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16. Abstract At 0431 A.s.t., July 11, 1975, a propeller blade separated from the No. 2 propeller of Puerto Rico International Airlines, Inc., Flight 303, during takeoff at Puerto Rico International Airport, San Juan, Puerto Rico. The takeoff was discontinued and the airplane was stopped on the runway pavement. Of the 11 occupants 1 was injured slightly. The airplane's flight controls, electrical system, and No. 2 engine were damaged heavily. The National Transportation Safety Board determines that the probable cause of the accident was the separation of the No. 1 propeller blade of the No. 2 propeller assembly. The blade separated as a result of vibratory stresses which induced fatigue cracks not readily detectable during routine preflight inspections. Contributing to the accident were inadequate overhaul inspection procedures at a certificated repair station and inadequate dissemination and enforcement of recommended maintenance practices by the Federal Aviation Administration.			
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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D. C. 20594

AIRCRAFT ACCIDENT REPORT

Adopted: April 14, 1976

PUERTO RICO INTERNATIONAL AIRLINES, INC.
DEHAVILLAND *DH-114*, N570PR
SAN JUAN, PUERTO RICO
JULY 11, 1975

SYNOPSIS

At 0431 A.s.t., July 11, 1975, a propeller blade separated from the No. 2 propeller of Puerto Rico International Airlines, Inc., Flight 303, during takeoff at Puerto Rico International Airport. The takeoff was discontinued, and the airplane **was** stopped on the runway pavement. Of the 11 occupants, 1 was injured slightly. The airplane's flight controls, electrical system, and No. 2 engine were damaged heavily.

The National Transportation Safety Board determines that the probable cause of the accident was the separation of the No. 1 propeller blade of the No. 2 propeller assembly. The blade separated as a result of vibratory stresses which induced fatigue cracks not readily detectable during routine preflight inspections.

Contributing to the accident were inadequate overhaul inspection procedures at a certificated repair station, and inadequate dissemination and enforcement of recommended maintenance practices by the Federal Aviation Administration.

1. INVESTIGATION

1.1 /History of the Flight

At 0431 A.s.t. 1/ on July 11, 1975, Puerto Rico International Airlines (PRINAIR) Flight **303**, a DeHavilland DH-114, was a scheduled air taxi flight from San Juan to Mayaguez, Puerto Rico. There were nine passengers and two crewmembers aboard when the airplane was taxied to the runway at Puerto Rico International Airport for takeoff. The captain and first officer had completed the preflight inspection.

After the aircraft was taxied out, the flightcrew completed the routine engine runup and checklist. They noted roughness when the Nos. 2 and 3 engines were checked; both engines were rechecked, and the takeoff clearance was requested and received.

Takeoff power was applied slowly and by the time full throttle power was set, the airplane had accelerated to between 30 and 40 kns. At this time, the flightcrew heard a loud explosive sound, and the airplane veered to the right. Power was reduced immediately, but directional control was difficult to maintain. The captain, however, was able to keep the airplane on the runway.

The first officer notified San Juan Tower that the takeoff was being aborted; the tower was also advised that an emergency existed and equipment was requested. The airplane was brought to a complete stop and the flightcrew initiated the emergency evacuation of the passengers.

Although all emergency shutdown procedures were completed for the four engines, including the closing of all four mixture controls, and fuel shutoff valves and the turning of magneto switches to the "off" position, the Nos. 1 and 2 engines continued to run. The feathering controls were partially jammed, but after several attempts the No. 1 engine propeller was feathered and stopped. Attempts to shut down No. 2 engine in this manner were unsuccessful, and attempts to change the fuel system cross-feed configuration to terminate the fuel supply also were unsuccessful. The No. 2 engine continued to run for about 10 minutes after the takeoff was discontinued.

Because of concern that an engine fire might develop, the four fire extinguishing systems were discharged, after which the No. 2 engine stopped. The captain then also evacuated the airplane.

The separated propeller blade was found near the centerline of the runway, about 1,000 feet behind the airplane.

1/ All times herein are Atlantic standard, based on the 24-hour clock.

1.2 Injuries to Persons

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Other</u>
Fatal	0	0	0
Nonfatal	0	1	0
None	2	8	

1.3 Damage to Aircraft

The aircraft was damaged substantially.

1.4 Other Damage

None.

1.5 Crew Information

The captain and first officer were properly certificated and qualified to serve as crewmembers for the flight. (See Appendix B.)

1.6 /Aircraft Information

The airplane was maintained in accordance with an FAA-approved aircraft inspection program which required periodic inspections every 65 hours and an overhaul every 2,400 hours. At the time of the accident, the airplane had accumulated 14,859 hours in service, including 6 hours since the last periodic inspection and 1,666 hours since the last overhaul.

The airplane was equipped with four Continental IO-520-E engines under Supplemental Type Certificate No. SA1685WE. The PRINAIR engine maintenance program called for top overhaul every 1,500 hours and a major overhaul every 4,500 hours. The inspection intervals, which were approved by FAA, serve as guidelines and are based on experience and condition; they are not mandatory. Maintenance records disclosed that the No. 2 engine had accumulated 8,812 hours in service, including 2,066 hours since the last major overhaul and 125 hours since the last top overhaul. New engine damper pins and bushings were installed at the last top overhaul of the No. 2 engine.

The engines are equipped with 3-blade Hartzell EHC-A3VF-2B propellers with V7636D blades. The PRINAIR propeller maintenance program called for an overhaul every 2,000 hours. The overhaul interval is used as a guideline based on experience and condition and also is not mandatory. The No. 2 propeller hub had accumulated 4,587 total hours in service including 827 hours since the last overhaul; at the last overhaul reconditioned blades had been installed. The separated No. 1 blade had accumulated 2,191 hours on another propeller hub before it was reconditioned and installed on N570PR; its total time in service, however, could not be determined from available records. (See Appendix C.)

