AVIATION OCCURRENCE REPORT

LOSS OF PROPELLER IN FLIGHT AND CABIN DEPRESSURIZATION

INTER-CANADIEN
ATR 42-300 C-GIQV
VAL D'OR, QUEBEC 53 mi SE
13 MARCH 1994

REPORT NUMBER A94Q0037

Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

Aviation Occurrence Report

Loss of Propeller in Flight and Cabin Depressurization

Inter-Canadien
ATR 42-300 C-GIQV
Val D'Or, Quebec 53 mi SE
13 March 1994

Report Number A94Q0037

Synopsis

The aircraft, with 26 occupants on board, was on a flight from Val D'Or Airport, Quebec, to Montreal International (Dorval) Airport, Quebec. At about 17,000 feet above sea level, the No. 2 blade of the right propeller fractured in flight and penetrated the fuselage, causing a depressurization of the cabin. The crew members executed the required emergency procedures and landed at Dorval without further incident.

The Board determined that corrosion pitting had occurred on the surface of the taper bore of the No. 2 blade as a result of water combining with chlorine deposits on the cork in the taper bore. The chlorine was associated with the bleaching of the corks during their manufacture. One of the corrosion pits was the point of origin of the fatigue cracks that caused the propeller blade to fracture.

Ce rapport est également disponible en français.

Table of Contents

1.0 Factual Information

1.1 History of the Flight

On 13 March 1994 at 0957 eastern standard time (EST[1]), an ATR 42, registration C-GIQV, Inter-Canadien regular flight 1678, departed Val D'Or Airport, Quebec, en route to Dorval Airport, Quebec. The aircraft, with two pilots, one flight attendant and 23 passengers on board, was on an instrument flight rules (IFR[2]) flight.

The aircraft took off from runway 18 in Val D'Or. The co-pilot occupied the right-hand seat and was flying the aircraft. The ATR 42 was cleared to climb to flight level 210 and proceed on airway V372 to the Mirabel VHF omni-directional range (VOR[3]). Shortly after take-off, the crew engaged the autopilot (A/P) at 3,000 feet above sea level (asl).

The climb was routine up to about 17,000 feet asl, when a violent explosion rocked the aircraft and the cabin depressurized. The CONTINUOUS REPETITIVE CHIME warning sounded in the cockpit, and at the same time the master warning light and cabin excessive altitude light illuminated. The crew observed that the right engine parameters indicated a total loss of power.

Nine seconds after the depressurization, the pilot-in-command assumed control of the aircraft and disengaged the A/P. He aborted the climb, commenced a descent, and maintained speed. The engine failure procedure and single engine checklist were completed during the descent. The co-pilot contacted Montreal Area Control Centre (ACC) and advised the controller that the aircraft had experienced an engine failure and requested clearance to descend to 15,000 feet, then to 11,000 feet.

The co-pilot pulled fire handle No. 2 after visually confirming the damage to the engine and observing a fuel leak. The cabin excessive altitude checklist was then completed. Three minutes after the occurrence, the crew declared an emergency with the Montreal ACC.

About seven minutes after the cabin depressurization, the co-pilot visually confirmed the structural damage in the cabin. The pilot-in-command felt it was preferable to minimize the number of turns in order to reduce the risk of further structural damage. The crew considered the position of the aircraft, the weather, the available airports, the emergency services available, the known damage to the aircraft, the flying stability of the aircraft, and the flying time to possible destinations. After noting the damage and assessing the situation, the pilot-in-command decided to continue the flight to Dorval. At that time, the aircraft was 36 minutes flying time from Val D'Or, 39 minutes from Mirabel and 44 minutes from Dorval.

