

AIRCRAFT ACCIDENT REPORT

ADOPTED April 20, 1964

RELEASED: April 28, 1964

STANDARD AIRWAYS, INC., LOCKHEED CONSTELLATION, L-1049G
N 189S, MANHATTAN MUNICIPAL AIRPORT
MANHATTAN, KANSAS, MAY 28, 1963

SYNOPSIS

On May 28, 1963, at 1746 c.s.t., a Standard Airways, Inc., Lockheed Constellation L-1049G, N 189S, operating as Civil Air Movement (CAM) Flight 388C, crashed and burned during the final stages of a VFR landing approach to runway 21 at Manhattan Municipal Airport, Manhattan, Kansas.

The aircraft was substantially damaged by impact and was destroyed in the resultant fire. None of the six crew members were injured and only one of the 64 military passengers sustained serious injury.

The Board determines the probable cause of this accident was the inflight reversal of the No. 3 propeller due to a propeller power unit malfunction resulting from improper maintenance practices and inspection procedures.

Investigation

A Standard Airways Lockheed Constellation, L-1049G, N 189S, operating under a military contract as Civil Air Movement (CAM) Flight 388C, crashed and burned during a Visual Flight Rules (VFR) landing approach to Manhattan Municipal Airport, Manhattan, Kansas, on May 28, 1963, at 1746 c.s.t. ^{1/} There were 64 military passengers and a crew of six. There were no fatalities and only one passenger was seriously injured.

Flight 388C was scheduled nonstop from Daggett, California, to Manhattan, Kansas. The crew consisted of Captain David R. Brown, First Officer Joseph A. Merlo, Flight Engineer Peter H. Raymon, Stewardesses Sandra R. Wise, and Ann H. Allen, and Pilot/Observer Penrod Rideout who was assigned to this flight to observe operating procedures preparatory to transitioning to L-1049 type aircraft.

The aircraft was serviced with fuel and oil at the company's maintenance base in Long Beach, California, and departed for Daggett at 1210. The only maintenance required prior to departure was the replacement of the Y-lead, high tension ignition leads, and spark plugs of cylinders Nos. 12 and 13 on the No. 3 engine.

Upon arrival at Daggett at 1245, Federal Aviation Agency (FAA) and Military Air Transport Service (MATS) inspectors conducted a visual ramp inspection of the aircraft and interrogation of the crew. The only discrepancy noted was a small area of corrosion on the underside of the aft fuselage in the vicinity of the lavatory service area.

^{1/} All times herein are central standard based on the 24-hour clock.

Sixty-four U. S. Army personnel boarded at Daggett and were briefed by a stewardess regarding emergency exit locations, emergency equipment and procedure. The aircraft required no servicing or maintenance and there were no carry-over maintenance items reported. Takeoff gross weight was computed to be 116,520 pounds. This weight and the center of gravity (c.g.) were both within prescribed limits.

Flight 388C departed Daggett at 1345 under an Instrument Flight Rules (IFR) flight plan to Manhattan, Kansas, with an estimated time en route of 4 hours and 30 minutes. The flight proceeded without incident and at 1720, in the vicinity of Salina, Kansas, canceled its IFR flight plan with Kansas City Air Route Traffic Control Center. The let-down was made in clear weather and the aircraft entered normal left-hand traffic pattern for a VFR approach to runway 21 at the Manhattan Municipal Airport. This runway is 5,500 feet long, 100 feet wide, and the field elevation is 1,060 feet m s l. The FAA Flight Service Station located on the airport ^{2/} reported the surface wind as west-northwest six knots and the altimeter setting 29.97 inches. The skies were clear and the visibility 15 miles.

According to the captain, who was flying the aircraft from the left pilot seat, the flight entered an extended downwind leg at an altitude of 2,500 feet m s l. The aircraft was turned onto a left base leg for runway 21 at which time the before-landing checklist was completed; landing gear extended, flaps set to 60 percent, 2400 r.p.m. selected for all propellers. A left turn onto the final approach was completed at an altitude of approximately 900 feet above ground level (a.g.l.) at an airspeed of 140 knots. During the final portion of the approach 100 percent flaps were extended, and the airspeed was reduced to 120 knots.

At an altitude estimated to approximately 170 feet a.g.l., the right wing dipped down, the aircraft yawed to the right, and a higher than normal rate of descent was noticed. The captain stated that his first impression was that the aircraft had entered a down draft but would fly out of it momentarily. However, the descent continued and the control forces became greater. Realizing that this was an abnormally high rate of descent he added " . . . considerable . . ." power to all four engines. Immediately following the power application, control forces became stronger as the rate of descent increased alarmingly. Within seconds the aircraft struck the ground.

The flight engineer recalled that after increasing the r.p.m. to 2400 on all four propellers during the approach, the No. 3 propeller surged to about 2475 r.p.m. He thereupon placed the No. 3 propeller control switch in the manual position, decreased r.p.m. to 2400, then repositioned the switch to automatic. The r.p.m. remained nearly steady with only slight fluctuations. His attention was next turned towards other duties in preparation for landing. During this time he felt the aircraft sink, followed by an application of high engine power. He quickly returned his attention to the panel but could only remember seeing the engines manifold pressures at approximately 50 inches hg. prior to ground impact.

The observer/pilot, who was standing between the captain's and first officer's seats, recalled that shortly after entering the final approach he observed the propeller r.p.m. increase approximately 100 r.p.m. and then return to the original setting of 2400 r.p.m. This fluctuation occurred three times. Then, following extension of full flaps, he observed the captain reduce power to approximately

^{2/} There is no airport traffic control tower at Manhattan Municipal Airport.

inches hg and almost immediately the rate of descent increased and the aircraft yawed to the right. The aircraft was at an altitude of approximately 75 feet a.g l. when he observed the No 3 propeller reverse indicating the light 3/ come on and shouted, "No. 3 is in reverse " This shouted warning was concurrent with the application of engine power and was not heard by the captain. None of the other flight crew members saw the reverse light illuminate.

