



National Transportation Safety Board Aviation Incident Final Report

Location:	Chicago, IL	Incident Number:	CEN111A369
Date & Time:	06/03/2011, 0605 CDT	Registration:	N607AE
Aircraft:	EMBRAER EMB-145	Aircraft Damage:	None
Defining Event:	Sys/Comp malf/fail (non-power)	Injuries:	52 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

The pilots reported that they felt one brake pedal fully release and then reapply during the landing roll. Air traffic control tower personnel saw a puff of smoke and asked the flight crew if a tire had blown on landing. The pilots taxied the airplane to a hold pad for further examination; however, the emergency brake would not hold the airplane stationary. The pilots also received caution messages for the brakes, and hydraulic fluid was observed on the tires and ground. An examination revealed the brake pressure plate and rotor failed. Separated brake parts were also found on the landing runway. Further examination of the incident brake and four other brakes revealed that they all contained varying levels of oxidation development.

The brake manufacturer had previously provided the operator with a maintenance procedure which involved using a fingernail or a specified plastic tool to check brakes for oxidation. The operator developed and provided related training to its maintenance personnel based on the manufacturer's procedures. However, interviews with airline and contract maintenance personnel revealed that they were not familiar with the inspection and were not issued the plastic tool. Subsequently, the brake manufacturer and operator provided additional related training to the operator's maintenance personnel, and the operator stocked their maintenance system with the specified tool.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: The overheat and failure the brake during landing due to oxidation of the brake rotors, which went undetected by maintenance personnel. Contributing to the accident was maintenance personnel's lack of familiarity with detailed brake oxidation inspection procedures.

Findings

Aircraft	Brake - Damaged/degraded (Cause) Brake - Failure (Cause) Brake - Inadequate inspection (Cause)
Personnel issues	Knowledge of procedures - Maintenance personnel (Factor) Training with equipment - Maintenance personnel (Factor)
Organizational issues	Parts/tools tracking - Operator

Factual Information

On June 3, 2011, about 0605 central daylight time, an Embraer EMB-145, N607AE, sustained no damage when its No. three brake overheated and parts of the brake separated during landing on runway 22R (7,500 feet by 150 feet, grooved asphalt) at the Chicago O'Hare International Airport (ORD), Chicago, Illinois. The 2 pilots, 1 flight attendant, and 49 passengers were uninjured. The airplane was registered to and operated by American Eagle Airlines as flight 4176, which was a scheduled domestic passenger flight conducted under 14 Code of Federal Regulations Part 121. Visual meteorological conditions prevailed for the flight, which operated on an activated instrument flight rules flight plan. The flight originated from the Port Columbus International Airport, near Columbus, Ohio, about 0512, and was destined for ORD.

According to the operator, during landing roll out and while transferring aircraft controls, the flight crew reported the sensation of having one brake pedal fully released then reapplied. The airplane cleared runway 22R and the air traffic control tower controller issued clearance to cross runway 9R and a further left turn on taxiway H. On taxiway H, the tower controller asked if a tire was blown on landing. The tower controller stated that a puff of smoke was seen during rollout.

Braking action diminished as the taxi progressed. The airplane was taxied to and stopped on the 32R pad for inspection. When stopped on the pad, it was discovered that emergency brake would not hold the aircraft stationary. The flight crew started getting caution messages pertaining to brake degrade including hydraulic system two failure and system two hydraulic pump fail. The flight attendant advised the flight crew that passengers reported seeing smoke on the right side of the aircraft. The flight crew started the auxiliary power unit and shut down both engines. The captain opened the service door and saw hydraulic fluid on the tires and the ground.

Airport rescue and fire fighting personnel arrived, inspected the main landing gear, and decided to have aircraft towed to gate. The passengers were deplaned via stairs and were bused to terminal.

The operator's maintenance personnel inspected the brakes and found a pressure plate and rotor failure.

Airport operations supervisors inspected the runway and recovered separated brake parts from runway 22R just south of its taxiway Uniform intersection.

