
Wake turbulence encounter between McDonnell Douglas MD-11 and Boeing 747, May 1, 1996

Micro-summary: This McDonnell Douglas MD-11 encountered wake turbulence from a Boeing 747 on approach.

Event Date: 1996-05-16 at 0633 ADT


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

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

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		NTSB ID: ANC96FA072		Aircraft Registration Number: N614FE	
		Occurrence Date: 05/16/1996		Most Critical Injury: Minor	
		Occurrence Type: Accident		Investigated By: NTSB	
Location/Time					
Nearest City/Place ANCHORAGE	State AK	Zip Code 99502	Local Time 0633	Time Zone ADT	
Airport Proximity: On Airport		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer McDonnell Douglas		Model/Series MD-11-F		Type of Aircraft Airplane	
Sightseeing Flight: No			Air Medical Transport Flight: No		
Narrative					
Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:					
<p>History of the Flight</p> <p>On May 16, 1996, about 0633 Alaska daylight time (ADT), a McDonnell Douglas MD-11-F, N614FE, sustained substantial damage when its tail struck the runway during landing at the Anchorage International Airport, Anchorage, Alaska. The airplane, operated by Federal Express Corporation, Memphis, Tennessee, as Federal Express flight 71 (FDX71), was being operated on an instrument flight rules (IFR) cross-country cargo flight under Title 14 CFR Part 121 when the accident occurred. The captain, a certificated airline transport pilot, reported minor injuries. The first officer, also a certificated airline transport pilot, was not injured. Visual meteorological conditions prevailed. The flight originated from Newark, New Jersey, about 2328 ADT, May 15, 1996.</p> <p>A Japanese Airlines Boeing 747 (JAL flight 49), contacted the Anchorage Air Route Traffic Control Center (ARTCC) at 0621:25 and reported passing 10,000 feet during its descent into the Anchorage terminal area from the northeast. The accident airplane (FDX71), also arrived in the terminal area from the northeast and advised the ARTCC of passing 10,000 feet at 0622:35. Each airplane was vectored for a visual approach to runway 24L. At 0622:50, FDX71 advised they would take runway 24R if it was available. At 0624:48, FDX71 requested a right base entry to the airport but the request was denied due to sequencing. At 0628:13, FDX71 advised the ARTCC that JAL49 was in sight. The ARTCC advised FDX71 to maintain visual separation from JAL49 and was cleared for a visual approach to runway 24R at 0628:31.</p> <p>At 0630:17, JAL49 received clearance to land on runway 24L from the Anchorage Air Traffic Control Tower (ATCT) local controller. At 0630:32, FDX71 was cleared by ATCT for a visual approach to runway 24R. At 0631:42 the local controller requested on-board inertial navigational system (INS) wind information from FDX71 and was told 180 degrees (true, 156 degrees magnetic) at 21 knots. At that time, the controller reported observing FDX71, 4 nautical miles southeast of the approach end of runway 24R. JAL 49 was observed approximately 1 mile from the approach end of runway 24L.</p> <p>The captain of FDX71 reported he was flying the airplane and turned onto the final approach at 1,000 feet mean sea level (msl). The captain was visually aligning the airplane with the visual approach slope indicator (VASI) for the runway. He indicated he was observing a "pink over white" visual angle indication from the VASI. The autopilot was disengaged and the autothrottle was engaged. About 50 feet above the ground, the captain noticed some instability of the airplane and then the airplane developed a high rate of descent. The captain initiated a wind shear "escape" procedure by applying go-around power and began pitching the nose of the airplane upward but the airplane continued to descend. The tail of the airplane scraped the runway and bounced into the air. The captain decided to discontinue the go-around maneuver and closed the throttles. The airplane descended and bounced a second time. The airplane touched down a third time and then rolled out.</p>					
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Narrative (Continued)

The pilot was concerned about the hazard of wind shear activity to other arriving aircraft and reported a 40 knot low level wind shear on short final.

The airplane was inspected externally by airport fire department personnel and then was taxied to parking. During the completion of the after landing checklist, the flight crew noticed the spoiler handle was retracted. The crew also noticed a "FADEC ALTN" (full authority digital electronic control - alternate) alert message from each engine on the engine activity display (EAD).

