

AAR 89/03/SUM

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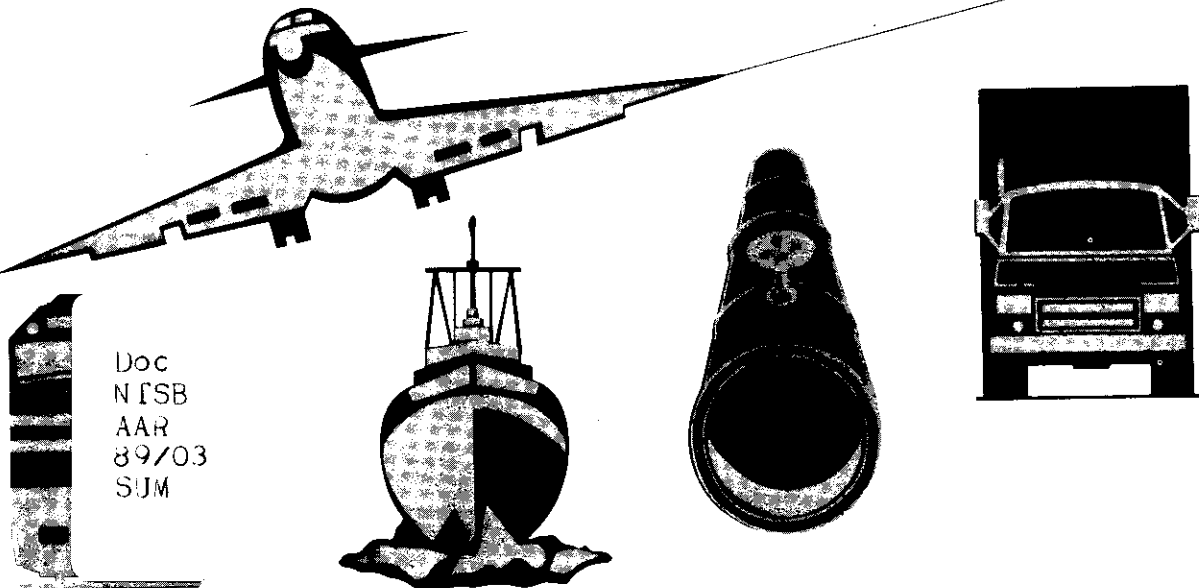
NATIONAL TRANSPORTATION SAFETY BOARD



AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORT

KENAI, ALASKA -- DECEMBER 23, 1987

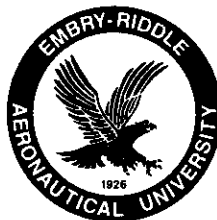
*See also : NTSB Reporter
Feb 1990, p.9*



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16. Abstract This report is a summary of an aircraft accident investigated by the National Transportation Safety Board. The accident location and date is Kenai, Alaska, December 23, 1987.			
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**National
Transportation
Safety Board**

Washington, D.C. 20594

AIRCRAFT ACCIDENT/INCIDENT SUMMARY

File No:	DCA 88-M-A-011
Aircraft Operator	South Central Airways, Inc.
Aircraft Type and Registration	Piper PA-31, N496SC
Location:	Kenai, Alaska
Date and Time:	December 23, 1987, 0611a.s.t.
Injuries:	6 Fatal, 2 Serious
Aircraft Damage:	Destroyed
Type of Occurrence:	Collision with ground
Phase of Operation:	Circle for landing

About 0611, December 23, 1987, a Piper PA-31-350 operated by South Central Air, Inc., as flight 2001, N496SC, crashed shortly after departing Kenai Municipal Airport, Kenai, Alaska. The flight was a regularly scheduled commuter flight (14 CFR Part 135) to Anchorage, Alaska. The flight departed during the hours of darkness. An instrument flight rules (IFR) flight plan had been filed and activated prior to departure. On board the airplane was one pilot and seven passengers (including one infant). The reported surface weather at the airport was, in part, as follows:

Measured ceiling 1,500 feet overcast; visibility 7 miles, light rain; temperature 33^o, dew point 29^o; wind 020^o at 8 knots; altimeter setting 29.26 inHg.

About 2 minutes 23 seconds after advising the Kenai Flight Service Station (FSS) specialist that he was departing from runway 01, the pilot of flight 2001 advised the FSS specialist that "Central one has lost an engine and we're circling for (runway) one." The specialist acknowledged receipt of the message, the last known radio transmission received from flight 2001, and provided the pilot with the runway winds and altimeter setting.

