



National Transportation Safety Board Aviation Accident Final Report

Location:	GREENSBORO, NC	Accident Number:	DCA00MA079
Date & Time:	08/08/2000, 1544 EDT	Registration:	N838AT
Aircraft:	Douglas DC-9-32	Aircraft Damage:	Substantial
Defining Event:		Injuries:	13 Minor, 50 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

Examination of the area of the fire origin revealed that relay R2-53, the left heat exchanger cooling fan relay, was severely heat damaged, as were R2-54 and the other relays in this area. However, the R2-53 relay also exhibited loose terminal studs and several holes that had burned through the relay housing that the other relays did not exhibit. The wire bundles that run immediately below the left and right heat exchanger cooling fans and the ground service tie relays exhibited heat damage to the wire insulation, with the greatest damage located just below the R2-53 relay. The unique damage observed on the R2-53 relay and the wire damage directly below it indicates that fire initiation was caused by an internal failure of the R2-53 relay. Disassembly of the relay revealed that the R2-53 relay had been repaired but not to the manufacturer's standards. According to the manufacturer, the damage to the relay housing was consistent with a phase-to-phase arc between terminals A2 and B2 of the relay. During the on-scene portion of the investigation, three of the four circuit breakers in the left heat exchanger cooling fan were found in the tripped position. To determine why only three of the four circuit breakers tripped, all four were submitted to the Materials Integrity Branch at Wright-Patterson Air Force Base, Dayton, Ohio, for further examination. The circuit breakers were visually examined and were subjected to an insulation resistance measurement, a contact resistance test, a voltage drop test, and a calibration test (which measured minimum and maximum ultimate trip times). Testing and examination determined that the circuit breaker that did not trip exhibited no anomalies that would prevent normal operation, met all specifications required for the selected tests, and operated properly during the calibration test. Although this circuit breaker appeared to have functioned properly during testing, the lab report noted that, as a thermal device, the circuit breaker is designed to trip when a sustained current overload exists and that it is possible during the event that intermittent arcing or a resistive short occurred or that the circuit opened before the breaker reached a temperature sufficient to trip the device.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: A phase-to-phase arc in the left heat exchanger cooling fan relay, which ignited the

surrounding wire insulation and other combustible materials within the electrical power center panel. Contributing to the left heat exchanger fan relay malfunction was the unauthorized repair that was not to the manufacturer's standards and the circuit breakers' failure to recognize an arc-fault.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION

Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings

1. (C) AIR COND/HEATING/PRESSURIZATION,CONTROL/INDICATOR - ASSEMBLY
2. (C) CIRCUIT BREAKER - IMPROPER - OTHER MAINTENANCE PERSONNEL
3. (C) MATERIAL INADEQUATE,IMPROPER - OTHER MAINTENANCE PERSONNEL
4. (C) INADEQUATE SURVEILLANCE OF OPERATION - MANUFACTURER
5. (C) ELECTRICAL SYSTEM,ELECTRIC RELAY - BURNED
6. (C) MAINTENANCE,OVERHAUL - INCORRECT - COMPANY MAINTENANCE PERSONNEL
7. (C) IMPROPER USE OF EQUIPMENT/AIRCRAFT - COMPANY MAINTENANCE PERSONNEL
8. (C) INADEQUATE CERTIFICATION/APPROVAL,MANUFACTURER - COMPANY/OPERATOR MGMT

Occurrence #2: FIRE

Phase of Operation: EMERGENCY LANDING AFTER TAKEOFF

Factual Information

On August 8, 2000, about 1544 eastern daylight time, the flight crew of AirTran Airways flight 913, a McDonnell Douglas DC-9-32, N838AT, executed an emergency landing at Greensboro Piedmont-Triad International Airport (GSO) shortly after declaring an emergency due to an in-flight fire and smoke in the cockpit. An emergency evacuation was performed. Of the 58 passengers and 5 crewmembers on board, 3 crewmembers and 5 passengers received minor injuries from smoke inhalation. Five passengers and one ground crewmember received minor injuries during the evacuation. The airplane sustained substantial fire, heat, and smoke damage. The flight was operating on an instrument flight rules flight plan under the provisions of 14 Code of Federal Regulations Part 121 as a regularly scheduled passenger flight from Greensboro, North Carolina, to Atlanta, Georgia. Visual meteorological conditions prevailed at the time of the accident.

