skin[7] that was located outside the area where the postcrash fire occurred showed signs of thermal damage. Localized areas of the underside of this component exhibited discolored primer paint, patches of charred/bubbling paint, and soot deposits, all of which were consistent with an in-flight fire. Additionally, the instrument panel glare shield, which is normally attached to the upper surface of the instrument panel deck skin, was found with thermal damage at the attachment point. (The glare shield was found on the roof of the first house, which was unburned.)

Further, the cabin door was found about 60 feet away from the main wreckage, as illustrated in figure 1, unburned and with latching pins undamaged. However, numerous soot deposits were noted on the interior side of this door, again consistent with an in-flight fire. These soot deposits trailed across the lower portion of the door from an area that would have been near the lower edge of the instrument panel on the intact airplane to the aft edge of the door. The undamaged latching pins and the location and existence of the observed trailing soot deposit are consistent with the pilots having opened the cabin door to vent smoke during an in-flight fire.

Most of the airplane's electrical system components and associated wiring that were recovered were severely damaged or destroyed, and most of the electrical insulation had been burned off those wires. Examination of some small sections of recovered wiring and one partial wire bundle found among the fuselage wreckage showed characteristics, such as strand fusing and globules of resolidified copper, that may be consistent with electrical arcing and/or exposure to heat from the postimpact fire. Too little remained to positively identify which system or systems those wires were associated with or to determine when the observed characteristics were created. Recovered flight instruments, cockpit avionics, controls, switches, and circuit breakers exhibited severe postimpact fire damage and yielded no usable information regarding their preaccident configuration or condition. A component of the weather radar antenna assembly and some attached electronic circuit boards exhibited severe impact and thermal damage; however, no evidence of arcing or other electrical faults was observed.

The insulation on most of the airplane's wiring was burned off. However, some wiring with unburned insulation had markings that identified that wiring as having polyvinyl chloride (PVC) insulation. PVC wire insulation can produce incapacitating fumes when burned,[8] and PVC-insulated wiring has not been used as a general-purpose wire in new airplane designs by

[7] The instrument panel deck skin is a sheet metal component that is fastened horizontally above the instrument panel, acting as a ceiling to the instrument panel compartment.

[8] Studies indicate that PVC releases toxic hydrogen chloride gas (hydrochloric acid) when it is heated.

Cessna and other manufacturers since the early 1970s. However, the FAA permitted the continued use of PVC-insulated wiring in airplanes in which it was already being installed, including Cessna 310s, which Cessna has been manufacturing since 1953. Because PVC-insulated wiring discovered in the wreckage had identifying numbers consistent with wiring commonly used by Cessna, it is likely that the PVC wiring in the accident airplane was installed by Cessna when the accident airplane was manufactured in 1977.

Six original (white) pages with pilot-recorded maintenance discrepancies[9] were recovered loose near the wreckage. These entries were dated from March 14, 2007 to July 9, 2007, and addressed the following topics, in chronological order: 1) right engine idle; 2) transponder mode C; 3) propeller deice amperage draw; 4) horizontal situation indicator sensitivity; 5) right engine revolutions per minute; and 6) weather radar system.

The discrepancy pages recovered from the wreckage indicated that the first three discrepancies had been addressed by maintenance personnel, but the last three (dated June 28, July 6, and July 9, respectively) had not.[10] The weather radar discrepancy page, which was dated July 9, 2007 (the day before the accident), stated:

> Radar went blank during cruise flight. Recycled – no response…smell of electrical components burning turned off unit – pulled radar [circuit breaker] – smell went away. Radar inop[erative]. [Underlining in original.]

The company pilot who experienced the weather radar system anomaly told investigators that he documented and reported the weather radar discrepancy to NASCAR personnel, leaving the white original page in the discrepancy binder in the airplane and providing the yellow copy to the director of maintenance (DOM), in accordance with the company's standard operating procedures (SOP). (For additional details, see the Accident Analysis section of this report.) However, no corrective action was recorded on the original white page of this discrepancy form. Additionally, NASCAR Aviation Division personnel could not produce the yellow copy of this form or any other written documentation indicating that any troubleshooting or corrective maintenance actions had been taken to resolve the discrepancy before the accident flight.

