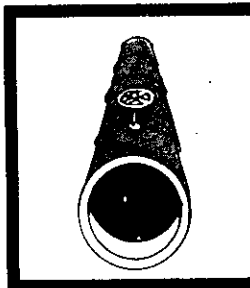
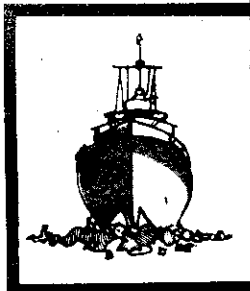
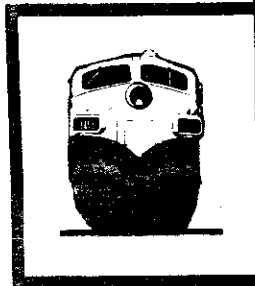
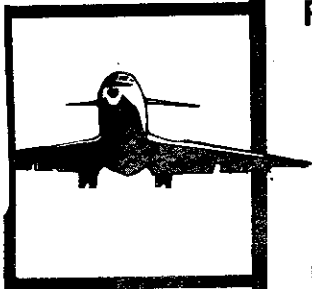


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PB89-910405



# NATIONAL TRANSPORTATION SAFETY BOARD



WASHINGTON, D.C. 20594

## AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORTS

BELLEVILLE, ILLINOIS--AUGUST 22, 1987  
PENSACOLA, FLORIDA--DECEMBER 27, 1987

NTSB/AAR-89/02/SUM

UNITED STATES GOVERNMENT

# TECHNICAL REPORT DOCUMENTATION PAGE

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15. Supplementary Notes					
16. Abstract  This publication is a compilation of the reports of two separate aircraft accidents investigated by the National Transportation Safety Board. The accident locations and their dates are as follows: Belleville, Illinois, August 22, 1987; and Pensacola, Florida, December 27, 1987.					
17. Key Words  airplane maintenance, main landing gear, wheel/brake assembly, final approach, flight instruments, improper emergency evacuation, windshield wiper blades monitoring <i>approach &amp; landing</i>				18. Distribution Statement  This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
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**National  
Transportation  
Safety Board**

Washington, D.C. 20594

## **AIRCRAFT ACCIDENT/INCIDENT SUMMARY**

File No.:	5076
Aircraft Operator:	Trans World Airlines (TWA)
Aircraft Type and Registration:	Boeing 767-231ER; N609TW
Location:	Scott Air Force Base Belleville, Illinois
Date and Time:	August 22, 1987; 1312 c.d.t.
Injuries:	3 Minor
Aircraft Damage:	Minor
Occurrence:	System Malfunction, Wheels Up Landing

On August 22, 1987, at 1312 c.d.t., a Trans World Airlines (TWA) Boeing 767, N609TW, landed at Scott Air Force Base in Belleville, Illinois, with the right main landing gear fully retracted. The airplane came to rest in a nose-high, right-wing-low attitude with the right engine supporting the weight of the right wing. (See figures 1 and 2.) The 181 persons aboard evacuated using the emergency exits and slides. Three passengers received minor injuries; there were no serious injuries. The airplane sustained minor damage.

The TWA Boeing 767, operating as flight 756, was a scheduled domestic passenger flight from San Francisco (SFO), California, to St. Louis (STL), Missouri, and had departed SFO in accordance with instrument flight rules at 1047 c.d.t. The captain stated that the flight was normal until the approach to STL. On the approach to runway 30 left and just before reaching the outer marker, the landing gear handle was lowered. Afterward, the engine indicating crew alerting system (EICAS) displayed "Gear Disagree, Gear Doors," and an aural gear unsafe warning sounded. The instrument panel displayed the following landing gear configuration: nose gear light--green; left main gear light--green; right main gear light--not illuminated; amber door light--illuminated; and the amber gear light--illuminated.

The captain broke off the approach, departed the traffic pattern, and recycled the landing gear in accordance with the "Gear Disagree" procedure. However, the right main landing gear continued to show an unsafe condition.

When the crew informed TWA's St. Louis maintenance facility of the landing gear difficulty, it received instructions to perform the alternate gear extension procedure. Despite the crew's attempts, the right main landing gear remained in an unsafe condition.

The flightcrew then attempted to free the right main landing gear by inducing positive and negative "G" forces on the airplane (performing vertical maneuvers). However, these maneuvers also failed to free the right main landing gear. The crew had followed all applicable emergency procedures to extend the right main landing gear, but they were unsuccessful.

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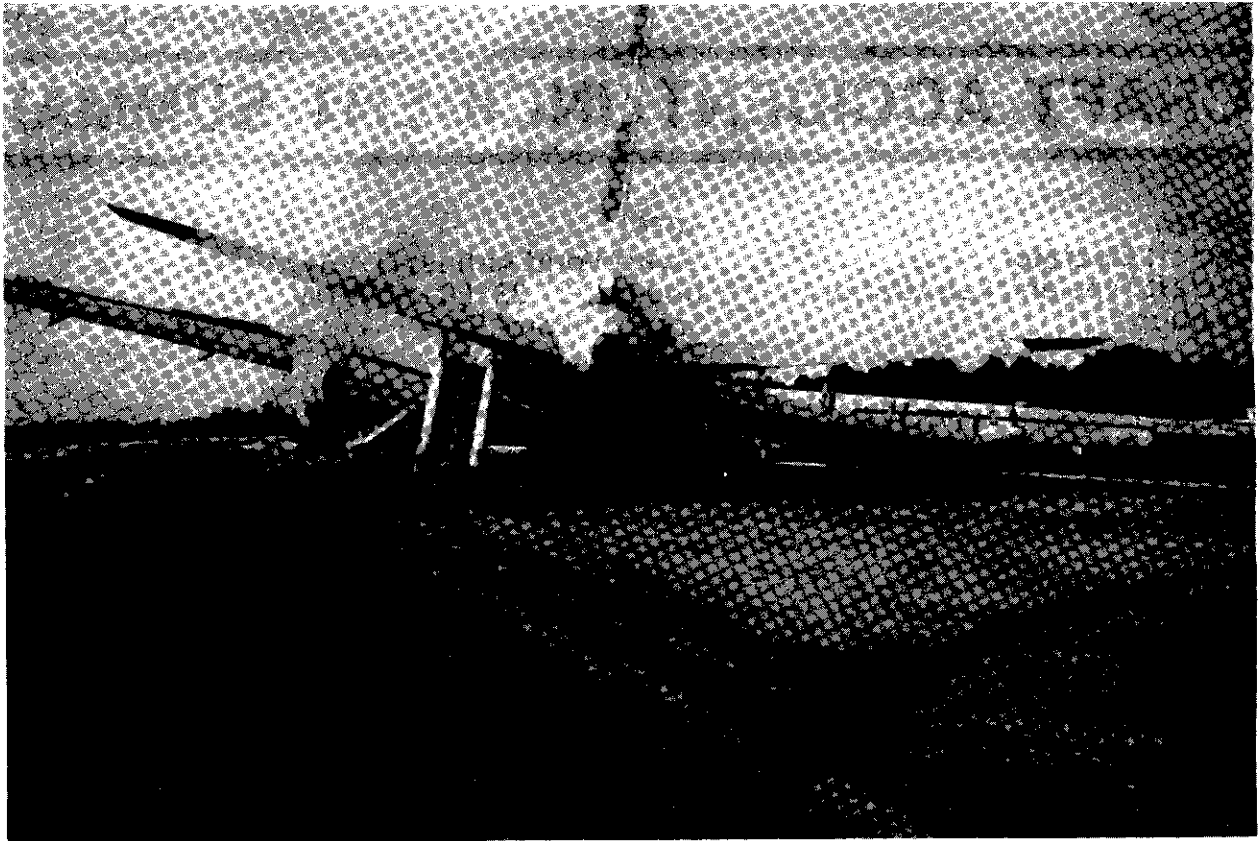


Figure 1.--Rear view.

