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## Engine failure, Boeing 737-7H4, July 7, 1998

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**Micro-summary: #2 engine failure on approach for this Boeing 737-7H4.**

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**Event Date: 1998-07-07 at 640 CDT**


**Investigative Body: National Transportation Safety Board (NTSB), USA**

**Investigative Body's Web Site: <http://www.nts.gov/>**

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1. Accident reports can be and sometimes are revised. Be sure to consult the investigative agency for the latest version before basing anything significant on content (e.g., thesis, research, etc).
  2. Readers are advised that each report is a glimpse of events at specific points in time. While broad themes permeate the causal events leading up to crashes, and we can learn from those, the specific regulatory and technological environments can and do change. ***Your company's flight operations manual is the final authority as to the safe operation of your aircraft!***
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 <b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b>		NTSB ID: MIA98IA193		Aircraft Registration Number: N701GS	
		Occurrence Date: 07/07/1998		Most Critical Injury: None	
		Occurrence Type: Incident		Investigated By: NTSB	
<b>Location/Time</b>					
Nearest City/Place BIRMINGHAM		State AL	Zip Code 35206	Local Time 0640	Time Zone CDT
Airport Proximity: Off Airport/Airstrip		Distance From Landing Facility:		Direction From Airport:	
<b>Aircraft Information Summary</b>					
Aircraft Manufacturer Boeing		Model/Series 737-7H4		Type of Aircraft Airplane	
Sightseeing Flight: No			Air Medical Transport Flight: No		
<b>Narrative</b>					
Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:					
<p>On July 7, 1998, about 0640 central daylight time, a Boeing 737-7H4, N701GS, registered to and operated by Southwest Airlines Company as flight 1565, a Title 14 CFR Part 121 scheduled domestic passenger flight from Tampa, Florida, to Birmingham, Alabama, had a failure of the No. 2 engine during descent for landing at Birmingham. Visual meteorological conditions prevailed at the time and an instrument flight rules flight plan was filed. The aircraft received minor damage. The airline transport-rated pilot, first officer, 3 flight attendants, and 91 passengers were not injured. The flight originated from Tampa, Florida, the same day, about 0549.</p> <p>The pilots reported to an FAA inspector and the operator that they were at 3,000 feet msl, about 20 miles from Birmingham, while in descent for landing, when they observed an indication that the No. 2 generator was off line and observed a rise in the No. 2 engine exhaust gas temperature. Flight attendants reported to them that flame was visible coming from the No. 2 engine tailpipe and extending aft toward the tail of the aircraft. They did not receive a fire warning for the No. 2 engine and did not activate the fire extinguishing system. They shut down the No. 2 engine and made an uneventful landing at Birmingham. After landing, they stopped on the taxiway and shut down the remaining engine. After fire department personnel on the ground examined the aircraft for fire and deemed it safe, the aircraft was towed to the gate, where the passengers were deplaned via the jetway.</p> <p>Examination of the digital flight data recorder, removed from N701GS after the incident, showed the aircraft was level at 2,875 feet pressure altitude, at an airspeed of 239 knots, on a heading of 310 degrees. The N1 speed for the Nos. 1 and 2 engines was 25.8 and 25.6 percent respectively. The fuel flow for the Nos. 1 and 2 engines was 656 pounds per hour. The No. 2 engine fuel flow then increased from a value of 656 pounds per hour to a high of 3,920 pounds per hour over a 74 second period, and then began to decrease. The No. 2 engine exhaust gas temperature (EGT) increased from 430 degrees centigrade to a high of 973 degrees centigrade over a 52 second period and then began to decrease. The No. 2 engine cutoff occurred about 74 seconds after the EGT began to rise. The N1 speed for the No. 2 engine decreased from 25.6 percent to 12.8 percent at the time of engine cutoff. (See attached Flight Data Recorder Specialist's Factual Report)</p> <p>Postcrash examination of the aircraft by an FAA inspector showed the tailpipe of the No. 2 engine contained metal debris. The aircraft structure had no fire damage.</p> <p>Examination of the No. 2 engine was performed at General Electric Aircraft Engines, Strother, Kansas, following removal from N701GS at Birmingham, Alabama. Examination showed that the melted metal debris found in the tailpipe was from the low pressure turbine and that the N1 rotor was locked. All chip detectors were clean and there was no evidence of fuel in the engine oil. Diagnostic interrogation of the engine's electronic control unit (ECU) revealed the hydromechanical unit (HMU) had a fuel metering valve (FMV) feedback disagree fault on Channel A and B and an FMV feedback out of range fault on Channel B. The HMU was removed from the engine for testing.</p>					
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## FACTUAL REPORT

AVIATION

NTSB ID: MIA98IA193

Occurrence Date: 07/07/1998

Occurrence Type: Incident

## Narrative (Continued)


Testing of the HMU showed the resolver module's Channel B sine output voltage became unstable when the HMU was tested on a flow bench with the test fluid heated to 180 degrees Fahrenheit. The resolver module was removed from the HMU and tested separately. The tests confirmed that when the resolver module was heated above 160 degrees Fahrenheit, the Channel B sine output voltage became unstable. Disassembly of the resolver unit revealed a broken wire to the sine magnet stator.


The ECU computer software logic allowed the unit to lock on the unstable Channel B and lock out Channel A. The unstable sine out voltage of Channel B resulted in the ECU commanding the FMV to a full open position. With the sudden increase in fuel flow while the engine was at idle speed, the core of the engine stalled.

