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## Rudder hardover, Boeing 747-400, October 9, 2002

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**Micro-summary:** This Boeing 747-400 experienced a lower rudder hardover during cruise.

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**Event Date:** 2002-10-09 at 1740 ADT


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

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

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  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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		NTSB ID: ANC03IA001		Aircraft Registration Number: N661US	
		Occurrence Date: 10/09/2002		Most Critical Injury: None	
		Occurrence Type: Incident		Investigated By: NTSB	
Location/Time					
Nearest City/Place Anchorage	State AK	Zip Code 99502	Local Time 1740	Time Zone ADT	
Airport Proximity: On Airport		Distance From Landing Facility:		Direction From Airport:	
Aircraft Information Summary					
Aircraft Manufacturer Boeing		Model/Series 747-400		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:					
HISTORY OF FLIGHT					
<p>On October 9, 2002, about 1740 Alaska daylight time, a Boeing 747-400 airplane, N661US, experienced a lower rudder hardover during cruise flight at FL350. The airplane was being operated as Flight 85, by Northwest Airlines Inc., as an instrument flight rules (IFR) scheduled international flight under Title 14, CFR Part 121. The 4 flight crew members, 14 flight attendants, and the 386 passengers, were not injured. Visual meteorological conditions prevailed, and an instrument flight plan was filed. The flight originated at the Detroit International Airport, Detroit, Michigan, about 1403 eastern daylight time, and was bound for the Narita International Airport, Tokyo, Japan.</p> <p>Following the lower rudder hardover, the flight diverted to Anchorage, Alaska, where an uneventful landing was made.</p>					
<p>During an interview with the National Transportation Safety Board (NTSB) investigator-in-charge (IIC), on October 10, 2002, the captain said the airplane was at a cruise altitude of 35,000 feet with the autopilot engaged, when it abruptly rolled into a 30 to 40 degree left bank. He said there were indications that the lower rudder initially moved left to the blowdown limit of 17 degrees deflection, and remained there. (The blowdown limit is a function of airspeed; the lower the airspeed, the greater the allowed deflection.) He said he declared an emergency, and diverted the airplane to the Ted Stevens International Airport, Anchorage, Alaska. The captain said he and the first officer ran through the available emergency procedures, but none of these could correct the problem. He said as the airspeed decreased during the approach for landing, the lower rudder deflected further to the left. During the approach and landing, the crew used differential power to aid in directional control. The captain said after landing, he observed that the lower rudder remained deflected fully to the left.</p>					
<p>During an inspection of the airplane by the IIC on October 10, the lower rudder was found in the centered position. A mechanic for the operator said during his initial inspection the lower rudder was deflected full left as witnessed by the pilot. He said the lower rudder could not be repositioned until the hydraulic line connected to the positioning actuator was disconnected, relieving the hydraulic pressure. An inspection of the lower rudder power control module (PCM) revealed the forged aluminum housing (manifold) of the lower rudder power control module was fractured. The end portion of the control module manifold that houses the yaw damper actuator piston, had fractured off from the main portion of the manifold. The fractured end contained a metal end cap that was safety-wired to the manifold. The separated portion of the manifold remained attached to the main portion by the safety wire.</p>					
<p>The lower rudder power control module, and the flight data recorder (FDR) were removed, and sent to the NTSB laboratory in Washington, DC, for examination.</p>					
FDR INFORMATION					
FACTUAL REPORT - AVIATION					

National Transportation Safety Board

## FACTUAL REPORT

AVIATION

NTSB ID: ANC03IA001

Occurrence Date: 10/09/2002

Occurrence Type: Incident

## Narrative (Continued)

The data retrieved from the flight data recorder showed an initial uncommanded lower rudder deflection of 17.5 degrees to the left, and as the airplane slowed during the approach and landing, a subsequent increase to 32 degrees (full) left deflection for the remainder of the flight.


## RUDDER SYSTEM INFORMATION


The Boeing 747-400 has two independently supported and operated rudders (upper and lower) which provide yaw control for the airplane. Each rudder is positioned by a hydraulically operated power control package (PCP). The hydraulic system operating pressure is 3000 psi, and typically the upper and lower rudders operate in unison. The lower rudder has less surface area than the upper, and is positioned by two hydraulic actuators, whereas the upper rudder has three actuators. The hydraulic actuators for the lower and upper rudders are controlled by independent power control modules. The power control modules for both rudders are virtually identical and are located next to each other in the vertical stabilizer. Each power control module contains a primary and secondary hydraulic control system, housed within a single manifold. In the event of a failure of the primary or secondary system, the remaining system can position the rudder. In this incident, the lower rudder power control module manifold fractured, allowing the yaw damper piston to travel beyond its normal position. This resulted in a full left command input to the main control valve hence driving the two actuators to the full left rudder position.

## TEST AND RESEARCH

The initial metallurgical examination of the fractured power control module by the NTSB laboratory revealed a mode of crack initiation and growth consistent with fatigue. Under the supervision of the NTSB systems group chairman, the fractured power control module was returned to the manufacturer for disassembly and further inspection. The yaw damper piston was visibly protruding from the manifold, and precluded operational testing of the manifold. All the individual components of the power control module were tested, and no anomalies were found. Dimensional checks of the power control module showed no discrepancies, and metallurgical testing by the manufacturer showed the manifold was made of material consistent with the manufacturer's specification. Since a fatigue type of failure typically cannot be visually detected prior to the actual failure, a non-destructive inspection process was developed. A group of similar power control modules that were installed on other airplanes, as well as a spare unit, were inspected. The inspected group contained power control modules with higher and lower use cycles than the incident airplane's power control module. No similar fractures were found.