1.7 Meteorological Information

The weather was not a factor in the accident.

1.8 Aids to Navigation

Aids to navigation were not factors in this accident.

1.9 Communications

There were no difficulties with communications between the flight and San Juan Tower.

1.10 Aerodrome and Ground Facilities

Aerodrome and ground facilities were not factors in this accident.

1.11 Flight Recorders

No flight recorders were installed nor were they required.

1.12 Aircraft Wreckage

The aircraft was damaged when the separated No. 1 propeller blade of No. 2 engine penetrated the fuselage. The blade entered through the left side of the fuselage adjacent to the plane of rotation of the No. 2 propeller and tore out a portion of the left forward passenger seat, which was unoccupied. The flight control system was disabled when the No. 1 propeller blade exited through the cabin floor. Control cables, electrical wiring, and aircraft plumbing were severed in the lower fuselage area. Fuel and pneumatic lines, which are routed through the lower section of the fuselage, were damaged heavily.

1.13 Medical and Pathological Information

One passenger sustained a minor injury.

1.14 Fire

There was no fire.

1.15 Survival Aspects

This was a survivable accident.

(Had the left forward passenger seat been occupied, the occupant may have sustained serious or fatal injuries by the propeller blade.)

1.16 Tests and Research

The failed propeller shank and propeller shank clamp were examined at the National Transportation Safety Board's Metallurgical Laboratory.

Metallurgical tests showed that the blade failed as a result of a fatigue crack that began in the hub fillet **on** the leading edge side of the blade and progressed across **90** percent of the shank cross section. (See Appendix D.) Numerous **small** secondary fatigue cracks were also found in **or** near the hub fillet.

A visual examination of the fracture disclosed several fatigue crack origins **in or** near the hub fillet. The primary fatigue crack probably originated in the fillet along the leading edge of the blade. The crack propagated outward and progressed to the overload zone. (See Appendix D.)

Initially, the crack progressed **on** a diagonal plane for a short distance inboard and then abruptly changed direction and progressed along a plane oriented transversely to the blade axis. Several small secondary fatigue cracks also originated along the hub fillet. These cracks progressed **on** diagonal planes radially inward until they intersected the primary fatigue crack, where they terminated.

The fractured surface and the area in which the primary fatigue crack originated were examined with the aid of the scanning electron microscope. No evidence of a material defect **or** mechanical damage, such as fretting, was found at the fracture's origin. The crack originated in an area that had been shot peened.

A metallographic section taken through the primary fracture origin showed no evidence of discontinuity **or** corrosion. The micro-structure was normal for 2025-T6 aluminum alloy which is the specified blade material. Vickers hardness measurements taken **on** the metallographic section averaged 126 Diamond Pyramid Hardness (DPH), which is above the **108** DPH minimum specified.

1.17 Other Information

1.17.1 Propeller Overhaul

PRINAIR had been using a facility in Tampa, Florida, for the overhaul of their Hartzell propellers. The facility, Aircraft Propeller, Inc., holds repair station certificate No. **5315**, with ratings for all models of Hartzell propellers. **In** addition, the facility has entered into a "distributorship agreement" with the manufacturer, Hartzell Propeller, Inc., of Piqua, Ohio. Under this agreement, "The distributor

agrees to establish and maintain an FAA certified propeller overhaul shop capable of overhauling all Hartzell propellers and accessories according to Hartzell specifications as listed in Specification DA-101 and any addendum, and in conformity to any and all FAA requirements, at each of distributor's facilities, unless excused from so doing by Hartzell, in writing. Distributor acknowledges that it is aware of the Hartzell specifications as listed in Specification DA-101 and the addendums thereto as well as all FAA requirements of a propeller overhaul shop."

The distributor also "agrees to keep abreast of Hartzell overhaul procedures and to comply with all service bulletins and service letters and to follow all service instructions issued by Hartzell."

Hartzell Specification D-101 specifies both technical and physical qualifications of overhaul personnel employed by the distributor. The physical qualification pertains to vision. Hartzell also specifies the tools and equipment to be used to overhaul the propeller. The National Transportation Safety Board investigation of the overhaul facilities disclosed that neither the Zyglo equipment, operator training, and certification nor the medical standards for vision of some shop personnel fully satisfied the requirements of Hartzell Specification D-101. Officials of Hartzell and the FAA testified that these requirements had been reviewed for compliance with Hartzell and FAA requirements and were found to meet those requirements.

Records of propeller discrepancies maintained by the air carrier and by the FAA disclosed that two cases of cracked propeller blades were encountered by PRINAIR on units that had just been overhauled. The Safety Board was not able to determine how these cracked blades were released from the overhaul facility and certificated as serviceable parts. A Service Difficulty Report, dated January 14, 1975, describes a failed propeller blade from which pits and dents had been removed improperly and the area repainted. (See Appendix E.)

1.17.2 Powerplants Maintenance Practices

PRINAIR operates in accordance with an FAA "Approved Aircraft Inspection Program." The approved program provides that:

"All maintenance, repairs, overhauls, or inspection of the company aircraft, engines, propellers, components and appliances shall be performed in accordance with existing Federal Aviation Regulations, Airworthiness Directives, and with Manufacturers Specifications except where such specifications are amended by the company, and approved by the Administrator. All major repairs will be made in accordance with FAA-approved technical data."

On September 25, 1968, Teledyne Continental Motors, Inc., the manufacturer of the IO-520-E engine, issued service bulletin No, 68-15 which recommended that the engine be overhauled every 1,500 hours. As provided by the Federal Aviation Regulations and PRINAIR Operations Specifications, specifically approved by the FAA, such time limitations are not mandatory if service experience indicates satisfactory operations beyond such time limits.