The FSS specialist stated that she saw flight 2001 flying west of the airport. She said that, "It appeared that he was not going to reach the airport since he was losing altitude...I observed the aircraft descend below the tree line west of the...airport." She told another FSS specialist to call the crash equipment.

A pilot awaiting takeoff at the airport said that he heard the pilot of flight 2001 report an engine problem and saw the airplane at about 300 to 400 feet above ground level (agl) as it turned on a downwind leg west of the airport. He thought that the airplane was in a gradual descent or flying away from the airport. He lost sight of it as it came abeam his position, which was in front of the South Central operations building.

Two passengers on the flight survived. One survivor said that it sounded like an engine blew up about 300 to 400 feet agl and he thought that it was the left engine. He estimated that the airplane climbed to about 500 to 600 feet agl, made a left 180° turn, and began to lose altitude slowly. After the initial "explosion" he only heard normal engine noise. He could not see if a propeller was feathered nor did he ever notice the position of the wing flaps.

The other survivor said that he heard a "loud backfire" either at or shortly after liftoff, but he could not identify which engine had backfired. He stated that the airplane gained some altitude after liftoff, then it banked to the left "and circled back around and as we were losing altitude I looked out the window and noticed that the flaps were down." He said that "both motors were running," but it sounded as if one engine had more power on it than the other, "it was an unbalanced hum." According to the survivor, both engines were running "right up to impact." The survivor said that the "stall buzzer (was) going off" as the airplane descended. He said that the only time he recalled "even noticing (what the pilot was) doing was when the stall buzzer was going off. I seen him reach over and whip (sic) some lever and then like a few seconds later the stall buzzer came on again and that's when we hit the trees."

Flight 2001 came to rest inverted in a house about 1/2 to 3/4 nmi west of the Kenai Municipal Airport. The airplane and the house were destroyed by impact forces and the post crash fire. The two occupants of the house escaped with minor injuries. The pilot and five passengers (including the infant) were killed by the impact and post impact fires. The two surviving passengers were able to get out of the airplane and out of the house before the airplane exploded and burned.

The investigation showed that the pilot was trained and qualified to operate the airplane. There was no evidence of any physiological or psychological factors that would have affected the performance of the pilot.

Weight and balance calculations performed after the accident indicated that the actual passenger weight (not including carry-on items) averaged approximately 186 pounds. The average passenger weight used by South Central Air for winter operations was 165 pounds and included carry-on baggage items. This procedure was in the company's FAA approved operations specification. The Safety Board notes that FAA Advisory Circular 120-27A "Aircraft Weight and Balance Control," dated May 14, 1980, states, in part, that "Actual or average weights may be used to compute passenger loads over any segment of a certificate holder's operation except that actual weights should be used for operations with reciprocating powered aircraft of 9 or less seats. . . ." The Principal Operations Inspector of South Central Air stated that of the 18 air carriers assigned to him, only South Central Air was permitted to use average passenger weights on this type of operation. He was unable to provide a reason as to why South Central Air was permitted to use average passenger weights.

The investigation found that the weight and balance documentation performed by the captain of the accident flight accounted for one passenger being seated in the right front (co-pilot) seat. The investigation determined that this seat was unoccupied during the flight. The investigation found that this change in seating resulted in the center of gravity being displaced 3.4 inches aft of the pilot's calculations. However, even with these errors, the calculations indicated that the airplane's takeoff weight and center of gravity locations were within the prescribed limits.

During the on-scene investigation, Safety Board investigators entered the cockpit of several South Central Air PA-31-350 airplanes. Three different normal operating checklists were found. One airplane was found to have all three different checklists inboard. One checklist contained the item "Flaps" on its Pretakeoff Checklist with the response -- "Set 0." This was the proper checklist, however, it was contained in the Airplane Flight Manual that was stowed behind the pilots seat. A second checklist (of unknown origin) was found above the pilot's sun visor. In regard to "flaps" on the Takeoff Checklist, the response was -- "Set." The third checklist, prepared by the company and carried by the flightcrews, was the one that was used most frequently. This checklist omitted any reference to flaps. This checklist contained the stamp of the FAA Flight Standards District Office responsible for the surveillance of South Central Air. Unfortunately, due to the intense fire, a checklist was not recovered from the accident airplane.

The airplane was not required to be equipped nor was it equipped with a flight data recorder or a cockpit voice recorder. Additionally, no recorded radar data were available to enable the Safety Board to reconstruct flight 2001's flight path. The investigation showed that flight 2001 descended into the trees approximately 480 feet from the final impact site. The airplane was descending in a wing-level attitude at initial impact and continued in a slight descent in that attitude as it cut a swath through the tops of the trees. About 100 feet from the final impact site, the airplane increased its descent angle and became inverted before crashing into the house.