Crew Information

The captain holds an airline transport pilot certificate with airplane single and multi-engine land ratings. He also holds a flight engineer certificate with a turbojet powered rating and type ratings in Douglas DC-8, Boeing 727 and 747, and McDonnell Douglas MD-11 aircraft. The captain received his basic indoctrination with Federal Express Corp., on April 4, 1977. Since that time the captain has functioned as captain of Boeing 727 and Douglas DC-8 aircraft and first officer of Boeing 747 aircraft. On July 20, 1994, he completed his initial operating experience (IOE) in McDonnell Douglas MD-11 aircraft. At the time of the accident, the captain had accrued 1,470 hours in the MD-11. The captain's most recent simulator training was provided on June 25, 1995.

The first officer holds an airline transport pilot certificate with an airplane multi-engine land rating. He also holds a flight engineer certificate with a turbojet powered rating and a type rating in McDonnell Douglas MD-11 aircraft. The first officer received his basic indoctrination with Federal Express Corp., on May 9, 1986. Since that time, the first officer has functioned as the second officer and first officer on Boeing 727 aircraft. On April 26, 1992, he completed his IOE in MD-11 aircraft. At the time of the accident, the first officer had accrued 2,107 hours in the MD-11. The first officer's most recent simulator training was provided on April 23, 1995.

Aircraft Information

The airplane had accumulated a total time in service of 12,392.54 flight hours. The most recent continuous airworthiness inspection was accomplished on April 29, 1996, 204.76 flight hours before the accident.

Following the accident, the operator measured the right main landing gear strut extension as 5 3/8 inches at 1,475 PSI. The left main landing gear strut extension was 4 3/4 inches at 1,500 PSI. The status of the fluid level of the main landing gear struts was not evaluated by the operator at the Anchorage base prior to the airplane being ferried to their maintenance facility in Los Angeles, California, for repair. During the repair to the airframe, the operator planned to conduct a check of the strut fluid level. On July 10, 1996, the operator informed the National Transportation Safety Board (NTSB) investigator-in-charge (IIC) of an internal miscommunication that resulted in the landing gear struts being deflated on May 27, 1996 while being prepared for the tail strike repair.

On the accident date, the airplane transmitted an automated Arinc Communications Addressing and Reporting System (ACARS) message to a Federal Express Inc., ground station at 0632:18. The message noted "turbulence". A second ACARS report obtained from the airplane's computer noted an "on report" at 0632:03. The accuracy of the transmittal time could not be correlated with the time reference contained on the flight data recorder. The operator indicated that the airplane could have generated the ACARS report as a result of the hard landing.

The airplane utilizes an auto ground spoiler system (AGS) that will automatically deploy the spoilers about 30 degrees when the main landing gear tires spin up at touchdown. The spoilers will fully deploy to 60 degrees upon nose wheel compression. The AGS also has an auto-retract feature for use in go-arounds. The spoilers will retract automatically when the number 2 throttle is advanced more than 1 inch from the idle stop.

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The airplane utilizes several systems to provide the crew with alert messages concerning the operational limits of the airplane. The previously noted FADEC ALTN alert message on the EAD is recorded when the throttles are advanced beyond the FADEC bar. At this point the FADEC systems reverts to the alternate mode for maximum manual selection of engine thrust.

The airplane is equipped with a wind shear alert and guidance system (WAGS) that provides a visual and aural warning and pitch guidance commands to the crew. The system is enabled from 1,500 feet down to 50 feet above ground level (AGL). The WAGS did not activate.

The airplane is also equipped with a ground proximity warning system (GPWS) that provides a visual and aural warning to the crew. The GPWS had several modes of operation which include excessive descent rate (Mode 1). Mode 1 can produce a warning of "sink rate" and "whoop-whoop pull-up" based on the profile of the airplane. The GPWS did not activate.

Meteorological Information

At 0555, a surface observation at the Anchorage airport was reporting, in part: Sky condition and ceiling, measured ceiling 10,000 feet broken, 20,000 feet broken; visibility, 60 miles; temperature, 46 degrees F; dew point, 30 degrees F; wind, 170 degrees at 9 knots; altimeter, 29.43 inHg.

