# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

**Date:** October 27, 2009

**In reply refer to:** A-09-113 through –128
A-06-37 and –38 (Reiteration)
A-07-52 and -54 (Superseded)

The Honorable J. Randolph Babbitt
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On June 4, 2007, about 1600 central daylight time, a Cessna Citation 550, N550BP, impacted Lake Michigan shortly after departure from General Mitchell International Airport, Milwaukee, Wisconsin (MKE).[1] The two pilots and four passengers were killed, and the airplane was destroyed. The airplane was being operated by Marlin Air under the provisions of 14 *Code of Federal Regulations* (CFR) Part 135 and departed MKE about 1557 with an intended destination of Willow Run Airport (YIP), near Ypsilanti, Michigan. At the time of the accident flight, marginal visual meteorological conditions prevailed at the surface, and instrument meteorological conditions prevailed aloft; the flight operated on an instrument flight rules flight plan.

The medical/air ambulance trip was flown under contract to the University of Michigan (UM) Health System and was transporting a medical transplant team to MKE so they could harvest an organ and return to YIP for an organ transplant at UM Medical Center; the accident occurred shortly after takeoff on the return leg of the trip.

The NTSB's review of cockpit voice recorder (CVR) evidence indicated that the captain[2] recognized a flight control anomaly almost immediately after takeoff from MKE, as he began to turn right from the runway heading of 009° to the flight's assigned departure heading of 050°. For the remainder of the flight, the CVR recorded repeated comments indicating that the captain was struggling with a flight control problem. The captain allowed the airplane to accelerate and climb while he and the first officer tried to troubleshoot the control anomaly. The airplane crashed into Lake Michigan about 3 minutes after takeoff, as the pilots tried to maneuver back to the airport.

[1] For more information, see *Loss of Control and Crash, Marlin Air Cessna Citation 550, N550BP, Milwaukee, Wisconsin, June 4, 2007,* Aircraft Accident Report NTSB/AAR-09/6 (Washington, DC: NTSB, 2009), which will be available on the National Transportation Safety Board's website at <http://www.ntsb.gov/publictn/2009/AAR0906.pdf>.

[2] The captain was Marlin Air's chief pilot and a Federal Aviation Administration-designated check airman.

The National Transportation Safety Board (NTSB) determined that the probable cause of this accident was the pilots' mismanagement of an abnormal flight control situation through improper actions, including failing to control airspeed and to prioritize control of the airplane, and lack of crew coordination. Contributing to the accident were Marlin Air's operational safety deficiencies, including the inadequate checkrides administered by Marlin Air's chief pilot/check airman, and the Federal Aviation Administration's (FAA) failure to detect and correct those deficiencies, which placed a pilot who inadequately emphasized safety in the position of company chief pilot and designated check airman and placed an ill-prepared pilot in the first officer's seat.

**Upset Recovery Training**

The NTSB evaluated several possible explanations for the initiating event experienced by the pilots and found that two of those possible explanations were most consistent with the abnormal control situation: 1) an inadvertent autopilot engagement, or 2) a runaway electric pitch trim. Although these two scenarios were the most likely explanations for the initiating flight control event, neither scenario was completely consistent with the investigative evidence and it was not possible to determine the exact nature of the initiating event.

Regardless of what the initiating event was, evidence from Cessna flight test records, postaccident simulator tests, and the NTSB's postaccident performance study indicated that the result should have been controllable if the captain had not allowed the airspeed and resulting control forces to increase while he tried to troubleshoot the problem. Evidence showed that, despite the abnormal control situation, the captain was able to maintain control of the airplane without much exertion when the airplane was operating at a relatively slow airspeed shortly after takeoff, but he increasingly struggled as the airplane accelerated and the control forces increased. By allowing the airplane's airspeed to increase while engaging in haphazard and poorly coordinated troubleshooting efforts, the pilots allowed an abnormal situation to escalate to an emergency. Therefore, the NTSB concludes that, regardless of the initiating event, if the pilots had simply maintained a reduced airspeed while they responded to the situation, the aerodynamic forces on the airplane would not have increased significantly; at reduced airspeeds, the pilots should have been able to maintain control of the airplane long enough to either successfully troubleshoot and resolve the problem or return safely to the airport.

In partial response to an NTSB safety recommendation issued after a series of upset-related air carrier accidents (A-96-120), an industry team developed an airplane upset recovery training aid designed to increase the ability of pilots to recognize and avoid situations that can lead to airplane upsets and to improve their ability to recover control of an airplane. The FAA has issued a notice of proposed rulemaking (NPRM), which,[3] if adopted as a rule, would require minimum standards for 14 CFR Part 121 flight crewmember upset and loss of control training that references the airplane upset recovery training aid. Although this aid was originally developed to address operations involving airplanes with 100 seats or more, the information it contains is directly applicable to most jet airplanes, such as the accident airplane, operating in environments similar to those used by Part 121 operators. In its comments on the NPRM, the

[3] The NPRM was issued on January 12, 2009, and comments were due by August 10, 2009.