The examination of the engines showed that neither propeller had been feathered, and that both engines were operating at impact; however, the examination did not reveal whether they were operating at high or low power settings at impact. Subsequent teardown inspections disclosed that the right engine's No. 3 cylinder head was cracked above the top of the cylinder barrel. The crack extended about 180° circumferentially around the cylinder head. The crack had propagated through the head and had opened up which would have prevented the cylinder from producing power. Additionally, when the crack opened up it caused the intake pipe to separate. The separation of the intake pipe would have caused the turbocharged air to have been expelled out the separated pipe rather than having been fed to the engine. This loss of turbocharged air would have caused the engine to operate as a normally aspirated engine with an attendant loss of power. During flow test examinations the no. 5 fuel injection nozzle for the right engine was completely clogged. An examination of the clogging material indicated that the material was composed of residue caused by the exposure of components of the fuel injector assembly to high temperatures and was not a product of normal engine operation.

Examination of the left engine disclosed that the cam lobes for cylinders 3, 4, 5, and 6 were severely worn. Evidence of spalling was found on the bearing surface faces of the valve tappet assemblies where they normally ride on the cam lobes. This wear would have affected operation of the numbers 3, 4, 5, and 6 intake valves and the numbers 4, 5, and 6 exhaust valves.

A Lycoming LT10-540-J2Bd engine is capable of producing 350 brake horsepower (BHP). It is estimated that the right engine was capable of producing about 193 BHP after the cylinder head crack had opened and the turbocharged air was exhausted through the separated intake pipe.

The cam wear on the left engine cam shaft would have had some adverse effect on the horsepower production from of the engine. After a thorough review of existing data relating power production to valve lift and duration, the manufacturer was unable to find baseline data upon which to estimate the power production with severe cam lobe wear. Engineers from Lycoming believe that some power loss from the effects of the worn cam lobes would have been recovered at high power settings due to operation of the turbocharger. However, the effects of the worn cam lobes probably was detectable through evidence of power loss from the left engine in comparison to the right engine at matched cruise throttle settings and by poor starting and rough idle characteristics.

The examination of the airplane's flight controls disclosed that the trailing edge flaps were extended about 37° at impact. The recommended flap setting for landing was full down or 40°. The rudder's trim tab was deflected full left at impact. This position would assist the pilot in moving the rudder to the right to counteract a leftward turning moment of the airplane. Additionally, the landing gear was in the up and locked position and the cowl flap actuators for both engines were fully extended.

The witness statements provided evidence that flight 2001 experienced some type of engine difficulties after liftoff. One of the survivors stated that he believed that it was the left engine which had experienced the problem. The position of the rudder trim tab indicated that the pilot had come to a similar conclusion and had trimmed for right rudder deflection to compensate for loss of power on the left engine. It was determined that the crack found in the right engine's No. 3 cylinder had existed before the accident flight but had extended circumferentially and had opened up during takeoff. The damage would have manifested itself with backfiring and other explosive sounds similar to those described by one of the survivors. Thus, the probability exists, that the pilot, as did the survivor, misidentified the source of the engine noises, and retarded the throttle on the left engine in a mistaken effort to control the engine and lessen the damage. This action would have caused the airplane to yaw to the left and would have required the pilot to apply right rudder to counteract the yaw. Since normal pilot action under such circumstances is to apply right rudder trim to relieve the rudder pedal forces, the Safety Board concludes that the full right rudder trim indicates that the pilot had reduced the power substantially on the left engine in the mistaken belief that the engine was backfiring and malfunctioning. Therefore, since the right engine was malfunctioning and was able to deliver only about 55 percent of maximum power, the pilot was unable to maintain altitude.

The Piper PA-31 operating instructions indicated that no flaps should be used for a normal takeoff. A short field takeoff requires 15° of flap. The Piper PA-31 pilot operating manual states that the airplane cannot be flown on one engine if the flaps are fully, or near fully, extended and that, except when taking off from short runways, the use of flaps on takeoff is prohibited because of this performance penalty.

The statement of one survivor indicated that the flaps were down as the airplane started to descend into the trees. He did not notice the position of the flaps during takeoff or on initial climbout. Given the fact that the airplane was able to maintain altitude for a while after the engine problem was encountered, the Safety Board believes that the flaps were not extended at takeoff. Since 37° is not a recommended flap setting for either takeoff or landing, the Safety Board believes that the pilot may have selected full flaps just before impact and that there was not sufficient time for them to fully extend before the airplane crashed. Therefore, the Safety Board concludes that the pilot extended the flaps at the last moment in an effort to prevent the airplane from stalling and to lessen the inevitable impact forces.