The captain of flight 756 then decided to land at Scott Air Force Base because of a more favorable runway wind component and because of the availability of on-base medical facilities and heavy crash/fire/rescue (CFR) equipment.

The flight attendants were advised to prepare the cabin and the passengers for an emergency landing. About 30 seconds before touchdown, the captain notified the flight attendants and passengers that they were about to touch down and the passengers were directed to assume the brace for impact position. When the airplane stopped and the evacuation alarm sounded, the flight attendants opened their assigned emergency doors, ensured that the slides were inflated, and started to evacuate the passengers. The evacuation was orderly and rapid.

All emergency doors were opened and the slides inflated with the exception of the left rear passenger cabin (L-3) door. The flight attendant who was responsible for L-3 door stated that when the evacuation alarm sounded, she grabbed the door handle and pushed it upward. The door opened slightly and then stopped. A passenger tried to assist the flight attendant by pushing the door up, but it would not open. The flight attendant then directed passengers to exit using the right rear (R-3) cabin door.

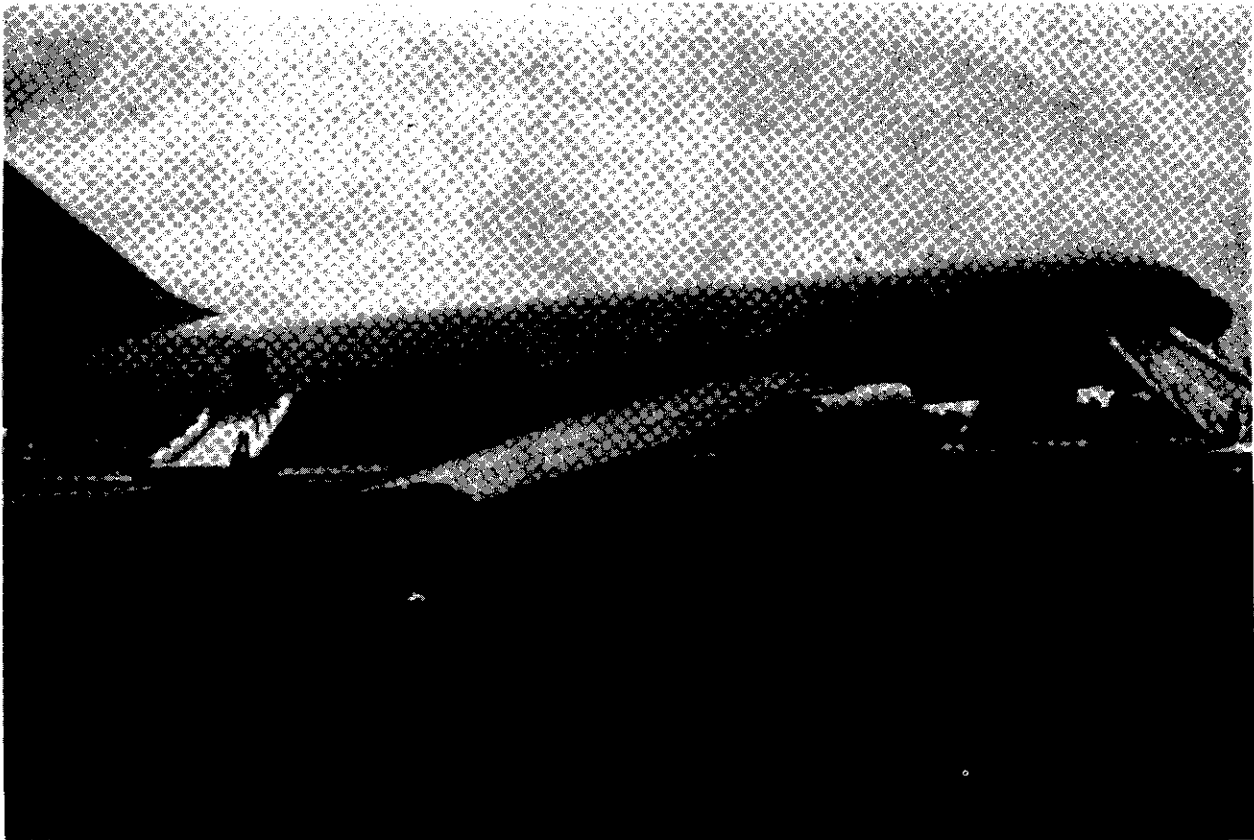


Figure 2.--Right side view.

When CFR vehicles arrived at the airplane, many of the passengers had already exited the airplane. The CFR personnel took up stations around the airplane in case of fire, but there was none.

There was no damage to the right main landing gear. The airplane received minor damage to the right engine cowl and right wing tip. The postincident examination of the right main landing gear revealed that the brake rod had separated from the brake torque arm, had moved in a horizontal plane, and had become jammed over the top of the gear door pad in the landing gear wheel well. (See figure 3.) The bolt that was used to hold the pin in the brake torque arm was still in place with a new cotter key installed in the nut. The pin used to hold the brake rod to the brake torque arm was missing and could not be found in the wheel well or landing gear doors. The seven pins and bolts that remained in the other wheel/brake assemblies were removed, metallurgically examined, and found serviceable.

An examination of the bottom of the brake rod showed no evidence of scuffing. The bushing in the brake rod end and the bushings in the brake torque arm were clean, smooth, and not distorted or damaged.



Figure 3.--Brake rod jammed over the gear door pad.  
Arrow shows brake torque arm with the pin missing.

The flightcrew was certificated in accordance with the existing Federal Aviation Administration (FAA) regulations and was qualified to conduct the flight. There was no evidence of any physiological or psychological factors that would have affected the performance of the flightcrew.

The airplane was properly certificated, equipped, and maintained (except as noted in this report) in accordance with existing FAA regulations and company procedures. The airplane weight and balance were within the specified limits at takeoff and landing.

TWA company records showed that the right main landing gear's No. 3 brake and wheel assembly was replaced during routine Aircraft Service One (AS-1) maintenance/inspection of N609TW during a layover at SFO early on the morning of the incident. Mechanics, who found an unserviceable brake and tire, requested a work order, and sometime between 0300 and 0500, they removed and replaced the No. 3 brake and wheel assembly on the right main landing gear.

According to the Boeing 767 maintenance manual, the correct procedure to remove the main gear wheel/brake assembly requires mechanics to first remove the

bolt that holds the pin in the brake torque arm. When the pin is pulled out far enough from the brake torque arm, the brake rod is free to move vertically. The mechanics who changed the brake and wheel at SFO stated that they removed the bolt and then, without the use of a puller, slid the pin out only far enough to free the brake rod from the brake. The free end of the rod was placed on the ground with the pin still retained in the rod.

After the new wheel/brake assembly was installed, the brake rod was aligned with the torque arm on the brake assembly. (Attaching the brake rod to the brake torque arm prevents the entire brake stack from moving in the direction of wheel rotation and keeps all four wheels on the ground when brake pressure is applied.) According to the mechanics, the retaining bolt was inserted through the hole in the torque arm and through the pin. The mechanics used a new cotter key to hold the nut on the retaining pin. TWA does not require that the removal and replacement of a wheel assembly be inspected by a mechanic with inspection authority when the work is completed. In this case, the mechanic who completed the work also signed off completion of the work on the company non-routine maintenance record dated August 22, at 0800.

According to TWA personnel, the maintenance performed was not required to be entered into the daily aircraft log. Therefore, the flightcrew who performed the preflight check of the airplane for the first flight after the maintenance was not aware that the No. 3 brake and wheel on the right main landing gear had been changed.

The mechanics who had performed the maintenance were long-time TWA employees--one had been employed since 1964, and the other had been employed since 1968. Both mechanics held FAA airframe and powerplant certificates and were company-qualified to perform airplane maintenance. Neither had ever changed the wheel/brake assembly on a Boeing 767. TWA training records showed that neither mechanic had been trained or instructed regarding the "differences" between changing the wheel/brake assembly on the Boeing 767 and on other Boeing airplanes.

