CIVIL AERONAUTICS BOARD

ACCIDENT INVESTIGATION REPORT

Adopted: July 14, 1954 Released: July 19, 1954

CONTINENTAL AIR LINES, INC., MIDLAND, TEXAS,
MARCH 16, 1954

The Accident

At approximately 0840[1] a Continental Air Lines Convair 340, N 90853, made an emergency wheels-up landing in a barren field about two and one-half miles northeast of the Midland Air Terminal, Midland, Texas. The accident occurred immediately following takeoff. There were no fatalities but serious injuries resulted to two of the eight passengers and minor injuries to several other passengers and the three crew members. The aircraft received major damage.

History of the Flight

Continental Air Lines' Flight 46 of March 16, 1954, was a daily scheduled flight between El Paso, Texas, and Kansas City, Missouri, with intermediate stops, one of which was Midland, Texas. The crew, assigned at El Paso for the entire operation, consisted of Captain Herbert E. Persing, First Officer Robert B. Bauer and Hostess Patricia A. Williams.

The first officer prepared an IFR (Instrument Flight Rules) flight plan according to company regulations although the weather conditions were forecast to be clear over the route at flight altitude.[2] The flight was dispatched by the company and following a walk-around inspection by the crew, the flight departed on schedule at 0610 MST. Over the first segment Trip 46 was uneventful and it arrived at Midland at 0821. This stop was for passenger changes only; therefore, the crew remained on board and the aircraft having apparently operated normally did not receive attention.

At 0833 Trip 46 was cleared to Runway 10 for takeoff. At this time the aircraft carried 585 gallons of fuel and was loaded to a gross takeoff weight of 36,345 pounds which was 10,655 pounds less than the maximum allowable. The load was properly distributed so that the center of gravity of the aircraft was within the approved limits. A pre-takeoff check was conducted adjacent to Runway 10 at which time the propellers, engines and instruments gave normal indications. A part of this check included moving the control column fore and aft and turning the wheel left and right in order to check the control system for freedom of movement and full travel. At 0838 the flight was cleared for takeoff which was made using normal takeoff power. Immediately after becoming airborne the crew noted a slight vibration which was attributed to an unbalanced condition of the spinning main landing gear wheels. Captain Persing applied brakes during the landing gear retraction to eliminate this vibration;

1/ All times herein are Central Standard Time unless otherwise indicated and are based on the 24-hour clock.

2/ Weather was no factor in this accident.

however, it not only continued but rapidly increased in severity. The aircraft reached an altitude of approximately 75 feet, the highest attained, and was near the airport boundary when the vibration stopped with a sudden jolt and the aircraft assumed a nose-down attitude. The first officer immediately sensing the situation joined the captain and both exerted their entire strength applying back pressure to their respective control columns to keep the aircraft from plunging into the ground. The captain quickly reduced power; however, the nose-down pressure could not be completely overcome. The first officer used nose-up trim control in an effort to relieve the nose-down pressure; this action had no appreciable effect and during the last attempt the trim tab control wheel appeared to be stuck. The captain established a shallow left turn with the thought of returning to the airport and continued the turn about 45 degrees from the takeoff heading. As air speed decreased power was momentarily increased whereupon it became evident to the crew that using power sufficient to maintain flight resulted in an insurmountable nose-down pressure. The captain therefore decided to make a wheels-up landing straight ahead. Close to the ground the first officer closed the throttles and the captain pulled the electrical crash bar. Contact with the ground followed with the aircraft in a near-level attitude and at approximately 100 m.p.h. Although the passengers and crew received injuries of varying degrees, they were able to get out of the aircraft unassisted in an orderly manner. The evacuation was mainly through the rear service door (emergency exit) and was accomplished in about 30 seconds. There was no fire.

Investigation

The investigation established that the aircraft first contacted the ground in a nearly straight and level attitude on a magnetic heading of 55 degrees. While sliding 1,200 feet the aircraft turned on its vertical axis and slid sideways before coming to a stop on a magnetic heading of 310 degrees. The left wing was sheared along a line near its fuselage attachments. This wing was located approximately 200 yards beyond the first ground contact point in a severely damaged condition. The left engine was torn from its mount and was found beyond the left wing and behind the main portion of the aircraft. The left horizontal stabilizer was crushed upward as the aircraft passed over the severed wing and remained attached only by the elevator torque tube. The fuselage and right wing were buckled.