At 1028 EST, the aircraft initiated a descent toward 9,000 feet asl and maintained that altitude, which was above the cloud layer, until it entered the Montreal terminal zone. The pilot-in-command requested that emergency response services (ERS) be placed on alert at Dorval and Mirabel airports. The aircraft was aligned with the instrument landing system (ILS) for Dorval runway 06L by radar vectors. It landed without further incident at 1116 EST.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	-	-	-	-

1 All times are EST (Coordinated Universal Time (UTC) minus five hours) unless otherwise stated.

2 See Glossary for all abbreviations and acronyms.

3 Units are consistent with official manuals, documents, reports and instructions used by or issued to the crew.

Minor/None	3	23	-	26
Total	3	23	-	26

Two passengers felt ill and experienced discomfort in their ears as a consequence of the cabin depressurization. Shortly after the landing, the airline conveyed them to hospital, where they were given a medical examination. Their discomfort was of brief duration and there was no permanent damage to their ears.

1.3 Damage to Aircraft

The damage was confined to the right side of the aircraft, aft of the propeller disc.

1.3.1 Right Engine

The front portion of the engine, beginning at the air inlet, separated from the remainder of the engine, and its three mounts were torn away from the titanium nacelle structure. The two rear mounts supported the rear of the engine. Six of the eight bolts securing the engine to the rear mounts sheared off. (See Appendix A.)

1.3.2 Fuselage

The top of the No. 2 blade punctured the fuselage as the blade passed on its trajectory toward and beneath the aircraft. A vertical cut measuring 104 cm by 2.5 cm was observed between stations 9157 and 9333 on the right side of the fuselage. The seat adjacent to the vertical cut was partially cut. Two landing gear hydraulic lines mounted under the floor were slightly bent. (See Figure 1 - Blade Trajectory.)

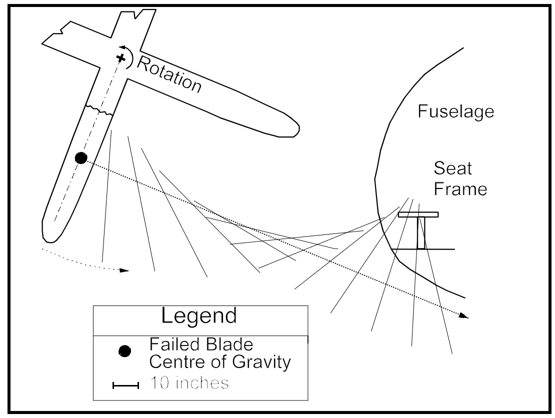

Figure 1 - Blade Trajectory

Some debris penetrated the upper surface of the landing gear nacelle and cut the pneumatic de-icer between the engine and the fuselage. Several scrapes were also observed on the painted surface of the fuselage. (See Appendix A.)

1.4 Personnel Information

1.4.1 General

	Captain	First Officer
Age	34	32
Pilot Licence	ATPL	ATPL
Medical Expiry Date	01 Nov 94	01 Nov 94
Total Flying Time	8,733 hr	6,000 hr
Total on Type	4,000 hr	4,000 hr
Total Last 90 Days	165 hr	180 hr
Total on Type Last 90 Days	165 hr	180 hr
Hours on Duty Prior to Occurrence	3.5 hr	3.5 hr
Hours off Duty Prior to Work Period	60 hr 72 hr	

1.4.2 Flight Crew

The pilot-in-command and co-pilot were certified and qualified for the flight in accordance with existing regulations. Both were experienced on the ATR 42 and had been flying the aircraft type for several years.

1.4.3 Flight Attendant

A flight attendant was also responsible for the safety and comfort of passengers on board the aircraft. She had received her initial training on the ATR 42 in December 1988, and had successfully completed all courses, examinations, and practices required by the company and approved by Transport Canada during the year preceding the accident.

1.4.4 *Crew Training in Cockpit/Cabin Coordination*

The three crew members had received training to improve coordination and communication between flight crews and flight attendants in emergencies and unusual situations. This training is not required by Transport Canada.