The changing of the wheel/brake assembly on N609TW was done at the terminal gate where the passengers board. The mechanics stated that they used the lighting that was available from the terminal gate area and from flashlights. They did not set up flood lights to illuminate the work area.

The Safety Board believes that during the installation of the wheel/brake assemblies, the mechanics installed the pin through the end of the brake rod, but only partially into the brake torque arm. The bolt used to secure the pin in the torque arm and prevent it from migrating outward probably was not inserted through the hole in the pin. The Safety Board believes that the brake rod was partially attached to the brake torque arm throughout taxi, takeoff, and gear retraction because the brake stack had not moved in the direction of rotation when brake pressure was applied during taxi; the hydraulic lines were not broken; and the bottom of the brake rod was not marred or scratched from dragging on the ground. However, when the landing gear was retracted, the No. 3 brake rod connector pin would have been head end downward. The Safety Board believes that during the en route phase of the flight, the pin dropped out of the brake torque housing allowing the brake rod to move horizontally until coming to rest on the landing gear door pad, preventing the landing gear from extending before landing.

During the investigation, the Safety Board examined the procedure for removal/installation of the main landing gear wheel/brake assembly. There were specific procedures pertaining to the removal/installation of the assembly that were not clear, and there were inconsistencies in existing nomenclature. These anomalies were discussed with Boeing, and it published and distributed revisions to the Boeing 767 maintenance manual to provide more specific and clear procedures. (See figure 4.) These changes included illustrating a larger and clearer cross section of the axle with the wheel removed, positive identification of the "brake housing torque arm," the listing of a "cotter pin" as a part of the pin retaining bolt assembly, and a procedure to re-install the pin and retaining bolt to the brake torque arm housing.

The Safety Board's investigation also noted that the L-3 emergency door did not open fully enough to deploy the slide. Later, when the airplane was back on the runway with all landing gears extended, the L-3 door was tested. During the postincident examination of the L-3 door, it opened and closed normally.

The Boeing Company conducted postincident tests to determine how various fuselage roll angles would affect the operation of the L-3 door in the Boeing 767. Similar testing had been conducted in conjunction with the FAA evaluation of the B. F. Goodrich configuration of the door with the slide/raft-emergency kit installed before the FAA issued a Supplemental Type Certificate (STC). In the certification testing, a mockup door was tested for proper operation at roll angles up to 12 degrees, to assure that the door would operate if the airplane had to be landed with a main gear retracted. The door operated properly with the emergency kit installed during the STC associated testing. However, in the postincident testing, at about the same angle at which the door had been tested during certification, the slide deployment bar contacted the emergency kit, preventing the door from being opened.

The Safety Board believes that the modified door met the certification requirements in conditions similar to the incident circumstances, but the emergency kit probably had shifted slightly or had become misshapened in service, and for one of those reasons interfered with the operation of the L-3 door.

In an effort to prevent future similar incidents, the FAA, on August 23, 1988, amended the STC to locate the emergency kit to the top of the slide/raft and to place restraining straps on the kit to keep it from shifting in service. The Safety Board found that only TWA and one foreign carrier used this door-slide installation. Following the incident, both carriers moved the emergency kit to prevent it from obstructing door operation in their Boeing 767 airplanes.

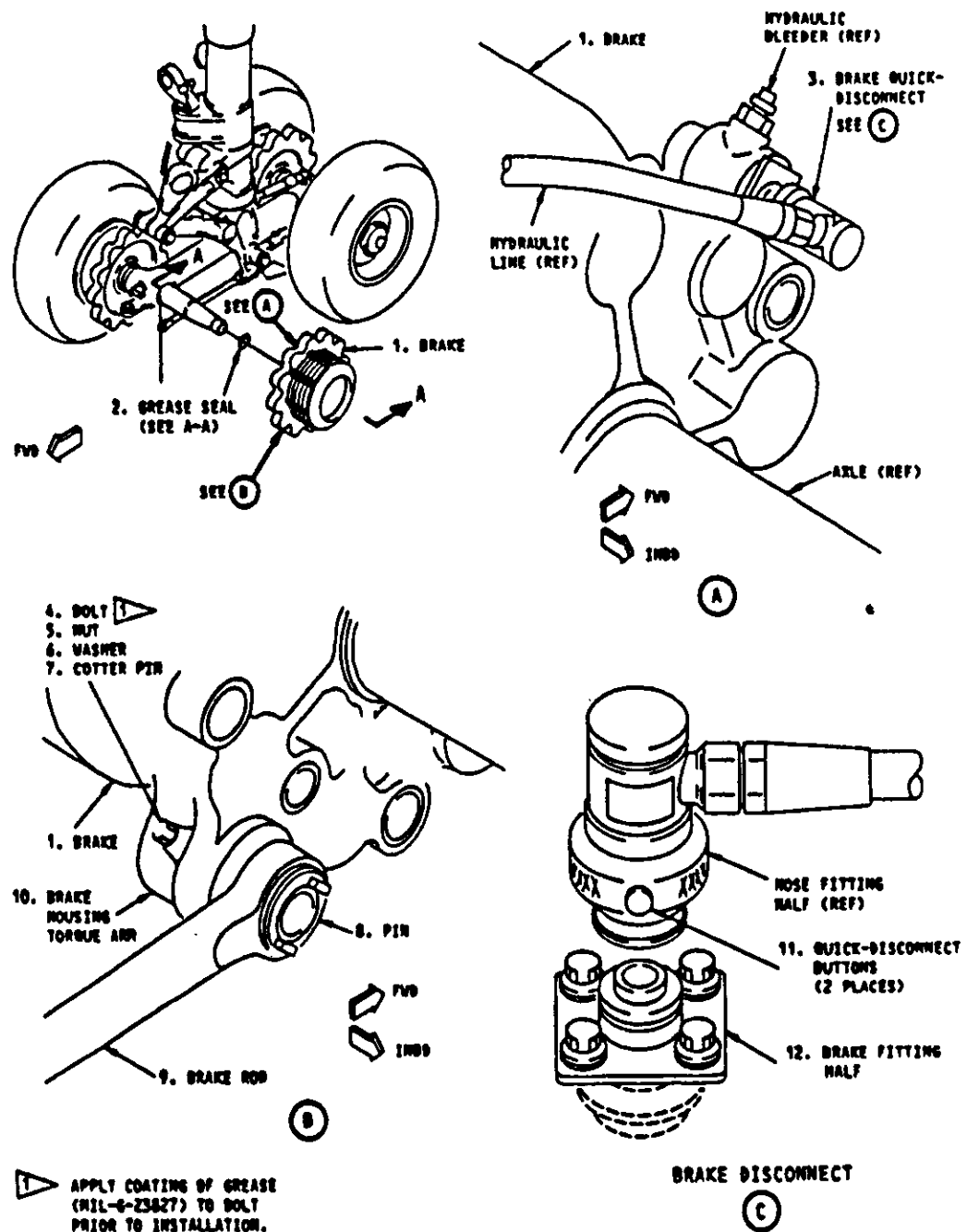
### Probable Cause

The National Transportation Safety Board determines that the probable cause of this incident was the improper installation of the No. 3 right main landing gear wheel/brake assembly and the inadequate inspection of the maintenance.



# BOEING 767

## MAINTENANCE MANUAL



Main Gear Brake Installation  
Figure 401 (Sheet 1)

19007

EFFECTIVITY \_\_\_\_\_

32-41-08

**Recommendations**

As a result of this incident, the National Transportation Safety Board issued the following recommendations:

--to the Federal Aviation Administration:

Issue an airworthiness advisory to illustrate the proper procedures for replacement of Boeing 767 wheel/brake assemblies. (Class II, Priority Action) ( A-89-24)

Issue an air carrier operations bulletin that would establish procedures whereby flightcrews would be informed of any maintenance performed on items that are required to be airworthy for flight. (Class II, Priority Action) ( A-89-25)

--to Trans World Airlines:

Review and amend maintenance assignment policies to ensure that persons performing maintenance actions are properly trained on the specific piece of equipment, aircraft, or engine. (Class II, Priority Action) ( A-89-26)

The attached brief of accident contains the Safety Board's findings.