NTSB stated that similar training requirements for Part 135 operators will be needed before Safety Recommendation A-96-120 can be classified "Closed—Acceptable Action."

The NTSB recognizes that although pilots receive training in unusual attitude and upset recovery during all phases of basic pilot training, pilots would benefit from additional and recurrent training related to airplane attitudes and/or control system failures not normally associated with air carrier flight operations.

Therefore, the NTSB concludes that pilots would benefit from training and readily accessible guidance indicating that, when confronted with abnormal flight control forces, they should prioritize airplane control (airspeed, attitude, and configuration) before attempting to identify and eliminate the cause of the flight control problem. The NTSB recommends that the FAA require all 14 CFR Part 91K and Part 135 operators to incorporate upset recovery training (similar to that described in the airplane upset recovery training aid used by many Part 121 operators) and related checklists and procedures into their training programs.

**Autopilot Panel Design**

Almost immediately after takeoff, the captain called for engagement of the yaw damper. The yaw damper engagement button is located immediately adjacent to the autopilot engagement button on the autopilot control panel. The switches present identical size, shape, texture, mode of operation (on/off push button), and actuation pressure to the pilot. Further, they are located outside of the pilots' normal range of vision, and are not separated by an intervening divider or partition. In periods of high workload or other distractions, a pilot might be inclined to activate the yaw damper by feel and location; under such circumstances, it would be easy for a pilot to select the wrong switch. (Anecdotal evidence indicates that inadvertent activation of the Cessna Citation's autopilot when attempting to engage the yaw damper is not uncommon.) In this accident, if the first officer had inadvertently activated the autopilot when intending only to activate the yaw damper it would likely have resulted in unanticipated, and possibly dramatic, consequences.

FAA airworthiness standards in 14 CFR 25.777 require cockpit controls to be "located and…identified…to prevent confusion and inadvertent operation." Additionally, human factors engineering principles indicate that, in a well-designed control system, every control must be detectable and discernable from other controls. The current design configuration of the Citation yaw damper and autopilot control push-button switches appears contrary to these standards. Therefore, the NTSB concludes that the design and location of the yaw damper and autopilot switches on Cessna Citation series airplanes do not adequately protect against inadvertent activation of a system, which could have disastrous consequences. The NTSB recommends that the FAA require Cessna to redesign and retrofit the yaw damper and autopilot switches on the autopilot control panel in Citation series airplanes to make them easily distinguishable and to guard against unintentional pilot activation. Further, because other airplanes may be equipped with similarly designed autopilot control panels and, therefore, may also be susceptible to inadvertent autopilot activation,[4] the NTSB recommends that the FAA identify airplanes other

[4] For example, the NTSB's investigation of the October 25, 2002, accident involving a King Air A100 in Eveleth, Minnesota, revealed that on a previous flight the King Air's pilot had inadvertently activated the autopilot instead of the yaw damper after takeoff, which resulted in an abrupt nose-down pitch.

than the Cessna Citation with autopilot control panel designs that may lead to inadvertent activation of the autopilot and require manufacturers to redesign and retrofit the autopilot control panels to make the buttons easily distinguishable and to guard against unintentional activation.

**Airplane Wiring**

This investigation revealed documentation of previous instances in which the Cessna Citation series of airplanes had experienced failures of the wiring within the control column shafts.[5] As a result of these wiring failures, Cessna issued Service Bulletin (SB) 550-24-14 on January 17, 1992, advising Citation operators to replace the flat ribbon cable installed inside the control column shafts with a rounded type of sheathed wire bundle that would fit better and be better protected within the shaft. None of the accident airplane's owners and operators had complied with SB 550-24-14, nor were any of them required to, as compliance with SBs is not mandatory. The flat ribbon cable installed in the accident airplane's control column shaft was found in the wreckage, folded and damaged, with evidence of prior repairs.

According to Cessna representatives, after SB 550-24-14 was issued, Cessna received numerous customer reports of short circuits and cut wires in control columns in various Citation models. In each case where sufficient data were available, analysis indicated that the actions suggested in SB 550-24-14 would likely have alleviated the situation. The NTSB concludes that a rounded type of sheathed wire bundle would fit better and be better protected within the control column shaft than the currently installed flat ribbon cable; replacement of the flat ribbon cable with a rounded type of sheathed wire bundle could result in fewer short circuits and other electrical events. Therefore, the NTSB recommends that the FAA issue an airworthiness directive (AD) mandating compliance with Cessna SB 550-24-14, "Control Wheel Electrical Cable Replacement," which was issued on January 17, 1992.

