



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: March 18, 1993

In reply refer to: A-93-40 and -41

Mr. Joseph M. Del Balzo
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On May 14, 1990, a Beech Bonanza Model A35 (serial no. D-1532), N511B, was involved in an accident when it sustained a flutter of the empennage during a descent in smooth air near Washington, Missouri, at an indicated airspeed of 140 to 145 knots. The pilot reduced the power to idle, cross-controlled rudder and ailerons, and the flutter subsided. The pilot landed without further incident and was not injured, but the aft portion of the fuselage (tailcone-empennage area) was damaged extensively. The entire empennage was loose and the fuselage, particularly the right side forward of the stabilizers, was buckled from top to bottom and torn. Subsequent investigation and testing disclosed that the static balance of the ruddervators was outside the manufacturer's service specifications, which require the underbalance (tail heaviness) to be from 16.8 to 19.8 inch-pounds. The right and left ruddervator underbalance was measured as 22.8 and 22.9 inch-pounds, respectively. The original ruddervator skins had been replaced and repainted, and it appeared that they were last painted while the ruddervator surfaces were attached to the aircraft. The pilot reported that he had previously experienced hum or vibration in the controls in smooth air, but that it would subside when he reduced airspeed or applied rudder and cross-control aileron. An annual inspection of N511B had been performed on April 6, 1990.

On January 16, 1991, a Beech Bonanza Model 35 (serial no. D-496), N3081V, was involved in an accident when it sustained a flutter of the empennage after encountering turbulence near Walla Walla, Washington. The airplane was descending at an indicated airspeed of about 150 knots at the time. According to the pilot, "the rudder pedals were shaking uncontrollably along with the whole airplane, mainly the empennage." The flutter subsided after the pilot-rated passenger pulled back on the control column and alternately pushed on the rudder pedals, and the airplane landed without further incident. Although the aft fuselage skin was wrinkled, the airplane continued to be flown for several months. In April 1991, a mechanic advised the owners that the airplane was

not airworthy due to damage to a rear bulkhead in the tail section. Subsequent investigation disclosed cracks in all four corners of the fuselage-empennage bulkhead in addition to the wrinkled aft fuselage skin. The right and left ruddervator underbalance was measured as 21.1 and 21.3 inch-pounds, respectively. No lead washers, used to correct out-of-balance conditions, were installed in either of the ruddervator counterweight housings.

On January 18, 1992, a Beech Bonanza Model 35 (serial no. D-805), N3342V, was involved in an accident when it sustained a flutter of the empennage near Nucla, Colorado, during a cruise-descent in smooth air at an indicated airspeed of about 148 knots. Power was reduced to slow the airplane, the flutter subsided, and the airplane landed without further incident. The airplane continued to be flown until an examination about a week later disclosed cracks in all four corners of the fuselage-empennage bulkhead and wrinkled and torn aft fuselage skin. The right and left ruddervator underbalance was measured as 20.2 and 21.2 inch-pounds, respectively. The left ruddervator had been removed from the airplane and repaired in December 1991. The repaired surface was accompanied by a yellow "serviceable" tag with the notation "balance confirmed." However, no lead washers were installed in either of the ruddervator counterweight housings. The ruddervator was reinstalled only a week before the accident during the airplane's annual inspection, which was completed on January 10, 1992.

On October 18, 1990, the Federal Aviation Administration published a special issue of Advisory Circular (AC) No. 43-16, General Aviation Airworthiness Alerts. The Alerts, entitled "Beech Models 35, 35R, A35, and B35 Ruddervator Static Balance," referenced 11 occurrences of empennage flutter as a result of improperly balanced (tail-heavy) ruddervators. The excessive underbalance was usually due to excessive paint aft of the hinge line. The Alerts recommended the following:

- 1) Check, and if necessary, correct, the static balance of the ruddervator as specified in the appropriate Beech shop or Maintenance Manual following any painting, repair, or modification of the surface.
- 2) Periodically check each ruddervator for internal dirt and debris, e.g. from dust storms or insects.
- 3) Do not paint the ruddervators while they are still on the airplane.
- 4) Paint the ruddervators with the leading edge down (trailing edge pointed up) so any paint run-down will accumulate forward of the hinge line.
- 5) Do not apply excessive paint since it adds weight aft of the hinge line. Also, an accumulation of paint stripping residue inside the ruddervators is common

following repeated stripping. Both of these make it impossible to properly balance the ruddervator.

Beechcraft Service Letter (SL) No. 63-1, "Elevator Rebalancing," issued July 1, 1963, also refers to empennage flutter because of improperly balanced ruddervators and emphasizes the importance of ensuring that the underbalance does not exceed 19.8 inch-pounds. The Letter notes:

Painting is the greatest contributor to out-of-balance conditions. Many early Bonanzas (D-1 thru D-1500) were delivered with properly balanced but lightly painted surfaces. When these surfaces are repainted, a major increase in tail heaviness can be expected. Later model Bonanzas had a heavier paint application at the factory but still should be checked for balance when the surface is repainted. Paint accumulation along the tab hinge or on the trailing edge, as well as any repairs or patching aft of the hinge line, contributes to an out of balance and tail heavy condition. Painting techniques, drying procedures, etc., vary from organization to organization and can be expected to have additional effect on balance. The only method by which proper surface balance can be maintained is to check the balance after painting and add balance weights as required.

