Sequoia Aircraft Corporation
2000 Tomlynn Street
P.O. Box 6861
Richmond, Virginia 23230
804/353-1713
FAX 804/359-2618

Service Bulletin

Service Bulletin No. 93-1
Subject: Flap Flutter
Date: June 24, 1993
Models Affected: Sequoia F.8L Falco (all aircraft built from plans and/or kits)
Compliance: Mandatory

Background
On April 1, 1993, the Falco G-MRCI developed a case of flutter in the left flap. At the time of the flight, the airplane was going through a flight test for the British CAA, since this Falco had been imported from the U.S., where it had been built by Charles Gutzman. The airplane was in a slight dive with the intention of taking the airplane to Vne, when at 205 mph indicated, the left flap developed a severe flutter. While the pilot immediately retarded the throttle, it was all over in a few seconds, and the flap departed the airplane. The pilot landed the airplane without incidence, and reported that the Falco flew well with one flap missing.

The outboard flap hinge pulled off the bushing, leaving the bushing and aileron hinge bolt in place and unharmed (an inspector reported that none of the hinge bolts had washers under the bolt heads as called for in the plans). At the inboard end of the flap, the flap hinge remained with the airplane and also a short length of the flap spar. In a preliminary report, we reported that a substantial amount of free play existed in the actuator after the accident, however we have since learned that this is not correct. The large amount of free play in the system (after the incident) came from the movement of the actuator supports and center torque tube support. In the violent shaking of the flutter incident, these supports became loose because the wood was compressed under the supports and under the screw heads for the supports.

Flap flutter is an extremely rare event, however in consulting with engineers, flutter in flaps can happen if the conditions are right. Large flaps, like the Falco's, are more prone to flutter than flaps of small area. Free play should be reduced to a minimum, ideally less than 1/16" at the trailing edge, but in no case more than 1/8" at the trailing edge.

Charles Gutzman reported that this aircraft had previously had an incident of flutter in the left flap. This occurred in the first 10-15 hours of flight, and it happened after raising the flaps after takeoff. The buzz in the flaps was momentary and after landing, Charles Gutzman reported that he realized that the flap torque tube had been joined in the center with only one bolt (vs two bolts shown in the drawings). He subsequently installed the second bolt and "tightened the system up". Charles Gutzman reported that after this, the system had very little free play.

Our analysis of this incident has brought us to the conclusion that this incident was caused by six factors:

1. Free play in the flap control system. If you take the trailing edge of the flap in your fingers and jiggle it, there is a certain unavoidable amount of 'jiggling free play' which results

from the sizes of the bolts within the bushing and bearing holes. Some of this can be reduced by tightening the bolts on each end of the flap actuating pushrods, however to reduce this 'jiggling free play' requires replacing the existing bolts with close tolerance bolts. The use of close tolerance bolts will reduce the jiggling free play to 1/16" or less at the trailing edge.

2. Flexing in the flap control system. If you push hard on the trailing edge of the flap, you can observe that, in addition to the 'jiggling free play', the flap control system also has a certain amount of flexing in it. In our analysis of this, we observe that the center flap torque tube support (P/N 726) moves slightly relative to the flap actuator support brackets (P/N 854-1 & -2). The rigidity of this part of the system depends partly on the rigidity of the three metal components, and also on the rigidity of the mounting on the spruce block in the bottom of the fuselage.

3. Use of countersunk screws. The flap torque tube support (P/N 726) and the flap actuator support brackets (P/N 854-1 & -2) are installed with washer-head screws with the head of the screws on the outside of the plywood skin of the aircraft. On this Falco, the screws were countersunk into the surface with the result that the heads of the screws bear on spruce. This weakens the mounting and adds to the flexing in the flap control system.

4. Out-of-balance condition. Ordinarily, flaps for production aircraft are not balanced. This is true for both the SF.260 and the Falco, which have very similar flap control systems. However, we have found that there is a very wide variation among our builders on the trailing edge weight of the flaps. A heavy weight at the trailing edge would increase the tendency of the flaps to flutter. It is evident that we must impose an upper limit on the flap trailing edge weight.