**Runaway Pitch Trim and Circuit Breakers**

The NTSB's accident/incident database contains at least eight accidents involving Cessna Citation pitch trim or related failures. For example, the NTSB previously addressed runaway pitch trim issues as a result of the July 22, 2003, accident involving a Citation 525 that ditched in the waters of Penn Cove, Coupeville, Washington, after a loss of elevator trim control that resulted in an uncommanded nose-down pitch attitude. Based on this accident, the NTSB issued Safety Recommendations A-07-52 and -54, asking that the FAA require Cessna to equip its Citation 525 airplanes with an aural trim-in-motion warning, better visual trim-in-motion cues (for example, contrasting color bands) on the pitch trim wheel, and collars on the pitch trim and autopilot circuit breakers, to provide pilots with the means for recognizing and correcting a runaway pitch trim condition before control forces become unmanageable. (Postaccident examination of Marlin Air's other Citation 550 revealed that it had identification collars on the starter and alternating current inverter circuit breakers, but not on the pitch trim or autopilot circuit breakers. Investigators also noted that the Citation's uncollared circuit breakers were difficult to grasp and pull and that the circuit breakers with identification collars were much easier to grasp and pull.)

[5] Review of documentation for these other instances revealed that in some cases multiple wires were damaged; however, there was no documentation of a dual failure (as may have occurred on the accident airplane in the runaway pitch trim scenario) or resulting inappropriate pitch trim function.

In its response letter, dated November 20, 2007, the FAA indicated that it believed that the combination of the normal cues of undesired trim motion and the issuance of AD 2004-14-20, which addressed the specific single-point failure mode identified in the Penn Cove accident investigation by requiring the replacement of the trim printed circuit board, corrected the unsafe conditions identified during the investigation of the July 22, 2003, Penn Cove accident, rendering the action recommended in Safety Recommendation A-07-52 unnecessary. The NTSB's June 11, 2009, response letter disagreed with the FAA's position, stating that, had the Penn Cove pilot received conspicuous warning of the pitch trim runaway condition earlier in the accident sequence, he would have been able to complete the related checklist procedure and pulled the pitch trim circuit breaker before the pitch control forces became unmanageable. Therefore, on June 11, 2009, the NTSB classified Safety Recommendation A-07-52, "Open—Unacceptable Response."

The NTSB notes that not only has the runaway trim problem not been satisfactorily addressed with regard to the Citation 525 model airplane involved in the Penn Cove accident, it also exists in other Citation model airplanes, such as the Citation 550 involved in the MKE accident. In a representative Citation 550 airplane, investigators observed that the movement of the large, black pitch trim wheel, which was located on the left side of the throttle console adjacent to the captain's right leg, was not always apparent. The addition of contrasting color bands, as recommended in Safety Recommendation A-07-52, would facilitate a pilot's recognition of the wheel's movement during a runaway pitch trim situation. Additionally, if a pitch trim anomaly was the initiating event in either the Penn Cove or MKE accidents, an aural trim-in-motion warning would have allowed the pilots to promptly identify the nature of the problem and correct it.[6]

Therefore, the NTSB concludes that the incorporation of an aural pitch trim-in-motion warning and contrasting color bands on the pitch trim wheel in all Cessna Citation series airplanes would help pilots of those airplanes to more promptly recognize and correct runaway pitch trim situations before control forces become unmanageable. Therefore, the NTSB recommends that the FAA require Cessna to modify all Citation series airplanes by incorporating an aural pitch trim-in-motion warning and contrasting color bands on the pitch trim wheel to help pilots recognize a runaway pitch trim condition before control forces become unmanageable. This recommendation, which is classified "Open—Unacceptable Response," supersedes Safety Recommendation A-07-52, which the NTSB reclassifies "Closed—Unacceptable Action/Superseded."

As an alternative response to the actions proposed in Safety Recommendation A-07-54, the FAA proposed issuing guidance recommending replacement of the pitch trim circuit breaker on the Citation 525 with a collared circuit breaker to aid the pilot in quickly identifying it if necessary. Pending the FAA's issuance of such guidance, on June 11, 2009, the NTSB classified Safety Recommendation A-07-54, "Open—Acceptable Alternate Response."

The MKE accident demonstrates that identification-collared circuit breakers on critical systems that a pilot might need to access during an abnormal or emergency situation would also

[6] An aural pitch trim-in-motion would also have been recorded by the CVR and, therefore, would have benefited the accident investigation as well.

benefit pilots operating Citation models not affected by the single-point failure identified in the Penn Cove accident. Filament analysis of autopilot computer-related annunciator lights and evidence inferred from the CVR transcript indicates that the MKE accident first officer was not able to immediately locate and identify critical circuit breakers (possibly those associated with the autopilot and pitch trim) during the accident sequence. In part, this may have been due to his lack of familiarity with the airplane; however, these critical circuit breakers were not easily distinguishable from the many other circuit breakers on the panel.

