National Transportation Safety Board
Aviation Accident Final Report

Location:	SEATTLE, WA	**Accident Number:**	SEA97FA202
Date & Time:	09/01/1997, 2110 PDT	**Registration:**	N951AS
Aircraft:	McDonnell Douglas DC-9-82 (MD-82)	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	19 Minor, 97 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

During the landing roll-out, the nose landing gear collapsed. Examination of the nose landing gear revealed the nose gear upper lock link, PN 3914464-503, had failed, and had separated into two pieces. The link, which was subject to recurring non-destructive testing every 5000 cycles (per AD 97-02-10), had an eddy current inspection by the operator, 1075 cycles before the accident. The link was one of a series manufactured from plate stock, rather than being forged. Due to this changed process, the lack of draft angle allowances on the machined parts reduced the load-carrying cross sectional area of the machined links to less than that of the forged links, resulting in a decrease in the overall strength. Metallurgical analysis revealed that about 10,000 major fatigue progression cycles had occurred within about .6 inches of the crack progression. Based on two major stress cycles per gear retraction/extension cycle, the crack length at 1075 cycles before the accident would have been greater than .25 inches. The inspection procedure and process provided by the airframe manufacturer did not specify removal of the upper lock link from the aircraft before recurring non-destructive tests (NDT). During the investigation, NTSB investigators and FAA inspectors observed that access to the upper lock link for NDT was limited when the part remained installed on the airplane.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: fatigue failure of the nose landing gear upper lock link, due in part to reduced strength after the manufacturing process was changed from forged to machined plate stock; and inadequate non-destructive inspection process for testing the link.

Findings

Occurrence #1: NOSE GEAR COLLAPSED
Phase of Operation: LANDING - ROLL

Findings
1. (C) LANDING GEAR,GEAR LOCKING MECHANISM - FATIGUE
2. (C) ACFT/EQUIP,INADEQUATE AIRCRAFT COMPONENT - MANUFACTURER
3. (C) MAINTENANCE,INSPECTION - INADEQUATE
4. (C) PROCEDURE INADEQUATE - MANUFACTURER

Factual Information

HISTORY OF FLIGHT

On September 1, 1997, at 2110 Pacific daylight time, N951AS, a McDonnell-Douglas DC-9-82 (MD-82), operating as Alaska Airlines flight 255 from Los Angeles, California, to Seattle, Washington, sustained substantial damage when its nose landing gear collapsed during landing roll-out on runway 16L at Seattle-Tacoma International Airport. The two flight crewmembers and three flight attendants were uninjured. Seventeen of the 111 passengers incurred minor injuries during the emergency evacuation commanded by the captain after the airplane slid to a stop. There was no fire.

According to the flight crewmembers, the airplane had departed Los Angeles, California with no indication of vibration or other abnormality. The flight was uneventful until the landing gear was extended and the nose landing gear warning light indicated an unsafe landing gear indication. At that time, the crew initiated a go-around (retracting the landing gear), climbed to a safe altitude in safe airspace, and then completed appropriate checklists in an attempt to obtain a safe gear-down indication with the landing gear extended. After completing appropriate checklists, the mechanical nose landing gear position indicator indicated that the nose landing gear was extended in a down and locked position, while the light continued to indicate an unsafe condition. The crew elected to land, and requested emergency equipment standing by.

The captain stated that he landed the airplane smoothly; at about 60 knots indicated airspeed, the nose settled onto the runway and the airplane slid to a stop. The airplane slid about 1300 feet and drifted slightly to the right of centerline. He commanded an evacuation. All slides were deployed manually and the passengers evacuated quickly.

During the course of recovering the airplane from the runway, it was determined that the nose landing gear upper lock link, part number 3914464-503, had failed, separating into two pieces. This item, which is subject to recurring non-destructive testing every 5000 cycles according to AD 97-02-10, had undergone an eddy current inspection 1075 cycles previous to the accident. This part was one of a series manufactured from plate stock, rather than being forged. Due to this changed process, according to the aircraft manufacturer, the lack of draft angle allowances on the machined parts reduced the load-carrying cross sectional area of the machined links to less than that of the forged links, resulting in a decrease in the overall strength. Metallurgical analysis revealed that approximately 10,000 major fatigue progression cycles had occurred within about .6 inches of the crack progression. Based upon the manufacturer's determination that there are two major stress cycles per gear retraction/extension cycle, the expected crack length 1075 cycles prior to the accident would have been greater than .25 inches.