Examination of the right horizontal stabilizer and elevator revealed no external damage, however, it was noted the right elevator trim-servo tab was jammed in a 24-degree up or aircraft nose-down position. There were overtravel marks and notching found on the leading edge skin of the tab at its hinge points. The access door on the lower horizontal stabilizer surface was immediately opened to examine the trim tab actuating mechanism. This examination disclosed that the forward push-pull rod, which normally extends from the jack assembly rearward to the elevator hinge-line idler, had failed. The failure occurred adjacent to the rear rod-end fitting. The free stub end attached to the idler was wedged against the bottom edge of the elevator spar cutout hole in such a manner as to hold the trim tab rigidly in a full-up position. The idler showed an interference mark at the base of its fork to which the forward push-pull rod was attached and this mark matched a similar one on the failed push-pull rod. The failure resulted from tension around the sides and bottom of the rod and compression at the top. Matching the fractured ends revealed a set of approximately one-eighth inch due to downward bending

before failure. All other components of the assembly were undamaged.

A comparison of the assembly, as installed, with the appropriate Convair drawing disclosed both the idler and the forward push-pull rod were installed in reverse. Interference between the idler and push-pull rod was caused by the reversed idler.

Company maintenance records showed the right elevator trim tab assembly had been removed, reinstalled and inspected by company maintenance personnel. This work was done during a No. 3 check, 14:40 flight hours prior to the accident, for the purpose of removing excessive play from the assembly. During the reassembly and reinstallation both the Company Convair Maintenance Manual and the Manufacturers Illustrated Parts Catalog were used as references.

Figure 7.4.101 of the Maintenance Manual, entitled "Elevator Tabs Installation," was first referred to during the installation. This figure illustrated the idler as a straight-designed component whereas the actual part is curved, and depicted the forward and rear push-pull rods incorrectly in their inboard and outboard relationship. Instructions 7.4.2 and 7.4.3 of the same publication referred to this figure for removal and installation purposes. From this figure, 7.4.101, correct positioning of the idler could not be determined.

In order to determine which way the curved idler should face in the assembly the maintenance personnel involved used as a reference Figure 2003 of the Manufacturers Illustrated Parts Catalog entitled "Elevator Trim Tab Idler Installation." This figure illustrated an exploded view of the complete left-hand elevator trim tab idler assembly including its left idler. Since the right idler for the right elevator trim tab assembly was of different design than the left, it appeared alone and below the left assembly but on the same plate. It was shown curved which correctly depicted its actual design. Thus, for a right-hand assembly it was necessary to substitute the right idler in place of the left. It was stated by the company that by conventional interpretation of this illustration the left assembly would be correctly installed in the aircraft and the left idler correctly installed in the assembly, however, upon substituting the right idler as required for the right assembly and following the same conventional interpretation of the figure, the result would be, and was, a reversed idler installation (the convex side forward instead of rearward).

Upon completion of the installation the mechanic told the inspector how he had installed the idler. The inspector referred to Figure 7.4.101 of the Maintenance Manual and Figure 2003 of the Parts Catalog, the same references used by the mechanic, and agreed with the mechanic's interpretation of the reference material. He then inspected the work and thought it was satisfactory. The assembly was functionally tested in accordance with prescribed procedures and the results were normal. Subsequent tests revealed that the normal indications would be obtained with the idler in reverse. Had the check procedure required the trim tab be moved through its travel with the elevator full-up, an interference would have been noted.

Figure 8.2.104 of the Maintenance Manual, commonly called the "rigging page," was not consulted during this installation or inspection. It was stated by company personnel that rigging was not involved and the figure did not include adequate installation and removal instructions. The figure however did illustrate correct positioning of the idler.

During the public hearing it was stated by Convair representatives that the Illustrated Parts Catalog should not have been used as a reference during the right elevator trim tab installation. It was stated that this manual was solely published for identification of parts and associated purposes. It was also stated that a question involving installation, as in this case, should have been resolved by consulting the appropriate blueprint.

On the other hand, company witnesses stated that common practice throughout the industry was to use the Manufacturers Illustrated Parts Catalog as a guide during maintenance work and they expected it to correctly illustrate the relative position of parts in an assembly and in an aircraft. Thus, it was believed the Illustrated Parts Catalog was correctly used as an installation reference but because of the incorrect fore and aft depiction of the right idler it was installed in reverse. They further stated that blueprints were used primarily during modification work, were not available at outlying stations where maintenance was performed, were cumbersome, and it was questionable whether or not an average maintenance employee could read a blueprint effectively. For these reasons company officials believed a blueprint was not satisfactory as a routine maintenance or installation reference.

