Aviation Investigation Final Report

Location:	Miami, Florida	**Accident Number:**	DCA11FA004
Date & Time:	October 26, 2010, 21:30 Local	**Registration:**	N626AA
Aircraft:	Boeing 757-223	**Aircraft Damage:**	Substantial
Defining Event:	Aircraft structural failure	**Injuries:**	160 None
Flight Conducted Under:	Part 121: Air carrier - Scheduled		

Analysis

Flight data recorder data revealed that, after takeoff from Miami International Airport (MIA), Miami, Florida, the airplane climbed for about 16 minutes and was passing through an altitude of approximately 32,000 feet when the rapid decompression occurred. The flight crew declared an emergency (the first officer was the pilot flying) and returned to MIA. Post accident examination of the airplane revealed fatigue cracking of the upper fuselage skin above the forward left passenger (L1) door. The fatigue cracking penetrated the fuselage skin, leading to a rupture and an approximate 18-inch-by-7-inch hole that depressurized the airplane.

NTSB examinations of a section of the fuselage crown skin (from body station 374 to body station 439) where the rupture occurred revealed fatigue cracking along the lower longitudinal step of the chemically milled pocket just above the stringer S-4L (left) lap joint. The fatigue cracking initiated on the interior surface of the skin at multiple locations and propagated through the skin thickness. The skin thickness at the base of the chemically milled step measured 0.035 to 0.037 inch—which is less than the 0.039-inch minimum thickness specified by Boeing. Calculations from an NTSB study of the fatigue striation density and propagation in the fatigue region indicate that it would take an average of 3,709 total cycles for a crack to grow through skin with 0.035-inch thickness and an average interval of 917 cycles for a crack to grow from a minimally detectable size and penetrate a 0.035-inch skin thickness.

The area of cracking and rupture on the accident airplane was not subject to any specific inspections, service bulletins (SB), or airworthiness directives (AD) at the time of the accident. Following the accident, on November 22, 2010, Boeing issued SB 757-53-0097, which called for repetitive external inspections (every 30, 200 cycles, or 300 hours depending on the inspection

method) to detect cracks in the fuselage skin along the chemically milled step at stringers S-4L (left) and S 4R (right) between body station 297 and body station 439. On January 10, 2011, the Federal Aviation Administration issued AD 2011-01-15 (effective January 25, 2011) mandating the inspections recommended in SB 757-53-0097.

During its investigation, the NTSB learned of a United Airlines 757 and a second American Airlines 757 that exhibited cracking in the fuselage skin similar to the accident airplane; both had nonconforming thickness at the base of the chemically milled step at the stringer location specified in the SB. Records of manufacture for the skin panels on the accident airplane and the other airplanes with fuselage skin cracking were not retained, and were not required to be retained; therefore, a cause for the manufacturing nonconformance could not be identified.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Fatigue failure of the fuselage crown skin due to incorrect manufacturing of the crown skin panel that resulted in a skin thickness less than the manufacturer-specified thickness.

Findings

Aircraft	Plates/skins (aux fuselage) - Fatigue/wear/corrosion
Organizational issues	Equipment manufacture - Manufacturer

Factual Information

History of Flight

Enroute	Aircraft structural failure (Defining event)

HISTORY OF FLIGHT
On October 26, 2010, about 2130 eastern daylight time, a rapid decompression occurred on board American Airlines flight 1640, a Boeing 757-223, N626AA, while it climbed through 32,000 feet after departure from Miami International Airport (MIA), Miami, Florida. The flight crew executed an emergency descent and returned to MIA, where they landed the airplane without further incident. No injuries to the 6 crewmembers and 154 passengers were reported. A ground inspection of the airplane revealed a section of the fuselage crown skin, measuring approximately 18 inches by 7 inches, had ruptured just above and aft of the forward left passenger (L1) door. The airplane had accumulated about 63,010 hours and 22,450 cycles. The flight was operating under the provisions of 14 Code of Federal Regulations (CFR) Part 121 on an instrument flight rules flight plan to Boston Logan International Airport, Boston, Massachusetts.

