

**AIRCRAFT ACCIDENT REPORT****ADOPTED:** June 15, 1960**RELEASED:** June 21, 1960

MOONEY M-18, N 4174 NR. BUTLER, PENNSYLVANIA,  
SEPTEMBER 7, 1959

SYNOPSIS

On September 7, 1959, about 1430 e. d. t., a Mooney M-18C55, N 4174, crashed one and one-half miles west of the Culmerville Airport near Butler, Pennsylvania. Donald W. Bailey, the pilot and sole occupant, received fatal injuries. The airplane, a single-engine, single-place, low-wing monoplane, was demolished.

Mr. Bailey planned a local VFR flight of 20 minutes' duration. He was seen to take off in N 4174 and climb to about 1,500 feet northwest of the airport where he executed several "lazy-eight" maneuvers. At approximately 1430 several persons on the ground saw the aircraft in straight and level flight on a southerly heading. A loud crack was heard and parts were seen to separate from the aircraft. Immediately thereafter N 4174 entered a spin and crashed.

The Board concludes that this accident was caused by the inflight separation of the trailing edge member of the right horizontal stabilizer. Investigation revealed very poor bonding of the glued wood joints of this structure due to improper production techniques. In addition, evidence was found throughout the aircraft of poor design and production practices in both welded metal parts and glued wood joints.

As a result of this investigation and the Board's recommendations, an Airworthiness Directive was issued by the Administrator of the Federal Aviation Agency. (See Attachment "A".)

Investigation

Mr. Bailey possessed a currently effective FAA commercial pilot certificate with a rating for single-engine land airplanes and an instrument rating. He had accumulated about 900 flying hours. Mr. Bailey's total flight experience in N 4174 was 1 hour and 40 minutes.

The flight on which the crash occurred was a proficiency flight in the local area and was to be of 20 minutes' duration. The weather conditions were: ceiling and visibility unlimited. The surface wind was from the west-southwest at five m.p.h.

Mr. Bailey took off on the west runway about 1415<sup>1</sup>/<sub>2</sub>. He circled the airport climbing to an altitude of about 1,200-1,500 feet above ground. About one to one and

1/ All times herein are eastern daylight based on the 24-hour clock.

one-half miles northwest of the airport he was observed executing "lazy-eight" maneuvers.<sup>2/</sup>

At approximately 1430, several persons on the ground saw the Mooney aircraft. They stated that it was proceeding in a southerly direction in straight and level flight. Several stated that they heard a loud sharp crack and saw objects separate from the aircraft. Several others heard the sound and then observed the aircraft in a spin with pieces falling behind it. Immediately thereafter the aircraft crashed one and one-half miles west of the Culmerville Airport. There was no fire.

Several aircraft parts were found back along the flightpath and confirmed the observations that inflight structural failure had occurred. The right side of the horizontal stabilizer was found 2,600 feet northwest of the main wreckage site; the right elevator was found 1,100 feet northwest; and the fin and rudder, plexiglass, and a piece of right wing plywood were found 550 feet northwest of the wreckage.

The main portion of the aircraft struck the ground in a near-vertical descent. Impact damage indicated it was pitched nose down to a 30- or 40-degree angle and yawed to the left. All components, other than those which separated in flight, were found within a 25-foot radius of the powerplant.

The right wing spar had failed downward from inflight overloads at two points; approximately one foot outboard of the attach point and four feet, nine inches outboard of the attach point. The section between the two breaks was in the main wreckage with the landing gear still attached. The right flap with its hinges had separated from the wing and was bent upward in a "U" shape which corresponded closely with the curvature of the top of the fuselage midsection. The hinge welds on the flap were cracked at impact. One piece of plywood, identified as a portion of the right wing lower surface at and forward of the spar just outboard of the inboard failure, was found 550 feet from the wreckage. The size of this piece, which was originally glued to the spar, was 10.3 inches long but showed bonding of the glued joint for only about 3.5 inches.

Inspection of the right horizontal stabilizer, which separated in flight, revealed that the spar had failed at the right attach bolt in downward overload. A section of the right trailing edge member extending from a point outboard of the inboard hinge to the No. 3 rib had pulled out. It remained attached to the elevator by the middle hinge when the elevator had separated from the stabilizer. The outboard elevator hinge remained with the stabilizer. The glued joint of the No. 2 rib and the trailing edge member had separated with only slight failure of the wood. The laminated plies of the middle hinge block were also separated with no wood failure. The rearmost lamination was cracked rearward by the hinge bolt. In addition, the No. 1 rib had separated from the spar with very little wood failure.

The right elevator was found 1,100 feet northwest of the main wreckage area. It was bowed spanwise so that the middle hinge was about two inches lower than the root and tip. The middle hinge was intact with the portion of trailing edge member mentioned above attached. The inboard and outboard hinges had separated at the upper and lower welds. These welds had very little penetration.