Persons on the ground who witnessed the accident generally agreed that the approach appeared normal until the aircraft reached a point approximately 1/3 of a mile from the airport. It was then observed to settle abruptly and contact the ground several hundred feet short of the runway

Initial impact occurred in a wheat field, 546 feet from the approach end of runway 21. At this point the aircraft was in a right bank of approximately 15 degrees and aligned slightly to the right of the runway centerline. The aircraft bounced once, then continued through the wheat field on all three landing gears until it struck an earth embankment, 3-1/2 feet high, located 176 feet from the end of the runway. This impact sheared the right main landing gear and the nose gear from the aircraft. The right wing separated from the fuselage when the aircraft contacted the end of the runway. The aircraft slid a distance of 774 feet down the runway, during which time the left main landing gear failed followed by separation of the left wing. The fuselage came to rest on a heading of approximately 270 degrees, 72 feet from the right side of the runway

A rapid and orderly emergency evacuation was carried out by all passengers and flight crew members through emergency exits and the rear passenger door. Small fires were ignited in the wing and fuselage fuel tanks during the impact sequence but did not reach major proportions until after the aircraft was completely vacated. The fire increased in magnitude and destroyed the fuselage and both wings.

The entire flight control system and all associated hydraulic booster control units were examined; all were capable of normal operation prior to impact. All three landing gears were in the down and locked position; and the wing flaps were symmetrically extended to the full down position at impact. There was no evidence of any aircraft structural or system failure prior to impact.

Examination of the engines revealed no evidence of any operating distress prior to impact; however, a number of discrepancies affecting the airworthiness of the engines are disclosed and are listed as follows:

1. The fire extinguisher manifold to the No. 2 PRT on the No. 1 engine had a wear hole five inches from its outlet.
2. The magneto lead connector plug on the No. 2 engine was not safetied.
3. Connector plugs for the left and right cowl flap actuators on the No. 2 engine were safetied backwards.

3/ The L-1049 propeller system contains individual early warning reverse lights which illuminate when the appropriate propeller blade angle is 6 to 8 degrees below the low pitch setting. The reverse lights on N 189S were located in the lower left-hand corner of the center instrument panel.

4. The spark plugs in engines Nos. 3 and 4 were of a type not approved for use in the TC18DA series engines.
5. The timing ring lock nut of the left distributor of the No. 4 engine was not safetied.
6. The retaining nut of the No. 2 PRT on the No. 4 engine was not safetied.

Examination of the Curtiss Electric Propeller assemblies revealed extensive impact damage generally concentrated on the blades and slip ring assemblies. Other than the No. 3 propeller assembly, the remaining propellers showed no evidence of operating failure prior to impact. Propeller power unit settings indicated blade angles at impact at 27 degrees for propellers Nos. 1, 2, and 4. The No. 3 propeller was at a blade angle of plus one-degree; in the reverse pitch range. The specified low blade angle setting is 23.7 degrees.

Detailed examination of the No. 3 propeller power unit 4/ (S/N 165047, S/N 11819, S/N A-119) revealed the threaded brake cage 5/ of the pitch change motor was unscrewed three threads and that the two cage lock safety bolts were missing. The armature of the pitch change motor was free to rotate. A brake clearance measurement indicated the brake clearance to be .052 inches. 6/ Normal specified clearances; inspect .008 to .018, reset .008 to .012. Two of the brake cage locking bolt slots were worn excessively, with the wear pattern extending into the cage retaining threads. These worn areas were 5/16 and 21/64 of an inch in length and were diametrically opposed. The lower cage shoulder showed indication of wear by the locking bolts over a surface dimension of 13/32 and 17/32 of an inch. The outer diameter of the splined disc duplex brake plate assembly contained two areas of heavy battering. Two of the brake cage window struts showed indication of heavy battering in the unscrewed direction in the area above the normal position for the brake cage wrench. The brake facing was in place and its measured thickness was .214 to .216; (specified thickness .169 to .259). The power unit motor was energized and speed reducer operation was obtained. The limit switches functioned normally.

Inspection of the Nos. 1, 2, and 4 propeller power units revealed no evidence of operating distress prior to impact.

The last overhaul, subsequent inspection, and maintenance records pertaining to propeller power unit S/N 165047 were examined. It was determined that the last overhaul of this unit was accomplished on July 6, 1962, at which time a zero time since

4/ The propeller power unit consists of three components; pitch change motor, speed reducer, and brake assembly. These units function electrically and mechanically to change and maintain selected blade angles.

5/ The propeller brake assembly is the component of the power unit which prevents the propeller blade angle from moving beyond the selected value called for by the synchronizer. Specified clearances must be maintained in the brake assembly in order to perform this function. The brake cage is a part of the brake assembly which assists in maintaining the specified brake clearances.

6/ All decimal measurements are denoted in inches.

Overhaul (TSO) was established. Cardex records 7/ for this unit indicate that following overhaul it was first installed in the No. 3 position on N 9742Z on January 14, 1963, with a TSO of 00 hours. The Cardex records further established that the unit was removed from N 9742Z on February 4, 1963, and was installed in the No. 3 position of N 189S with a TSO of 4.7 hours. There were no Cardex records entries for the unit from July 6, 1962 - January 14, 1963. However, an entry in the propeller logbook of aircraft N 9742Z indicates that the unit was installed in the No. 3 position of that aircraft on July 10, 1962. The records indicate that the TSO of this power unit from the date of installation on July 10, 1962, until its removal from N 9742Z on February 4, 1963, was 194.8 hours.