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[9] NASCAR pilots documented airplane maintenance discrepancies on nonserialized, duplicate reporting forms in binders on each airplane. The maintenance discrepancy report form consisted of two pages—a white original and a yellow carbon copy—in an airplane maintenance discrepancy binder. The white original page was to remain in the airplane's maintenance discrepancy binder until corrective maintenance action was taken, and the director of maintenance was to receive the yellow copy.

[10] According to the director of maintenance, after satisfactorily addressing a maintenance discrepancy, the responsible maintenance technician was to record the corrective action on the white sheet and then initial and date the sheet.

1.3 Operator and Personnel Information

1.3.1 General Information

At the time of the accident, NASCAR's corporate aviation division[11] operated a fleet of nine airplanes, including seven corporate jets, one turbopropeller-driven airplane, and the accident airplane. NASCAR employed 10 maintenance technicians and about 25 pilots in support of its airplane fleet. According to NASCAR records, the airplanes were flown about 1,950 flights per year for a total fleet use of about 2,500 to 3,000 flight hours, primarily transporting NASCAR's corporate personnel. The accident airplane, a light twin piston-engine airplane, manufactured in 1977 and purchased by NASCAR in March 1995, was based and maintained at DAB. The accident airplane was the only piston-engine powered airplane operated by NASCAR's corporate aviation division, and, unlike the rest of the NASCAR fleet, was used primarily to transport parts, goods, and documents for NASCAR, rather than personnel. In addition to these business flights, the accident airplane was occasionally used by the commercial pilot for personal flights. As previously noted, NASCAR's policies did not permit any pilot who was not an ATP to act as PIC in a company airplane; therefore, the commercial pilot had to be accompanied by the ATP on all such flights.

1.3.2 The Accident Pilots

The commercial pilot, age 53, was a medical doctor and was hired by NASCAR as a medical officer; he was not on NASCAR's payroll as a pilot. As PIC, he occupied the left seat during the accident flight. The commercial pilot held a commercial pilot certificate with single-engine, multiengine, and instrument ratings. The commercial pilot also held an FAA third-class medical certificate, dated December 2005, with no limitations.

A review of company and FAA records indicated that the commercial pilot had accumulated about 276 total flight hours, 106 hours of which were in multiengine airplanes, and 26 hours of which were in Cessna 310 airplanes. He had flown about 11 and 6 hours, respectively, in the 90 and 30 days before the accident flight. The commercial pilot last flew the accident airplane 4 days before the accident. The day before the accident, the commercial pilot saw patients in his office from 0800 to 1300 and then returned home. He did not perform any scheduled or emergency surgeries, nor was he on call after he left the office.

The ATP, age 56, was hired by NASCAR as a pilot on October 1, 1985. He occupied the right seat during the accident flight. He held a multiengine ATP certificate and type ratings in several business jet airplane makes and models, including the Cessna Citation (-500, -550, and -600), Dassault Falcon (-50 and -2000), British Aerospace HS-125, Beechcraft Premier IA

[11] NASCAR's corporate aviation division is a separate entity not related to the aviation departments operated by NASCAR member race teams.

jet, and Learjet (-60 and -JET). The ATP also held a first-class FAA airman medical certificate, dated June 2007, with the limitation that he "must wear corrective lenses."

Company records indicated that the ATP had accumulated 10,580 total flight hours, 67 hours of which were in Cessna 310 airplanes. He had flown about 50 and 17 hours, respectively, in the 90 and 30 days before the accident flight. According to NASCAR, the day of the accident was the ATP's third duty day in the last 9 days. He last flew the accident airplane with the commercial pilot 4 days before the accident. The ATP was not on duty the day before the accident, and, on the day of the accident, his duty day began about 0700 (about 1.5 hours before the accident flight's departure). The accident flight was his first flight of the day.

The commercial pilot and the ATP both completed Cessna 310 proficiency training at a professional flight training facility on January 25, 2007.[12] During postaccident interviews, the commercial pilot's instructor stated that the commercial pilot needed extra classroom instruction, and an additional 2 hours of simulator instruction to pass the course. The instructor stated that the chief pilot told him that the commercial pilot would never fly the Cessna 310 without another pilot on board. The instructor stated that although he was aware of this stipulation, the commercial pilot successfully completed the training by his own merits.