A Federal Aviation Administration (FAA) inspector examined the airplane and separated brake parts on-scene. Observation and images of the No. three brake, part number 2-1707, revealed that parts of it disintegrated and separated. The operator quarantined and shipped the incident brake, separated parts, and the No. two brake to the brake manufacturer for detailed examinations. The No two brake was installed on the incident airplane about the same time as the incident brake was installed on it,

The operator downloaded a data file from the flight data recorder (FDR) and sent it to the National Transportation Safety Board's Vehicle Recorder Division for decoding. The FDR data showed that during landing, the air-ground switch parameter first recorded a ground indication at 0603:58 at an indicated airspeed of 132 knots. The air-ground switch parameter then showed an additional air indication for 2 seconds before recording a ground indication

again. At this time, the recorded brake pressure values for the No. one and three brake systems were increasing and they reached peak values of 1,426 and 1,534 psi respectively in less than 10 seconds. A maximum longitudinal deceleration value of $-0.39 g$'s was reached at 0604:10. The No. three brake pressure value then decreased to a nominal value and remained there for the remainder of the recording.

The two brakes from the incident airplane were shipped to the Goodrich Aircraft Wheel and Brake Facility, near Troy, Ohio. Brakes from three additional occurrences were collected and also sent for examination: the brake from the No. three position on N724AE, the brake from the No. three position on N812AE, and the brake from the No. four position on N630AE. A representative from the brake manufacturer examined the brakes using a specified plastic probing tool and published procedures for a detailed visual inspection (DVI), which checks for oxidation. Two Goodrich brake inspection service bulletins (SB 1063 and SB 1064) were released in September 2008, followed by the release of a brake inspection service letter (SL 2087) in April 2009. Using the visual inspection procedures and tool, the examination revealed that all brakes contained varying levels of oxidation development.

According to an operator's safety representative, Goodrich provided training material to the operator's training department for brake oxidation course development. The operator developed Brake Oxidation Training courses IO462 and IO462_11 in 2009. These courses were loaded into all airplane mechanics required training folders on 24 June 2009. All mechanics were required to complete the web base training within 30 days. Completion of training is electronically monitored by the employee's supervisor to ensure training is/was completed. The representative reported that the visual brake inspection alone was never suggested and that these training courses derived from the Goodrich material stated that the use of a sharp plastic pick or a fingernail to check the carbon disk was the indicated method for oxidation detection.

A FAA inspector assigned to the operator's certificate management office was asked to conduct interviews with the mechanics and inspectors that were involved with the five aircraft brake failures to verify what procedures were being used during wheel removal and replacements. On June 21, 2011, the operator submitted a revision for a Main Landing Gear Wheel Assembly-Removal and Installation work card, which incorporated details of the DVI requirement into the work card. On June 30, 2011, the operator received the first batch of brake inspection scribes that are specified in the detailed inspection.

On June 27, 2011, a mechanic who worked at the operator's Dallas/Ft. Worth maintenance facility was asked if he visually inspected a brake on N630AE in accordance with the DVI and he indicated that he did not. He stated that he had not received any training on the inspection and was not aware of the special tool for the inspection. The facility did not have the plastic probe.

On June 28, 2011, a mechanic who worked at the operator's Dallas/Ft. Worth maintenance facility was asked if he visually inspected a brake on N812AE in accordance with the DVI and he indicated that he did not. He stated that he had not received any training on the inspection and was not aware of the special tool for the inspection. The facility did not have the plastic probe.

On July 28, 2011, a mechanic who worked at the operator's Raleigh/Durham International Airport maintenance facility was asked if he visually inspected a brake on N724AE in

accordance with the DVI and he indicated that he did not remember. He stated that he had not received any training on the inspection and was not aware of the special tool for the inspection and used a screwdriver to inspect the brake. The facility did not have the plastic probe.

On August 1, 2011, a mechanic who worked at a contractor's maintenance facility near Savoy, Illinois, was asked if he visually inspected a brake on N607AE and he indicated that he thought he did. He stated that he had not received any training on the inspection and was not aware of the special tool for the inspection and used his fingernail to inspect the brake. The facility did not have the plastic probe.

On August 2, 2011, a mechanic who worked at a contractor's maintenance facility near Erlanger, Kentucky, was asked if he visually inspected a brake on N607AE and he indicated that he thought he did. He stated that he had not received any training on the inspection and was not aware of the special tool for the inspection. He indicated that he used a hyperlink, which he thought took him to the correct inspection. The hyperlink took him to the general visual inspection. The facility did not have the plastic probe.

Between July 06, and July 12, 2011, the operator and brake manufacturer conducted formal training of the DVI inspection at four of the operator's main maintenance base locations. The operator has added a computer based training course that incorporates the DVI into recurrent training for their maintenance technicians.