Postaccident examination of another Marlin Air Citation 550 revealed that it had identification-collared circuit breakers on the starter and the alternating current inverter. If the accident airplane had been equipped with identification-type collars on the autopilot and pitch trim circuit breakers, the accident pilots would have been better able to identify those breakers. In addition, after the pilots located those circuit breakers, the identification collars would have made the breakers easier to grasp and pull. Therefore, the NTSB concludes that if circuit breakers that a pilot might need to quickly access during an abnormal or emergency situation were equipped with identification collars, pilots would be able to locate them more readily and pull them more easily during such a situation. Therefore, the NTSB recommends that the FAA require Cessna to replace all Citation series airplane pitch trim, autopilot, and any other circuit breakers for critical systems that a pilot might need to access during an emergency situation with easily identifiable and collared circuit breakers to aid a pilot in quickly identifying and easily pulling those circuit breakers if necessary. This recommendation, which is classified "Open—Unacceptable Response," supersedes Safety Recommendation A-07-54, which the NTSB reclassifies "Closed—Unacceptable Action/Superseded."

Additionally, because pilots should be able to easily identify and pull critical circuit breakers during abnormal or emergency situations in any airplane, the NTSB recommends that the FAA require airplane manufacturers to develop guidance on the identification of circuit breakers that pilots need to identify quickly and pull easily during abnormal or emergency situations and to provide such guidance, once developed, to operators of those airplanes. Further, the NTSB recommends that the FAA require operators to implement the manufacturers' guidance asked for in Safety Recommendation A-09-119 regarding which circuit breakers pilots need to identify quickly and pull easily during abnormal or emergency situations in their airplanes.

**Human Factors in Aircraft Design**

Several of the safety issues identified during this investigation (the autopilot panel design and the aileron trim sensitivity are two examples) reflect a lack of attention to human/airplane system interactions that was typical when the Citation cockpit was designed and certificated. However, the aviation industry has learned much about human factors issues in the years since the Citation was certificated, and it is now clear that areas of the airplane's design would benefit from that knowledge. It is likely that many other aircraft that were designed and certificated in the last 3 decades would benefit from similar review and application of human factors principles.

In its 2006 study of the aircraft certification process, the NTSB made two recommendations to the FAA concerning human/aircraft interaction issues in the certification of aircraft. Safety Recommendation A-06-37 asked the FAA to "amend the advisory materials associated with 14…[CFR] 25.1309 to include consideration of structural failures and

human/airplane system interaction failures in the assessment of safety-critical systems." Safety Recommendation A-06-38 asked the FAA to

> …require a program for the monitoring and ongoing assessment of safety-critical systems throughout the life cycle of the airplane. … Once in place, use this program to validate that the underlying assumptions made during design and type certification about safety-critical systems are consistent with operational experience, lessons learned, and new knowledge.

In response to these recommendations, the FAA indicated that it was incorporating more standardized consideration of human factors into new certification projects and planned to develop new regulations and advisory materials and a human factors design guide. Additionally, the FAA stated that it intended to formalize a process for monitoring and assessing safety critical systems throughout the life cycle of an airplane. Pending the FAA's related actions, the NTSB classified Safety Recommendations A-06-37 and -38, "Open—Acceptable Response" on September 12, 2007.

However, although this investigation revealed that many Citation pilots were aware of some of the human factors issues associated with the Citation cockpit design (such as the potential for inadvertently pressing the wrong button when engaging the autopilot or yaw damper), the NTSB is not aware of any plans by Cessna or the FAA to change the design to address these issues. The FAA indicated to the NTSB that it was developing guidance on human factors issues in aircraft for use by its certification staff; however, the NTSB is not aware that this new guidance has been developed and distributed, nor that it would address the many issues identified in this accident. Therefore, the NTSB concludes that the circumstances of this accident demonstrate the importance of a program for the FAA to monitor and conduct ongoing assessments of safety-critical systems throughout the life cycle of an airplane; the FAA did not perform this task adequately for the Cessna Citation. Because the numerous human factors issues identified in the accident airplane's cockpit design may have been corrected if current human factors principles had been applied after certification, the NTSB reiterates Safety Recommendations A-06-37 and –38 and classifies both "Open—Unacceptable Response."