Accordingly, PRINAIR had been operating the IO-520-E engine for 4,500 hours between major overhauls. The manufacturer had been aware of the practice for about 2 years before the accident. Since no specific service problems were brought to the attention of the manufacturer or the FAA region responsible for the certification of the engine, no action was taken to have PRINAIR change its policy.

Continental's overhaul manual, which describes overhaul procedures for the IO-520-E engine, under subheading, "Specific Inspections-Crankshaft and Counterweight Pins and Bushings," states:

"Excessive localized brinelling of the crankshaft dampener pin bushings can affect propeller blade tip stresses. It is, therefore, recommended that at each normal major overhaul the pin bushings be inspected and replaced as required. This applies to both the dampener bushings and the crankshaft blade bushings."

The counterweight pins and bushings which had been installed in the No. 2 engine of N570PR had been replaced 125 hours before the blade failure; examination of these pins and bushings did not disclose out-of-tolerance dimensions. The pins and bushings that had been installed in the engine before this time had been discarded and were not available for dimensional checks. Shop personnel interviewed during the investigation could not state positively whether the pins and bushings removed were worn. The parts were changed as part of normal practice when performing a top overhaul of the engine.

After the accident, the FAA issued Airworthiness Directive (AD) 75-16-22, applicable to DeHavilland DH-114 airplanes modified in accordance with STC SA1685WE. The directive, which became effective on August 8, 1975, stated:

"Compliance required within the next 200 hours' time in service after the effective date of this AD, unless already accomplished within the last 1,500 hours' time in service from the last inspection."

To prevent excessive wear of the counterweight bushings and subsequent ineffectiveness of the counterweight function, accomplish the following:

Inspect and replace, if required, crankshaft counterweight pins and bushings in accordance with Teledyne Continental Overhaul Manual X-30039 or an equivalent procedure approved by the Chief, Engineering and Manufacturing Branch, ASO-210, P.O. Box 20636, Atlanta, Georgia 30320."

1;17.3 Propeller Maintenance Practices

On November 27, 1970, PRINAIR reported to the Hartzell Propeller Company numerous problems caused by loose blades or vibrations, and cracked or excessively worn blade bearings.

In response to this report, Hartzell advised PRINAIR on December 22, 1970, that because of the high number of operating cycles they would recommend that propellers be overhauled every **1,000** hours instead **of** every 1,500 hours. Hartzell also advised the air carrier that it is essential that the engine damper pin bushings be replaced when the engine is overhauled and that any wear of these parts seriously affects the vibrations which pass into the propeller. (See Appendix F.) The recommendation did not specify time intervals for the engine overhaul.

Hartzell Service Letter No. 61, revised December **16**, 1971, recommended that the propeller be overhauled every **1,000** hours. The operator did not comply with this service letter nor was he required to do so under existing regulations.

Testimony by Hartzell disclosed that the air carrier was operating the engines as many as 2,700 hours and possibly up to 4,500 hours between overhauls. Hartzell's testimony further indicated that the company did not become aware of this practice until May 1975 during a visit to PRINAIR.

After several propeller service difficulties, on May 22, 1975, the Hartzell Propeller Company requested that the **FAA's** Great Lakes Region, which has the certification responsibility for the Hartzell propeller, issue a mandatory directive on inspection of the propeller. (See Appendix G.)

Hartzell Service Bulletin No. **113**, dated May 13, 1975, detailed the inspection and replacement requirements for the V7636D propeller blades and for the inspection of the clamp assemblies. In effect, the Bulletin imposed a 2,000-hour maximum service life limit **on** the blade.

On May 21, 1975, in a letter to Hartzell, PRINAIR requested that Service Bulletin 113 be reviewed, specifically the 2,000-hour service life limit and the imposition of the rigid inspection procedure. (See Appendix H.)

On May 30, 1975, Hartzell replied to PRINAIR regarding the seriousness of the matter and explaining its rationale for imposing the service bulletin. (See Appendix I.)

On July 15, 1975, 4 days after the accident, the FAA issued a telegraphic AD to require an immediate propeller inspection program and to require compliance with Hartzell's Service Bulletin No. 113A. The AD also required compliance with the inspection requirements set forth in Hartzell Service Bulletin 97, dated March 1, 1973, and Hartzell's Overhaul Manual 1148.

1.17.4 FAA Approval of Supplemental Type Certificate

A supplemental type certificate, issued by the FAA, provided for the installation of the Continental IO-520-E engine with the Hartzell 7636 propeller blade. The party who initially applied for the certificate, Aircraft Technical Services, directed inquiries to Hartzell regarding the compatibility of the IO-520-E engine with Hartzell 7636D EHC-A3VF-2B propeller assembly. Hartzell replied that the installation was compatible based on an Aero Commander 500A in-flight vibratory test program.

However, without any testing on the DeHavilland DH-114, the supplemental type certificates were approved and issued.

Hartzell Engineering personnel and FAA personnel did not know whether the flight characteristics were different on the DH-114 and the Aero Commander 500A. Flight characteristics can alter appreciably the angle of air inflow to the propeller. Another factor which could affect propeller vibratory stresses is propeller proximity to the fuselage. No dynamic testing relative to this aspect had been conducted on the DH-114.

2. ANALYSIS AND CONCLUSIONS

2.1 Analysis

The crewmembers were qualified and certificated in accordance with existing regulations. The airplane was maintained in accordance with an FAA-approved aircraft inspection program.

The Safety Board concludes from the physical evidence that the No. 1 propeller of the No. 2 engine separated as a result of multiple fatigue cracks around the propeller blade shank. These cracks indicate that the blade had been subjected to abnormal vibrations over a prolonged period.