Additionally, the component overhaul time sheets in Standard's maintenance manual for N 9742Z, approved by the FAA on October 29, 1962, lists a power unit S/N 801 in the No. 3 position. TSO was shown as 411 hours, and approved overhaul time 2,500 hours.

Aircraft flight log entries relating to power unit S/N 165047 were examined and the following significant discrepancy write-ups on the unit were revealed:

January 6, 1963 - N 9742Z

discrepancy: "Props hunt in both auto and manual"

corrective action: Adjusted brakes on all propeller power units installed on the aircraft.

(Note: It was stated by the mechanics who adjusted the brake clearances that a strap wrench was used to install 8/ the brake cages on the power units).

February 16, 1963 - N 189S

discrepancy: "No auto operation for No. 3 propeller."

corrective action: Replaced No. 3 propeller alternator.

discrepancy: "On taxi or runup, no manual, no feather, no unreverse, no auto of No. 3 prop. stuck in reverse pitch."

corrective action: "Ran circuit check, found open in power unit blade switch, feather manually feathered propeller, replaced power unit (still in reverse pitch). Roped No. 4 cylinder. OK for ferry."

7/ The Cardex System was used as part of the Standard Airways Maintenance Records to control the operation and replacement of time controlled aircraft components and parts. Specifically, a card was kept for each component to show, identification, replacement time, time on, time off, and time since new or overhaul.

8/ The recommended procedure for installing the cage is detailed in the manufacturer's Maintenance Manual. It calls for tightening the brake cage by using a cage wrench (ST-1299) and a two-pound hammer until a specified clearance of .001 is obtained between the five segment shoulders and the outer brake cowl housing. The cage is then further tightened 1/2 inch plus whatever distance is necessary to align the safety lock bolt holes.

The aircraft was then ferried on three engines to Miami, Florida, where the following additional work was performed on the power unit

February 16, 1963 - N 189S

"Removed power unit, installed two new limit switches, five new commutators, ground run-up OK."

February 26, 1963 - N 189S

discrepancy "Suggest check on #3 prop FEA limit. Rotates backward when feathered."

corrective action: Reset by overhaul shop. Propeller blade feather angle lowered 1.5 degrees.

The mechanic who reinstalled the power unit in the No. 3 position following the resetting of the propeller blade feather angle stated that both the external safeties and the brake cage locking bolts were checked, and were in place. According to the records this was the last time work was accomplished on this unit prior to the accident.

May 27, 1963 - N 189S

discrepancy: "No. 3 propeller surges in auto. (OK manually) 100 RPM up or down."

corrective action. Replaced contactor.

Civil Air Regulations 9/ (CAR's) require the carrier to prepare and maintain a maintenance manual which contains full information pertaining to the maintenance, repair, and inspection of aircraft and equipment, and that the content of this manual be acceptable to the Administrator of the FAA. Provisions within the regulation specify that the manual must contain a schedule of the aircraft's component parts which are subjected to maintenance functions along with the approved time limits at which such functions are to be conducted. All repairs, alterations, and maintenance are to be performed in accordance with procedures set forth in the manual.

The procedures used by Standard Airways for component identification and time control were implemented through the use of the Cardex system in conjunction with the manual and aircraft flight log.

A review of these records revealed numerous instances of erroneous identification and inaccurate accounting of the time controlled components installed on aircraft N 189S. Principal examples of these discrepancies are listed below:

1. The No. 3 engine on aircraft N 189S was identified in the records as S/N 547255 rather than S/N 547253.
2. Engine component records did not agree entirely with respect to serial numbers, date of installation, replacement times, and adjusted TSO's.

3. Serial numbers listed in the records for propellers Nos. 2, 3, and 4, did not coincide with the serial numbers on the propellers actually installed on N 189S.
4. Propeller component records indicated different serial numbers for the same installation date, absence of serial numbers, the same unit installed on two different dates, differences in adjusted TSO's for the same dates, and some units not listed at all.
5. Records indicated the following components were overdue for replacement.
 - Power recovery turbine for the No 2 engine.
 - Fuel pump injector L/H - No 2 engine
 - Ignition distributor L/H - No. 4 engine

The aforementioned discrepancies were documented in various factual reports. At the public hearing, Standard Airways volunteered an admission that the factual reports accurately portrayed the discrepancies.

Civil Air Regulations also require that the maintenance manual clearly outline duties and responsibilities of maintenance personnel and that they be acceptable to the Administrator. Standard's Maintenance Organization as set forth in the maintenance manual, was comprised of a Maintenance Coordinator, Maintenance Representative, and a Chief Inspector.

The duties of the Chief Inspector as specified in the manual were that, "The Chief Inspector shall be responsible for all company aircraft and engine records, for compliance with All Civil Air Regulations as regards maintenance, AD notes, other regulations . . . he shall be responsible for the acceptance or rejection of all work done on company equipment by maintenance contractors, and shall have authority to accept or reject such work "

In a letter dated March 27, 1963, the designated Chief Inspector, informed the Administrator by letter that as of March 3, 1963, he had been relieved of these duties. From that date until the time of the accident the records do not indicate that a replacement was appointed.

According to the maintenance records the aircraft was certificated by the FAA on August 3, 1962, and the portion of the manual concerning the maintenance organization was approved on December 14, 1962.

