SA-None File No. 1-0038

AIRCRAFT ACCIDENT REPORT

WIEN CONSOLIDATED AIRLINES,, INC.
FAIRCHILD F-27B, N4905
PEDRO BAY, ALASKA
DECEMBER 2, 1968

Adopted: July 22, 1970

NATIONAL TRANSPORTATION SAFETY BOARD
Bureau of Aviation Safety
Washington, D. C. 20591

For sale by Clearinghouse for Federal Scientific and Technical Information, U.S. Department of Commerce, Springfield, Va. 22151. Annual subscription price $12.00 Domestic; $15.00 Foreign; Single copy $3.00; Microfiche $0.85.

Report Number: NTSB-AAR-70-16

WIEN CONSOLIDATED AIRLINES. INC.
FAIRCHILD F-27B, N4905
PEDRO BAY, ALASKA
DECEMBER 2. 1968

TABLE OF CONTENTS

		Page
	Synopsis	1
	Probable Cause	1
1.	Investigation	3
1.1	History of the Flight	3
1.2	Injuries to Persons	3
1.3	Damage to Aircraft	4
1.4	Other Damage	4
1.5	Crew Information	4
1.6	Aircraft Information	4
1.7	Meteorological Information	5
1.8	Aids to Navigation	9
1.9	Communications	9
1.10	Aerodrome and Ground Facilities	10
1.11	Flight Recorders	10
1.12	Wreckage	12
1.13	Fire	15
1.14	Survival Aspects	15
1.15	Tests and Research	16
1.16	Other Information	19
2.	Analysis and Conclusions	20
2.1	Analysis	20
2.2	Conclusions	26
	(a) Findings	26
	(b) Probable Cause	28
3.	Recommendations	28
	Appendices	

A Investigation and Hearing
B Crew Information
C Aircraft Information
D Wreckage Distribution Chart
E Letter to FAA from NTSB dated December 23. 1968
Letter to NTSB from FAA dated January 8. 1969
F Winds Aloft
G Aviation Area Forecasts
H Letter to FAA from NTSB dated December 30. 1968
Letter to NTSB from FAA dated January 10. 1969

File No. 1-0038

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
AIRCRAFT ACCIDENT REPORT

Adopted: July 22, 1970

WIEN CONSOLIDATED AIRLINES, INC., FAIRCHILD F-27B, N4905 PEDRO BAY, ALASKA DECEMBER 2, 1968

SYNOPSIS

A Wien Consolidated Airlines, Inc., Fairchild F-27B, N4905, crashed at Pedro Bay, Alaska, at approximately 0936 Alaskan standard time, December 2, 1968. The 36 passengers and three crewmembers died in the accident and the aircraft was destroyed.

The aircraft was operating as Flight 55 from Anchorage to Dillingham, Alaska, with en route stops at Iliamna, Big Mountain, and King Salmon, Alaska. Flight 55 had been cleared for an approach to Iliamna Airport and as it neared the vicinity of Pedro Bay, witnesses on the ground observed a large cloud of black smoke and fire behind the aircraft. They stated that shortly after that, they saw pieces separate from the aircraft and the aircraft descend in a spin. The weather at the time of the accident was clear with good visibility. High winds were reported on the ground in the Pedro Bay area.

Investigation showed that the right outer wing, the empennage, portions of the left wing, and other components of the aircraft structure had separated from the aircraft in flight.

The Board determines that the probable cause of this accident was an in-flight structural failure caused by an encounter with severe-to-extreme turbulence. This turbulence was not forecast and its presence was not known to the flightcrew. The failure occurred in an area of the right wing (WS 197) which had been weakened to an indeterminate degree by pre-existing fatigue cracks.

The Board recommended to the Administrator, Federal Aviation Administration, that all F-27 aircraft which had more than 5,000 hours in service be inspected for possible fatigue cracks in the wings. This recommendation was carried out by the Administrator and a total of 13 cracks were found in eight of the 67 aircraft inspected.

With reference to the possibility of the inadvertent feathering of the Rolls-Royce Dart engine/Dowty Rotol propeller installation under a negative "g" condition, the Board recommended to the Administrator that he bring this information to the attention of all users of aircraft with this powerplant installation. It was also recommended that this problem be considered during the certification of future, similar parer-plant installations. The Administrator indicated that he had taken action to carry out these recommendations.

1. INVESTIGATION

1.1 History of the Flight

A Wien Consolidated Airlines, Inc., Fairchild F-27B, N4905, crashed at approximately 0936 A.s.t., 1/ December 2, 1968, at Pedro Bay, Alaska. The 36 passengers and three crewmembers were killed in the accident and the aircraft was destroyed by in-flight breakup and ground impact.

The aircraft was being operated as Flight 55 in scheduled domestic passenger service between Anchorage and Dillingham, Alaska, with en route stops at Iliamna, Big Mountain, and King Salmon, Alaska.

Flight 55 departed from Anchorage International Airport at 0846 on an instrument flight plan for Iliamnc Airport. The flight was cleared to cruise at 16,000 feet mean sea level. 2/ The weather at Iliamna was reported to be clear, and the visibility was 15 miles at the time of the flight's departure from Anchorage.

The flight proceeded toward Iliamna without reported difficulty, and at 0925:29.5, the first officer requested a clearance for an approach to Iliamna. This request was approved just prior to 0926. No further communication was received from the crew.

Ground witnesses in and around the Pedro Bay area reported that they saw a fireball and a large cloud of black smoke which appeared to be behind the wing of the aircraft. The aircraft appeared to continue on course for a short period of time, then pieces of the aircraft were seen falling, and the aircraft entered a spinning descent.' The aircraft disappeared from the view of the witnesses, and no fire or explosion was observed after the initial fireball.

The major portion of the wreckage was located on the southern shore of Foxies Lake at an elevation of approximately 220 feet. The fuselage was located at latitude 59° 46' 17" N. and longitude 154° 08' 28" W. The accident occurred in bright daylight.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	3	36	0
Nonfatal	0	0	0
None	0	0	

1/ All times are Alaskan standard time based on the 24-hour clock unless otherwise noted.

2/ All altitudes are mean sea level, unless otherwise indicated.

1.3 Damage to Aircraft

The aircraft was destroyed by in-flight breakup and ground impact.

1.4 Other Damage

None reported.

1.5 Crew Information

The crewmembers were properly certificated and medically qualified for the performance of their duties. Their flight training and check flights were current, (For details, see Appendix B.)

1.6 Aircraft Information

The aircraft maintenance records of N4905 indicated that it had been properly certificated and was being maintained in accordance with the applicable FAA and company regulations.

An examination was made of a number of X-ray radiographs supplied by the carrier. These radiographs had been prepared, in compliance with Fairchild Hiller Service Bulletin 51-2, during periodic radiographic inspections of the aircraft structure in the vicinity of the No. 1 access doors in both wings.

The examination of these radiographs, subsequent to the accident, revealed that cracks were present before the accident in structural components of both wings near the No. 1 access doors at Wing Station (WS) 197. The aircraft maintenance records indicated that these cracks were not detected by the persons interpreting the radiographs for the carrier.

The maximum gross takeoff weight for this aircraft was 40,500 pounds and the center of gravity (c.g.) limits were 20 percent forward and 38 percent aft mean aerodynamic chord (MAC), The aircraft was reported to have weighed 39,206 pounds on departure from Anchorage with a c.g. of 32 percent.

The aircraft had been fueled with 6,052 pounds of aviation kerosene before takeoff, and an estimated 1,300 pounds of fuel and 50 pounds of water methanol were consumed before the accident occurred. The calculated aircraft weight at the time of the accident was 37,856 pounds. (For details of aircraft history see Appendix C.)

1.7 Meteorological Information

The 0800 surface weather chart showed a deep, low-pressure area over the northern Gulf of Alaska with its center located approximately 120 miles south of Cape St. Elias. A flat ridge of high pressure covered western Alaska. A steep pressure gradient was shown eastward from King Salmon 3/ and, at map time, the pressure differential between King Salmon and Anchorage was more than 21 millibars.

The 0200 and 1400, 500-millibar charts (approximately 18,000 feet) showed a very sharp trough of low pressure oriented in a northeast/southwest direction. This trough had moved through the Iliamna area during the morning. At 700 millibars (approximately 9,800 feet) the trough was near the Iliamna area at 0200 and was well to the east of Iliamna by 1400.

The official weather observation taken at Iliamna at 0757 reported that the sky was clear and the visibility was 15 miles. The temperature was -11° F., the dew point was -23° F., the wind was from 270° at 18 knots gusting to 22 knots, the altimeter setting was 29.99 inches, and there was stratus and ice fog over the lake, south of the airport.

At 0857, the observation reported similar weather except that the wind was from 280°, the altimeter setting was 29.98, and ice fog was reported over the lake east to south.

After the accident was reported, a special observation was taken at 1046. It reported that the sky was clear, the visibility was 9 miles, the temperature was -11° F., the dew point was -19° F., the wind was from 280° at 15 knots, and the altimeter setting was 30.00. There was ground fog over the lake to the south and blowing snow in the distance in all quadrants. There were a few stratocumulus clouds in the distance from the east to south to southwest.

The area aviation forecast prepared by the Weather Bureau at Anchorage was issued at 0648 and valid for a 12-hour period beginning at 0700. This forecast was in part: "Heights above sea level unless noted. 974 mb. low pressure centered 125 miles south Cape Yakataga moving east-northeastward 10 knots, curling eastward 10 knots and weakening after 1900 Tuesday. Cook Inlet. 4/ Ceiling 500-1,500, sky obscured, 3/4-3 miles, light (?) snow except western third 6,000 broken, top 9,000. Eastern 2/3 after 1300, 2,000 overcast, light snow, locally ceiling 1,000, sky obscured, 1 mile, light snow.

3/ King Salmon is approximately 85 NM southwest of Iliamna.

4/ Cook Inlet was the designation of a forecast area which included Cook Inlet and was northeast and east of Iliamna. The accident occurred in this forecast area.

"Passes. Lake Clark, Merrill open. Rainy, Windy, marginal in intermittent snow. Chickaloon, Portage closed.

"Possible moderate rime icing in clouds 6,000 - 12,000 Cook Inlet till 1400. ---freezing level surface ---.

"---Bristol Bay. 5/ No significant clouds or weather except patchy 1,500-2,000 broken, top 3,500 western coastal area. ---After 1100, surface winds eastern Bristol Bay occasionally 340, 15 knots, gusts 30 knots.

"No significant icing.

"Occasional light to moderate turbulence eastern Bristol Bay below 4,000 above ground level."

At 0843, the aviation area forecast was amended as follows:

"Occasional moderate turbulence below 6,000 feet above ground level eastern Bristol Bay, eastern Kuskokwim Valley."

At 0700, AIRMET Papa 5 was issued valid until 1100. It read:

"Cook Inlet, western end of Susitna Valley. Areas ceilings below 1,000 feet, visibility below 2 miles in snow. Occasional moderate turbulence near rough terrain. Conditions continuing beyond 1100."

Routine terminal forecasts were not prepared by the Weather Bureau for Iliamna, Big Mountain, or Dillingham, but they were prepared for King Salmon.

The King Salmon terminal forecast issued at 0656, valid for a 12-hour period beginning at 0700 was as follows:

"0700 - 1600, clear

1600 - 1900, 1800 thin scattered, wind 350°, 10 knots."

