



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

2238

Date: June 4, 1990

In reply refer to :A-90-80 and -81

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President
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On April 24, 1990, at 1350 CDT, a Bellanca Decathlon, 8KCAB, N2976R, sustained an in-flight separation of the right wing and crashed near West Bend, Wisconsin. The right wing had separated from the airplane at the two wing spar-to-fuselage and two wing lift strut-to-spar attachment points and was found approximately 0.5 miles from the crash site. The accident occurred during an aerobatic instructional flight in a designated aerobatic practice area. The instructor and student were fatally injured.^{1/}

The airplane crashed in a swamp and was buried 3 to 5 feet. A witness near the crash site stated that he saw the airplane spiralling straight down with only the left wing on the airplane. Two other witnesses saw a wing falling to the ground, but did not see the accident airplane.

Metallurgical examination of the failed attachment fittings by the National Transportation Safety Board determined that the forward strut-to-spar attachment fitting, p/n 2-1976, on the right wing separated because of fatigue cracks in both fitting side plates. The forward lift strut attachment fitting is a welded sheet metal assembly with two formed side plates (forward and aft) welded to a flat plate at the inboard ends. The airplane tie down loop is also welded to the flat plate. The fatigue cracks had initiated at the outboard ends of both assembly welds between the flat plate and each side plate and had independently propagated upward into both of the side plates. The fatigue cracks had penetrated more than 75% of the forward side plate and 30% of the aft side plate at the time of complete separation of the fitting.

Separations of the forward and rear wing spar-to-fuselage attachment points, and the rear strut-to-spar attachment were consistent with a structural overload following the failure of the forward strut-to-spar attachment fitting.

^{1/} NTSB Field Accident Report CHI 90-F-A117.

Metallographic investigation of the weld area revealed hardened zones in the side plates immediately adjacent to the weld fusion zones. Microhardness testing established that these zones were considerably harder (45 to 50, Rockwell "C", (HRC)) than either the surrounding base metal (22 to 24 HRC) or the weld fusion zone (30 to 40 HRC). The base metal of the fitting pieces was specified to be normalized AISI 4130, an alloy steel which is air hardenable in thin sheets necessitating close control of the cooling rate after welding. Inadequate control of the cooling rate during manufacture can result in high hardness regions within the weld heat affected zone. Preheating and post heating of the welded assembly are typical methods used to control the cooling rate. Similar high hardness zones were found near the welds on an intact attachment fitting that had been previously removed from another Decathlon. The differences in hardness between the weld fusion zone, the heat affected zone and the base metal act as a metallurgical stress concentration and exaggerate the mechanical stress concentration normally associated with the weld bead geometry.

Methods for control of the cooling rate after welding are not specified in either the engineering drawing of the fitting or the welding specification, CW-1S, noted in the drawing. The Safety Board believes that the manufacturing procedures should provide adequate instructions for the proper control of the cooling rate. However, the detrimental affects of the high hardness zones near the welds that have resulted from the improper control of the cooling rate may be substantially reduced or eliminated by heat treatment of the fittings after welding.

The accident airplane, serial number 624-80, was manufactured on February 20, 1980 and had a total airframe time of 1775 hours at the time of the accident. The last annual inspection was completed on February 26, 1990, 50 hours prior to the accident.

The Decathlon is designed to FAR Part 23 standards, and is certified for +6 and -5 g-loading. It is approved for all aerobatic maneuvers except the Lomecevak and tailslides. Normal aerobatic maneuvering would produce many cycles of high wing loads in a relatively short time period. Because of this, the Safety Board did not attempt to establish the rate of crack growth in relation to flight hours or flight cycles.

The investigation revealed four previous incidents of cracking near welds in the forward strut-to-spar fitting on Decathlon 8KCAB airplanes that were reported to the International Aerobatic Club (IAC) by its members. The total time on the four airplanes involved in the incidents ranged from 980 hours to 2,100 hours. The reports describe two typical locations for cracking, one at the welds between the flat plate and the side plates, similar to the location of the fatigue cracks on the accident airplane and another at the welds securing the reinforcement doublers at the lift strut attachment bolt holes. In one instance, a fitting with a crack at the reinforcement doublers had been submitted to a private laboratory for failure analysis. The laboratory determined that the crack was caused by fatigue that initiated in a high hardness region of the weld heat affected zone. A west coast repair station has reported one additional forward strut-to-spar attachment fitting crack which had been weld repaired. No additional incidents of attachment fitting cracks have been uncovered in either previous accident files or service difficulty reports.

The Safety Board concludes that the cracking in the right forward strut-to-spar attachment fitting on the accident airplane was caused by fatigue propagation initiated by the metallurgical stress concentration of the high hardness region in the heat affected zone combined with the normal mechanical stress concentration due to the weld bead geometry. The Safety Board believes that the difference in hardness was caused by improper welding techniques involving inadequate weld cooling control. The Safety Board is concerned that the entire Bellanca Decathlon fleet of approximately 360 airplanes may be equipped with improperly welded forward strut-to-spar attachment fittings, are therefore susceptible to fatigue cracking. Therefore, the Safety Board believes that the FAA should mandate immediate and recurrent inspections of Bellanca Decathlon 8KCAB strut-to-spar attachment fittings to detect cracks before they become critical.

It is our understanding that your organization, which currently holds the type certificates for the Bellanca Decathlon 8KCAB airplanes, is considering engineering changes to develop and manufacture improved strut-to-spar fittings for the Decathlon. Although recurrent inspection of the existing fittings should preclude catastrophic failure of the fittings, the Safety Board believes that the existing fittings should be replaced with improved fittings without undue delay to assure the continued airworthiness of these vital components. Therefore, the National Transportation Safety Board recommends that the American Champion Aircraft Corporation:

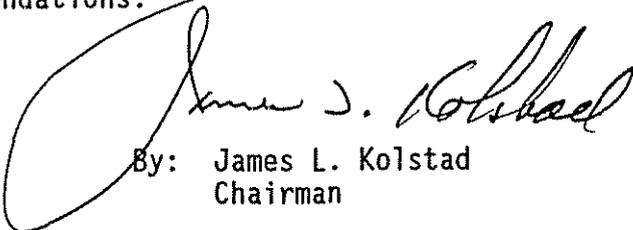
Expedite the development and manufacture of improved forward lift strut-to-spar attachment fittings for the Bellanca Decathlon 8KCAB series airplanes.(Class I, Urgent Action) (A-90-80)

Revise the manufacturing procedures for welded assemblies to provide adequate instructions during welding for the proper control of cooling rates on hardenable steel components. (Class II, Priority Action) (A-90-81)

As a result of the investigation, the Safety Board issued Safety Recommendation A-90-82 to the Federal Aviation Administration.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "...to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendations A-90-80 and -81 in your reply.

KOLSTAD, Chairman, COUGHLIN, Acting Vice Chairman, LAUBER and BURNETT, Members, concurred in these recommendations.



By: James L. Kolstad
Chairman