On February 18-19, 1963, a MATS inspection team conducted an inspection of Standard's Maintenance Facility at Long Beach, California. FAA inspectors were present during this inspection and the FAA report states in part. ". . . Briefly, results of the inspection were satisfactory. Standard's rapid expansion was noted, as was the carrier's expected acquisition of Las Vegas Hacienda, Inc., and Air Station Facilities. The problem of monitoring maintenance when the aircraft are physically located throughout the United States was also discussed. However, all these were mentioned in the light of what might result if close monitoring of aircraft operation were not maintained, and changes in their maintenance adopted when it became apparent that these changes were needed The only discrepancy that was noted was that the component time control cards were not being kept up to date

On April 9, 1963, the FAA held a meeting with Standard in order to rectify deficiencies in the company's maintenance program. Items for discussion in the category of maintenance records included component serial numbers, TSO times, and missing cards for aircraft components. It was agreed at this meeting that a closer monitoring of logbooks and maintenance records was needed. It was also agreed that the FAA would continue with the inspection of Standard's records and maintenance manuals and that the company would make the necessary revisions and corrections as soon as possible. The completion date of this project was not to exceed May 27, 1963; however, as of the date of the accident it had not been completed. It may be well to note that following the accident and during the period the accident investigation was in process, six additional aircraft were certificated by the FAA and were incorporated into Standard's aircraft fleet.

On June 3, 1963, six days after the Manhattan, Kansas, accident, another Standard Airways, L-1049G, N 9742Z, experienced a propeller malfunction in flight. The captain of the flight stated that while cruising at 9,000 feet in the vicinity of Elkins, West Virginia, the No. 2 propeller surged twice from 2300 to 2800 r.p.m. Attempts to control the propeller through the use of the manual propeller control switch were unsuccessful. The propeller was then feathered and the flight continued to Philadelphia and landed without further difficulty. After landing, the No. 2 propeller was unfeathered and during ground run-up the propeller inadvertently went into reverse pitch.

On examination of the No. 2 propeller assembly the spinner was removed and the power unit (S/N 168011) brake cage was found completely unscrewed lying loose inside. The two cage lock safety bolts were missing from the unit and two of the brake cage locking bolt slots were worn excessively. The outer periphery of the splined disc duplex brake plate assembly was peened for approximately 180 degrees. The brake lining was well within limits. A part of a bolt, similar in appearance to the specified brake cage locking bolt (P/N 106024), was found on the ground under the engine. This portion of the bolt was examined and found to be within the manufacturer's metallurgical design specification tolerances. The threaded brake cage was reinstalled to the locked position and the brake clearance was found to be .011 inches. The power unit was energized and normal propeller operation was obtained.

It is to be noted that on May 29, 1963, both the CAB and the FAA contacted Standard Airways, and requested that the propeller power units on N 9742Z be inspected "as soon as possible" regarding the possibilities of a similar propeller malfunction. The crew of N 9742Z stated they had been advised by the company of the accident at Manhattan but did not receive specific information as to the nature of the propeller malfunction. Moreover, it was stated that no instructions were received from the company to inspect the propellers or power units on N 9742Z prior to the incident on June 3, 1963.

Analysis

Examination of the No 3 propeller assembly revealed an impact blade angle of plus one-degree, this is 22 7 degrees below the specified low blade angle setting and in the reverse pitch range. The threaded brake cage locking bolts were missing and the cage had unscrewed three threads. This resulted in an

excessive brake clearance of 052^{10/} which rendered the brake incapable of propeller control

It was evident from examination of the brake cage that it had not been tightened properly at the time it was last installed and had been subjected to repeated cycles of loosening and tightening over a prolonged period of time. If the cage is not properly tightened during installation it will tend to work loose even with the safety bolts in place due to the high torque of the pitch change motor and the drag by the brake. As the pitch change motor calls for a lower blade angle the cage will tend to unscrew and, conversely, a higher blade angle selection will produce a tightening effect.

The wear patterns on the cage safety bolt slots were indicative of repeated cycling predominantly in the loosening direction. These repeated cycles of loosening and tightening eventually caused failure of the safety lock bolts.^{11/} This was evidenced by the battered condition of the splined disc duplex brake as well as the wear patterns on the top and lower surfaces of the inboard brake cage ring. After the failure of the safety lock bolts, the cage would tend to unscrew to whatever extent would be provided by the cycling action of the pitch change motor in addition to normal vibration effect.

It was learned from the crew of N 189S that the No. 3 propeller r.p.m. surged when approach power was being established for the landing at Manhattan. This surging was due to the lack of adequate propeller brake action. As the airspeed and power were reduced for landing the synchronizer continued to maintain the selected 2400 r.p.m. However, with the brake inoperative on the No. 3 power unit, the blades of that propeller continued to move to a lower blade angle in order to maintain the selected r.p.m. as the airspeed was reduced. Eventually, the blades went beyond the low limit switch and into the reverse pitch range. The fact that this propeller had moved into the reverse range was confirmed by the observer/pilot who saw the No. 3 reverse light come on when the aircraft was approximately 75 feet above the ground.

With the No. 3 propeller in the reverse pitch range, the increased drag would tend to yaw the aircraft to the right, the right wing would drop due to loss of lift behind the propeller disc, and an increased rate of descent would result. Addition of engine power at the airspeed involved (115 knots or less) resulted in forward thrust from engines Nos. 1, 2, and 4, and negative thrust with high drag forces from engine No. 3. The combination of these forces at the airspeed and altitude at which N 189S was operating, resulted in an accelerated descent that could not be overcome prior to contact with the ground.

