MEMO

ISSUED: 26 SEPTEMBER 1984

TO: ALL AUTHORIZED ULTRAFLIGHT DEALERS AND DISTRIBUTORS

FROM: ULTRAFLIGHT SALES LTD.

SUBJECT: NEGATIVE PUBLICITY

A few concerned customers have phoned regarding a newspaper article which appeared in several newspapers a couple of weeks ago (copy attached). Although we do not yet have all the answers, we will pass along what we can.

Based on the information we have received, it appears tht out of the 1,400 Rotax 185 engines in service, there have been twelve occurrences of a broken crankshaft. Eleven out of the twelve are either confirmed or highly suspected of having been operated with large wooden propellers, and/or shaved cylinder heads to increase the compression ratio.

Four of the failed crankshafts were sent to Rotax in Austria for lab analysis. They report that three of the failures were due to torsional vibration. The fourth could be a combination of torsional and bending vibration. Tests showed no indication of defective material or workmanship. Endurance testing using a standard engine, engine mounting system, and standard biblade propeller, which has been performed by both Rotax and by Ultraflight, has shown no indication of any design defect or misapplication of the engine, when the production configuration is adhered to.

All of this, plus the general high reliability of the engine when it has been used without modification and with the standard biprop, indicates that the crankshaft failures have been the result of customer modifications.

The effects of using a different propeller are very difficult to predict without knowing all the parameters of the propeller. It should be noted, however, that the standard biblade propeller is unique in several ways:
1. It has a very small diameter, 2. It has a very thin and very narrow blade section, 3. It has a high degree of taper from the hub to the tip, 4. It is injection molded using a precisely machined, high symmetry mold. All of these features contribute to low crankshaft stress for the following reasons: the small diameter, the small blade section and high taper all help to reduce the mass of the propeller. The small diameter, the blade section, and the taper all tend to keep the center of mass of the blade very close to the center of rotation, thereby reducing the radius of gyration of the propeller. The injection molding process and the use of a homogeneous material ensure that the propeller will be very nearly perfectly balanced without modification. As each of these factors makes a contribution, the combination of all of them results in a propeller which stresses the crankshaft much less than any standard wooden propeller.

Measurements made on the biblade show that it has a weight of 1.18 pounds total and the radius of gyration is located approximately 3.60 inches from the center of rotation. A 34/9 wooden propeller (a typical size that might be used on the Rotax) could weigh from 1.3 to 1.5 pounds, depending on the material and manufacturer. The radius of gyration is typically at about 16 percent of the diameter, which would be 5.45 inches.

The forces imposed on the crankshaft due to an unbalanced propeller (assuming the unbalance is evenly distributed and can be considered to be concentrated at the radius of gyration) are proportional to the unbalanced mass times the radius of gyration times the square of the rotational speed. Assuming that the possible unbalance is proportional to the weight of the propeller, then the ratio of potential loading on the crankshaft using a wood prop instead of the biblade would be (1.4 x 5.45) to (1.18 x 3.6) or about 1.8 to 1. Due to the differences in manufacturing methods, it is quite conceivable that the asymmetry of the wooden prop could easily be twice that of a molded prop and this would increase the ratio to 3.6 to 1. If we then consider that the wooden prop could be turning as much as 10 percent higher rpm, (especially if the engine is modified as well), the ratio would be $3.6 \times (1.1)^2 = 4.3$.

Although this analysis is based on several assumptions, it shows that substituting a different propeller could quite possibly increase crankshaft stress by more than four times. This could obviously have a profound effect on the fatigue life of the crankshaft.

Another interesting piece of the puzzle is the fact that eight of the twelve broken crankshafts came from one particular area where owners have acquired a reputation for aerobatic flying. While there is no proof, this tends to indicate that part of the problem may be caused by the gyroscopic forces associated with aerobatic flying.

In any case, the evidence indicates that Lazair owners who fly their aircraft in a sensible manner, in a stock configuration, should not be overly concerned about crankshaft failures.

The second subject mentioned in the article apparently concerns the loss of a propeller from a JPX engine on a Lazair II. We have been told by our distributor who investigated the incident that the propeller bolts broke and a DOT investigator took the broken bolts away for lab analysis to determine the cause of failure. We have also been told that the holes in the propeller had been elongated to about half an inch. If this is true, then it is quite obvious that the engine was operated with the propeller nuts loose, and it is no wonder that the bolts broke. The obvious lesson to be learned from this is to make sure your prop nuts are kept tight and checked frequently as suggested in the Technical Update mailed to all Lazair II owners in June '84. A torque of 14 foot pounds is recommended. Remember that wood will expand and contract with changes in humidity, so be especially observant after any prolonged decrease in relative humidity. You should also be aware that if a wooden prop is left in a vertical position, moisture will tend to gravitate toward the lower blade and can cause the prop to be unbalanced. When leaving your aircraft for any appreciable time, make sure the props are turned to a horizontal position.