The upper wind and temperature forecasts for Anchorage and King Salmon were prepared by the National Meteorological Center, Suitland, Maryland, at 0430, valid at 0800, and were in part as follows:

5/ Bristol Bay was the designation of the forecast area which included the Iliamna Airport.

Anchorage	King Salmon
3,000 feet, 350°, 25 knots	320°, 39 knots
6,000 feet, 350°, 16 knots, -19° C.	320°, 38 knots, -26° C.
9,000 feet, 350°, 8 knots, -24° C.	310°, 38 knots, -31° C.
12,000 feet, light and variable, -30° C.	300°, 38 knots, -35° C.
18,000 feet, 170°, 14 knots, -40° C.	300°, 39 knots, -42° C.

Radiosonde ascents were made and recorded at Anchorage and King Salmon at 0200 and 1400. The Anchorage 0200 ascent at intermediate levels (10,000 to 18,000 feet m.s.l.) showed generally stable, moist, subfreezing conditions. Except for some warming around 10,000 feet, the 1400 ascent showed little change.

The King Salmon 0200 ascent for the same levels showed moderately moist, stable, subfreezing conditions. Similar conditions were shown on the 1400 ascent except that warming was in evidence throughout the layer.

The winds aloft observations associated with these ascents are shown, in part, in Appendix F.

Ground witnesses in the Pedro Bay area stated that the wind was blowing quite hard and estimated the velocity to be from 25 to 60 knots. They stated that the sky was clear and visibility was good except over the lake which had "ice fog" over it. Several of them noted that there was blowing snow on the mountain peaks to the north and west of the village.

A local pilot from Iliamna was sent out in a Cessna 180 to search for the wreckage location. He reported that the rough air between Iliamna and the accident site required him to reduce his airspeed about 40 miles per hour and put down some landing flaps. The closer he got to Pedro Mountain the worse the turbulence became because of the winds 'burbling over the mountain as north-northwest, it was coming right over the top of the mountain and partly around the mountain. . . ." At an altitude of about 1,500 feet the turbulence was ". . . to a point where there was no positive control whatsoever'. The aircraft just went where it felt like going." The time of this observation was about 1000 or 1015. He estimated the wind velocity to be 45 to 50 knots with stronger gusts in the vicinity of Pedro Bay. He reported the sky to be clear with unrestricted visibility above 2,000 feet, but the fog off the lake and the blowing snow was from 1,500 to 2,000 feet high. He also reported blowing snow off the mountain peaks and a cap on the higher peaks. This pilot had lived in the area all his life and he couldn't recall flying "in this rough of weather before."

The captain of a Douglas DC-3 reported that he left Anchorage at 1237 destined for Iliamna. His route of flight was east and slightly south of the intended flightpath of Flight 55. At a point approximately 60 NM east of Iliamna, he canceled his instrument flight plan and proceeded direct to Iliamna by way of Pedro Bay at 8,500 feet. Approaching the accident area, he began a slow descent with the landing gear down. The updraft in the area was sufficient to keep the aircraft above 7,000 feet over the crash site. When he attempted to descend, he began to encounter increased turbulence and at about 6,700 feet he decided to pull up. By that time, turbulence was severe enough that he was using almost full aileron and about 75 percent rudder to maintain a correct flying position. The lowest altitude to which he descended was 6,500 feet, and he stated he would not have attempted to fly below that altitude. The time of this report was approximately 1400. He estimated that the wind velocity at the surface over Pedro Bay was in excess of 50 knots, based on its effect on the surface of the water.

He said that the surface of the lake indicated that an area of high velocity wind began about 12 miles east of Iliamna village and extended east to the hills at the end of the lake. The direction of the wind in this area was from the northwest as compared with a lesser wind from the west reported at the Iliamna Airport.

On his return trip about 40 minutes later, he encountered strong updrafts about 5 miles south of his previous course at 9,000 feet. Light turbulence was experienced, but it was impossible to maintain altitude due to updrafts over the hills between File Bay and Inisking Bay, east of Pedro Bay.

An Air Force pilot reported that, in the accident area at approximately 1240, his aircraft received several sharp jolts of turbulence while flying between 1,500 and 2,500 feet. The accelerometer on his aircraft indicated -2g and almost +2g after this incident. He did not report his airspeed or type of aircraft.

A special weather study was conducted for the manufacturer by an independent weather consultant. The consultant reported that, based upon a careful study of all available meteorological information from the gross macroscale to the lower mesoscale, and a further study of orographic effects, the area was under the influence of a vigorous outflow of arctic air which had pooled to the west of the Alaskan range in great depth and to a point 180 NM north of Pedro Bay. His study indicated that this outflow began between 0200 and 0400 on December 2, 1968. Estimating a gradient wind of about 60 knots over an intervening cyclonically curved trajectory of about 120 NM, he believed that the outflow over Pedro Bay began at about 0600.

The study further indicated that a pressure gradient equivalent to a northerly geostrophic wind of between 96 and 110 knots existed over Pedro Bay throughout the morning and early afternoon. Over terrain of this roughness, he did not believe such speeds would be attained in ambient gradient winds. He did expect, however, that northwest winds of between 70 and 80 knots could be expected at gradient levels between 2,000 and 4,000 feet.

Based on these gradient winds and the topography west and north of Pedro Bay, he calculated that the formation of an intense low-level mountain wave about 5 NM downwind from the ridge of Knutson Mountain (approximately 6 NM northwest of Pedro Pay) could ". . . easily be predicted." This formation would have been intensified by flow through a channeling gap between Pedro Mountain and a range just northeast of Pedro Bay. The consultant also calculated that the rotor region of this mountain wave would have existed between 2,000 and 3,000 feet over the northern tip of Pedro Pay, and "gust loads in excess of those specified for ultimate loads for transport aircraft could easily have existed." In this connection, he cited the experience of the Air Force aircraft referred to above and stated that ". . . the constancy of conditions throughout the morning and early afternoon indicate that this structure probably existed at 0930 AST."

This consultant finally concluded that ". . . a low-level mountain wave, unmarked by cap or rotor clouds in this dry air mass, of an intensity sufficient to impose gust loads beyond ultimate-load design limits on a transport category aircraft, existed over Pedro Bay, Alaska, at 0930 AST, December 2, 1968."

The dispatcher briefed the pilot of Flight 55 on the weather to be expected along his route, and he discussed the possibility of turbulence with the pilot. A copy of the current Weather Bureau forecast and existing weather was given to the pilot before departure from Anchorage.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

Radio communications were considered to be routine between the aircraft and ATC facilities while the aircraft was en route. There was no evidence in tone of voice, content, or phraseology of the last transmission from Flight 55 to indicate that the crew was experiencing any difficulty with the aircraft.

1.10 Aerodrome and Ground Facilities

Not applicable.

1.11 Flight Recorders

N4905 was equipped with both a flight data recorder (FDR) and a cockpit voice recorder (CVR).

The FDR was a United Control Data Division Model F-542, serial No. 1031. The recorder was recovered from the wreckage and forwarded to the NTSB Washington office for examination and readout of the flight record.

The recorder sustained crushing damage overall, predominately in the aft portion containing the electronic components. However, the foil recording medium was intact and all recorded traces were clear and readable. Examination of the traces disclosed that only the altitude and airspeed parameters were active, while the heading and vertical acceleration parameters were static -- a condition which had existed in this recorder for some 200 hours of aircraft operation.

Further, examination of the three auxiliary binary traces (trip and date/reference, heading North-South indicator, and timing) disclosed abnormal appearances during the last minute of recording. Accordingly, these three traces were read out in the same manner as altitude and airspeed, and all five traces were plotted on a data graph prepared from the readout results.

The flight recorder data graph covered the entire flight from Anchorage to the end of the recorded traces, a time period of 46:35 minutes, with the exception of the period between 19 and 38 minutes after takeoff which represented cruise flight at a relatively stable altitude and airspeed. Only the last 5 minutes of recorded binary traces were plotted.

Thirty-nine minutes after takeoff (0925), the indicated airspeed (IAS) was approximately 180 knots and the altitude, corrected to an altimeter setting of 29.98 inches Hg, was approximately 16,300 feet and was slowly decreasing. One minute later (0926), the airspeed had increased to approximately 210 knots IAS and the altitude was approximately 16,250 feet. A few seconds later, the altitude began to decrease, and the airspeed increased further to approximately 215 knots IAS. The rate of descent averaged approximately 975 feet per minute until reaching 11,650 feet at 0931:42. At this time, the rate of descent increased suddenly to 4,100 feet per minute and the airspeed increased from approximately 220 knots to 340 knots IAS over a period of 14 seconds.

Prior to this sudden change in rate of descent, the airspeed had varied between 210 and 230 knots **IAS.** The recorded traces terminated at 0932:32 or 46:32 minutes after'takeoff from Anchorage. At this time, the indicated altitude was approximately 4,700 feet and the indicated airspeed was approximately 260 knots.

Commensurate with the sudden increase in airspeed and rate of descent, there was a brief upward excursion in the timing, heading, and reference binary traces which measured .001 inch. At 0931:59, when the continuous altitude and airspeed traces ended and became aberrant, there was a sharp downward excursion in each binary trace, which measured .003 inch. The three binary traces were ragged in appearance thereafter. The three binary styli and solenoid assemblies are rigidly mounted on the recorder frame, and the recording styli are in constant contact with the foil recording medium.

A third excursion in a downward direction was noted on the timing and heading binary traces at 0932:08, or 46:08 minutes after takeoff, a time when both binary solenoids had been energized and the styli were positioned at the upper limit of their movement. Following this downward excursion, both styli returned to their original or energized positions. This excursion indicated a temporary removal of electrical power from these binary solenoids.

The Board believed that the binary excursions noted above were significant and could be considered indicative of a turbulence encounter in lieu of the malfunctioning vertical acceleration parameter. Therefore, the remains of the FDR, together with the foil recording medium and the accelerometer removed from the wreckage, were forwarded to the manufacturer's facilities for further examination and study. Their findings, based on calculations and actual tests, indicated that the FDR would have to be subjected to approximately ≠ 8g to result in magazine movement sufficient to cause the brief excursion of the binary traces at 0931:42, and approximately -20g to -30g to cause the sudden excursion at 0931:59. Although tests of the latter did not simulate these magnitudes, extrapolation of the test results verified the calculations of these forces. These tests did not take into account any dynamic response of the aircraft, and there was no way to determine whether these excursions were induced by gusting, turbulence, or aircraft maneuvers. The manufacturer found that the third excursion, at 0932:08, was most likely due to temporary loss of electrical power to the recorder.

The CVR aboard N4905 was a United Control Model V-557, serial No. 1416. The tape was removed and found to be creased at the end of each loop and a considerable portion contained heavily wrinkled segments. The wrinkles and creases were ironed out and the tape was transcribed by Board technicians.

A comparison with the time-correlated recording of Air Traffic Control communications indicated that the CVR had been operating at speeds 5 to 6 percent slower than the nominal rate of tape movement.

The tape contained a 400 Hz induced signal on each of its four channels. A study of the variations of this signal indicated that the CVR was subjected, in the latter stages of the recording, to accelerations that caused additional short-period slowdown of the tape.

The recording ended abruptly as a result of the removal of electrical power from the unit. The recorder was operated by direct current from the aircraft electrical power supply and a removal of electrical power could result from any interruption to that system.