At 0638, a special observation was reporting, in part: Sky condition and ceiling, measured ceiling 10,000 feet broken, 20,000 feet broken; visibility, 60 miles; wind, 150 degrees at 5 knots; altimeter, 29.42 inHg.

The FAA did not include any reports of wind shear (other than the accident airplane) in their report of this accident. JAL49 did not report any wind shear during their approach.


Communications

Examination of voice recordings from the airplane's cockpit voice recorder was conducted by the Safety Board. At 0632:36 the voice recording indicated a comment from the first officer, "got about twenty knots of left cross right here." At 0632:37, the airplane's central aural warning system (CAWS) provided an audible altitude warning of 500 (feet). Between 0632:46 and 0632:52, the first officer reported a decreasing cross wind with a last report of 12 knots. At 0632:54, the first officer reported the airplane's sink rate was 1,000 feet per minute and at 0632:55, the CAWS provided an altitude warning of 100 feet. At 0632:57, the CAWS indicated 50 feet and less than 1 second later, the first officer voiced an exclamation of "whoa". The airplane touched down at 0633:00.

After touchdown, the crew voiced concern both in the cockpit and to the Anchorage ATCT that they had experienced wind shear. The crew indicated, "and ah tower, Fedex ah 71, we had about a forty knot wind shear on final. It could have been ah due to that seven four that was ahead of us." JAL49 touched down on runway 24L at 0632, as reported by JAL operations.

The Anchorage International Airport does not routinely record low level radar data in the terminal area. Anchorage Center Radar records radar track information on a continuous data recording (CDR).

The coverage for center radar usually begins above 2,000 feet msl in the terminal area. Radar data was reviewed by the NTSB IIC to determine the profile of both arriving airplanes. The radar data indicated that both airplanes made left turns from the downwind pattern southeast of the airport onto the final approach. JAL49 turned onto the final approach for runway 24L east (outside of) the flight profile of FDX71. Radar data from JAL49 revealed at 0629:52, the last recording with altitude information, the JAL flight was at 1,400 feet msl at 181 knots ground speed. At the same time, FDX71 was at 3,200 feet at 229 knots.

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A transcript of communications with Anchorage Center and Anchorage ATCT, the cockpit voice recorder, and radar data is included in this report.

Aerodrome and Ground Facilities

The airport is within Class C airspace and Federal Aviation Regulation (FAR) Part 93 applies to the terminal area. The air traffic control tower is equipped with a D-BRITE radar repeater display. The Brite system is designed to display primary and secondary (transponder) radar returns of aircraft and alphanumeric target symbology generated by the Automated Radar Terminal System (ARTS) to positions in the tower. The equipment is specifically intended to present usable visual display in the tower of the traffic inbound/outbound to the respective runways during both day and night conditions. The radar display augments visual observations by tower personnel of arrival, departure, and overflight aircraft. The tower is an ARTS IIA facility.

The airport is equipped with two parallel hard-surfaced runways on a 247/067 degree magnetic orientation. A single hard surface runway is oriented on a 321/141 degree heading. Runway 24R is 10,601 feet long by 150 feet wide. The southern edge of runway 24R is separated from the northern edge of runway 24L by 550 feet. The approach end of 24R is situated 4,300 feet east of the approach end of runway 24L. Runway 24R is equipped with a two bar visual approach slope indicator (VASI). The airport is not equipped with a low level wind shear advisory system (LLWAS).

According to the Alaska Supplement, airport/facility directory, the VASI light system for runway 24R consists of a 3 bar system. The upper glide slope is reported as 3.25 degrees and the lower glide slope is reported as 3 degrees. According to FAA Airways Facilities personnel and Anchorage International Airport personnel, the VASI system installed at runway 24R consists of 4 light boxes.

The downwind boxes consist of two light boxes, parallel to each other, positioned on either side of the runway threshold. The upwind boxes are positioned 700 feet further along and on either side of the runway.

On June 28, 1996, the VASI was examined by FAA Airways Facilities personnel. They reported that the upwind boxes were in close tolerances and set to 3.0 degrees. The downwind boxes were set to 2.5 degrees. The proper visual approach angle is maintained by the pilot observing a white light bar in the downwind box and a red light bar in the upwind box (red over white). Deviation above the established visual glidepath will produce a change in the upwind light bar from red through pink, to white. Deviation below the glidepath will produce a change in the downwind light bar from white through pink, to red. The total change in color, both above and below the glidepath occurs within 1/4 to 1/2 degree.