The Board, subsequent to the hearing, conducted a nationwide survey of approximately 70 maintenance bases owned and operated by scheduled and irregular carriers. Results indicated that approximately 65 per cent of the operators did not consider the Manufacturers Parts Catalog as a maintenance reference and confined its use to an identification of parts only. The survey also revealed that aircraft manufacturers with one exception do not intend that their Parts Catalogs be used for any other purpose.

Investigation disclosed the blueprint of the assembly which was available at the time of the subject installation illustrated the right-hand view but was incorrectly labeled a left-hand view. The blueprint was also designated a plan view; however, to be read as such, it was necessary to hold it overhead or interpret it as if it were in such a position.

Immediately after Board investigators learned the cause of the failure in this accident, an accelerated inspection program was conducted on all Convair 340 aircraft. This was done in the interest of safety to insure that no others were in operation with the idler reversed. The manufacturer also took immediate measures to apprise all purchasers of these aircraft of the factual situation as well as corrective action if necessary. As a result of the inspections which followed, reports revealed that four Convair 340 aircraft were in service with reversed idlers. Two of them had no maintenance records relative to the assembly and were alleged to have been unaltered factory installations. One other aircraft was found with a forward push-pull rod bent evidencing a reversed idler installation some time prior to the inspection. The total flying time on these aircraft varied between 1,600 and 3,000 hours.

Company maintenance and inspection records relative to the aircraft and engines disclosed no other discrepancies and appropriate CAA directives had been complied with.

Investigation disclosed that all maintenance, inspection and flight personnel were currently certificated for their respective duties by the Civil Aeronautics Administration.

Analysis

Immediately after the aircraft became airborne the crew noted a vibration which became more severe as air speed increased. It is very probable that this vibration was due to tab flutter which occurred after the push-pull rod failed and the air flow over the horizontal tail surfaces increased to the critical flutter speed for the free tab condition. As air speed built up, the oscillations increased in magnitude until the stub end of the failed rod became wedged, holding the trim tab in a full-up or aircraft nose-down position. The trim tab position and resulting nose-down pressure could not be overcome by the crew and necessitated the wheels-up landing which followed. The failure of the push-pull rod was caused by stresses imposed on it as a result of the reversed idler installation.

As shown under Investigation, the Maintenance Manual was first consulted during the right elevator trim tab installation and Figure 7.2.101 of this manual was considered the appropriate reference. Since the figure did not illustrate correct positioning of the idler, nor were instructions clarifying its installation included, this part of the Maintenance Manual was inadequate. Although rigging was not considered to be involved by the mechanic and inspector, it was closely related to this installation. When the idler installation question was referred to the inspector by the mechanic his experience and responsibility should have prompted him to refer to the "rigging page" (Figure 8.2.104 of the Maintenance Manual) in addition to the references previously mentioned. Had he done so the inspector should have realized that the idler was installed contrary to the rigging diagram, alerting him to the inconsistencies of the references.

The carrier is required by Civil Air Regulations to prepare and maintain a Maintenance Manual and it is responsible to determine that this manual is complete, current and adequate. The Illustrated Parts Catalog is not considered a part of, or supplement to, the Maintenance Manual. The Board therefore is of the opinion that the carrier did not meet its responsibility to determine adequacy of its Maintenance Manual and its policy permitting the use of the Parts Catalog as a maintenance guide was incorrect.

The public hearing revealed that other carriers have used the catalog as a maintenance guide. This practice indicates that in most instances the publication has been reliable for this purpose and leads to the conclusion that due to a mistake of the manufacturer is preparing Figure 2003 of the Parts Catalog, the right idler was shown with its convex side forward, or reversed relative to its correct installation. Although representatives of the manufacturer stated this publication was not intended to be used as a maintenance guide, it is evident the carrier was not aware of the publication's limited purpose.

As shown by the Board's safety survey, approximately one-third of the scheduled and irregular carriers have used Parts Catalogs as maintenance references although manufacturers have not prepared them for this purpose. The Board believes that the publication, unless specified by the manufacturer, should not be used for maintenance purposes and as a result, the Civil Aeronautics Administration has taken measures which will clarify the conflicting opinions relative to the proper use and purpose of the Illustrated Parts Catalog, emphasizing that it is not considered a maintenance guide under Civil

Air Regulations. The Board is of the opinion that this action taken by the Civil Aeronautics Administration is appropriate; however, the misuse of the Parts Catalog should have been noted sooner by the CAA through its assigned agents for more timely action.3/

Findings

On the basis of all available evidence the Board finds that:

1. The carrier, the aircraft and the crew were properly certificated.

2. The aircraft was loaded to a weight less than its maximum allowable for takeoff and its center of gravity was located within the approved limits.

