National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 24, 2012

In reply refer to: A-12-21 through -23

The Honorable Michael P. Huerta
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20590

The National Transportation Safety Board (NTSB) recently investigated two fatal accidents involving airplanes equipped with multiple supplemental type certificate (STC) modifications. The investigations revealed that multiple STCs[1] installed on an airplane can adversely affect the airplane's performance and structure if the STCs are not properly analyzed for compatibility.

On February 15, 2010, about 1542 eastern standard time, a Cessna T337G, N12NA, collided with terrain following an in-flight separation of the outboard section of the right wing while overflying the runway at the Monmouth County Executive Airport, Farmingdale, New Jersey.[2] The pilot and four passengers were fatally injured. The airplane sustained substantial damage. The airplane was registered to Jack Air, LLC, and operated by a private pilot under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91 as a personal flight. Visual meteorological conditions (VMC) prevailed at the time of the accident, and no flight plan was filed for the local flight. The flight originated from the same airport about 1526. The NTSB determined that the probable cause of this accident was the pilots' failure to adhere to the airplane's operating limitations, which resulted in overload failure of the right wing. Findings of the investigation were the adverse effects of multiple STCs to the airframe wing structure that were not evaluated at the time the STCs were installed and the lack of guidance by the Federal Aviation Administration (FAA) for multiple STC interaction evaluation.

[1] In this letter, the term "STC" will refer to a modification to an aircraft that is authorized by a supplemental type certificate for that aircraft.

[2] The report for this accident, NTSB case number ERA10FA140, is available online at <http://www.ntsb.gov/aviationquery/index.aspx>.

On August 7, 2010, about 0920 eastern daylight time, a Beech 58, N28MR, collided with a house near Saltsburg, Pennsylvania.[3] The commercial pilot and certified flight instructor were fatally injured.[4] The airplane sustained substantial damage, and the occupied house was destroyed. The airplane was registered to Sataire, LLC, and operated by the pilot under the provisions of 14 CFR Part 91 as an instructional flight. VMC prevailed at the time of the accident, and no flight plan was filed. The flight originated from Arnold Palmer Regional Airport, Latrobe, Pennsylvania, about 0908. The NTSB determined that the probable cause of this accident was the pilot's loss of control of the airplane during low-airspeed airwork[5] and his failure to promptly recover the airplane from the aerodynamic stall, which resulted in a spin. Contributing to the accident were the pilot and certified flight instructor's intentional operation of the airplane for the purpose of performing instructional airwork with only a throw-over control yoke installed and the pilot's lack of recent flight experience in the airplane make and model. Contributing to the lack of accurate performance data (including the minimum control airspeed [V_{mca}]) for the modified airplane was the lack of guidance by the FAA for an installer of an STC modification to determine the interrelationship between all STCs incorporated into an aircraft.

The airplane in the Farmingdale, New Jersey, accident was modified with 22 different STCs, including a short field takeoff and landing kit[6] and an extended wingtip fuel tank with winglets.[7] Postaccident examination of the airplane revealed skin fatigue cracks at certain stations on the wing, which indicate that the wing was subjected to vibratory stresses. The investigation revealed potential issues with the multiple STCs installed on the wing that warranted further investigation. Independently, each individual STC did not pose a concern; however, the combination of multiple STCs installed on the wing created wing loads that were not evaluated in conjunction with one another. The FAA's evaluation of the STCs installed on the accident airplane after the accident revealed that revised operating limitations should have been developed, disseminated, and implemented based on the findings of this investigation. Following this accident, the FAA issued airworthiness directives (AD) to address operating limitations for these STCs.[8]

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[3] The report for this accident, NTSB case number ERA10FA404, is available online at <http://www.ntsb.gov/aviationquery/index.aspx>.

[4] An occupant of the house was not injured.

[5] Airwork is defined as basic flight maneuvers.

[6] The short field takeoff and landing kit included installation of leading edge cuffs and stall fences, which help the aircraft take off and land at a slower speed, obtain better performance at high altitudes (with better aileron control at low speeds), reduce the tendency to spin, and reduce the stall speed.

[7] This STC included the addition of two 3-foot-long, 20-gallon fuel tanks that were attached to the outboard ends of the original wings, with winglets attached to the outboard end of each fuel tank.

[8] The FAA published AD 2010-21-18 on October 19, 2010 (75 *Federal Register* [FR] 64111), to instruct operators of such type airplanes modified by Aviation Enterprises STC to inspect the wings for internal and external damage, repair any damage found, install an operational limitations placard (weights and airspeeds) in the cockpit, add those limitations to the flight manual supplement, and report the results of the inspection to the FAA if damage is found. Further, the FAA published AD 2011-15-11 on August 1, 2011 (76 FR 45657), to instruct operators of such type airplanes modified by Flint Aero, Inc., STC wing tip auxiliary fuel tanks to inspect the wings for internal and external damage, repair any damage, reinforce the wings, install an operational limitations placard (minimal fuel requirements at specific weights) in the cockpit, and add those limitations to the airplane flight manual supplement.