During postaccident interviews, the ATP's instructor stated that the ATP was "highly qualified," required little or no academic instruction, and showed "exceptional" proficiency during his two simulator sessions. The ATP completed the training in less than the programmed syllabus time. According to NASCAR aviation division personnel, the ATP's Cessna 310 training was conducted to enable him to serve as the safety pilot for the commercial pilot.

1.3.3 Other NASCAR Aviation Division Personnel

NASCAR's aviation director, who was the head of NASCAR's aviation division at the time of the accident, held an ATP certificate and type ratings in 10 airplane models. He had been employed by the company since 1987 and had been the company's aviation director, reporting directly to the president of NASCAR, since 1994.

The chief pilot had been employed in that position by NASCAR since August 2004. He held an ATP certificate and type ratings in three airplanes and reported to the aviation director. The DOM held an FAA airframe and powerplant (A&P) mechanic certificate with inspection authorization. He had been employed by NASCAR since October 1996 and had been DOM since 1998. The DOM reported to the aviation director. The maintenance technician who was responsible for the accident airplane was also an FAA-certificated A&P mechanic with inspection authorization. He was hired by NASCAR in October 1995.

[12] According to the training syllabus, the 3-day course typically included 9 hours of classroom training, 1.5 hours of briefing, 6 hours of simulator training, and 1.5 hours of debriefing.

1.3.4 Preaccident Maintenance and Airworthiness Responsibilities and Procedures

NASCAR's aviation department was operated under 14 CFR Part 91 and thus, was not required by the FAA to establish official standard operating procedures. Nonetheless, NASCAR's corporate aviation division did develop an SOP manual containing the company's policies and procedural guidance. However, investigators found evidence that the SOP guidance was not consistently updated[13] or adhered to by company personnel. For example, the SOP indicated that company airplanes were for corporate use and that a pilot acting as PIC on a NASCAR airplane must hold an ATP certificate. Yet, the commercial pilot, who was not ATP rated, was permitted to fly the accident airplane for personal use.

The guidance contained in the SOP manual was also not readily accessible to company personnel and, therefore, was not often referenced. When investigators asked NASCAR's aviation director for a copy of the SOP manual, he could not immediately locate a copy. The aviation director told investigators that company personnel did not always follow NASCAR's SOPs and that the SOPs were mostly "used as a training tool."

Moreover, the SOP lacked crucial specifics. The SOP stated, for example, that NASCAR personnel were to make and maintain records of all scheduling and maintenance issues related to its airplanes and that those records should be easily retrievable. However, the SOP did not contain any specific information about the methods, procedures, or tools to be used for scheduling or tracking airplane maintenance, and evidence indicates that maintenance information was not accessible to all NASCAR aviation division personnel. For example, although the DOM used maintenance tracking computer programs to track scheduled maintenance requirements on all the NASCAR airplanes, other NASCAR personnel did not have access to these programs. Maintenance technicians had to contact the DOM to get maintenance information for the airplanes on which they worked. NASCAR did not have a communication procedure for providing flight operations personnel (pilots and schedulers) with airplane airworthiness information.

The SOP indicated that the DOM was ultimately responsible for ensuring that all NASCAR airplanes were maintained in an airworthy condition at all times and for releasing airplanes for flight after maintenance; however, the SOP did not specify a means for the DOM to communicate the maintenance status of an airplane to anyone else within NASCAR. Further, NASCAR had no system through which any individual, including the DOM, could remove an airplane from the flight schedule because of airworthiness concerns. In practice, such a decision was made collaboratively by the aviation director, chief pilot, and DOM. Planned and unplanned maintenance activities were finalized through a combination of verbal and e-mail coordination between those individuals.

Although the DOM, chief pilot, and aviation director did discuss the weather radar discrepancy writeup, none of these individuals took any actions to ensure that the discrepancy

[13] At the time of the accident, the most recent SOP revision page was dated September 30, 2004.

was addressed before agreeing that the airplane could be flown. According to the chief pilot, the DOM told him: “It will be okay. Just tell [the ATP] not to turn it on.”