Descent rate calculations using known factors of weight, airspeed, engine power, and aircraft configuration were made by the Lockheed Aircraft Corporation. A descent rate of approximately 730 feet per minute prior to the propeller malfunction was calculated using the above factors. Since absolute values for loss of wing lift and drag, due to reversal of the No. 3 propeller, were not available, assumed values of 15 percent loss of lift over the right wing and 6,000 pounds

^{10/} The specified brake clearances range from .008 to .018. When these clearances are exceeded propeller surging can occur and a critical loss of propeller control can be encountered.

^{11/} This same type of failure was evidenced on the No. 2 power unit brake assembly of aircraft N 9742Z at Philadelphia June 3, 1963.

increase drag were used. It was found that with all engines developing approach power, the No. 3 propeller in reverse thrust, and the Nos. 1, 2, and 4 propellers in forward thrust, the descent rate would increase to about 1,845 feet per minute. Then, with approximately 50 inches of engine power applied to this combination it was indicated that the descent rate would eventually decrease to about 535 feet per minute.

Since it is difficult to predict or determine the exact blade angles and engine power that may have existed during each of these flight regimes, the calculations are intended only as a rough approximation of the relative magnitudes of the sudden increase in descent rate with which the pilot was suddenly confronted. Moreover, the value for drag used in the calculations is considered conservative in that no attempt was made to account for the increase in drag due to presumed large control surface deflections during the maneuver.

In addition, a series of L-1049G flight simulator runs were conducted in order to obtain more refined information concerning aircraft controllability under essentially the same conditions as used in the calculations. Data supplied to the simulator produced a 15 percent lift loss over the right wing due to propeller reversal and a less conservative drag value of approximately 9,000 pounds. The result of these tests, although qualitative, produced an initial descent rate of approximately 1,800 feet per minute and indicated that under these prescribed conditions of flight, successful recovery could not be effected.

Examination of the four engines revealed no evidence of operating distress prior to impact; however, all of the engines did exhibit discrepancies^{12/} the nature of which did adversely affect the airworthiness qualification of the aircraft. Although these discrepancies did not in themselves directly relate to the cause of the accident, they are indicative of inadequate maintenance practices and inspection procedures on the part of the carrier.

Moreover, a comprehensive review of all maintenance records pertaining to aircraft N 189S revealed that these records both in terms of quantity and quality were not sufficient to present an accurate history of the aircraft and engine components. Many instances of inaccurate, erroneous, and incomplete data were found including evidence of time controlled components remaining on the aircraft beyond replacement times.

Similarly, maintenance records for the failed propeller power unit (S/N 165C47), were conflicting, incomplete, and from them, accurate component time control information could not be obtained. However, on the basis of all investigative data, it can logically be concluded that the unit was installed in the No. 3 position of aircraft N 9742Z on July 10, 1962, following the overhaul on July 6, 1962. It remained in this position until February 4, 1963, at which time it was removed from N 9742Z and installed in the No. 3 position of aircraft N 189S. It remained in this position until the time of the accident. Consequently, the unit was in the No. 3 position of N 9742Z on January 6, 1963, when, according to the aircraft flight logs all propeller power units were adjusted.^{13/} This is the last record of any adjustment to this unit which would have involved removal and reinstallation of the brake cage.

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^{13/} All four propeller power units including (S/N 168011), the failed unit on N 9742Z, were adjusted at this time.

As previously stated, the failure of the safety lock bolts and the unscrewing of the brake cage resulted from improper tightening of the cage during installation. The recommended procedures for installing the cage specify that a cage wrench be utilized for this function. However, testimony of maintenance personnel indicates Standard Airways' Maintenance Base did not possess a cage wrench, but used a strap wrench for this purpose. Because of the tapered surface of the cage, it is considered highly unlikely that proper tightening of the cage would be obtained through the use of a strap wrench. This may well account for two different cage assemblies wearing through the safety bolts and becoming unscrewed at nearly the same time. These were the No. 3 cage (Power Unit 165047) on N 189S which failed on May 28, 1963, and the No. 2 cage (Power Unit 168011) on N 9742Z which failed on June 3, 1963.

The carrier's maintenance manual states that the Chief Inspector is responsible for compliance with all CAR's as regards maintenance, and that he shall be responsible for the acceptance or rejection of all work performed on company equipment by maintenance contractors. Additionally, the last designated Chief Inspector prior to the accident testified that it was his responsibility to, ". . . observe techniques, proper tools, proper equipment, proper parts," and when the job was completed to, ". . . go out and go over the job and see that it was properly done." Yet, the records indicate that the position of Chief Inspector was unoccupied from March 3, 1963, until after the accident occurred. Testimony by officials of the carrier was to the effect that acquisition of the Long Beach Maintenance Facility resulted in unnecessary duplications in the maintenance organization and that verbal instructions had been given as to who was the Chief Inspector during this period. This is pointed out only to illustrate that: Improper tools and procedures and inadequate inspection procedures were employed in the maintenance of two propeller power units that failed in flight, and that; within the framework of the carrier's maintenance system it is the Chief Inspector who is responsible for the detection of improper equipment and procedures, and that; although there was a designated Chief Inspector at the time the involved power unit brakes were adjusted, the records indicate this position was not filled for a period of time in which aircraft maintenance was continually performed. Although it may or may not have been understood by maintenance personnel who the Chief Inspector was during this period, the lack of a well organized maintenance structure is apparent.

It is evident that as early as February 18, 1963, both Standard and the FAA were aware of discrepancies in Standard's maintenance organization and in the maintenance records of Standard's L-1049 aircraft. In this regard a meeting was held on April 19, 1963, by FAA with company maintenance representatives in which the record status and maintenance organization were discussed in detail. In fact, a project completion date of May 27, 1963, was fixed wherein these discrepancies were to be corrected.