The airplane in the Saltsburg, Pennsylvania, accident was modified with two STCs that changed the airplane's V_{mca}. The first modification installed vortex generators (VGs), which decreased the airplane's V_{mca} from 81 knots to 74 knots. The second modification installed engines with an increase of 15 horsepower per engine, changed the type of propellers installed, added winglets, and modified the engine nose cowlings. The second modification accounted for a change to only the original type design (not the airplane as it was equipped with VGs) and increased the airplane's V_{mca} to 87 knots; however, the airplane's airspeed indicator remained marked to indicate a V_{mca} of 74 knots. The current STC holder for the engines and propellers installation reported that, to his knowledge, no flight testing was performed on the accident airplane or any similar make and model airplane to determine the interrelationship between his company's STC and the STC pertaining to the installation of VGs. Therefore, the actual performance data for the accident airplane, including the V_{mca}, were unknown. However, the V_{mca} for the accident airplane was likely higher than the 74-knot V_{mca} marked on the airspeed indicator. Although it was not possible to determine which low-airspeed maneuver was being demonstrated, one scenario that is consistent with the radar data evidence (and is typically performed during multiengine checkrides) is the V_{mca} demonstration. If the pilot were performing a V_{mca} demonstration, it is possible that the airplane began to lose directional control earlier than expected because the actual V_{mca} of the airplane with multiple STCs was unknown, and the airspeed indicator was improperly marked. Following this accident, the FAA issued an AD to address the V_{mca} airspeed indicator marking issue for these airplanes.[9]

The NTSB notes that STCs are generally considered major alterations and are performed by an installer (an FAA-approved airframe and powerplant [A&P] mechanic).[10] The first page of an FAA-approved STC has a limitations and conditions section requiring the installer to perform a compatibility evaluation of the STCs. In the Farmingdale, New Jersey, accident, the limitations and conditions section of both STCs clearly indicated that the compatibility of this design change with previously approved modifications must be determined by the installer. In the Saltsburg, Pennsylvania, accident, the limitations and conditions section of the STC pertaining to the engines indicated the following:

> This approval should not be extended to other aircraft of this model on which other previously approved modification [*sic*] are incorporated, unless it is determined by the installer that the interrelationship between this change and any other previously approved modifications will produce not [*sic*] adverse effect upon the airworthiness of that airplane.

[9] The FAA published AD 2011-27-04 on December 21, 2011 (76 FR 81790), applicable to airplanes with both the engine installation STC and other STCs that may have changed the V_{mca} operating limitations. The AD requires inspection of the airspeed indicator for proper V_{mca} marking using the Pilot's Operating Handbook (POH), Flight Manual Supplement, and/or placards for proper V_{mca} indications. The AD also indicates that, in the absence of FAA-approved testing to determine a correct V_{mca} for airplanes with multiple STCs with conflicting V_{mca} operating limitations, the airspeed indicator is required to be marked with the highest V_{mca} airspeed indicated in the POH, airplane flight manual, and/or placards.

[10] An A&P mechanic can install an STC; an A&P mechanic with inspection authorization is required to inspect and approve the STC for the airplane's return to service.

However, in the case of these two accidents, there was no evidence that an installer performed a compatibility evaluation.

Discussions with several A&P mechanics, including those with an inspection authorization, revealed that, although they attempt to evaluate the compatibility and interaction of the design change with previously approved modifications as specified in the limitations and conditions section of the STC, the installer must ultimately decide if the evaluation will be performed, how the evaluation will be performed, and how extensive of an evaluation will be needed to determine the interrelationship between the new STC and other STCs already on the airplane. No FAA guidance or checklist is available to aid the installer in making such a determination.

The FAA has previously recognized the need for a revision of the STC evaluation process. On December 17, 2003, the FAA published an aircraft certification policy notice, titled "Notice of Availability and Requests for Public Comment; Correction" (published at 68 *Federal Register* 70334) to revise the STC evaluation process to ensure that modified aircraft will be airworthy. Specifically, the policy notice stated, "The STC certification process does not adequately address how to evaluate the compatibility of an STC with other previously installed STCs, major alterations or repairs. We need a more rigorous compatibility evaluation for certain STCs." Although the FAA took some action to improve its certification process for evaluating and approving STCs, it did not create any guidance or checklists to aid installers in evaluating the interrelationship between multiple STCs.[11] The NTSB concludes that, without specific guidance and/or a checklist to help the installer determine the interrelationship between STCs, the installer may not be able to ensure that an appropriate evaluation is performed. As these accidents show, multiple STCs installed on an aircraft can adversely affect each other and, ultimately, the performance and structure of the aircraft if their interaction is not evaluated properly. Therefore, the NTSB recommends that the FAA develop specific guidance and/or a checklist to help installers performing STC modifications determine the compatibility and interaction between a new STC and any previously installed STCs on the aircraft to ensure that the new STC will not adversely affect the aircraft's structural strength, performance, or flight characteristics. If the guidance and/or checklist indicate any adverse effects between the STCs, additional testing and/or an engineering evaluation should be performed before installing the new STC.

