Log 2025

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: December 21, 1987

In reply refer to: A-87-125 and -126

Honorable T. Allan McArtor
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On December 5, 1987,1/ about 0955 eastern standard time, the right engine separated from the airframe of a Boeing 737-200, N319AU, being operated as scheduled USAir flight 224, while the airplane was ascending through 4,000 feet after departing Philadelphia, Pennsylvania. The engine landed in an open field with no property damage or injuries to persons on the ground. The airplane was returned to Philadelphia and a normal landing was made with crash equipment and personnel standing by. After the airplane was taxied from the runway, the remaining engine was shut down and the airplane was towed to the gate. The pilot reported that the aircraft experienced a failure of the "A" hydraulic system after the engine separation.

The first officer had made the takeoff and was flying the airplane when he noticed a right yaw and heard a loud bang. He said that he noticed the right throttle was closed and that he felt continuous airplane buffet. The captain took control of the airplane. He said that the buffet was like an in-flight deployment of a thrust reverser. He said that he tried to move the right throttle, but it would not move. He then shut down the right engine. A flight attendant reported to the flightcrew that the right engine was sagging. Passengers in the cabin said the rear of the right engine was hanging down about 30 degrees briefly before it fell from the aircraft.

The Safety Board's investigation of this incident is continuing. Safety Board investigators have determined that all three of the right engine's mounting cone bolts (two forward and one aft) separated in the thread relief undercut radii between the threaded and cone bearing surfaces. Preliminary metallurgical examination of the forward cone bolts disclosed complete overstress fractures. However, examination of the aft cone bolt revealed fracture characteristics indicative of fatigue cracking.

The aft cone bolt, identified by Boeing as P/N 10-60517-44, was manufactured by Barry Wright Control Corporation (Barry) and contained Barry's P/N R18424-2J and S/N 15B 2001 identification.

1/ NTSB Field Accident Report NYC 88-F-A050

4769/3B2

Examination of the aft cone bolt revealed evidence of preexisting fatigue cracks initiating on diametrically opposite sides of the thread relief radius between the threaded and cone surface sections of the bolt. Primary fatigue crack growth extended from multiple origins on the outboard side of this radius with propagation inboard through approximately 70 percent of the fractured cross sectional area. What appeared to be a secondary fatigue crack also emanated from the inboard radius surface with fatigue propagation only a short distance outboard encompassing about 5 percent of the fractured cross sectional area. The remaining fracture area between fatigue zones was typical of an overstress condition stemming from the fatigue regions. The aft engine mount secondary support cable fractured through the cable strands about midway within the lower swaged-on end fitting. Microscopic examination of these wire breaks disclosed tensile shear and cup cone fractures representative of a single tensile overstress condition.

A Barry representative said that the aft cone bolt was shipped new to Allegheny Airlines (now USAir) in late 1978 and that Barry had never reconditioned or refurbished the bolt. Maintenance records for N319AU show that the bolt was installed in November 1985, and since then the airplane had experienced 3,042 hours of service and 2,430 engine cycles.

On January 3, 1986,[2/] a Southwest Airlines Boeing 737-200 on departure from Dallas, Texas, experienced a similar aft cone bolt failure from fatigue and related overstress separation of the support cable. In that incident, the engine remained with the wing, supported by the two forward cone bolts, and the airplane was returned to the airport without further incident. The aft cone bolt, Barry P/N R18424-2R, was a Barry reconditioned bolt with 3,139 service hours and 3,702 engine cycles since installation.

All Boeing 737-100 and -200 airplanes containing engine aft mount support cables have a red painted stripe on the top of the wing nacelle fairing about 3 feet forward of the thrust reverser. The red stripe when visible indicates that the aft cone bolt has separated and the rear of the engine has dropped. If this occurs, the rear of the engine is supported only by the aft mount secondary support cable. Safety Board investigators have determined that neither the flightcrew of N319AU nor USAir's flight managers of B-737 training and B-737 operations were aware of the location and significance of the red stripe.

The Safety Board believes that while airplane maintenance workers are aware of the significance of the red stripe, the flightcrews of Boeing 737-100 and -200 airplanes may not be aware of the red stripe. In addition to USAir, the Safety Board has discovered that other airlines also do not instruct their flightcrews on either the location or significance of the red stripe, and it is not a check item for flightcrews during preflight or postflight inspections.

2/ For more detailed information, read Field Accident Brief No. 5046 (attached).

On USAir the flightcrew is required to perform a walk-around inspection only on the first flight of the day or after a crew change. In addition, they operate out of airports where they do not have maintenance personnel available to perform a walk-around inspection. Under these conditions, with no maintenance or pilot walk-arounds inspections, it is possible for mechanical irregularities such as a separated aft cone bolt to go undetected, allowing the airplane to return to passenger service in an unairworthy condition.

Airlines normally develop their operational checklists from the manufacturers' recommended checklists. There is no mention of the red stripe check in the pilot portion of Boeing's 737-200 airplane flight manual. According to Boeing, this information is not considered part of a pilot's walk-around preflight inspection, but instead is a maintenance check item.