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

/s/ JAMES L. KOLSTAD  
Acting Chairman

/s/ JIM BURNETT  
Member

/s/ JOHN K. LAUBER  
Member

/s/ JOSEPH T. NALL  
Member

/s/ LEMOINE V. DICKINSON, JR.  
Member

**April 18, 1989**

National Transportation Safety Board  
Washington, D.C. 20594

Brief of Incident

File No. - 5076      8/22/87      BELLEVILLE, IL      A/C Reg. No. N609TW      Time (Lcl) - 1312 CDT

-----Basic Information-----

Type Operating Certificate-AIR CARRIER - FLAG/DOMESTIC      Aircraft Damage      Injuries      Fatal      Serious      Minor      None  
Name of Carrier      -TRANSWORLD AIRLINES      MINOR      0      0      0      9  
Type of Operation      -SCHEDULED DOMESTIC;FAX/CARGO      Fire      0      0      3      169  
Flight Conducted Under      -14 CFR 121  
Incident Occurred During      -LANDING

-----Aircraft Information-----

Make/Model      - BOEING 767-231ER      Eng Make/Model - P & W JT9D-7R4D  
Landing Gear      - TRICYCLE-RETRACTABLE      Number Engines - 2  
Max Gross Wt      - 310000      Engine Type      - TURBOFAN  
No. of Seats      - 192      Rated Power      - 40550 HP

ELT Installed/Activated - NO -N/A  
Stall Warning System - YES

-----Environment/Operations Information-----

Weather Data  
WX Briefing      - COMPANY  
Method      - IN PERSON  
Completeness      - FULL  
Basic Weather      - VMC  
Wind Dir/Speed- 330/012 KTS  
Visibility      - 7.0 SM  
Lowest Sky/Clouds      - 5000 FT SCATTERED      Type of Flight Plan - IFR  
Lowest Ceiling      - NONE      Type of Clearance      - IFR  
Obstructions to Vision- NONE      Type Appch/Lnds      - TRAFFIC PATTERN  
Precipitation      - NONE      FULL STOP  
Condition of Light      - DAYLIGHT

Airport Proximity

ON AIRPORT

Airport Data

SCOTT AFB  
Runway Ident      - 32  
Runway Lth/Wid      - 7061/ 150  
Runway Surface      - CONCRETE  
Runway Status      - DRY

-----Personnel Information-----

Pilot-In-Command  
Certificate(s)/Rating(s)  
ATP  
SE LAND,ME LAND  
GLIDER

Age - 55  
Biennial Flight Review  
Current      - YES  
Months Since      - 2  
Aircraft Type      - 767

Medical Certificate - VALID MEDICAL-NO WAIVERS/LIMIT  
Flight Time (Hours)  
Total      - 16900      Last 24 Hrs - 6  
Make/Model- 1193      Last 30 Days- UNK/NR  
Instrument- 100      Last 90 Days- UNK/NR  
Multi-Eng - 16000

Instrument Rating(s) - AIRPLANE

-----Narrative-----

DRG APCH TO ST. LOUIS AN UNSAFE RT MLGR INDICATION WAS NOTED. NORMAL AND ALT GR EXTENSION PROCEDURES WERE INEFFECTIVE IN LOWERING RT MLGR. DIVERTED TO SCOTT AFB AND LNDG WITH RT MLGR RETRACTED. EVAC WAS ORDERLY EXCEPT L3 DOOR WOULD NOT OPEN BECAUSE SLIDE DEPLOYMENT BAR WAS CAUGHT UNDER EXTERNALLY MOUNTED EMERG KIT. AT SFO, TWA HAD REPLACED NO. 3 BRAKE & WHL ASSY. PIN USED TO SECURE THE BRAKE ROD TO THE BRAKE TORQUE ARM WAS NOT INSTALLED PROPERLY AND FELL OUT DRG FLT, ALLOWING BRAKE TORQUE ARM TO MOVE HORIZ TO TOP OF GR DOOR PAD AND TO PREVENT EXTENSION OF GR. MAINT PERS NOT TRAINED ON BOEING DIFFERENCES. MAINT DONE IN EARLY AM HOURS AT GATE.

Brief of Incident (Continued)

Time (Lcl) - 1312 CDT

A/C Reg. No. N609TW

BELLEVILLE, IL

8/22/87

File No. - 5076

Occurrence #1 AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION  
Phase of Operation APPROACH

Findings(s)

1. LANDING GEAR, NORMAL BRAKE SYSTEM - NOT SECURED
2. MAINTENANCE, INSTALLATION - IMPROPER - COMPANY MAINTENANCE PSNL
3. INSTRUCTIONS, WRITTEN/VERBAL - INADEQUATE - COMPANY/OPERATOR MGMT
4. LIGHT CONDITION - DARK NIGHT
5. MAINTENANCE, INSPECTION OF AIRCRAFT - INADEQUATE - COMPANY MAINTENANCE PSNL

Occurrence #2 GEAR NOT EXTENDED  
Phase of Operation LANDING

Findings(s)

6. LANDING GEAR, NORMAL RETRACTION/EXTENSION ASSEMBLY - FAILURE, PARTIAL
7. LANDING GEAR, NORMAL RETRACTION/EXTENSION ASSEMBLY - JAMMED
8. MISC EQPT/FURNISHINGS, SLIDES - BINDING (MECHANICAL)

-----Probable Cause-----

The National Transportation Safety Board determines that the Probable Cause(s) of this incident is/are findings(s) 1,2,5



## National Transportation Safety Board

Washington, D.C. 20594

# AIRCRAFT ACCIDENT/INCIDENT SUMMARY

File No.:	1505
Aircraft Operator:	Eastern Air Lines, Inc.
Type and Registration:	McDonnell Douglas DC-9-31, N8948E
Location:	Pensacola Regional Airport, Pensacola, Florida
Date and Time:	December 27, 1987; 2339 central standard time
Occupants on Board:	4 crew, 103 passengers
Injuries:	4 minor injuries
Aircraft Damage:	Substantial
Type of Occurrence:	Hard landing
Phase of Operation:	Landing flare/touchdown

On December 27, 1987, at 2339, a McDonnell Douglas DC-9-31, N8948E, operating as Eastern Air Lines flight 573 (EA573), was substantially damaged during a hard landing at the Pensacola Regional Airport, Pensacola, Florida. The scheduled passenger flight had departed Atlanta, Georgia, at 2245 on an instrument flight rules (IFR) flight plan. Instrument meteorological conditions prevailed at the time of the accident. No fire occurred, but the captain ordered an emergency evacuation after the airplane came to a stop on the runway. The airplane carried 107 people: 100 revenue passengers, 3 nonrevenue passengers (one of whom occupied the cockpit jumpseat), 2 flightcrew members, and 2 flight attendants. Four passengers sustained minor injuries during the emergency evacuation.

The en route phase of the flight was uneventful. With the captain flying the airplane, EA573 contacted Pensacola Approach Control indicating receipt of automatic terminal information service (ATIS) "India" at 2323:40. The controller advised the flightcrew to expect an instrument landing system (ILS) approach to runway 16, vectored the flight around weather, and issued descent instructions. At 2330:10, the controller advised that the glideslope monitor in the tower had just gone into "alarm"<sup>1</sup> but the localizer appeared normal. At 2331:42, the controller advised the flight that the wind was beginning to shift and was then from 310° at 7 knots. At 2332:33, EA573 was cleared for the ILS approach and advised that the glideslope was still indicating in alarm. At 2333:51, the controller reported the wind from 300° at 7 knots and again stated that the glideslope was in alarm. At 2334:36, the controller advised that a new weather observation showed a measured 900-foot overcast ceiling with visibility 2 miles, rain, and fog. The flightcrew acknowledged and stated they would execute the localizer approach if they did not receive the glideslope. At 2336:24, the flightcrew reported they appeared to have the glideslope. The controller acknowledged and reported that the glideslope was still in alarm, cleared the flight to land, and reported the wind from 310° at 7 knots. At

<sup>1</sup>Equipment in the tower that monitors the ILS glideslope for reliability and alerts controllers when reliability parameters are not met.

