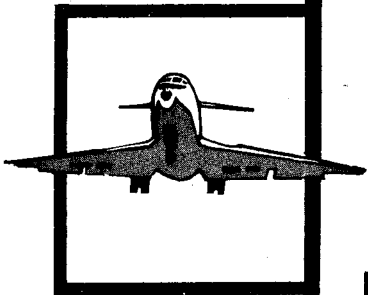
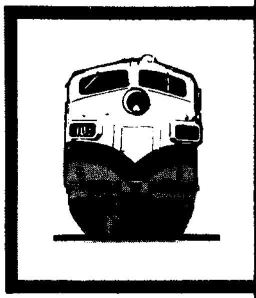
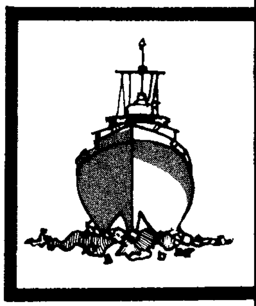
PB88-910409



NATIONAL TRANSPORTATION SAFETY BOARD

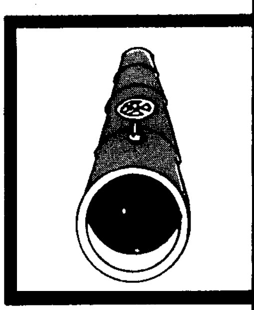


WASHINGTON, D.C. 20594

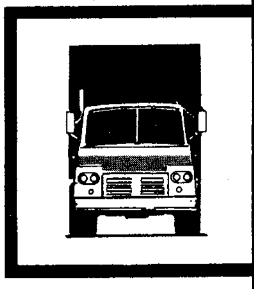


AIRCRAFT ACCIDENT REPORT

EXECUTIVE AIR CHARTER, INC.,
dba AMERICAN EAGLE, FLIGHT 5452
CASA C-212, N432CA
MAYAGUEZ, PUERTO RICO
MAY 8, 1987



NTSB/AAR-88/07



UNITED STATES GOVERNMENT

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. NTSB/AAR-88/07	2. Government Accession No. PB88-910409	3. Recipient's Catalog No.

4. Title and Subtitle Aircraft Accident Report--Executive Air Charter, inc., dba American Eagle, Flight 5452, CASA C-212-CC, N432CA, Mayaguez, Puerto Rico, May 8, 1987

5. Report Date
August 2, 1988

6. Performing Organization Code

7. Author(s)

8. Performing Organization Report No.

9. Performing Organization Name and Address

National Transportation Safety Board
Bureau of Accident Investigation
Washington, D.C. 20594

10. Work Unit No.
4677A

11. Contract or Grant No.

12. Sponsoring Agency Name and Address

NATIONAL TRANSPORTATION SAFETY BOARD
Washington, DC. 20594

13. Type of Report and Period Covered

Aircraft Accident Report
May 8, 1987

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

On May 8, 1987, at 0650, local time, Executive Air Charter, Inc., doing business as American Eagle, flight 5452 crashed short of runway 9 while on a visual approach to the airport at Mayaguez, Puerto Rico, in visual meteorological conditions.

The safety issues examined in the accident were pilot performance, air carrier maintenance procedures and practices, bilateral type certification of the airplane, and Federal Aviation Administration surveillance of the air carrier..

17. Key Words

maintenance; certification; surveillance; fire-blocking material; training; beta mode

18. Distribution Statement
This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

19. Security Classification (of this report) UNCLASSIFIED	20. Security Classification (of this page) UNCLASSIFIED	21. No. of Pages 50	22. Price

NTSB Form 1765.2 (Rev. 5/88)

CONTENTS

EXECUTIVE SUMMARY

On May 8, 1987, at 0650, local time, Executive Air Charter, Inc., doing business as American Eagle, flight 5452, crashed short of runway 9 while on a visual approach to the airport at Mayaguez, Puerto Rico, in visual meteorological conditions.

The safety issues examined in the accident were pilot performance, air carrier maintenance procedures and practices, bilateral type certification of the airplane, and Federal Aviation Administration (FAA) surveillance of the air carrier.

The National Transportation Safety Board determines that the probable cause of the accident was improper maintenance in setting propeller flight idle blade angle and engine fuel flow resulting in the pilot's loss of control from an asymmetric power condition. Contributing to the accident was the pilot's unstabilized visual approach.

As a result of this investigation, the Safety Board reiterates Safety Recommendations A-87-27 and -28 to the FAA, and it furthers recommends to the FAA concerning the CASA airplane in the areas of stall warning information, passenger-seat installation, flightcrew restraints, head clearance, and door controls. The Safety Board also made recommendations to the FAA concerning fire-blocking material on seats, surveillance of propeller overhaul facilities, of turbopeller flight idle blade angle maintenance, design of propeller pitch controls, flightcrew training, and on the bilateral aircraft certification program.

AIRCRAFTACCIDENT REPORT

EXECUTIVE AIR CHARTER, INC.
dba AMERICAN EAGLE, FLIGHT 5452,
CASA C-212-CC, N432CA
MAYAGUEZ, PUERTO RICO
MAY 8.1987

1. FACTUAL INFORMATION

1.1 Historv of the Flight

On May 8, 1987, flight 5452, a commuter flight regularly scheduled to depart from San Juan, Puerto Rico, at 0615 local time, for a flight to Mayaguez, Puerto Rico, departed at 0620 with four passengers and two crewmembers. The captain was 15 minutes late when he arrived for the flight at 0600. The first officer arrived on time at 0545. The airplane, a CASA C-212-CC, was operated by Executive Air Charter, Inc., doing business as American Eagle.

The flight was on a visual flight rules flight plan, and communications with the flight en route were reported to have been routine. The first officer handled the initial radio communications, and the captain made subsequent radio communications. While in the vicinity of Mayaguez, the captain cancelled the flight plan and proceeded to make a visual approach to runway 9. The captain did not make the customary in-range call to the operations agent at Mayaguez to report the flight's arrival estimate and fuel requirements.

Witnesses who observed the airplane on its downwind leg reported that it appeared normal. One witness said the airplane seemed too fast on the approach and appeared to overshoot the extended centerline on the baseleg turn to final. Another said the airplane "turned tighter" and did not extend the downwind leg as normal. He said as the airplane came toward him, the nose rose up quickly and then the airplane rolled to the right and nosed over. A third witness said the airplane made a violent turn, and he thought the engine noise was louder than normal. A fourth confirmed that the airplane made a shortened downwind leg, making a continuous left turn and sinking fast. He said that it turned rapidly to the right and nosed down and struck the ground. He then saw it pivot around and slide backwards. He stated that fire began when the right wing and engine separated from the airplane. A fifth witness, a company baggage handler, said he heard an explosion and saw flames come out of the right engine before it turned twice and struck the ground.

A crop duster pilot reported that everything appeared normal until the airplane was about 1,000 feet from the runway and about 100 feet above the ground. He said at that point, he heard a sound similar to that of a turbopropeller airplane going into reverse pitch to slow down after landing. He said the airplane then yawed to the right, followed by a roll to the left, as if the pilot had attempted to counteract the yaw. The airplane then rolled back to the right and the right wing tip struck the ground. A fire erupted immediately, the airplane turned about 180°, and it came to rest upright.

The four passengers on board reported that the flight was routine until the approach into Mayaguez. One passenger seated in 3A noticed that the noise from the engines was lower than usual and that it was not the normal engine sound. He thought afterward that perhaps an engine had stopped and that the noise was different on the right. He said the airplane was not shaking or vibrating. A second passenger seated in 4C reported that the airplane lost altitude abruptly and that it fell rapidly as it banked to the left on the approach. He said he heard strange sounds from the left side and that it was an engine or scraping noise. He stated that he saw a 1 1/2- to 2-foot long flame come from the left engine, but that it did not appear to be spreading. He reported that the airplane jerked before it hit the ground. The third passenger, seated in 6A, reported that she heard an unusual metallic sound similar to a landing gear retracting or extending immediately before the crash. The fourth passenger in seat 7B was asleep and did not awaken until the crash. He said that he thought the airplane made a hard or gear-up landing.

The accident occurred at about 0650 in daylight hours. The coordinates of the accident site are 18°15'N latitude, 67°09'W longitude.

1.2 Injuries to Persons

Iniuries	Crew	Passengers	Other	Total
Fatal	2	0	0	2
Serious	0	0	0	0
Minor	0	4	0	4
None	0	0	0	0
Total	2	4	0	6

1.3 Damage to Aircraft

The airplane was destroyed by impact forces and postcrash fire. The estimated loss was $1.2 million.

1.4 Other Damage

A portion of the airport perimeter fence was damaged extensively. The estimated cost of repair was $1,500.

1.5 Personnel Information

The flightcrew was certificated and currently qualified to conduct the flight. (See appendix 8.)

The captain, age 44, held an Airline Transport Pilot (ATP) certificate. He had 20 years of pilot experience with about 10,000 hours of total pilot time. He had accumulated about 5,000 hours of turbine engine airplane experience, 4,500 hours of which were in the deHavilland DHC-6, Twin Otter, and 473 hours of which were in the CASA C-212. He received his type rating in the CASA C-212 on March 3, 1987. He held a current first-class medical certificate with a limitation that required him to wear corrective lenses. He was employed by the carrier on September 29, 1986.

The first officer, age 32, also held an ATP certificate. He had 10 years of pilot experience with about 4,473 hours of total pilot time, 459 hours of which were in the CASA C-212. He was not type rated in the CASA C-212. He held a current first-class medical certificate with a limitation that required him to wear corrective lenses for both near and distant vision. He was employed by the carrier on October 15, 1986.

The captain and the first officer had flown together only once before, on March 17, 1987, for 4 hours of flight time. Both were familiar with the Mayaguez Airport. Their accumulated flight and rest time was within the limits prescribed by Federal regulations.

1.6 Aircraft Information

The CASA C-212-CC was the second airplane built by Construcciones Aeronautics, S. A. (CASA) of Spain. It received U.S. type certificate on May 16, 1980, under the bilateral provisions of Title 14 Code of Federal Regulations Part 21. It was a civil version of an earlier military airplane. The airplane was equipped with two Garrett Turbine Engine Company turbopropeller TPE-331-10R-511C engines and Hartzell Propeller Products HC-B4MN-5AL, constant-speed, hydraulic, full-feathering, reversible, composite, four-bladed propellers. The engines develop a take-off power rating of 900 shaft horsepower each. Placed in service by Executive Air Charter, Inc., (Executive Air) in October 1986, N432CA was configured for 19 passengers, 1 flight attendant, and 2 flightcrew. It was issued a certificate of airworthiness in the transport category on February 28, 1983. (See appendix C.)

1.6.1 Weiaht and Balance

The weight and balance of the airplane at the time of the takeoff and landing was within prescribed limits. The maximum allowable takeoff gross weight for the C-212-CC is 16,976 pounds, and the maximum allowable landing gross weight is 16,424 pounds.

The calculated V_{ref} for the landing weight of 13,097 pounds was 85 knots indicated airspeed (KIAS) at full flaps and 89 KIAS for 37.5 percent. With flaps up, the V_{ref} was 97 KIAS.

1.6.2 Maintenance History

The carrier had maintained the airplane in accordance with an FAA-approved continuous airworthiness maintenance and inspection program in accordance with 14 CFR Part 135. The last scheduled maintenance and inspection for the airplane was performed on May 7, 1987, at 6,261 hours.

A review of the airplane's flight/maintenance log disclosed that on April 27, after a I-hour flight, the flightcrew reported that the right engine had a high oil temperature and that it was starting too hot. The corrective action taken was to flush the oil cooler and replace the starter/generator. The next day, after 3 hours of flight time, the right engine again was reported to have been starting hot. Following the latter report, the corrective action taken was to adjust the specific gravity setting on the fuel control unit (FCU); an engine run-up check indicated that the engine was operating satisfactorily.

On April 29, after a 15-minute test flight (no passengers) that was completed at 0732, the right engine propeller was reported to have been vibrating. Action taken to correct the problem was to replace the propeller and comply with Airworthiness Directive (AD) 83-08-01. This required lubricating the propeller. The log also showed that the airplane departed at 0800 and flew six flights with the last flight terminating at 1735. During these flights, there were recurring problems with the right engine starting too hot and operating at a higher fuel flow than the left. Also during these flights, the log showed that the single red line computer was adjusted. On May 1, the airplane was flown on a test flight from 0800 to 0837; it was not flown again. The pilot reported that the right engine was still starting too hot.

From May 1 to 5, the right engine was replaced as a result of the previous discrepancies. The propeller from the replaced engine was reinstalled on the new engine--an engine on loan from Garrett. During an engine run-up, the propeller vibrated at all power settings, and it was replaced with an overhauled propeller. Also, the propeller governor and the underspeed governor were found out of adjustment and were reset.

On May 5, the pilot who test flew the airplane on May 1 performed a 13-minute test flight and reported that the airplane was satisfactory. Following the test flight, the airplane flew four scheduled flights for a total time of 2 hours. On the first flight, the captain reported in the flight/maintenance log, "Right engine on beta, propeller is NTSing[1] and percent of torque goes over 40% (left 20%), yaw action, fuel flow 260 lbs." On return to San Juan, maintenance personnel readjusted the propeller governor and the underspeed governor settings. On the last flight of the day, the same captain reported, "Landing at San Juan when flight idle was selected the right propeller went to the reverse mode." The first officer, who was flying the airplane, reported that the airplane yawed to the right when he moved the power levers (PLs) to flight idle. As the main gear touched down on the runway, he heard the propeller going into reverse. He said the propeller was NTSing; he said the propeller was changing pitch rapidly and he noticed a reading of 40 percent torque on the indicator. Maintenance personnel readjusted the propeller blade angles in response to the latter discrepancy.

On May 6, the airplane flew eight scheduled flights for a total time of 4.4 hours. No discrepancies were reported in the flight/maintenance log. However, during an interview, the first officer stated that the airplane had a left yaw tendency with the PLs at flight idle during these flights.

On May 7, after the first two flights of the day, a captain reported, "Right engine 20% torque at flight idle!" Maintenance readjusted the angle of the blades again. Another flightcrew flew the airplane for a total of 4.7 hours on eight flights and did not report any discrepancies. The accident occurred on the first flight of the next day.

1.7 Meteorological Information

'-a

Weather observations at Mayaguez are made by National Weather Service certified observers. On the morning of the accident, the reported observations were as follows:

0550(L) Clear, visibility--lo miles; temperature--70"; dew point--67"; wind--l 50" at 4 knots; altimeter--30.01 inHg.

0650(L) Clear, visibility--lo miles; temperature--75"; dew point--68"; wind--160" at 3 knots; altimeter--30.01 inHg.

1.8 Aids to Navigation

Not applicable.

1.9 Communications

There were no communication difficulties.

[1]NTS means negative torque sensing system. Negative torque is a condition wherein the propeller drives the engine instead of vice versa. The NTS system detects this condition and moves the propeller blades automatically to high pitch to reduce drag on the airplane.

1 .10 Airport Information

The Mayaguez Airport is located inland about 3 miles from the west coast of Puerto Rico at an elevation of 29 feet msl. It is owned and operated by the Puerto Rico Ports Authority and is equipped with a single asphalt runway, 9-27, which is 100 feet wide and 5,000 feet long. A 3°-visual approach slope indicated is installed for runway 9. It is an index A airport.[2] An air traffic control tower was located on the airport, but its service was discontinued because of Federal Aviation Administration (FAA) budgetary contraints; flight services were provided by the International Flight Service Station at San Juan.

1 .11 Flight Recorders

The airplane was not equipped with flight recorders, nor were they required equipment by Federal regulation. As a result, the Safety Board had to rely on witness observations, ground scar and impact damage information, flight test data, and airplane performance information in its investigation.

1.12 Wreckage and Impact Information

1.12.1 General

The right wing tip first struck the ground 643 feet short of the runway threshold and 67 feet to the right of the extended runway centerline. The airplane traveled about 100 feet after initial ground impact, and the nose of the airplane struck a chain-link fence and a ditch before pivoting about 180" and coming to rest upright. It cleared a 6-foot bank parallel to the airplane's flightpath about 75 feet before principle impact. Except for the cockpit, the fuselage remained relatively intact. There was substantial postcrash fire damage to the left wing and engine and minor fire damage to the right wing and engine. (See figure 1.)

