National Transportation Safety Board
Aviation Accident Final Report

Location:	Port Townsend, WA	**Accident Number:**	SEA03LA076
Date & Time:	04/17/2003, 1530 PDT	**Registration:**	N730FE
Aircraft:	Fokker F27MK 600	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	2 None
Flight Conducted Under:	Part 121: Air Carrier - Non-scheduled		

Analysis

After initiating their descent the crew heard a "thunk" sound from the left side of the aircraft, followed by the gearbox LOW OIL PRESSURE warning light illuminating. After consulting the Quick Reference Handbook, the left engine was shut down, the crew declared an emergency, and a single-engine landing was made at the destination airport without incident. Subsequent examination by maintenance personnel revealed that the #1 engine drive shaft had failed at the universal joint connection area on the gear side of the engine, resulting in substantial damage to the firewall. The left engine's accessory drive shaft assembly, including the forward and aft universal joints, were sent to the NTSB Materials Laboratory Division, Washington, D.C., for examination. The examination revealed that the accessory drive shaft failed due to deterioration of bearing number 1 in the aft fork of the joint. This failure led to frictional heating for some time and off-axis rotation that eventually allowed the spider journal to slip out of the bearing cup at bearing number 3, leading to the rapid separation of the joint. The cause for the number 1 bearing failure is unknown.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The failure of the accessory drive shaft due to deterioration of bearing number 1 in the aft fork of the universal joint for undetermined reasons during cruise flight.

Findings

Occurrence #1: LOSS OF ENGINE POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation: CRUISE

Findings
1. 1 ENGINE
2. (C) TURBOSHAFT ENGINE,POWER OUTPUT SHAFT - FAILURE
3. (C) REDUCTION GEAR ASSY,ACCESSORY DRIVE BEARING - FAILURE

Factual Information

On April 17, 2003, about 1530 Pacific daylight time, a Fokker F27MK 600, N730FE, registered to Federal Express Corporation, and operated by Empire Airlines as a 14 CFR Part 121 cargo flight en route to Seattle, Washington, sustained substantial damage to the firewall following a #1 engine failure while in cruise flight near Port Townsend, Washington. The flight continued to Seattle where a single-engine landing was made without incident. Visual meteorological conditions prevailed at the time and an instrument flight rules flight plan was filed. The two airline transport pilots were not injured. The flight departed Ketchikan, Alaska, as Empire Flight CFS 8202, at 1247 Alaska daylight time.

According to the Pilot/Operator Aircraft Accident Report (NTSB Form 6120.1/2), the pilot reported that just prior to starting the descent into the Seattle area, the crew heard a "thunk" sound from the left side of the aircraft and the gearbox LOW OIL PRESSURE warning light illuminated. The pilot stated that the crew consulted the Quick Reference Handbook, then elected to shut down the left engine in accordance with the Precautionary Engine Shutdown checklist. The pilot reported that after the engine had been shut down and the checklists completed, the crew declared an emergency and proceeded to the Seattle-Tacoma International Airport where a single-engine landing was made without incident. The NTSB investigator-in-charge was subsequently notified by company maintenance personnel that an initial examination indicated that the #1 engine drive shaft had failed at the universal joint connection area on the gear side of the engine, resulting in substantial damage to the firewall.

The accessory drive shaft assembly includes a universal joint at each end of the drive shaft. Each universal joint consists of two forks aligned perpendicular to each other in the plane of rotation and a center unit assembly. Each fork has two lugs, each of which contains a bearing outer race, called a cup. The center unit assembly includes a center body, called the spider, with four journals that comprise the bearing inner races, each having 21 cylindrical rolling elements and a cage. The cup fits over the spider journals and rolling elements. A grease seal is located at the inner end of the cup between the cup and the spider, with spring clips inserted in grooves in the fork lugs, which retain the cups within the forks. Grease is applied to the bearings in each joint using a zerk fitting on each joint.

A Senior Materials Engineer at the NTSB Materials Laboratory in Washington, D.C conducted an examination of the accessory drive shaft including the forward and aft universal joints. (Refer to Attachment 1)

The results of the examination revealed that the forward joint of the drive shaft was fractured through its aft fork, with the fracture features and deformation consistent with overstress fracture in bending and rotation.