**Aileron Trim Sensitivity and Responsiveness**

The Citation 550 aileron trim system is a manual (unpowered) trim system in which small inputs on the manual trim wheel in the cockpit can have a disproportionate effect on aileron movement. Postaccident interviews indicated that many Citation pilots have been surprised by the disproportionate sensitivity and responsiveness of the Citation aileron trim control system. In addition, numerous Citation pilots have reported problems or even declared an emergency as a result of aileron trim issues. The anecdotal evidence indicates that it is easy to set the Citation aileron trim inappropriately, possibly resulting in a hazardous out-of-trim condition. The disproportionate sensitivity and responsiveness of this system would likely have compounded the effect of any aileron trim inputs made by the first officer during the accident flight and exacerbated an already challenging troubleshooting effort.

The FAA's certification requirements contained in 14 CFR 25.143(d) protect against a trim runaway for powered surfaces by requiring that the aileron flight control forces experienced by the pilot do not exceed 50 pounds for temporary applications. However, the Citation's aileron

trim tab is unpowered, and the certification requirements for unpowered aileron trim surfaces do not protect against the forces that might result from excessive manual inputs. During accident-related flight tests, control wheel forces in excess of 50 pounds were measured when half of the available aileron trim was applied at an airspeed of 250 knots. Cessna estimated that application of full aileron trim at 250 knots would have resulted in control wheel forces in excess of 150 pounds. Therefore, the NTSB concludes that the control wheel forces resulting from adjustments to the Cessna Citation's unpowered aileron trim could exceed the control force limits specified by regulations for powered aileron trim surfaces.

The NTSB is concerned that the design of the Citation's aileron trim system allows for trim forces that far exceed those needed during an emergency, such as a loss of engine power. Additionally, because of the relative sensitivity of the small aileron trim control knob, even a small aileron trim adjustment could result in trim forces that would require excessive control wheel inputs to counteract and keep the airplane's wings level. Therefore, the NTSB concludes that limiting the deflection of the Cessna Citation's manually operated aileron trim tab to the deflection certification limit for powered trim tabs and reducing the Citation's aileron trim sensitivity (the unexpectedly significant aileron trim deflection that results from a relatively small amount of trim knob input) would help pilots avoid sudden and excessive aileron trim deflections. Therefore, the NTSB recommends that the FAA require Cessna to evaluate and limit the maximum aileron trim deflection on Citation series airplanes to that required to meet the certification control requirements for powered trim tabs, unless there is a design justification to exceed those requirements. In addition, the NTSB recommends that the FAA require Cessna to reduce the aileron trim sensitivity (the unexpectedly significant aileron trim deflection that results from a relatively small amount of trim knob input) on Citation series airplanes to avoid sudden and excessive aileron trim deflections.

These recommended changes to the Citation aileron trim system will take time to develop and implement. In the meantime, Citation pilots who are unaware of the aileron trim system's potentially excessive sensitivity and responsiveness might unintentionally exacerbate an abnormal flight control situation. The NTSB concludes that if Cessna Citation pilots and operators were informed of the potential hazards related to the sensitivity and responsiveness of the airplane's aileron trim system, they would be better able to avoid problematic aileron trim inputs until a more permanent solution (an aileron trim system retrofit) is in place. Therefore, the NTSB recommends that the FAA, as an interim measure (pending an available aileron trim system retrofit), notify Citation pilots and operators of the potential hazards related to the sensitivity and responsiveness of the airplane's aileron trim system.

## FAA Oversight

### *Check Airman Appointment Guidance*

The FAA principle operations inspector (POI) appointed the captain as Marlin Air's designated check airman about 2 years before the accident. The FAA defines a check airman as an airman approved by the FAA who has the appropriate training, experience, and demonstrated ability to evaluate and to certify the knowledge and skills of other airmen. The roles of a check airman are (1) to ensure that the flight crewmember has met competency standards before the crewmember is released from training, and (2) to ensure that those standards are maintained while the crewmember remains in line service. A check airman candidate must have achieved

and maintained a favorable record as a flight crewmember. Once approved, a check airman's conduct and professional reputation should always reflect positively on the employer and the FAA.

When Marlin Air nominated the captain for check airman appointment, the POI reviewed the nomination letter and verified the captain's pilot and medical certificate qualifications as required by FAA procedures. The captain was eligible under federal regulations to serve as the company's chief pilot and as an FAA-designated check airman, and the POI approved the designation. The POI stated that during his review process, he noticed that the captain had previously had his pilot certificates revoked because of a drug violation; however, the POI did not seek further information regarding the nature or circumstances of the revocation. He stated that he assumed the revocation was related to a personal issue with prescription medications. The POI further stated that he did not believe it would be necessary for him to pursue the issue because the FAA had reviewed the situation and reissued the captain's pilot certificates.