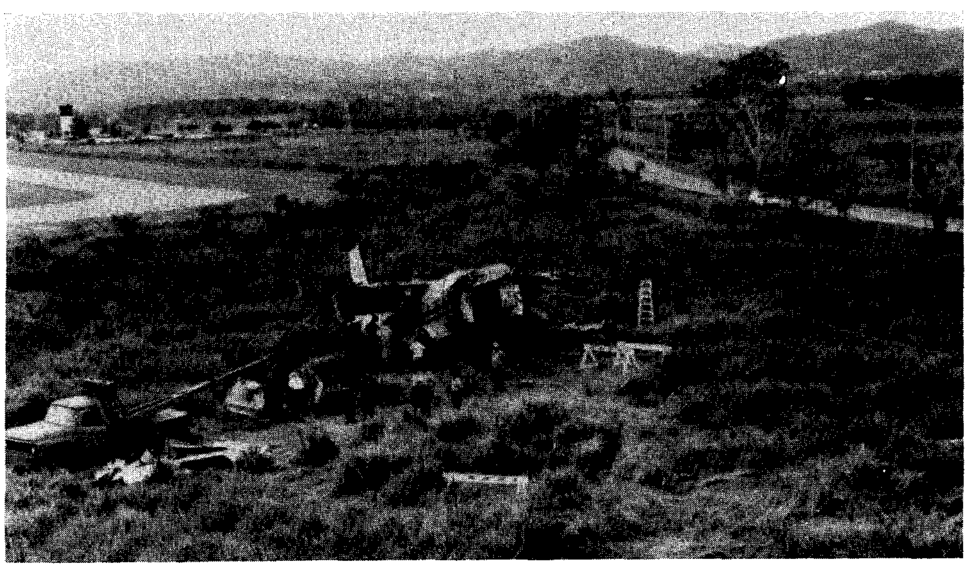


Figure 1.--The aircraft is facing the opposite direction of the approach to runway. The right engine was off at impact; the left engine was removed when the photograph was taken.

---

[2]An index A airport provides firefighting capability for aircraft less than 90 feet long and requires one vehicle providing at least 500 pounds of dry chemical or 450 pounds of dry chemical and 50 gallons of water or foam production (Aqueous Film Forming Foam (AFFF)) capability (14 CFR 139.49).

1 .12.2 Airframe Damage

The cockpit was demolished up to the area of the forward cabin bulkhead. (See figure 2.) Except for some slight crushing of the bottom of the aft fuselage, the remainder of the center fuselage to the aft fuselage remained relatively intact. The right wing was separated about midspan. The wing tip was bent upward to about a 45°-angle; the inboard portion was damaged by fire from fuel spillage. The right engine had separated from the wing. Postcrash fire from fuel spillage burned the outboard 1/3 of the left wing; the left engine remained attached to the wing.

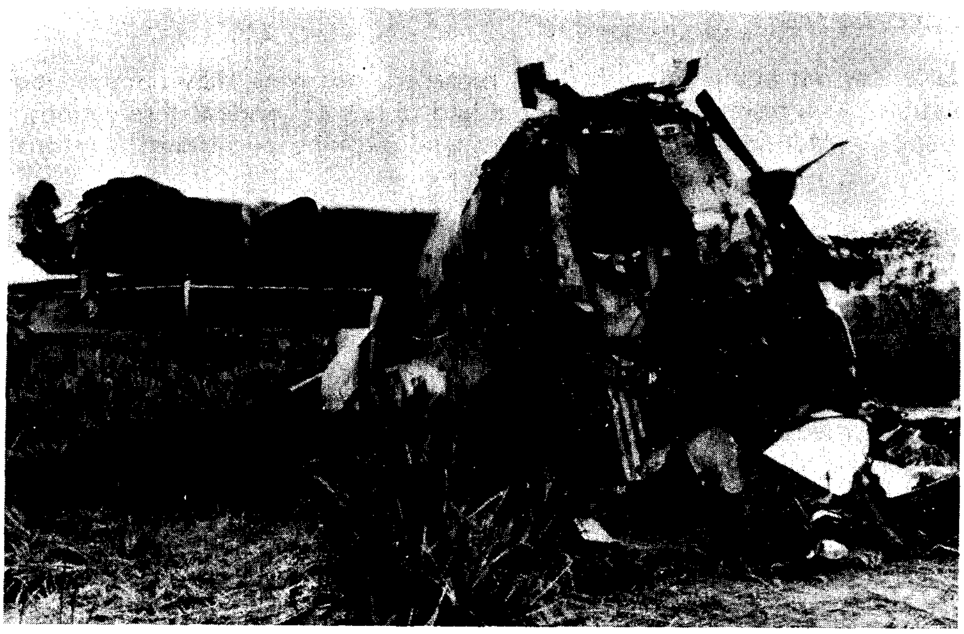


Figure 2.--View of the demolished cockpit.

Portions of the ailerons and wing flaps were also damaged. However, an examination disclosed control continuity in the flight control system. Impact marks on the inboard end of the right flap matched similar marks on the fuselage flap fairing. This evidence showed that the flaps were in the retracted position at the time the right wing struck the ground. Continuity in the flap control system was established, the hydraulic lines were secured and no leaks were present, and the hydraulic pump functioned normally in a subsequently test. Further examination of the wings, including the trim system, did not reveal a preimpact failure or malfunction.

The flap control lever in the cockpit was found in the full up position and bent to the left about 30". (The flap control lever position actuates the flap selector valve sending hydraulic fluid to retract the flaps.) The indicator reading was not reliable because of impact damage.

1 .12.3 Powerplant Damage

The left engine and propeller remained in place. The left side of the engine cowling was damaged by fire. Except for some gouges in the trailing edges of the propeller blades, the engine and propeller sustained no other impact damage. The propeller could be rotated freely, and it was in the feathered position. The firewall fuel shutoff valve (manually operated) and the engine fuel valve (electrically operated) were closed. The propeller feathering valve was in the feather position and the cowl flaps were closed. These valves and the cowl flaps are actuated through aluminum rods and teleflex cables from the emergency handles in the upper front panel of the cockpit which were found in the normal position.

The right engine and propeller sustained moderate impact damage and very little fire damage. The engine and propeller came to rest about 40 feet in front of the airplane. The four propeller blades separated above the blade shank plugs as a result of ground impact. However, the propeller hub and pitch change mechanism remained attached to the engine. The pitch change mechanism was displaced by impact forces several degrees from its normal position.

Examination of the engine control pedestal in the cockpit showed that the left PL was jammed in the maximum forward or takeoff position and bent about 45" to the right. The right PL was at the flight idle position and exhibited a compound bend. The beta latch[3] mechanism in both PLs appeared in good working order. The left speed (RPM) lever was also jammed in the maximum forward position and bent 45° to the right. The right speed lever was found about midway between the taxi position and the maximum forward position. It was bent 90° to the right.

The engine beta light and NTS light bulbs showed no evidence of having been on at the time of the crash. Impact damage to the left engine torque indicator stopped the needle at 87 percent. The right engine torque indicator read 100 percent, but the needle was free to move. Examination of the cockpit disclosed no other remarkable evidence.

1.13 Medical and Pathological Information

The four passengers sustained minor injuries in the accident. The flightcrew sustained fatal injuries. The cause of death was severe corporal trauma. Toxicological tests were negative for alcohol, carbon monoxide, and drugs.

1.14 Fire

Examination of the wreckage disclosed no evidence of an inflight fire. Fire erupted as a result of the right wing separation and impact damage to the left wing resulting in fuel spillage. The airplane had about 1,300 pounds of Jet A fuel on board at the time of the accident.

A firefighter at the airport observed the crash and alerted others on duty. They responded in less than 1 minute in a quick response vehicle and a Walters 1,000-gallon pumper truck. The fire was extinguished in about 2 minutes using AFFF.

1.15 Survival Factors

The passengers had no difficulty evacuating the airplane through the left main cabin door. They were already out of the airplane when the crash-fire-rescue crew arrived on scene. One of the passengers stated that the door had opened on impact.

[3]The beta latch is a lever mechanism that allows the pilot to move the power levers on the engine control quadrant rearward into the beta mode of propeller operation. The beta mode is a range of engine operation speeds below the point where propeller governing occurs and requires control of the propeller blade pitch angles by the pilot.

Both flightcrew seats remained attached to their floor tracks. The four-point restraint system remained normally attached to the anchorages. The shoulder harnesses did not show evidence of use. The flight attendant's jumpseat remained in place, but was found extended for use instead of retracted because the inboard spring retainer bar had separated from the seat. (See figure 3.) All of the 19 passenger seats, manufactured to Technical Standard Order C39A, remained attached to the cabin floor. Passenger seats 7B and 7C were installed adjacent to a Class III emergency exit. In this location, the armrests protruded into the pathway of the exit, as did the seatbacks if they were folded forward.

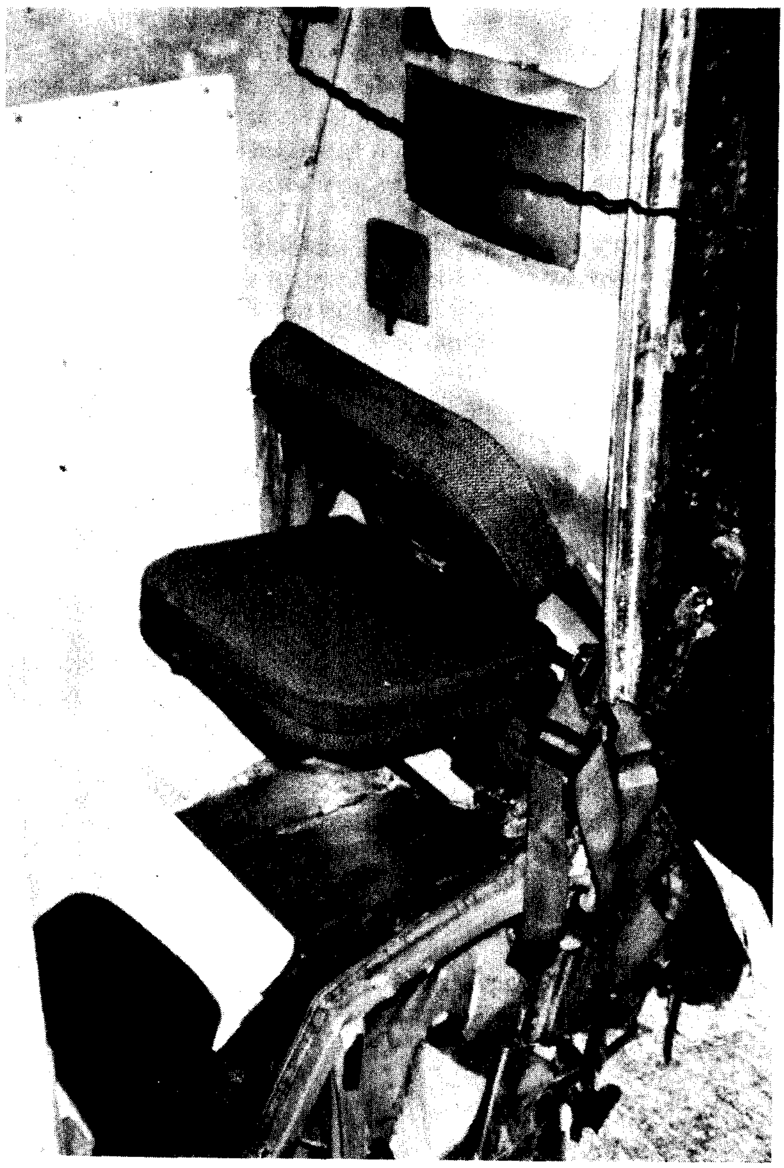


Figure 3.--Rearward facing jump seat remained in its original location.

The flightcrew cockpit seat restraints were manufactured by Autoflug, GmDh, Rellingen, West Germany. Examination of another CASA C-212-CC revealed that the seat restraints operated by an inertial reel and a manual override handle. The inertial reel mechanism contained a self-locking ratchet device. The straps, with the handle in the manual override position, tightened whenever the occupant moved which created slack in the harness. When the straps tightened automatically, the harness was uncomfortable and restricted the occupant's movement. To reach controls and switches, the occupant had either to move the seat or place the handle in the inertial position. However, the stitching that connected these straps was bulky, and the straps frequently snagged inside the reel each time the occupant moved forward with the handle in the inertial position. This prevented the harness from retracting consistently, and thus created a lot of slack in the harness.

1 .16 Tests and Research

1.16.1 Powerplants and Propellers

Examination of the powerplants and their individual components and accessories disclosed no evidence of a failure or malfunction. There was evidence of normal gas path soot deposits, with turbine rotor blade tip and nozzle shroud rubbing. There was some combustion shroud material splatter on the inlet side of the turbine blades and shrouds. The right engine showed evidence of light contour rubbing of the impeller blades of the first and second stages of the compressor as well as light rubbing of the second stage impeller shroud. Some portions of the diffuser vane assembly sustained foreign object damage. Also, ingested debris was found lodged between the combustion chamber nozzle bodies and shrouds, and on the tips of the ignitors. Ingested debris was found plugging the cooling holes in the right engine.

Examination of the right engine fuel control unit (FCU), manufactured by Woodward Governor, showed that the flight idle fuel flow adjustment cover plug had no lockwire. Garrett had installed an antitamper seal on the maximum power cover plug of the FCU. Also, there was a different lockwire on the top cover screws and on the FCU minimum and maximum speed governor setting screws. The speed setting shaft was found bent about 15". It was noted that the specific gravity adjuster was set at the maximum setting. Also, the minimum and maximum governor speed setting stops and the flight idle and maximum power settings had been readjusted and mis-set. Tests by the manufacturer revealed higher fuel flow values than nominal under different power conditions. It was not possible to set them using the normal rigging procedure. The test showed that fuel flow was 299 pounds per hour (pph) at flight idle instead of the 204 + /-5 pph used by the manufacturer as a reference when setting the FCU. Disassembly of the component showed that the angular relationship of the P_2 bias lever had not shifted on its shaft. The runout measurement of the shaft (0.0015 inch) was within the tolerance of a new part. There was no evidence of a preimpact malfunction or impending failure of the FCU assembly.

The left and right propeller governors were examined and tested. The results indicated that all of the test points were within production limits.

Fire damage to the left propeller melted the blade-to-clamp index tapes which precluded determining if the propeller blades had slipped in the accident. There was no evidence of blade slippage in the right propeller. Disassembly of both propellers disclosed that all the correct parts had been installed.

The right propeller sustained severe impact damage. The beta tube was bent, the dome assembly (piston, cylinder, and spring assembly) was canted about 13°, and the cylinder was stripped from the hub. The nose of the piston was crushed and gouged in a diagonal pattern; the deepest gouge was located between two of the blades. There was a 390°-spiral gouge on the inside of the piston. A semicircular rub mark in the center bore of the hub corresponded to the beginning of the spiral gouge on the inside of the piston.

In an effort to determine the propeller blade angles at the time of the impact with the ground, the butt ends of the separated blades and the corresponding hub arm flanges were examined in the Safety Board's metallurgical laboratory for impact or "witness mark" evidence. (See figure 4.) When each blade butt end was positioned onto the hub and matched to these faint impact arc impression marks at the hub end, the blades appeared to be at or near 0" pitch. However, matching these faint marks did not reveal precisely the blade angles at impact due to the overall width of the impressions.

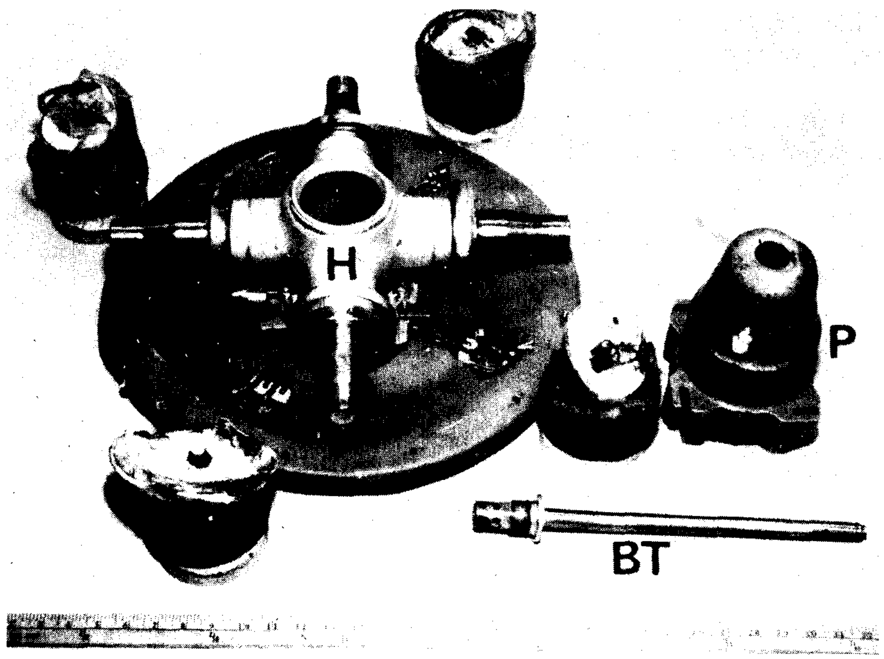


Figure 4.--Overall view of the right propeller components submitted for examination. 'H" indicates hub which is surrounded by the four propeller butt ends. "BT' locates portion of beta tube and "P" denotes the piston.