A transcription of the last 6 minutes of the CVR recorded flight was prepared. The recorded conversation during this time period was general and did not relate to the flight or the aircraft. Fourteen seconds before the recording ended, the cockpit area microphone recorded a loud noise followed by a warning horn and clacker sound. Eleven seconds later, the copilot said, "Landing gear UP," and the pilot said, "Think we're in trouble." Three seconds later, a second loud noise was heard through the cockpit area microphone, and then the recording ended abruptly.

1.12 Wreckage

The major portion of the aircraft, consisting of the fuselage, center wing, and most of the left wing was recovered on the south shore of Foxies Lake, approximately 23 NM east of Iliamna Airport.

The right wing, outboard of Wing Station 197 (WS 197), the right aileron, the right outboard flap panel, right horizontal stabilizer and elevator, the left horizontal stabilizer and half of the left elevator, the rudder trim tab, the left engine 'cowling and the left engine accessory gearbox were not recovered.

Portions of the aircraft that separated in flight were recovered, at various locations, along a line oriented generally east-west. This area was approximately 1-1/2 miles long and 1,200 to 1,500 feet wide. Among the recovered components were the vertical stabilizer, the inboard half of the left elevator, portions of the leading edge of the left wing and the left wingtip, portions of the left engine, pieces from various parts of the left wing other than the leading edge, the rudder in two pieces, the left engine and propeller, and other material from various parts of the aircraft.

A wreckage trajectory analysis was not prepared in this case. Critical components of the wreckage were not recovered and, because of the accident location, sufficient data were not available to perform such an analysis.

The order of recovered components along the probable flightpath of the aircraft from east to west is depicted in Appendix **D.**

There was no evidence of an explosion in any of the examined wreckage.

The fractures of the empennage surfaces were all consistent with a counterclockwise (viewed from the rear) separation of the surfaces. The fin failed to the left, the left stabilizer failed downward, and the right stabilizer failed upwards. **All** of the observed fractures were typical of bending overloads, with some evidence of torsion observed in the fractured fin. No evidence of fatigue was seen in any of these fractures.

The left engine was separated from the left nacelle at Nacelle Station **(NS)** 71. The upper inboard firewall engine mount fitting was intact, except that the outboard ear was bent outward approximately 45°. The upper outboard firewall engine mount fitting, inboard ear upper half, was twisted approximately 10° inboard. The outboard ear was bent outward approximately 45". The lower inboard mount fitting outboard ear was broken off. There was no evidence of fatigue in this fracture. The lower outboard fitting was bent outward approximately 45".

The landing gear and the landing flap screwjacks were found in the retracted position.

The left wing **was** relatively intact from **WS *0*** to 164, with various areas of damage noted. The leading edge was intact out to **WS** 258, where a piece was missing out to WS 348. The remainder of the leading edge and wingtip were separated but were recovered.

The upper wing skin at WS 318 was torn chordwise from the front spar aft to the rear spar, with five hat sections extending 48 inches beyond the tear. The lower wing skin and hat sections at **WS** 313 were torn chordwise from the front spar aft to the rear spar. The skin in this fracture area **was** buckled. The front spar failed vertically at **WS** 311 and, looking inboard, the spar was twisted counterclockwise. The rear spar also failed vertically at WS 395 and was twisted counterclockwise, more **so** than the front **spar.** The top wing skin was flat at the breaks and the rearmost hat sections were bent down.

During initial examination of the left wing, a radiograph was made in the area of the fuel access panel at WS 197. Upon completion of the radiographs, the fuel access panel was removed, and a visual inspection revealed cracks in this area. The inboard half of the wing skin and access door cutout were removed and examined by the Board's metallurgist. He reported that fatigue cracks were found in five different locations adjacent to the access door. All of the cracks were at or near WS 197. A review of radiographs made during periodic inspections of the aircraft indicated that cracks were present in the structure adjacent to the access door in October 1967, and that additional cracks had developed before the accident occurred.

The right outer wing panel had separated in flight at approximately WS 197 and was not recovered. The outer wing apparently fell into Iliamna Lake in deep water. Aerial and ground searches were conducted in an effort to find the panel. They were unsuccessful, as were attempts by divers who searched the bottom of the lake in those areas that they could reach.

All that remained of the outer wing panel upper skin was approximately 3 inches of the laminated skin, which was attached to the center wing, and two hat sections with the broken tie bars that were found close to the main wreckage. The laminated skin which was attached to the center wing was curled up at the fracture. Eight of the tie bars failed in upward bending where the bars are connected to the hat sections at the first bolthole. The ninth tie bar failed in the same manner except further inboard.

Approximately 33 inches of the right wing lower skin and stringers were partially attached to the center wing. This section of skin and stringers was bent upward approximately 18 inches inboard from a fracture at WS 197. This fracture was a straight, chordwise fracture through the fuel access plate, wing skin, and hat sections. An on-site examination revealed evidence of fatigue cracking on the fore and aft sides of the fuel access cutout, extending approximately 3 inches in both directions.

A metallurgical examination of this piece of structure confirmed the existence of the fatigue cracks. Previously made radiographs also indicated that cracks were present in the structure adjacent to this access door in October 1967, and that additional cracks had developed prior to the accident.

Examination of the powerplants shared no evidence of any mechanical failure of either engine or propeller prior to the time of the initial in-flight breakup.

As previously noted, the left engine had separated from the aircraft in flight, but the right engine remained attached to the right wing structure.

The distance between the propeller operating piston and the ground fine pitch stop was measured on each propeller. Based on these measurements, it was determined that, at impact, the left propeller was just above the flight fine pitch stop at a blade angle of approximately 21°. The right propeller was in the feathered position.

Examination of the right engine fuel system indicated that the right-hand electrically operated fuel shutoff valve was in the open position. The mechanically operated fuel emergency shutoff valve was closed. The collector tank was crushed and separated, and only a small section of the collector tank was recovered.

The feathering system used in this parerplant installation included an auto-feathering circuit which could be actuated by a loss of torque on the engine or a transient negative "g" condition. The controller unit was an electrohydraulic unit which used engine oil, under pressure, to position the propeller blades to the desired blade angle. When low torque was sensed, the low torque switch completed a circuit to the auto-feathering relay, which in turn, energized the pitch coarsening solenoid in the propeller controller unit which ultimately feathered the propeller. The operation was normally accomplished within 5 to 7 seconds, according to the manufacturer's data. The electrical parer to initiate an auto-feather would have been obtained from the emergency d.c. bus.

Feathering of one engine energized an isolation relay which prevented the auto-feather circuit from operating on the other parerplant. Thus, the feathering of one propeller would prevent the auto-feather circuit from feathering the other propeller in the event of a loss of torque or exposure to negative "g".

1.13 Fire

The only reported fire was that observed in flight before the aircraft began its descent. This was described as a ball of fire and black smoke which appeared behind the wing of the aircraft. There was no post impact fire. Examination of the recovered wreckage did not reveal any evidence of fire damage.

1.14 Survival Aspects

This was a nonsurvivable accident. All the cabin seats were separated from their attachment points, but all the passengers' bodies except two were found in the cabin area. These two were found outside the cabin within 20 feet of a break in the fuselage.

Autopsies and toxicological examinations indicated that there was no evidence that an act of violence or explosion occurred in the aircraft prior to impact. There was no evidence of any significant pre-existing disease found during the examination of either pilot. The toxicological examinations disclosed no evidence of ethanol in 15 cases, and only two of 15 cases showed an indication of an elevated carbon monoxide saturation. Both of these cases involved passengers. No evidence of drug ingestion was found during tests of the two pilots.

1.15 Tests and Research

Because of the existence of fatigue cracks in the area of WS 197 on both lower wing surfaces, portions of these wing sections were returned to Washington for metallurgical examination. In addition, the carrier's radiograph records of these portions of the wings were returned to Washington for further examination and evaluation.

During these examinations, fatigue fractures were found in the lower surface of the right wing at or near WS 197, adjacent to the fuel access door in that area. Fatigue cracks were found in five different locations in the lower surface of the left wing near the fuel access door at WS 197.

The fatigue fractures in the right wing were part of a long, chordwise break in the lower surface. This fracture passed through the fuel access door, through four fastener holes (two on each side of the access door) and through the fatigue cracks that had developed in the wing before the accident.

The fatigue cracks had originated at the fastener holes and propagated chordwise in both the forward and aft directions. Adjacent to the fastener holes, the fracture surfaces were generally flat, smooth, and perpendicular to the surface of the material. At varying distances from the fastener holes, an increasing number of "jump" marks, or small areas of ductile rupture, began to appear and the cracks showed an increasing tendency to propagate as slant fractures on 45° shear planes.

The structure in this area consisted of wing skin, five doublers, a "J" stringer, and a nut plate. The skin, doublers, and stringers were made of clad 7075-T6 aluminum alloy with the following thickness: skin 0.055 inch; doublers 0.047 inch; and stringer 0.080 inch. The skin and doublers were bonded together with a vinyl adhesive, and one flange of a hat section stringer was bonded into the doubler assembly.

Evidence of the fatigue fracture was found in all of the five doublers and in the "J" stringers on both sides of the access door. The fatigue crack on the aft side of the access door had also propagated into the flange of the hat section stringer bonded into the doubler assembly. The well defined fatigue portions of the chordwise fracture were about 3-1/4 inches long on the aft side of the access door and about

2-1/2 inches long on the forward side. However, the exact length of the fractures, beyond that indicated above, immediately prior to the wing failure, could not be determined because of the indefinite nature of progression marks on slant fractures and because of the possibility of intermittent tearing that did not produce identifying marks on the fracture surface.

The outer skin on both sides of the access door had broken inboard of the fatigue fractures in the doublers and stringers. Both of these breaks were typical of bending overload fractures and showed no evidence of prior fatigue cracking. The fracture in the access door cover was typical of a tension overload separation and did not show any evidence of fatigue cracking.

Metallographic examination was made of samples taken from the outer skin, the five doublers, and the "J" stringers adjacent to the area of the access door where the fatigue fractures were found. The microstructure of all the samples examined was typical of those found in properly heat-treated 7075-T6 clad aluminum alloy material.

The National Bureau of Standards analyzed samples of the skin, doublers, and stringers cut from the area of the access door to determine the chemical composition of the material in these components. All of the samples complied with the chemical requirement of American Society for Testing and Materials (ASTM) Specification B 209-64, Aluminum Alloy Sheet and Plate, for Alclad 7075 core material. The cladding was not analyzed.

The National Bureau of Standards also tested longitudinal tensile specimens cut from the skin and doubler material adjacent to the access door. All of the specimens tested complied with the tensile requirements of ASTM Specification B 209-64 for Alclad 7075-T6 material in the thickness range of 0.040 to 0.062 inch. Tensile tests were not made on the "J" stringer material because of the small amount of suitable material available. However, hardness tests on the core material gave an average value of 75 on the Rockwell 30T scale or approximately 150 Brinell. This hardness and the microstructure of the material indicated that it had been properly heat-treated and that its tensile properties would comply with the specification's requirements.

X-ray radiographs were made during regular periodic X-ray inspections of the structure adjacent to the inboard end of the fuel access doors in both wings at WS 197. The inspection area designations were 1-AR in the right wing and 1-AL in the left wing. A review of all the available radiographic data on these two areas indicated that there were no cracks visible at WS 197 on either wing in April 1967.

The radiographs dated October 1967 showed one crack visible in 1-AL and two or more cracks in 1-AR. The 1-AL radiograph in April 1968 showed that this crack had increased in length from 3/16 inch to 1/4 inch. 6/ The 1-AR radiograph showed that the number of cracks increased from two or more to seven or more. Five or more cracks had appeared in a different location than those previously observed. These cracks ranged from 3/16 to 5/16 inch in length.