3. The pre-takeoff checks performed at Midland indicated the engines, propellers, instruments and controls functioned normally.

4. Immediately following a normal takeoff the right elevator trim tab push-pull rod failed and the stub end became wedged, holding the trim tab in a full-up or aircraft nose-down position.

5. The trim tab position resulted in the crew being unable to control the aircraft and a wheels-up landing resulted.

6. The push-pull rod failed as a result of excessive stresses caused by interference resulting from a reversed idler installation.

7. The right elevator trim tab assembly was removed, reinstalled, inspected and functionally checked by company maintenance personnel 14:40 flight hours prior to the accident.

8. Correct positioning of the right idler component could not be determined from the Maintenance Manual figure, 7.4.101, which the carrier considered appropriate for the installation.

9. The Manufacturers Illustrated Parts Catalog was used in accordance with company policy as an installation reference to determine the idler positio

10. Under conventional interpretation of the appropriate exploded diagram of the Parts Catalog, the idler was installed in reverse.

11. The Illustrated Parts Catalog was not intended and should not have been used as a maintenance reference.

3/ CAR 18.30 "Standard of performance: general. All maintenance, repairs, and alterations shall be accomplished in accordance with methods, techniques, and practices approved by or acceptable to the Administrator."

Probable Cause

The Board determines that the probable cause of this accident was loss of control due to a failure of the right elevator trim tab push-pull rod caused by a reversed installation of the right elevator trim tab idler as a result of the carrier's reliance on the Manufacturers Illustrated Parts Catalog as a maintenance reference.

By the Civil Aeronautics Board:

/s/ CHAN GURNEY

/s/ OSWALD RYAN

/s/ JOSH LEE

/s/ JOSEPH P. ADAMS

Harmar D. Denny, Vice Chairman, did not participate in the adoption of this report.

SUPPLEMENTAL DATA

Investigation and Hearing

The Civil Aeronautics Board was notified through its Fort Worth office of this accident at 0915, March 16, 1954. An investigation was immediately initiated in accordance with the provisions of Section 702 (a)(2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was ordered by the Board and was held in the Albany Hotel, Denver, Colorado, on April 22 and 23, 1954.

Air Carrier

Continental Air Lines, Inc., a Delaware corporation, maintains its principal offices in Denver, Colorado. The corporation holds a current certificate of public convenience and necessity issued by the Civil Aeronautics Board to provide transportation of persons, property and mail over a number of routes including the route segment between El Paso, Texas, and Kansas City, Missouri, with intermediate stops, which was the route segment over which Flight 46 was operated. Continental Air Lines, Inc., also holds a valid air carrier operating certificate issued by the Civil Aeronautics Administration.

Flight Personnel

Captain Herbert E. Persing, age 40, was employed by Continental Air Lines, Inc., February 25, 1944, as a first officer and was promoted to captain August 20, 1946. He held a currently effective airline transport certificate and an appropriate Convair 340 rating. Captain Persing's aggregate pilot time was 11,038 hours of which 620 hours were in Convair 340's and 503 hours were instrument. His last instrument check was completed November 2, 1953, and his last route check November 22, 1953. Captain Persing had received his last physical examination on March 9, 1954.

First Officer Robert B. Bauer, age 25, was employed by the company June 18, 1951. He had accumulated a total of 2,742 pilot hours of which 659 hours were in Convair 340's and 122 hours were instrument. First Officer Bauer held a valid airman certificate with commercial and instrument ratings. His last instrument check was completed October 10, 1953, and his last route check February 11, 1954. First Officer Bauer had been given his latest required physical examination on June 23, 1953.

Stewardess Patricia A. Williams was employed by Continental Air Lines, Inc., October 8, 1951, and completed the Hostess Trainee course October 22, 1951. Emergency procedures review for the Convair 340 was given Miss Williams on June 29, 1953, and on August 10, 1953.

The Aircraft

N 90853, a Convair 340, bearing manufacturer's serial #44, was manufactured January 15, 1953, and delivered to Continental Air Lines on February 11, 1953. It was equipped with Pratt and Whitney R-2800-CB-16 engines and Hamilton Standard 43E60 propellers. Total flying time on the aircraft was 3,099 hours of which 15 hours had been flown since the last No. 3 maintenance check.