The Safety Board found that the cracking of the right No. 3 cylinder was insidious in nature such that the pilot and South Central Air maintenance personnel could not have been expected to know of its presence prior to failure. The Safety Board does not believe that the crack would have been discovered during routine maintenance. However, the Board believes that the wear to the cam lobes on the left engine probably could have been detected through poor starting and idling characteristics and through uneven throttle position in flight. Although the loss of performance would have been gradual as the cam lobes wore over a period of time, the Safety Board believes that a proper analysis of the engine's performance characteristics and monitoring for metal particles in the oil samples should have resulted in a conclusion that corrective action was needed. However, the maintenance records for the airplane disclosed no significant maintenance on the left engine.

The investigation into the operating and overhaul histories of the engines disclosed that on the right engine the No. 3 cylinder had been re-barrelled several times. During the process of attaching the cylinder head to the cylinder barrel, a stress riser was created in the cast aluminum head. Macroscopic examination of the fracture area revealed multiple fatigue crack origins near the thread roots, at the cylinder head to cylinder barrel interface, and on the exhaust port side of the head.

Investigation of the left engine disclosed excessive wear and loss of metal on five of the nine cam lobes on the engine's cam shaft. This condition resulted from regrinding the nitrated exterior surface of the cam during reprocessing to the extent that minimum hardness was below limits. This condition exposed the softer underlying material to contact with the cam follower and resulted in accelerated wear.

The Safety Board's investigation was hampered by the fact that most of the airplane was consumed by the post crash fire which substantially reduced the amount of factual evidence available. The absence of a cockpit voice recorder or a flight data recorder further complicated the Safety Board's efforts to determine the cause of this accident conclusively. However, the Safety Board believes that the probable cause of this accident was the failure of the No. 3 cylinder of the right engine during a critical phase of flight and the pilot's mishandling of the emergency during which he allowed the airplane to descend and impact terrain.

As a result of this accident, on July 28, 1988, the National Transportation Safety Board issued the following recommendations to the Federal Aviation Administration (FAA):

Verify that all Title 14 Code of Federal Regulations Part 135 operators carry only prescribed checklists in the cockpits of their aircraft. (A-88-78)

Require that the principal operations inspectors assigned to Title 14 Code of Federal Regulations Part 135 operators of reciprocating-engine aircraft that carry nine or fewer passengers verify that the operator complies with Advisory Circular 120-27A concerning the use of actual passenger weight. (A-88-79)

Issue an Air Carrier Operations Bulletin to principal operations inspectors assigned to Title 14 Code of Federal regulations Part 135 operators of reciprocating-engine aircraft which carry nine or fewer passengers; the bulletin should stress the importance of informing pilots of these airplanes about ensuring passenger seat assignments in accordance to planned weight and balance data. (A-88-80)

On October 12, 1988, the FAA informed the Safety Board that it intended to issue one or more Air Carrier Operations Bulletins that will address the above recommendations. Pending the Safety Board's review of the proposed Bulletins, the Safety Board

classified Safety Recommendations A-88-78, -79 and -80 as "Open-Acceptable Action."

The attached Brief of Accident contains the Safety Board's conclusions, findings of probable cause, and related factors.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES L. KOLSTAD
Acting Chairman

/s/ JIM BURNETT
Member

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

/s/ LEMOINE V. DICKINSON, JR.
Member

August 2, 1989

Brief of Accident

File No. - 2618 12/23/87 KENAI, AK A/C Reg. No. N496SC Time (Lcl) - 0611 AST

---Basic Information---

Type Operating Certificate-COMMUTER
Name of Carrier -SOUTH CENTRAL AIR, INC.
Type of Operation -SCHEDULED,DOMESTIC,PASSENGER
Flight Conducted Under -14 CFR 135
Accident Occurred Under -DESCENT
Aircraft Damage DESTROYED
Fire ON GROUND
Fatal 1
Serious 5
Minor 0
None 0
Crew 0
Pass 2
Other 0

---Aircraft Information---

Make/Model - PIPER PA-31-350
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 7000
No. of Seats - 10
Eng Make/Model - LYCOMING TIO-S40
Number Engines - 2
Engine Type - RECIP-FUEL INJECTED
Rated Power - 350 HP
ELT Installed/Activated - YES/YES
Stall Warning System - YES

---Environment/Operations Information---

Weather Data
Wx Briefing - FSS
Method - TELEPHONE
Completeness - FULL
Basic Weather - VMC
Wind Dir/Speed- 020/008 KTS
Visibility - 7.0 SM
Lowest Sky/Clouds - UNK/NR
Lowest Ceiling - 1500 FT OVERCAST
Obstructions to Vision- NONE
Precipitation - RAIN
Condition of Light - NIGHT(DARK)