In summation, a review of all evidence indicates that the carrier's maintenance organization did not provide adequate maintenance records for N 189S, nor did it insure the performance of proper maintenance practices or inspection procedures necessary for adequate standards of airworthiness. These practices resulted in the failure of a propeller power unit directly linked to the cause of this accident.

Probable Cause

The Board determines the probable cause of this accident was the inflight reversal of the No. 3 propeller due to a propeller power unit malfunction resulting from improper maintenance practices and inspection procedures.

Recommendation

The Board submitted recommendations to the Administrator during the investigation of this accident. These recommendations directly related to the cause of this accident are set out in attachments A and B.

BY THE CIVIL AERONAUTICS BOARD:

/s/ ALAN S. BOYD
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ CHAN GURNEY
Member

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

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

Investigation

The Civil Aeronautics Board was notified of this accident at approximately 1800 c.s.t., May 28, 1963. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958, as amended. A public hearing was ordered by the Board and held at the Hollywood-Roosevelt Hotel, Hollywood, California, July 30 - August 2, 1963.

Air Carrier

Standard Airways, Inc, is a supplemental air carrier incorporated in the state of Maryland with its principal business office at Burbank, California. It is operated in accordance with FAA air carrier operating certificate No. WE-119, 1/ and an interim certificate for Supplemental Air Service issued by the Civil Aeronautics Board on October 5, 1962. 2/ This certificate authorized the company to transport passengers and cargo, according to specified provisions, for charter service, individual service, and service for the military establishment. The subject flight was conducted under a provision which authorized the carrier to engage in interstate, overseas, and foreign air transportation, pursuant to contracts with the Department of Defense.

The Aircraft

The aircraft was a Lockheed Constellation L-1049G, S/N 4541, manufactured on March 17, 1954, and purchased by Trans Canada Air Lines as CF-TGB. It was purchased by the California Airmotive Corporation on March 24, 1962, with a total time of 19,008 hours and relicensed under U. S. registry to N 9739Z. Ownership was transferred to Standard Airways on July 30, 1962, and the aircraft relicensed to N 189S. At the time of the accident the aircraft had a total time of 19,803.9 hours and a time since overhaul of 795.9 hours. The aircraft was equipped with four Wright cyclone engines model 972TC18DA1, and four Curtiss electric propellers, hub design C634S-C504. Summarized engine and propeller data follow:

<u>Engine Position</u>	<u>S/N</u>	<u>TSO</u>	<u>TT</u>
No. 1	547275	795.9	12991.5
No. 2	700576	987.1	8719.9
No. 3	547253	923.1	14048.8
No. 4	547356	1017.8	12349.3

1/ In accordance with the authority contained in Title VI, Section 609 of the Federal Aviation Act of 1958, as amended, the FAA suspended air carrier operating certificate WE-119 on an emergency basis indefinitely, effective midnight, January 31, 1964. The suspension was based on the inability of the carrier to meet requirements of Section 401 of the Federal Aviation Act of 1958 regarding the financial condition of the carrier to conduct supplemental air transportation.

2/ The Civil Aeronautics Board ordered a 30-day suspension of the interim operating certificate held by Standard Airways, Inc., effective February 12, 1964. (Order No. E-20468)

<u>Propeller Position</u>	<u>Hub S/N</u>	<u>TSO</u>	<u>TT</u>
No 1	173882	1907.3	Unknown
No 2	171896	1579.5	17940.9
No. 3	175713	1445.9	7649.5
No. 4	172191	2251.8	15802 9

Flight Personnel

Captain David R. Brown, age 44, was employed by Standard Airways, Inc., on March 28, 1961. He holds valid airline transport pilot certificate No. 390404 with ratings for Lockheed Constellation DC-3/4, DC-6/7, and C-46 type aircraft. Captain Brown has a total of approximately 16,200.00 flying hours of which 3,287 hours are in the Lockheed Constellation and 357 hours in the model 1049G aircraft. He satisfactorily completed a company proficiency check on March 9, 1963, and an FAA en route inspection on August 12, 1962. He held an FAA first-class medical certificate with no limitations, dated January 21, 1963.

First Officer Joseph A. Merlo, age 39, was employed by Standard Airways, Inc., on December 31, 1962. He holds valid FAA commercial pilot certificate No. 141077 with multiengine land and instrument ratings. First Officer Merlo has a total of approximately 9,000 flying hours of which 2,500 hours are in L-1049G/H type aircraft. He satisfactorily completed his last FAA flight proficiency check on December 31, 1962. He held an FAA first-class medical certificate dated October 12, 1962 with the following limitation, The holder shall possess correcting glasses for near vision while exercising the privileges of his airman's certificate.

Flight Engineer Peter H. Raymen, age 39, was employed by Standard Airways, Inc. on November 1, 1962. He holds valid FAA flight engineer certificate No. 1360213 and has approximately 4,395 flight engineer hours of which 1,150 hours are in L-1049G/H and 749 type aircraft. He satisfactorily completed an equipment and proficiency check on November 3, 1962, and an FAA en route check on November 3, 1962. Flight Engineer Raymen held an FAA second-class medical certificate with no limitations, dated September 25, 1962.

Stewardess Sandra R. Wise, age 25, was employed by Standard Airways Inc., October 31, 1962. Her last proficiency stewardess line check was passed on November 16, 1962, and she completed the emergency evacuation training in Constellation aircraft on December 12, 1962.

Stewardess Ann H. Allen, age 28, was employed by Standard Airways, Inc., May 24, 1963. She completed the emergency evacuation training in Constellation type aircraft on May 28, 1963. Her initial stewardess proficiency line check was to be accomplished on the subject flight.