2339:12, the flightcrew reported a hard landing and advised they would evacuate the airplane. Tower personnel then summoned emergency equipment.

After the accident, the flightcrew stated that on being advised that the wind had shifted to the northwest, they reset the airspeed reference indicators to the computed reference speed ( $V_{ref}$ ) of 126 knots for a landing with the wing flaps extended 50°. When advised that the glideslope was indicating unreliability, they briefed for localizer-only minimums of 500 feet msl.<sup>2</sup> Although the glideslope appeared to be presenting reliable information, they did not rely on that indication. The crew observed the approach lights when breaking out of the clouds at about 900 feet msl (779 feet agl). Touchdown on the runway was hard. During rollout the airplane did not respond normally to the flight controls and the crew noted that the engine reverse thrust system had become inoperable. However, directional control was maintained, braking appeared normal, and the airplane was stopped on the runway about 300 feet from the departure end.

The captain stated he elected the 50° wing flap setting instead of the normal 40° because of the downsloping runway, quartering tailwind, and the possibility of a wet runway. The airplane was heavily loaded but operating within the applicable weight limitations. The captain said he had to apply more power than normally required to maintain the desired airspeed and rate of descent for the 50° flap setting. He said he executed primarily a visual approach after sighting the approach lights. He also said the rain did not restrict visibility much and that there was no glare from the landing lights. The captain did not think he was high on the glideslope when the first officer so advised. The captain reported that he was comfortable with the approach the entire way.

The first officer reported that when they were in visual contact with the runway environment, about a mile out, he thought they were high and told the captain he was high on the glideslope. He said he thought he had advised the captain a second time, but a second comment is not indicated by the transcription of the cockpit voice recorder (CVR). (Data from the flight data recorder (FDR) indicate that the airplane was about 400 feet above the ground and 2,000 feet from the runway when the first officer advised the captain that he was high.) The first officer said his first comment was based on the glideslope indicator presentation, and the second was based on that and visual reference.

The occupant of the cockpit jumpseat was an Eastern Air Lines DC-9 first officer. He stated that shortly before arriving at the sequenced flashers of the approach light system, the airplane seemed to level off. The glidepath indication showed the airplane above the glidepath and the approach lights disappeared from sight under the nose. He recalled the first officer advising the captain of the glidepath indications. The captain responded by reducing power and pushing the nose over. As the landing lights illuminated the runway, the airplane was in a higher-than-normal rate of descent. The first officer advised the captain to flare. The jumpseat occupant said the captain then executed a rounding out maneuver but did not get the nose above a level attitude before the airplane struck the runway. He said the airplane touched down hard in a slightly nose-down attitude, bounced back into the air, and came down hard again. He perceived that the nose wheel touched before the main wheels on the first impact. He noted that several warning lights on the

<sup>2</sup>Runway 16 touchdown zone elevation was 121 feet msl.

annunciator panel and both master caution lights illuminated during the hard landing. The jumpseat occupant noticed only light turbulence during the approach.

The flight attendant occupying the inboard side of the double jumpseat at the forward cabin bulkhead said she heard "Pull up, pull up" (from the ground proximity warning system (GPWS)) immediately before they hit the ground. She said the airplane bounced "way back up" then hit the ground again. She saw the cabin break open and heard a loud crack and two loud compressor stalls before the aft fuselage began to slide down the runway.

As the airplane progressed down the runway, flight attendants advised over the public address (PA) system for the passengers to "grab ankles" several times. They said the passengers failed to comply but responded immediately to commands of "heads down." The CVR transcription showed that after the airplane stopped, the captain and first officer discussed evacuation, then the captain announced over the PA for passengers to evacuate by the forward left and right doors. The cabin doors were opened without difficulty and the evacuation slides inflated properly. Passengers using the tail cone exit experienced difficulty because the damaged tail section had come to rest on the ground making it difficult to remove the tail cone. Many passengers egressed through the tail cone exit. Two off-duty Eastern Air Lines flight attendants assisted in the evacuation.

Passengers were not advised during the cockpit or flight attendant PA announcements to leave personal articles behind, and many attempted to carry belongings with them. Flight and cabin crewmembers had to forcibly remove the articles from some passengers. Discarded items littered the area around the forward exits and impeded the evacuation of the airplane.

Immediately after the accident, a tower controller activated an alarm that sounded in fire station No. 6 of the Pensacola Fire Department (PFD). The station, designated as the primary response crash, fire, and rescue (CFR) station for the airport, was located 0.4 mile from the approach end of runway 16, outside the airport perimeter fence. The controller also telephoned the PFD dispatcher to report the accident and request assistance. Tower controllers informed the station No. 6 commander by radio that the airplane had stopped near the departure end of runway 16. Station No. 6 equipment entered the perimeter fence through a "knock-down" gate at the approach end of runway 16 and arrived at the scene within 3 minutes. The equipment encountered heavy rain en route to the airplane.

The PFD dispatcher alerted fire station No. 3, the designated backup CFR station, located inside the airport boundary but outside the perimeter fence 0.2 mile from the departure end of runway 16. The dispatcher, however, sent the equipment to the gate at the approach end of the runway. Therefore, instead of station No. 3 equipment responding through its assigned "knock-down" gate at the departure end of runway 16, the equipment traveled in heavy rain about 3.4 miles around the airport on city streets and entered the airport through the same gate used by the station No. 6 equipment. The station No. 3 equipment arrived on scene about 14 minutes after being notified.

Flightcrew members were properly certificated and rated to conduct the flight, and company records showed they had satisfactorily completed the required proficiency checks. The flightcrew had more than 12 hours rest or off-duty time before reporting for duty at 1615. Both pilots had often flown into Pensacola and

were familiar with the airport. The captain had 13,246 hours flight experience, including 4,397 hours in the McDonnell Douglas DC-9. The first officer had 7,129 hours flight experience, including 1,968 hours in the McDonnell Douglas DC-9.

Both flight attendants assigned to the flight had been employed by Eastern Air Lines for more than 10 years and were qualified in DC-9 airplanes. The senior flight attendant completed recurrent training in September 1987; the other flight attendant completed recurrent training in October 1987.

The surface weather observation at 2334 at Pensacola was as follows: ceiling measured 900 feet overcast; visibility 2 miles, moderate rain, fog; wind 300° at 8 knots; altimeter 30.05 inHg. No significant changes were noted in the 2350 observation which showed both the temperature and dewpoint to be 68° F. The wind gust recorder trace showed a maximum wind of 10 knots during the period 2330 to 2345. At about the time of the accident, a line of weak to strong (VIP level 1 to 3)<sup>3</sup> weather echos was passing over the airport with the eastern edge of a moderate to strong (VIP level 2 to 3) weather echo at the approach end of runway 16. The flightcrew reported rain at the time of the approach and landing. The sound of the airplane's windshield wipers was recorded on the CVR. A study of the mean wind profile did not indicate the presence of windshear. However, the Safety Board found that since the approach and landing occurred in a moderate to heavy rain shower in convective activity that was moving across the field, the possibility of windshear could not be eliminated.

Runway 16 was grooved asphalt; 7,002 feet long; 150 feet wide; and had a downslope grade of approximately 0.3 percent. The field elevation was 121 feet msl. Runway 16 was equipped with high-intensity runway lights, high-intensity approach lights, and sequenced flashers in addition to the ILS. A visual approach slope indicator (VASI) was not available for runway 16. The decision height for the ILS runway 16 approach was 321 feet msl, and the minimum descent altitude for the localizer-only approach was 500 feet msl.