Metallurgical examination indicated that the spiral gouge mark on the inside of the piston of the right propeller was probably made when the propeller struck the ground, forcing the piston to contact the forward corner of the cylinder under impact forces.

Mechanical deformation of the gouge indicated that the piston had moved aft relative to the cylinder and had rotated slightly from to the normal fixed position of the cylinder. (See figure 5.) There was no buildup of piston material at the forward edge of the gouge, but the aft edge contained numerous areas of buildup and a ridge as shown by the lower two arrows in figure 6. This buildup indicated that the piston had rotated and moved aft relative to cylinder and toward the feather position. Examination of a section cut through this gouge confirmed the aft movement, which produced extreme grain deformation transverse to the gouge as shown in figure 7. The position of the forward edge of the cylinder at the time it made the initial gouge in the wall of the oiston corresponded to a 0°-blade angle.

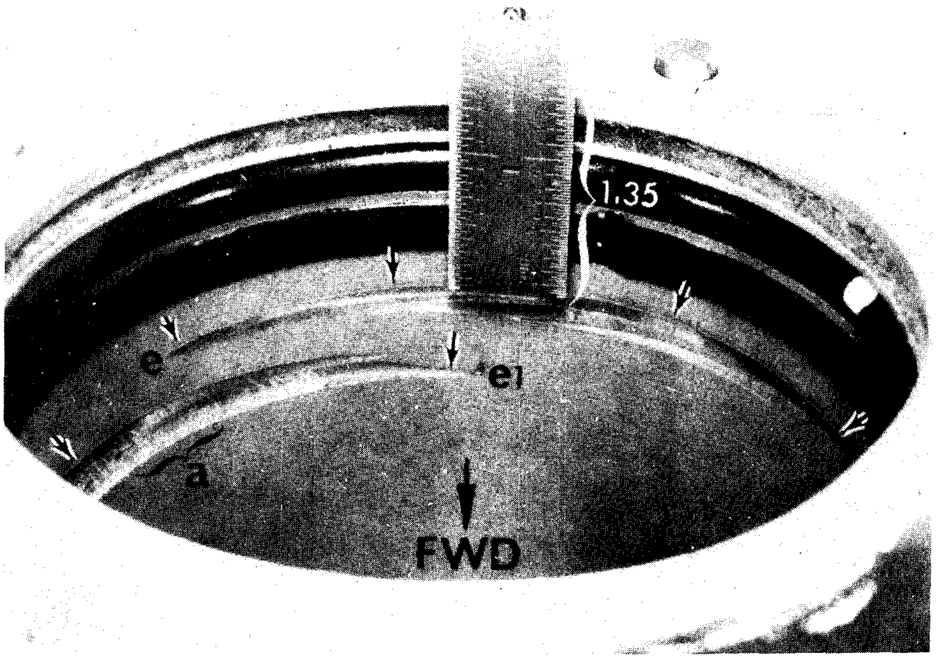


Figure S.--Oblique view looking into the inner cavity of the piston showing the spiral indent mark on the hole wall of the piston.

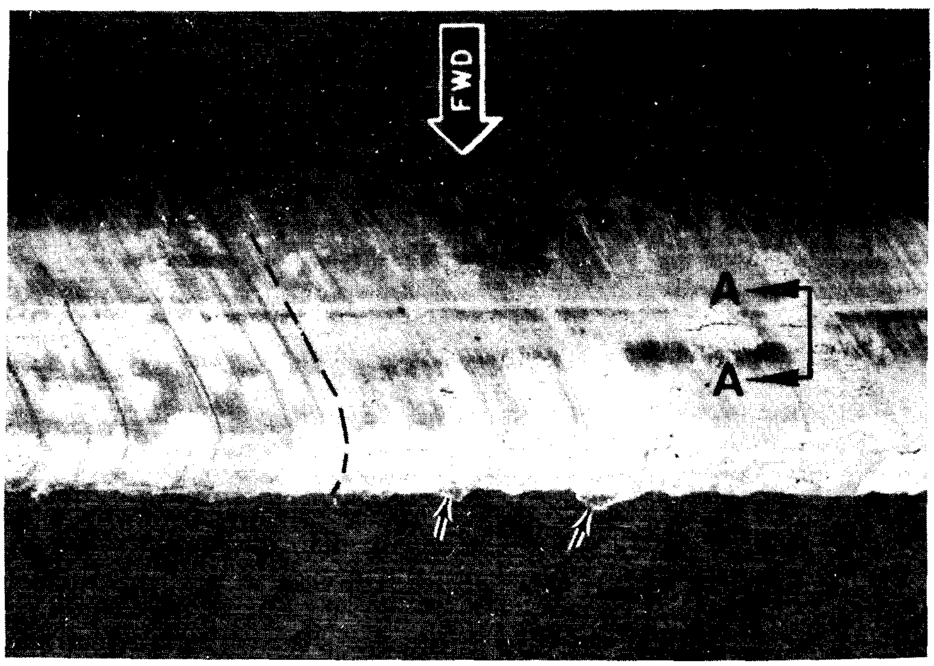


Figure 6.--Perpendicular view of the indent mark on the piston's internal wall in the area located by bracket "a," figure 5. (Magnified approximately X4.)

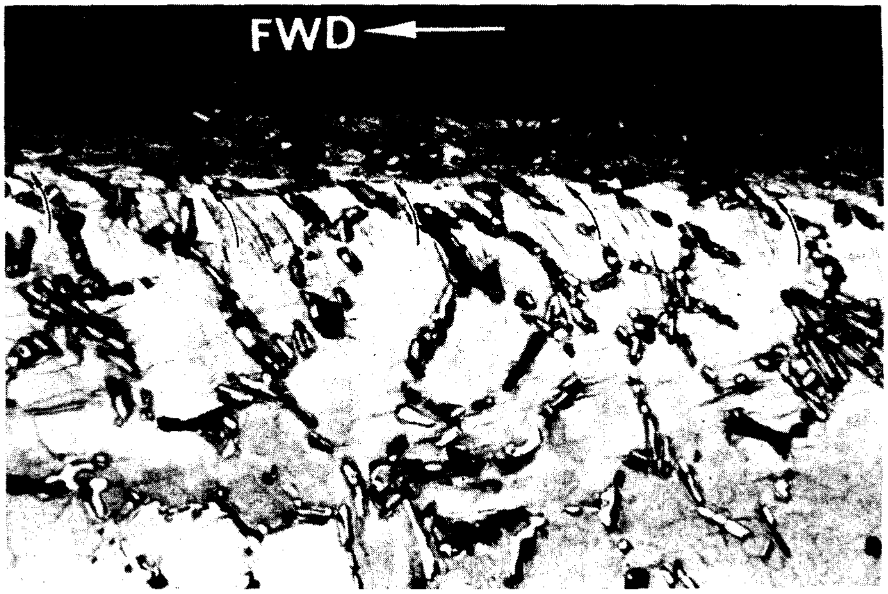


Figure -/.--Transverse to gouge metallographic cross section in the area of section A-A in figure 6. Small curved arrows denote direction of metal flow deformation. (Heavily etched Kellers reagent.)

Control of the propeller blade angle is achieved through governed engine oil pressure and aerodynamic forces which counterbalance feathering spring and counter weight forces. Oil pressure and aerodynamic forces move the blades to a low pitch (high RPM position), and the feathering spring and counterweight forces move the blades to a high pitch (low RPM position). The propeller blade angle is limited by two physical stops located in the propeller: one for the feather position (high pitch limit 83" +/-0.3°); and one for the full reverse position (low pitch limit 10" +/-0.5°). The start lock positions the blades to -1.5" +/- 0.2" to reduce the aerodynamic load on the propellers during engine start. The static flight idle blade angle is 7" +/-0.3°) and is hydraulically positioned by metered oil pressure through the "beta" tube. The beta tube is mounted concentrically in the propeller shaft and extends from the propeller piston through the engine reduction gearbox assembly to the propeller pitch change unit which is mounted on the rear of the reduction gearbox. Establishing the flight idle blade angle requires placing the corresponding PL at the flight idle gate before an adjustment is made. The pilot controls the propeller with the PLs and the engines with the speed levers (RPM levers). With the PLs at or above the flight idle gate, the propeller governor regulates the blade angles as a function of airspeed and load on the engine to maintain a desired constant engine RPM. With the PLs in the beta range below the flight idle gates, the pilot has direct control over the propeller pitch because the propeller governor is mechanically locked out of the pitch control system in this configuration. Beta mode operation and use of full reverse is designed for ground operation only, that is, for deceleration after landing and for taxiing.

CASA reported that the flight idle blade angle was determined by adopting a 7"-flightpath angle at 1.3 V_{SO}[4] (85 KIAS typically) in the landing configuration (full flaps) which results in a descent rate of 1,500 fpm (+/-100 fpm) at about 5,000 feet mean sea level (msl). This rate of descent is established by adjusting engine fuel flow. The normal setting is 170 pph per engine. Since propeller

[4]V_{SO} is the stalling speed or the minimum steady flight speed in the landing configuration.

blade angle will vary as a function of airspeed, the blade angle with the PLs at the flight idle gates will vary also. Propeller blade angle setting at 1.3 V_{SO} had not been measured by the manufacturer. CASA estimated that near 90 KIAS, the blade angles would be about 10". If the airplane was to slow to about 70 KIAS, the blade angles would move to 7°, and the beta light would illuminate to indicate to pilots that they now have direct control over propeller blade pitch for ground operation.

According to the CASA maintenance manual, setting the propeller blade angles in a static condition to the corresponding flight idle position of the PLs involves a 13-step set-up procedure followed by a 9-step adjustment procedure. The maintenance manual cautions the operator to perform the procedure in windless conditions. The procedures require use of a ground power unit, and the engine(s) must be operated until oil temperatures reach at least 85°C. The engine is then shut down with the propeller feathered. The relevant PL is placed in the flight idle position and a rigging pin is installed. The adjustment procedure requires operating the unfeathering pump until the propeller unfeathers and stabilizes at an angle as measured at the 42-inch blade station indicated by a line painted on the blade face (back of blade). (The procedure in the maintenance manual specified measuring the blade at the 30-inch station also indicated by a line on the blade face. This was the correct position for measuring the earlier model C-212-CB Hartzell propeller, but not for the C-212-CC. The carrier's maintenance personnel, however, stated that they were aware of this error and that they were using the 42-inch station. The manual was later corrected by CASA). If the blade angle is incorrect, the blades are adjusted by removing the beta tube lock pin and by turning the beta tube in the appropriate direction. The manual noted:

> One complete clockwise turn of beta tube decreases blade angle by 2 degrees.
> One complete counter-clockwise turn increases blade angle by 2 degrees.

If the blade angle is too high, the previous six steps must be repeated, and if it is too low, nearly the entire procedure, beginning with restarting the engine, must be repeated. Once the correct adjustment has been made, a nine-step close-up procedure is performed.

The preflight check requires the flightcrew to examine the PL and beta latch mechanism for freedom of movement and latch spring operation. A detailed visual inspection is a required "C" check every 3,600 hours of flight operations. The latch spring tension cannot be adjusted and must be replaced if it malfunctions or fails.

In addition to the general adjustment procedure, a flight idle descent flight test must be performed each time a propeller is replaced on an engine. in the test, flight is established briefly between 4,500 feet and 5,500 feet msl with full flaps (40°). The speed levers are advanced to 100 percent RPM, the PLs are retarded to the flight idle gate, and an airspeed of 85 KIAS is established. The resulting rate of descent should be between 1,400 and 1,600 feet per minute (fpm). If the rate of descent does not fall within the range, then the flight test must be repeated after the fuel flows are readjusted. The pilot is required to note whether any asymmetric thrust exists (yaw in one direction or another), if the beta light remains off, and the fuel flow readings per engine.

1.162 Aircraft Type Certification History

On March 11, 1987, personnel from the FAA Office of Airworthiness briefed Safety Board representatives on the type certification history of the CASA C-212. It was type certificated in the U.S. under the Bilateral Airworthiness Agreement (BAA) with Spain, dated September 23, 1957, and updated in 1978, and in accordance with 14 CFR Part 21, Certification Procedures for Products and Parts, Section 21.29, *Issue* of type certificates: import products. The basis under which the CASA C-212 was certificated was 14 CFR Part 25, effective February 1, 1965, including Amendments 25-l through 25-35, and 14 CFR Part 36, effective December 1, 1969, including Amendments 36-l through 36-4, and Special Federal Aviation Regulation No. 41.

A BAA is an executive agreement between governments. An executive agreement is less formal than an international treaty and is made between chiefs of state without senatorial approval. A BAA with the U.S. is normally developed when another country has an aeronautical product manufacturing industry and a competent civil airworthiness authority and intends to export its product to the U.S. BAAs are a part of international conventions and trade agreements between countries (Multilateral Trade Negotiations under the General Agreement on Tariffs and Trade). However, since they are technical agreements rather than trade agreements, they are intended to prevent unnecessary repetitive certification activities by facilitating cooperation between the exporting country's airworthiness authority and the FAA and by making full use of the country's type certification system. When a foreign country requests a BAA or a revision to a BAA, the U.S. Interagency Group on International Aviation must review the request. In addition, the FAA, on behalf of the State Department, must evaluate the technical competence, capabilities, regulatory authority, and efficacy of the foreign country's airworthiness authority. Further, the FAA assesses the foreign country's airworthiness laws and regulations, and the general state-of-the-art in design and manufacturing capability including the need for a BAA. Title VI of the Federal Aviation Act of 1958 requires the Secretary of the Department of Transportation (DOT) to be consistent in exercising duties and responsibilities under the act with respect to international agreements.[5]

When CASA sought to market the CASA 212 in the U.S., the FAA European Region Aircraft Engineering staff in Brussels, Belgium, evaluated the type design in several meetings with personnel from CASA and from the Instituto Nacional de Tecnica Aerospacial (INTA), the responsible Spanish civil airworthiness authority. The certification meetings began on November 5, 1974, and pertained to the C-212-CB. From November 1974 to February 1977, the airplane was flown by the FAA on three separate occasions by two test pilots in November 1974 and June 1976 and by the chairman of the Flight Operations Evaluation Board in January 1977. There were no serious unacceptable or unsafe features reported as a result of those flight tests. Type certificate No. A43EU for the C-212-CB was issued on February 22, 1977. Subsequently, the director general of Civil Aviation approved and the United States amended the type certificate by adding other models. The other CASA C-212 models were the CC, CD, CE, and CF.

The FAA reported that there was no test pilot on the staff in the Brussels office and no engineering flight evaluations were made when the model CC was undergoing certification evaluation. The FAA amendment of the type certificate to add the model CC was based on the INTA's certification on May 17, 1979, that, "the type design had been examined, tested, and found to meet 14 CFR Part 25, effective February 1, 1965, including Amendments 25-l through 25-35." Model CC was given a U.S. type certificate on May 16, 1980. The model CD, CE, and CF were given U.S. type certificates on September 6, 1985, September 9, 1985, and December 6, 1985, respectively.

The C-212-CC has a takeoff gross weight of 2,644 pounds more than the CB model, and the engines each have 150 shaft horsepower more to handle the extra gross weight. Also, the CC uses the Keviare composite propeller blade material, whereas the CB model uses an aluminum alloy blade material. The composite blade design was approved on September 12, 1978. According to the FAA, in order to handle the increase in asymmetric thrust that could be generated in the CC model over the CB, V_{mc} (minimum control speed with the critical engine inoperative) was increased from 78 to 85 KIAS, and the rudder deflection in both directions was increased from 25" to 27.5".