The last radiographs of these areas were taken in October 1968. The 1-AL showed a new crack approximately 1/8 inch in length. The 1-AR showed nine or more cracks at four different locations around the access door. These cracks ranged from 1/8 to 5/16 inch in length. Thus, the results of the examination of the radiographs indicated that cracks were present in the structure adjacent to the access door in both wings in October 1967, and that additional cracks developed prior to the accident.

In accordance with Fairchild Hiller F-27 Service Bulletin 51-2 dated February 2, 1959, as revised through December 19, 1967, the detection of cracks, during the checks prescribed by the service bulletin, was to be reported to the Service Manager, Fairchild Hiller, Aircraft Division, so that repair instructions could be forwarded. In addition, Airworthiness Directive 65-24-3 Fairchild, effective November 7, 1965, and revised April 4, 1967, required ". . .(c) inspect in accordance with Service Bulletin 51-2, Revision 8, dated September 23, 1966, including Supplements 001 through 011 or later additional supplements and revisions . . . or in accordance with an equivalent inspection program approved by the . . . FAA Eastern Region. (d) If cracks are found or if repaired cracks are found to be propagating, replace the cracked part with a part of the same part number or an FAA approved equivalent, or incorporate an FAA Engineering approved repair before further flight, except that the airplane may be flown in accordance with FAR 21.197 to a base where the repair can be made. . . ."

A review of the maintenance records of N4905 indicated that no written record reported the existence of any of the cracks listed above, and there was no record of any maintenance performed to correct or repair the cracks exhibited in the radiographs.

In view of these findings, the Board recommended to the FAA that an inspection should be accomplished of all F-27 type aircraft with 5,000 hours or more in service. Fifty-nine air carrier and eight general aviation aircraft were inspected as a result of this recommendation.. A total of 13 cracks, varying in length from 1/4 to 3 inches, were found in eight individual aircraft. This inspection also indicated that cracks were not always observable on radiographs but could sometimes be detected by other means of nondestructive testing such as dye checks. Additionally, it was found that on occasion, cracks had been detected and repaired but an adjacent crack was not repaired, even though it was known to exist. (See Appendix E.)

6/ Lengths given are those of the visible indications in the radiographs. Some cracks may have been longer but the indications ended in areas where cracks would have been obscured by changes in film density.

At the request of the Board, the manufacturer performed a series of calculations to obtain an estimate of the vertical load factors required to fail the wing of an F-27 under the accident conditions of weight, c.g., airspeed, etc. Based on these calculations, it was determined that an undamaged wing would fail at approximately + 5.7g. Additional calculations indicated that an F-27 wing containing cracks as depicted in the October 1968 radiographs would fail at approximately + 4.5g. These calculations apparently considered the fuel access door as being fully effective in carrying wing loading and there was no apparent accounting for stress concentrations at the tips of the fatigue cracks. In this connection, the Board was unable to determine the length of the existing fatigue cracks just prior to the wing failure.

The manufacturer also submitted a preliminary analysis of the events depicted on the flight data recorder traces during the time 0931 to 0932. This analysis was incomplete because of a lack of information regarding the location of several key structural components; however, it suggested that the airplane was subjected to "excessive wind shear or alternatively the aircraft's airspeed system was disoriented. There is some suggestion that the airspeed trace represents spin characteristics although, in our opinion, the characteristic indication of spin did not occur until after the extreme high speed condition."

1.16 Other Information

Federal Plan for Clear Air Turbulence

Because of concern about the problem of clear air turbulence (CAT), the National Committee on Clear Air Turbulence was formed on February 18, 1966. The Committee submitted a report in December 1966, which indicated that the availability of CAT remote detection and avoidance systems was not likely in the near future. In view of this belief, the Committee felt that it was necessary to review the meteorological programs as well as the programs related to aircraft operation, cockpit instrumentation, and pilot/aircraft relationships in turbulence.

The Committee found that full coordination of programs and accomplishments was not available among interested organizations to solve the CAT problem. It became apparent to the Committee that a national project concerning CAT and CAT projects was needed.

The Committee felt that the first order of priority should be for airborne remote detection. They stated that although forecasting Tor CAT was improving, precise forecasts of the location and time of local patches of CAT did not appear feasible. Such a system would permit pilots to avoid areas of significant CAT in the same manner that they now avoid thunderstorm and squall line turbulence through the use of radar.

7/ Paraphrased from Department of Commerce Report FCM 69-2, November 1969.

They also indicated that the requirement for an accurate prediction of CAT areas was closely related to the importance of the airborne detection system.

Recognizing the difficulties and time required to solve these problems, the Committee also considered other actions which would bring significant improvements in operations and lessen the chance of unexpected CAT encounters. These actions included: improved criteria for identifying and reporting CAT; establishment of a National CAT Forecasting Facility; maintenance of a continuous CAT watch; publication of climatological atlases showing seasonal and geographical areas of CAT; review of aircraft design criteria; and improvements in flight techniques in turbulent areas, aircraft flight instrumentation, and pilot/aircraft response in turbulence.

The Committee made several recommendations based upon its findings and the implementation of these recommendations by the Federal Coordinator for Meteorological Services and Supporting Research, formed the basis for a 5-year Federal plan to attack the CAT problem. This plan was published in November 1969, by Department of Commerce FCM 69-2, titled Federal plan for Clear Air Turbulence.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

It was established early in the investigation that the aircraft had broken up in flight, and the major thrust of the investigation was an attempt to learn what factor or factors had led to the breakup. The factors that were examined in this respect included: the weight and balance of the aircraft; the handling of the aircraft by the crew; crew incapacitation and sabotage; the weather; and the history of the aircraft with particular reference to previous structural damage.

The weight and balance were within limits both at takeoff and at the time of the accident. There was no evidence available which would indicate that the crew intentionally operated the aircraft outside the parameters established by the pilot's operating instructions and the pilot's handbook.

Both the aircrew and the aircraft were properly certificated for the operation of the aircraft in air commerce. The crew had been properly qualified for the flight and were trained in the operation of the F-27B.

The autopsies and toxicological studies, conducted as part of this investigation, revealed no evidence of crew incapacitation or interference with the normal operation of the aircraft.

Examination of the recovered wreckage revealed no evidence of an in-flight fire or explosion. The fire, observed by witnesses while the aircraft was in flight, left no evidence on the examined wreckage. The Board believes this fire resulted from the ignition of fuel escaping from the severely cracked wing skin.

There was nothing found during the investigation that suggested a lack of controllability of either the aircraft or the powerplants prior to the in-flight breakup. The Board believes, in this connection, that the right propeller was feathered by the auto-feather system rather than the flightcrew. There was nothing in the recorded conversation of the crew to indicate that they intended to feather the right propeller. Furthermore, the positions of the fuel shutoff valves for that engine were not in the position they would have been had the crew initiated the feathering sequence according to the checklist.

There were two methods of initiating the auto-feather function of the electrohydraulic control unit; either a transient negative "g" condition or a loss of torque. A transient negative "g" condition of -0.1g applied to the aircraft for more than 2 seconds could have caused an unwanted auto-feather of the propeller in this powerplant installation. This value of negative "g" would not normally be encountered in turbulence of a lesser intensity than severe. 8/

The second method of initiating an auto-feather was the detection, by the system, of a loss of torque delivered to the propeller.

When the right outer wing separated from the aircraft, it disrupted the flow of fuel to the engine and this would have caused an almost immediate loss of torque, thus initiating the auto-feather sequence.

In view of these considerations, the Board believes that the most likely cause of the feathering of the right engine was the loss of torque following the separation of the right outer wing panel. The left engine did not auto-feather because of the deactivation of the auto-feather system following the completion of the feathering cycle on the right propeller.

An investigation of the aerodynamic loads imposed on the aircraft by an inadvertent or unwanted feathering of the propeller indicated that no excessive loads would be generated nor would such an event cause a problem in controlling the yaw and roll resulting from an unwanted feathering.

The forecast weather provided to the flightcrew indicated that the weather would be suitable for the intended flight. The only significant

---

8/ See Appendix G, extracted from the Weather Bureau Operations Manual 68-12, Section 5, Issuance May 24, 1968.

forecast weather was possible moderate rime icing in clouds, and occasional light to moderate turbulence over eastern Bristol Bay below 4,000 feet.

The Board's analysis of the weather indicates that, in the area of the accident, there was a potential for severe to extreme turbulence from the surface to the tropopause at approximately 21,500 feet. 'phis condition existed because there were present:

(a) a strong mountain wave generated by an intense windflow over the mountains west and north of Iliamna; 9/

(b) a sharp trough aloft with its associated horizontal wind shear;

(c) the vertical wind shear between 9 and 12 thousand feet of approximately 6 knots per thousand feet; and

(d) the strong thermal gradient which existed in the accident area.

The Board's assessment of the turbulence at the lower altitudes was substantiated by the statements of the crews of other aircraft who had flown in these altitudes in the accident area after the accident occurred. However, no flight, other than Flight 55, traversed the accident area at the specific altitude where we believe that the severe to extreme turbulence occurred.

The post accident analysis of the weather conditions, prepared for the manufacturer by an independent meteorological consultant, was in agreement with the Board's weather analysis insofar as they both indicated that severe to extreme turbulence would have existed in the accident area and that this turbulence was not forecast.

There are deficiencies in CAT forecasts that, according to the Department of Commerce, result primarily from the inability of the forecast system to predict the location and intensity of CAT in sufficient detail or with sufficient accuracy to permit aircraft operators to select, with an acceptable degree of reliability, routes and altitudes which will avoid areas of CAT. The deficiencies of the CAT forecast production system result primarily from the following: 10/ the nature and cause of

---

9/ Severe turbulence is usually found from the surface to the tropopause and from the ridge line to 150 miles leeward when the wind over the mountain is 50 knots or higher. USAF Manual 105-5, 1962.

10/ Extracted from Federal Plan for Clear Air Turbulence, Department of Commerce FCM 69-2, November 1969.

CAT are not well understood; CAT reports are subjective, producing data which cannot be quantified; and this inadequacy precludes the establishment of a meaningful verification system; CAT reports are not sufficient in either time or space; and this inadequacy hinders not only verification procedures, but also the CAT watch and alerting system; and CAT forecasts are prepared from analyses of the atmosphere, based upon a data grid that is too gross to identify the scale of motion involved in CAT.

Based on the analysis of the available evidence, the Board believes that the aircraft encountered severe to extreme turbulence at an altitude of approximately 11,500 feet at an indicated airspeed of approximately 220 knots.

Both the flight recorders contained evidence of this encounter, and they correlate well. The FDR indicates a normal flight within the prescribed operating envelope of the aircraft with two exceptions. Between 0925:20 and 0926:20, there is an increase of airspeed depicted on the FDR trace while the altitude trace shows a decrease of approximately 50 feet. A review of the thrust available compared with the thrust required for this apparent increase of airspeed shows that there was not sufficient engine thrust available to cause this increase in indicated airspeed. Neither can this increase in indicated airspeed be accounted for by the loss of indicated altitude, nor by an encounter with a shear line or turbulence.

The second exception to normal operation of the aircraft occurred at 0931:42 when the first excursion of the binaries was recorded along with a sharp increase in the rate of descent and the indicated airspeed. Both of these traces were interrupted approximately 16 seconds later at the time of the second excursion of the binaries. About 4 seconds later, there was an interruption of electrical power to the FDR, the traces reappeared, and the traces terminated at approximately 0932:32.