The hardness and microstructure of the metal was as specified. There was no evidence of mechanical damage or of a material defect in the area in which the fracture originated. Previous failures of this type of blade had been attributed to pressure caused by excessive contact between the shank clamp and the shank fillet; however, the Safety Board found no evidence of such pressure on the hub surface. The surfaces that could have contacted the clamp were not damaged.

The Safety Board could not determine the exact cause of the abnormal vibrations. However, the vibrations which are transmitted to the propeller by excessively worn counterweight pins and bushings in the engine's crankshaft can be supported by the past experience.

Although the Safety Board could not determine the past history of the failed blade, it is possible that the blade had been installed on an engine which had counterweight pins and bushings that were worn beyond acceptable limits and that excessive stresses were imposed and caused a crack nucleus in the propeller shank.

If this was the case, the crack nucleus should have been found when the propeller was last overhauled. However, based on its evaluation of the propeller overhaul facility, the Board believes that it is probable that facility personnel would have failed to detect the defect during overhaul.

The carrier had been advised as early as 1970 of the manufacturer's recommendations on operating times between overhauls. The Safety Board has found that it is not unusual for the carrier and local FAA authorities to adjust such recommendations to suit both service experience and economic considerations.

Since the FAA was aware of the potential hazard to flight which could result from noncompliance with the manufacturer's recommendations of 1970, it was incumbent upon them to make this clear to the operator and make such recommendations mandatory.

The Board believes that the manufacturers of the propeller and the engine as well as the respective FAA Region share the responsibility for insuring compliance with mandatory inspection and maintenance procedures, which, to their knowledge, can adversely affect safe flight. In the instant case, the manufacturer of the propeller acted in a positive manner to apprise the FAA Great Lakes Region of the urgent need for mandatory inspections. (See Appendix G.)

While the carrier is charged with the ultimate responsibility for safe transportation of its passengers, in-depth technical expertise, which is often required to make decisions involving safety and economics, is not always available to the air carrier. This does not imply that

the carrier should arbitrarily neglect to comply with service instructions which are issued by the manufacturer. If there are questions as to the safety implications of noncompliance with service instructions, it is again incumbent upon the carrier to communicate with the manufacturer and resolve such questions.

Continuous and close liaison between the carrier and these manufacturers must be maintained in order for them and the FAA to observe and evaluate trends and potential hazards and to initiate effective remedies.

The Safety Board believes that the overall capability of the overhaul facility was marginal. The FAA, which conducted periodic surveillance of the facility, did not provide guidance and control to assure adequate levels of technical capability for the repair station.

The Safety Board cannot determine if the issuance of the Supplemental Type Certificate, without the benefit of vibratory stress test data on the DH-114, was a factor in this accident. Although the data on in-flight vibratory stresses which were derived from tests on the Aero Commander 500A were used as the basis for approving certificate for the DH-114, the question remains as to whether flight characteristics of the 500A and the DH-114 are similar enough to cause like air inflow angles to the propeller blades.

2.2 Conclusions

(a) Findings

1. The aircraft was maintained and certificated in accordance with existing FAA regulations and company procedures.
2. The flightcrew was properly certificated and qualified.
3. The No. 1 blade of the No. 2 propeller separated at the blade shank during the takeoff roll.
4. Vibratory stresses caused a fatigue fracture in the blade's shank area.
5. The crack existed before Flight 303 began the takeoff roll but was not detectable during preflight inspection.
6. The manufacturer of the propeller and the manufacturer of the engine were aware of conditions which induce vibratory stresses.

7. The manufacturer of the propeller and the manufacturer of the engine had recommended inspection periods and time limitations before the accident.
8. The carrier did not follow, nor was it required under existing regulations to comply with, manufacturer's recommendations.
9. The FAA was aware of the conditions which induced vibratory stresses, but failed to take timely action to require mandatory compliance with the manufacturers' recommendations.
10. Airworthiness directives applicable to the propeller and the engine were issued by the FAA after the accident.
11. No in-flight vibratory stress tests were conducted on the DH-114 before the supplemental type certificate was issued.
12. Field service coverage and technical liaison between manufacturers and the operators was inadequate.

1 (b) Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the separation of the No. 1 propeller blade of the No. 2 propeller assembly. The blade separated as a result of vibratory stresses which induced fatigue cracks not readily detectable during routine preflight inspections.

Contributing to the accident were inadequate overhaul inspection procedures at a certificated repair station and inadequate dissemination and enforcement of recommended maintenance practices by the Federal Aviation Administration.

3. RECOMMENDATIONS

As a result of this accident, the National Transportation Safety Board has issued the following recommendations to the Administrator, Federal Aviation Administration:

"Review immediately its programs for surveillance of certificated repair stations and its procedures which govern the granting of supplemental type certificates.

"Review its policies relative to users compliance with manufacturers' service bulletins which may have safety of flight implications, and, where appropriate, issue Airworthiness Directives **as** soon as possible after service difficulties are discovered."

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ WEBSTER B. TODD, JR.
Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ ISABEL A. BURGESS
Member

/s/ WILLIAM R. HALEY
Member

PHILIP A. HOGUE, Member, did not participate in the adoption of this report.

April 14, 1976

APPENDIX A

INVESTIGATION AND DEPOSITIONS

1. Investigation

The Miami Field Office of the National Transportation Safety Board was notified of the accident by the Federal Aviation Administration Office at San Juan, Puerto Rico, at 0722 e.d.t. on July **11**, 1975. An air safety investigator from the NTSB's Miami Field Office was dispatched to conduct the on-scene investigation.

The Federal Aviation Administration, PRINAIR, and Hartzell Propeller Company participated in the investigation.

2. Depositions

Depositions were taken from FAA personnel in Des Plaines, Illinois, on November 12, 1975; in Atlanta, Georgia, on November **14**, 1975; in St. Petersburg, Florida, on November 21, 1975; and in San Juan, Puerto Rico, on December **4**, 1975.

