

SCOTTISH AVIATION BULLDOG WING SPAR MODIFICATION

The Scottish Aviation Bulldog is a two-seat side-by-side training aircraft originally designed by Beagle Aircraft at Shoreham Airport, West Sussex, in the late 1960's. The first order for the type was for 78 from the Swedish Air Board, but before any production aircraft were built, Beagle Aircraft ceased trading and the production rights for the aircraft, together with the Swedish order, were taken over by Scottish Aviation Limited at Prestwick, Ayrshire. All subsequent aircraft were built at Prestwick Airport by Scottish Aviation, later to become part of British Aerospace.

The largest customer was the Royal Air Force, which placed an order for 130 Bulldog T Mk 1 aircraft in 1972 to replace the Chipmunk. It was used by the Royal Air Force as a basic trainer, in particular as the standard aircraft of the University Air Squadrons and, later, Air Experience Flights. The aircraft was also used for Elementary Flying Training (EFT) of Royal Navy aircrew. The RAF withdrew its Bulldog fleet in 2001, replacing them with the Grob Tutor, and all were purchased by civilian operators.



SA Bulldog G-UWAS in its element executing a loop

Every metal aircraft suffers fatigue damage caused by the reversals and fluctuations of load applied to the airframe during all phases of operation including aerobatics. Fatigue damage accumulates continuously, although its effects are not detectable until it eventually appears as a crack in a structural component. Since such cracks may have catastrophic results, it is necessary in the interests of safety to establish by ground test a safe fatigue life at which non-damage tolerant aircraft must be either retired from service or modified to permit further flying.

Fatigue life consumption is measured in the RAF as the consumption of 'Fatigue Index' (FI). This is a non-dimensional number, derived from a fatigue formula specific to the aircraft type. The FI consumed is normally calculated from records of the aircraft's fatigue meter counters taken before and after each flight. The changes in the counter readings, together with the number of landings, are inserted into the fatigue formula to obtain the FI consumed over a specific period, so enabling the total FI of an individual aircraft to be monitored throughout its life. The Bulldog Full Scale Fatigue Test was run until actual structural failures occurred, establishing the maximum safe life for the aircraft, as built (and with due safety factors) as 114 FI.

Modification No. BH.193 was developed by the manufacturer to strengthen and otherwise improve the wing-to-fuselage (stub-wing) main spar joint following the discovery of this cracking. The

modification introduces lengthened and strengthened replacement joint straps, replacement doublers attached to the spar and stepped attachment bolts to allow for installation/removal without damage to the spar strap doubler holes from the bolt threads. Resumption of the Fatigue Test determined that Mod No. BH.193 increased the ultimate safe life from 114 FI to 200 FI.

To date BH.193 has been embodied only on one Series 120 Bulldog whilst still in RAF service and on one Series 100 aircraft located in Malaysia. After cessation of RAF Bulldog flying the programme was terminated and BAE Systems thereafter relinquished their Bulldog Design Authority role to de Havilland Support Ltd, here at Duxford.

With many Bulldogs now approaching their 114 FI life limit it has fallen to de Havilland Support Ltd to manufacture BH193 Mod Kits and offer owners the opportunity of life extension as an alternative to retiring their aircraft. The owner of Bulldog G-UWAS was faced with just such a dilemma, but as he is a huge fan of the aircraft, the decision to have the modification carried out was an easy one.

Work at Duxford commenced by dismantling the wing spar joint area. The spar bolt holes were inspected for elongation and defects using non destructive inspection techniques. With results showing no apparent defects work could start on reaming the existing bolt holes to a larger diameter to refresh the hole bores and accept the replacement close tolerance oversize bolts. The reaming of these holes was carried out using special jigs and reamers supplied by de Havilland Support Ltd.

The next task was to prepare the new joint straps and determine the shims required to ensure correct alignment of the wings when refitted to the stub wings. Once prepared the holes and joint straps were drilled and also reamed for the oversize bolts. The modified joint straps for the lower spar are longer than the original parts, requiring spar rivets to be removed from the wings and stub wings. The holes are then reamed to 21/64 inch diameter for the new bolts. In addition some of the rivets in the upper spar are also removed and bushes are freeze-fitted prior to fitting bolts. With all the drilling and reaming operations complete the wings were cleaned and a yellow epoxy primer was applied.



Drill jig fitted to wing spar for drilling and reaming operations

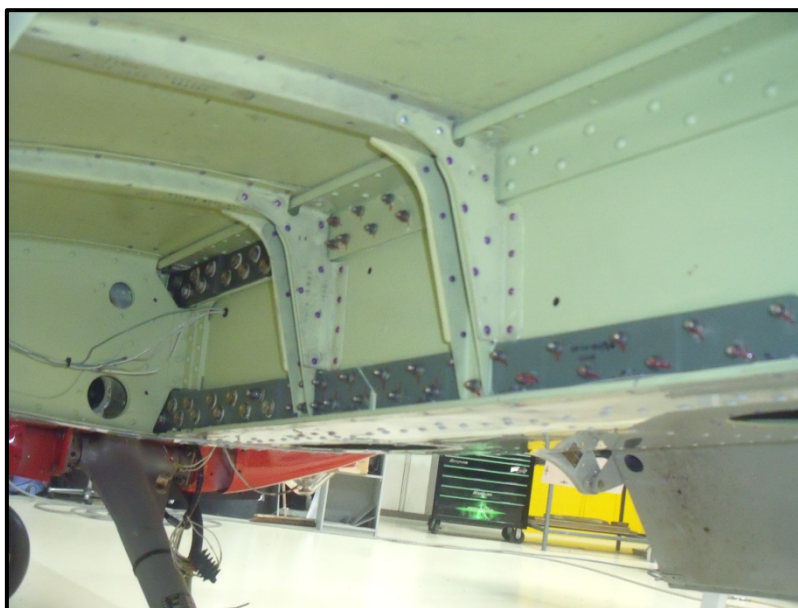


Drill jig fitted inside the stub wing for drilling and reaming operations



New wing spar straps being drilled and reamed Completed wing tank bay cleaned and primed

Reassembly commenced with fitting the new joint straps to the stub wings. The strap bolts are fitted together with special washers followed by the nuts which are tightened to a specific torque value. Straps and shims are fitted to the wing spars at this time in the same way. With all the straps and shims in place the wings were carefully refitted to the stub wings, and the bolts, washers and nuts fitted and torque loaded. After a final inspection the aileron controls were reconnected and rigged and the fuel tanks refitted into the wing tank bays.



The port wing refitted ready for the fuel tank installation

The above description of Mod BH.193 is abbreviated and the work entailed many challenges. Although the modification had long previously been carried out on two aircraft, those involved were not contactable for advice. Our engineers, Jim Neal, Conner Dimmock and Trevor Woodgate therefore worked very closely with Mark Miller from de Havilland Support Ltd to interpret the supplied data and also generate comprehensive notes for accomplishing the same job in future.

The aircraft is currently undergoing an avionics upgrade which will soon be completed. A first post-modification flight is eagerly anticipated.



With the wing modification complete, G-UWAS awaits its avionic upgrade.
G-UWAS has also assumed the identity XX625 which served with the
University of Wales Air Squadron, Royal Air Force St. Athan