The CVR also indicated a normal operation of the aircraft with two exceptions. The first detected anomaly was the failure of the CVR to record the request for clearance, the issuance of the clearance, and the acknowledgment of the clearance for a descent and approach to the Iliamna Airport. These transmissions were recorded on the ARTCC tape at 0925:29.5. There was nothing on the last 6 minutes of the CVR recording which would provide the Board with a time correlation that could be used to determine when the recording ended. CVR's normally depict the slow down of the recorder when the electrical power is removed, and this characteristic sound is easily identified. There is no indication of such an occurrence prior to the final shutdown of the recorder which was apparently caused by the removal of electrical power from the recorder.

The last 6 minutes of recorded conversation did not relate to the operation of the aircraft and was general in nature. Approximately 15 seconds before the end of the recording, the first loud noises were recorded, followed by the sound of the landing gear warning horn and the overspeed clacker. Then followed the crew comments "Landing gear Up" and "Think we're in trouble," a second loud noise, and the recording ended.

The Board believes that these two time intervals of 14 and 15 seconds were coincident and resulted from the encounter with turbulence. The Board also believes that this point in the flight was observed by the ground witnesses who reported that they first observed a ball of fire and a puff of smoke, and that the aircraft continued to fly for a short period of time before pieces separated, and the aircraft entered a spin which continued into the ground.

The aircraft was operated in a normal fashion through the flight, and a descent was initiated by the pilots following receipt of their clearance from Anchorage ARTCC. This descent was continued for about 5:40 minutes in a normal manner, with an average rate of descent of less than 1,000 feet per minute and an airspeed less than the limiting airspeed. At 0931:42, the aircraft encountered turbulence which was reflected on the FDR by the excursion of the binaries, the sharp increase in rate of descent, and a fluctuation of indicated airspeed; and resulted in the first loud noise recorded by the CVR.

The loads induced on the structure cannot be accurately determined because of the failure of the FDR to accurately record the "g" levels imposed on the aircraft; the lack of information regarding the exact nature and magnitude of the turbulence encountered; and a lack of information to calculate the dynamic response of the aircraft. However, these loads were sufficient to fracture the bottom surface of the wing through the area where the fatigue cracks existed. This failure was probably the loud noise recorded by the CVR which was then followed by the sounds of the warning devices and the crew's exclamations.

The sounding of the landing gear warning was probably the result of the jolting of the landing gear handle out of the up and locked position, and the overspeed clacker was probably activated when the pitot static system sensed an apparent high speed due to a change in relative wind in the turbulence. The period of 14 seconds between the recording of the first loud noise and the second loud noise was probably the period of time that the witnesses observed the aircraft continuing after the appearance of the ball of fire and the cloud of smoke. During this time period, the fuel escaped from the wing and was probably ignited by the engine exhaust. The resulting flame and smoke was visible to the ground witnesses but not to the aircrew. The crew was confronted with a turbulent flight condition accompanied by loud noises and warning devices which took their full attention. The failure of the wing section had weakened the wing to such an extent that it was no longer able to withstand the loads imposed on it by continued flight in the turbulent conditions that existed, and the wing finally failed completely and separated from the aircraft. As the wing separated from the aircraft, the aircraft entered the spin which was observed by the witnesses. This flight condition was recorded by the FDR as the aberrant excursions of the binaries as well as the airspeed and altitude traces.

As previously stated, there were anomalies in the FDR and the CVR; the failure of the CVR to record the conversation between the crew and the ARTCC regarding the clearance to Iliamna, and the FDR indication of a rise in airspeed with no corresponding loss of altitude. The Board, cannot offer an explanation for these phenomena; however, it has been determined that even though they are puzzling, they would not affect our analysis of the causal areas of this accident.

There was evidence in the metallurgical studies of the fatigue cracks near WS 197 of the right wing that there might have been some recent (relative to the accident time) tearing of the metal which occurred at a more rapid rate than normally occurs in fatigue crack propagation. While this condition cannot be pinpointed exactly in time relative to the accident, it might have been the result of an encounter with turbulence prior to the separation of the wing.

The aircraft was not in compliance with the existing airworthiness directives at the time of takeoff from Anchorage on this flight and had not been, within the scope of the maintenance requirements, airworthy for a considerable period of time before the accident. The existence of cracks in both wings was evident on the radiographs prepared in October 1967 and subsequently. The presence of these cracks required corrective action on the part of the carrier in order to comply with the Airworthiness Directives issued by the FAA November 7, 1965, as revised April 4, 1967. The aircraft records indicated that the inspection requirements of this AD had been last complied with at an aircraft time of 16,997.47 and 17,194.49 hours. There was nothing in the aircraft maintenance records to indicate that the cracks were detected and no action had been taken to correct them, as required by the AD.

Based on the record of this investigation, there was no apparent explanation for the failure of the Wien Airline quality control inspector to detect the cracks displayed in the radiographs. He had been trained in the examination of radiographs, and the Service Bulletin provided clear instructions regarding the areas on the radiographs that should be examined for cracks. In addition, the bulletin contained figures showing a typical access door area with cracks at the edges of the fastener holes and a typical radiograph with the areas where cracks might be found marked off with dashed lines.

The special inspection conducted by the FAA indicated that similar cracks existed in aircraft operated by other carriers and that these cracks had not been noted in the aircraft records. Based on these findings, it appears that quality control personnel are not adequately trained to read radiographs; the cracks were not easily identifiable on radiographs; or, some combination of these factors existed.

There are many AD's that require the use of radiographs for inspection purposes in addition to the one cited above. Because of the importance of adequately complying with these AD's, the Board believes that the aviation community would benefit if increased emphasis were placed on the proper qualification of personnel charged with the conduct of radiographic inspections and with the interpretation of radiographs.

In summary, the Board believes that this aircraft was subjected to severe-to-extreme turbulence while descending to land at Iliamna. This resulted in incremental load factors being imposed on the wing that were in excess of the ultimate load carrying capability of the cracked wing and the structure failed at its weakest point, near WS 197. The right wing failed, releasing fuel which ignited, and the wing subsequently separated from the aircraft.

The turbulence that was encountered by the aircraft was not forecast and was not detectable by the crew.

While the fatigue cracks present in the wing contributed to the failure of the wing, the Board is unable to determine the magnitude of this contribution. The extent of the detrimental effect of the fatigue cracks could not be assessed accurately because of the indefinite nature of the terminal stage of fatigue cracking and the possibility of rapid extension of the pre-existing cracks before the wing failed.

2.2 Conclusions

(a) Findings

1. The weight and balance of the aircraft were within limits at takeoff and at the time of the accident,

2. The crew operated the aircraft in accordance with the approved operating instructions. There is no evidence to indicate that they intentionally exceeded the operating limitations of the aircraft during this flight.

3. Both the aircraft and the aircrew were properly certificated.

4. The crew had been properly qualified for the flight and were trained in the operation of the F-27B.

5. There was no evidence of flightcrew incapacitation or interference with the normal operation of the aircraft.

6. There was no evidence of an in-flight fire or explosion other than the fireball observed by ground witnesses. This fireball occurred after disruption of the structure and left no evidence of its existence on the recovered wreckage.

7. There was no evidence of a loss of control of either the aircraft or powerplants prior to the separation of the right outer wing.

8. The right propeller was feathered by the auto-feather system a6 a result of a loss of engine torque. The left propeller was prevented from auto-feathering by the design of the system.

9. The weather forecast provided to the crew indicated that the weather conditions would be suitable for the planned flight. There was no indication of severe weather in the forecasts.

10. The crew requested and received a clearance for a descent and approach to Iliamna Airport.

11. During the descent, at approximately 11,500 feet, the aircraft encountered turbulence, severe to extreme in nature. This turbulence was not forecast and was not detectable by the crew.

12. The encounter with turbulence resulted in a structural failure of the right wing in an area that had been previously weakened by fatigue cracking.

13. Fatigue cracks had existed in this area of the wing since October 1967. These cracks had never been reported and no corrective action had been taken to repair the wing.

14. There were Airworthiness Directives and Service Bulletins requiring inspections to detect this type of crack and providing instructions for their repair.

15. Although the aircraft records indicated that the aircraft was airworthy, the radiographs taken of the wing structures indicated that fatigue cracks existed in both wings. Because of the presence of these cracks, the aircraft was not in compliance with existing airworthiness directives.

(b) Probable Cause

The Board determines that the probable cause of this accident was an in-flight structural failure caused by an encounter with severe to extreme turbulence. This turbulence was not forecast and its presence was not known to the flightcrew. The failure occurred in an area of the right wing (WS 197) which had been weakened to an indeterminate degree by pre-existing fatigue cracks.

3. RECOMMENDATIONS

On December 23, 1968, the Board advised the Administrator, Federal Aviation Administration, that our investigation of this accident had revealed the presence of fatigue cracks in the wing of the accident aircraft. The Board had.previously recommended that the Administrator initiate a special inspection of F-27 and FH-227 aircraft to determine whether such cracks might exist in other aircraft.

The Administrator issued a telegraphic Airworthiness Directive regarding the recommended inspection and reported to the Board that 59 air carrier and eight general aviation aircraft had been inspected. Eight aircraft were found to have cracks in the suspect area. The Administrator also indicated that he was continuing a reassessment of design and inspection data in order to determine what additional actions might be needed to assure adequate structural integrity of these aircraft. (See Appendix E.)

On December 30, 1968, the Board advised the Administrator that it believed the finding that the Rolls-Royce Dart engine/Dowty Rotol propeller combination could auto-feather under a -0.1g condition for no longer than 2 seconds was a hazardous operational characteristic. The Board recommended that all operators of the affected aircraft types be expeditiously advised on this matter, and that followup action be accomplished to bring airplane flight manuals in consonance with the intent of certain of the Federal Aviation Regulations. It was also recommended that this condition be considered during future certification proceedings of similar installations.

The Administrator replied that this problem had been under evaluation by the FAA since September 30, 1968. He had requested the manufacturers of the affected aircraft to prepare and issue appropriate airplane flight manual revisions to warn the pilot of the possibility of propeller auto-feathering in negative "g" encounters. The operators of all affected aircraft were alerted to this problem through issuance of an operations alert bulletin. (See Appendix H.)

The Board believes that increased emphasis on the training and physical qualifications of radiograph interpreters, as well as the proper interpretation of radiographs, should become a matter of continuing concern to the FAA and to the aviation community.

Finally, the Board advocates the program incorporated *in* the Federal Plan for Clear Air Turbulence described in Department of Commerce Publication FCM 69-2, dated November 1969. In this connection, the Board, on March 26, 1968, recommended, inter alia, to the Administrators of the Federal Aviation Administration and the Environmental Science Services Administration, the establishment of a Clear Air Turbulence Forecasting Center similar to the Weather Bureau Severe Local Storms Unit at Kansas City, Missouri.

Both the Weather Bureau and the Federal Aviation Administration support the establishment of such a facility, and the FAA is ready to provide the necessary communication support and other FAA coordination required. Included in the Federal plan referenced above, is a requirement for a forecasting center. Funds for this center have been requested by the Weather Bureau.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

/s/ JOHN H. REED
Chairman

/s/ OSCAR M. LAUREL
Member

/s/ FRANCIS H. McADAMS
Member

/s/ LOUIS M. THAYER
Member

Isabel A. Burgess, Member, did *not* participate in the adoption of this report.

July 22, 1970.