Depositions from Hartzell Propeller Company personnel were taken in Piqua, Ohio, on December 15, 1975.

Depositions were also taken from Aircraft Propeller, **Inc.** personnel on November **1**, 1975, and from Puerto Rico International Airlines, Inc. (PRINAIR) personnel on December **20**, 1975.

APPENDIX B

CREW INFORMATION

Captain Reginaldo Blanco holds a valid Airline Transport Pilot Certificate No. 1638751 with ratings for airplane multiengine land and type rating in Douglas DC-3. He has an FAA first-class medical certificate issued **on** June 6, 1975. Captain Blanco's total flying time was 7,870 hours at the time of the accident.

First Officer Edwin Purcell holds a Commercial Pilot Certificate No. 2178160 with airplane, single, and multiengine land and instrument ratings. He has a FAA second-class medical certificate issued **on** February 6, 1975. First Officer Purcell's total flying time was 900 hours at the time of the accident.

APPENDIX C

AIRCRAFT INFORMATION

The airplane, a DeHavilland DH-114, serial No. 14074, United States Registry N570PR, was originally certificated in the United Kingdom in 1957 with four Gipsy Queen 3D Mark 2 engines.

Supplemental Type Certificate (STC) SA1685WE, amended August 22, 1968, and held by Puerto International Airlines, Inc., provided for installation of four Continental IO-520-E engines. Also installed under STC 8165WE were Hartzell HC-A3x21-2L/L7636D propeller assemblies. The airplane was certificated and maintained in accordance with existing FAA regulations and company procedures. There were no uncorrected or open safety of flight items when the airplane was released for flight on July 11, 1975. The last regularly scheduled major inspection had been accomplished on July 8, 1975.

The No. 2 engine had accumulated a total of 8,812 operating hours, including 2,066 hours since major overhaul and 125 hours since top overhaul.

The No. 2 propeller had accumulated 827 hours since last overhaul. The No. 1 blade of the No. 2 propeller had accumulated 2,191 hours while installed in another propeller assembly for a total known operating time of 3,018 hours. The operating history of the No. 1 blade before its last overhaul in May 1973 could not be determined.

APPENDIX D

PHOTOGRAPHS OF METALLURGICAL EXAMINATIONS

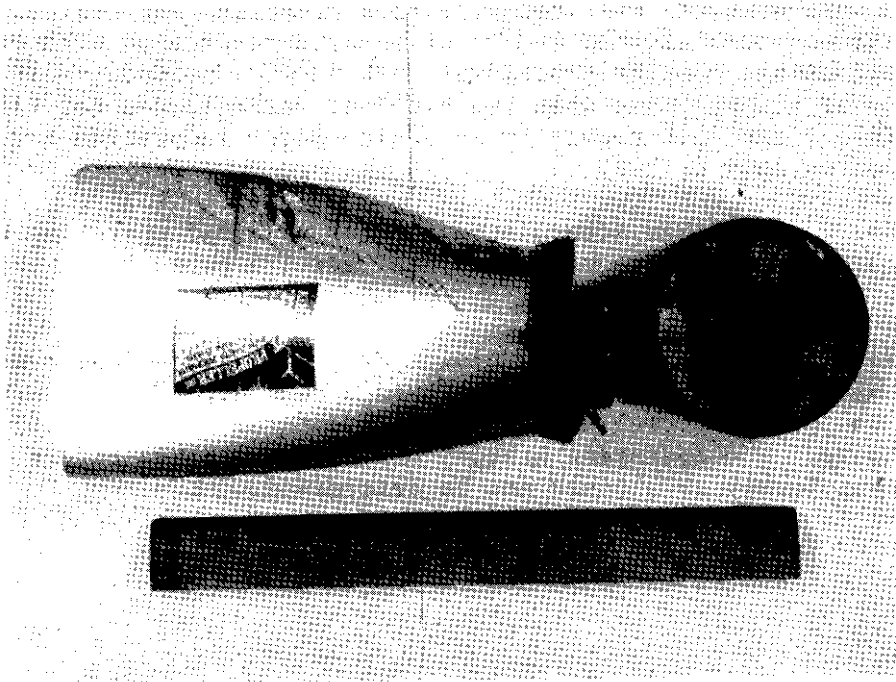
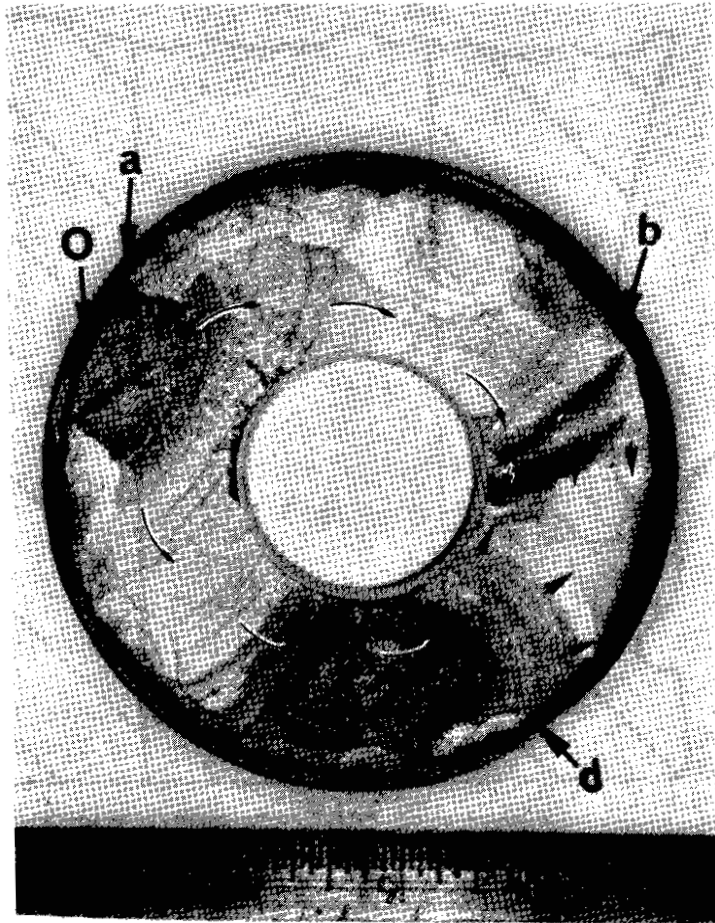


Figure 1. Shank end of the broken propeller, as received for examination.