Examination of the broken wire by the NTSB Materials Laboratory showed the wire had fracture features typical of ductile overstress separation and that the fracture surface was covered with lead-tin deposits. (See attached NTSB Materials Laboratory Factual Report)

Changes were made in the resolver unit design and manufacture processes, the ECU computer software to improve handling of resolver failures, and a dispatch prohibition if a single Channel resolver fault is indicated in the cockpit. (See attached Powerplants Group Chairman Report and CFM report-CFM56-7B Uncommanded Fuel Flow Increase Events)

An additional party to the NTSB investigation was John H. Middleton, Kearfott Guidance and Navigation, Black Mountain, North Carolina.

 <b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b>		NTSB ID: MIA98IA193			
		Occurrence Date: 07/07/1998			
		Occurrence Type: Incident			
<b>Landing Facility/Approach Information</b>					
Airport Name	Airport ID:	Airport Elevation Ft. MSL	Runway Used 0	Runway Length	Runway Width
Runway Surface Type:					
Runway Surface Condition:					
Type Instrument Approach:					
VFR Approach/Landing:					
<b>Aircraft Information</b>					
Aircraft Manufacturer Boeing		Model/Series 737-7H4		Serial Number 27836	
Airworthiness Certificate(s): Transport					
Landing Gear Type: Retractable - Tricycle					
Homebuilt Aircraft? No	Number of Seats:	Certified Max Gross Wt.	LBS	Number of Engines: 2	
Engine Type: Turbo Fan	Engine Manufacturer: Cfm	Model/Series: CFM56-7B	Rated Power: 24200 LBS		
- Aircraft Inspection Information					
Type of Last Inspection Continuous Airworthiness	Date of Last Inspection 07/1998	Time Since Last Inspection 1 Hours	Airframe Total Time 1754 Hours		
- Emergency Locator Transmitter (ELT) Information					
ELT Installed? Yes	ELT Operated? No	ELT Aided in Locating Accident Site?			
<b>Owner/Operator Information</b>					
Registered Aircraft Owner SOUTHWEST AIRLINES COMPANY		Street Address 2702 LOVE FIELD DRIVE			
		City DALLAS	State TX	Zip Code 75235	
Operator of Aircraft Same as Reg'd Aircraft Owner		Street Address Same as Reg'd Aircraft Owner			
		City	State	Zip Code	
Operator Does Business As:			Operator Designator Code: SWAA		
- Type of U.S. Certificate(s) Held:					
Air Carrier Operating Certificate(s): Flag Carrier/Domestic					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 121: Air Carrier					
Type of Flight Operation Conducted: Scheduled; Domestic; Passenger Only					
FACTUAL REPORT - AVIATION					

 <p><b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b></p>	NTSB ID: MIA98IA193
	Occurrence Date: 07/07/1998
	Occurrence Type: Incident

**First Pilot Information**

Name On File	City On File	State On File	Date of Birth On File	Age 53
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Sex: M	Seat Occupied: Left	Principal Profession: Civilian Pilot	Certificate Number: On File
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Certificate(s): Airline Transport; Flight Engineer

Airplane Rating(s): Multi-engine Land; Single-engine Land

Rotorcraft/Glider/LTA: Glider; Helicopter

Instrument Rating(s): Airplane

Instructor Rating(s): None

Type Rating/Endorsement for Accident/Incident Aircraft? Yes	Current Biennial Flight Review?
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Medical Cert.: Class 1	Medical Cert. Status: Valid Medical--no waivers/lim.	Date of Last Medical Exam: 03/1998
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- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night	Instrument		Rotorcraft	Glider	Lighter Than Air
						Actual	Simulated			
Total Time	15000	9745								
Pilot In Command(PIC)										
Instructor										
Last 90 Days	233									
Last 30 Days										
Last 24 Hours										

Seatbelt Used? Yes	Shoulder Harness Used? Yes	Toxicology Performed? No	Second Pilot?
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**Flight Plan/Itinerary**

Type of Flight Plan Filed: IFR

Departure Point TAMPA	State FL	Airport Identifier TPA	Departure Time 0549	Time Zone CDT
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Destination Same as Accident/Incident Location	State	Airport Identifier BHM	
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Type of Clearance: IFR

Type of Airspace: Class C

**Weather Information**

Source of Briefing:  
Company

Method of Briefing:

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<b>Weather Information</b>					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
BHM	0652	CDT	644 Ft. MSL	20 NM	130 Deg. Mag.
Sky/Lowest Cloud Condition: Scattered			30000 Ft. AGL	Condition of Light: Day	
Lowest Ceiling: None		0 Ft. AGL	Visibility: 5	SM	Altimeter: 30.00 "Hg
Temperature: 27 °C	Dew Point: 24 °C	Wind Direction:		Density Altitude: 1200 Ft.	
Wind Speed: Calm	Gusts:	Weather Conditions at Accident Site: Visual Conditions			
Visibility (RVR): 0 Ft.	Visibility (RVV) 0	SM	Intensity of Precipitation: Unknown		
Restrictions to Visibility: Haze					
Type of Precipitation: None					

<b>Accident Information</b>		
Aircraft Damage: Minor	Aircraft Fire: None	Aircraft Explosion: None

Classification: U.S. Registered/U.S. Soil					
- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot				1	1
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants				3	3
Other Crew					
Passengers				91	91
- TOTAL ABOARD -				96	96
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	0	96	96

National Transportation Safety Board

**FACTUAL REPORT**

**AVIATION**



NTSB ID: MIA98IA193

Occurrence Date: 07/07/1998

Occurrence Type: Incident

Administrative Information

Investigator-In-Charge (IIC)

JEFFREY L. KENNEDY

Additional Persons Participating in This Accident/Incident Investigation:

CLOVIS JACKSON  
FAA FSDO  
BIRMINGHAM, AL 35206

JIM SOKOL  
SOUTHWEST AIRLINES  
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