The Safety Board determined that there have been seven cracked or fractured upper lock links reported; all have RM serial numbers indicating that they came from Ready Machine, a now-defunct supplier to the airplane manufacturer.

INJURIES TO PERSONS

Nineteen individuals sustained minor injuries during the evacuation, including three with neck or back pain or spasms, some knee injuries, and one with a sprained ankle.

FLIGHT RECORDERS

The flight data recorder readout for the approach, landing, and landing rollout is attached.

WRECKAGE AND IMPACT INFORMATION

The airplane was inspected on-scene. The cockpit switches and controls were found to be secured. Their positions were not recorded. The cockpit crew side windows were open and the cockpit door was locked. During interviews, the flight crew noted that after calling for evacuation, they had evacuated out the cockpit windows.

Damage included nose gear doors, skin scraping, and a wrinkled forward pressure bulkhead. During the course of on-scene investigation, it was noted that the jump seat at the mid-cabin flight attendant position was not retracted. The flight attendant at that duty station at the time of the accident noted that she did not notice that anomaly until after the evacuation was completed, and noted that it did not hamper the evacuation.

TESTS AND RESEARCH

The nose landing gear upper lock link, P/N 3914464-503, s/n RM 486, was analyzed by the material laboratory division of the NTSB. The metallurgist's factual report is attached.

The inspection procedure and process provided by the airframe manufacturer does not specify removal of the upper lock link from the aircraft prior to recurring non-destructive tests (NDT). During the course of investigation, NTSB investigators and FAA inspectors observed that access to the upper lock link for NDT is limited when the part remains installed in the airplane.

ADDITIONAL INFORMATION

The aircraft was moved from the scene to the Alaska Airlines maintenance facility at SEATAC airport on the night of the accident. The Safety Board did not take possession of the wreckage.

Pilot Information

Certificate:	Airline Transport	**Age:**	47, 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):	Instrument Airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	**Last Medical Exam:**	03/04/1997
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	27388 hours (Total, all aircraft), 1491 hours (Total, this make and model), 18068 hours (Pilot In Command, all aircraft), 222 hours (Last 90 days, all aircraft), 69 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	McDonnell Douglas	**Registration:**	N951AS
Model/Series:	DC-9-82 (MD-82) DC-9-82 (M	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	49111
Landing Gear Type:	Retractable - Tricycle	**Seats:**	138
Date/Type of Last Inspection:	08/30/1997, AAIP	**Certified Max Gross Wt.:**	149500 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Fan
Airframe Total Time:	45378 Hours	**Engine Manufacturer:**	P&W
ELT:		**Engine Model/Series:**	JT8D-217
Registered Owner:	INTEGRATED AIRCRAFT SERVICES	**Rated Power:**	20800 lbs
Operator:	ALASKA AIRLINES	**Air Carrier Operating Certificate:**	Flag carrier (121)
Operator Does Business As:		**Operator Designator Code:**	ASAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Night/Dark
Observation Facility, Elevation:	, 0 ft msl	**Observation Time:**	0000
Distance from Accident Site:	0 Nautical Miles	**Direction from Accident Site:**	0°
Lowest Cloud Condition:	Clear / 0 ft agl	**Temperature/Dew Point:**	19°C / 13°C
Lowest Ceiling:	Broken / 3800 ft agl	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	6 knots, 220°	**Visibility (RVR):**	0 ft
Altimeter Setting:	30 inches Hg	**Visibility (RVV):**	0 Miles
Precipitation and Obscuration:			
Departure Point:	LOS ANGELES, CA (KLAX)	**Type of Flight Plan Filed:**	IFR
Destination:	(KSEA)	**Type of Clearance:**	IFR
Departure Time:	1821 PDT	**Type of Airspace:**	Class B

Airport Information

Airport:	SEATTLE-TACOMA INTL (KSEA)	**Runway Surface Type:**	Asphalt
Airport Elevation:	420 ft	**Runway Surface Condition:**	Dry
Runway Used:	16L	**IFR Approach:**	None
Runway Length/Width:	11900 ft / 150 ft	**VFR Approach/Landing:**	Full Stop

Wreckage and Impact Information

Crew Injuries:	5 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	19 Minor, 92 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	19 Minor, 97 None	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	MICHAEL L STOCKHILL	**Adopted Date:**	04/15/1999
Additional Participating Persons:	WILLIAM WHITAKER; RENTON, WA TERRY CLARK; SEATTLE, WA JOHN BENTLEY; RENTON, WA RONDA RUDERMAN; 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/.		