Feigure 2. Closeup view of the inboard fracture surface in the propeller shank. The primary fatigue crack originated at the approximate location denoted by arrow "0" and propagated to the overload zone shown within the arrowheads. Secondary fatigue cracks were found along the radius at locations between arrows "a" and "b," and "c" and "d," The curved arrows indicated the propagation direction of the primary fatigue crack.

APPENDIX D

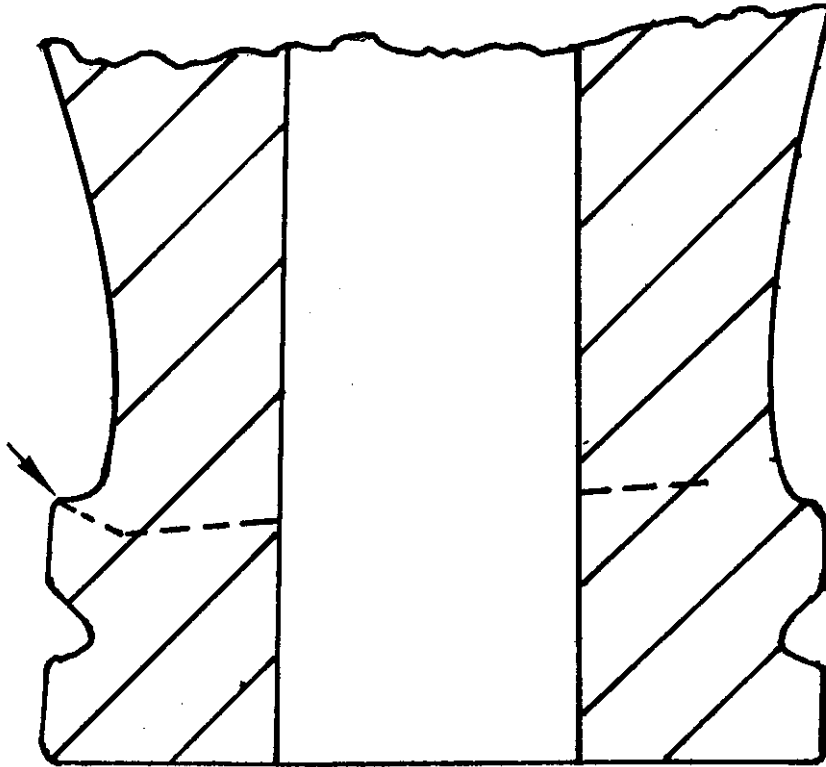


Figure 3. Sketch to illustrate the approximate location of the primary fatigue crack which is indicated by the dashed line. The arrow denotes the approximate origin site.

APPENDIX E

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

Date: **JAN 14 1975**

Engineering & Mfg, District Office 48
Room 123, FSS/NWS Building
Dayton Municipal Airport
Vandalia, Ohio 45377

IN REPLY
REFER TO: **FY75-39**

SUBJECT: **Service Difficulty Report - Propeller**



TO: **AGL-210**

GL-EMDO-48 REPORT CONTROL NO. - FY75-39

MANUFACTURER

Hartzell Propeller Co., Piqua, OH

PRODUCT INVOLVED

1. DEFECTIVE/FAILED ITEM & OPERATING TIME:

Propeller blade **P/N 7636D, S/N 865230** (SP)
 TT - Unknown; TSO - Unknown.

2. DEFECTIVE/FAILED ITEM INSTALLED ON:

	MAUFACTURER	MODEL/SERIES	SERIAL NO.	REG. NO.
Aircraft	DeHavilland	DH-114-2X		N565PR
Power Plant	---	---	---	---
Propeller	Hartzell	Unknown	---	---

REPORTED DIFFICULTY

"Blade failure" per FAA Form 8020-2, "Incident".

No other information.

SOURCE OF SERVICE DIFFICULTY REPORT

FAA Form 8020-2 signed by FAA Inspector George E. Mattern dated 11/12/74.

CONCLUSION(S)

Preliminary finding based on visual examination of fracture surface on remaining blade, shank end -- fatigue failure originating at two (2) gouges in thrust face. Blade separated completely across chord about 18 inches from butt end.

FINDINGS

Propeller blade separated completely 18 inches from butt end. Fracture surface runs chordwise across blade. There are six (6) elliptical-shaped gouges in thrust face surface within one-half inch of fracture surface. One of these gouges is on the edge of the fracture about three-fourths inch from the chord midpoint. The major axis of this elliptical shaped gouge is about 7/16 inch long and it is about 3/64 inch deep. The other gouge is about three-fourths inch long also extending along the fracture edge and this one starts about one-half inch from the trailing edge. The thrust face is painted black and the above six gouges have all been painted over. Markings on the butt end indicate it has been overhauled on two occasions.

Hartzell's Quality Manager said he believed the markings were Hartzell's, but he said they would not have returned this blade to service with such gouges as previously reported. He believes the gouges were the result of someone attempting to dress out deep pits, dents or scratches and then repainting the thrust face.

FAA Form 8020-2 shows 2,561 hours since overhaul, but it is not known if this is aircraft or propeller time.