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<sup>2/</sup> An advanced flight training maneuver which combines the dive, the turn, and the climb. This maneuver does not impose excessive or abnormal loads on the aircraft when properly executed.

The vertical stabilizer failed to the left and with the rudder attached fell 70 feet from the wreckage. When the rudder separated from the aircraft the lower hinge failed in the weld. The rib trailing edge glued butt joint adjacent to the middle hinge was loose. It was being held in place by one brad and the joint showed very little wood failure.

All other damage to the aircraft was the result of impact forces. There was some evidence of deterioration present in several of the glued joints which had separated with very little wood failure. In other joints, which had failed in a similar manner, there was no evidence of any deterioration. (It was noted that none of the glued joints were reinforced with gusset plates but depended entirely upon the strength of the glue to hold them.)

In view of the findings during this investigation and the fact that the model 18 production ceased in 1956, the Board carried its investigation into the Mooney Aircraft Company present production methods for the model 20A. The present company, which took over control of the Mooney Aircraft Company in 1956, maintains a strict inspection system to check all stock as it is received into the plant to ensure conformity to specifications. Quality control of all fabricated parts is maintained by visual inspection of each operation and comparison with blueprints. In addition, a conformity report on each lot of parts has to be filled out stating the number of units inspected, the workmanship, and conformance to the drawings. Further, each step in the assembly and subassembly must be inspected and signed off before the next operation can be started.

#### Analysis

The evidence indicates that the initial inflight failure occurred when the glue joint of the No. 2 rib separated allowing the trailing edge member of the right horizontal stabilizer to pull out. Airload bowed the elevator down in the middle, its inboard and outboard hinges remaining intact. As the elevator was bowed downward and the lateral distance between the inboard and outboard hinges decreased, an abnormally high downward loading was consequently imposed on the stabilizer, failing it downward at its attach point. It is probable that as the stabilizer separated from the aircraft the outboard elevator hinge failed and the elevator remained attached to the aircraft momentarily until the inboard hinge also failed. This is indicated by the location of the stabilizer farther from the wreckage than the elevator.

The immediate result of the loss of the stabilizer was a violent nosedown pitching of the aircraft, which failed the right wing spar downward in two places. Following this the aircraft rolled rapidly to the right and the vertical fin separated. The aircraft then fell nearly vertically to the ground.

The generally poor condition of glued wood joints throughout the aircraft appears to be a result of poor production techniques. Although deterioration from weathering was noted in some which had failed, it is not believed to have been of such a degree as to cause separation with little or no wood failure. The design practice of using glued butt joints without gussets or the equivalent is considered poor. In the later models 20 and 20A this problem is overcome because the stabilizer and wings are completely covered with plywood and this surface acts as gusset for the structure.

Similarly, poor production techniques were noted in numerous welds throughout one aircraft. Because of poor penetration several had failed in the weld deposit or at the juncture of the weld deposit and the parent metal. The weld should, if

properly made, be the strongest point in a tubular member and loads exceeding design strength of the part should fail it at a point adjacent to the weld rather than through the weld itself.

### Conclusions

The Board concludes that the inflight structural failure resulted from the separation of a glued wood joint. The Board further concludes that proper bonding between the wood and glue was not obtained during production because of improper techniques and control. It is also concluded that the design practices did not provide a sufficient margin of safety to guard against weakening of the structure over a prolonged period.

As a result of recommendations made by the Board to the Administrator of the Federal Aviation Agency following this investigation, the latter issued an airworthiness directive to correct these deficiencies. (See Attachment "A".)

### Probable Cause

The Board determines that the probable cause of this accident was an inflight structural failure brought about by the separation of an improperly glued wood joint.

BY THE CIVIL AERONAUTICS BOARD:

/s/ WHITNEY GILLILLAND  
Chairman

/s/ CHAN GURNEY  
Vice Chairman

/s/ G. JOSEPH MINETTI  
Member

/s/ ALAN S. BOYD  
Member

## S U P P L E M E N T A L D A T A

### Investigation and Taking of Depositions

The Civil Aeronautics Board was notified of this accident shortly after it occurred on September 7, 1959. An investigation was immediately initiated in accordance with section 701(a)(2) of the Federal Aviation Act of 1958. Depositions ordered by the Board were taken at the Culmerville Airport, Culmerville, Pennsylvania, on October 13, 1959, and in Kerrville, Texas, on October 15, 1959.

### The Aircraft

N 4174, a Mooney M-18C55, manufacturer's serial number 339, was manufactured July 1955. A production test flight was performed on April 30, 1956, and the aircraft found to be airworthy. It was classified in the standard category. A current certificate of airworthiness was issued January 5, 1959. The current certificate of registration, dated September 2, 1959, listed Fred O. Eiler of Tarentum, Pennsylvania, as the owner. The aircraft and engine had a total of 356 hours, of which six hours had been accumulated since the last 100-hour inspection August 26, 1959. It was equipped with a Continental engine, A65-12, and a Flottrop propeller, 65A66, installed new on May 21, 1959.