Before a U.S. airworthiness certificate can be issued, the law requires that the FAA find that the aircraft conforms to the approved type design and is in a condition for safe operation. By Federal regulation (14 CFR 21.183 and 21.185), an import aircraft is entitled to a U.S. airworthiness certificate

[5]FAA Advisory Circular 21-18.

if the exporting state certifies and the FAA finds that the aircraft does conform to the type design and is in a condition for safe operation. The FAA can make a determination based in whole, or in part, on the exporting state's certification, provided a BAA exists between the U.S. and that state permitting such an arrangement. The FAA does not have to flight test the airplane. N160FB was issued an airworthiness certificate on July 18, 1980.

However, during proving tests for another CASA C-212-CC operator, Fischer Bros. Aviation, Inc., on September 15, 1980, the FAA general aviation district office (GADO) in Cleveland, Ohio, responsible for the Fischer Bros. operating certificate, found reason to believe that the airplane did not meet certain sections of 14 CFR Part 25. The areas of possible noncompliance dealt with five sections in Subpart D, Design and Construction of personnel and cargo doors (25.783 (b)(d)(e)); seats, seatbelts, and harnesses (25.785 (h)); emergency provisions for emergency exit arrangement (25.809 (f)), emergency exit marking (25.811 (e)(2)(i), (e)(3), (e)(4)(i), (iii), and (f)); and emergency lighting (25.812).

During the interim period of the airplane's service, the FAA underwent a reorganization of its airworthiness departments which resulted in the "lead region" aircraft type certification concept. Consequently, primary responsibility for the C-212 project was transferred from the Brussels office to the FAA's Northwest Regional office in Seattle, Washington, which was responsible for 14 CFR Part 25 type certification. After an inspection of another airplane on August 23, 1983, the FAA Northwest Mountain Region found other areas of possible noncompliance. These areas were communicated to CASA on September 30, 1983. Since flight characteristic issues were also involved, the FAA decided to have a flight test pilot evaluate these issues as part of a trip to Europe involving other projects. As a result, on March 19 and 23, 1984, a flight test pilot and flight test engineer evaluated the model CC on two different flights of 2.5 hours duration. They reported that the airplane did not have adequate stall warning, that the stall characteristics were unsatisfactory, that it did not meet the directional stability requirements, and that it had insufficient rudder control in the engine-out takeoff, climb condition. Additionally, proposed modifications by CASA to correct other possible noncompliance discrepancies in the cockpit were evaluated by the test pilots. These discrepancies were trim control indicator, gust lock provision, power lever jamming provision, and the flap system. The test pilots noted that the flap system:

> . . . is powered by a single hydraulic pump which is turned ON prior to selecting flaps and turned OFF after flap selection. It was noted on the aircraft tested that after flap selection and the hydraulic pump turned off, the flaps would not hold position but would tend to creep down to a greater flap setting.

By the time of another inspection of a CASA C-212 on May 14, 1984, the FAA had compiled an additional 14 areas of possible noncompliance in addition to the 5 identified in the Fischer Bros. proving tests in September 1980. During the May 14 inspection, several of the possible noncompliance areas were resolved, and no new questions arose at that time. According to the FAA personnel in the Northwest Mount Regional Office, they were not successful in resolving all possible noncompliance items that were noted in its evaluation of the airplane because there were differences of opinion between the FAA and INTA on how to interpret the rules, because the certification basis had already been determined, and because they had already issued the type certificate.

ADs were issued to correct many discrepancies found in the airworthiness evaluations of the airplane. One AD was issued in 1983, two in 1984, one in 1986, and six in 1987. A 1984 AD (84-02-30) was issued to correct the door and exit discrepancies identified by the Cleveland GADO in September 1980.

At the time of the Fischer Bros. accident on March 4, 1987,[6] 5 of the 19 items remained open; of these, 2 were in the final Notice of Proposed Rulemaking (NPRM) stage, and the findings of the flight test evaluation evidently remained in dispute. The two in the NPRM stage concerned Part 25.629--flutter, deformation, and fail-safe criteria, and Part 25.809--emergency exit arrangement. The three areas that remained in an open status pertained to Part 25.671(c)(l)--flap drive system; Part 25.735(b)--brakes; and Part 25.1415(e)--approved flotation means.

As a result of the Fischer Bros. accident, the FAA reported to the Safety Board that they were forming a multiple expert opinion team (MEOT) to conduct a special flight certification review of the airplane. This team did not include the test pilot and flight test engineer who had made the March 1984 flight test evaluation. On March 24, 1987, the MEOT briefed FAA and Safety Board representatives on the results of the flight tests. The findings in their report of June 16, 1987,[7] are as follows:

- Stall characteristics, directional stability, and directional control were found to comply. (Data reviewed by the team indicated that there was a wide central band from about the middle 1/3 to 1/2 of the rudder travel where pedal forces were very light. Beyond this band, rudder pedal forces increased substantially, up to 150 to 160 pounds at full rudder deflection. Flight test showed that the rudder would tend to float with feet off the pedals and that pedal forces are very light. The airplane showed a clear tendency to return to straight flight when the wings were held level when the rudder was released, but it would not return to coordinated flight. The airplane would return to a steady state flight condition with 1/2 ball displacement depending upon the initial amount of sideslip introduced and the rate at which the rudder was released.)

- Stall warning was found to be inadequate and not in compliance; moreover, the team considered the deficiency to be an unsafe feature and recommended mandating improved stall warning.

During the MEOT briefing, the Safety Board was advised that ail operators and flightcrews would be made aware of the results of the MEOT evaluation. However, during the next few days of the investigation, the Safety Board learned that some operators were not aware of the MEOT findings. The Safety Board concluded that steps should be taken to inform operators and FAA aviation safety inspectors of the MEOT findings immediately. Therefore, the Safety Board issued Safety Recommendations A-87-27 and -28 to the FAA on March 31, 1987:

<u>A-87-27</u>

Issue a general notice (GENOT) immediately to ail U.S. owners and operators of the CASA C-212 airplanes describing the background and significant findings of the recent flight test of the CASA C-212. The notice should provide an evaluation of the existing CASA C-212 stall characteristics, operational precautions, and training procedures to preclude inadvertent stalls until an approved artificial stall warning system is installed.

---

[6]Aircraft Accident Report--*Fischer Bros. Aviation Inc., dba Northwest Airlink, Flight 2268 Construcciones Aeronauticas, S.A. (CASA) C-212-CC, N160FB, Detroit Metropolitan Wayne County Airport, Romulus, Michigan, March 4, 1987* (NTSB/AAR-88/08).

[7]The flight tests were performed in the C-212-CC. CASA began immediate development of an artificial stall warning system kit. On April 1, 1987, the Director of the Northwest Mountain Region issued an NPRM requiring installation of a stall warning system. The comment period closed on May 15, 1987. On July 29, 1987, an AD requiring installation of an artificial stall warning system was issued.

<u>A-87-28</u>

Expedite the rulemaking action to require installation of an artificial stall warning system on the CASA C-212 airplanes.

Stall warning devices are not required on all transport airplanes. Aerodynamic buffeting that results from near-stall conditions may suffice as a stall warning. Title 14CFR 25.207 defines the requirements:

- **Section a--Stall warning with sufficient margin to prevent inadvertent stalling with the flaps and landing gear in any normal position must be clear and distinctive to the pilot in straight and turning flight.**

- **Section b--The warning may be furnished either through the inherent aerodynamic qualities of the airplane or by a device that will give clearly distinguishable indications under expected conditions of flight.**

Title 14 CFR Part 23 has similar exemptions for general aviation airplanes.

During the investigation of the Executive Air accident in Mayaguez, it was learned that the carrier had posted a memorandum to all its C-212 pilots on April 10, 1987, which stated that the FAA certification review team intended to recommend that an artificial stall warning system be installed in the CASA. It also reminded them, among other points, that only a small amount of aerodynamic buffet preceded the stall and that vigilance was required at all times when operating at low speeds.

1 .16.3 Service History

According to CASA, at the time of the accident, they had sold over 400 C-212s which were operating in 30 countries. The airplanes had accumulated over 870,000 flight hours. To CASA's knowledge, no in-service operational difficulties relating to the natural stall warning had been reported.

At the time of the accident, 30 C-212s were operating in the United States. Twenty-six were being operated by four scheduled commuter air carriers. The largest air carrier (with 10 C-212s) was Executive Air, operating as an American Eagle carrier.

According to the International Civil Aviation Organization, there were eight reported accidents of the C- 212 worldwide before the Fischer Bros. accident: three controlled collisions with the ground; two hard landings; one engine failure/forced landing; one nosegear collapse; and one in which a person was fatally injured after being struck by a propeller.

In November 1987, FAA surveillance of Executive Air following the accident in Mayaguez by the Flight Standards District Office (FSDO) in San Juan, disclosed a flap discrepancy trend involving uncommanded flap movement. During an associated en route inspection by the FSDO of seven Executive Air airplanes from November 4-6, the FSDO found that the flaps failed to maintain their selected positions on 15 consecutive flights. In the take-off phase of the flight, the flaps bled down 5 percent from the selected position in five instances, and they bled up 5 percent during take-off roll in four instances. On landing, the flaps bled up 3 to 6 percent in seven instances, and after landing, the flaps bled down 2 percent. Other factors associated with incremental movement of the flaps included inadvertent positioning of the selector, a faulty flap indicator, and rapid movement of the flaps during selection.

The Safety Board learned of this situation in December 1987 and conducted a special review of these recurring flap discrepancies in January 1988 at Executive Air. A review of the maintenance records of nine aircraft revealed that during the previous 5-month period, there had been 74 flap system write-ups, 59 of which were reported as uncommanded flap movement either airborne or on the ground or both. Forty of the flap system write-ups resulted in a component change. In addition, a review of the maintenance manuals revealed several inconsistencies or inadequacies for ensuring correct flap component installation.

According to CASA, because of the mechanical transmission of the flap system linkage in the C-212, insignificant movements in the selected flap position are produced when there is considerable variation of the aerodynamic loads over the flap surfaces. This occurs from the elasticity in the system, including the elasticity in the mechanical linkage (rods and bellcranks) and the compressibility of the hydraulic fluid. Even though the C-212 series airplane has been certified with this inherent defect and no changes in the flap system design have been made since it was certificated, CASA conducted flight tests to quantify the actual flap position variation and to assess its effects on flight safety. The results of the tests were:

- During takeoff, there was a variation of flap position indication from the selected 25 percent on the ground to 22 percent in the air.
- There was no flap position indication variation during approach.
- Only a 97 percent flap position could be achieved when full flaps were selected for landing. When the airplane was on landing rollout at about 50 KIAS, the flap position indication went to 100 percent.

CASA reported that during the type certification flight tests, the position of the flaps was determined using the flap indicator. Thus, the performance information in the flight manual includes the extra movement due to elasticity. In CASA's opinion, movement greater than 3 percent from the selected flap position should not occur and that previous reported instances of this having happened were due to inadequate maintenance.

CASA has subsequently issued revised maintenance and inspection procedures and revisions to its maintenance manuals. In addition, Executive Air's Operations Specifications have been amended to require a functional flight test of the flap system of each CASA 212 aircraft every 50 flight hours.

The FAA was concerned that a failure of the flight control system could render the C-212 uncontrollable (14 CFR 25.671 (c)(l)). If the flap system failed, a sudden asymmetric reaction of the flaps during landing approach would result. This issue was resolved by CASA through a damage tolerance examination, flight tests; a fleet inspection, a study of adverse effects in flap system from human errors in maintenance, corrosion and fatigue, and overload, and a request of the FAA by CASA to make mandatory SB 212-27-22.

According to CASA's maintenance manual, the pressure relief valve is the only on-condition component of the flap system requiring inspection every 2 years. The other components are on "hard time" inspection intervals. The four-way selector valve requires an inspection every 2 years or at every 3,200 hours, whichever occurs first.

Chaparral Airlines, another C-212 operator, reported to the Safety Board that they had experienced flaps bleeding up and down. They believed the problem was associated with a leaking check valve, and they replace four check valves each year.

1.16.4 Flight Tests

In an attempt to determine how the airplane would react in flight when the PLs were placed in the beta mode, CASA performed several flight tests on April 3, 1987, in support of the Safety Board's investigation. The airplane was trimmed at 120 KIAS, and a symmetrical reduction of power was made to a position one notch or about 1 inch behind the flight idle gate into the beta mode. The following was observed:

- Torque indications went to 0.
- There was a characteristic cyclic propeller and powerplant noise, coupled with oil pressure fluctuations due to the NTS system operation.
- The airplane pitched down to 12" (stick free).
- The rate of descent reached 4,000 fpm with the airspeed held constant at 120 KIAS. Pitch attitude control is positive with elevator input, and higher elevator forces were required to maintain an attitude as compared to normal conditions. The airplane will decelerate rapidly when leveled.
- There was about a l-second delay in power recovery when the PLs were moved forward into the flight idle gate.

Further aft movement of the PLs into the beta range produced oil pressure fluctuations in both engines, the NTS lights did not illuminate, and the airplane pitched down more than 12°. With the PLs retarded further behind the flight idle gate, powerplant and propeller cyclic noise disappeared while engine RPM increased to 105 percent The airspeed had to be reduced in order for the engines and propellers to recover from this condition after the PLs were returned to the flight idle gate. There was a delay in symmetric engine operation after the PLs were advanced simultaneously.

Asymmetric application of power, with one PL at flight idle and the other in the ground idle range, produced a descending roll and yaw in the direction of the propeller in the ground idle position, which was easily controlled with aileron.

1 .17 Additional Information

1.17.1 Company Organization

Executive Air was originally certificated as an air carrier on November 2, 1979. At the time of the accident at Mayaguez, the carrier was conducting commuter operations under 14 CFR Parts 121 and 135 and on-demand charter flights under Part 135. Their Part 121 operation consisted of operating two 44-passenger Aerospatiale/Aeriatalia, ATR-42 airplanes. Ten 19-passenger CASA C-212-CCs were used in the Part 135 commuter air carrier operation. One Mitsubishi MU-2, a Cessna 402, and a Piper PA-60 were used for the on-demand charter service. The carrier's certificate was reissued on October 31, 1986, to show that it was operating as an American Eagle carrier. The carrier had acquired a code-sharing marketing agreement with American Airlines to provide connecting service to the American Airlines' hub at San Juan. Executive Air was providing 92 scheduled flights daily serving 18 cities throughout Puerto Rico, the Virgin Islands, the West Indies, and the Dominican Republic.

The carrier obtained its first CASA C-212 on December 30, 1985, which replaced some older airplanes. From the end of December to May 1987, the carrier added nine more C-212s to its operation. On October 30, 1986, the carrier began the proving tests with the two ATR-42s. In the summer of 1986, it had 14 pilots. It began hiring and training additional pilots in August 1986 and had obtained about 60 pilots by October.

Executive Air had 224 employees at the time of the accident on May 8, 1987. The operations department consisted of the director of operations, the chief pilot, the assistant chief pilot/director of training, 4 check airmen, 7 flight dispatchers/coordinators (weight and balance agents), 28 line captains, 27 line first officers, and 9 flight attendants (ATR-42 only).

The carrier required that captains hold ATPs and first officers hold at least a commercial pilot certificate with a current second-class medical certificate in accordance with Federal regulations. The amount of flying done by the first officer was at the discretion of the captain.

The maintenance department consisted of 56 personnel: the vice president of maintenance; the director of maintenance; the director of quality control; the chief inspector; 6 designated quality control inspectors/mechanic supervisors; 19 mechanics; 10 mechanic's helpers; 8 cleaners; 6 stockroom personnel; 2 clerks; and 1 secretary. A number of the maintenance personnel were former employees of Puerto Rico International Airlines, which operated the CASA C-212 before ceasing its operations.

1.17.2 Personnel Training

The carrier developed its own FAA-approved training program for crewmembers, check airmen, instructors, and flight dispatchers. The program consisted of four phases of ground training: initial, recurrent, upgrade, and transition. The flight training program consisted of 3 hours of initial, 20 hours of initial operating experience, and a l/2 hour of seat-dependent task training. Seat-dependent task training was required before a qualified flightcrew member could occupy and perform assigned duties for another flightcrew member. For the CASA C-212, this type of training included taxiing from the left seat because of the location of the steering handle, activating the oxygen system in an emergency, and using the hydraulic pump from the right seat. This type of training also included performing both a normal and an aborted takeoff and all the training was performed until the crewmember was proficient. Differences training was included as part of the carrier's initial and transition training program. A minimum passing grade on any written or oral examination was 70 percent. Flightcrew members received no specific cockpit resource management training.

The carrier used the standard challenge and response method in complying with checklists. The flying pilot was responsible for verifying the callout and acknowledging the appropriate action.