Flight Data Recorder

The airplane's flight data recorder was sent to the Safety Board for examination. The recorded parameters are listed by subframe numbers. One subframe is equivalent to one second of time. Downloading the airplane's recorded parameters revealed the following, in part:

At subframe number 2970, the airplane was configured with the autopilot off, flaps were set at 35 degrees, the airplane was near wings level at an indicated airspeed of 155.5 knots. The Vref speed was 147 knots. The heading of the airplane was 241.61 degrees and was slowly increasing.

At subframe 2975, the airplane began a slight roll to the left reaching 3.52 degrees. The roll rate decreased and the airplane then began a roll toward the right.

At subframe 2976, the vertical acceleration decreased to 0.84 g's and returned to 1.11 g's in subframe 2977. It then began decreasing once again. The airspeed began increasing from 151 knots.

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At subframe 2978, the thrust resolver angles began decreasing in response to the autothrottle commands. The lower rudder began moving toward 7.47 degrees trailing edge left and then began moving toward the right. The airplane experienced a lateral acceleration to the left of 0.09 g's. The airspeed reached 158.5 knots and then began decreasing. In subframe 2978 and 2979, the number 1 and number 2 angle of attack indicators displayed about a 3 degree difference in their respective values.

At subframe 2979, the right roll reached 8.09 degrees right wing down. The vertical acceleration moved upward from a low of 0.65 g's. The thrust resolver angle for engine number 2 and 3 increased in subframe 2980 to 85.80 degrees. The elevators began to deflect toward 22.85 degrees trailing edge up.

At subframe 2981, the pitch angle of the airplane reached 11.6 degrees nose up. A vertical acceleration spike of 2.6 g's occurred. The thrust resolver angle decreased to previous settings. The lower rudder reached 23.38 degrees trailing edge to the right. The airplane was near wings level and on a 249.7 degree heading.

From subframe 2982 to 2984, the elevators were deflected to 15.47 degrees trailing edge down and then toward 22.59 degrees trailing edge up. The pitch angle of the airplane decreased to 2.11. From subframe 2982 to 2985, the left wing spoilers reached 34.13 degrees. The right wing spoilers reached 28.41 degrees. Both wing spoilers then began to retract.

At subframe 2984, a second vertical acceleration spike of 3.03 g's occurred

From subframe 2985 through 2988, the elevators were deflected in a similar manner as subframe 2982 through 2984 but to a lesser degree.

At subframe 2987, a third vertical acceleration spike of 1.77 g's occurred.

At subframe 2990, the nose gear compressed.

Examination of flight data revealed an average descent rate of approximately 1,380 feet per minute during the last 20 seconds of the landing approach. The average airspeed was 152 knots. Calculation of the descent angle of the airplane, based on the above averages, indicated a flight path angle of 5.12 degrees.

Wreckage and Impact Information

The NTSB's IIC examined the accident airplane on May 16, 1996, as it was parked at the Anchorage International Airport. The underside of the fuselage about fuselage station number 1821 to station number 2047, received scraping and buckling damage. A blade type antenna was destroyed. Examination of the aft fuselage pressure bulkhead revealed wrinkling and cracking of the bulkhead. Several adjacent lateral formers were also cracked and broken.

Measurement of the main landing gear strut extension by the IIC revealed that the right main gear strut extension was 6 30/32 inches. The left main gear strut was extended 6 21/32 inches. The strut pressures were not recorded.

Additional Information

Prior to the accident, the operator provided wind shear recovery procedures that recommended applying firewall power and increasing the pitch of the airplane to 15 degrees nose up. Following the accident, the operator added additional language that recommended a 7 1/2 degree pitch attitude for a bounced landing recovery.

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Following the accident, the operator published a notice concerning landing procedures and techniques. The notice emphasized early stabilization of thrust, airspeed, pitch and descent rate to provide a good landing. The notice stated, in part: "The desired final approach conditions consists of a 3 degree glide path and the airspeed a Vapp plus wind additives as required. For normal landing configuration, the descent rate will be 650 to 800 feet per minute. Autothrottles should be used for all landings and will begin to retard after passing 50 feet AFL. The autothrottles will retard at a linear rate for a 3 degree glide path..."