INVESTIGATION

1. Investigation

The Board received notification of the accident at approximately 1000 Alaskan standard time on December 2, 1968. The investigation was conducted by the Alaskan Field Office with technical assistance from the Board's Washington headquarters. Working groups were established for Operations, Weather, Structures, Powerplants, Aircraft Systems, Human Factors, Aircraft Maintenance Records, Flight Data Recorder, and Cockpit Voice Recorder.

Interested Parties who participated in the investigation included: The Federal Aviation Administration; Wien Consolidated Airlines, Inc.; Air Line Pilots Association; Rolls-Royce; Dowty-Rotol; and the Fairchild Hiller Corporation.

The on-scene investigation was completed December 18, 1968.

No public hearing was held and no preliminary report was issued in this case.

CREW INFORMATION

Captain Milford D. Stanley, 37, was regularly employed by Wien Consolidated Airlines. He held airline transport pilot certificate No. 13000114, with airplane multiengine land and Fairchild F-27/227 aircraft ratings. He also held a current Class I medical Certificate with no limitations or waivers noted.

Captain Stanley had a total of 10,557 hours flying time recorded, which included 5,357 hours in the F-27 aircraft.

Captain Stanley completed his initial ground school on the F-27 on April 19, 1960, and qualified as a captain October 17, 1960. His last recurrent ground school was in April 1968. and he satisfactorily completed a 12-month check July 30, 1967, and his latest route check October 19, 1968.

First Officer Jerry T. Svendgard, 44, possessed commercial pilot certificate No. 1261070, with airplane single- and multiengine land and sea, and instrument ratings. He possessed a current Class I medical certificate that required him to possess correcting lenses while exercising the privileges of his certificate.

Mr. Svendgard had 12,087 hours of recorded flying time. He completed the initial ground school in the F-27 on June 22, 1967, and checked out in the aircraft on July 13, 1967, as a first officer. His latest 12-month check was completed on August 31, 1968, with all maneuvers completed in a satisfactory manner.

Stewardess Sally Lamar completed her initial training on May 28, 1968, and was flight-checked on August 28, 1968. Her last emergency training on the F-27 was completed May 23, 1968.

LEGEND:

1. VERTICAL STABILIZER
2. INBOARD HALF OF LEFT ELEVATOR
3. SECTION OF OUTBOARD END OF LEFT AILERON WITH PORTION OF TAB ATTACHED
4. SECTION OF LEFT WING FUEL TANK BAFFLE
5. LEFT WING LEADING EDGE AND TIP - WS-440- WS-562
6. LEFT ENGINE WATER METHANOL SHROUD TUBE
7. SECTION OF LEFT WING LEADING EDGE HONEYCOMB
8. SECTION OF AFT FUSELAGE - FS-730 - FS-779
9. PIECE OF ALUMINUM ANGLE
10. SECTION OF INBOARD END OF LEFT AILERON WITH SECTION OF TAB ATTACHED
11. PIECES OF ROTATING BEACON LIGHT LENS
12. FRONT LEFT HAND ATTACHMENT FOR HORIZONTAL STABILIZER
13. SECTION OF LEFT WING LEADING EDGE - WS-322- WS-440
14. ELEVATOR CONTROL STOPS
15. SKIN AND FRAME WITH GUST LOCK
16. SECTION OF LEFT WING REAR SPAR CONTAINING OUTBOARD FLAP TRACK AND JACKSCREW
17. LOWER HALF OF RUDDER WITH BALANCE TAB ATTACHED
18. ENGINE PUSH-PULL ROD
19. UPPER HALF OF RUDDER
20. CENTER PORTION OF LEFT AILERON
21. LEFT ENGINE MOUNT ATTACHING LUG EAR
22. LEFT ENGINE FUEL HEATER AND LINE
23. LEFT ENGINE STARTER HARNESS
24. LEFT ENGINE MOUNT LEG
25. CABLE TENSION REGULATOR
26. LEFT ENGINE MOUNT - TWO LEGS
27. LEFT ENGINE MOUNT LEG
28. ACCESSORY GEAR BOX DOOR
29. LEFT ENGINE RUBBER COWL SEAL
30. LEFT ENGINE AND PROPELLER

PHOTO "A"
AERIAL VIEW OF FOXIES
LOOKING WEST

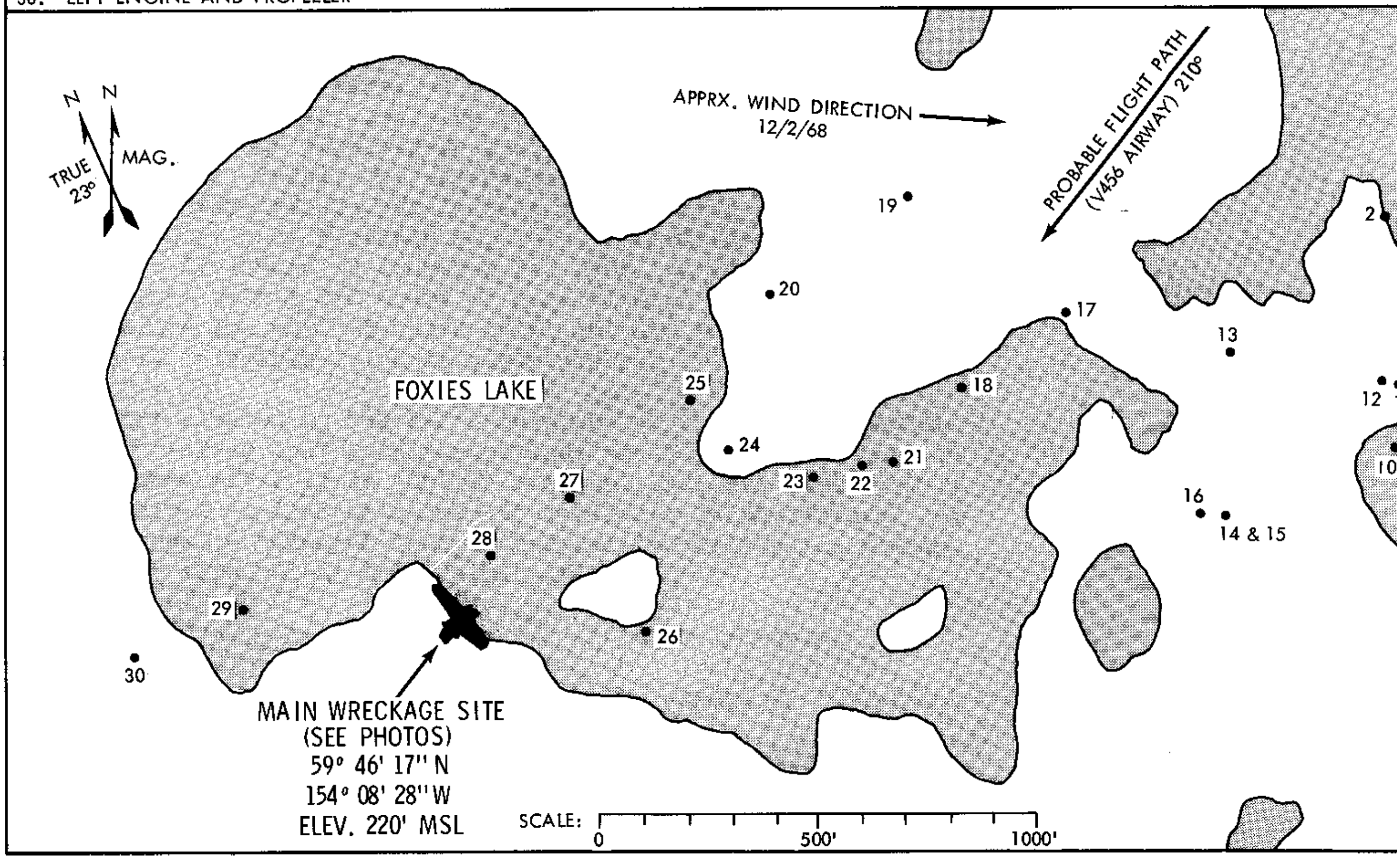


PHOTO "A"
AERIAL VIEW OF FOXIES LAKE
LOOKING WEST

PHOTO "B"
AERIAL VIEW LOOKING SOUTHEAST
FROM MAIN WRECKAGE SITE

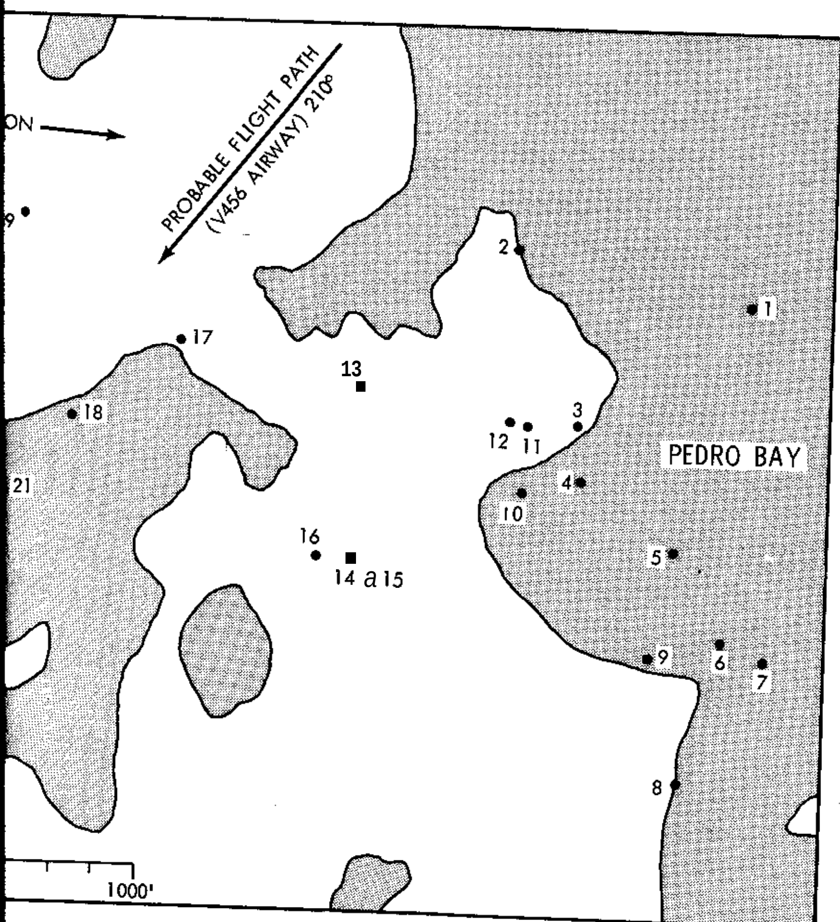
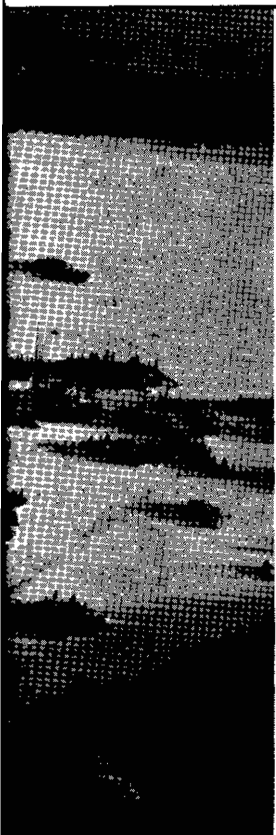