According to the carrier's training program and normal operating procedures, a visual approach was flown by first stabilizing the airplane in the traffic pattern on a downwind leg at 120 KIAS. The flaps are extended to 15°, and the speed was reduced to 105 KIAS abeam the runway threshold. At this point, the flightcrew goes over the before landing checklist. There are six items to check: 1) hydraulic pump ON, pressure up; 2) steering handwheel centered; 3) flaps set; 4) speed levers full forward; 5) engine instruments; and 6) landing lights ON at 400 feet. The baseleg turn, descent, and final approach are to be flown at the appropriate speeds and flap settings. All of the pilots interviewed stated that they used the approach flap setting of 37.5 percent for landings at all airports but one in Virgin Gorda.

1.17.3 Personnel Interviews

Company pilots who had flown with the captain and first officer were interviewed to determine their flying habits and piloting techniques. These persons were also asked for their opinions of the CASA C-212 and for information about Executive Air's operating procedures. The following is a summary of the interviews.

> The captain conducted his duties in a very professional manner. He was a normal captain. He liked to fly very high and land with full flaps. He used the checklist and demonstrated good judgment. He was observed to use the company's normal approach flap setting of 37.5 percent for landing. He used normal procedures except for using full flaps on landings and would take his hands off the power levers and put them on the control wheel during an approach. About 65 percent of his landings were hard because he used full flaps. He used to fly approaches at a very low airspeed at times. He was a responsible person and would go out of his way to help his first officer. He never used the shoulder harness. He flew higher approach and landing profiles than other captains.
>
> The first officer was a very good pilot. An excellent pilot and very responsible about his duties. He used the checklist and had very good judgment. He used the normal approach flap setting of 37.5 percent for landings.
>
> The CASA C-212 is a very safe aircraft overall. The engines could be described as "delicate" as far as temperature--the [exhaust gas temperature (EGT)] is something to be concerned about. Many crewmembers do not retard the PLs to the flight idle gates until the airplane has touched down on the runway. It is company policy that flightcrews report for duty in sufficient time to prepare for flight properly, and no later than 30 minutes before flight time. This would include such things as checking for irregularities recorded in the flight log on previous flights. It is common practice for the captain to fly the first leg of the day, but this is not a set company policy. The company flight procedure is for the nonflying pilot to operate the radios.
>
> On a visual approach into Mayaguez, the baseleg turn is made over the shoreline.

Interviews were conducted with Chaparral Airlines in July 1987. This operator, who was doing business as American Eagle, had operated three C-212s for 6 years and had accumulated 36,000 hours of experience with the airplane. The chief pilot, the director of training (also a check airman), a line captain/check airman, a line captain, and the vice president of maintenance were interviewed. The pilots had from 2,000 to 4,000 hours of flight time in the CASA C-21 2.

Questions concerning operations and maintenance included the area of operations, initial training, flight characteristics of the C-212, transition problems, and flight procedures. The following is a compilation of various crew comments.

Initial Training

- Initial factory training obtained from CASA Aircraft USA, the manufacturer's customer support facility in the United States, consisted of 40 hours of ground school and 5 hours of flight training.

- The company developed its own crewmember training based on the factory school. This consisted of 45 hours of basic indoctrination, 28 hours ground school in the C-212, and 4 hours of flight training. The carrier developed a video tape presentation of the ground school which is available at any time to crewmembers.

Flight Characteristics

- The airplane has a lot of drag and will decelerate quickly particularly when the PLs are positioned to flight idle. At that time, a very high sink rate will develop (1,500 to 2,000 fpm).

- The airplane appears to be stable in all flight regimes. It has light control pressures. It is sluggish and not too responsive to control deflections. Large amounts of trim are required to reduce control pressures. The rudder is effective. Changes in pitch are not very noticeable with corresponding changes in airspeed.

- It is somewhat difficult to notice the effects of changes in flap positions and one may not notice if flaps bleed up on an approach, and they tend to bleed down during long periods during ground operations. It is easy to mis-set the flaps, and the flap handle sometimes binds and is very stiff; one broke off during an operation.

- The setting of fuel flow and blade angle adjustments can change the landing characteristics of the airplane significantly.

- A stall can occur in the airplane with very little increase in pitch attitude, very little buffet, and with no wing rolloff under certain conditions (in the clean configuration or with approach flaps and at flight idle), which can result in a very high sink rate (1,500 to 2,000 fpm). The stall warning characteristics of the airplane were adequate for an experienced pilot. The airplane should be equipped with a stall warning device. It is very difficult to move the PLs into the beta mode in flight. Little movement is required to move the beta latch mechanisms into the beta mode. It is a common practice to move the PLs between beta and flight idle during taxi operations in order to control taxi speed. The captain always taxies the airplane and uses the beta latches the most and could, therefore, be more prone to use beta inadvertently in flight. The beta latches are easy to reach and move. The beta latch mechanism is a good design. It has to be a deliberate act to move the PLs into the beta mode.

Transition

- The most common problem for pilots transitioning into the C-212 is overconfidence. Students have a problem initially using the flap system.

Flight Procedures

- High density terminal airport operations preclude using flight idle on landing approach. Pilots are reluctant to use flight idle because of the high drag and high rate of descent that result.

- A takeoff flap setting of 15° is used for approach and an approach flap setting for landing. Although crews are taught to use full flaps for landing, full flaps are not used as a standard practice. No-flap landings are not recommended.

- A visual approach is flown at 120 KIAS on downwind leg with a takeoff flap setting. Approach flaps are selected, and the speed is reduced to V_{ref} + 10 crossing the runway threshold and reduced to V_{ref} for landing while using some power on touchdown. At 10 percent torque, the airplane tends to float, but at 0 percent torque, it will sink quickly. Fuel flows of 160 pph will result in a high sink rate, and fuel flows of 190 to 200 pph will not.

Regarding training and maintenance experience on the C-212, the carrier reported the following:

- Ten mechanics were sent to Garrett for training on the TPE-331-10 engine. Experience in changing numerous engines has shown that once the propeller blade angle has been set properly, any further adjustments to obtain the desired amount of power should be made only by adjusting the fuel control unit. It would be tempting to adjust the blade angles using the beta tube to make power adjustments because it is relatively easy and accessible.

- The maintenance manual contained several mistakes that appeared related to the problem of not updating them completely from the 100 to the 200 series airplane. As an example, it contained the incorrect blade angle station to use for setting blade angle (30-inch station instead of the proper 42-inch station). This was corrected by CASA on July 7, 1987. The carrier has had difficulty obtaining manufacturer support, and the technical representatives were not able to expand their support.

- The most common problem experienced has been nosewheel shimmy problems--about 100 such occurrences failures. There have been some problems with EGT gauges resulting in fluctuating readings. Engine combustion chamber and fuel nozzle modifications have caused problems with engines developing sufficient power. Propeller overhauls have disclosed that some propellers did not contain the complete feather spring assembly, and in one case, a propeller had the improper spring assembly installed.

The PLs and beta latch mechanism were evaluated by physically examining and manipulating them from both the captain's and first officer's seats (see figures 8 and 9) and the following were noted :

- With the right hand placed with the palm on top of the PL knobs, the fingers can easily touch the beta latch arm (flight idle latch arm) without moving the hand and could be done unconsciously.

- The beta latch mechanism was easy to move upward, requiring only finger movement. The latch had to move 1/2 inch, from full retraction to full extension, to clear the flight idle gate. It was noted that movement of the latches was more difficult if the PLs were against the flight idle gate than if they were at an intermediate position in front the gate. This was attributed to the resistance of the latch plate against the gate.

- It was noted that the right PL latch tended to raise before the left latch when retarding both PLs and actuating the latch mechanisms from the intermediate and flight idle positions. This was attributed to the natural arm motion and tendency to bring the elbow closer to the body in an aft movement. The motion resulted in more pressure being applied to the outside of the aft movement resulting in more pressure to the right ring finger and thus, more pressure on the right latch arm. Also, since the ring finger is shorter, it appeared that it had more contact with and more tension against the latch arm than the middle finger.

- When moving the PLs from the right seat, it was more difficult to actuate the latches because the PLs are further away. It required rotating the left hand forward in order to place the fingers underneath the latch arms.

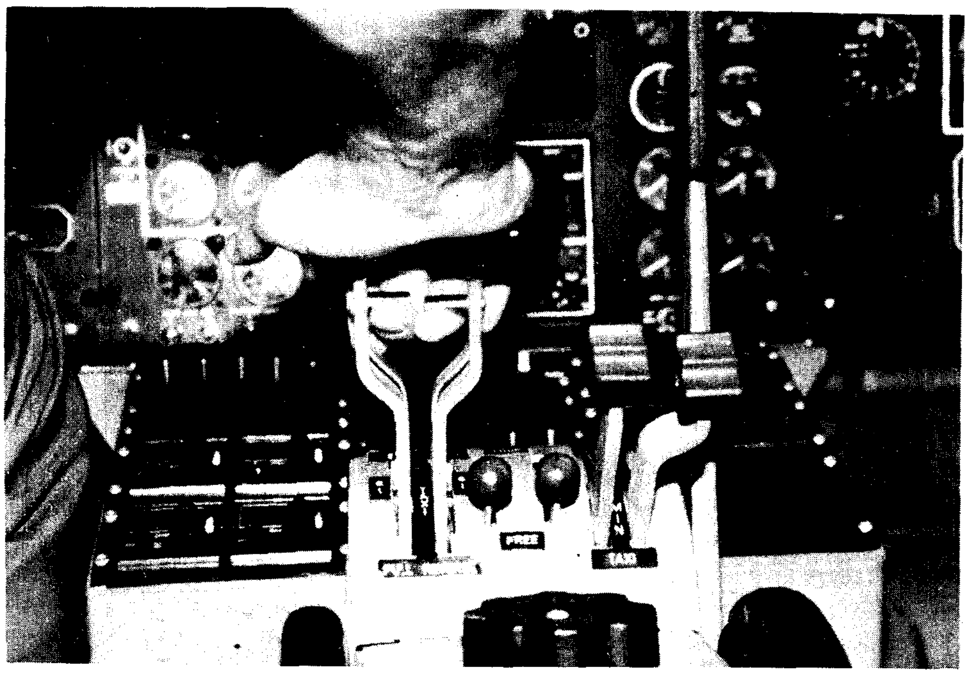


Figure B.--Closeup of the PLs showing operation of the latch lever arms with the PLs in the full reverse position.

1.17.5 FAA Surveillance

As a result of the Safety Board's investigation, the FAA, Southern Region, conducted an airworthiness inspection of Executive Air from June 1 to 5, 1987. Fourteen areas of the maintenance department were examined. In the areas of manuals and inspection procedures, AD compliance, and maintenance programs and inspection system, the following are some of the findings and excerpts from the report:

- Numerous sections in the compliance manual did not reflect how the carrier complied with the appropriate section of the Federal regulations.

- Required Inspection Item (RII) listing in the maintenance manual did not include all of the items that were in fact RII items as shown on the maintenance and inspection forms.

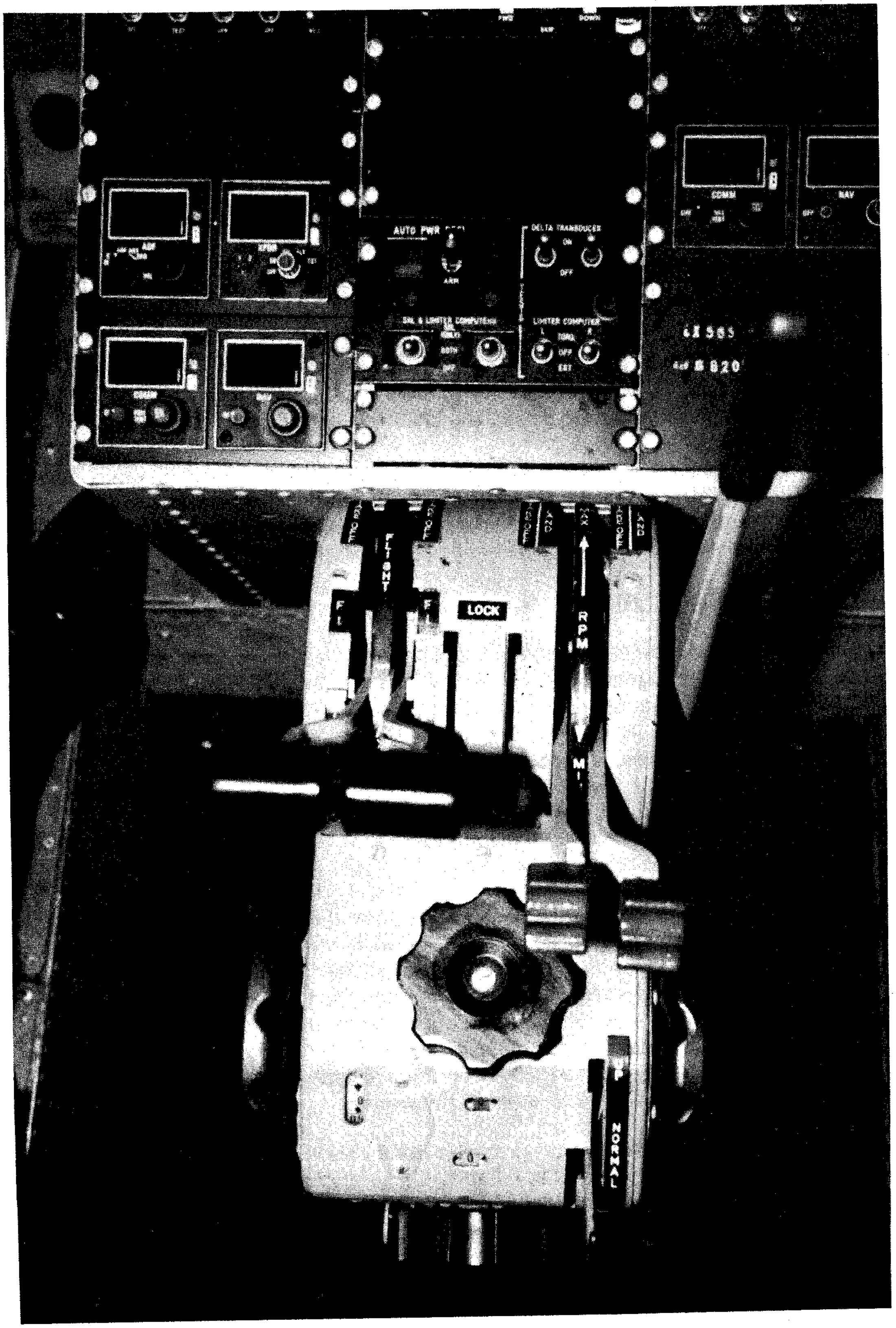


Figure 9--Top view of quadrant.

- The carrier should be more specific when entering the method of compliance for ADs.

- Flight numbers were omitted from the reported discrepancy on the flight/maintenance log in several instances making it difficult to determine when it occurred and who reported the discrepancy.

- Test flight corrective action was recorded on flight/maintenance logs without a leading discrepancy entered which resulted in the test flight.

- Corrective actions taken related to adjustments to engines, propellers, and their components were not considered to be in enough detail to determine exactly . what was done.

- Letter check inspection forms did not have a provision for an authorized inspector to approve the aircraft for return to service following a required inspection. The airworthiness release for the next day in the flight/maintenance constituted the only overall approval.

A review of the San Juan FSDO's surveillance program for the carrier disclosed that its inspectors had visited the carrier on numerous occasions for 1 year before the accident. During this period, the operations and maintenance departments were visited by the inspectors.

1.18 New Investiaation Techniques

Experience has shown that the determination of propeller blade angles at ground impact can be useful in airplane performance considerations. However, this can be difficult when dealing with propellers that do not have "shim plates" installed at the butt ends of the blades, like those installed in the Hamilton Standard propellers. Propellers produced by McCauley and Hartzell are examples of manufacturers that do not incorporate this feature. Therefore, accident investigators who must determine propeller blade angles at the time of ground impact will have difficulty with the McCauley and Hartzell propellers and will not in all cases be able to make a determination. Success in doing so depends on many variables and on the confidence that can be placed on the distinction and correlation of "witness mark" evidence.

The Safety Board was faced with this difficulty in investigating the Executive Air and the Fischer Bros. aviation accidents, and it has experienced this problem with other investigations in the past. Fortunately, the consistency and the ability to correlate "witness mark" evidence with other associated data permitted the Board to arrive at such a determination in the Fischer Bros. accident. However, the left engine propeller was relatively free of impact damage in the Executive Air accident. Since flight recorder data was not available, the Board was not able to assess the airplane's performance accurately . Thus, the Board had to rely on the available evidence in the right engine propeller and on the maintenance and service history of the airplane.