AIRPLANE INFORMATION

N838AT, a DC-9-32, serial number 47442, was delivered new to Turkish Airlines on August 24, 1970. It was registered to ValuJet on March 7, 1995 (ValuJet was acquired by AirTran Airways in 1997).

FIRE DAMAGE

Examination of the airplane revealed severe smoke and heat damage around the electric power center (EPC) and within the cockpit. Removal of the forward and aft EPC panels revealed heavy sooting, melted wire insulation, visibly broken wires, and localized heat damage. The lowest point of the fire damage on the cabin (aft) side of the EPC was in the upper compartment where it was noted that the aluminum stanchion brace that runs the length of that compartment was destroyed along with the AC bus feeder wires and numerous other airplane wiring bundles. No fire damage was noted in the lower aft compartment. The lowest point of the fire damage was on the cockpit side of the EPC, behind the lower right access panel where the AC ground service tie relay and the right and left heat exchanger cooling fan relays were located. The location of the fire damage is consistent with it being the point of origin for the fire.

TESTS AND RESEARCH

Relay Examination and Evaluation

Examination of the relays located in the area of the fire origin (R2-53 and R2-54) revealed that R2-53, the left heat exchanger cooling fan relay, was severely heat damaged, as were the other relays in this area. However, only the R2-53 relay had loose terminal studs and several holes that had burned through the relay housing. The largest of the burn holes observed in the R2-53 relay were on the terminal "A" side directly above the wiring bundles.

Removal of the R2-53 relay cover revealed that none of the rotating contacts, or armatures, were touching the stationary contacts, indicating that the relay was in the de-energized, or open, condition. This finding suggests that, initially, the relay functioned properly by returning the rotating armature to the open position after takeoff.

Disassembly of the relay revealed that the floor between the housing upper cavity and lower cavity was heavily heat damaged. Arc damage extended around three sides of the relay; only the side containing the "C" terminals remained intact. According to the manufacturer,

Leach International Corporation, the damage to the relay housing was consistent with a phase-to-phase arc between terminals "A2" and "B2" of the relay. Disassembly of the relay also revealed that one of the wires that passes between the two coils in the lower housing adjacent to the armature shaft exhibited insulation damage. No evidence was observed to suggest that the wire arced or overheated, indicating that the wire did not cause or contribute to a short in the relay.

Relay Repairs

Visual examination and disassembly of the R2-53 relay revealed numerous repairs that did not conform to Leach production standards. For example, the baseplate and coil assembly time-delay circuit were attached with four slotted screws that exhibited mechanical damage and that did not have the typical coating of sealant, some of the diodes on the time-delay circuit board appeared to be different than those used by Leach during production, nonstandard shims were installed between the relay housing and the stationary contact, and nonstandard, pre-drilled two-hole washers were found installed below the contact carrier assembly.

According to Leach, no overhaul or component maintenance manual has been released to outside repair stations or vendors for repair of this part. Leach representatives reported that their facility does not overhaul this relay but might do minor repairs as part of warranty work, such as changing the time-delay circuit board. Additionally, according to Leach, any repairs performed at the facility would require stamping the outside of the relay housing with the letter "R." No such marking was found anywhere on the R2-53 relay housing.

Disassembly of the R2-54 relay revealed many of the same nonconforming repairs noted during the examination of the R2-53 relay. During the examination of the R2-54 relay, an alphanumeric stamp, "JNR 11-17-78," was discovered on the underside of the relay cover. Leach indicated that this stamp is not a Leach repair or manufacturing mark. The repair date code indicates that the repair was performed while the aircraft was owned and operated by Turkish Airlines.

Circuit Breakers Examination and Evaluation

During the on-scene portion of the investigation, three of the four circuit breakers in the left heat exchanger cooling fan were found in the tripped position. To determine why only three of the four circuit breakers tripped, all four were submitted to the Materials Integrity Branch at Wright-Patterson Air Force Base, Dayton, Ohio, for further examination. The circuit breakers were visually examined and were subjected to an insulation resistance measurement, a contact resistance test, a voltage drop test, and a calibration test (which measured minimum and maximum ultimate trip times). Testing and examination determined that the circuit breaker that did not trip exhibited no anomalies that would prevent normal operation, met all specifications required for the selected tests, and operated properly during the calibration test. Although this circuit breaker appeared to have functioned properly during testing, the lab report noted that, as a thermal device, the circuit breaker is designed to trip when a sustained current overload exists and that it is possible during the event that intermittent arcing or a resistive short occurred or that the circuit opened before the breaker reached a temperature sufficient to trip the device.