1.4.5 *Cockpit Resource Management*

The pilot-in-command and co-pilot had taken a cockpit resource management (CRM) course, which concentrates on achieving optimum utilization of the resources available to ensure a safe and efficient flight. This training is not required by regulation.

1.5 *Aircraft Information*

Particulars	
Manufacturer	Avions de transport régional
Type	ATR 42-300
Year of Manufacture	1989
Serial Number	203
Certificate of Airworthiness (Flight Permit)	valid
Total Airframe Time	8,276.7 hr
Engine Type (number of)	PW120 (2)
Propeller/Rotor Type (number of)	Hamilton Standard 14SF-5 (2)
Maximum Allowable Take-off Weight	16,704 kg
Recommended Fuel Type(s)	Jet B
Fuel Type Used	Jet B

1.5.1 *General*

Inter-Canadien had been operating C-GIQV since 08 September 1990. The aircraft had never been involved in an accident or struck by lightning. The weight and centre of gravity were both within the prescribed limits. The aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures. All pertinent service bulletins and airworthiness directives had been completed.

The change to the aircraft's centre of gravity caused by the separation of the propeller was inconsequential. Although six of the eight bolts securing the engine to the rear mounts sheared off and the engine's three front mounts were torn away, the engine remained in its frame. It is unlikely that there was any possibility of the engine separating from the aircraft.

1.5.2 *Right Engine*

The engine had 8,603 hours total time in service and 3,705 hours since overhaul.

The engine fractured at the mount securing the turbine to the reduction gearbox. The reduction gearbox auxiliary components remained attached to the engine by their lines and electrical harnesses.

The engine teardown and analysis did not reveal any discrepancies prior to the propeller rupture. Damage to the engine corresponds to damage caused by instantaneous overload.

1.5.3 *Propeller*

This type of composite propeller is used by many aircraft manufacturers, on over 2,000 aircraft. These propellers have accumulated over 17 million flying hours as of the occurrence date.

1.5.3.1 *Right Propeller*

The propeller was found on the frozen surface of the Cabonga Reservoir, Quebec. The No. 1, 3 and 4 blades were twisted and their surfaces showed substantial damage. The No. 2 blade (serial number 856922) was fractured at station 22.27. The tip of the No. 2 blade was not found.

The operator had inspected the right propeller three days before the occurrence and the No. 2 blade retaining ring spacer clearance had been set. Examination of the blade surfaces did not reveal any discrepancies.

1.5.4 *Propeller Blade*

The blade is 188.55 cm long, with a chordwise dimension of 30.50 cm; its surface is fibreglass. The spar is bored out from the root to a depth of 56 cm.

The No. 2 blade was manufactured in December 1987. It had 12,238 hours total time since new (TTSN) and 4,748 hours time since major inspection (TSMI).