The situation required emphasis on the right propeller examination. When the typical approach used to arrive at a blade angle finding proved unreliable, the Safety Board pursued the evidence of impact marks within the piston of the Hartzell propeller as described in Section 1.16.1 of this report. The type of evidence found within the piston of the propeller hub was attributed to significant impact wrenching forces on the right propeller hub when it hit the chain-link fence and ditch, and the airplane pivoted. Although not necessarily a new technique, the Safety Board believes that investigators should look for such possible evidence in future investigations of this type.

2. ANALYSIS

2.1 General

The flightcrew was certificated and trained in accordance with the airline's approved training program; they were current and qualified to conduct the flight. There was no evidence of factors that would have detracted from their physical ability to operate the airplane. Both crewmembers were very experienced pilots with a total of 15,000 flight hours between them, and they had a reasonable amount of flight experience in the CASA C-212- CC. The Safety Board noted, however, that this was the second flight on which the two of them had flown together, having flown for the first time together a little over a month before. It was common practice, but not company policy, for the captain to fly the first flight leg of the day; it was company procedure for the nonflying pilot to operate the radios. Since both pilots made various radio communications during the flight, the Safety Board cannot conclude which pilot was flying the airplane at the time of the accident.

When other pilots were interviewed about the first officer's performance as a crewmember, they were consistently complimentary. Except for landing procedures and technique, statements concerning the captain's performance were fairly consistent and also complimentary. Several pilots stated that the captain flew at higher altitudes en route and that he used full flaps and made steep approaches, sometimes at very low airspeeds on landings. The captain had acquired most of his turbine engine experience in the deHavilland DHC-6, a short takeoff and landing (STOL) airplane. He likely carried over his STOL-type flying techniques to the CASA C-212, which is also considered a STOL airplane. The carrier and other carriers do not consistently use STOL techniques in flying the c-212.

The Safety Board noted that the captain did not use the shoulder harness, which was similarly reported about the captain involved in the Fischer Bros. accident in Detroit, Michigan. Both pilots were small. The captain in the Fischer Bros. accident was 5 feet 5 inches and weighed 140 pounds, and the captain in this accident was 5 feet 4 inches and weighed 170 pounds. Since the shoulder harness restricted movement and did not always retract properly, the Safety Board believes that the harness would have been more of a nuisance for these two captains than for larger pilots. However, other pilots also had difficulty with the harness, and there was no evidence that the first officer in this accident had used his shoulder harness. Consequently, the Safety Board believes that pilots' failure to use the shoulder harness in the CASA C-212, especially smaller pilots, may have been more widespread than reported. Therefore, the Safety Board believes the FAA should inspect these harness installations in the C-212 to verify that it conforms with accepted anthropomorphic criteria of intended users. Considering the nature of the impact and the destruction to the cockpit, use of the shoulder harnesses by the flightcrew would not have prevented their fatal injuries in this accident. However, the Safety Board believes that features which restrict movement and render a shoulder harness uncomfortable will tend to discourage its use. These features should be eliminated since appropriate use of the harness prevents certain types of injuries.

2.2 The Visual Approach

Visual meteorological conditions prevailed at the airport at the time of the accident. The wind was reported to have been calm, and there was no indication of any wind shear at the airport. Therefore, the Safety Board believes that the weather was not a factor in the accident.

Both crewmembers were familiar with the approach to the airport at Mayaguez. Although they did not make the in-range report to the carrier's station at Mayaguez, they also did not report any difficulty. Also, the investigation disclosed no evidence of a failure or malfunction of the airplane, its systems, or components. Therefore, the Safety Board believes that the flightcrew was not confronted with a problem as they set up for a left downwind, visual approach to runway 09.

Furthermore, witness statements support the conclusion that the flight was normal until the baseleg and final turns to the final approach were initiated.

Since there was no flight recorder or radar data available, the Safety Board was unable to determine the airplane's configuration, attitudes, speeds, and altitudes during the baseleg turn to final. However, witnesses reported that the flightcrew made a shortened downwind and baseleg turn. One witness stated the airplane made a continuous left turn, descending rapidly. A shortened approach would have contributed to an unstabilized approach, wherein a uniform approach path at the proper angle, speed, and rate of descent could not be achieved. Another witness reported that the airplane appeared to overshoot the extended centerline of the runway during the turn to the final approach and that it appeared to have been flying too fast. Additionally, if the crop duster pilot's estimate of altitude and distance were accurate, the airplane was making a fairly steep approach, from 5" to 6°, when he observed it on final approach. These observations tend to confirm that the final approach was not stabilized. The crop duster pilot's description of the approach, as well as those of other witnesses, correlated with the ground and airplane damage. The consensus of the descriptions was that the airplane yawed and rolled to the right, striking the right wing tip first. The airplane then struck a ditch and chain-link fence before it came to rest.

Pilot action required to correct an approach that is too steep and too fast involves a combination of power and pitch control changes in order to achieve the proper approach path at the correct airspeed. If the power and pitch changes are not coordinated properly, the airplane will overshoot or undershoot the intended point of landing on the runway. The earlier corrective action is taken in the approach, the smaller the amount of power and pitch attitude adjustments required and the more time available in which to make the adjustments. If the airplane is on a steep, close-in approach to the runway threshold before the necessary corrections are made, the pilot can be rushed into making sudden and large corrections in power and pitch attitude to re-establish the proper approach path to the runway. If a large increase in pitch attitude is not accompanied by an appropriate increase in power or exchanged for excess airspeed, the airplane can rapidly enter a stall condition. Moreover, if the pitch increase is made rapidly enough the airplane can enter an accelerated stall at an airspeed significantly higher than its normal 1 .0G stall speed.

Correlation of the accident site terrain features, impact marks, airplane geometry, and damage to the right wing tip indicated that the airplane was in right bank of 30" or greater and that its flightpath angle was 5" or greater when it struck the ground 643 feet short of the runway threshold and 86 feet below a normal 3°-approach path. The Safety Board believes the evidence confirms that the pilot flew an unstabilized approach at a steep angle and at a fairly high rate of descent. This resulted in the airplane sinking below the normal approach path requiring the pilot to arrest the rate of descent at the last minute. In fact, a witness reported that the nose of the airplane rose up quickly, and the airplane then rolled to the right when he observed it coming toward him. This suggests the pilot may have suddenly increased the pitch attitude to arrest the rate of descent and attempted to extend the approach path or that he attempted to make a go-around before lateral and directional control was lost. The evidence further suggests that the loss of control could have been the result of a stall.

The Safety Board determined that the wing flaps were up at the time the right wing struck the ground at the site of initial impact. This was inconsistent with the procedures used by the carrier, in that the approach flap setting of 37.5 percent was normally used. Moreover, this finding was contrary to the manner in which the captain reportedly flew visual approaches using full flaps. Finding the flaps retracted at impact suggests that either the flightcrew failed to extend the flaps, they intentionally executed a no-flap approach, they mishandled the operation of the flaps, or the flaps bled up during the approach.

Given the subsequent reported service difficulties with the flaps experienced by the carrier, it is possible that the flaps bled up during the rapid descent. However, full retraction of the flaps during an approach had not been previously reported or documented; only a small amount of flap retraction movement had been experienced. Since the flap service difficulty history did not come to the Safety Board's attention until several months after the accident, it was unable to determine if there was a problem with some component(s) of the system because the wreckage had been released for salvage and later disposed. However, examination did not disclose evidence of a failure, malfunction, or leaks in the flap hydraulic system. Since uncommanded flap movement had only amounted to 3 to 5 percent, the Safety Board would have expected to find some extension of the flaps at impact unless the pilot had intentionally or unintentionally made a no-flap approach. Therefore, the Safety Board believes that the flaps probably would not have retracted fully had the pilot used full flaps during the final approach.

If the flaps had been mis-set, the Safety Board also believes that it would have found some degree of flap extension at the time the right wing struck the ground. Therefore, the Safety Board is inclined to believe that either the flightcrew made a no-flap approach intentionally or unintentionally or they mishandled the flaps in an attempted go-around maneuver by leaving the flap lever in the up position. This belief is further supported by the fact that the lever was found in the full-up position.

There is a power-off stall difference of about 15 KIAS between full flap extension and full retraction. Therefore, with flaps up, a lack of awareness on the part of the pilot could lead to his failure to maintain a sufficient margin above the stall speed, particularly if he attempted to arrest the high sink rate by increasing pitch attitude alone. The potential increase in the rate of sink during flap retraction in a go-around maneuver would also be a significant factor in a recovery to stabilized flight. Either of these two possibilities would have led to an entry into a stall at about 75 KIAS or into an accelerated stall at a higher airspeed.

The indication of a stall resulting from the unstabilized approach and the nature of the stall warning of the C-212-CC brought into question the adequacy of aerodynamic buffeting as a stall warning. The C-212 was originally determined to have adequate inherent aerodynamic buffeting to provide warning of an impending stall, and it was not required to be equipped with a stall warning device. Later subjective evaluations by the FAA reversed the original determination. In both evaluations, only straight and turning flight were required to be evaluated. The warning margins assume a "normal" deceleration rate and nearly constant 1 .O G maneuver to provide a timely, early warning of an approaching stall. However, stalls may result from more severe deceleration rates or more abrupt maneuvers, and airplane vibrations and atmospheric turbulence may mask the inherent aerodynamic buffeting cues. Therefore, the warning time can be significantly reduced or masked depending on the particular maneuver and other environmental conditions.

The Safety Board is concerned that the absence of a stall warning device compromises safety in 14 CFR Parts 135 and 121 passenger-carrying operations by placing too much reliance on a subjectively approved "inherent" buffeting stall warning feature that may be less noticeable during an emergency or in the presence of atmospheric turbulence. Therefore, the Safety Board believes that the FAA should reevaluate the stall warning certification criteria for airplanes used in Parts 135 and 121 air carrier operations with a view toward requiring stall warning devices on these airplanes.

2.3 Asymmetric Power Condition

The Safety Board's investigation determined that other factors also contributed to the pilot losing control of the airplane. Four of the passengers heard unusual engine sounds during the approach, and two ground witnesses remarked about the sound of the engines. The crop duster pilot said the sound was similar to the sound of reverse propeller pitch, and it was associated with the airplane's yaw to the right. These observations indicated that the pilot encountered a problem with an engine or propeller or both. Since no evidence of a failure or malfunction in these components was found, the Safety Board believes the evidence supports the contention that the problem was associated with the manner in which the pilot manipulated the PLs, or with rigging of an engine and propeller controls, or a combination of both.

Postaccident metallurgical examination of the pitch change piston from the right propeller established that the initiation of the spiral gouge in the wall of the piston corresponded to a propeller blade angle of 0". Consequently, the Safety Board concludes that the blades on the right propeller were at an angle of 0° when the propeller dome struck the fence and ground. However, this condition could have been the result of propeller pitch control linkage distortion when the right engine separated from the wing during the impact sequence, of movement of the PLs aft into the beta mode by the pilot, or of static misadjustment of the low-pitch stop by maintenance personnel.

Although the Safety Board cannot exclude crash dynamics as having produced the low-blade angle on the right propeller, it is of the opinion that distortion of the propeller pitch control linkage did not occur simultaneously with the availability of oil flow from the engine driven pump through the propeller governor to the pitch control cylinder at sufficiently high pressure to force the pitch control piston toward the 0°-blade angle in opposition to feather spring and counterweight forces. Furthermore, unlike the left engine and propeller which retained its operational integrity for a comparatively long period during the crash sequence, the right engine and propeller was subjected to severe impact forces almost immediately after the right wing tip struck the ground. Consequently, even though components of the right engine and propeller could be functionally tested after the accident, it is probable that the operational integrity of the components was destroyed immediately after the right propeller struck the ground.

As a result of the Safety Board's investigation of the Fischer Bros. accident, it examined the possibility that the pilot could have intentionally or inadvertently placed the PLs into the beta mode which would account for the witness observations and the physical evidence found at the accident site. Moving the PLs behind the flight idle stop and into the beta mode produced significant deceleration, propeller cyclic noise, stick-free nosedown pitch which is correctable, and potential high rates of descent. The CASA approved flight manual (AFM) contained this warning, "Power lever must not be retarded aft of F.I. [flight Idle] when inflight. Excessive drag may result." However, the design of'the beta latch mechanism of the PLs permits selection of the beta mode in flight. In the Fischer Bros. accident, the Board concluded that the pilot intentionally used the beta mode during a visual approach which was the significant causal factor in the accident. In contrast, however, there were no reports from other Executive Air crewmembers of the captain or first officer ever using the beta mode in flight, and there were no reports of it happening to other crewmembers in the company. Furthermore, examination of the light bulbs from the beta lights for both propellers indicated that neither light was illuminated during the crash sequence. The 0°-blade angle of the right propeller indicates that it was well within the beta range of operation. Consequently, had the low-pitch stop for the right propeller been near the nominal 7°-blade angle, the right engine beta light should have illuminated during the crash. Therefore, the Safety Board believes that this evidence tends to rule out the pilot's intentional or inadvertent use of the beta mode during the approach.

The Safety Board also recognized that inadvertent selection of the beta mode in flight is possible based on the its examination of the beta latch mechanism in the C-212 and the views expressed by some pilots. However, line pilot opinions varied on this question, and the operational history of the airplane revealed that this was a remote occurrence. The design of the beta latch mechanism in the C-212 is not unlike that of other turbopropeller airplanes. Federal regulation governing the design criteria, 14 CFR 25.1155, states:

> Each control for reverse thrust and for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime.

Although the rule requires that inadvertent operation of the propeller pitch control below the flight regime be prevented, the rule relies on a positive lock or stop plus a separate and distinct operation. However, the rule is subjective because it is dependent on the degree of separate and distinct movement that prevents its inadvertent operation. Further, the rule does not provide for a positive means of preventing the in-flight selection of propeller pitch settings below the flight regime of propeller operation when such settings are prohibited by the FAA AFM.

The Safety Board's evaluation of the beta latch mechanism on the C-212 in conjunction with the service history of the airplane indicate that the design meets the provisions of the current rule, but it is not foolproof. That is, if the pilot is not aware and conscious of how arm and finger movements must be coordinated to prevent retraction of the beta latch arm during movement of the PLs, inadvertent retraction of the latch arm could occur concurrently with movement of the PLs toward the flight idle position. Consequently, pilots must consciously avoid positioning their fingers on the beta latch arm during aft movement of the PLs to the flight idle position; otherwise, inadvertent movement of the PLs into the beta mode appears possible.

For those airplanes certificated under the current rule, if operation of the propellers below the flight regime is prohibited, the Safety Board believes that provisions for certain operational reinforcements should have been an integral part of the certification process. For instance, the proper operation of the beta latch mechanism, proper use of the PLs to avoid making a mistake in selecting the beta mode in flight, and the use of crew coordination as a backup against making such a mistake should be items emphasized in a training program. Certainly, caution against using the beta mode in flight and a discussion of the hazards associated with it should be emphasized to instill an awareness of the danger and to instill the proper discipline in using the PLs to foster the proper habit-pattern development. Operators are responsible for ensuring that their pilots adhere to the limitations in the airplane as outlined in the AFM. Any deviations from those limitations, particularly in a critical flight regime, should not be tolerated. The fact that another air carrier's pilots attempted, with passengers on board, to find out how the airplane would react in flight while in beta mode, may be an indication that these operational reinforcements were not emphasized.

With regard to the future application of 14 CFR 25.1155 (and 14 CFR 23.1155), the Safety Board believes that from a human engineering perspective, a means to prevent inadvertent operation of a critical control should be positive or foolproof. That is, the designer should provide either a separate control that requires a deliberate act on the part of the pilot to select, under certain conditions, a function that is prohibited or an interlock mechanism that will automatically prevent the selection of a prohibited function except when the correct conditions have been established. Therefore, in airplanes where selection of propeller pitch settings below the flight regime of propeller operation is to be prohibited, the Safety Board believes that a positive means to prevent this from happening, such as incorporating an additional control or air-ground interlock mechanism that prevents removal of the flight low pitch stops during flights, should be required. Consequently, the Safety Board believes that 14 CFR 25.1155 (and 14 CFR 23.1155) should be revised accordingly.

