



National Transportation Safety Board Aviation Accident Final Report

Location:	DFW AIRPORT, TX	Accident Number:	FTW96FA282
Date & Time:	07/01/1996, 0711 CDT	Registration:	N335AE
Aircraft:	Saab-Scania AB (Saab) SF340B	Aircraft Damage:	Substantial
Defining Event:		Injuries:	15 None

Flight Conducted Under: Part 121: Air Carrier - Scheduled

Analysis

The airplane departed runway 13L and climbed to an altitude of approximately 400 feet AGL when the flight crew 'heard a loud bang.' The right engine upper cowling departed the airplane, the right engine shut itself down, and the right propeller automatically feathered. The flight crew declared an emergency and executed a single engine landing without further incident. Examination of the airplane's right CT7-9B turboprop engine revealed that the Stage 2 turbine disk was missing and that approximately one third of the disk was found in the right landing light compartment. One end of the disk fragment progressed through a cooling air hole and there was evidence of a fatigue fracture that had initiated from multiple origins on the inboard side of the cooling air hole. Research revealed a layer of deformed microstructure and an associated zone of increased disk hardness near the origin area of the fatigue crack. Test disks were drilled using dull and worn drill bits which resulted in plastic deformation and increased hardness of the inner diameter hole surfaces. The manufacturer reported that the deformed microstructure correlates to a zone of reduced fatigue properties.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The manufacturer's inadequate procedure for manufacturing the number two turbine disk.

Findings

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

Findings

1. 1 ENGINE
2. TURBINE ASSEMBLY, TURBINE WHEEL - FAILURE, TOTAL
3. TURBINE ASSEMBLY, CASING - PENETRATED
4. (C) PROCEDURE INADEQUATE - MANUFACTURER

Factual Information

HISTORY OF FLIGHT

On July 1, 1996, at 0711 central daylight time, a Saab SF340B, N335AE, sustained an uncontained engine failure resulting in structural damage to the airframe, while on initial takeoff climb from the Dallas/Fort Worth International Airport, Texas. The two pilots, one flight attendant, and 12 passengers were not injured. The airplane was being operated by Wings West as American Eagle Flight 547, under Title 14 CFR Part 121. Visual meteorological conditions prevailed for the scheduled passenger flight which originated from DFW Airport, Texas, approximately 1 minute before the accident. An IFR flight plan had been filed with Shreveport, Louisiana, as its intended destination.

The airplane departed runway 13L and climbed to an altitude of approximately 400 feet AGL when the flight crew "heard a loud bang." The right engine upper cowling departed the airplane, the right engine shut itself down, and the right propeller automatically feathered. The flight crew declared an emergency and continued their climb to 2,000 feet MSL while coordinating a flight path reversal with DFW tower. The flight crew executed a single engine landing on runway 31R without further incident 7 minutes after the engine failure.

DAMAGE TO AIRCRAFT

Examination of the airplane's right General Electric Aircraft Engines CT7-9B turboprop engine, serial number 785-199, revealed two holes in the turbine case in the Stage 2 turbine disk plane of rotation, and that the Stage 2 gas generating disk was missing. Approximately one third of the disk exited the engine case at the 9 o'clock position, separating the engine nacelle's left nacelle longeron, penetrating the landing light fairing, and coming to rest in the right landing light compartment. The outer passenger window for seat 6C had two puncture holes in it with one having a piece of the gas generating disk fir tree lodged in the window. The skin on the right side of the fuselage and the wing root fairing was penetrated 12 times, with 6 of the holes containing debris from the right engine.

The right side of the engine case was penetrated with corresponding penetrations to the nacelle from approximately 1 to 3 o'clock position. The right nacelle longeron was deformed, but was not severed. The remaining portion of the number two gas generator disk was not recovered.

AIRCRAFT INFORMATION

The Stage 2 turbine disk, part number 6064T12P01, serial number GAT2M710, was approximately 6 inches in diameter and was manufactured from Rene 95 nickel alloy material. The disk had 15 holes through the web area for 5 each tiebolt holes, cooling plate bolt holes, and cooling air holes.

The engine and the Stage 2 disk were mated at the time of manufacture. At the time of the accident, they had accumulated a total of 10,502.9 hours and 10,133 cycles since new. They had accumulated 4,472.6 hours and 4,549 cycles since the last shop visit when the Stage 2 disk was exposed and inspected.

The engine was removed from the airplane and shipped to the manufacturer's facility for disassembly and examination. See the enclosed Powerplant Group Chairman's Report for details of the examination.

TESTS AND RESEARCH

The NTSB's materials laboratory examined the wedge shaped fragment of the Stage 2 turbine disk which was recovered from the right landing light cavity and observed the following: One end of the disk fragment progressed through a cooling air hole. The portion of the fracture radially inboard of the hole contained a heat tinted region that ranged in color from dark blue to gray and covered approximately 2/3 of the area between the cooling hole and the bore. The crack arrest marks and river pattern within the heat tinted region were indicative of a fatigue fracture that had initiated from multiple origins on the inboard side of the cooling air hole adjacent to the radius at the front face of the disk. Examination of the origin area of the fracture with the scanning electron microscope showed that the surface of the air hole did not have any mechanical gouges or visible defects that could have contributed to the initiation of the crack. The fracture surfaces on the outboard side of the cooling hole and on the other end of the disk fragment had ductile dimple features that are an indication of an over stressed fracture.

