Aviation Investigation Final Report

Location:	Napoleon, Ohio	**Accident Number:**	IAD01LA031
Date & Time:	February 3, 2001, 11:30 Local	**Registration:**	N98PM
Aircraft:	Enstrom F28A	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	3 None
Flight Conducted Under:	Part 91: General aviation - Other work use		

Analysis

The helicopter developed a vibration, and the pilot elected to return to the departure airport. On final approach to landing, approximately 10 feet above the ground, the main rotor mast fractured, and the main rotor system departed the helicopter. The pilot and two passengers were not injured. Examination of the fracture surfaces by a Safety Board metallurgist revealed the mast failed in fatigue in the area of the fillet radius. Microscopic examination revealed that a portion of the fatigue region had been painted over with paint that matched the exterior of the mast. The mast installed in the accident helicopter had a narrower fillet radius than masts subsequently produced by the manufacturer. An FAA Airworthiness Directive (AD) that required inspecting and strengthening of the fillet radius affected the narrower masts. As a result of this investigation, the FAA amended the AD to immediately retire some transmission/mast combinations, and to ultimately remove all of the narrower masts from service.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The fatigue failure in the fillet radius of the mast, which resulted in the separation of the main rotor system.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: APPROACH - VFR PATTERN - FINAL APPROACH

Findings
1. (C) ROTOR SYSTEM,MAIN ROTOR - FATIGUE
2. (C) ROTOR SYSTEM,MAIN ROTOR - SEPARATION

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Factual Information

On February 3, 2001, at 1130 eastern standard time, an Enstrom F28A helicopter, N98PM, was substantially damaged after the main rotor separated and it collided with terrain while on final approach to the Henry County Airport, Napoleon, Ohio. The certificated commercial pilot/owner and two passengers were not injured. Visual meteorological conditions prevailed for the local sightseeing flight that originated at Henry County, about 1120. No flight plan was filed for the flight conducted under 14 CFR Part 91.

In a telephone interview, the pilot said the purpose of the flight was to provide a sightseeing/orientation flight to the two passengers during an airport open house. He said:

"We took off, and the helicopter developed an in-flight vibration. I came back to the airport and the main rotor departed the aircraft about 10 feet off the ground. The mast fractured right below the hub."

The pilot also held a mechanic's certificate with ratings for airframe and powerplant. He said that he had just completed a 100-hour inspection of the helicopter the day before the accident flight. The pilot stated that during the inspection the flight controls were disconnected so that measurements and adjustments could be made. He said the helicopter was re-assembled, and a test flight was performed that was approximately 18 minutes in duration. The pilot said the helicopter "flew fine" and he released the helicopter for service.

The pilot said the accident occurred during the second flight after the test flight. He said:

"There was one other flight after the test flight. It failed on the next basic flight. You see it's not unusual for the helicopter to have a slight vibration when it's cold, but it'll smooth out after it warms up. On the first flight, there was a vibration but it smoothed out after a couple of minutes. On the second flight the vibration was back, but then it got worse, and I returned to the airport. I didn't fly a quarter- mile away. I just made a circle and came back."

The pilot said he flew his approach to an area that was clear of obstacles and spectators, and that the rotor system caused no property damage or personal injury after it departed the helicopter.

The pilot/owner reported 9,000 hours of flight experience, 2,000 hours of which were in helicopters. He reported approximately 1,200 hours in the Enstrom F28.

The helicopter was a 1974 Enstrom F28A, and the pilot registered it on November 26, 1996. A preliminary review of the maintenance records revealed that the main transmission's most recent overhaul was at the Enstrom factory in 1993, at 1,036 aircraft hours. Total time on the

helicopter at the time of the accident was 1,732 aircraft hours.

Portions of the main rotor mast above and below the fracture were examined at the Safety Board's Materials Laboratory in Washington, DC, on April 13, 2001. The mast was fractured in the fillet radius, just below the upper shoulder.