According to the manufacturer, the beta light was not designed to operate in flight to alert the pilot, but rather, it is a feature to alert the pilot on landing that he can take manual control of the propeller. However, the Safety Board found in its investigation that the beta light should alert the pilot of his selection of the beta mode in flight. Furthermore, the Board believes that a pilot would be alerted if the beta mode was selected inadvertently. Flight tests showed that with the PLs behind the flight idle gate, the torque readings went to 0, there was a sound of propeller cyclic noise, and the airplane pitched down. These characteristics would obviously alert the pilot once the beta mode was selected. Such an event occurred previously to another air carrier's flightcrew. Therefore, the Safety Board believes that inadvertent selection of the beta mode would not go unnoticed by the pilot.

The other factor that the Safety Board considered and believed was involved in the loss of control was the misrigging of an engine and propeller controls. There was no evidence of previous malfunctions in the left engine or propeller, nor was there any postaccident evidence of a failure or malfunction of these components. The feathered position of the blades of the left propeller was attributed to movement of the control cable during the crash sequence that opened the propeller feathering valve and initiated the feathering sequence including the closing of engine fuel valves during the crash. Also, these valve actuating handles in the cockpit were found in the normal position which further supports this conclusion.

In contrast, during the weeks preceding the accident, the right engine and propeller were repeatedly cited by company pilots as functioning improperly. In view of the reported discrepancies and the nature of the corrective actions taken, the Safety Board believes that the carrier's maintenance department personnel did not follow completely the manufacturer's instructions or sound maintenance practices. Although the right engine and propeller were replaced in early May and the airplane reportedly was test flown satisfactorily on May 5, several discrepancies involving the right engine and propeller continued to be reported thereafter. Later on the same day, the propeller was reported to be operating on beta and NTSing. The torque was over 40 percent, the airplane yawed, and the flight idle fuel flow was 260 pph. The corrective action taken by the maintenance department to readjust the propeller governor and the FCU underspeed governor would not have corrected the root of the problem. The manufacturer recommends that the two governors be separated by 2.5 percent RPM in order to maintain proper governor control of the engine. Following this corrective action, the airplane was returned to service. On the last flight of the day, the right propeller was reported to have gone into the reverse mode when flight idle was selected on landing. In an interview, the flightcrew was not certain that the propeller went into reverse, but they reported observing the propeller "hunting" (blade pitch oscillation). The maintenance corrective action was to adjust the propeller blade angle. On May 6, eight flights were flown without a reported discrepancy. However, the first officer who flew the airplane that day confirmed that the airplane had a tendency to yaw to the left when the PLs were placed in flight idle on landing.

On May 7 after the first two flights of the day, the right engine was reported producing 20 percent torque with the PL at flight idle--10 percent more than normal. Again, maintenance personnel readjusted the blade angle on the right propeller. Although the airplane flew eight flights thereafter with no reported discrepancies, the flightcrew that flew the airplane on those subsequent flights reported not having used flight idle until the airplane was on the ground and had slowed down. As a result, it is probable that during these eight flights before the accident, the flightcrew did not encounter a significant yaw problem in the airplane.

Considering that the postaccident test of the right engine FCU showed a significantly high flight idle fuel flow of 299 pph, the Safety Board believes that the right engine fuel flow was mis-set well beyond normal limits for operating the C-212-CC. Examination of the FCU showed that at some time, a fuel flow adjustment had been made, and the specific gravity flow of the unit had been changed. Although there was no record to show that the unit had been adjusted by the carrier's maintenance personnel, the Safety Board is inclined to believe that they probably made adjustments in response to the pilot-reported discrepancies. Furthermore, it is apparent that maintenance personnel attempted to correct the high torque of the right engine by repositioning the beta tube which would have resulted in a lower flight idle blade angle than specified by the manufacturer. There was no record showing what exactly was done to readjust the blade angle, and there was no record of a flight idle descent check as required in order to ensure that fuel flows were adjusted properly. It did not appear that the complete procedure was done after the engine change. The Safety Board doubts that a thorough flight idle descent check including accurate fuel flow settings could be accomplished after one 15-minute test flight. It would be highly unlikely to have the fuel flow set correctly after an engine change on the first attempt without having to make a readjustment. The Safety Board believes that had maintenance personnel followed the manufacturer's procedures properly for establishing the flight idle blade angle and flight idle descent fuel flows for the airplane, the problems would not have occurred. Consequently, the Safety Board concludes that on the day of the accident, the right engine in the airplane was developing excessive torque at flight idle and that the flight idle hydraulic stop of the propeller could have been set significantly lower than the 7" prescribed by the manufacturer.

The significance of an abnormally high flight idle fuel flow on the right engine becomes evident only when the PLs were retarded to the flight idle position--a position normally used only during descent and the landing flare. Under conditions of equal torque on both engines, the propeller blade angles would be essentially equal in response to propeller governor operation to maintain constant engine RPM. However, when the PLs were retarded to the flight idle position, the right engine would have produced more torque because of the high flight idle fuel flow, and the airplane would have yawed to the left toward the engine with the lower torque. At airspeeds above about 70 KIAS, the propeller blade angles would have varied in response to propeller governor operation to maintain constant engine RPM, but the blade angles on both propellers would have continued to decrease as airspeed decreased. Under these circumstances, had the left engine propeller contacted the flight low pitch stop, in effect, it would have become a fixed-pitch propeller while the right propeller continued to reduce its blade angle in response to decreasing airspeed since the right propeller could have had an abnormally low flight idle pitch stop setting. Under these conditions, the left propeller would have placed a load on the engine, thereby reducing the engine RPM while the right propeller continued to reduce its blade angle to a lower thrust condition. The left engine governor would have sensed an underspeed condition requiring more fuel to increase and maintain the RPM. As more fuel was introduced by the underspeed governor, the left propeller would have produced additional thrust, which in conjunction with the decreasing thrust condition of the right propeller would have caused the airplane to yaw to the right. Consequently, the Safety Board believes that the pilot could have been correcting the initial left yaw produced by the right engine with right rudder and encountered a sudden yaw to the right in conjunction with a rapid reduction in airspeed.

A reduction in propeller blade angles to the flight idle low pitch stop would not normally occur in the C-212 until the airspeed is reduced below stall speed and the airplane is on landing rollout. However, a rapid increase in airplane pitch attitude might cause this condition to occur at airspeeds above the airplane's stall speed because the rapid increase in pitch attitude would significantly increase the angle of attack on the propellers momentarily causing the propeller governors to rapidly reduce the blade angles in order to maintain constant engine RPM. The rapid reduction in blade angles could, therefore, cause a rapid asymmetric thrust reversal with the left propeller constrained by the low pitch stop and the right propeller blade angle reduced to a lower thrust condition.

Moreover, forward movement of the PLs under these circumstances, a conditioned response to a rapid increase in pitch attitude at approach airspeeds, would have aggravated the asymmetric thrust reversal because with the higher blade angle on the left propeller, it would have immediately begun producing significantly more thrust than the right propeller with its lower flight idle blade angle.

In consideration of all the evidence related to the operation, maintenance, and postaccident condition of the right engine and propeller on the airplane, the Safety Board concludes that the series of trial-and-error maintenance actions performed during the 3 days preceding the accident most likely resulted in the misadjustment of propeller's flight idle low pitch stop to a degree significantly below the setting prescribed by the manufacturer. Additionally, although the pilot, in an attempt to salvage approach, flew an unstabilized and steep landing approach that resulted in a rapid increase in pitch attitude at a relatively low altitude that may have aggravated the situation by placing the airplane near an accelerated stall condition, the Safety Board concludes that the pilot's actions probably would have resulted in either a successful landing or missed approach had the right engine and propeller been adjusted properly. Finally, the Safety Board concludes that the improper maintenance performed on the right engine and propeller during the 3 days preceding the accident relates directly to the cause of the accident.

2.4 Aircraft Maintenance

The Safety Board's investigation disclosed a number of discrepancies in the carrier's maintenance practices. Regarding the maintenance department's actions, the Board believes that there was a failure to troubleshoot the pilot-reported discrepancies correctly. This poor performance led to unnecessary and time-consuming maintenance tasks that aggravated the carrier's maintenance difficulties. The carrier was averaging about seven flights per day per airplane with most flights lasting less than 1 hour based on its flight schedule. This flight schedule adds to an accumulation of numerous takeoff and landing cycles requiring a corresponding increase in the level of maintenance and inspections in a compressed time frame. Additionally, the carrier had the two ATR-42's in a Part 121 maintenance program to manage. This situation could have placed a burden on the maintenance department contributing to the development of shortcuts in maintenance and inspection practices.

The setting of the C-212's flight idle blade angle and corresponding fuel flow adjustments can be tedious and time consuming. However, their proper settings are critical to the proper handling and landing characteristics of the airplane. The evidence indicates that the carrier's maintenance personnel were inclined to take the most expedient means to correct an engine rigging problem by simply adjusting the beta tube a couple of turns in a quick trial-and-error approach to correct the discrepancies. The determination of the airplane's flight idle blade angle is a manufacturer design and is evaluated from a performance and safety standpoint in the type certification process by the regulatory authority. Proper maintenance of this flight characteristic is critical to the airplane and should not have been taken lightly as shown by this accident. Therefore, the Safety Board concludes that the management and supervision of the maintenance personnel were deficient.

In addition, during its investigation, the Safety Board found it difficult to verify when scheduled maintenance actions had been taken and when final inspections of the maintenance had been performed without extensive interviews of the maintenance personnel involved because of poor maintenance recordkeeping. This situation came to light when it was learned during interviews that the accident airplane had been released for flight during the day when the scheduled inspection interval was incomplete. Although performing a particular scheduled inspection in intervals is a common maintenance practice under a continuous airworthiness inspection program, it was not possible to determine from the records what date the RIIs were inspected before the airplane was released for flight each day. This type of recordkeeping should not have been acceptable to the FAA FSDO responsible for issuing the carrier's operating certificate. In fact, the FAA FSDO questioned if the carrier's maintenance program permitted this type of maintenance activity. Additionally, though this kind of maintenance practice is acceptable, the Safety Board believes it can lead to difficulties without the proper controls in place, such as adequate staffing, supervision, and a sound system of recordkeeping.

The Safety Board's findings prompted the FAA's Southern Region to conduct an airworthiness inspection of the carrier on June l-5 1987. The FAA's findings reflect, in part, the difficulty the Safety Board had in tracking maintenance and inspection accomplishments. The Safety Board believes that routine surveillance would have proved difficult under these circumstances and that this practice should have been uncovered during the FSDO's certification process and in its continuous surveillance of the carrier.

2.5 Airworthiness

Although very limited in scope, the Safety Board, in a review of the bilateral certification process, did not find reason for concern about the overall approach and intent of BAAs. The Safety Board noted that a system to eliminate a duplication of aircraft certification is worthwhile in view of the costs, time, and resources involved. However, some weaknesses do exist in the system that require careful implementation. For example, when the FAA performs its technical evaluation of an exporting country's airworthiness certification authority and aircraft manufacturing capability, the review forms the basis of the BAA between two countries. The Board, therefore, believes that the technical review process should have close scrutiny by the FAA and the DOT. The FAA does have the authority to withhold a type certificate and an airworthiness certificate by verifying that the aircraft conforms to the type design standards. In other words, the FAA does not have to "rubber stamp" its approval of a foreign manufactured aircraft because of an existing BAA. On the contrary, if the FAA finds that the design does not meet U.S. airworthiness standards and does not conform to the approved design, then a certificate is withheld. On the other hand, the FAA can accept the exporting country's certification that the airplane meets the U.S. requirements.

The Safety Board believes that it was evident that many of the airworthiness issues and resolution difficulties that occurred were not necessarily unique to the C-212. Several other type certification problems have also been encountered with other types of aircraft. Most aircraft have their share of airworthiness problems which are eventually corrected during their service life through manufacturer service bulletins and ADs. In this case, technical problems were not new and could have been anticipated and corrected in the early stages of the airplane's development. In some areas, the FAA did not identify problems early enough in the certification process of the civil version of the C-212. It is apparent that in regard to the model CC, which was certificated 3 years after the CB model, the FAA did a minimal evaluation of the airplane. Considering the significant changes made to the model CC over the original CB model, the Safety Board believes that the FAA should have conducted a flight test evaluation of the CC model airplane.

In the Safety Board's opinion, many of the difficulties that arose during the certification of the model CC were due primarily to the inability of the FAA at the time to manage effectively its participation in the bilateral certification program. For instance, the Board noted that while the CC model was being developed, there were no flight test pilots or engineers on the staff of the Brussels office, and there were many changes in FAA personnel assigned to the CASA project. Also, the FAA underwent a reorganization of its airworthiness departments which consequently led to a transfer of responsibility for the C-212 program from the Brussels office to its Northwest Mountain Regional Office in Seattle, Washington. This inevitably interrupted the continuity in FAA's review of the C-212, and it detracted from effective management of the program.

For example, the first sign of reported noncompliance in the design of the C-212 was reported by the Cleveland GADO in September 1980 to the FAA's Office of Airworthiness. However, the FAA did not issue an AD to correct the problems for nearly 3 1/2 years. In view of the Safety Board's findings, FAA action to correct problems with the doors and exits of the model CC was incomplete, and its monitoring of this issue was inadequate. This issue also indicated that in the Supplemental Type Certificate (STC) approval process with respect to the main cabin door stairs, FAA did not make an accurate assessment. Additionally, the STC approval of the galley/electronics compartment installation did not comply with Federal rules. There was an apparent lack of standardization and coordination, and field office certification and surveillance was incomplete. Although the Cleveland GADO did identify one of the noncompliance items found by the Board, its correction was apparently later overlooked by engineering personnel, and an AD was not issued to correct the installation discrepancy.

In addition, the March 1984 flight test evaluation disclosed several deficient areas that required followup, but some of these areas received no corrective action. Two of the deficiencies, the inadequate stall warning and the flap position integrity, were proven to be accurate evaluations of potential difficulties and were supported by expert evaluation and service difficulty history 3 years later. The Safety Board believes that, after being apprised of these deficiencies in 1980 and 1984, it would have been prudent for the FAA to have withheld issuance of U.S. type certificates for the CASA models C-212-CD, CE, and CF until the problems were resolved. As a result, resolution of the problems were delayed and three possible noncompliance airworthiness issues remained unresolved at the time of the Fischer Bros. accident. The Board believes that these problems could have been prevented by close monitoring and active participation in the overall type certification project by the FAA.

The history of the type certification of the CASA C-212 raises some doubt about the FAA's management of bilateral type certification projects. It appears that more FAA resources are devoted to foreign manufactured aircraft of greater complexity than to aircraft in the commuter air carrier class. However, given the growth of the U.S. commuter airline industry with its demand for suitable aircraft and the efforts of foreign manufacturers to fulfill this demand, the Safety Board believes that such aircraft must be given the evaluation scrutiny they deserve. The Board recognized the FAA had made changes and improvements in its engineering and operations organizations to provide better monitoring and follow-up on foreign type certification projects. However, several noncompliance problems remained unresolved after the FAA's changes and improvements had been put into place.

Accordingly, questions remain about management capabilities and about the availability and allocation of resources devoted to such projects by the FAA. Since the demands of the U.S. aircraft industry occupy the majority of FAA's type certification and continuous airworthiness attention, the increase in foreign aircraft certification activity appears to have placed a less manageable burden on FAA resources. The Safety Board is aware that as a result of the CASA C-212-CC accidents in Romulus, Michigan, and Mayaguez, Puerto Rico, and some other occurrences, the FAA has conducted an in-house review of its bilateral certification program. However, a report on the review has not yet been made available to the Safety Board. Further, the Safety Board has not been made aware of any corrective actions taken as a result of the in-house review. Therefore, the Safety Board believes that the FAA should complete its report on the bilateral certification review and make it available as soon as possible along with any corrective actions taken or contemplated.

3. CONCLUSIONS

3.1 Findings

1. The flightcrew was certificated and qualified to conduct the flight in accordance with the air carrier's approved training program and Federal regulations.

2. The captain and the first officer were experienced pilots based on their recorded flying experience and airman certifications.

3. The air carrier's scheduled maintenance and inspection of the airplane was not performed in conformance with its approved maintenance program.

4. The manner in which required inspections of maintenance tasks were recorded and the subsequent approval of the airplane for return to service were not conducted in accordance with the proper maintenance practices.

5. The maintenance troubleshooting of pilot-reported discrepancies was deficient and was not in conformance with manufacturer instructions.

6. The right propeller flight idle blade angle was inadvertently mis-set to operate below prescribed limits.

7. The weather was not a factor in the accident.

8. The airport facilities, personnel, and equipment involved operated normally and were not factors in the accident.

9. The pilot made an unstabilized approach at a relatively steep angle and at a high rate of descent resulting in the airplane sinking below a normal approach path to the runway.

