Analysis by Mike Busch A&P/IA, Savvy Founder and CEO

On April 4, 2018 an Embry Riddle Aeronautical University training aircraft, a 2007 Piper PA-28R-201 Arrow, crashed after its left wing separated in flight. The accident occurred shortly after the aircraft departed Runway 25L at Daytona Beach International Airport following a touch-and-go, killing ERAU student Zach Capra and FAA pilot examiner John Azma.

NTSB investigators found that the left wing's main spar had suffered a fatigue fracture at the bolted shear joint that attaches the lower spar cap to the fuselage carry-through structure. That joint consists of a 10-bolt cluster arranged as two rows of five bolts each. The fracture originated at the outboard forward bolt hole and propagated through the outboard aft bolt hole. Fatigue cracking was also found in the corresponding bolt holes of the aircraft's right wing.

Piper PA-28 wings attach to the fuselage carry-through structure with bolted shear joints at the upper and lower spar caps.

Investigators found no evidence of corrosion or pre-existing damage to the wing attach structure. However, the accident aircraft had accumulated more than 7,600 hours time-in-service during its 11-year life—that's almost 700 hours per year—and had a history of hard landings and high load-factor maneuvers, not unusual for training aircraft. Repetitive stress on the joint caused fatigue cracks to develop in the edges of the outboard bolt holes, and those cracks ultimately grew to the point that the lower spar cap failed completely.

** History of the AD

On December 21, 2018 the FAA issued a Proposed AD that would have mandated removal of the outboard bolts and eddy-current inspections of the bolt holes for cracks on about 20,000 Piper PA-28 and PA-32 airplanes. This proposal was opposed as excessive by AOPA, EAA, Piper, and even the NTSB—largely on the basis that removal of the wing bolts to facilitate the inspection might well create a greater safety risk than the one the inspection was meant to address. Many individual commenters, both aircraft owners and mechanics, also weighed in on the NPRM.

More than two years passed during which the FAA did not issue a final-rule AD nor offered any further indication of what its intentions were. Owners of Piper PA-28 and PA-32 airplanes were left twisting in the wind, waiting for the other shoe to drop.

That finally changed yesterday when the FAA issued its final rule AD 2020-26-16 (https://www.federalregister.gov/documents/2021/01/15/2021-00044/airworthiness-directives-piper-aircraft-inc-airplanes) . This AD becomes effective on February 16, 2021, and impacts nearly every Piper PA-28 and PA-32 in the fleet, although it impacts some aircraft a lot more than others (as we shall explain shortly). Specifically, the AD applies to all Piper Models PA-28-151, PA-28-161, PA-28-181, PA-28-235, PA-28R-180, PA-28R-200, PA-28R-201, PA-28R-201T, PA-28RT-201, PA-28RT-201T, PA-32-260, PA-32-300, PA-32R-300, PA-32RT-300, and PA-32RT-300T airplanes, with the exception of a handful of serial numbers that the FAA has determined to have already complied with the requirements of the AD.

The AD applies to any Piper aircraft in this list of models with 5,000 or more hours time-in-service (TIS). The FAA estimates that there are 5,440 such aircraft under U.S. registry. Although the AD technically affects only U.S.-registered aircraft, virtually every other country in the world is certain to adopt a substantially identical AD, so the total number of affected aircraft worldwide will be a good deal higher.

** Pull Out Your Calculator

For any of these aircraft that have accumulated 5,000 hours or more hours TIS, the AD requires that a review of the aircraft's maintenance records be performed within 30 days after the AD becomes effective; i.e., by March 18, 2021. The maintenance record review may be performed by either an A&P mechanic or by the aircraft's owner/operator who holds at least a private pilot certificate.