PHOTO "C"
MAIN IMPACT AREA

APPENDIX D



)TO "B"
)OKING SOUTHEAST
WRECKAGE SITE

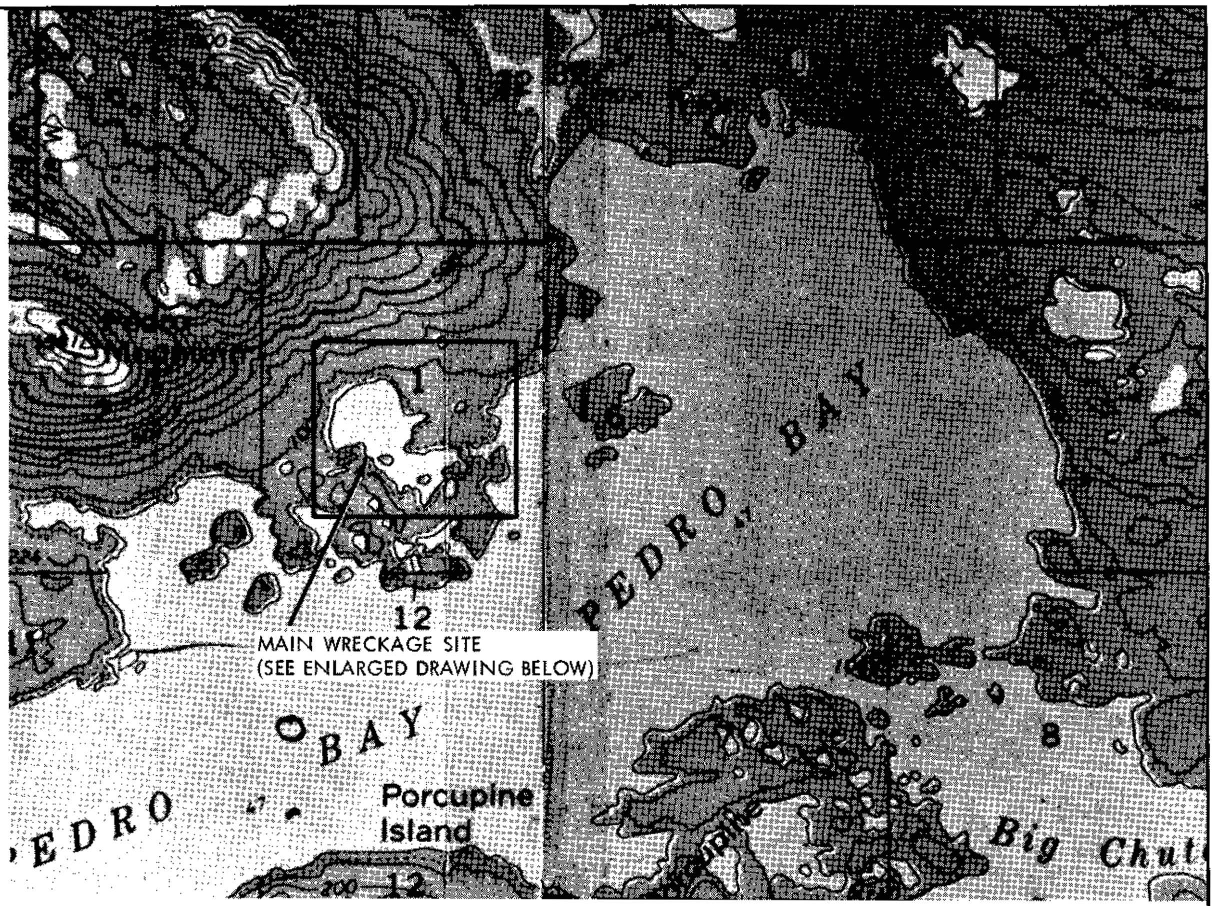


PHOTO "C"
MAIN IMPACT AREA

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
Washington, D.C.

WRECKAGE DISTRIBUTION CHART
DCA-69-A-6, WIEN CONSOLIDATED AIRLINES
F-27B, N4905
23 MI. E. OF ILIAMNA, ALASKA
DECEMBER 2, 1968

C
O
P
Y

NATIONAL TRANSPORTATION SAFETY BOARD
DEPART " OF TRANSPORTATION
WASHINGTON, D. C. 20591

December 23, 1968

Mr David D. Thomas
Acting Administrator
Federal Aviation Administration
Department of Transportation
Washington, D. C. 20590

Dear Mr. Thomas:

This is to confirm the telephone conversations on December 17 and 19, 1968, between our Director, Bureau of Aviation Safety, and your Director, Flight Standards Service, in which we pointed out the findings of our investigators in the Wien Alaska Airlines F-27, N4905, accident at Iliamna, Alaska, on December 2, 1968. Our investigation disclosed chordwise fatigue cracks at Station 197 both fore and aft of the inboard fuel tank access panel on the right wing. Each of these cracks was approximately three inches long.

The Board was convinced by its findings that neither the X-ray techniques utilized in complying with AD 65-24-3 nor the interpretation of the X-ray plates were adequate to assure early detection of such fatigue cracks. We understand that these findings and the preliminary findings of your inspectors resulting from your inspection alert published December 18, 1968, formed the basis for a telegraphic AD issued on December 19, 1968, to inspect all F-27 type aircraft with 5,000 hours or more time in service for such cracks before the next 25 hours of flight and to restrict such aircraft until this inspection is accomplished.

We were pleased at the FAA's response to our recommendation and are satisfied that such inspections and followup actions, which will be taken after these initial examinations, are essential to insure against similar catastrophic accidents in the future. We would appreciate being advised of the results of the inspections required by this recent telegraphic AD.

Sincerely yours,

/s/ Joseph J. O'Connell, Jr.

Joseph J. O'Connell, Jr.
chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF THE ADMINISTRATOR

JAN 8 1969

Honorable Joseph J. O'Connell, Jr.
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This is in reply to your letter of December 23, 1968, in which you request the results of the F-27/FH-227 inspections required by our telegraphic airworthiness directive (AD) of December 20, 1968. This AD was issued subsequent to the Wien Alaska Airlines F-27, N4905, accident at Iliamna, Alaska. The results of the inspections on 59 air carrier and eight general aviation aircraft have been reported. Thirteen cracks varying in length from 1/4 to three inches in the wing cover at stations 194 to 204 have been found on eight aircraft. The total flight time on the airplanes with cracks varied from 25,600 to 28,800 hours. We have enclosed a detailed summary of the findings.

We are continuing our re-assessment of design and inspection data in order to determine the additional actions which may be needed to assure adequate structural integrity.

Sincerely,

D. D. Thomas
Acting Administrator

Enclosure

December 30, 1968

F-27/FH-227 Inspections

Carrier	No. aircraft require	No. aircraft inspected to	Remaining to be inspected	Remarks
[illegible]	1	1	0	Negative Results
[illegible]	0	0	0	5,000 FH-227s, all under [illegible] Two high time aircraft inspected. Negative results.
Allegheny	8	8	0	All inspections per maintenance alert. Negative results.
Mohawk	8	8	0	18 total; only 8 aircraft over 5,000 hours; 8 inspections: negative results.
Northeast	3	3	0	Negative results.
Air West	34	34	0	11 cracks N 2701 1½" @ STA 204 R. H. (X-ray) Total time 28820. 490 hours since last inspection. N 2710 2" @ STA 198 R. H. (X-ray) ½" @ STA 204 R. H. (dye check) not visible on X-ray). Total time 25620. 630 hours since last inspection. N 746L New 2" crack at STA 197 detected by X-ray in laminations 1" away from previous 2.8" crack at 198 in external skin. Previous repair @ 15900 hours takescare of "new" crack. Back in service. Total time 24440. 720 hours since last inspection. "New" 2" crack has existed 24 years and was known at time of repair. N 2711 2 ¼" cracks left wing @ STA 198 at land screw hole, ½" @ STA 197 starts at hole. Total time 26370. 650 hours since last inspection.

Carrier	No. aircraft require inspection	No. aircraft inspected to date	Remaining to be inspected	Remarks
				N 2705 3/4" @ Str. 5 and 1" @ Str. 7 @ STA 198. Total time 28750. 90 hours since last inspection. N 2773 2" @ Str. 7 and 1" @ Str. 5 @ STA 197 left wing. Total time 20710. 940 hours since last inspection. N 2777 Suspected crack was not present. Miscellaneous N 2708 was suspect Sunday; confirmed no cracks on Monday. N 2771 ¼" @ Str. 5, thru outer skin of land rivet, 1½" @ Str. 7 thru land on plate nut and Outer skin @ STA 194 right wing. Total time 20530. 990 hours since last inspection.
Wien	5	5	0	~~4904~~ crack 4903 2" to 3" crack
Ozark	0	0	0	21 FH-227's No aircraft at 5000 hours (FH-227 N 4215 4700 hours. Scheduled for inspection 1/6/69)
Avco	1	1	0	N 1004 Negative results. Total time 5761 hours.
S. East	1	1	0	Negative. 13653 hours. 403 hours since last inspection.
Johns Manville	1	1	0	Negative
IBM	2	2	0	Negative. Total timc 6848 and 5844 hours.
Totals	64	64	0	13 cracks in 8 airplanes.

WINDS ALOFT

ANCHORAGE

0200

Height Feet x 1,000 m.s.l.	Direction Degrees True	Velocity Knots
(Surface)	020	9
1	040	10
2	090	7
3	140	10
4	140	14
6	150	20
7	160	20
8	170	19
9	185	17
12	190	18
14	175	19
16	140	16

1400

(Surface)	360	12
1	360	22
2	360	21
3	360	23
4	340	22
6	010	10
7	080	8
8	125	15
9	120	21
12	140	19
14	140	19
16	140	17

King Salmon

0200

(Surface)	360	6
1	350	17
2	330	20
3	325	24
4	330	25

Height Feet X 1,000 m.s.l.	Direction Degrees True	Velocity Knots
6	315	33
7	310	36
8	305	42
9	305	45
12	305	39
14	300	36
16	300	30

1400

Height Feet X 1,000 m.s.l.	Direction Degrees True	Velocity Knots
(Surface)	100	3
1	360	15
2	335	21
3	325	23
4	325	27
6	320	42
7	310	48
8	310	55
9	310	61
12	310	80
14	310	68
16	310	74

TURBULENCE REPORTING CRITERIA TABLE

INTENSITY	AIRCRAFT REACTION	REACTION INSIDE AIRCRAFT	REPORTING TERM-DEFINITION
Light	**Turbulence that momentarily causes slight, erratic changes in altitude and/or attitude (pitch, roll, yaw). Report as Light Turbulence;*** w **Turbulence that causes slight.** rapid and somewhat rhythmic bumpiness without appreciable changes in altitude or attitude. Report as **Light Chop**.	Occupants may feel a slight strain against seat belts or shoulder straps. Unsecured objects may be displaced slightly. Food service may be conducted and little or no difficulty is encountered in walking.	Occasional - Less than 113 of me time. Intermittent - 1/3 to 2/3. Continuous - More than 2/3.
Moderate	Turbulence that is similar to Light Turbulence but of greater intensity. Changes in altitude and/or attitude occur but the aircraft remains in positive control at all times. It usually causes variations in indicated airspeed. Report as **Moderate Turbulence;*** **or** Turbulence that is similar to Light Chop but of greater intensity. It causes rapid bumps or jolts without appreciable changes in aircraft altitude or attitude. Report as **Moderate Chop.**	Occupants feel definite strains against seat belts or shoulder straps. Unsecured objects are dislodged. Food service and walking are difficult.	**NOTE** 1. Pilots should report location(s), time (GMT), intensity, whether in or near clouds, altitude, type of aircraft and, when applicable, duration of turbulence. 2. Duration may be based on time between two locations or over a single location. All locations should be readiiy identifiable. **EXAMPLES:** a. Over Omaha, 12322. Moderate Turbulence, in cloud. Flight Level 310. *8707.* b. From *50* miles south of Albuquerque *to* 30 miles north of Phoenix. 12102 to 1250Z, occasional Moderate Chop, Flight Level 330, DC8.
Severe	Turbulence that causes large, abrupt changes in altitude and/or attitude. It usually causes large variations in indicated airspeed. **Aircraft may be** momentarily out of control. Report as **Severe Turbulence.** *	Occupants are forced violently against seat belts or shoulder straps. Unsecured objects are tossed about. Food service and walking are impossible.	
Extreme	Turbulence in which the aircraft is violently tossed about and is practically impossible to control. It may cause structural damage. Report as **Extreme Turbulence.***		

* High level turbulence (normally above 15,000 feet ASL) not associated with cumuliform cloudiness, including thunderstorms, should be reported as CAT (clear air turbulence) preceded by the appropriate intensity, or light or moderate chop.