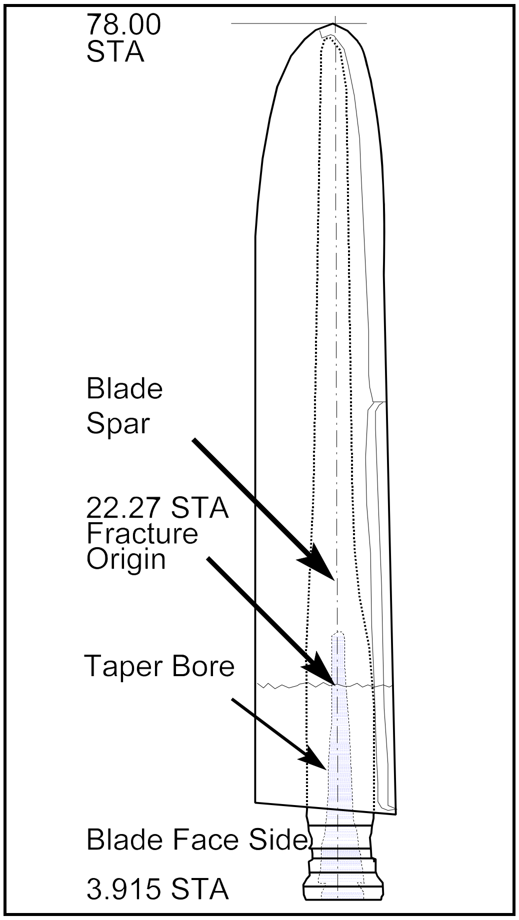

Figure 2
No. 2 Blade

1.5.4.1 Blade Manufacture

The blade spar was forged from 7075-T73 aluminum alloy. A characteristic of this alloy is that it inhibits stress corrosion cracking. The fluorescent particle inspection (FPI) method was used to check the spar for cracks. The manufacturer has never found cracks in the bore using this method. The spar and bore were then treated against corrosion; they were anodized and coated with Alodine 1200 solution.

Before April 1987, shotpeening was used to enhance the blade material fatigue strength in the taper bore area. Hamilton Standard evaluated the process and determined that shotpeening the bore was superfluous for this type of blade. The No. 2 blade was manufactured in accordance with approved procedures after this shotpeening procedure was discontinued.

1.5.4.2 Blade Balancing

The blades undergo static balancing with lead wool placed in the bore after manufacture, major inspection, or repair.

To avoid damage to the internal surface of the bore, the lead wool is packed with a series of steel rods tipped with brass. (A pneumatic driver is occasionally used with the steel rods to remove the lead.) The lead is then secured in the bore with a cork placed against the lead.

The No. 2 blade was balanced following the last major inspection. At that time, the bore was visually inspected with the cork in place. The inspection can be done without removing the cork; in fact, it was recommended that the lead not be removed if possible. No signs of corrosion were observed in the bore.

1.5.4.3 Corks

There are no manufacturing specifications for the corks; however, the corks meet laboratory-grade specifications. They were cooked in steam and washed in chlorinated water. On installation, a V-shaped cut was made along the length of the cork to allow air to escape. Examination of the corks established that chlorine was present on their surface.

1.5.4.4 No. 2 Blade Fracture Surface

The fracture surface showed fatigue marks originating in the spar bore on the face side of the blade. Approximately
80 per cent of the fracture surface exhibited fatigue cracks; damage on the remainder of the fracture surface was attributable to overload failure. Metallurgical analysis revealed that a corrosion pit 0.1524 cm in the circumferential direction, 0.0762 cm into the material (radial direction) and 0.1447 cm in the axial direction was the point of origin of the fatigue crack. Tensile stresses were greatest on the face side of the bore where the crack originated.

Four other superficial cavities were found in the bore at the same station on the camber side of the blade. The camber side of the taper bore was subjected to high compression stresses in flight.

1.6 Meteorological Information

A weather analysis was carried out by the Quebec Weather Centre of Environment Canada. Western Quebec was under the influence of a low pressure system extending from Parent, Quebec, to Maniwaki, Quebec. Associated with this system was an area of light snow covering all of western Quebec and creating generally IFR conditions close to and south of the low pressure system.

Meteorological conditions at 1000 EST, 15 minutes before the accident, were as follows:

- at Val D'Or, a ceiling of broken cloud at 800 feet and overcast at 1,500 feet, visibility reduced to three miles in light snow, temperature minus three degrees Celsius, dew point minus four degrees Celsius, and surface winds from 320 degrees at three knots;
- at Dorval, ceiling overcast at 500 feet, visibility three miles in light snow, temperature minus six degrees Celsius, dew point minus eight degrees Celsius, and surface winds from 040 degrees at 10 knots;
- at Mirabel, ceiling overcast at 700 feet, visibility four miles in light snow grains and light freezing drizzle, temperature minus six degrees Celsius, dew point minus eight degrees Celsius, and surface winds from 070 degrees at six knots.