The purpose of this review is to gather the information that is required to determine whether or not the aircraft will be required to have an eddy current inspection of its wing spar attachment. The review must determine:
1. How many hours TIS the aircraft has accumulated since it was new or since its main wing spar was replaced with a new one, whichever is less.
2. How many 100-hour inspections the aircraft had performed as required by FAR 91.409(b) because the aircraft was being operated to carry passengers for hire or to provide flight instruction for hire. [These include all inspections performed to comply with FAR 91.409(b) regardless of whether they were recorded as "100-hour" or "annual" inspections. They do not include inspections performed on aircraft that were not being operated for hire and performed 100-hour inspections voluntarily rather than as required by FAR 91.409(b).]
3. Whether the main wing spar has ever been replaced with a used/serviceable (not new) one. [If this is the case, the spar will be deemed to have an indeterminate TIS and an eddy current inspection will always be required.]

The findings of this logbook review must be recorded in a maintenance record entry for the aircraft in accordance with FAR 43.9, meaning that the entry must contain the date of the logbook review, the findings of the review, the signature of the person who performed the review, and that person's pilot or mechanic certificate and type.

Once this logbook review has been performed and before further flight, a calculation must be made of "factored service hours" for each main wing spar. This calculation reflects the FAA's belief that the risk of wing spar attachment cracks affects primarily aircraft used in flight training and similar for-hire operations. Conceptually, factored service hours is derived as follows:

Factored Service Hours = (For-Hire Hours) + (Not-For-Hire Hours)/17

The idea is that an aircraft with 12,000 hours total time that was used in for-hire operations its entire life would have factored service hours equal to 12,000, while an aircraft with 12,000 hours total time that was never used in for-hire operations would have factor service hours of 12,000/17 or about 706. A 12,000 hour aircraft that was used in for-hire operations part of its life and for not-for-hire operations the rest of its life would have factored service hours somewhere in between.

The actual official formula in the AD is slightly harder to parse:

Factored Service Hours = (N x 100) + [T - (N x 100)]/17

where N is the number of 100-hour inspections performed per the requirements of FAR 91.409(b) and T is the total hours TIS of the airplane (or the wing spar if it was replaced with a new one at some point).

** Spar Inspection and Replacement

If the factored service hours reaches 5,000 or more, the AD requires an eddy current inspection of the wing attachment for cracks. This eddy current inspection is both invasive and somewhat expensive because it requires special test equipment and the services of a certified NDT (non-destructive testing) technician. The reason the FAA came up with the rather oddball formula for factored service hours is to ensure that most airplanes in for-hire service would be required to perform this inspection and most personal-use airplanes would be spared. An airplane that spent part of its life in for-hire ops and the rest of its life in personal-use ops might go either way.

The eddy current inspection focuses on the inner surface of the two lower outboard bolt holes on the lower main wing spar cap. It requires removing these wing attach bolts (which is a bit scary), running an eddy current probe through the bolt holes to detect any cracks, and then installing new bolts and torquing them to spec.

If the eddy current inspection detects a crack is found, things get really expensive because the main wing spar will be required to be replaced with either a new spar or a used/serviceable spar that has passed the eddy current inspection. The aircraft cannot be flown until the wing spar is replaced; ferry permits will not be issued for such aircraft. So it’s important that the eddy current inspection be performed at a shop that either has the capability of doing the wing spar replacement (which is a big sheet metal job) or the capability of removing the wing and shipping it to a good sheet metal shop for the spar transplant.

The latter course of action will usually be the most advisable. I know I certainly wouldn’t want my main wing spar replaced by anyone but the best sheet metal guys I could find. Nobody knows how many of these airplanes will turn out to have detectable cracks, but if it turns out that hundreds of airplanes have cracks, the relatively few really good sheet metal shops in the country might be overwhelmed and backlogged. Owners should plan accordingly.

The AD requires that the results of any eddy current inspection required by the AD be reported to the FAA within 30 days. The FAA states that it considers this AD to be “interim in nature” and that it may be amended based on the inspection data that the FAA receives.

The FAA has estimated that the eddy current inspection will cost a bit over $1,000 per airplane and a wing spar replacement will cost over $12,000 per wing. Keep in mind, however, that FAA cost estimates are notorious for being low, so the actual cost owners pay is likely to be a good deal more.