According to the metallurgist's factual report, examination of the fracture surfaces revealed a portion relatively smooth and flat with a surface parallel to the circumferential plane, features typical of fatigue. The smooth fatigue features were present through about one-third of the circumference of the mast. Outside of the smooth fatigue region, a relatively rough area was observed with features typical of low cycle, high stress fatigue propagation.

The remainder of the fracture surface displayed features consistent with overstress separation and post-separation damage. Microscopic examination of the fatigue region revealed a portion 1.17 inches in length, with a red appearance that matched a red paint layer on the exterior surface of the mast.

The metallurgist's report also stated:

"The main rotor mast was Enstrom part number 28-13104-1, originally designed for the F-28/F-28A and 280 aircraft. The original design had a 0.13-inch radius fillet below the upper shoulder (in the area of the fatigue initiation). In Revision K of the engineering drawings, the fillet radius was increased to 0.5-inch radius for aircraft with a higher gross weight. The mast with revision K was applicable for the F-28A and 280 aircraft, but replacement was not required. The mast in the accident aircraft was not replaced with a Revision K mast."

As a result of this investigation, the Federal Aviation Administration (FAA) issued Airworthiness Directive 2001-22-01, that amended and superseded AD 76-17-08. According to the AD Summary:

"This amendment supersedes an existing airworthiness directive (AD) for Enstrom Helicopter Corporation (EHC) Model F-28, F-28A, and 280 helicopters. That AD currently requires inspecting the main rotor shaft (shaft) for a crack or other evidence of damage until appropriately modifying or replacing the shaft with and airworthy shaft at specified time intervals. This amendment adds EHC Model F-28C, F-28F, 280C, 280F, and 280FX helicopters and establishes life limits after which all unmodified shafts must be retired. This amendment requires determining the radius of the shaft fillet, certain visual and dye-penetrant inspection before further flight, and replacing certain main rotor transmissions. This amendment is prompted by the failure of a shaft on an EHC Model F-28A helicopter due to a fatigue crack. The actions specified by this AD are intended to prevent shaft failure and subsequent loss of control of the helicopter."

The weather at the time of the accident was a broken cloud layer at 4,800 feet with winds from 180 degrees at 11 knots.

Pilot Information

Certificate:	Commercial	**Age:**	39,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane single-engine; Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 Valid Medical--w/ waivers/lim	**Last FAA Medical Exam:**	February 28, 2000
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	9000 hours (Total, all aircraft), 1200 hours (Total, this make and model), 150 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Enstrom	**Registration:**	N98PM
Model/Series:	F28A	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	200
Landing Gear Type:	Skid	**Seats:**	3
Date/Type of Last Inspection:	February 2, 2001 Annual	**Certified Max Gross Wt.:**	2150 lbs
Time Since Last Inspection:	1 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	1732 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Not installed	**Engine Model/Series:**	HIO-360-C1A
Registered Owner:	William E. Bolin	**Rated Power:**	205 Horsepower
Operator:		**Operating Certificate(s) Held:**	None
Operator Does Business As:	Classic Aviation	**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	TOL,684 ft msl	**Distance from Accident Site:**	17 Nautical Miles
Observation Time:	11:52 Local	**Direction from Accident Site:**	30°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Broken / 4800 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	11 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	180°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.27 inches Hg	**Temperature/Dew Point:**	-7°C / -12°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Napolean, OH (7W5)	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	11:20 Local	**Type of Airspace:**	Class G

Airport Information

Airport:	Henry County 7W5	**Runway Surface Type:**	Grass/turf
Airport Elevation:	683 ft msl	**Runway Surface Condition:**	Snow;Vegetation
Runway Used:	10	**IFR Approach:**	None
Runway Length/Width:	4487 ft / 65 ft	**VFR Approach/Landing:**	Forced landing;Full stop

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	2 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 None	**Latitude, Longitude:**	41.374168,-84.067779

Administrative Information

Investigator In Charge (IIC):	Rayner, Brian
Additional Participating Persons:	Jim Davidson; FAA; Cleveland , OH Jim Bournonville; Enstrom Helicopter; Menominee, MI
Original Publish Date:	May 13, 2003
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=51423