At the time of the landing, the conditions at Dorval were: sky partially obscured, ceiling 500 feet above ground level (agl), visibility 1.5 miles in very light snow grains and fog, winds northeast at seven knots. Turbulence was not considered to be an important factor.

1.7 Aids to Navigation

Shortly after the depressurization, the pilot-in-command asked the controller for a radar vector to Dorval Airport to align the ATR 42 with the runway 06L ILS. Although part of the flight had been conducted below the minimum en route altitude (MEA) of 10,000 feet, the aircraft's navigational equipment functioned normally throughout the flight. Although the aircraft was below the MEA, it stayed above the minimum obstacle clearance altitude (MOCA) of 4,000 feet for most of the flight and was in no danger of colliding with any obstacles.

1.8 Communications

The air-to-ground communication systems functioned normally during the flight. Air-to-ground communications were recorded on magnetic tape by Air Traffic Services (ATS). The tapes were obtained for analysis.

The intercom system between the cockpit and the flight attendant also functioned properly. However, after the depressurization, the ambient noise in the cabin made the public address system practically inaudible. Some passengers did not hear the pilots' announcements clearly. The flight attendant repeated the pilots' messages to the passengers to ensure effective communications between the crew members and passengers.

The flight attendant was serving the passengers when the depressurization occurred. She immediately sat down in the aft jump seat and informed the pilot-in-command, via the intercom, that the forward portion of the right engine had separated from the aircraft.

Just after the depressurization, the flight crew and flight attendant coordinated their actions to manage the unusual emergency. The flight attendant reported the damage she observed to the pilot-in-command and an emergency plan was immediately established. She noted that no passengers were injured and that the fuselage was cut at seat 3D. An emergency landing action plan (TESTRA[3]) was established by the crew and flight attendant. She returned to the cabin and moved the passengers sitting near the cut to a position further aft.

The pilot-in-command kept the flight attendant and passengers informed of the situation during the flight until the landing. All

3 TESTRA is a French acronym. Roughly translated, it stands for **T**ype of problem, **E**vacuation (which exits), **S**ignal to be given, **T**ime, **R**elocation of passengers, **A**nnouncement to passengers.

indications are that effective communications were established between the crew members.

1.9 Aerodrome Information

Dorval Airport is located on the western part of Montreal Island. The municipalities of Dorval and St-Laurent share the airport, and their firefighting services respond to emergencies. The airport also has an emergency response service (ERS) for first response.

Aerodromes are categorized according to the level of ERS response they provide. The ERS category provided is based on the length of the aircraft and the number of aircraft movements. The longer the fuselage, the higher the ERS category. With a higher ERS, the quantity of fire-extinguishing agent available increases. The highest category is 9. The ERS category for Val D'Or is 4; Dorval's is 8, and Mirabel's is 9. A category of 5 is recommended for the ATR 42. However, the ERS category can be up to two categories below the category of the aircraft.

Dorval Airport has three runways: one runway 10/28 and two runways 06/24. Runway 06L, with a length of 11,000 feet, is the longest.

1.9.1 Emergency Response Services Deployment

Dorval and Mirabel Airport ERS were placed on alert at the request of the pilot-in-command.

At 1025 EST, the shift supervisor in the Dorval tower informed the ERS of the ATR 42's situation and reported that its estimated landing time was 1108 EST. The emergency centre was put in operation at 1030 EST. The Royal Canadian Mounted Police (RCMP), airport firefighters, Montreal Urban Community Police Service (SPCUM), City of Dorval fire department, Urgence-Santé, Inter-Canadien, and TSB were informed. At 1050 EST, the Dorval fire department and ERS vehicles were in position to respond on runway 06L.

The aircraft landed without further difficulty and stopped on taxiway Echo, where a damage assessment was carried out to determine the risk of fire. No significant fuel leaks were found, and the aircraft was cleared to taxi to gate 43P, where the passengers disembarked. There was no emergency evacuation of the passengers from the aircraft.