1.3.5 Postaccident Changes

NASCAR’s corporate aviation division began to address many of these procedural concerns almost immediately after the accident. The division made several changes to improve communication about, and awareness of, airplane airworthiness status. These changes included the following:

- Using aircraft status boards[14] that detail the planned maintenance activity and general status for each airplane in the maintenance department and the schedule and availability of the maintenance technicians;
- Placing an aircraft status log in each airplane’s maintenance discrepancy logbook for pilots to review before flight;
- Implementing an improved maintenance-tracking tool that provides a report of upcoming scheduled maintenance for each airplane in NASCAR’s fleet and is available on-demand to pilots and maintenance and other NASCAR personnel; and
- Developing new, serialized maintenance discrepancy forms that include a number of additional entry categories and enable better tracking of maintenance issues.

NASCAR corporate aviation division also made several revisions to its SOPs,[15] such as requiring a placard that states “IN MAINTENANCE” to be placed near the airplane’s entrance during maintenance and to be removed by the maintenance technician only when the airplane is returned to service. The revised procedures also require maintenance and flight crew personnel to meet face-to-face before each flight to discuss the airworthiness of the airplane.

[14] The status boards listed the planned maintenance activity for and general status of each airplane. The availability and schedules of the maintenance technicians were also indicated on these boards.

[15] According to the NASCAR corporate personnel department, every pilot and maintenance technician received the updated procedures and was individually briefed on the new procedures and responsibilities. In addition, these changes were communicated in memos and at a flight crewmember group meeting.

2. Investigation and Analysis

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

Company records indicate that the weather radar system was installed in the airplane in May 1988. Its display was mounted in the instrument panel, and the associated 5-ampere circuit breaker was located on the bottom row of the main circuit breaker panel, with associated wiring located along the left cockpit sidewall, to the left of the commercial pilot's left leg. Examination of similar airplanes revealed that the densest concentration of wiring in Cessna 310R airplanes is in this area. In addition, fuel lines to instrument panel gauges are routed through this area.

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. Airplane electrical system anomalies that result in smoke and/or burning odors are indications of possible fire hazards. Moreover, the heat, smoke, fumes, and restrictions to visibility associated with an in-flight fire can 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 of the discrepancy report on the throttle quadrant, and provided the yellow copy and a verbal briefing of the incident to the DOM. 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.[16] Further, Federal regulations state that an appropriately rated pilot or mechanic must determine that the inoperative equipment does not constitute a hazard to flight.

[16] The FAA explains that equipment may be deactivated in some cases, by pulling the circuit breaker, while other cases might require that equipment be deactivated by a certificated and appropriately rated maintenance person.

Postaccident interviews indicate that NASCAR's aviation director, DOM, 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 1) removed the airplane from service; 2) reset the circuit breaker; 3) placed a placard in the cockpit regarding the discrepancy; or 4) deactivated the weather radar system, collaring the associated circuit breaker and placing a placard in the cockpit indicating the system's inoperative status. 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 and in person by the maintenance technician who was responsible for the accident airplane the morning of the accident flight. On both occasions, the ATP dismissed the issue as unimportant.[17]

There is no indication that anyone specifically advised the commercial pilot of the weather radar discrepancy, but he was the designated PIC for the accident flight and, as such, had primary responsibility for determining the airplane's airworthiness. He was responsible for reviewing all maintenance discrepancy reports in the airplane's binder. The maintenance discrepancy binder was prominently placed on the throttle quadrant and would have been easy to review during the preflight inspection or before the airplane departed. 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

[17] It is unlikely that the accident pilots believed they would need to activate the weather radar system during the relatively short accident flight conducted in visual conditions.

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. The location of the cabin door (about 60 feet from the main wreckage) and the undamaged door latching pins, indicated that the door was likely unlatched during flight to alleviate conditions of heat and smoke and was subsequently thrown clear during the impact sequence. Also, the soot trail on the cabin door was consistent with the flow of smoke being drawn from below the instrument panel and out the door by the slipstream.

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.[18] 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.

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.