The ILS glideslope monitor, located in the control tower, received radio-frequency energy from the glideslope transmitter. When the radio-frequency energy level falls below predetermined levels or is interrupted for a period of 6 seconds, the monitor produces both an aural and visual alarm in the control tower. Review of the runway 16 ILS maintenance logs showed no preexisting or recurring problems with the glideslope transmitter in the 6 weeks before the accident. A postaccident ground check of the glideslope transmitter and monitor indicated that the equipment was within operational parameters. The glideslope was recertified and returned to service at 0147 on December 28, 1987. A postaccident operational flight check of the runway 16 ILS by the Federal Aviation Administration (FAA) indicated satisfactory operation.

The Safety Board could not determine why the ILS system was in an alarm status during the approach of EA573. The technician responsible for maintenance of the solid state system reported that it had an excellent operational history with no recurring problems since installation in May 1985. He said he had been called on two occasions in the past when the glideslope monitor showed an alarm status. On

<sup>3</sup>Video integrator and processor (VIP) levels define 6 levels of radar echo reflectivity. These levels correspond to specific expected precipitation rates.



one occasion, he found the glideslope transmitter operating normally at the site while the monitor in the tower cab indicated alarm status. On the second occasion, the glideslope alarm ceased before he arrived and he found the system operating normally. He noted that on both occasions heavy rain was occurring. He considered the monitor system very reliable but added that, as with the transmission of any radio-frequency energy, fading or bending is possible due to atmospheric conditions or heavy rain.

N8948E, airframe serial No. 47184, was manufactured in 1968. Records showed that the airplane was maintained according to applicable regulations. The airplane had accumulated 55,645 hours in service and 52,937 landing cycles at the time of the accident. The airplane records documented no previous hard landings; one overweight landing occurred in April 1987.

The exact point of touchdown on the runway could not be determined because of heavy rubber deposits in the touchdown zone. A piece of the door hinge pin for the left landing gear was found about 700 feet beyond the runway threshold. A scrape in the pavement began 1,130 feet beyond the threshold and continued almost uninterrupted to the point where the tail of the airplane came to rest 377 feet from the departure end of the runway. Debris--including fuselage stringer sections, insulation, and cabin window seal material--was scattered in the path of the airplane on the runway.

EA573 stopped with the lower empennage resting on the runway. A fracture in the top of the cabin originated at fuselage station 813, angled forward to the top of the cabin windows, and continued downward into the main wheel well areas. In the left wheel well, the aft bulkhead was cracked diagonally from the lower outboard corner to the upper inboard corner, and the keel beam was buckled near the center of the wheel well. Broken and upwardly displaced frames and stringers, and sheet metal tearing and abrasions were observed where the tail skid and aft lower fuselage were in contact with the runway. Inside the airplane, a circumferential separation between seat rows 21 and 22 extended upward from the floor. With the tail resting on the ground, the cabin area aft of seat row 21 was deflected downward about 20° (see figure 1.) The fracture surfaces along the break in the fuselage structure were typical of static overload failures. No evidence of corrosion or preexisting cracks were found.

Functional tests of the VOR/ILS receivers, air data computer, captain's steering computers and amplifier, flight directors, altimeters, airspeed indicators, vertical speed indicators, and the GPWS computer disclosed no significant operational anomalies.

The Safety Board found that the spring tension on the captain's windshield wiper arm was about 5 pounds, while that of the first officer's was about 9 pounds. Nominal tension is 10 pounds, plus or minus 1 pound. Inadequate windshield wiper arm spring tension during flight through rain can degrade rain removal capability and cause visual illusions. Although neither the captain nor the jumpseat occupant reported difficulty seeing the runway environment, the Safety Board was not able to resolve whether the lower-than-normal spring tension on the captain's windshield wiper arm affected his ability to clearly distinguish the runway environment. A review of the Eastern Air Lines maintenance program disclosed that verification of windshield wiper spring tension was not required during scheduled periodic inspections. Spring tension measurements were usually made when troubleshooting

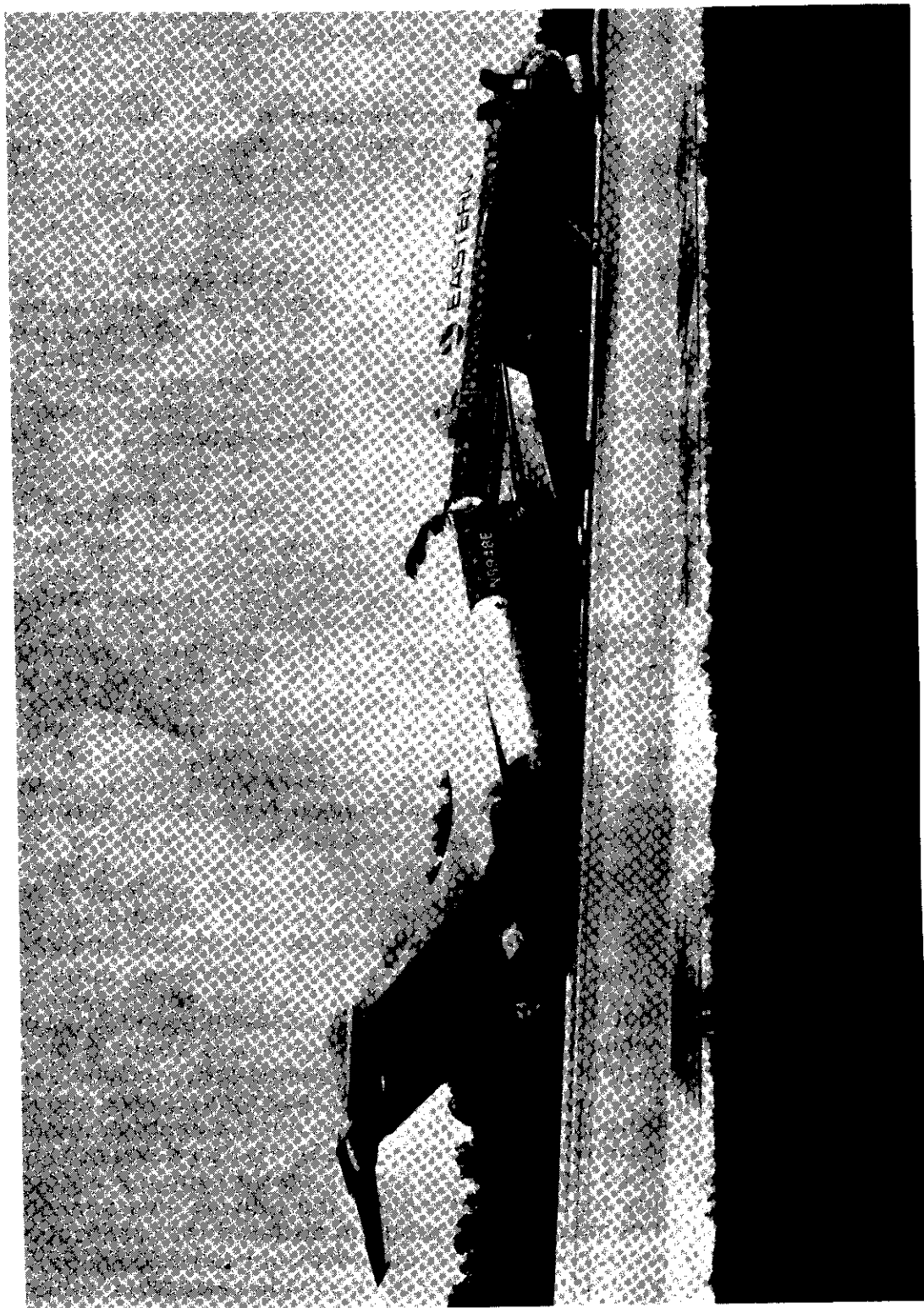


Figure 1.--Side view of fuselage after the hard landing.

windshield wiper discrepancies reported by pilots. The daily log sheets for N8948E indicated that two adjustments to the captain's windshield wiper were made in the year preceding the accident, most recently on August 22, 1987, in response to pilot discrepancy reports. Because insufficient tension of the wiper can cause degraded rain removal capability, the Safety Board believes that Eastern Air Lines' practice of examining windshield wiper blade tension only after pilot discrepancy reports does not provide adequate assurance that wipers will perform effectively during adverse weather conditions, when their performance could be critical to flight safety. The Safety Board believes that periodic verification of proper windshield wiper spring tension should be performed by air carriers using similar windshield wiper equipment.