ADDITIONAL INFORMATION

As a result of this accident, AirTran inspected its entire DC-9 fleet for anomalies in the R2-53 and R2-54 relays. Five relays were removed from service due to loose terminal studs. A

DC-9 fleet campaign was conducted to inspect R2-53 and R2-54 relays and to determine if relay degradation was time-related and whether a hard-time inspection was warranted. The results of the survey indicate that a hard-time service limit is not warranted; however, several relays showed clear indications that unauthorized repairs had been performed, similar to those apparently performed on the accident R2-53 relay.

The Safety Board also learned during its investigation of this accident that neither flight attendant on board flight 913 attempted to locate the source of the smoke in the cabin or to use any of the firefighting equipment available to them. It was also learned that AirTran's flight attendant training program does not include any drill involving hidden fires but does include a drill that uses a visible, open flame. Based on this accident (and others involving in-flight fires), the Safety Board issued five safety recommendations to the FAA on January 4, 2002, regarding improved crewmember training for fighting in-flight fires.

The Safety Board's investigation also revealed that after donning his oxygen mask, the first officer removed it to address the passengers on the public address system, exposing himself to the smoke and the potential for incapacitation. He reported in a postaccident interview that he continued to feel the effects of the smoke after he replaced his mask. The first officer was treated for smoke inhalation after evacuating the airplane.

Pilot Information

Certificate:	Airline Transport; Commercial	Age:	51, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	Helicopter	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane; Helicopter	Second Pilot Present:	
Instructor Rating(s):		Toxicology Performed:	
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	Last FAA Medical Exam:	06/23/2000
Occupational Pilot:		Last Flight Review or Equivalent:	04/24/2000
Flight Time:	22000 hours (Total, all aircraft), 15000 hours (Total, this make and model)		

Co-Pilot Information

Certificate:	Airline Transport; Commercial	Age:	52, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Right
Other Aircraft Rating(s):	None	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	Second Pilot Present:	
Instructor Rating(s):	None	Toxicology Performed:	
Medical Certification:	Class 1 Valid Medical--w/ waivers/lim.	Last FAA Medical Exam:	11/19/1999
Occupational Pilot:		Last Flight Review or Equivalent:	04/25/2000
Flight Time:	8000 hours (Total, all aircraft), 2000 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Douglas	Registration:	N838AT
Model/Series:	DC-9-32 DC-9-32	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Transport	Serial Number:	
Landing Gear Type:	Retractable - Tricycle	Seats:	119
Date/Type of Last Inspection:	Unknown	Certified Max Gross Wt.:	
Time Since Last Inspection:		Engines:	2 Turbo Jet
Airframe Total Time:		Engine Manufacturer:	Pratt & Whitney
ELT:		Engine Model/Series:	JT8D
Registered Owner:		Rated Power:	14500 lbs
Operator:	AIRTRAN AIRLINES INC	Operating Certificate(s) Held:	Flag carrier (121)
Operator Does Business As:		Operator Designator Code:	VJ6A

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Not Reported
Observation Facility, Elevation:		Distance from Accident Site:	
Observation Time:		Direction from Accident Site:	
Lowest Cloud Condition:	Clear	Visibility	10 Miles
Lowest Ceiling:	None	Visibility (RVR):	0 ft
Wind Speed/Gusts:	Calm /	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:	IFR
Destination:	ATLANTA, GA (ATL)	Type of Clearance:	
Departure Time:	0000	Type of Airspace:	

Airport Information

Airport:	PIEDMONT TRIAD INTERNATIONAL (GSO)	Runway Surface Type:	Asphalt
Airport Elevation:		Runway Surface Condition:	Dry
Runway Used:	0	IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	Precautionary Landing

Wreckage and Impact Information

Crew Injuries:	3 Minor, 2 None	Aircraft Damage:	Substantial
Passenger Injuries:	10 Minor, 48 None	Aircraft Fire:	In-Flight
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	13 Minor, 50 None	Latitude, Longitude:	

Administrative Information

Investigator In Charge (IIC):	Lorenda Ward	Report Date:	05/08/2003
Additional Participating Persons:	ROBERT HENLEY		
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.nts.gov/pubdms/ .		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report. A factual report that may be admissible under 49 U.S.C. § 1154(b) is available [here](#).