1.10 Flight Recorders

The flight recorders were retrieved just after the passengers disembarked. The recorders were played back and analyzed at the TSB Engineering Branch Laboratory.

1.10.1 Cockpit Voice Recorder (CVR)

The CVR is a Fairchild model A100A. As its recording period is only 30 minutes, the material recorded at the time of the occurrence had other information recorded over it and was lost.

1.10.2 Flight Data Recorder (FDR)

The FDR is a Sundstrand. The recording lasts approximately 25 hours, during which time 43 flight parameters are registered. The parameters for the last 21 flights were recorded during that period. Analysis of this data revealed no anomalies prior to the blade fracture. The aircraft systems recorded by the FDR were operating within the prescribed limits.

Since the commissioning of the aircraft, the Inter-Canadien maintenance department has uploaded certain FDR data onto computer disks on a daily basis. These data are analyzed to monitor engine performance and patterns. The analysis is also used to detect operational irregularities in aircraft systems. Examination of the data revealed that no prescribed limits were exceeded.

1.11 Survival Aspects

When the No. 2 blade punctured the fuselage, it partially cut the aluminum seat of seat 3D. (See Figure 1 - Blade Trajectory.) Seats 3D and 3C were unoccupied. Depressurization occurred at an altitude where the risks associated with decompression sickness are minimal.

1.12 Tests and Research

1.12.1 Study on Fatigue Cracks

A crack propagation study is ongoing at Hamilton Standard. The study involves correlating the flight parameters retrieved from the FDR and the fatigue tests done by the manufacturer, Hamilton Standard, with the striations observed on the fractured section of the No. 2 blade. This study provided additional support to the 1,250 cycle blade ultrasonic inspection interval that Hamilton Standard addressed in the Alert Service Bulletin 14SF-61-A74 dated 29 August 1994.

1.12.2 Study on Cause of Corrosion

Examination of the spar revealed no discrepancies related to its fabrication.

The physical evidence and the tests conducted by Hamilton Standard indicated that water combined with the chlorine on the surface of the cork to produce an acidic solution strong enough to corrode the anodic coating and aluminum alloy.

Although there were five corrosion pits in the bore, only the pit on the face side of the No. 2 blade produced the fatigue cracks.

1.13 Additional Information

1.13.1 Similar Occurrence

On 30 March 1994, in Brazil, a similar blade fractured in flight. The fracture was caused by fatigue originating from a corrosion pit. It was determined that a solution of chlorine, coming from the cork, and water probably produced the corrosion in the bore where the fracture originated. The blade had 4,185 hours total time in service.

1.13.2 External Examinations

A visual examination of the exterior of the aircraft was carried out by the co-pilot. This examination must be done after each crew change.

No discrepancies related to the propellers were reported by the pilots who had flown the aircraft on the days preceding the accident.

1.13.3 Emergency Procedure

There is no particular emergency procedure for the event of a blade separating in flight.

1.14 Useful or Effective Investigation Techniques

1.14.1 Search for Reduction Gearbox and Propeller

The blade broke 53 nm from Val D'Or Airport, over the Cabonga Reservoir and the La Vérendrye game reserve. This area is uninhabited and densely wooded. The area has relatively uniform topography and numerous lakes.

A ballistic study was conducted by the TSB laboratory to determine the area where the reduction gearbox and propeller could have fallen. The elements considered in the study included the FDR data, radar data, meteorological information, and the dimensions, weights, and shapes of the missing parts. The reduction gearbox and propeller were found less than 500 metres from the estimated point of impact.

2.0 Analysis

2.1 Introduction

The following analysis concentrates on the flight, the aircraft, the propeller, and the manufacturing of the blades.