The GPWS provides aural and visual warnings of five hazardous conditions between radio altitudes of 2,450 and 50 feet. The GPWS is equipped with mode indicators that trip when a warning for a particular mode is activated (e.g., Mode 1 provides a warning of excessive sink rate.) The Mode 1 indicator on the GPWS computer was found tripped. Operation of the GPWS during the approach and landing was confirmed by the CVR that recorded the "pull up" warning about 3 seconds before ground contact. The Mode 1 indicator is designed to trip at a sink rate of 1,345 feet per minute or about 22 feet per second at a radio altitude of 50 feet. The DC-9 design limit for landing sink rate is 10 feet per second.

The transcription of the Fairchild model A-100 CVR documented cockpit sounds from 2308:20, when the airplane was climbing to the assigned cruise altitude, until 2339:46, after the engines were shut down. The transcription confirmed that the flightcrew complied with the requisite checks and briefings before commencing the approach; however, the captain, as the flying pilot, did not make altitude awareness callouts during the approach as required by the Eastern Air Lines Flight Operations Manual. Neither did the first officer challenge the absence of these callouts, as required by company procedures.

Eastern Air Lines procedures require that the pilot flying the airplane make the following callouts during nonprecision approaches:

Crossing Altitude -- at the final approach fix, or at a selected appropriate point on the approach chart.

1,000 feet above field elevation.

Any significant deviation from glidepath when below 1,000 feet. "Immediate corrective action will be taken or the approach will be abandoned."

100 feet above the minimum altitude specified for the approach.

Minimum altitude.

Note: Callouts shall be verbally acknowledged by the pilot not flying (PNF). Visual cues . . . such as ground contact, approach lights, etc., should be called out by the PNF.

Postaccident statements by the flightcrew and the absence of required altitude callouts indicate that both crewmembers were focusing their attention outside the cockpit during the approach rather than on the flight instruments. Although the

flightcrew members were apparently responding to a natural urge to search for the runway and to establish a desired visual descent profile during the visual portion of a nonprecision instrument approach, the Safety Board believes that greater attention to the timely and accurate cockpit indications of airspeed and rate of descent would have provided the crew earlier and more positive indications that the approach had become destabilized. Such information, if known by the captain, may have enabled him to take necessary action to correct the glidepath and to prevent the accident. The Safety Board believes that consistent with Eastern Air Lines procedures, the captain should have initiated a missed approach as soon as a significant deviation from glidepath was detected, late in the approach.

The foil readout of the Sundstrand model FA-542 FDR showed that all parameter and binary traces were present and active, and appeared to have been recorded in a normal manner. However, an abnormality in the foil takeup drive system resulted in periodic gaps of variable spacing in all parameter traces. The condition was most prominent at the landing touchdown where there was a gap in the recorded data of approximately 6 seconds. FDR readout values were arithmetically corrected to bring all data into proper time alignment.

An FDR readout was prepared for about the last 12 minutes of the flight. The readout showed that the heading and vertical acceleration traces remained fairly constant in the 4 minutes before touchdown. The readout showed an airspeed of 155 knots when the airplane intercepted the glideslope about 2 minutes before touchdown. The speed decreased to 125 knots 50 seconds before touchdown and then increased to 145 knots 12 seconds before touchdown. The altitude trace showed a fairly constant rate of descent of about 550 feet per minute (equivalent to a 2.4° glidepath) after the airplane intercepted the glideslope until 14 seconds before touchdown, when the descent rate increased to a rate exceeding 1,300 feet per minute. The FDR indicated that the airplane was about 500 feet above the ground or 150 feet above the ILS glidepath when it was 1 mile from the runway. The airplane remained about 150 feet above the glidepath until it was 2,000 feet from the runway. The FDR readout showed large excursions in all of the traces at touchdown and immediately thereafter.

Toxicological studies of specimens voluntarily submitted by the captain were negative for alcohol and drugs. On August 15, 1988, the Safety Board received medical records relating to the captain from the Air Line Pilots Association (ALPA). The records showed that on April 4, 1988, the captain was diagnosed as having Parkinson's disease. The report by the Emory Clinic in Atlanta, Georgia, stated that in the previous 2 years the captain had noticed a peculiar sensation in his left shoulder and arm, and in the previous few months had noticed a tremor of his left upper extremity.

The medical records showed that the captain complained to his doctor 3 days after the accident, on December 30, 1987, of intermittent nervousness in his left arm that had become more evident since the airplane accident. The report from a neurologist who examined the captain on January 13, 1988, indicated he first noticed some vague weakness, nervousness, and sometimes a tremulousness in his left arm and hand about a year earlier. Following a second visit to the neurologist on February 9, 1988, the captain was given "a clean bill of health from a neurologic standpoint" and was returned to his primary physician. The Mayo Clinic in Rochester, Minnesota, completed a special aeromedical evaluation on May 24, 1988, and reported that the captain had noticed some increasing fatigue and weakness in

his left arm for several years, and earlier in 1988 had noticed some mild tremor in his left arm and hand.

Following its review of the medical records received from ALPA, the Safety Board requested and reviewed the captain's medical records on file with the FAA. In five applications for medical certificates since October 2, 1985, the captain reported no changes in his medical condition or any illnesses.

Parkinson's disease begins insidiously with any of its three cardinal manifestations characterized by tremor, muscular rigidity, and a loss of postural reflexes, either alone or in combination. Tremor, usually in one but sometimes in both hands, involving the fingers in a pill-rolling motion, is the most common initial symptom according to medical references. This symptom is often followed by stiffness in the limbs, general slowing of movements, and inability to carry out normal and routine daily functions with ease.

Based on the review of the captain's medical records and study of the symptoms of Parkinson's disease, the Safety Board does not believe the early symptoms being experienced by the captain at the time of the accident had progressed sufficiently to adversely affect his ability to fly the airplane. Nonetheless, the Safety Board is concerned that the captain withheld information regarding the early symptoms he was experiencing on his recent applications for FAA airman medical certificates.

The Safety Board believes that significant windshear was not encountered during the approach and landing. The observations of the first officer and jumpseat occupant, in conjunction with data presented on the FDR readout, indicated that the captain allowed the latter stages of the approach to become destabilized. The FDR readout showed a significant increase in airspeed which, when coupled with the steepened slope of the descent profile, caused the airplane to contact the runway with an excessive sink rate. The high rate of descent was confirmed by FDR data, the crew observations, the GPWS alert, and the damage sustained by the airplane.

The National Transportation Safety Board determines that the probable cause of the accident was the captain's failure to maintain a proper descent rate on final approach or to execute a missed approach, which caused the airplane to contact the runway with a sink rate exceeding the airplane's design limitations. Contributing to the cause of the accident was the failure of the captain and first officer to make required altitude callouts and to properly monitor the flight instruments during the approach.

The Safety Board found the circumstances of the evacuation of EA573 to be similar to those of the evacuation of an American Airlines DC-9-83, at Nashville, Tennessee, on February 3, 1988.<sup>4</sup> During that evacuation following a hazardous material spill and fire in a cargo compartment, passengers were orally instructed, as they approached the emergency slides, to leave personal articles behind and to

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<sup>4</sup>Hazardous Materials Incident Report: In-flight Fire, McDonnell Douglas DC-9-83, N569AA, Nashville Metropolitan Airport, Nashville, Tennessee, February 3, 1988 (NTSB/HZM-88/02).

remove their shoes before they exited the aircraft. The airline's safety briefing cards did not contain these instructions. The discarded articles littered the floor near the exits and hampered the evacuation of the airplane. As a result of that incident, the Safety Board recommended that the Federal Aviation Administration:

A-88-128

Instruct principal operations inspectors to determine if passenger safety cards and flight attendant instructions to passengers for emergency evacuations are consistent with each air carrier's evacuation procedures.