Based on visual examination of the fracture surface in the as-received condition with a 10-power glass, the writer believes the origins of fatigue were at the gouges located at mid-chord and near the trailing edge.

Hartzell will submit their report at a later date upon completion of a more detailed examination.

R. J. STEINERT
Supervising Inspector
GL-EMDO-48

**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

DATE: MAR 28 1975

Great Lakes Reeion
300 East Devon Avenue
Des Plaines, Illinois 60018



IN REPLY
REFER TO: AGL-210

SUBJECT: Hartzell Model **EHC-A3VF-2B/V7636D** Propeller Blade Failures;
ASJU-265 letters to AGL-214 dated October **10**, 1973, November 15, 1974,
and February 13 & 27, 1975

FROM: Chief, Engineering & Manufacturing Branch, AGL-210

TO: ASO-FSDO-61 (ASJU-265). San Juan, Puerto Rico
Attn: Mr. Leonard Davis, Chief

This is in response to your referenced letters and is further to our telephone conversation of Feb. 27, 1975, concerning certain service difficulties being experienced with the subject propellers which are used on the Puerto Rico International Airlines' De Havilland DH-114-2X aircraft (conversions).

Enclosed for your information is a copy (Item #1) of our Manufacturing Inspection, AGL-EMDO-48, Service Difficulty Report (Control No. 8Y75-39), dated Jan. **14**, 1975. This report summarizes the results of the examination of Hartzell Model V7636D propeller blade, S/N 65230, submitted by ASJU-265 (Aircraft/ Part Identification and Release FAA Form 8020-2, Nov. 12, 1974).

The report findings are self-explanatory. In brief, it is indicated that the blades failed due to fatigue which originated in areas subjected to foreign object damage. The blade repairs which were accomplished were unsuitable, since the damage which remained resulted in stress raisers thereby contributing to this failure.

In reference to your request about the Model V7636D propeller blade, S/N 873741, failure, which was covered in Service Difficulty Report No. 08-31-03-940, dated August **31**, 1973 (Ref: your copy of AGL-210 ltr. to Hartzell dated Oct. 16, 1973), we are enclosing a copy of Hartzell's Engineering Report No. 411, dated Dec. 17, 1973, for your reference (Item #2). The report, which was submitted to this office in accordance with BAR 21.277, indicates that the blade cracked due to fatigue. The crack originated in a corroded area at the pilot hole radius where spacer, P/N A-1499, is situated. The means of preventing such failures are covered in Hartzell Bulletin No. 97A, dated March **1**, 1973. A copy of this bulletin and related information was recently forwarded to your office.

In reference to your letters of Feb. 13 & 27, 1975, concerning propeller blade serial numbers, 865225 and 89184, respectively, we will advise you on the results of the inspection of these blades as soon as we are informed accordingly by the manufacturer and our local Manufacturing Inspection Office.

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As for the cracked Hartzell **EHC-A3VF-2B/V7636D** propeller blade clamps, P/N C-3-5A, which were likewise forwarded to us for inspection, we will apprise you about this matter by separate letter. Copies of our continued correspondence with Hartzell concerning this problem have also been directed to your attention earlier.

In summary, the service problems which are being experienced with these propellers, primarily by the Puerto Rico International Airlines, coincides with operations involving severe service (i.e., maximum utility of aircraft with a high cycle of landings and takeoffs daily, coupled with the added total hours time in service such equipment accrues). Therefore, in order to ensure that the airworthiness of these propellers is satisfactorily maintained, it becomes necessary in our opinion that the operator institute improved (service/maintenance) schedules that call for more frequent inspections and overhauls. Coordination with the propeller manufacturer about such matters can be helpful.

/s/ KEITH D. ANDERSON

Enclosures: Items 1 & 2

APPENDIX F

December 22, 1970

Puerto Rican International Airlines, Inc.
International Airport
Isla Verde, Puerto Rico 00913

Attention: Luis E. Quinones
Assistant Chief Inspector

Gentlemen:

We have investigated the problems you are having with the propellers and can comment as follows.

- 1) It is noted that **you** are flying 1500 plus hours between overhauls, and the flights are about 30 minutes in duration. With this type of operation, 1500 hours is equivalent to about twice that of normal flying where the flights are longer, as far as the wear and tear on the propellers is concerned. In view of this, we recommend that propellers be overhauled at 1000 hours. After experience is obtained, this can be raised if the propellers appear to justify a longer period.
- 2) Regarding the A-282 bolts which have been breaking, we have taken precautions for the propellers recently overhauled, to insure that the two halves of the clamps are pulled up tight, metal to metal, either at the clamp corners or against the bearing race. Whether this will eliminate the problem within the 1000 hour period, we don't know. If it does not, we recommend changing the bolts, on the flight line, at 500 hours. It is not necessary to examine the bearings for this, as they will continue to function even though they might be cracked.
- 3) It is essential that the engine damper pins and bushings be replaced at engine overhaul. Any wear of these parts seriously affects the vibrational stresses which pass into the propeller.

Yours truly,

HARTZELL PROPELLER, INC.

David Biermann
President

APPENDIX G

May 22, 1975

Department of Transportation
Federal Aviation Administration
3166 Des Plaines Avenue
Des Plaines, Illinois 60018

Attention: Mr. Keith D. Anderson, AGL-210
Chairman, Engineering & Manufacturing Branch

Gentlemen:

As we indicated at the time of **our** last evaluation involving your agency, it is **our** intention to keep you aware of **our** procedures involving service difficulties. With this in mind we are presenting the following information for your evaluation and comment.