### The Pilot

Donald W. Bailey, age 24, resided at Gibsana, Pennsylvania. He possessed a currently effective FAA commercial pilot certificate with an airplane single-engine land and an instrument rating. He had accumulated approximately 900 flying hours, of which 1 hour 40 minutes were in the Mooney M-18.

ATTACHMENT "A"

FAA AIRWORTHINESS DIRECTIVE

59-22-3

MOONEY (Applies to all Mooney M-18 series aircraft)

COMPLIANCE REQUIRED WITHIN THE NEXT 10 FLIGHT-HOURS BUT NOT LATER THAN DECEMBER 15, 1959

The following inspections, repairs, and replacements shall be accomplished

(a) Empennage

(1) Remove and disassemble empennage. Remove control surface and hinge brackets from fin and horizontal stabilizer. Remove bolts through stabilizer main spar attach blocks. Disassemble stabilizer and fin from empennage truss and each other.

(2) Inspect all bolted joints for the following items.

- (i) Wear on bolt
- (ii) Wear on bolt holes in fittings and lugs
- (iii) Wear on bushing
- (iv) Wear on bushing on fittings, lugs and wood.  
(Replace parts as necessary)

(3) Remove all fabric from stabilizer and fin. Inspect all wood and glue joints including attachment of leading edge skin to main spar for deterioration.

(4) At center section of stabilizer spar inspect glue joint between attach blocks and spar for deterioration and inspect spar and blocks for cracks. Inspect fin spar for cracks at attach bolts

(5) Any defective wood parts shall be replaced or repaired in accordance with CAM 18 and/or manufacturer's recommendations. When the fin and stabilizer are satisfactory, reinforcement of the stabilizer main spar center section and the fin and stabilizer center hinge rib-rear spar attachment shall be accomplished in accordance with Mooney M-18 Service Letter No. 16. (Kits of reinforcement parts are available from Mooney Aircraft, Inc.)

(6) Clean all empennage drain holes, and see that they are located as specified in Mooney M-18 Service Letter 16.

(7) Inspect welds at rudder and elevator hinges and control horns and at all joints on the tail truss for inadequate welds (i.e. weld which does not fill fillet cross section area) and for cracks using either method (1) or (ii) below.

- (i) Magnetic particle or X-ray inspection.
- (ii) Remove paint and primer and visually inspect welds with a 10-power glass.

Parts with defective welds are to be replaced or repaired. A joint may be rewelded providing the old weld is removed and the surfaces thoroughly cleaned.

(8) Remove upper tail truss attach fittings from aft fuselage bulkhead and inspect as described in item (2). Inspect bulkhead front and back for cracks in area of these fittings. Inspect glue joints between bulkhead and aft fuselage skin and longerons for deterioration or separation. Repair in accordance with Mooney M-18 Service Letter No. 17. Examine trim linkage attached to lower part of aft bulkhead for worn bolts. Replace bolts as necessary.

(9) Reassemble and install empennage making sure all bolts are tight. Block airplane solidly at tail skin and inspect for empennage play as follows:

- (i) Stabilizer - Move up and down at one tip and measure at opposite tip. Total allowable play  $\frac{1}{2}$  inch up and down.
- (ii) Stabilizer - Move fore and aft at one tip and measure at opposite tip. Total allowable play  $\frac{3}{4}$  inch fore and aft.
- (iii) Fin - Move fore and aft at top leading edge and measure at bottom of rudder trailing edge. Total allowable play  $\frac{1}{2}$  inch up and down.

(b) Aft Fuselage

(1) Inspect wood around forward fuselage tubular structure attach fittings for deterioration. Clean all drain holes. Inspect all glue for deterioration. See that drain holes are located as specified in Mooney M-18 Service Letter 16.

(c) Wing

(1) Remove seat, auxiliary fuel tank and belly access panel.

Inspect ribs, skin and both spars at lower center section and around fuselage fittings for wood and glue joint deterioration.

(2) Inspect all wood and glue joints in wheel well area for deterioration. Inspect both spars for cracks in area of the gear attachments.

(3) Inspect interior of wing in areas having access openings.

(4) Remove aileron and inspect hinges and control horn in accordance with part (a), item (7).

(5) Remove wing fabric locally in area of aileron hinges and at inboard corner of aileron cutout and check condition of wood and glue joints. If evidence of deterioration is found remove fabric further as necessary for

complete examination of forward area of wing trailing edge. Check security of attachment of wing trailing edge in aileron area.

(6) Clean all drain holes in wing, and see that they are located as specified in Mooney M-18 Service Letter 16.

(d) Control Systems

(1) Inspect all control systems (aileron, trim, rudder, and elevator).

(i) Visually inspect all welds for cracks and inadequate welds (i.e., welds which do not completely fill fillet cross section area).

(ii) Check security of all bolted hinge and fitting attach points.

(Mooney M-18 Service Letters Nos. 16 and 17 pertain to this same subject).