2.2 Flight

2.2.1 Absence of Visual and Sensory Indications

Because the point of origin of the fracture was inside the bore, the fatigue cracks propagated from the interior toward the blade surface. It was, therefore, impossible for the crew to detect any discrepancies during the external inspection of the aircraft. Additionally, there were no indications prior to or during the flight which could have enabled the flight crew to anticipate the fracture of the blade. Analysis of the FDR data for the occurrence flight and for previous flights revealed no failures or abnormal vibrations prior to the blade fracture.

2.2.2 Crew Performance

Fracture of a propeller blade in flight is considered a highly improbable occurrence, as is the partial disintegration of an engine. Crews are not specifically trained to deal with such emergencies. In an emergency situation, the crew will react in accordance with the procedures practised during training. In the absence of training or standard procedures dictating how to deal with a particular situation, the crew must react by drawing upon their knowledge and experience.

The crew reacted first to the cabin depressurization, then to the engine failure. The pilots were not fully aware of the situation until the flight attendant informed them that the forward portion of the engine had separated in flight and that there was a cut in the fuselage. When it became evident that they had indeed lost the right engine, the co-pilot cut off fuel to the engine by pulling fire handle No. 2.

After stabilizing the aircraft and controlling the emergency, the crew assessed the situation. Because the behaviour of the aircraft in horizontal flight was satisfactory and the crew did not know the extent of the damage to the aircraft, the pilot-in-command felt it was preferable to minimize the number of turns in order to reduce the risk of further structural damage. The crew took into consideration the position of the aircraft, the weather, the airport services available, the known damage, the reactions of the aircraft, and the flying time to possible destinations. Analysis of ATS communications and the pilots' statements suggests that the decision to continue the flight to Montreal was taken nine minutes after the blade fracture.

2.3 Propeller Separation

When the blade separated, the forces induced by the propeller imbalance on the three forward engine mounts exceeded the ultimate limits of each support and of the reduction gearbox mount. This allowed the propeller and reduction gearbox to separate from the turbine.

2.4 Fuselage Damage

None of the propeller or reduction gearbox components found showed traces of paint from the fuselage. All indications are that the No. 2 blade fractured when in a position such that its trajectory allowed it to penetrate and then pass through the fuselage before following its course. The other damage to the aircraft was caused by nacelle debris during the separation.

2.5 Corrosion

There were traces of chlorine in the corrosion pit at the point of origin of the No. 2 blade fracture. The chlorine was associated with the bleaching of the corks during their manufacture.

Chlorine deposits on the surface of the cork, in the presence of water, produce an acidic solution which can attack the anodic coating on the aluminum and initiate superficial corrosion pitting.

There were five corrosion pits in the taper bore of the No. 2 blade. Only one of the pits observed had progressed to the point where it initiated the fatigue fracture. This was the only pit on the face side of the blade bore. It is on this side of the blade bore, and at this station, that tensile stresses are greater than at any other point in the bore.

2.6 Blades

The blades on this type of aircraft are manufactured in accordance with their Federal Aviation Administration (FAA) certification.

The investigation revealed that shotpeening as part of the blade manufacturing process was discontinued in April 1987. Shotpeening offered supplementary protection in the form of reduced crack propagation in the area of the residual compressive stress induced by the shotpeening.

Corks have been used for many years to hold lead wool in place in blade bores.

Hamilton Standard had never observed that corrosion had been initiated by the use of corks. Additionally, the taper bore was not an area of the blade that was susceptible to corrosion. Internal visual inspection during major inspections was the only kind of inspection required by the manufacturer for this area.

The moisture necessary to initiate the corrosion pitting must have been introduced when the cork was installed: that is, either at the 7,500-hour major inspection or during the manufacturing process. However, it could not be determined with certainty at which moment the moisture was introduced.

3.0 Conclusions

3.1 Findings

1. The aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures.

2. The blade was manufactured and inspected in accordance with the manufacturer's standards and procedures.

3. The corks used in the taper bore are covered with a chlorine deposit.

4. Water in the taper bore in contact with the chlorine from the cork can produce an acidic solution which can cause corrosion.