Service Difficulty: Cracks in Propeller Blade and Clamp
Propeller Model: HC-A3VF
Blade Model: V7636D
Engine Model: Continental 10-520
Aircraft Model: **D** Havilland **114**
Aircraft Owner: Prinair of Puerto Rico

As you are aware, through reported **M & Ds** and your own investigation, this difficulty does exist and is of a quite serious nature. **You** asked that we evaluate the situation and take action to provide for its correction in existing equipment and prevention in future production.

During the process of evaluation of what steps are to be followed as routine inspection, we note that Owner's Manual 106 calls out inspection at twenty-five, one hundred, and one thousand hour intervals, all being quite explanatory in nature. Secondly, Service Letter 61 dated December 16, **1971** also recommends overhaul at one thousand hours of operation. Thirdly, on December 22, **1970** Mr. Biermann clearly defined his evaluation of the difficulty and provided his recommendations.

Department of Transportation
Page *Two*
May 22, 1975

It is apparent to us that the aforementioned procedures were not and presumably are not being carried out by the aircraft owner. With this as a base, we have issued Service Bulletin 113 covering in detail the inspection and replacement of ()7636D blades and the inspection of the blade clamp assembly.

To assure **no** misunderstanding **on** the owner's part and to acquaint the FAA with the adopted procedures involved in this inspection process, a meeting was arranged with all parties involved and held at Aviation Propellers in Opa Locka. They being a Hartzell Distributor had all necessary tooling and equipment necessary to permit a detailed instruction program.

The time of this meeting was 1:00 PM, Thursday, May 15, 1975. Attending were Mr. Rafael Gilestra of Prinair and his propeller specialist; Mr. Paul Gaither and Mr. Michael Smith, owners of Aviation Propellers; and myself representing Hartzell Propeller, Inc. After some preliminary discussion we asked if any information had been received from either of the FAA groups that were to attend. It was **our** understanding that, due to the extenuating circumstances, the FAA was to be represented from the immediate area in Opa Locka and **by** representatives from the office in Puerto Rico. It is disappointing, after giving you **our** commitment of keeping you aware of **our** procedures, not to have the cooperation expected. Mr. H. Weiss made the arrangements with these people to be present, indicating his concern for the situation. We believe an explanation of the decision not to attend **on** their part should be requested. We can only succeed in this type of situation when all parties cooperate.

There were many areas discussed in which your investigation, we believe, is necessary. After reviewing the maintenance procedures it was discovered that the engines in the aircraft are now **run** to 4500 hours. This is 3000 hours above the manufacturer's recommended overhaul time, which must mean excessive damper wear. See Continental bulletin. This amount of time could not be established as accurate **on** the propellers; however, they do indicate they run them about the same time.

With all the aforementioned information considered we believe it is time, or possibly past the time, for you to intercede and issue a directive causing, in the least, the inspection to take place. As you have stated many times, this is Flight Safety, your obligation and **ours**.

Department of Transportation
Page Three
May 22, 1975

We will await your answer, totally aware that these aircraft, 23 in number, are flying 15 hours a day carrying **19** passengers on each flight.

If you have questions, please let us know at your earliest convenience.

Yours truly,

HARTZELL PROPELLER, INC.

Jimmie A. Reedy
Distributor Coordinator
Field Service Representative

JAR/smj

Enc. Manual 106
Service Letter 61
Continental Bulletin M68-15
Manual No. X-30039 (part on^ly)
Service Bulletin 113
Service Instructions **103**
Mr. Biermann's Letter

CC/ Paul Gaither, Aviation Propellers
Mike Smith, Aviation Propellers

APPENDIX H

May 21, 1975

Mr. R. V. Grimes
President
Hartzell Propeller, Inc.
350 Washington Avenue
Piqua, Ohio 45356

Re:- Hartzell Bulletin No. 113, May 13, 1975
Inspection and Replacement of () 7636D Blades
and the Inspection of the Blade Clamp Assembly

Dear Mr. Grimes:

It is necessary for me to request your personal review of the subject bulletin because of its impact on both of our companies. This bulletin applies only to PRINAIR because we alone operate De Havilland DH-114 aircraft with Continental IO520E Engines. When this bulletin is read by an outsider it will appear that PRINAIR is operating unairworthy aircraft and Hartzell's world renowned quality standards are suspect. This is not the case. We operate an airline which is exempted from local FAA surveillance as a result of the FAA's Systemworthiness Analysis Program. The Hartzell name speaks for itself.

The bulletin's inspection interval requirements and blade life limitation create questions such as:

1. How can a new Hartzell Propeller require an extensive 25 hour inspection?
2. How can an inspection procedure, which is directed only to PRINAIR, be written without knowledge of our present daily inspection procedures?
3. What is the criteria for placing a 2,000 hour life on the blade?

cont/.....

Puerto Rican International Airlines, Inc.

May 30, 1975

Page 2

Finally, further failure reports were received regarding the propellers on your installations. These failures were typical of damper malfunctions in the engine. Further investigation indicated that damper bushings were not replaced for possibly 4500 hours.

Knowing that the blades in the propeller have experienced excessive stresses for many hours, it would be impossible to determine the fatigue damage to existing blades and, therefore impossible to know how much more stress the blades can withstand.

There is no better and safer method than to replace the blades and start anew. It will also be necessary that the Continental Bulletin M68-15 be adhered to - A copy enclosed. This particularly applies to Part 6-18 which is enclosed. Further precaution should be taken by looking at the propellers every 1000 hours.

If these procedures are followed, the propellers will have unlimited life safely. After a series of tear-downs with good results possibly longer overhaul time can be used.

It would also be advisable to set the high ~~RM~~ stop on the governor on a governor test stand and use that setting rather than rely on tachometers which are inaccurate.

We cannot accept the liability of 19 people if the above precautions are **not** taken. We will work with you and give you as much financial relief as possible. This whole matter is **very** serious.

Yours truly,

HARTZELL PROPELLER, INC.

R. V. Grimes
President

RMG/kas
Enclosure