Before the accident, the operator did not have a formal tailstrike awareness training program for the MD-11. Neither pilot reported receiving training in bounce recovery or tail strike prevention techniques during their ground school, simulator, or flight training. Information was provided in the MD-11 flight manual that discussed visual approaches, go-around procedures, and tail and wing clearance issues. Following the accident, the operator developed and implemented a tail strike awareness training program that included bounced landing recovery and a simulator training profile.

Wreckage Release

The cockpit voice recorder was released to the operator on August 7, 1996. The flight data recorder was released to the operator on June 10, 1996.

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Landing Facility/Approach Information					
Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
ANCHORAGE INTERNATIONAL	ANC	144 Ft. MSL	24R	10601	150
Runway Surface Type: Asphalt					
Runway Surface Condition: Dry					
Type Instrument Approach: Visual					
VFR Approach/Landing: Full Stop					
Aircraft Information					
Aircraft Manufacturer		Model/Series		Serial Number	
McDonnell Douglas		MD-11-F		48528	
Airworthiness Certificate(s): Transport					
Landing Gear Type: Retractable - Tricycle					
Homebuilt Aircraft? No	Number of Seats: 4	Certified Max Gross Wt.	625500 LBS	Number of Engines: 3	
Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:		
Turbo Fan	GE	CF6-80C2	61800 LBS		
- Aircraft Inspection Information					
Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time		
Continuous Airworthiness	04/1996	205 Hours	12393 Hours		
- Emergency Locator Transmitter (ELT) Information					
ELT Installed? Yes	ELT Operated? No	ELT Aided in Locating Accident Site?			
Owner/Operator Information					
Registered Aircraft Owner		Street Address			
WILMINGTON TRUST CO., TRUSTEE		1100 N. MARKET ST.			
		City	State	Zip Code	
		WILMINGTON	DE	19890	
Operator of Aircraft		Street Address			
FEDERAL EXPRESS		2837 SPRANKEL, HANGER 7			
		City	State	Zip Code	
		MEMPHIS	TN	38118	
Operator Does Business As:			Operator Designator Code: FDEA		
- Type of U.S. Certificate(s) Held:					
Air Carrier Operating Certificate(s): Cargo; Flag Carrier/Domestic; Supplemental					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 121: Air Carrier					
Type of Flight Operation Conducted: Non-scheduled; Domestic; Cargo					

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First Pilot Information

Name On File	City On File	State On File	Date of Birth On File	Age 48
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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: None

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--w/ waivers/lim.	Date of Last Medical Exam: 01/1996
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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	17500	1470								
Pilot In Command(PIC)										
Instructor										
Last 90 Days		195								
Last 30 Days										
Last 24 Hours		8								

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

Type of Flight Plan Filed: IFR

Departure Point NEWARK	State NJ	Airport Identifier EWR	Departure Time 2328	Time Zone ADT
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Destination Same as Accident/Incident Location	State	Airport Identifier ANC	
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Type of Clearance: VFR

Type of Airspace: Class C

Weather Information

Source of Briefing:
Company

Method of Briefing:

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Weather Information					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
ANC	0638	ADT	144 Ft. MSL	0 NM	0 Deg. Mag.
Sky/Lowest Cloud Condition: Unknown			0 Ft. AGL	Condition of Light: Day	
Lowest Ceiling: Broken		10000 Ft. AGL		Visibility: 60 SM	Altimeter: 29.00 "Hg
Temperature: 8 °C	Dew Point: -1 °C	Wind Direction: 150		Density Altitude: Ft.	
Wind Speed: 5	Gusts:	Weather Conditions at Accident Site: Visual Conditions			
Visibility (RVR): 0 Ft.	Visibility (RVV) 0 SM	Intensity of Precipitation: Unknown			
Restrictions to Visibility: None					
Type of Precipitation: None					

Accident Information		
Aircraft Damage: Substantial	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					
Other Crew					
Passengers					
- TOTAL ABOARD -			1	1	2
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	1	1	2

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Administrative Information

Investigator-In-Charge (IIC)

SCOTT R. ERICKSON

Additional Persons Participating in This Accident/Incident Investigation:

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