The Safety Board considered several explanations for the airplane's rapid right turn before it crashed in the residential area. Following is a list of possible scenarios and the Board's analysis of each:

1) **Did the pilots lose control of the airplane because of exposure to smoke and fumes?** Although the pilots reported smoke in the cockpit when they diverted to SFB, autopsies revealed no evidence of smoke or soot inhalation in the pilots' tracheas and did not show definitive evidence of hydrochloric acid (a byproduct of burning PVC) exposure.[19] Further, toxicological tests did not detect evidence of carbon monoxide or cyanide in the commercial pilot's blood.[20] This suggests that the pilots did not suffer

[18] As previously mentioned, some individual wire strands and one wire bundle found among the wreckage showed characteristics that could be consistent with either electrical arcing or exposure to heat from an intense fire. It was not possible to identify which system those short wire fragments were associated with or what caused the observed characteristics.

[19] The Office of the Medical Examiner for Volusia and Seminole Counties, Florida, performed autopsies on the pilots. The autopsy reports indicated that both pilots died as a result of "multiple blunt force trauma."

[20] Toxicological tests to detect the presence of carbon monoxide and/or cyanide were not performed for the ATP.

a prolonged exposure to a significant amount of smoke, which would be consistent with the short time between the takeoff, declaration of an emergency, and impact. Further, the airplane's bank shallowed as it reached a westerly heading, indicating that the pilots may have had some control of the airplane as it impacted the trees.

2) **Did in-flight fire and/or heat compromise the flight controls and make the airplane uncontrollable?** As mentioned above, the airplane's relatively shallow bank at the time of impact suggests that the pilots were able to manipulate the flight controls. Also, an evaluation of the duration, intensity, and location of the fire indicates that it is unlikely that fire or heat behind the instrument panel could have been severe enough to render the flight control systems partially or fully inoperative.[21]

3) **Did the pilots intentionally attempt to divert to an alternate landing site when they recognized that they would not reach SFB?** Aerial photographs of the area surrounding the accident site show some fields and marshy areas to the west of the site. The airplane's sudden, rapid right turn, followed by its shallower bank as it neared a westerly heading, would be consistent with an intentional diversion. It seems likely that the pilots would choose to try to reach an alternate landing site if they believed that they would not be able to reach SFB. However, at the time of impact, the airplane's flaps and landing gear were not extended and the airplane was traveling at a high speed, which would indicate that the pilots had not configured the airplane for an immediate emergency landing.

4) **Did the pilots lose situational awareness because of a preoccupation with the in-flight fire?** An in-flight fire, especially one located in front of the pilots and directly over their legs, would be very distracting, and it is likely that the pilots would want to get the airplane on the ground as soon as possible. Therefore, it is possible that the pilots were distracted by or coping with the in-flight fire.

The Safety Board concludes that, after analyzing the available evidence, it was not possible to definitively determine the events that led to the accident airplane's maneuvers away from SFB.

[21] The only portion of the flight control system that would have had lengthy exposure to the in-flight fire was the steel control shaft that extended through the instrument panel.

3. Safety Issues

3.1 Circuit Breaker Reset Hazards

Circuit breakers are installed on aircraft to protect wiring. When current flow in 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. 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 MD-11[22] 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 FAA develop and issue an advisory circular (AC) to address in-flight fire issues.[23] On January 8, 2004, the FAA issued AC 120-80,[24] “In-Flight Fires,” which stated, in part:

[22] -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.

[23] 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.

> 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 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.[25]

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 most 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 contrary to the guidance in the AC, 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 (AOPA)[26] 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

[24] 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>.

[25] 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.

[26] AOPA is a general aviation organization with about 400,000 members. The organization publishes several magazines and e-mailed newsletters, written primarily for general aviation pilots.

> 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.[27]

As discussed previously, it is likely that one of the pilots reset the circuit breaker associated with the weather radar system out of habit or based on the “Before Starting Engines” checklist associated with the accident airplane. Given the conditions at the time of the flight, it is unlikely that the pilots believed that they needed the weather radar system. However, the operating handbook aboard the accident airplane gave no indication that resetting a circuit breaker once might be dangerous, even though in this case that action likely led to a recurrence of an earlier problem and, ultimately, to an in-flight fire.

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

3.2 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. In part, the AC states:

> 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

[27] This quote is from “Training Notes and News: Popped circuit breaker” in the May 2007 issue of *Flight Training*, published by AOPA.

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.[28] 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 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.

3.3 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

[28] 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>.

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 and concerns 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.