Further analysis of the disk fragment by the metallurgists from the NTSB and the manufacturer determined that the chemical composition, grain structure, and material properties all conformed to the specifications for properly processed Rene 95. There were no indications of any inclusions or handling damage to the part. A cross section of the disk's air hole adjacent to the fracture surface showed the front face of the disk, which was the drill exit side, was slightly mushroomed at the tangent to the radius. Additionally, the metallurgists found a layer of deformed microstructure and an associated zone of increased disk hardness near the origin area of the fatigue crack. See the enclosed NTSB Metallurgist's Group Chairman Report and the manufacturer's metallurgists report for details.

The manufacturer reported that they drilled a number of holes, in test disks, using dull and worn drill bits. Examination of these holes revealed displaced material similar to that noted on the fractured disk from the accident airplane's engine. Additionally, the manufacturer found that the inner diameter of these test drill holes exhibited plastic deformation of the hole surface and these deformed areas were found to exhibit increased hardness.

ADDITIONAL DATA

The FAA Engine Certification Office, Burlington, Massachusetts, advised the NTSB that it had worked with the manufacturer to publish three service bulletins affecting the inspection of the CT7 Stage 1 and 2 turbine disk holes (see attached service bulletins). The FAA also reported that they had published an airworthiness directive (AD), which became effective April 15, 1997, requiring the inspection of all CT7 Stage 1 and 2 turbine disk holes by the end of 1997 (see attached AD). As the result of this investigation, the manufacturer has made several changes in manufacturing procedures of these turbine disks (see attached letter) and in their Overhaul Manual for the CT7 engine.

The airplane was released to the owner's representative.

Pilot Information

Certificate:	Airline Transport; Commercial	Age:	41, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	Airplane Single-engine	Toxicology Performed:	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	Last FAA Medical Exam:	03/01/1996
Occupational Pilot:		Last Flight Review or Equivalent:	
Flight Time:	9200 hours (Total, all aircraft), 2000 hours (Total, this make and model), 8000 hours (Pilot In Command, all aircraft), 173 hours (Last 90 days, all aircraft), 58 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Saab-Scania AB (Saab)	Registration:	N335AE
Model/Series:	SF340B SF340B	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	340B-335
Landing Gear Type:	Retractable - Tricycle	Seats:	27
Date/Type of Last Inspection:	06/12/1996, Continuous Airworthiness	Certified Max Gross Wt.:	29000 lbs
Time Since Last Inspection:	121 Hours	Engines:	2 Turbo Prop
Airframe Total Time:	6501 Hours	Engine Manufacturer:	GE
ELT:	Installed, not activated	Engine Model/Series:	CT7-9B
Registered Owner:	AMR LEASING CORPORATION	Rated Power:	1750 hp
Operator:	WINGS WEST AIRLINES, INC.	Operating Certificate(s) Held:	Flag carrier (121)
Operator Does Business As:	AMERICAN EAGLE	Operator Designator Code:	WWMA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Day
Observation Facility, Elevation:	KDF, 603 ft msl	Distance from Accident Site:	4 Nautical Miles
Observation Time:	0653 CDT	Direction from Accident Site:	270°
Lowest Cloud Condition:	Clear / 0 ft agl	Visibility	10 Miles
Lowest Ceiling:	None / 0 ft agl	Visibility (RVR):	0 ft
Wind Speed/Gusts:	9 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:	180°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30 inches Hg	Temperature/Dew Point:	25° C / 18° C
Precipitation and Obscuration:			
Departure Point:	(DFW)	Type of Flight Plan Filed:	IFR
Destination:	SHREVEPORT, LA (SHV)	Type of Clearance:	IFR
Departure Time:	0711 CDT	Type of Airspace:	Class B

Airport Information

Airport:	DFW INTERNATIONAL AIRPORT (DFW)	Runway Surface Type:	Concrete
Airport Elevation:	603 ft	Runway Surface Condition:	Dry
Runway Used:	13L	IFR Approach:	None
Runway Length/Width:	9000 ft / 200 ft	VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	3 None	Aircraft Damage:	Substantial
Passenger Injuries:	12 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	15 None	Latitude, Longitude:	

Administrative Information

Investigator In Charge (IIC): JAMES F STRUHSAKER **Report Date:** 03/31/1998

Additional Participating Persons: TONY D PIRRELLO; DFW AIRPORT, TX
BO-GORAN G WINDOFF; SWEDEN,
MARK E TAYLOR; LYNN, MA
STEVE DICKEY; SAN LUIS OBISPO, CA

Publish Date:

Investigation Docket: NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at <http://dms.nts.gov/pubdms/>.

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