Flight data recorder and cockpit voice recorder (CVR) data revealed that, after takeoff, the airplane climbed for about 16 minutes and was passing through an altitude of 32,000 feet when a sound similar to a low frequency bang was recorded followed by the sound of the flight crew using the oxygen masks. The captain declared an emergency with Miami Center, and the flight was cleared to descend to 10,000 feet. The first officer, who was the pilot flying, executed the descent. After leveling off at 10,000 feet, the flight crewmembers removed their oxygen masks. CVR data indicated that the flight and cabin crewmembers followed prescribed operational procedures following the rapid decompression, emergency descent, and landing at MIA.

INJURIES TO PERSONS
No injuries were reported following the event.

DAMAGE TO AIRCRAFT
A hole measuring 18 inches in the longitudinal direction by 7 inches in the circumferential direction was located in the upper fuselage crown skin just above and aft of the L1 door. The forward 13-inch-by-7-inch section of the ruptured skin remained attached to the airplane by the upper edge and flapped upward. The aft 5-inch-by-7-inch section of the ruptured skin separated from the aircraft during the rapid decompression and was not recovered.

PERSONNEL INFORMATION
The captain had a total of 20,566 flight hours, with 13,226 hours as pilot-in-command (PIC); 2,501 hours as PIC were in the 757. He held an airline transport pilot (ATP) certificate and a

class 1 medical certificate without limitations or waivers.
The first officer had a total of 6,621 flight hours, with 3,686 hours in the 757. He held an ATP certificate and a class 2 medical certificate without limitations or waivers.

AIRCRAFT INFORMATION

The airplane, serial number 24584, was delivered new to American Airlines August 14, 1990. At the time of the accident, the airplane had accumulated approximately 63,010 hours and 22,450 cycles. The accident skin panel was likely manufactured during early 1990 based on the airplane delivery date and estimated manufacturing flow. However, no panel specific manufacturing records were available for the accident skin panel, and there was no requirement to keep them.

This one crown skin panel on 757 airplanes is subjected to a single-step chemical milling process to form waffle-like pockets. The other skin panels on the 757 are all a multi-step skin where the tendency for channeling (thin-out) to occur in the pocket edge is smoothed out by the subsequent chem milling and will not result in the same type of thin-out in the minimum gage pocket edge areas. The 767 is another Boeing airplane model with skin panels processed at the same facility as the event airplane that uses a single-step chemical milling process in a skin panel immediately above a lap splice, but the milled step is shallower, in which less material is removed and in the very forward-most low stress nose area of the airplane. According to standard procedure, at the time of manufacture, the skin panels would have been stretch-formed for contour before being masked, hand-scribed, peeled, and placed on a rack. The rack would then be dipped vertically in a chemical bath several times and measurements of select pocket thicknesses taken each time it was removed and rinsed. Once the specified amount of material was removed, the panel would have been final rinsed and inspected. During the final inspection, all pocket thicknesses would be checked. The typical chem-mill rate achieved is about 0.001inch per minute.

TESTS AND RESEARCH

A 60-inch-by-18 inch section (from body station 374 to body station 439) of the fuselage crown skin where the rupture occurred was removed and sent to the NTSB Materials Laboratory. Materials laboratory examinations revealed fatigue cracking along the lower longitudinal step of the chemically milled pocket just above the stringer S-4L (left) lap joint. The fatigue cracking initiated on the interior surface of the skin at multiple locations and propagated through the skin thickness. The skin thickness at the base of the chemically milled step measured 0.034 to 0.035 inch—less than the 0.037-inch minimum thickness specified by Boeing.

The NTSB Materials Laboratory performed a study of the striation density and propagation in the fatigue region. The calculations from the study indicate that it would take an average of 3,709 total cycles for a crack to grow through skin with 0.035-inch thickness and an average interval of 917 cycles for a crack to grow from a minimally detectable size and penetrate a 0.035-inch skin thickness.