The Safety Board believes that a simple check by the flightcrew would verify that the aft cone bolt is intact before flight. Also, the Safety Board is concerned that a fatigue failure of the aft cone bolt and subsequent overstress of the support cable could once again lead to a complete engine separation with far more serious consequences than that experienced by N319AU.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an airworthiness directive requiring operators of Boeing 737-100 and -200 airplanes with engine aft mount support cables to check for engine security by performing a "red stripe inspection" before each flight to verify that the aft cone attachment bolt is intact on each engine. (Class I, Urgent Action) (A-87-125)

Issue an airworthiness directive requiring operators of Boeing 737-100 and -200 airplanes to periodically inspect the thread relief undercut radius of the aft cone attachment bolt of each engine for evidence of cracking; such inspections should be at service time intervals that will ensure that a fatigue crack in the bolt will not propagate to a critical crack length before detection. (Class II, Priority Action) (A-87-126)

BURNETT, Chairman, GOLDMAN, Vice Chairman, and NALL and KOLSTAD, Members, concurred in these recommendations. LAUBER, Member, did not participate.

By: Jim Burnett
Chairman

National Transportation Safety Board
Washington, D.C. 20594

Brief of Incident

File No. - 5046 1/03/86 DALLAS,TX A/C Reg. No. N866W Time (Lcl) - 0722 CST

----Basic Information----

Type Operating Certificate-AIR CARRIER - FLAG/DOMESTIC
Name of Carrier -SOUTHWEST AIRLINES CO.
Type of Operation -SCHEDULED,DOMESTIC,PAX/CARGO
Flight Conducted Under -14 CFR 121
Incident Occurred During -TAKEOFF

Aircraft Damage
MINOR
Fire
NONE

Injuries	Fatal	Serious	Minor	None
Crew	0	0	0	5
Pass	0	0	0	39

----Aircraft Information----

Make/Model - BOEING 737-2H4
Landing Gear - TRICYCLE-RETRACTABLE
Max Gross Wt - 115528
No. of Seats - 128

Eng Make/Model - P&W JT-8D-9A
Number Engines - 2
Engine Type - TURBOFAN
Rated Power - 14500 LBS THRUST

ELT Installed/Activated - NO -N/A
Stall Warning System - YES

----Environment/Operations Information----

Weather Data
Wx Briefing - COMPANY
Method - IN PERSON
Completeness - WEATHER NOT PERTINENT
Basic Weather - VMC
Wind Dir/Speed- CALM
Visibility - 10.0 SM
Lowest Sky/Clouds - 15000 FT SCATTERED
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
SAME AS ACC/INC
Destination
AUSTIN,TX

ATC/Airspace
Type of Flight Plan - IFR
Type of Clearance - IFR
Type Arch/Lnds - STRAIGHT-IN
PRECAUTIONARY LANDING

Airport Proximity
ON AIRPORT

Airport Data
LOVE FIELD
Runway Ident - 31R
Runway Lth/Wid - 7753/ 150
Runway Surface - ASPHALT
Runway Status - DRY

----Personnel Information----

Pilot-In-Command
Certificate(s)/Rating(s)
ATP
SE LAND,ME LAND
HELICOPTER

Age - 45
Biennial Flight Review
Current - YES
Months Since - 9
Aircraft Type - 737-200

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT

Flight Time (Hours)

Total	13050	Last 24 Hrs	1
Make/Model	8550	Last 30 Days	UNK/NR
Instrument	UNK/NR	Last 90 Days	UNK/NR
Multi-Eng	UNK/NR	Rotorcraft	UNK/NR

Instrument Rating(s) - AIRPLANE

----Narrative----

THIS INCIDENT OCCURRED WHEN THE NO. 2 ENGINE EXPERIENCED AN AFT ENGINE MOUNT CONE BOLT FAILURE AND THE SUBSEQUENT FAILURE OF THE SECONDARY SUPPORT LINK (STAINLESS STEEL CABLE). THE FAILURE OF BOTH AFT ENGINE SUPPORT ASSEMBLIES DURING THE TAKEOFF ROLL ALLOWED THE AFT SECTION OF THE ENG TO HANG DOWN TO WITHIN 4° OF THE GROUND. AS A RESULT, THE NO.2 THRUST REVERSER ACTUATOR ASSEMBLY DRUG THE RUNWAY ON ROTATION. IN ADDITION, ONE LEADING EDGE FLAP AND THE FORWARD ENGINE FAIRING WERE SLIGHTLY DAMAGED. THE ACFT SUBSEQUENTLY RETURNED TO THE ARPT AND LANDED WITHOUT FURTHER INCIDENT. METALLURGICAL EXAMINATION OF THE CONE BOLT REVEALED THAT IT FAILED AS A RESULT OF FATIGUE, MOST PROBABLY DUE TO IMPROPER INSTALLATION OF THE BOLT, SPECIFICALLY, THAT IT WAS UNDER TORQUED WHEN THE OPERATOR RE-INSTALLED THE ENG. THE SAFETY CABLE FAILED AS A RESULT OF OVERSTRESS, PROBABLY INDUCED WHEN THE ACFT ENCOUNTERED A ROUGH STRETCH OF RUNWAY DURING THE TAKEOFF ROLL.

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Occurrence AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation TAKEOFF - GROUND RUN

Finding(s)
1. ENGINE INSTALLATION,SUSPENSION MOUNTS - FAILURE,PARTIAL
2. ENGINE INSTALLATION,SUSPENSION MOUNTS - FATIGUE
3. ENGINE INSTALLATION,SUSPENSION MOUNTS - SEPARATION
4. ENGINE INSTALLATION,SUSPENSION MOUNTS - OVERLOAD
5. ENGINE INSTALLATION,SUSPENSION MOUNTS - UNDERTORQUED
6. MAINTENANCE,INSTALLATION - IMPROPER - COMPANY MAINTENANCE PSNL
7. AIRPORT FACILITIES,RUNWAY/LANDING AREA CONDITION - ROUGH/UNEVEN

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this incident is/are finding(s) 1,2,3,4,5,6

Factor(s) relating to this incident is/are finding(s) 7