Airworthiness Directive (AD) 57-18-01, effective December 20, 1973, applicable to Beech Model 35 airplanes (serial nos. D-1 through D-1500) requires an inspection of the stabilizer front and rear spar attachment bulkheads every 100 flight hours for cracks, buckles, or distortion, and associated cracks or buckles in the fuselage skin in the vicinity of the bulkheads. The AD also states:

Within the next 100 hours of operation, unless already accomplished, check the static balance of the ruddervator (as originally manufactured) on airplane Serial Numbers D-1 through D-1500, and on all other aircraft where the ruddervators have been repainted or repaired, to ascertain that the static balance is within acceptable limits. This check of the static balance must also be made each time the ruddervators are repaired or repainted.

Beech Aircraft flutter test data indicate that Beech 35 series airplanes are susceptible to an antisymmetric flutter instability (fuselage torsion coupled with ruddervator oscillation) if the ruddervators are not properly balanced. This mode of flutter, as evidenced in the accident at Washington, Missouri, is sometimes presaged by buzzing, vibration, or shaking, and can be "triggered" by an encounter with turbulence at relatively low airspeeds within the normal operating envelope.

Beech 35 series maintenance manuals provide instructions for checking ruddervator underbalance by either of two methods: actual force measurement or counterbalancing. The first method measures the force applied by the ruddervator surface on a single support at a known distance from the centerline of the hinge; the second method applies a known force or weight at a measured distance from the hinge line to counter the unbalance moment of the ruddervator assembly. Correction of excessive underbalance to service specifications is accomplished by adding lead washers or solder to the ruddervator counterweight housing. However, as evidenced by the above accidents, these essential field service procedures following repair or repainting are frequently not performed.

Changes to ruddervator underbalance occur most frequently when the ruddervators are repaired or repainted in the field. The application of excess paint or improper orientation of the ruddervators while drying/curing will result in excessive underbalance. Moreover, limitations on the amount of counterweight that can be installed may preclude rebalancing to service specifications. Beech factory painting and finishing specifications have changed over the years and, as indicated in SL No. 63-1, ruddervators on early Bonanzas, serial nos. D-1 thru D-1500, were lightly painted at the factory and are particularly susceptible to increased tail heaviness when repainted in the field. Beechcraft Service Bulletin No. 35-26, issued May 20, 1953, provides the following advisory regarding balancing of repaired/repainted surfaces:

Where repairs have been made on elevator surfaces, the added weight of the repair material may make it impossible to balance the surface and remain within the maximum weight addition of the eleven lead washers even after repainting the surface. Should this condition exist, it is recommended that the surface be replaced. In some instances, an elevator having a heavy coat of paint cannot be balanced satisfactorily. To correct this condition, the heavy coat of paint should be stripped and the elevator repainted and rebalanced.

AD 87-20-02 R1, effective June 15, 1988, applicable to all Bonanza Model 35 series airplanes, was issued to minimize the possibility for in-flight failures due to inadequate strength of the longer chord V-tail (C35 models and subsequent) and/or adverse flight characteristics resulting from operation outside the aft limit of the center of gravity envelope. In conjunction with the installation of external stabilizer reinforcements, the AD required, among other things, that all models with the increased stabilizer chord length/overhang be subject to an inspection of the aft fuselage and bulkheads in the area of the empennage for evidence of cracks, distortion, or other damage and a check, and correction as necessary, of the ruddervator static balance. Compliance with this particular provision was not required for

evidence of cracks, distortion, or other damage and a check, and correction as necessary, of the ruddervator static balance. Compliance with this particular provision was not required for Model 35, 35R, A35, or B35 airplanes (serial nos. D-1 thru D-2680) with the shorter chord stabilizers. However, according to Beech records, all documented occurrences of empennage flutter in Model 35 series airplanes have been confined to this latter model grouping, with the majority of the occurrences involving the original Model 35 airplanes.

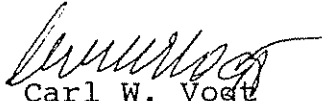
Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an airworthiness directive applicable to Beech Model 35, 35R, A35, and B35 airplanes requiring: (1) at the next annual or 100-hour inspection, whichever occurs first, and at any time the ruddervators are repaired or repainted, a check of ruddervator underbalance (tail heaviness) to ensure that it is within the manufacturer's specified limits of 16.8 to 19.8 inch-pounds, and (2) at the next annual or 100-hour inspection, whichever occurs first, and at each annual and 100-hour inspection thereafter, an inspection of the aft fuselage bulkheads at stations 256.9 and 272.0 (stabilizer front and rear spar attachment bulkheads) for evidence of cracks, distortion, loose rivets, or other damage, and the fuselage skin in the vicinity of the bulkheads for evidence of wrinkles or cracks. Any damage found should be repaired before further flight. (Class II, Priority Action) (A-93-40)

Require the Beech Aircraft Corporation to amend Pilot Operating Handbooks and Airplane Flight Manuals applicable to Models 35, 35R, A35, and B35, by including in "Emergency Procedures" information regarding potential empennage flutter. This information should include the immediate operational and post-flight structural inspection procedures to be followed in the event of excessive vibration or flutter of the empennage; a warning that flutter is sometimes presaged by buzzing, humming, vibration, or shaking in the control systems; and the need to balance the ruddervators any time they are repaired or repainted to ensure that the static balance remains within service limits. (Class II, Priority Action) (A-93-41)

Also as a result of its investigation, the Safety Board has issued Safety Recommendation A-93-42 to the Beech Aircraft Corporation.

Chairman VOGT, Vice Chairman COUGHLIN, and Members LAUBER, HART and HAMMERSCHMIDT concurred in these recommendations.

By: 
Carl W. Vogt
Chairman