3.4 Safety Management Systems

An operator's SOPs 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. The airplane should not have been allowed to fly until the discrepancy was addressed.

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 formalizes a company's SOPs and establishes methods for ensuring that those SOPs are followed. Guidance issued in November 2006, by the International Civil Aviation Organization (ICAO) 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:

- Identify safety hazards;
- Ensure that remedial action necessary to maintain an acceptable level of safety is implemented;
- Provide for continuous monitoring and regular assessment of the safety level achieved; and
- 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].[29] 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 (NBAA)[30] actively encourages its business aviation members to incorporate SMS programs into their operations and endorses the IS-BAO program. At the time of this writing, the more than 120 IS-BAO-registered corporate aviation

[29] The International Business Aviation Council, comprised 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.

[30] The NBAA was founded in 1947 to support business aviation in the United States and around the world, in part by encouraging aviation safety.

operators include NASCAR Aviation, Hendrick Motorsports, Incorporated, and many NASCAR corporate sponsors.[31]

The Safety Board recognizes the benefits of SMS programs and issued a related safety recommendation in its report on the October 14, 2004, accident involving Pinnacle Airlines flight 3701 near Jefferson City, Missouri.[32] Safety Recommendation A-07-10 asked the FAA to require that all 14 CFR Part 121 operators establish SMS programs.[33]

The FAA responded that it had been actively engaged in SMS-related rulemaking activities and plans to comply with the ICAO guidance by requiring air carrier implementation of SMS programs.

Based on the FAA's actions and stated rulemaking intentions related to 14 CFR Part 121 operators, the Safety Board classified Safety Recommendation A-07-10 as "Open—Acceptable Response," on January 22, 2008. In a November 26, 2008, Information for Operators, the FAA stated that they would be filing a difference with ICAO with regard to the January 2009 deadline for SMS programs because the FAA has not yet developed regulations or policy for implementation of SMS by U.S. operators. These regulations and policies are currently under development.

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.[34]

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.

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[31] Hendrick incorporated an SMS program into its operations after a King Air 200 aircraft carrying two pilots and eight passengers, Hendrick racing team personnel, crashed near Martinsville (Stewart), Virginia, on October 24, 2004. For additional information, see the Safety Board's website at <http://www.ntsb.gov/publictn/2006/AAB0601.pdf>.

[32] For additional information, see National Transportation Safety Board, *Crash of Pinnacle Airlines Flight 3701, Bombardier CL-600--2B19, N8396A, Jefferson City, Missouri, October 14, 2004*, Aircraft Accident Report NTSB/AAR-07/01 (Washington, DC: NTSB 2007)

[33] The full text of this recommendation is available online at <http://www.ntsb.gov/recs/letters/2007/A07_1_11.pdf>.

[34] 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>.

Therefore, the Safety Board believes that the FAA should develop a safety alert for operators encouraging all 14 CFR Part 91 business operators to adopt SMS programs that include sound risk management practices.

4. Conclusions

4.1 Findings

1. The weather radar system anomaly that was experienced and formally documented by the National Association for Stock Car Auto Racing 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.

2. 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.

3. The airline transport pilot 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 .

4. The pilots accepted the airplane as made available by National Association for Stock Car Auto Racing management and maintenance personnel, despite the fact that no diagnostic, corrective, or interim maintenance action had been taken to address the discrepancy.

5. There was insufficient evidence to conclusively determine the origin of the in-flight fire.

6. 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.

7. After analyzing the available evidence, it was not possible to definitively determine the events that led to the accident airplane’s maneuvers away from Orlando Sanford International Airport.

8. Existing guidance in manuals provided by general aviation airplane manufacturers regarding the resetting of circuit breakers often does not consider the cumulative nature of wiring damage and that the removal of power only temporarily stops the progression of such damage.

9. 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 Advisory Circular 120-80), they would be less likely to reset a tripped circuit breaker without knowing what caused that circuit breaker to trip.

10. 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.

11. 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.

12. Although National Association for Stock Car Auto Racing's corporate aviation division's standard operating procedures 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.

13. Safety Management System programs would provide corporate flight departments a formal system of risk management, safety methods, and internal oversight programs that could improve safety.

4.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were the actions and decisions by National Association for Stock Car Auto Racing'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.