FAA guidance regarding appointment of check airmen requires POIs to verify the check airman candidate's "certificates and background." Additionally, all required training must be completed, and the airman's training records must show satisfactory completion of initial, transition, or upgrade training, as applicable. The guidance does not specifically address POI actions when the background evaluation discloses negative information. This lack of guidance can result in the appointment of check airmen who do not adhere to standards, possibly jeopardize flight safety, and generally do not represent the FAA well. In this case, it resulted in the accident captain (who routinely failed to comply with procedures and regulations) being appointed to the positions of company chief pilot and check airman, with responsibility for supervision and training of all company pilots. This contributed to an inadequate company safety culture and allowed an ill-prepared first officer to fly in Part 135 operations.

The NTSB concludes that if the FAA guidance regarding check airman appointments and oversight contained procedures for POIs to follow (such as heightened surveillance) in cases where review of the pilot's background or performance reveals negative information, checkride failures, or other performance-related deficiencies, the agency might prevent inadequate and/or undisciplined pilots from being appointed or retained as check airmen. The NTSB therefore recommends that the FAA revise check airman approval and oversight procedures to incorporate heightened surveillance during a probationary period and at other times, as warranted, for check airmen whose background evaluation uncovers a history of criminal convictions, certificate revocations, checkride failures, or other performance-related deficiencies.

***Regional Aviation Safety Inspection Program Guidance and Procedures***

The FAA's postaccident Regional Aviation Safety Inspection Program (RASIP) for Marlin Air involved an inspection team that included three inspectors from the FAA's Great Lakes Regional office and the three principal inspectors assigned to the operator at the time of the accident. The FAA decided to include the principal inspectors on the RASIP team because their familiarity with the operator's policies and procedures could facilitate the inspection. The team did not evaluate FAA oversight of the operator. The Marlin Air RASIP team leader told NTSB investigators that RASIP inspections were not intended to assess the quality or adequacy of the principals' oversight, but rather to provide additional surveillance of the operators.

The Marlin Air RASIP was focused on the operator's policies and procedures, including training. Because Marlin Air's operations had been suspended during the inspection because of the accident, the RASIP team did not interview any company line personnel or directly evaluate day-to-day operations, but instead coordinated with the director of operations and the assistant chief pilot. The inspection revealed one finding related to operation of an airplane by only one pilot when the operations specifications required two.[7]

The RASIP report indicated that the team reviewed training records for all Marlin Air pilots, but those records were, in fact, not available to the team. Marlin Air personnel advised the RASIP team that the only copies of the accident pilots' records had been furnished to NTSB investigators. Marlin Air did not retain copies of the pilots' records or obtain copies from the NTSB to fully comply with the RASIP team's request for them. Yet the RASIP team's report indicated that "records for all pilots were reviewed," and the team issued no adverse findings. The RASIP report did not qualify its findings by indicating that some of the pilot records were not reviewed nor did it indicate that the team was unable to fully and directly assess Marlin Air's day-to-day operations because the company's operations were suspended after the accident.

As discussed above, the RASIP report did not reveal the training form irregularities for the first officer's recent checkride approval if the inspection team had no information regarding him and did not discover irregularities in two recent checkride forms pertaining to other Marlin Air pilots that were subsequently discovered during the NTSB's investigation. The NTSB concludes that the RASIP inspection conducted after this accident failed to uncover evidence of training irregularities and did not evaluate the quality of FAA surveillance provided before the accident. Therefore, the NTSB recommends that the FAA conduct a detailed review of the oversight provided to Marlin Air to determine why the oversight system failed to detect (before and after the accident) and correct Marlin Air's operational deficiencies, particularly in the areas of pilot hiring, training, and adherence to procedures. Further, FAA Order 8900.1, "Flight Standards Information Management System," contains guidance for FAA inspectors involved in operator surveillance and oversight. Therefore, the NTSB recommends that the FAA, based on the review described in Safety Recommendation A-09-125, revise the oversight system and FAA Order 8900.1 as needed.

***Mechanisms for Alerting the FAA to Potential Operator Problems***

Complaints from outside the FAA may alert the FAA to a variety of operator-related safety issues that the FAA can pursue through a formal investigation or increased oversight. This investigation revealed that although UM Survival Flight program personnel had felt comfortable with Marlin Air for most of the 19 years they had contracted with the operator, UM personnel had increasing reservations regarding Marlin Air's operations in the couple of years preceding the accident. UM personnel stated that they began to hear complaints about Marlin Air and their pilots and had concerns related to the number of Marlin Air flights cancelled due to mechanical issues. According to the UM program manager, the number of trip cancellations had increased in the year preceding the accident, and medical personnel were beginning to think that Marlin Air was unsafe. However, UM personnel did not relay any of these concerns to the FAA before the

[7] The only other recent FAA inspection of Marlin Air was an Office Safety Inspection Program (OSIP) that was accomplished in March 2002, more that 5 years before the accident. The OSIP findings were minor and were immediately corrected by Marlin Air.

accident because they were not aware of the FAA safety hotline or other methods by which they might make their concerns known.