10. The pilot experienced an asymmetric power condition as the airplane was slowed rapidly in his attempt to arrest a high rate of descent and to salvage the approach or to initiate a go-around maneuver.

11. The retracted position of the flaps could have been a factor in the accident and could have contributed to a stal l.

12. The pilot lost control of the airplane at an altitude from which recovery could not have been accomplished.

13. Standards for inherent aerodynamic qualities are probably not adequate for providing stall warning in new aircraft used in new aircraft used in 14 CFR Parts 135 and 121-passenger-carrying operations.

14. The impact forces and the destruction of the cockpit made the accident unsurvivable for the flightcrew.

15. The impact forces were survivable for the passengers because the structural integrity of the cabin was maintained, the seats remained attached to the floor tracks, and passengers used their seatbelts which remained intact.

16. The carrier's management and supervision of the maintenance department personnel was deficient.

17. The FAA FSDO's initial certification of the carrier was deficient in the area of maintenance recordkeeping.

18. The bilateral type certification program of the CASA C-212 was not managed effectively by the FAA. The reorganizational changes, personnel changes, and the limited availability of resources within the engineering and operations departments of FAA are contributing factors.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was improper maintenance in setting propeller flight idle blade angle and engine fuel flow resulting in a loss of control from an asymmetric power condition. A factor contributing to the accident was the pilot's unstabilized visual approach.

4. RECOMMENDATIONS

As a result of the Fischer Bros. accident in Romulus, Michigan, on March 4, 1987, the Safety Board issued Safety Recommendations A-87-27 and -28 to the FAA:

> <u>A-87-27</u>
>
> Issue a general notice (GENOT) immediately to all U.S. owners and operators of the CASA C-212 airplane describing the background and significant findings of the recent flight test of the CASA C-212. The notice should provide an evaluation of the existing CASA C-212 stall characteristics, operational precautions, and training procedures to preclude inadvertent stalls until an approved artificial stall warning system is installed.
>
> <u>A-87-28</u>
>
> Expedite the rulemaking action to require installation of an artificial stall warning system on the CASA C-2 12 airplanes.

On June 16, 1987, the FAA responded to these recommendations stating that for Safety Recommendation A-87-27, the FAA had issued a GENOT to all flight standards field offices addressing the flight characteristics of the CASA 212 aircraft. Based on this response, Safety Recommendation A-87-27 was classified "Open--Acceptable Action" pending a final rule.

Also in the FAA's June 16, 1987 letter, it was stated that in response to Safety Recommendation A-87-28, the FAA had issued an NPRM (Docket No. 87-NM-38-AD) requiring installation of an artificial stall warning system. Based on this response, Safety Recommendation A-87-28 was classified "Open--Acceptable Action" pending a final rule.

On October 19, 1987, the FAA notified the Safety Board that an AD based on the NPRM mentioned above was issued with an effective date of August 31, 1987. Based on this AD, Safety Recommendation A-87-28 was classified "Closed--Acceptable Action" on December 10, 1987.

As a result of this investigation and the Fischer Bros. accident in Romulus, Michigan, the Safety Board further recommended to the FAA:

> Correct any deficiencies in compliance with Title 14 Code of Federal Regulations 25.813 regarding the installation of passenger seats adjacent to Type II and III exits in CASA C- 212 airplanes with 19 seats or less. (Class II, Priority Action) (A-88-92)
>
> Remedy the deficiencies in compliance with Title 14 Code of Federal Regulations 25.809, .811, and .813 of the supplemental type certificate for the CASA C-212-CC main door regarding accessibility to door controls during emergency conditions. (Class II, Priority Action) (A-88-93)
>
> Require in accordance with Title 14 Code of Federal Regulations 25.785(c) adequate head clearance between passenger seats and bulkheads/partitions installed in CASA C-212 airplanes. (Class II, Priority Action) (A-88-94)
>
> Inspect flightcrew restraints in CASA C-212 airplanes to verify the adequacy of operation, convenience, and comfort based on anthropomorphic criteria, and take appropriate remedial action. (Class II, Priority Action) (A-88-95)

Require fire-blocking materials on all passenger and crew seats on Title 14 Code of Federal Regulations Part 21 and Special Federal Aviation Regulations No. 41 and Title 14 Code of Federal Regulations Part 23 commuter category airplanes that are operated under Title 14 Code of Federal Regulations Part 135. (Class II, Priority Action) (A-88-96)

Conduct a special surveillance inspection of approved Hartzell Propeller overhaul facilities and of other propeller manufacturer overhaul facilities as service difficulty historical data and experience dictate to determine that the proper quality control organization and procedures are in place and are being followed. (Class II, Priority Action) (A-88-97)

Alert all principal operations and maintenance inspectors to emphasize in their surveillance of operators of turbopropeller airplanes the need to adhere to prescribed manufacturer instructions in maintaining flight idle blade angles and to emphasize to operators the criticalness of maintaining them properly. (Class II, Priority Action) (A-88-98)

Reissue to operations and maintenance inspectors Federal Aviation Administration Notice N8320.301 of September 17, 1984, prompted by Safety Board Recommendation A-84-l 5. (Class II, Priority Action) (A-88-99)

Complete as soon as possible and make the findings available to the Safety Board the report on the in-house review of the bilateral aircraft type certification program and the corrective actions taken or contemplated as a result of the review. (Class II, Priority Action) (A-88-100)

Amend Title 14 Code of Federal Regulations 23.207 and 25.207 to require a stall warning device and eliminate the use of "inherent aerodynamic qualities" (aerodynamic buffeting) as a stall warning. (Class II, Priority Action) (A-88-101)

Amend Title 14 Code of Federal Regulations Parts 121 and 135 to require a stall warning device on those airplanes that currently use "inherent aerodynamic qualities" (aerodynamic buffeting) as a stall warning. (Class II, Priority Action) (A-88- 102)

Require the aircraft evaluation group during the type certification process of turbopropeller airplanes to review carefully the design of propeller pitch controls in order to identify and establish appropriate fightcrew training guidelines and to emphasis the proper use of these controls to prevent inadvertent operation in the beta mode in flight where prohibited by the airplane manufacturer. (Class II, Priority Action) (A-88-l 03)

Require the principal operations inspectors for operators of turbopropeller airplanes to review carefully flightcrew training programs to verify that appropriate information is provided by the operators on the proper use of propeller pitch controls to prevent inadvertent operation in the beta mode in flight. (Class II, Priority Action) (A-88-104)

Amend Title 14 Code of Federal Regulations 25.1155 and 23.1155 to provide for a positive means to prevent inadvertent operation of the propellers at blade pitch settings below the flight regime in those airplanes where such operation of the propellers is prohibited. (Class II, Priority Action) (A-88-105)

BY THE NATIONALTRANSPORTATION SAFETY BOARD

/s/ JIM BURNETT
Chairman

/s/ JAMES L. KOLSTAD
Vice Chairman

/s/ JOHN K. LAUBER
Member

/s/ JOSEPH T. NALL
Member

/s/ LEMOINE V. DICKINSON, JR.
Member

August 2, 1988

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident at 0730 on May 8, 1987. An investigation team was dispatched from Washington, D.C., the same day and arrived on scene later that evening. An organizational meeting was held the next day, and investigation groups were formed for operations, survival factors, structures, systems, and powerplants. A human performance specialist was also assigned to the team.

Parties to the investigation were the Federal Aviation Administration, the Spanish Director General of Civil Aviation, Executive Air Charter, Inc., Construcciones Aeronauticas, S.A. (CASA), Garrett Turbine Engine Co., Hartzell Propeller Products, Propeller Service of Miami, and the Mayaguez Airport Authority.

2. Public Hearing

The Safety Board did not hold a public hearing on this accident

APPENDIX B

PERSONNEL INFORMATION

Franklin Rivera Velez

Captain Franklin Rivera Velez, 44, was employed by Executive Air on September 29, 1986. He held an ATP certificate No. 1736858 issued on July 25, 1981, with an airplane multiengine land rating and a type rating in the CASA C-212. He also held a commercial privileges for airplane single-engine land. He had also obtained an airframe and powerplant certificate in 1983. He received his initial type rating in the C-212 on March 3, 1987. He completed his second-in-command flight check satisfactorily on October 12. However, he had difficulty in his captain upgrade flight training in October by demonstrating unsatisfactory performance in emergency procedures, instrument holding procedures, rejected takeoff procedures, and engine failure on takeoff procedures. His training was resumed in November and January 1987 at which time he demonstrated satisfactory performance, and passed an FAA flight check for his type rating on March 3,1987. His initial operating experience as a captain was completed on March 7 after 11.6 hours of flight time and 17 takeoffs and landings.

Captain Franklin held a first-class medical certificate issued on November 25, 1986, with the limitation that he wear corrective lenses at all times. He was 5 feet 5 inches and weighed 170 pounds.

Captain Franklin had accumulated 78.4 hours flight time in the last 30 days and 17.3 hours in the 7 days before the accident. At the time of the accident, he had accumulated about 9,802 hours of total flight time, 473 hours of which were in the C-212. About 9,432 hours of his flight time was in multiengine land airplanes. Before employment with Executive Air, he had been flying the deHavilland DHC-6 and the Britten-Norman Islander, BN-2A, for another commuter air carrier for 4 years. During that period, he was a line pilot, check airman, and for a brief period, the chief pilot.

Reynold E. Santiago Cordero

First officer Reynold E. Santiago Cordero, 32, was employed by Executive Air on October 15, 1986. He held an ATP certificate No. 584782102, issued May 17, 1986, with airplane multiengine land rating. He also held commercial privileges for airplane single-engine land. He received his initial ground training in the C-212 on October 20, 1986, and his flight training and check ride on October 30,1986.

First officer Santiago held a first-class medical certificate with the limitation that he wear corrective lenses for near and distant vision. He was 5 feet 7 inches and weighed 180 pounds.

First officer Santiago had accumulated about 14 hours in the 7 days before the accident. He was off duty the 2 days before the accident. At the time of the accident, he had accumulated a total flight time of about 4,473 hours, 459 hours of which were in the C-212. He had about 2,821 hours of flight time in single-engine airplanes, and the balance in multiengine airplanes. The 459 hours in the C-212 represented his total experience in turbopropeller airplanes.

APPENDIX C

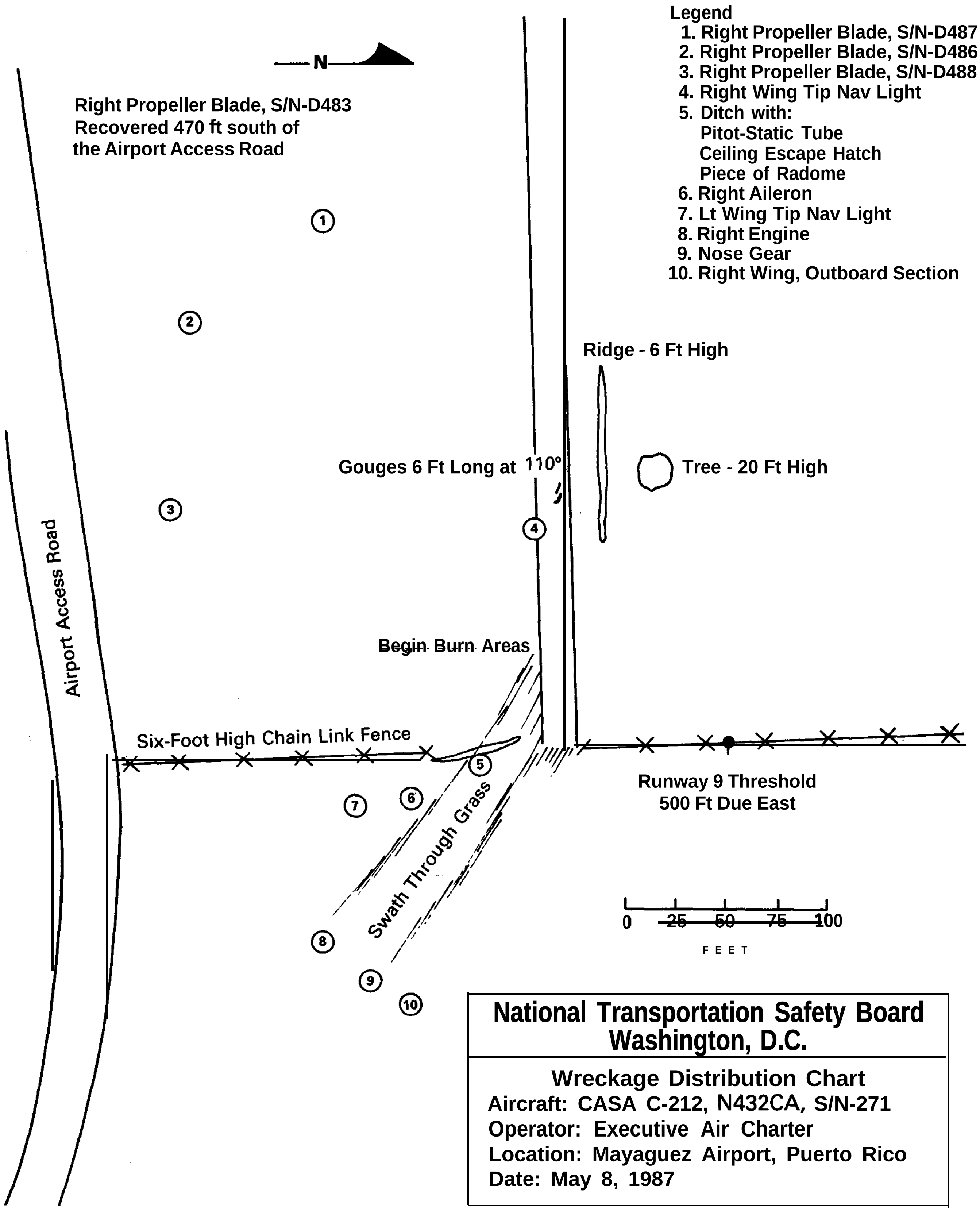
AIRCRAFT INFORMATION

The Construcciones Aeronauticas, S.A. (CASA), C-212-CC was first issued a U.S. type certificate on May 16, 1980, under the bilateral provisions of 14 CFR Part 21. It was configured for two flightcrew members and 22 passengers. It was equipped with two Garrett Turbine Engine Company TPE-331-10R-511C engines and the Hartzell Propeller products HC-B4MN-5AL propellers. N432CA, serial No. 271, was issued a certificate of airworthiness in the transport category on February 28, 1983, and it was configured to carry 19 passengers. It was obtained by the carrier in October 1986 and had been operated continuously by the carrier up to the time of the accident.

The airplane had accumulated a total of about 6,264 flight hours and about 11,774 cycles at the time of the accident. The left engine, serial No. P37048-CP, had a total time of 6,967 hours and 84 hours since overhaul. It was installed on April 14, 1987. The right engine, serial No. P37056-C, had a total time of 4,824 hours; its time since overhaul was not available. It was installed on May 4, 1987. The left propeller, serial No. FL-259, had a total of 2,091 hours since new. The right propeller, serial No. FL-275, had a total time of 2,964.3 hours since new and 12.3 hours since it was overhauled on March 17, 1987. It was installed between May 1 and 5, 1987.

APPENDIX D

WRECKAGE DISTRIBUTION CHART



ERRATA

THESE CORRECTIONS SHOULD BE MADE TO THE PREVIOUSLY PUBLISHED REPORT IDENTIFIED AS FOLLOWS

AIRCRAFT ACCIDENT REPORT

NORTHWEST AIRLINES, INC.
McDONNELL DOUGLAS DC-9-82, N312RC
DETROIT METROPOLITAN WAYNE COUNTY AIRPORT
ROMULUS, MICHIGAN
AUGUST 16, 1987

NTSB/AAR-88/05 (PB88-910406)

1. The last line on the bottom of page 28 should read:

a throttle split of about 2/3 of a throttle knob diameter. The measurements obtained were slightly less than half of the available throttle lever movement. The No. 2 engine was started to obtain a

2. Add the following finding to the bottom of page 67:

12. **The loss of input from the airplane to the CAWS unit does not illuminate the CAWS fail light.**

☆ U. S. GOVERNMENT PRINTING OFFICE: 1988-242-320:81026

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

OFFICIAL BUSINESS

Penalty for Private Use, $300

BULK RATE
POSTAGE & FEES PAID
NNS
Permit NO, G-292

021001 -89243 003

EMBRY- RIDDIE AERO U
D5021656
PI-AL/RT 92 COMPLEX
DAYTONA BEACH FL 32014