Itinerary

Last Departure Point
SAME AS ACC/INC
Destination
ANCHORAGE, AK
ATC/Airspace
Type of Flight Plan - IFR
Type of Clearance - IFR
Type Appch/Lnds - NONE

Airport Proximity

OFF AIRPORT/STRIP
KENAI MUNI
Runway Ident - 01
Runway Lth/Mid - 7600/ 150
Runway Surface - ASPHALT
Runway Status - ICE COVERED

---Personnel Information---

Pilot-In-Command
Certificate(s)/Ratings(s)
ATP
SE LAND,ME LAND

Age - 54

Biennial Flight Review
Current - YES
Months Since - 2
Aircraft Type - PA-31

Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT

Flight Time (Hours)
Total - 14500
Make/Model - UNK/NR
Instrument - 1075
Multi-Eng - 9700
Last 24 Hrs - 4
Last 30 Days - 62
Last 90 Days - 86

Instrument Ratings(s) - AIRPLANE

---Narrative---

THE PILOT HAD JUST DEPARTED THE RUNWAY WHEN HE REPORTED TO THE FLIGHT SERVICE STATION THAT HE HAD ENGINE PROBLEMS. THE AIRCRAFT WAS OBSERVED BY WITNESSES TO BE ABOUT 300 FT ON A DESCENDING DOWNWIND. THE PILOT STATED THAT HE WAS CIRCLING FOR RUNWAY ONE. SURVIVING PASSENGERS DESCRIBED THE ENGINES AS RUNNING ROUGH AND UNEVEN. THE INVESTIGATION REVEALED THAT THE AIRCRAFT'S WEIGHT WAS MORE THAN THE PILOT HAD CALCULATED AND THE C.G. WAS 3.4 INCHES FURTHER AFT THAN WAS CALCULATED. HOWEVER, THE WEIGHT AND C.G. WERE WITHIN LIMITS. EXAMINATION OF THE ENGINE DISCLOSED THAT THE RIGHT ENGINE HAD AN EXTENSIVE CYLINDER HEAD CRACK, A PARTIALLY DISCONNECTED INTAKE PIPE, AND WAS CAPABLE OF PRODUCING 55% OF RATED POWER. THE LEFT ENGINE HAD SEVEN SEVERELY WORN CAM LOBES. THE RUDDER TRIM WAS DEFLECTED FULL LEFT AT IMPACT. THE EVIDENCE INDICATED THAT THE PILOT HAD RETARDED THE THROTTLE FOR THE LEFT ENGINE AND WAS USING ONLY THE RIGHT ENGINE TO SUSTAIN FLIGHT. EXAM OF COMPANY CHECKLIST USAGE REVEALED SEVERAL DIFFERENT IMPROPER VERSIONS.

Brief of Accident (Continued)

File No. - 2618 12/23/87 KENAI, AK A/C Res. No. N496SC Time (Lcl) - 0611 AST

Occurrence #1 LOSS OF ENGINE POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation TAKEOFF - INITIAL CLIMB

Findings(s)

1. ENGINE - FAILURE, PARTIAL
2. ENGINE ASSEMBLY, CYLINDER - FAILURE, TOTAL
3. ENGINE ASSEMBLY, CYLINDER - FATIGUE
4. INDUCTION AIR CONTROL, INTAKE MANIFOLD - SEPARATION

Occurrence #2 LOSS OF ENGINE POWER
Phase of Operation MANEUVERING

Findings(s)

5. ENGINE - FAILURE, PARTIAL
6. ENGINE ASSEMBLY, CAMSHAFT - WORN
7. MAINTENANCE, 100 HOUR INSPECTION - INADEQUATE - COMPANY MAINTENANCE PSNL
8. EMERGENCY PROCEDURE - IMPROPER - PILOT IN COMMAND
9. THROTTLE/POWER CONTROL - IMPROPER USE OF - PILOT IN COMMAND

Occurrence #3 FORCED LANDING
Phase of Operation DESCENT - EMERGENCY

Occurrence #4 IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation DESCENT - EMERGENCY

Findings(s)

10. TRIM SETTING - IMPROPER - PILOT IN COMMAND
11. LOWERING OF FLAPS - PERFORMED -
12. OBJECT - TREE(S)
13. OBJECT - RESIDENCE

-----Probable Cause-----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are findings(s) 2,3,8,9

Factor(s) relating to this accident is/are findings(s) 4,5,6,7,10