Major alterations require the installer to complete FAA Form 337, "Major Repair and Alteration (Airframe, Powerplant, Propeller, or Appliance)," and submit the form to the FAA when the work is complete. This form provides aircraft owners, operators, and the FAA with a record of major repairs and major alterations (for example, an STC), the details of the alterations, and the approval. However, the installer is not required to document in FAA Form 337 how the compatibility and interaction evaluation process was completed between the new STC and any previously installed STCs on the aircraft. The NTSB is concerned that, without such documentation, installers may be less likely to perform a thorough evaluation of the interrelationship between the STCs. The NTSB concludes that documenting an evaluation of the compatibility and interaction of STCs in FAA Form 337 will help ensure that the installer

[11] The FAA issued Order 8110.4C, "Type Certification," on October 12, 2005, and an appendix to Order 8900, which addresses the FAA's STC certification process.

performed an appropriate evaluation and produces a permanent record for the aircraft. Therefore, the NTSB recommends that the FAA instruct installers to document in the Description of Work Accomplished block of FAA Form 337 how the installer determined the compatibility and interaction between the new STC and previously installed STCs on the aircraft to show that the new STC will not adversely affect the aircraft's structural strength, performance, or flight characteristics.

Further, the installation of multiple STCs is becoming more prevalent in general aviation aircraft because modifications that can enhance the performance and capability of older aircraft are attractive and less costly alternatives to the purchase of newer aircraft. The NTSB concludes that, based on the size and composition of the general aviation fleet, there are likely many aircraft that are flying with multiple STCs for which the interrelationship may not have been properly evaluated by the installer. Because such aircraft, like the two accident airplanes, may be operating with unknown adverse effects to their structural strength, performance, or flight characteristics, the NTSB believes that it is important to evaluate these aircraft to ensure their safety of flight. Therefore, the NTSB recommends that the FAA should, once it develops specific guidance for installers performing STC modifications, as requested in Safety Recommendation A-12-21, (1) educate owners and operators of all aircraft with multiple STCs about the potential hazards of incompatible STCs; (2) encourage them to have their aircraft evaluated to determine if the multiple STCs adversely affect the aircraft's structural strength, performance, or flight characteristics; and (3) document any evaluation in FAA Form 337 for that aircraft.

Therefore, the National Transportation Safety Board makes the following recommendations to the Federal Aviation Administration:

> Develop specific guidance and/or a checklist to help installers performing supplemental type certificate (STC) modifications determine the compatibility and interaction between a new STC and any previously installed STCs on the aircraft to ensure that the new STC will not adversely affect the aircraft's structural strength, performance, or flight characteristics. If the guidance and/or checklist indicate any adverse effects between the STCs, additional testing and/or an engineering evaluation should be performed before installing the new STC. (A-12-21)

> Instruct installers to document in the Description of Work Accomplished block of Federal Aviation Administration Form 337 how the installer determined the compatibility and interaction between the new supplemental type certificate (STC) and previously installed STCs on the aircraft to show that the new STC will not adversely affect the aircraft's structural strength, performance, or flight characteristics. (A-12-22)

Once the Federal Aviation Administration (FAA) develops specific guidance for installers performing supplemental type certificate (STC) modifications, as requested in Safety Recommendation A-12-21, (1) educate owners and operators of all aircraft with multiple STCs about the potential hazards of incompatible STCs; (2) encourage them to have their aircraft evaluated to determine if the multiple STCs adversely affect the aircraft's structural strength, performance, or flight characteristics; and (3) document any evaluation in FAA Form 337 for that aircraft. (A-12-23)

In response to the recommendations in this letter, please refer to Safety Recommendations A-12-21 through -23. We encourage you to submit updates electronically at the following e-mail address: correspondence@ntsb.gov. If a response includes attachments that exceed 5 megabytes, please e-mail us at the same address for instructions. To avoid confusion, please do not submit both an electronic copy and a hard copy of the same response.

Chairman HERSMAN, Vice Chairman HART, and Members SUMWALT, ROSEKIND, and WEENER concurred in these recommendations.

[Original Signed]

By: Deborah A.P. Hersman
Chairman