C O P Y

CIVIL AERONAUTICS BOARD
WASHINGTON, D C

June 14, 1963

Honorable N E Halaby
Administrator
Federal Aviation Agency
Washington 25, D C

Dear Mr Halaby

After investigating the accident involving Seaboard and Western Airlines L-1049D, N6503C, at Idlewild Airport on November 10, 1958, the Board recommended requirement of a mechanical low pitch stop in the Curtiss electric propeller to prevent any inadvertent reversal. Enclosed is a copy of the pertinent letter to the Director of Flight Operations and Airworthiness, dated December 19, 1958. At this time Curtiss-Wright had available a power unit assembly which provided this safety device. Subsequent correspondence from the Bureau of Flight Standards, dated February 20, 1959, indicated that an appropriate proposed airworthiness directive, which pertained to a mechanical low pitch stop, would be submitted to the industry for coordination. This action did not result in an official requirement of this feature.

On May 28, 1963, Standard Airways L-1049G, N1898, crashed during approach at Manhattan, Kansas. Investigation of the aircraft indicated that the No 3 Curtiss electric propeller was inadvertently in the reverse range at one degree blade setting, the low pitch setting is 23.8 degrees. Ground inspection of the power unit revealed that the brake cage was not locked to the brake solenoid and had backed off several revolutions. Since this propeller installation did not incorporate a mechanical low pitch stop, the brake was ineffective in fixing the blades at low pitch and preventing blade angles in the reverse range. Although the aircraft burned after crashing, fortunately no fatalities were incurred by the 65 passengers; however, the potential catastrophe is readily apparent.

Several days later on June 3, 1963, Standard Airways L-1049G, N9742Z, feathered the No 2 propeller after severe surging during cruise over Elkins, West Virginia. After safely landing at Philadelphia, subsequent ground operation of the No 2 powerplant revealed that the propeller would go into the reverse range without throttle selection. Examination of the propeller power unit disclosed that the brake cage

Attachment A
(page 1 of 6)

Honorable N E Halaby (2)

had completely backed off the brake solenoid, rendering the brake ineffective. This Curtiss electric propeller installation also did not feature a mechanical low pitch stop

Both of these propeller malfunctions involved the brake assembly with the threaded type cage, in which the brake cage is screwed to the brake solenoid. The safety margin of the locking device in this design has proven inadequate in both of these malfunctions. Since this threaded type brake assembly has displayed susceptibility to either improper assembly or maintenance malpractice which might result in a serious accident, the Board recommends that all threaded type brake assemblies be removed from service and replaced by the later bolted design.

Both of these propeller malfunctions have also demonstrated the basic need for a mechanical device to prevent inadvertent operation of the propeller in the reverse range. Accordingly the Board resubmits the recommendation that a mechanical low pitch stop assembly be incorporated in Curtiss electric propellers as expeditiously as possible.

Various particulars of this matter have been discussed with Mr. John Morris of your FS-140 section, Mr. D. Ballard of Air Carrier Office, Kansas City, and Mr. Henry Weiss of Engineering and Manufacturing Branch, New York.

Sincerely yours,

/s/ Alan S. Boyd

Chairman

Attachment A
(page 2 of 6)

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FEDERAL AVIATION AGENCY
WASHINGTON 25, D.C.

July 8, 1963

Dear Mr. Chairman:

This is to acknowledge your letter of June 14, 1963, reference B-1-96, concerning the removal from service of all threaded type brake assemblies and the incorporation of a mechanical low-pitch stop in Curtiss electric propellers.

This matter has been referred to our Flight Standards Service for attention. We will advise you of our final determination in this matter.

Sincerely yours,

/s/ N E. Halaby

N. E. HALABY
Administrator

Honorable Alan S. Boyd
Chairman
Civil Aeronautics Board
Washington 25, D. C.

Attachment A
(Page 3 of 6)

July 30, 1963

Dear Mr. Chairman:

This supplements our July 8, 1963, acknowledgment of your letter dated June 14, 1963, reference B-1-96, concerning brake failures of Curtiss propellers on Lockheed 1049G aircraft

Based on the recommendations made by the Civil Aeronautics Board and our investigation of the recent accident at Manhattan, Kansas, on May 28, 1963, and incident at Elkins, West Virginia, on June 3, 1963, involving Standard Airways Lockheed 1049G aircraft, made in conjunction with CAB and Curtiss investigators, we have instituted the following corrective measures:

1. Aircraft Maintenance Bulletin FS P 8340 1 CH 38 dated July 9, 1963, was issued on July 24, 1963, to advise our air carrier inspectors that, if the older threaded type brake cage units are not properly tightened and locked, the cage unit can back off, rendering the brake and low pitch stop ineffective. A copy of the bulletin is enclosed.
2. An airworthiness directive is being prepared which will require replacement of older threaded brake cage units with newer bolted configurations.

Regarding the November 10, 1958, Seaboard and Western accident at New York International Airport, the CAB Aircraft Accident Report, File No. 1-0116, adopted March 22, 1960, indicated the probable cause was an unwanted propeller reversal and a contributing factor was the inadequate overhaul procedure employed by the propeller manufacturer. The CAB analysis noted that the wear of the rotor spline and mating speed reducer sleeve was of sufficient magnitude to cause complete disengagement between the power unit motor assembly and the speed reducer, thus preventing electrical control of the propeller. The analysis also stated these conditions would permit the centrifugal forces on the blades to move them to the flat pitch position and beyond. Action by this Agency resulted in issuance of Airworthiness Directives 58-25-2 and 59-7-1 requiring inspection of the old motor and speed-reducer spline couplings and AD 59-18-3 which required installation of modified oilbath-lubricated spline couplings. Mechanical low pitch stops were not required on the basis of satisfactory service experience of other Curtiss propeller models equipped with the modified spline couplings. This decision has been amply supported by service

experience over the last four years, during which no spline coupling failures or malfunctions were reported. There, also, have been no reported failures or malfunctions of the bolted brake cage units for more than ten years. The above maintenance bulletin and installation of new bolted brake cage units should prevent repetition of brake failures as experienced by Standard Airways.