5. Reflexing of the flaps. The flaps of this Falco were reflexed five degrees. This was in an attempt to increase the speed of the airplane, but Charles Gutzman reported that it did not increase the speed at all. While reflexing of the flaps is not something which would cause flutter by itself, when the other conditions are existing, we believe the reflexing contributed to the conditions which caused the flutter incident. To explain, with the flaps in the normal 'trail' position, the air loads would cause a constant 'up' load on the flaps, pushing the flap control system to the limit of the 'jiggling free play' and against the flexing in the system. If the flaps are raised beyond the trail position, at some point they would enter a neutral zone in which the flaps would be neither pushed from below or above, but rather simply buffeted by turbulence. We think this reflexing caused the conditions of buffeting which induced the flutter incident.

6. Omission of washers under hinge bolt heads and nuts. An inspector reported that no washers were installed under either the hinge bolt heads or under the nuts for any of the control surface hinge bolts. The outboard flap hinge pulled off its bushing and was not restrainted from doing so by a washer under the bolt head. It is impossible to know, however, if the outcome would have been any different if the washer had been in place.

The Falco has been built with three types of control surfaces. The original Series I and II Falcos, had wood-and-fabric control surfaces with open bays aft of the spars. These were covered with fabric. The Series III and IV Falcos had aluminum control surfaces. Many of our early Falcos were built with the original wood-and-fabric method, but most have been made by covering them entirely with plywood—as was the Falco G-MRCI.

To determine the balancing of the flaps, we asked Falco builders to weigh their flaps according to the following procedure:

Flap weighing instructions: Remove the flap pushrod. Suspend the flap on its hinges (on the airplane or on a bench). With the flap in horizontal (flight) position, measure the weight of the trailing edge of the flap at a point 5mm outboard and 5mm forward of the innermost trailing edge point of the flap. The overall weight of the flap is not something we want to know.

The following flap trailing-edge weights have been reported.

Wood-and-Fabric	
Karl Hansen	14
Neville Langrick	20
Larry Black	20
John Oliver	19.5/20.4
Metal Construction	
Gar Williams	21 (for Series III production Falco)
Wood with Plywood Covering	
Cecil Rives	29 (in primer, not painted yet)
Jonas Dovydenas	32
Dick Reichenbach	19.8/20.3
Rex Hume	20
John Shipler	27/27.8
Ray Purkiser	20/21
Guido Zuccoli	27/30
Steve Wilkinson	27
Bob Bready	23/24
G-MRCI	37.4 (for right flap)

All weights are given in ounces, and when two weights are given, e.g. 19.8/20.3, the weights are for the left and right flaps. In other cases, only a single weight was reported.

Note the substantial variation from one airplane to another, and also that when both flaps have been weighed for an airplane, with one exception, the weights have come within one ounce of each other. Thus we think it is logical to conclude that the unrecovered left flap of G-MRCI was within one ounce of the 37.4 oz weight of the right flap.

While we cannot guarantee that the flaps will never flutter, we believe it is prudent to establish an upper limit for the trailing edge weight of the flaps, because the aircraft has been flying without any incident of flap flutter for nearly 40 years. We think the appropriate limits can be expressed best this way: 20-21 oz. desired, not to exceed 23 oz., however anything under 20 oz. is fine.

Corrective Action
To avoid further incidents of flap flutter, the following actions should be taken:

1. Balance the flaps. In accordance with the flap weighing instructions given above, balance the flaps to 20-21 oz. desired, not to exceed 23 oz., however anything under 20 oz. is fine. Any Falcos with trailing edge weights in excess of 23 oz. should have the flaps balanced as soon as practical, i.e. within the next 2 to 3 hours of flying.