An FAA representative of its Executive Office for Flight Standards stated that there were several FAA programs that might have been beneficial to the UM personnel in raising safety concerns. These included the Customer Service Initiative administered through the local flight standards district or regional offices, the Safety Hotline administered by the Office of Accident Investigation, and the Administrator's Hotline. Had the FAA been aware of UM's concerns, FAA staff could have responded with increased oversight or a formal investigation.

The NTSB concludes that customers (such as UM) who contract with aviation operators may not understand the FAA's role in aviation safety or know how to contact FAA personnel when safety concerns arise. Therefore, the NTSB recommends that the FAA require all 14 CFR Part 135 and Part 91K operators to provide their customers, when a business agreement or contract is finalized, with FAA contact information identified as specifically for use in expressing concerns about flight safety, thus providing customers with a clear means of communicating any safety concerns to the FAA.

**Operators with Financial Difficulties**

Marlin Air exhibited many signs of financial difficulties before the accident. For example, about 7 months before the accident, a court judgment was entered against Marlin Air for nonpayment of hangar rent. The company made an initial payment against the rent due but subsequently defaulted on the second payment. Additionally, a supplier that had previously provided Marlin Air with fuel on a contract basis terminated its contract with the company about 2 to 3 years before the accident because the operator fell behind in account payments. Another fuel supplier terminated its credit arrangement with Marlin Air due to nonpayment but continued to provide fuel, with payment required at the time of purchase.

Postaccident interviews and CVR evidence showed that the captain occasionally focused on business issues at the expense of flight safety. For example, the captain intentionally took off in an airplane that was loaded beyond allowable weight limits because he was "tankering" inexpensive fuel to avoid paying for more expensive fuel elsewhere. In addition, CVR evidence showed that, during the accident airplane's approach to MKE in marginal weather conditions, the captain advised the first officer not to ask for current weather information. Although asking for the most current weather conditions immediately before an instrument approach is not required by regulation, a specific decision not to do so is consistent with a willingness to attempt an approach to an airport that may be below minimums, thus decreasing the level of safety for the operation. Concerns about the cost of a go-around or diversion to another airport might have played a part in that decision.

The UM program manager stated that the financial condition of Marlin Air appeared troubled before the accident because requested upgrades were not accomplished. The program manager was disturbed to learn shortly before the accident that Marlin Air had failed to pay its recent renewal dues to the Association of Aeromedical Services. She felt this failure could potentially jeopardize the accreditation and standing of the UM program.

The examples above clearly indicate that the operator was experiencing financial difficulties. However, current federal regulations and procedures require only Part 121 operators to report financial information to the FAA. The FAA detected none of the signs of Marlin Air's financial hardship during the FAA's routine surveillance of that company's Part 135 operations. The POI and local flight standard district office management personnel reported that they were unaware of Marlin Air's financial situation.

The NTSB concludes that had FAA personnel been aware of Marlin Air's financial situation, the FAA would have had an opportunity to increase surveillance of the company. Therefore, the NTSB recommends that the FAA require all 14 CFR Part 91K and Part 135 operators to notify the assigned POIs of specific adverse financial events, such as bankruptcy, court judgments related to nonpayment of recurring expenses, or termination of a credit agreement or contract by a vendor for reasons of late payment or nonpayment. Upon receipt of such information, inspectors should increase their oversight of operators who appear to be in financial distress.

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

> Require all 14 *Code of Federal Regulations* Part 91K and Part 135 operators to incorporate upset recovery training (similar to that described in the airplane upset recovery training aid used by many Part 121 operators) and related checklists and procedures into their training programs. (A-09-113)
>
> Require Cessna to redesign and retrofit the yaw damper and autopilot switches on the autopilot control panel in Citation series airplanes to make them easily distinguishable and to guard against unintentional pilot activation. (A-09-114)
>
> Identify airplanes other than the Cessna Citation with autopilot control panel designs that may lead to inadvertent activation of the autopilot and require manufacturers to redesign and retrofit the autopilot control panels to make the buttons easily distinguishable and to guard against unintentional activation. (A-09-115)
>
> Issue an airworthiness directive mandating compliance with Cessna Service Bulletin 550-24-14, "Control Wheel Electrical Cable Replacement," which was issued on January 17, 1992. (A-09-116)
>
> Require Cessna to modify all Citation series airplanes by incorporating an aural pitch trim-in-motion warning and contrasting color bands on the pitch trim wheel to help pilots recognize a runaway pitch trim condition before control forces become unmanageable. (A-09-117) (This recommendation supersedes Safety Recommendation A-07-52 and is classified "Open—Unacceptable Response.")

