NTSB

SAFETY ALERT

National Transportation Safety Board

★ Mechanics: Prevent Misrigging Mistakes ★

Verify correct directional travel of controls and trim

The problem

- Incorrect rigging of flight control and trim systems has led to in-flight emergencies, accidents, and even deaths.
- Four such mishaps within a 2-year span share common safety issues:
  - Maintenance personnel who serviced or checked the systems did not recognize that the control or trim surfaces were moving in the wrong direction.
  - Pilots who flew the airplanes did not notice the control anomalies during their preflight checks.
- Anyone can make mistakes. In some cases, the mechanics who performed the work incorrectly were highly experienced.

Related incident and accidents:

- In December 2014, the pilot of a Cessna T182T airplane experienced extreme nose-down control forces on the yoke shortly after takeoff. The airplane had just undergone maintenance on the elevator trim system, and the mechanic briefed the pilot about the work before the flight. Both the pilot and the pilot-certificated passenger needed to pull hard aft on the yoke to prevent the airplane from pitching down, even though the elevator pitch trim indicator showed a nearly full nose-up trim position. The pilot remembered that work had been done on the elevator trim system, and he thought that there might be some kind of control-reversal problem. While maneuvering for the emergency landing, the pilot applied nose-down trim control inputs and found that the extreme control forces lessened, and he successfully landed the airplane. The elevator trim control cables were misrigged such that the elevator trim control was reversed. The mechanic who performed the work had 26 years of experience and described that he had carefully checked the trim tab deflection angles. However, he did not recognize that the trim tab moved in the wrong direction. The mechanic who checked the work had 24 years of experience and noted that the cable rigging problem could not be clearly visually identified through the airplane's access panel. The maintenance manual provided the following information:

"Make sure that the trim tab moves in the correct direction when it is operated by the trim wheel. NOTE: Nose down trim corresponds to the tab UP position." (CEN15IA079)[1]

- In May 2013, the pilot of a Schweizer SGS 2-33A glider received serious injuries after the glider crashed due to improper rigging of the rudder control cables. The glider had just received an annual inspection, and its rudder had been removed and reinstalled. The mechanic who conducted a flight control check after the annual inspection with assistance from another pilot seated in the cockpit stated that he confirmed movement of the rudder while at the rear of the glider; however, he did not see which pedal the pilot was pushing and did not verbally confirm the corresponding position of the rudder pedals. The mechanic had 35 years of experience and had assembled hundreds of gliders. (ERA13LA229)
- In October 2013, the private pilot and passenger in a Piper PA-22 received serious injuries when the airplane crashed during takeoff on its first flight since an annual inspection in which frayed elevator control cables were replaced. During the takeoff roll, when the pilot applied forward stick controls to raise the tail, the tail did not rise, and the airplane instead "jumped" off the runway. The pilot reduced engine power and attempted to control the airplane's pitch, but it responded abnormally and crashed. The elevator control cables were installed incorrectly such that the elevator moved in the direction opposite to that commanded. (ERA14LA015)
- In July 2014, the pilot of a Piper PA-12 airplane was fatally injured after his airplane pitched up steeply during takeoff and crashed after the airplane had undergone extensive maintenance. The elevator control cables were installed incorrectly such that the elevator moved in the direction opposite to that commanded. (ANC14FA050)

What can maintenance personnel do?

- Become familiar with the normal directional movement of the controls and surfaces before disassembling the systems. It is easier to recognize "abnormal" if you are very familiar with what "normal" looks like.
- Carefully follow manufacturers' instructions to ensure that the work is completed as specified. Always refer to up-to-date instructions and manuals—including airworthiness directives, maintenance alerts, special airworthiness information bulletins, and unapproved parts notifications—when performing a task.
- Be aware that some maintenance information, especially for older airplanes, may be nonspecific. Ask questions of another qualified person if something is unfamiliar.
- Remember that well-meaning, motivated, experienced technicians can make mistakes: fatigue, distraction, stress, complacency, and pressure to get the job done are some common factors that can lead to human errors. Learn about and adhere to sound risk management practices to help prevent common errors.

[1] These pilots and the mechanic are featured in the NTSB's safety video, "Airplane Misrigging: Lessons Learned from a Close Call," which is available on the NTSB's safety videos web page at http://www.ntsb.gov/safety/safety-alerts/Pages/Safety-Videos.aspx.

- Ensure that the aircraft owner or pilot is thoroughly briefed about the work that has been performed. This may prompt them to thoroughly check the system during preflight or help them successfully troubleshoot if an in-flight problem occurs.

Interested in more information?

The reports for the accidents referenced in this safety alert are accessible by NTSB accident number from the Accident Database and Synopses web page at http://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx.[2] Each accident's public docket is accessible from the NTSB's Docket Management System web page at http://dms.ntsb.gov/pubdms/.

Education and training are critical to improving GA safety. The Federal Aviation Administration (FAA) Safety Team (FAASTeam) provides access to online training courses, seminars, and webinars to provide mechanics with recurrent training that focuses on accident and incident causal factors, special emphasis items, and regulatory issues. The courses listed below (and many others), as well as seminar and webinar information, can be accessed from the FAASTeam website at www.faasafety.gov. (Course access requires login through an existing free FAASTeam account or creating a new one.)

- Dirty Dozen: Human Error in Aircraft Maintenance
- Human Factors Primer for Aviation Mechanics
- Failure to Follow Procedures: Installation
- Failure to Follow Procedures: Inspections
- Aircraft Maintenance Documentation for AMTs
- Fatigue Countermeasure Training

"Aviation Maintenance Technician Handbook — General" (FAA-H-8083-30) includes an "Addendum/Human Factors," which discusses the human factors-related conditions behind most maintenance errors. The addendum (which is also called chapter 14) can be accessed from the FAA's website at www.faa.gov.

"Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair" (FAA Advisory Circular 43-13-1B) contains a Personal Minimums Checklist in chapter 13 that lists actions to reduce maintenance errors.

Aircraft Safety Alerts, including airworthiness directives, maintenance alerts, special airworthiness information bulletins, and unapproved parts notifications, can be accessed from www.faa.gov/aircraft/safety/alerts.

This NTSB safety alert and others can be accessed from the NTSB's Safety Alerts web page at http://www.ntsb.gov/safety/safety-alerts/Pages/default.aspx or searched from the NTSB home page at http://www.ntsb.gov/Pages/default.aspx.

[2] Less-recent fatal accidents that may also be of interest are CHI05FA038, CHI08MA270, and DCA03MA002.