To add weight to the leading edge of the flap, we suggest drilling a series of holes in the leading edge strip and filling them with lead birdshot and epoxy. Ideally, the weight should be evenly distributed along the leading edge.

There is an approximate 3-to-1 leverage between the leading edge and the trailing edge, thus you will have to add about 3 ounces of weight to the leading edge for each ounce of extra weight at the trailing edge. So, if your trailing edge weight is presently 27 ounces and you want to reduce it to 20 ounces, the 7 ounces at the trailing edge will require 21 ounces of weight at the leading edge.

2. Install close tolerance bolts in the entire flap control system. The objective is to reduce the free play in the flap control system to 1/16" or less at the trailing edge of the flap. Anything above 1/8" is an invitation for flutter.

The close tolerance bolt installations are these:

At the inboard flap hinge, the hinge bolt hardware is:
AN174-17
AN960-416L (2)
AN310-4
MS24665-132
washer under nut and bolt head

At the aft end of the flap pushrod, where it joins the flap hinge and arm:
AN174-11
AN960-416L
AN310-4
MS24665-132

At the forward end of the flap pushrod, where it joins the flap torque tube:
AN174-11
AN960-416L
AN310-4
MS24665-132

At the outboard end of the flap torque tube, where it pivots on the fittings in the wing:
AN173-20
AN960-10L (2)
AN310-3
MS24665-132
washer under nut and bolt head

At the center of the flap torque tube, where it pivots on the P/N 726 support:
AN174-12
AN960-416L
AN310-4
MS24665-132

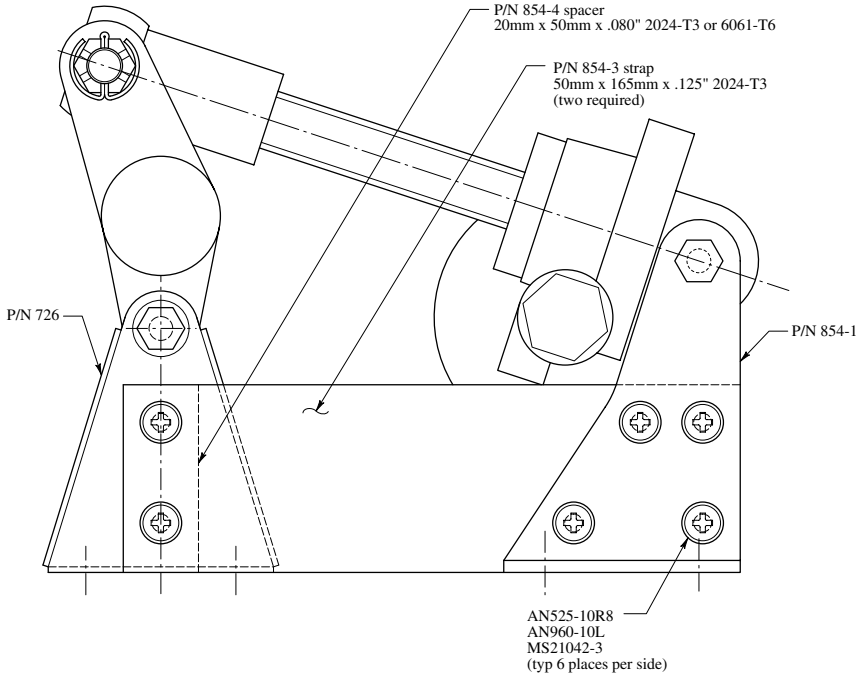
At the aft end of the flap actuator, where it pivots on the P/N 854-1 & -2 flap actuator support mounts:
AN174-17
AN960-416L
AN310-4
MS24665-132

These changes are described in Revisions B4g, B6d and B7c of F.8L Falco Revision List No. 93-1.