The FAA responded to this safety recommendation in a letter dated January 5, 1989, stating that an Advisory Circular (AC) was being developed to address the problem. It was stated that the AC would include information on passenger briefing and information cards as well as a discussion of flight attendant instructions to passengers. The Safety Board is holding Safety Recommendation A-88-128 in an "Open--Acceptable Action" status pending review of the proposed AC. American Airlines has advised the Safety Board that they will revise their safety instruction cards to advise passengers to remove heel shoes and not to carry personal articles during the evacuation of an airplane.

As a result of this accident, the Safety Board made the following recommendations to the Federal Aviation Administration:

Review the design and service history of spring tension type windshield wiper blades used on large air carrier aircraft to determine an appropriate inspection interval for verifying wiper spring tension. (Class II, Priority Action) (A-89-31)

Require operators of large air carrier aircraft equipped with spring tension-type windshield wiper blades to inspect and adjust windshield wiper blade tension at appropriate intervals. (Class II, Priority Action) (A-89-32)

The attached brief of accident contains the Safety Board's findings.

**BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

/s/ JAMES L. KOLSTAD  
Acting Chairman

/s/ JIM BURNETT  
Member

/s/ JOHN K. LAUBER  
Member

/s/ JOSEPH T. NALL  
Member

/s/ LEMOINE V. DICKINSON, JR.  
Member

May 9, 1989

**National Transportation Safety Board  
Washington, D.C. 20594**

**Brief of Accident**

File No. - 1505      12/27/87      PENSACOLA, FL      A/C Reg. No. N8948E      Time (LCL) - 2339 CST

-----Basic Information-----

Type Operating Certificate-AIR CARRIER - FLAB/DOMFSTIC	Aircraft Damage				
Name of Carrier -EASTERN AIR LINES	SUBSTANTIAL	Fatal	0	0	4
Type of Operation -SCHEDULED-DOMESTIC,PASSENGER	Fire	Crew	0	0	4
Flight Conducted Under -14 CFR 121	NONE	Pass	0	0	99
Accident Occurred During -LANDING					

-----Aircraft Information-----

Make/Model - MCDONNELL-DOUGLAS DC-9-31	Eng Make/Model - P&W JT8J-7B	ELT Installed/Activated - NO	N/A
Landing Gear - TRICYCLE-RETRACTABLE	Number Engines - 2	Stall Warning System - YES	
Max Gross Wt - 105000	Engine Type - TURBOFAN		
No. of Seats - 106	Rated Power - 14000 LBS THRUST		

-----Environment/Operations Information-----

Weather Data

Mx Briefing - COMPANY	Itinerary
Method - IN PERSON	Last Departure Point
Completeness - FULL	ATLANTA, GA
Basic Weather - IMC	Destination
Wind Dir/Speed- 310/007 KTS	SAME AS ACC/INC
Visibility - 2.000 SM	ATC/Airspace
Lowest Sky/Clouds - N/A	Type of Flight Plan - IFR
Lowest Ceiling - 900 FT OVERCAST	Type of Clearance - IFR
Obstructions to Vision- FOG	Type Aech/Lnds - ILS-LOCALIZER
Precipitation - RAIN	
Condition of Light - NIGHT(DARK)	

-----Personnel Information-----

Pilot-In-Command	Age - 52	Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT
Certificate(s)/Rating(s)	Biennial Flight Review	Flight Time (Hours)
ATP,FLT ENG	Current - YES	Total - 13246
SE LAND,ME LAND	Months Since - 4	Make/Model - 4397
HELICOPTER	Aircraft Type - DC-9	Instrument - UNK/NR
		Multi-Eng - UNK/NR
		Rotorcraft - UNK/NR

Instrument Ratings(s) - AIRPLANE

-----Narrative-----

EASTERN FLT 573 CTCD APCH CTL AT 2323 CST, WAS ADZD TO EXPECT AN ILS RWY 16 APCH & WAS VECTORED ARND WX. AT 2330, THE CTLR ADZD THE ILS GLIDE SLOPE (G/S) HAD GONE INTO 'ALARM' BUT THE LOC APPEARED NML. AT 2333, THE WND SHIFTED TO 310 DEG AT 7 KTS. SINCE THE BC APCH TO RWY 34 WAS NOTAMED AS INOP, THE CREW CONTD TO RWY 16, USING 50 DEG OF FLAPS. AT 2334, THEY TOLD THE CTLR, 'IF YOU DON'T GET THE G/S UP, WE'LL DO A .LOC APCH.' THEY RPTD RECEIVING THE G/S, BUT WERE ADZD THE G/S WAS STILL IN ALARM. THE ACFT BROKE OUT OF CLDS IN RAIN AT 900' LBT TURRC WAS ENCTR ON FINAL APCH. AT ABOUT 1 MILE OUT, THE F/O NOTED THE ACFT WAS HIGH AND ADVISED THE CAPT. THE CAPT PUSHED THE NOSE OVER AND REDUCED POWER, INCREASING SPEED AND RATE OF DESCENT. RECD ALT CALLOUTS WERE NOT MADE. F/O ADVISED CAPT TO FLARE, BUT FLARE WAS INADDT. THE ACFT TOUCHED DOWN HARD & THE FUSELAGE FAILED BTN STNS 813 & 756. ACFT WAS STOPPED WITH THE TAIL RESTING ON THE RWY. 4 PAX RECD MINOR INJURIES DRG EVAC. WX STUDY SHOWED A HND TO STRONG (VLP LVL 2 TO 3) WX ECHO OVER THE APCH END OF RWY 16.

Brief of Accident (Continued)

File No. - 1505 12/27/87 PENSACOLA, FL A/C Reg. No. N8948E Time (Lcl) - 2339 CST

Occurrence #1 HARD LANDING  
Phase of Operation LANDING - FLARE/TOUCHDOWN

Findings(s)

1. LIGHT CONDITION - NIGHT
2. WEATHER CONDITION - FOG
3. WEATHER CONDITION - RAIN
4. WEATHER CONDITION - TAILWIND
5. TERRAIN CONDITION - DOWNHILL
6. AIRPORT FACILITIES, VISUAL APCX SLOPE IND(VASI) - UNAVAILABLE
7. PROPER DESCENT RATE - NOT MAINTAINED - PILOT IN COMMAND
8. MISSED APPROACH - NOT PERFORMED - PILOT IN COMMAND
9. CREW/GROUP COORDINATION - NOT PERFORMED -
10. FLIGHT AND NAVIGATION INSTRUMENTS - INATTENTIVE - PILOT IN COMMAND
11. FLARE - IMPROPER - PILOT IN COMMAND

-----Probable Cause-----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident is/are findings(s) 7,8,11

Factor(s) relating to this accident is/are findings(s) 9,10



## ERRATA

**THESE CORRECTIONS SHOULD BE MADE  
TO THE PREVIOUSLY PUBLISHED REPORT  
IDENTIFIED AS FOLLOWS**

### AIRCRAFT ACCIDENT REPORT

GRAND CANYON AIRLINES, INC.,  
AND HELITECH, INC.,  
MIDAIR COLLISION OVER  
GRAND CANYON NATIONAL PARK  
JUNE 18, 1986

NTSB/AAR-87/03(PB87-910403)

Page 27, paragraph 3, lines 1-3

Delete, "Moreover, there was no evidence that the NPS worked with the FAA in making suggestions on route changes to the operators or considered the safety implications of those suggestions."

Add the last sentence of paragraph 3 to paragraph 2.

Page 28, Conclusion 11, line 2

Change

the word "influence"

To

"require changes in"