5. Recommendations

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)
>
> 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)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

MARK V. ROSENKER
Acting Chairman

ROBERT L. SUMWALT
Member

DEBORAH A. P. HERSMAN
Member

STEVEN R. CHEALANDER
Member

KATHRYN O'LEARY HIGGINS
Member

Adopted: January 28, 2009

Member Robert L. Sumwalt filed the following concurring statement on January 29, 2009.

Board Member Statement

Member Robert L. Sumwalt, concurring:

I applaud staff for their diligent efforts in investigating this accident and proposing recommendations to prevent future accidents. And, I commend my colleagues on the Board for having the foresight to unanimously adopt a probable cause that, I believe, truly gets to the underlying reasons this crash occurred.

A less-than-thorough investigation might simply have stated that there was an in-flight fire that somehow led to the pilots crashing the aircraft into houses. However, in this case, investigators went beyond the obvious factors which, I believe, helps the Safety Board achieve its ultimate mission of accident prevention.

When the layers of the investigation were peeled back, a picture emerged that revealed that the organization—NASCAR corporate aviation division—enabled this tragic and unnecessary crash. NASCAR enabled the accident by failing to have adequate procedures in force to prevent such an event and/or by failing to ensure compliance with the procedures they did have in place. As the facts of the accident surfaced, it became apparent that this accident started before the aircraft even left the ground.

Failures on NASCAR's part allowed an un-airworthy aircraft to be dispatched and flown with a known maintenance discrepancy that directly led to the crash.

Examples of NASCAR not having adequate procedures include:

- No communication procedures for providing flight operations personnel (pilots and schedulers) with airplane airworthiness information.
- No specific procedure for the director of maintenance to communicate maintenance status of an aircraft to anyone else within NASCAR.
- No system through which any individual, including the director of maintenance, could remove an aircraft from flight status because of an airworthiness concern.
- No procedure spelled out for a pilot to determine airworthiness before flight. Instead, the organization relied on an informal procedure where in most cases (not all), a pilot would attempt to determine airworthiness by a preflight fact sheet taped to the airplane with highlighted items signed off by a mechanic.

And for procedures that were in a manual, there was widespread evidence that many of those procedures were not followed. Of important note—when NTSB investigators interviewed the director of aviation after the accident, he could not readily locate the Standard Operating Procedures (SOP) manual. Examples of not following NASCAR's existing procedures include:

- NASCAR's director of aviation told investigators that company personnel did not always follow NASCAR's SOPs, and SOPs were mostly "used as a training tool." This is contrary to industry guidance for SOPs indicating that procedures should be written the way the organization intends to operate, and once the procedures are in place, the organization makes every effort to operate that way.
- Investigators uncovered gross deviations from SOP. For example, the SOP manual stated that aircraft would not be operated for personal business and that the pilot-in-command (PIC) must possess an Airline Transport Pilot certificate. Conversely, this flight was personal in nature and the PIC did not meet those qualification requirements.
- The last three maintenance discrepancies had not been addressed by maintenance, contrary to federal requirements.

NASCAR is an organization with an impressive reputation and a sizeable net worth. They had hundreds of millions of dollars invested in their aviation department. Yet, at the time of the accident, they did not have the essential underpinnings of a professionally run aviation department-standard operating procedures that are rigorously followed and adhered to. According to FAA Advisory Circular AC 120-71A, "Standard operating procedures are universally recognized as basics to safe aviation operations."

A primary function of aviation department leadership is to ensure their aviation department operates to the highest standards. In this accident case, it appears that the NASCAR flight department management failed to provide leadership that could have safeguarded against such a tragic event.

The message to top leaders of organizations that operate aircraft is clear: You should take steps to ensure that your organization is receiving the professional aviation leadership and management that you expect. One way of ensuring a high standard is to conduct internal and external audits of your aviation department. A well-run aviation department should have meticulous written policies, procedures and guidelines that are rigorously followed. One standard discussed in this report is the International Standard for Business Aircraft Operations (IS-BAO). This takes a quality management approach to managing a business aviation department. Sadly, less than 130 organizations throughout the world have demonstrated and achieved this standard.

Do you want a professionally run aviation department, or do you want an expensive flying club? This accident tragically illustrates the potential consequences of a less than professionally managed flight department.