As a result of this incident, the airplane's manufacturer has issued Alert Service Bulletin 747-27A2397, dated July 24, 2003, which recommends operators perform an ultrasonic inspection of pertinent high-time lower and upper rudder power control modules. The Federal Aviation Administration has issued a Notice of Proposed Rule Making (NPRM), "Airworthiness Directive; Boeing Model 747-400, -400D, and -400F Series Airplanes," published in the Federal Register on August 28, 2003, which would make this inspection mandatory on affected airplanes.

 <b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b>		NTSB ID: ANC03IA001				
		Occurrence Date: 10/09/2002				
		Occurrence Type: Incident				
<b>Landing Facility/Approach Information</b>						
Airport Name		Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
Ted Stevens International		PANC	Ft. MSL			
Runway Surface Type: Unknown						
Runway Surface Condition: Unknown						
Type Instrument Approach: ILS-complete						
VFR Approach/Landing: None						
<b>Aircraft Information</b>						
Aircraft Manufacturer		Model/Series		Serial Number		
Boeing		747-400		23719		
Airworthiness Certificate(s): Transport						
Landing Gear Type: Retractable - Tricycle						
Homebuilt Aircraft? No		Number of Seats: 429		Certified Max Gross Wt.	873000 LBS	Number of Engines: 4
Engine Type:		Engine Manufacturer:		Model/Series:		Rated Power:
Turbo Fan		Pratt & Whitney		PW4056		
- Aircraft Inspection Information						
Type of Last Inspection		Date of Last Inspection		Time Since Last Inspection		Airframe Total Time
Conditional		08/2001		5209 Hours		50090 Hours
- Emergency Locator Transmitter (ELT) Information						
ELT Installed? No		ELT Operated? No		ELT Aided in Locating Accident Site? No		
<b>Owner/Operator Information</b>						
Registered Aircraft Owner		Street Address				
State Street Bank and Trust Company Trustee		PO Box 778				
		City		State	Zip Code	
		Boston		MA	02102	
Operator of Aircraft		Street Address				
NORTHWEST AIRLINES INC		6300 Boeing Ave.				
		City		State	Zip Code	
		Anchorage		AK	99502	
Operator Does Business As: Northwest Airlines Inc.				Operator Designator Code: NWAA		
- 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; International; Passenger Only						

 <p><b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b></p>	NTSB ID: ANC031A001
	Occurrence Date: 10/09/2002
	Occurrence Type: Incident

**First Pilot Information**

Name On File	City On File	State On File	Date of Birth On File	Age 54
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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

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

Rotorcraft/Glider/LTA: None

Instrument Rating(s): Airplane

Instructor Rating(s): Airplane Single-engine

Type Rating/Endorsement for Accident/Incident Aircraft? Yes	Current Biennial Flight Review? 04/2002
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Medical Cert.: Class 1	Medical Cert. Status: Valid Medical--w/ waivers/lim.	Date of Last Medical Exam: 06/2002
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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	11297	630								
Pilot In Command(PIC)										
Instructor										
Last 90 Days	43	43								
Last 30 Days	10	10								
Last 24 Hours	10									

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	State	Airport Identifier	Departure Time	Time Zone
Detroit	MI	DTW	1403	EDT
Destination	State	Airport Identifier		
Narita		NRT		


Type of Clearance: IFR

Type of Airspace: Class A

**Weather Information**

Source of Briefing:  
Company


Method of Briefing: In Person

 <p><b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b></p>	NTSB ID: ANC03IA001
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	Occurrence Type: Incident

Weather Information					
WOF ID	Observation Time	Time Zone	WOF Elevation  Ft. MSL	WOF Distance From Accident Site  NM	Direction From Accident Site  Deg. Mag.
Sky/Lowest Cloud Condition: Clear				Ft. AGL	Condition of Light: Night
Lowest Ceiling: None			Ft. AGL	Visibility: SM	Altimeter: "Hg
Temperature: °C	Dew Point: °C	Wind Direction:		Density Altitude: Ft.	
Wind Speed:	Gusts:	Weather Conditions at Accident Site: Visual Conditions			
Visibility (RVR): Ft.	Visibility (RVV) SM	Intensity of Precipitation:			
Restrictions to Visibility: None					
Type of Precipitation: None					

Accident Information		
Aircraft Damage: None	Aircraft Fire: None	Aircraft Explosion: None

Classification: U.S. Registered/U.S. Soil					
- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				2	2
Second Pilot				2	2
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants				14	14
Other Crew					
Passengers				386	386
- TOTAL ABOARD -				404	404
Other Ground					
- GRAND TOTAL -				404	404

 National Transportation Safety Board <b>FACTUAL REPORT</b> AVIATION	NTSB ID: ANC03IA001	
	Occurrence Date: 10/09/2002	
	Occurrence Type: Incident	

Administrative Information

Investigator-In-Charge (IIC)

Lawrence R. Lewis

Additional Persons Participating in This Accident/Incident Investigation:

Glenn R Smith  
Aviation Safety Inspector  
Anchorage FSDO-03  
4510 W. International Airport Road  
Anchorage, AK 99502