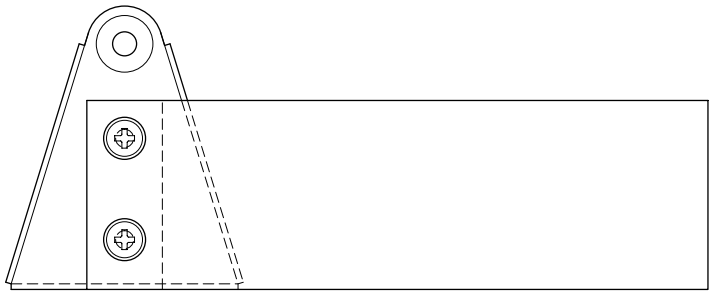
As an interim measure, the bolts on the aft end of the flap control pushrod can be tightened onto the spherical bearings and a substantial amount of free play can be eliminated. In addition, the

close tolerance bolts can be installed incrementally. It is quite easy to install the bolts on the outboard end of the flap control system.

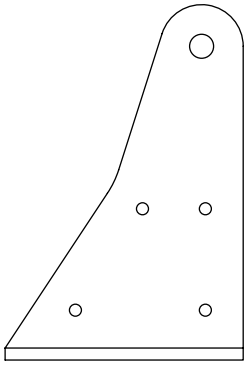
3. Install reinforcing straps between P/N 726 torque tube support and P/N 854-1 & -2 flap actuator support mounts as shown below.



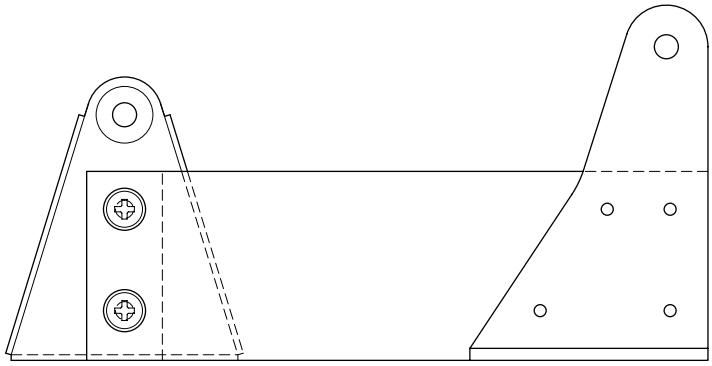
To be sure, this installation is a difficult one. In order to accomplish this, you must first remove the actuator and torque tube. The torque tube does not have to be removed from the airplane, only from P/N 726.



Remove P/N 726 from the aircraft and install P/N 854-4 spacers and P/N 854-3 straps on each side. In order to do this, you must grind the turned out flange of P/N 725 down to a height of 2mm (.080”). Install the straps with the screws. When you drill the holes for the screws, clamp the components to a flat table so that the bottoms of the parts will be aligned. The screws should be located about 10mm (or 3/8”) from the edge of the parts. Note that there is very little space in the middle of P/N 726, thus you must first slide the nuts and washers in place, and then install the screws.



Drill four 1/8” holes in the actuator support brackets as shown above. Again, these holes should be located about 10mm from the edge of the parts.



Put the components back in the airplane and tighten up the nuts on the screws which hold them in the bottom of the aircraft. The straps on the outside of P/N 726 should go on the inside of the actuator support brackets.

With an angle drill with a 1/8” drill in the actuator support brackets to drill through the P/N 854-3 straps. As you drill each hole, put a cleco in the hole.

When all holes are drilled, remove this from the aircraft. By removing one cleco at a time, ream up the screw holes and install the four screws between the actuator supports and the straps.

Put the entire assembly back in the aircraft, and reinstall the flap actuator and torque tube.

In addition to the method outlined above, there are other methods that could be used to install these braces. For example, it might be possible to epoxy the spacer to the brace, drill pilot holes for the screws, epoxy the braces in place on the brackets, drill the holes with an angle drill and then use rivets or screws to hold the parts in place.

At this time, we are putting together a package of the required bolts, nuts and the braces. These will be sent out shortly to purchasers of the kits free of charge, and they will be available at a modest cost to those who have not purchased the kits.