Require Cessna to replace all Citation series airplane pitch trim, autopilot, and any other circuit breakers for critical systems that a pilot might need to access during an emergency situation with easily identifiable and collared circuit breakers to aid a pilot in quickly identifying and easily pulling those circuit breakers if necessary. (A-09-118) (This recommendation supersedes Safety Recommendation A-07-54 and is classified "Open—Unacceptable Response.")

Require airplane manufacturers to develop guidance on the identification of circuit breakers that pilots need to identify quickly and pull easily during abnormal or emergency situations and to provide such guidance, once developed, to operators of those airplanes. (A-09-119)

Require operators to implement the manufacturers' guidance asked for in Safety Recommendation A-09-119 regarding which circuit breakers pilots need to identify quickly and pull easily during abnormal or emergency situations in their airplanes. (A-09-120)

Require Cessna to evaluate and limit the maximum aileron trim deflection on Citation series airplanes to that required to meet the certification control requirements for powered trim tabs, unless there is a design justification to exceed those requirements. (A-09-121)

Require Cessna to reduce the aileron trim sensitivity (the unexpectedly significant aileron trim deflection that results from a relatively small amount of trim knob input) on Citation series airplanes to avoid sudden and excessive aileron trim deflections. (A-09-122)

As an interim measure (pending an available aileron trim system retrofit), notify Citation pilots and operators of the potential hazards related to the sensitivity and responsiveness of the airplane's aileron trim system. (A-09-123)

Revise check airman approval and oversight procedures to incorporate heightened surveillance during a probationary period and at other times, as warranted, for check airmen whose background evaluation uncovers a history of criminal convictions, certificate revocations, checkride failures, or other performance-related deficiencies. (A-09-124)

Conduct a detailed review of the oversight provided to Marlin Air to determine why the oversight system failed to detect (before and after the accident) and correct Marlin Air's operational deficiencies, particularly in the areas of pilot hiring, training, and adherence to procedures. (A-09-125)

Based on the review described in Safety Recommendation A-09-125, revise the oversight system and Federal Aviation Administration Order 8900.1 as needed. (A-09-126)

> Require all 14 *Code of Federal Regulations* Part 135 and Part 91K operators to provide their customers, when a business agreement or contract is finalized, with Federal Aviation Administration (FAA) contact information identified as specifically for use in expressing concerns about flight safety, thus providing customers with a clear means of communicating any safety concerns to the FAA. (A-09-127)

> Require all 14 *Code of Federal Regulations* Part 91K and Part 135 operators to notify the assigned principal operations inspectors of specific adverse financial events, such as bankruptcy, court judgments related to nonpayment of recurring expenses, or termination of a credit agreement or contract by a vendor for reasons of late payment or nonpayment. Upon receipt of such information, inspectors should increase their oversight of operators who appear to be in financial distress. (A-09-128)

In addition, the National Transportation Safety Board reiterates the following safety recommendation to the Federal Aviation Administration:

> Amend the advisory materials associated with 14 *Code of Federal Regulations* 25.1309 to include consideration of structural failures and human/airplane system interaction failures in the assessment of safety-critical systems. (A-06-37)

> Adopt Society of Automotive Engineers [Aerospace Recommended Practice] 5150 into 14 *Code of Federal Regulations* Parts 21, 25, 33, and 121 to require a program for the monitoring and ongoing assessment of safety-critical systems throughout the life cycle of the airplane. Safety-critical systems will be identified as a result of [Safety Recommendation] A-06-36. Once in place, use this program to validate that the underlying assumptions made during design and type certification about safety-critical systems are consistent with operational experience, lessons learned, and new knowledge. (A-06-38)

Safety Recommendations A-06-37 and -38 are also reclassified "Open—Unacceptable Response."

Further, the following previously issued recommendations to the Federal Aviation Administration are classified "Closed—Unacceptable Action/Superseded":

> Safety Recommendation A-07-52 (previously classified "Open—Unacceptable Response") is classified "Closed—Unacceptable Action/Superseded" (replaced by Safety Recommendation A-09-117).

> Safety Recommendation A-07-54 (previously classified "Open—Acceptable Alternate Response") is classified "Closed—Unacceptable Action/Superseded" (replaced by Safety Recommendation A-09-118).

The NTSB also issued a safety recommendation to the American Hospital Association.

In response to the recommendations in this letter, please refer to Safety Recommendations A-09-113 through -128, A-06-37 and -38 (Reiteration), and A-07-52 and -54 (Superseded). 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 secure mailbox. 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).

Chairman HERSMAN, Vice Chairman HART, and Member SUMWALT concurred with these recommendations.

*[Original Signed]*

By: Deborah A.P. Hersman
Chairman