5. The fractured blade showed corrosion pitting in the taper bore.

6. The inside of the taper bore of the fractured blade had not been shotpeened during manufacture.

7. An inspection of the No. 2 blade three days before the occurrence did not reveal any damage to the blade surface.

8. The 7,500-hour major inspection was performed using the procedures and materials specified by the manufacturer.

9. The fractured section of the blade punctured the fuselage and caused the cabin depressurization.

3.2 Causes

Corrosion pitting had occurred on the surface of the taper bore of the No. 2 blade as a result of water combining with chlorine deposits on the cork in the taper bore. The chlorine was associated with the bleaching of the corks during their manufacture. One of the corrosion pits was the point of origin of the fatigue cracks that caused the propeller blade to fracture.

4.0 Safety Action

4.1 Action Taken

The Board issued an Aviation Safety Advisory requesting that Transport Canada confirm with Hamilton Standard and the FAA that the measures taken by Hamilton Standard meet Canadian airworthiness requirements.

Hamilton Standard was able to take the following steps to prevent similar occurrences:

A - Field Actions:

1) Alert Service Bulletin 14SF-61-A73, dated 18 April 1994 (mandated by FAA Airworthiness Directive 94-09-06, effective date 02 May 1994), provided instructions to perform a one-time inspection of all 14SF blades using ultrasonic methods to inspect the taper bore for anomalies.

2) Alert Service Bulletin 14SF-61-A74, dated 29 August 1994, provided instructions for the performance of a blade taper bore ultrasonic inspection as described above every 1,250 cycles, or to perform a one-time removal of the taper bore cork and visually inspect that portion of the taper bore for pits for blades that had not been shotpeened or had not had their taper bores inspected at Hamilton Standard's overhaul facility. The cork removal/visual inspection procedure is addressed by Service Bulletin 14SF-61-75. At the present time, the FAA is preparing an Airworthiness Directive to mandate this bulletin.

3) Revision No. 8 to the Hamilton Standard Component Maintenance Manual 61-13-02, dated 01 September 1994, includes instructions for inspection and repair of the blade taper bore area when the blade is returned to a repair facility. It also requires shotpeening of the taper bore for blades not previously shotpeened and mandates the use of new tools to reduce the chance of damaging the taper bore during lead wool removal. It also deletes instructions to install cork in the taper bore.

B - Manufacturing Actions:

1) Re-introduced shotpeening to blade taper bores in May 1994.

2) Deleted cork installation in the taper bores in May 1994.

3) Changed the sequence of steps associated with the manufacturing to prevent water being introduced into the taper bore after lead wool is installed.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson, John W. Stants, and members Gerald E. Bennett, Zita Brunet, the Hon. Wilfred R. DuPont and Hugh MacNeil, authorized the release of this report on 28 February 1995.

Appendix A - Photographs of Aircraft

Propeller Damage to Fuselage

Engine as it was at Landing

Appendix B - List of Supporting Reports

The following TSB Engineering Branch Laboratory reports were completed:

LP 042/94 - FDR Analysis;

LP 048/94 - ATR-42 Propeller Separation Analysis;

LP 049/94 - Propeller and Gearbox Analysis; and

LP 050/94 - Propeller and Gearbox Search.

These reports are available upon request from the Transportation Safety Board of Canada.

Appendix C - Glossary

A/P	autopilot
ATS	Air Traffic Services
cm	centimetre(s)
CRM	cockpit resource management
CVR	cockpit voice recorder
ERS	emergency response services
EST	eastern standard time
FAA	Federal Aviation Administration
FDR	flight data recorder
hr	hour(s)
IFR	instrument flight rules
ILS	instrument landing system
kg	kilogram(s)
MEA	minimum en route altitude
RCMP	Royal Canadian Mounted Police
SPCUM	Montreal Urban Community Police Service
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VHF	very high frequency
VOR	very high frequency omni-directional range