ADDITIONAL INFORMATION

The area of rupture was not subject to any specific inspections, service bulletins (SB), or airworthiness directives (AD) at the time of the accident. Following the flight 1640 event, on November 22, 2010, Boeing issued SB 757-53-0097, which called for repetitive external inspections (at 30, 200, or 300 flights depending on the inspection method) to detect cracks in the crown fuselage skin along the chemically milled step at stringers S-4L (left) and S-4R (right) and between body stations 297 and body station 439. On January 10, 2011, the Federal Aviation Administration issued AD 2011-01-15 (effective January 25, 2011), mandating the inspection requirements in SB 757-53-0097. On March 28, 2011, Boeing provided an Alternate Method of Compliance (AMOC) Notice in SB 757-53-0097-01-AMOC-02 that allows the extension of intervals for the sliding probe eddy current (SPEC) inspections in the Boeing SB to 620 flight cycles (from 300 cycles). This AMOC was approved by the FAA in a letter reference 120S-11-162 dated March 25, 2011. Striation data from the reported cracks was used to substantiate this change for the SPEC inspections.

After the flight 1640 event, NTSB investigative staff was informed of two additional airplanes (a United Airlines 757 and an American Airlines 757) with cracking in the fuselage crown skin similar to the event airplane; both had nonconforming thickness at the base of the chemically milled step at the stringer location specified in the SB. About 6 weeks before the flight 1640 event, a 10.75-inch long thru crack was found in the upper crown skin of the United Airlines 757 after reports of a whistling noise. About 6 weeks after the flight 1640 event, American Airlines found three parts thru crack indications in the crown skin of another airplane during an inspection to comply with the Boeing SB.

Effective April 16, 2011, records associated with the manufacture of articles or products under the authorization of the Production Approval Holder must be retained for a minimum of 5 years per 14 CFR 21.137(k). Also effective April 16, records associated with the manufacture of “critical components,” as defined by 14 CFR 45.15(c), must be retained for a minimum of 10 years. Due to the length of time between the manufacture of the crown skin panel on the accident airplane and the accident, the new regulatory requirement, if implemented earlier, would not have affected the availability of the airplane’s manufacturing records for investigation.

Information

Certificate:	**Age:**
Airplane Rating(s):	**Seat Occupied:**
Other Aircraft Rating(s):	**Restraint Used:**
Instrument Rating(s):	**Second Pilot Present:**
Instructor Rating(s):	**Toxicology Performed:**
Medical Certification:	**Last FAA Medical Exam:**
Occupational Pilot:	**Last Flight Review or Equivalent:**
Flight Time:	

Aircraft and Owner/Operator Information

Aircraft Make:	Boeing	**Registration:**	N626AA
Model/Series:	757-223	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	24584
Landing Gear Type:	Tricycle	**Seats:**	178
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:	63010 Hrs	**Engine Manufacturer:**	ROLLS-ROYC
ELT:	Installed, not activated	**Engine Model/Series:**	RB.211 SERIES
Registered Owner:	WILMINGTON TRUST COMPANY TRUSTEE	**Rated Power:**	22000 Lbs thrust
Operator:	AMERICAN AIRLINES INC	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:		**Operator Designator Code:**	AALA

Meteorological Information and Flight Plan

Conditions at Accident Site:		**Condition of Light:**	
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:		**Visibility**	
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	
Precipitation and Obscuration:			
Departure Point:		**Type of Flight Plan Filed:**	
Destination:		**Type of Clearance:**	
Departure Time:		**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	6 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	154 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	160 None	**Latitude, Longitude:**	25.779413,-80.19902(est)

Administrative Information

Investigator In Charge (IIC):	Ward, Effie Lorenda
Additional Participating Persons:	Robert Hendrickson; FAA
Original Publish Date:	September 19, 2011
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=77677