SC/AMS Meeting 7/67

Exhibit D-20-7: Turbulence Reporting Criteria Table

FORECASTING GUIDE ON TURBULENCE INTENSITY

	DERIVED GUST VELOCITY AND TYPICAL RESPONSE OF MOST AIRCRAFT			FREQUENTLY ASSOCIATED METEOROLOGICAL EVENTS			
		Incremental 2/ Vertical Acceleration					
INTENSITY	Ude 1/	Root Mean Square	Peak	Vertical Wind Shear 3/	Convective Clouds 4/	Surface Winds 5/	Mountain Wave
Light	5 to 20 fps	Less than .2 g	Absolute Value >.2 to .5 g	3-5 kts per 1000 ft	Fair weather cumulus and altocumulus	When surface winds exceed 15 kts and where air is colder than the underlying surface	See Footnote 6/
Moderate	> 20 to 35 fps	.2 to .3 g	Absolute Value > .5 to 1.0 g	6-9 kts per 1000 ft	Thunderstorms, cumulonimbus, and towering cumulus	When surface winds exceed 25 kts or atmosphere is unstable due to strong insolation or cold air advection	See Footnote 6/
Severe	> 35 to 50 fps	>.3 to .6 g	Absolute Value >1.0 to 2.0 g	10 kts or more per 1000 ft	Mature or rapidly growing thunderstorms and occasionally with cumulonimbus or towering cumulus	Not specified	See Footnote 6/
Extreme	More man 50 fps	Over .6 g	Absolute Value >2.0 g	Not specified	Severe thunderstorms	Not specified	See Footnote 6/

FOOTNOTES:

1/ **Ude.** The derived gust velocity, Ude, is only a rough approximation of true vertical gust velocity. See Federal Aviation Regulations, Part 23, paragraph 23.341 and Part 25, paragraph 25.341.

2/ **Incremental Vertical Acceleration.** As measured at the center of gravity of an aircraft. For a given intensity of atmospheric turbulence, these accelerations depend on weight, airspeed, and design characteristics of the aircraft. These values are for guidance only and do not indicate precise limits.

3/ **Vertical Wind Shear.** These values (vectors) are statistically typical for a layer 5,000 feet thick as obtained from rawinsonde data encoded for teletypewriter transmissions. *Turbulence of* these specified intensities is not always present.

4/ **Convective Clouds.** Turbulence associated with convective clouds may be present in the immediate environment of, as well as in, the cloud systems. Severe turbulence may be present in some portion of any thunderstorm. Extreme turbulence may be present in some portion of any mature or rapidly growing thunderstorm. Superadiabatic lapse rates near the surface also may produce moderate tubulence.

5/ **Surface Winds.** Depends on terrain roughness and stability as well as wind speed. Interactions are *often* present between low-level convective activity and mechanical turbulence.

6/ **Mountain Wave.** Moderate or greater turbulence may be found with strong winds generally normal to the mountain ridge, wind speed increasing with height and relatively stable layers. Turbulence is likely at levels near the ridge height, in relatively stable layers and at the tropopause. Turbulence layers may be up to about 5,000 feet thick and may extend 50 to 100 miles downstream. The presence of troughs and jet streams can enhance wave development. Wind-shear turbulence and mountain wave activity may interact to produce variations in turbulence over a wide range of altitudes. Severe or occasionally extreme turbulence may be found in or near rotor clouds and may extend to the ground. Turbulence may be present in mountain waves even though there is insufficient moisture available for the formation of lenticular or rotor clouds.

SC/AMS Meeting 7/67

Exhibit D-20-8: Forecasting Guide on Turbulence Intensity

C
O
P
Y

NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON, D. C. 20591

December 30, 1968

Mr. David D. Thomas
Acting Administrator
Federal Aviation Administration
Department of Transportation
Washington, D. C. 20590

Dear Mr. Thomas:

It has come to the Board's attention that operation of aircraft powered by the Rolls-Royce Dart engine/Dowty Rotol propeller installation under a negative "g" condition, even at only -0.1g for no longer than two seconds, can cause automatic propeller feathering.

This is a potentially hazardous operational characteristic unless the crew is forewarned of the reason for such auto-feathering and of the appropriate corrective action. Without this awareness, the unexpected loss of power and/or the sudden asymmetric parer condition could be serious, especially if the triggering negative "g" were a result of atmospheric turbulence when aircraft control might already be marginal. In addition, there is the possibility of engine failure as a result of the overtemperature that would accompany auto-feathering under these conditions, if prompt remedial action is not taken.

The automatic feathering systems in question are designed to initiate auto-feathering when two basic conditions are met: (1) cockpit power lever setting is above that representing a certain cruise range rpm, and (2) the engine torquemeter oil pressure is below a triggering value, usually set at 50 psi. In addition, there is an interlock arrangement in the twin-engine installation so that auto-feathering action can take place only if not already initiated in the other propeller. However, there are two four-engine aircraft, the Vickers Viscount and the de Havilland Argosy AW-650, in which auto-feathering can take place in all four propeller systems simultaneously under these conditions.

The reduced engine oil pressure accompanying negative "g" operation is the auto-feather triggering element. Rolls-Royce has been cognizant of this inherent characteristic of the Dart oil system, and published information thereof in a March 1965 revision to the various Dart engine model operating instructions, in the following manner:

> "Negative 'g' maneuvers should be avoided where possible. If, however, sustained negative 'g' flight is encountered, close both throttles to **IDLE** until normal flight is resumed and normal oil pressure is restored. This action will prevent any tendency of the auto-feathering circuit to energize through a temporary reduction in oil pressure in the torque measuring system."

However, there has been a lack of followthrough in appropriately apprizing the flightcrews of this auto-feathering mode. It is considered that this information should be in the applicable Airplane Flight Manuals in consonance with the intent of Section 25.1501 and of Paragraphs 25.1581(c) and 25.1587(c)(4) of the Federal Aviation Regulations.

It is therefore recommended that all operators of the affected aircraft types be expeditiously advised on this matter, and that followup action be accomplished for twin-engine installations in the form of Airplane Flight Manual revisions along the lines of the above-quoted Rolls-Royce advisory. For the four-engine installations, the recommended method of accomplishing the basic purpose is to prescribe deactivation of the auto-feathering systems when turbulence is encountered, or at any other time negative "g" operation might be anticipated. This second method is suggested as an alternative, or supplemental, method for the twin-engine installations.

The known affected aircraft operational in this country are the Grumman Gulfstream G-159, the Fairchild F-27, the Fairchild Hiller FH-227, the Vickers Viscount, the Convair 600, the Convair 640, the deHavilland Argosy AW-650, and the Nihon YS-11. Close to 500 aircraft are involved among these types.

The above recommended measure, of making these negative "g" powerplant phenomena and operating techniques common knowledge among operational people, is considered the optimum action to be taken at this time for currently certificated aircraft. In consideration of future certifications, it is presumed that, under a comparatively recent addition to the FAR's, turbine-powered aircraft will no longer be certificated with powerplant operation as sensitive to negative "g" forces. Section 25.939, "Turbine Engine Operating Characteristics," now is additionally specific in this area by stating that no hazardous malfunction may occur under negative acceleration and that "This must be shown for the greatest duration expected for that acceleration."

However, we are taking this opportunity to recommend that full cognizance be taken of the inadvertent negative "g" probabilities when judgments are made, during future certification proceedings, regarding compliance with Section 25.939. Airworthiness is, of course, involved as long as aircraft are occasionally subjected to sustained negative "g" forces resulting from operation in extreme turbulence, with the attendant tendencies toward reductions in fuel and oil pressures. It is suggested that possible magnitudes and durations of negative "g," for which allowances should be made, could be obtained from flight recorder readouts of extreme turbulence encounters.

A recent airline experience serves as a case in point illustrating some cause of our concern. An Air West F-27 encountered extreme turbulence on November 6, 1968, during an instrument approach to North Bend, Oregon. Negative "g" and auto-feathering of the right propeller were experienced. Passenger injury was sustained as a result of the violent yaw induced by the auto-feathering. Apparently, prompt corrective action by the pilot was largely responsible in averting a serious accident. But if the pilot had been forewarned with the aforementioned negative "g" advisory, it is likely that he would have been forearmed sufficiently to have circumvented the sudden auto-feathering and yaw.

A Board representative has discussed the foregoing with personnel of your Flight Standards Service in New York as well as here in Washington. Our technical staff is available to provide you with further information or assistance as required.

Sincerely yours,

/s/ Joseph J. O'Connell, Jr.

Joseph J. O'Connell, Jr.
Chairman

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

WASHINGTON, D.C. 20590

OFFICE OF
THE ADMINISTRATOR

JAN 1 G 1969

Honorable Joseph J. O'Connell, Jr.
Chairman, National Transportation Safety Board
Department of Transportation
Washington, D. C. 20591

Dear Mr. Chairman:

This is in reference to your letter of December 30, 1968, concerning a potentially hazardous operational characteristic of aircraft powered by the Rolls-Royce Dart engine/Dowty Rotol propeller combination due to the occurrence of propeller autofeathering in certain negative "g" flight conditions.

This problem has been under evaluation by the Federal Aviation Administration since receipt of information from the Navy on September 30, 1968, that an unwanted autofeather was encountered during flight testing in accordance with Navy procedures. As a result of these evaluations, we have requested the manufacturers of the affected aircraft to prepare and issue appropriate airplane flight manual revisions which will warn the pilot of the possibility of propeller autofeathering in negative "g" encounters. This action is in agreement with your recommendations. Operators of all of the affected aircraft are being alerted to this problem through issuance of an operations alert bulletin. Possible deactivation of the autofeathering system on twin-engine installations in anticipation of known turbulence penetration or sustained negative "g" flight is also being considered in discussions with the affected manufacturers.

Your suggestion to obtain data on possible magnitudes and durations of negative "g" experience from flight recorder readouts of extreme turbulence encounters has merit. We would appreciate your continuing to provide us with flight recorder reports of turbulence encounters. We have already requested advance data on the Air West autofeathering occurrence mentioned in your letter.

We will inform you of the precautionary instructions that are issued for the affected airplanes.

Sincerely,

D. D. Thomas

D. D. Thomas
Acting Administrator