On August 12, 2011, the operator issued a revised Main Landing Gear Wheel Assembly-Removal and Installation work card that clarifies the DVI requirement.

According to the operator's safety representative, as a result of the brake separation incident the training courses IO462 and IO462_11 were re-loaded for all mechanics in August 2011. Within 30 days 3,089 airplane mechanics had completed the web based training. The requirement for the use of a plastic pick or a finger nail during the brake inspection process did not change from the original courses. Plastic picks were bought for the operator's entire maintenance system in late June 2011. The representative indicated that during the new hires indoctrination training, time is set aside daily to allow the employee time to do the required web based training and the required documentation of the completed training.

History of Flight

Prior to flight	Aircraft maintenance event
Landing-landing roll	Sys/Comp malf/fail (non-power) (Defining event) Part(s) separation from AC

Pilot Information

Certificate:	Airline Transport	Age:	53, Male
Airplane Rating(s):	Multi-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):		Toxicology Performed:	No
Medical Certification:	Class 1 With Waivers/Limitations	Last Medical Exam:	01/11/2011
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	04/24/2011
Flight Time:	20691 hours (Total, all aircraft), 9911 hours (Pilot In Command, all aircraft)		

Co-Pilot Information

Certificate:	Commercial	Age:	30
Airplane Rating(s):	Multi-engine Land	Seat Occupied:	Right
Other Aircraft Rating(s):		Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):		Toxicology Performed:	No
Medical Certification:	Class 1 Without Waivers/Limitations	Last Medical Exam:	02/15/2011
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	02/07/2011
Flight Time:	4820 hours (Total, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	EMBRAER	Registration:	N607AE
Model/Series:	EMB-145	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	145064
Landing Gear Type:	Retractable - Tricycle	Seats:	55
Date/Type of Last Inspection:	06/02/2011, Continuous Airworthiness	Certified Max Gross Wt.:	
Time Since Last Inspection:		Engines:	2 Turbo Jet
Airframe Total Time:		Engine Manufacturer:	ALLISON
ELT:	Installed, not activated	Engine Model/Series:	AE3007C SER
Registered Owner:	AMERICAN EAGLE AIRLINES INC	Rated Power:	6442 lbs
Operator:	AMERICAN EAGLE AIRLINES INC	Air Carrier Operating Certificate:	Flag carrier (121)
Operator Does Business As:		Operator Designator Code:	SIMA

Meteorological Information and Flight Plan

Observation Facility, Elevation:	ORD, 672 ft msl	Observation Time:	1051 CDT
Distance from Accident Site:	0 Nautical Miles	Condition of Light:	Day
Direction from Accident Site:	0°	Conditions at Accident Site:	Visual Conditions
Lowest Cloud Condition:	Few / 4900 ft agl	Temperature/Dew Point:	26° C / 17° C
Lowest Ceiling:	None	Visibility	10 Miles
Wind Speed/Gusts, Direction:	13 knots, 170°	Visibility (RVR):	
Altimeter Setting:	30.09 inches Hg	Visibility (RVV):	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Columbus, OH (CMH)	Type of Flight Plan Filed:	IFR
Destination:	Chicago, IL (ORD)	Type of Clearance:	IFR
Departure Time:	0512 CDT	Type of Airspace:	

Airport Information

Airport:	Chicago O'Hare IAP (ORD)	Runway Surface Type:	Asphalt
Airport Elevation:	672 ft	Runway Surface Condition:	Unknown
Runway Used:	22R	IFR Approach:	Unknown
Runway Length/Width:	7500 ft / 150 ft	VFR Approach/Landing:	Full Stop

Wreckage and Impact Information

Crew Injuries:	3 None	Aircraft Damage:	None
Passenger Injuries:	49 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	52 None		

Administrative Information

Investigator In Charge (IIC):	Edward F Malinowski	Adopted Date:	11/07/2012
Additional Participating Persons:	Mark Richter; Federal Aviation Administration; Rosemont, IL Trevor Johnson; American Eagle Airlines; Dallas, TX Nathan Hott; Goodrich Corporation; Troy, OH Lloyd Lewis; Federal Aviation Administration; Dallas, TX Carlos Antonio Motta de Souza; CENIPA; DF, Brasília, Brazil, Paulo M Ribeiro; Embraer Aircraft Holding, Inc; Ft Lauderdale, FL		
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