The drive shaft exhibited circumferential score marks concentrated near the aft end. Damage was consistent with contact with an adjacent structure, with the shaft rotating counterclockwise relative to the structure.

Tinting consistent with heating was observed on all components of the aft joint. The output shaft, which included the aft fork of the aft joint, had multiple damage locations and was not connected to the spider, the center unit assembly. Two bearing cups contained their rolling elements, cages, and washers, while only one rolling element from the other two cups was submitted. All four grease seals were missing and the grease zerk fitting on the forward side of

the spider was fractured. One bearing cup was fractured and deformed with most of the cup missing. One retaining cup was fractured with a portion missing, and a second retaining cup was nearly straightened, consistent with deformation at high temperature.

Witness marks were observed on the forward fork of the aft joint. The marks corresponded to contact and wear with a lug from the aft fork at the bearing 1 location and contact with spider journal number 3. An additional mark was observed on the interior of the fork in one zerk fitting access hole, corresponding to contact with the missing zerk fitting portion (refer to figure 4).

The aft fork of the aft joint exhibited wear damage near the horizontal axis of the fork. The location of the wear corresponds to off-axis contact with the grease valve retaining screw head (refer to figure 5). The damage was consistent with the spider shifting toward the bearing 1 location and either rotating counterclockwise or shifting toward the bearing 4 location, all relative to the aft fork. The location and orientation of this mark, combined with the location of the wear mark at the bearing 1 location on the forward fork indicates that the aft fork lug corresponds to the bearing 1 location.

Although heat damage was observed throughout the aft joint, the bearing 1 location of the output shaft showed the greatest level of heating. A darker level of heat tinting and missing coating in the vicinity of the bearing 1 location was evidence of greater heat damage in that area.

Pilot Information

Certificate:	Airline Transport; Flight Instructor	**Age:**	38, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):		**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	**Last Medical Exam:**	02/28/2003
Occupational Pilot:		**Last Flight Review or Equivalent:**	03/18/2003
Flight Time:	4134 hours (Total, all aircraft), 880 hours (Total, this make and model), 1970 hours (Pilot In Command, all aircraft)		

Co-Pilot Information

Certificate:	Airline Transport; Flight Instructor	**Age:**	32, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Rear
Other Aircraft Rating(s):		**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last Medical Exam:**	02/19/2003
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Fokker	**Registration:**	N730FE
Model/Series:	F27MK 600	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	10386
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	04/16/2003, Continuous Airworthiness	**Certified Max Gross Wt.:**	45000 lbs
Time Since Last Inspection:	7.9 Hours	**Engines:**	2 Turbo Prop
Airframe Total Time:	50151.9 Hours	**Engine Manufacturer:**	Rolls-Royce
ELT:	Installed, not activated	**Engine Model/Series:**	Dart 532-7R
Registered Owner:	Federal Express Corporation	**Rated Power:**	1835 hp
Operator:	EMPIRE AIRLINES INC	**Air Carrier Operating Certificate:**	Air Cargo; Supplemental
Operator Does Business As:		**Operator Designator Code:**	EMPA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	CLM, 291 ft msl	**Observation Time:**	1553 PST
Distance from Accident Site:	21 Nautical Miles	**Direction from Accident Site:**	260°
Lowest Cloud Condition:	Clear	**Temperature/Dew Point:**	6°C / 3°C
Lowest Ceiling:	None	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	11 knots, 240°	**Visibility (RVR):**	
Altimeter Setting:	30.21 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:			
Departure Point:	Ketchikan, AK (KTN)	**Type of Flight Plan Filed:**	IFR
Destination:	Seattle, WA (SEA)	**Type of Clearance:**	IFR
Departure Time:	1230 ADT	**Type of Airspace:**	Class E

Wreckage and Impact Information

Crew Injuries:	2 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	48.153889, -122.930278

Administrative Information

Investigator In Charge (IIC):	Thomas M Little	**Adopted Date:**	09/29/2004
Additional Participating Persons:	Tom W Normoyle; Seattle, Washington; Seattle, WA		
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.ntsb.gov/pubdms/.		