Executive Summary
ABS-Commissioned Spar Web Engineering Reports

October 25, 2004

ABS encouraged its contract engineers to share information, but to take independent looks at the carry-through spar web cracking issue and generate separate reports. Nonetheless they are in almost total agreement on all topics. Here is a synopsis of the engineers' comments and conclusions:

Probable cause of spar web cracking

- Carry-through spar web cracks appear to result from deflections caused by low-intensity, frequently repeated operating loads experienced either continuously or intermittently in normal operation.
- Analysis of the design and orientation of reported cracks suggest that cracking results not from wing loading, but from longitudinal airframe stresses that are directed around the fuselage skin cutouts through which the wing spars pass.
- Cracking in the spar web and in the bend radius is primarily driven by nose gear loads during landing and ground operation.
- Initial cracking from fuselage stresses leads to increased bending deflection in the bend radius, leading to cracking there.
- The engineers doubt the validity of Dick Wilson's theory (available at http://mysite.verizon.net/dick.wilson/) that cracks relieve the stress because the source of stress that leads to cracking remains continuous. The engineers "cannot agree with (Mr. Wilson's) conclusion that the cracking will not potentially cause safety problems."

Potential safety consequences of spar web and fuselage flange cracking

- Initial cracking is not entirely self-relieving.
- After cracking, this structure must continue to experience load transfer. The cracks could potentially become serious if they extend into the web area between the spar chords. The web is subject to shear loads for unsymmetrical loading conditions and this load path must remain viable at all times for all loads up to and including design ultimate.
- Any significant cracking of the load path between spar caps could seriously degrade safety. However, if cracking in the bend radius remains local to the area below the lower spar cap, the potential for a safety problem is fairly remote.

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Current Service Bulletin effectiveness

- The current repair kits take care of cracks locally but do very little for the fore and aft loads that are the cause of cracks seen to date. The kits alone do not provide a permanent repair unless a set of doublers is installed on the outside of the fuselage skin to redirect fore/aft loads around the cutouts.
- Installing the existing repair kit doubler will increase the stiffness and therefore increase the web stresses because the doubler will not significantly reduce the deflection. It is possible that cracking may even occur earlier. However, installation of the Beech kit in conjunction with a robust external doubler to the fuselage skin should cause no harm.

Engineers' recommendations

- It is vital to obtain all available data to better understand this behavior.
- A finite element model should be made of the fuselage from the rear spar carry-through forward to the nose landing gear attachment points, and the wing from the main landing gear attachment points. Application of various loading conditions to the model will show where more critical deflections occur.
- The most effective solution would be to reduce the skin shear deflection by additional skin reinforcement around the wing spar fuselage skin cutouts.
- A comprehensive, state-of-the-art analysis is essential to fully understand the behavior of airframe stress and validate any proposed repair or preventative action.

Concurrent to the engineers' studies, ABS conducted a survey of its members, receiving responses from approximately 15% of the ABS members owning affected aircraft (10% of the estimated remaining affected aircraft population). The engineers took these responses into account in their findings.

Of 1007 responses:

- 71 airplanes (7.1%) experienced some form of MSB-defined crack.
- 27 airframes (2.7% of those reporting) had cracks requiring installation of the doubler as required under the current ADs.
- 44 aircraft (4.4% of the reports) experienced cracking not meeting current AD criteria for doubler installation.

Our best information is that the survey results provide a representative picture of the affected fleet as a whole. However, caution must be taken not to extrapolate too many generalities from this limited survey response; ABS plans to conduct a second, directed survey with hopes of receiving a greater response rate. Further, ABS has direct knowledge of two aircraft, and second-hand knowledge of a third, where known spar web cracks presented no growth for several inspection cycles only to later propagate to the upper spar web. These three instances involve airplanes whose owners chose for whatever reason not to respond to the ABS survey.

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