With respect to your recommendation that installation of mechanical low pitch stops be made mandatory, we do not believe there is sufficient justification to require them in view of the corrective action already taken as a result of the Seaboard and Western accident and the corrective action being applied as a result of the Standard Airways accident. Apart from the fact that there is reason to believe the brake failures on the Standard Airways aircraft were due to insufficient tightening of the brake cages to the brake housings, it is noted that the service record on Curtiss propellers has been highly satisfactory over a great number of years and no serious control difficulties have been reported other than the Seaboard and Western and Standard Airways cases. Since the causes of these malfunctions have now been corrected and in view of the fact that the propeller incorporates an electrical low pitch stop actuated by blade angle to prevent unwanted travel below the stop, there is no evidence to support a mandatory requirement to back up the electrical low pitch stop with a mechanical low pitch stop, which, while contributing little to safety, would impose a considerable financial penalty on the affected operators.

We believe that closer surveillance of the threaded type brake cage units and replacement of the threaded units with bolted configurations will preclude the possibility of further Curtiss propeller brake failures.

Sincerely yours,

/s/ Harold W. Grant

HAROLD W. GRANT
Acting Administrator

Honorable Alan S. Boyd
Chairman
Civil Aeronautics Board
Washington 25, D. C.

Enclosure

Attachment A
(Page 5 of 6)

COPY

FEDERAL AVIATION AGENCY
Washington, 25, D.C. 20553

JAN 13 1964

In Reply
Refer to: FS-100

Mr. Leon H Tanguay
Director, Bureau of Safety
Civil Aeronautics Board
Washington, D. C. 20428

Dear Mr. Tanguay:

This supplements our July 30, 1963, reply to Mr. Boyd's letter dated June 14, 1963, reference B-1-96, concerning brake failures of Curtiss propellers on Lockheed 1049G aircraft.

This is to advise that on November 25, 1963, Airworthiness Directive No. 63-24-1 was issued requiring replacement of brake cages within 100 hours' time in service after the effective date of the airworthiness directive. A copy of FAA Airworthiness Directive Issue No. 63-24 is enclosed for your information. Mr. Frank Taylor of your Engineering Division was notified by telephone of this airworthiness directive immediately following its issuance.

As indicated in our July 30, 1963, letter, we believe that closer surveillance of the threaded type brake cage units and replacement of the threaded units with bolted configurations will preclude the possibility of further Curtiss propeller brake failures.

Sincerely yours,

/s/ C Schuck

George S. Moore
Director
Flight Standards Service

Enclosure

Attachment A
(Page 6 of 6)

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CIVIL AERONAUTICS BOARD
WASHINGTON, D. C.

June 10, 1963

Honorable N. E. Halaby
Administrator
Federal Aviation Agency
Washington 25, D. C.

Dear Mr Halaby

Current investigation of the accident involving Standard Airways L-1049G, N189S, at Manhattan, Kansas, on May 28, 1963, has revealed that the No. 3 propeller inadvertently went into the reverse range. Detailed inspection indicated that the brake cage locking bolt necessary to prevent rotation and disengagement from the outer brake solenoid was missing. Consequently, the cage backed off several turns rendering the brake ineffective in preventing centrifugally induced low blade angles in the reverse range.

In addition to this discrepancy, the No. 2 powerplant had the cannon plugs for the left and right cowl flaps safety-wired backwards and the cannon plug for the magneto not safetied. The No. 4 engine did not have either the No. 3 PRT turbine wheel nut or the left distributor adjustment nut safetied; in addition, there was no magnetic plug in the rear sump (pressure side) as prescribed by the maintenance manual of the air carrier.

This brief review of the mechanical discrepancies on this aircraft indicates unsatisfactory maintenance and overhaul practices. The Board therefore recommends that the maintenance and overhaul procedures and practices of Standard Airways and any other maintenance agencies involved be reviewed for compliance with current regulations and accepted practices

Mr. D. Ballard, FAA coordinator, and Mr. J. J. Rotelli, FAA member of the Powerplant Committee, both from your Kansas City Air Carrier Office, are aware of and familiar with the discrepancies that have been noted.

Sincerely yours,

/s/ Alan S. Boyd

Chairman

Attachment B
(page 1 of 2)

COPY

FEDERAL AVIATION AGENCY
Washington 25, D. C.

OFFICE OF
THE ADMINISTRATOR

June 24, 1963

Dear Mr. Chairman

In reply to your letter of June 10, 1963, reference number B-1-96, we have requested our Western Region to review the maintenance and overhaul procedures of Standard Airways, Incorporated, and any other contract agencies involved in the maintenance of their aircraft, as you have recommended.

We understand that a review of Standard Airways' main base facilities and maintenance procedures was accomplished subsequent to the Manhattan, Kansas, accident. We will keep you informed of their findings as they are reported to this office.

Sincerely yours,

/s/ N. E. Halaby

Administrator

Honorable Alan S. Boyd
Chairman
Civil Aeronautics Board
Washington 25, D. C.

Attachment B
(Page 2 of 2)