



# National Transportation Safety Board Aviation Incident Factual Report

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<b>Location:</b>	Anchorage, AK	<b>Incident Number:</b>	ANC031A001
<b>Date &amp; Time:</b>	10/09/2002, 1740 AKD	<b>Registration:</b>	N661US
<b>Aircraft:</b>	Boeing 747-400	<b>Aircraft Damage:</b>	None
<b>Defining Event:</b>		<b>Injuries:</b>	404 None
<b>Flight Conducted Under:</b>	Part 121: Air Carrier - Scheduled		

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## HISTORY OF FLIGHT

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. Following the lower rudder hardover, the flight diverted to Anchorage, Alaska, where an uneventful landing was made.

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.

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.

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.

## FDR INFORMATION

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.

## Pilot Information

<b>Certificate:</b>	Airline Transport	<b>Age:</b>	54, Male
<b>Airplane Rating(s):</b>	Multi-engine Land; Single-engine Land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	Seatbelt, Shoulder harness
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	Airplane Single-engine	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 1 Valid Medical--w/ waivers/lim.	<b>Last FAA Medical Exam:</b>	06/12/2002
<b>Occupational Pilot:</b>		<b>Last Flight Review or Equivalent:</b>	04/22/2002
<b>Flight Time:</b>	11297 hours (Total, all aircraft), 630 hours (Total, this make and model), 43 hours (Last 90 days, all aircraft), 10 hours (Last 30 days, all aircraft), 10 hours (Last 24 hours, all aircraft)		

## Co-Pilot Information

<b>Certificate:</b>	Airline Transport; Flight Engineer	<b>Age:</b>	57, Male
<b>Airplane Rating(s):</b>	Multi-engine Land; Single-engine Land	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	Seatbelt, Shoulder harness
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 1 Valid Medical--no waivers/lim.	<b>Last FAA Medical Exam:</b>	06/13/2002
<b>Occupational Pilot:</b>		<b>Last Flight Review or Equivalent:</b>	01/15/2002
<b>Flight Time:</b>	3420 hours (Total, all aircraft), 651 hours (Total, this make and model), 129 hours (Last 90 days, all aircraft), 63 hours (Last 30 days, all aircraft), 10 hours (Last 24 hours, all aircraft)		

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Boeing	<b>Registration:</b>	N661US
<b>Model/Series:</b>	747-400	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>		<b>Amateur Built:</b>	No
<b>Airworthiness Certificate:</b>	Transport	<b>Serial Number:</b>	23719
<b>Landing Gear Type:</b>	Retractable - Tricycle	<b>Seats:</b>	429
<b>Date/Type of Last Inspection:</b>	08/30/2001, Condition	<b>Certified Max Gross Wt.:</b>	873000 lbs
<b>Time Since Last Inspection:</b>	5209 Hours	<b>Engines:</b>	4 Turbo Fan
<b>Airframe Total Time:</b>	50090 Hours as of last inspection	<b>Engine Manufacturer:</b>	Pratt & Whitney
<b>ELT:</b>	Not installed	<b>Engine Model/Series:</b>	PW4056
<b>Registered Owner:</b>	State Street Bank and Trust Company Trustee	<b>Rated Power:</b>	
<b>Operator:</b>	NORTHWEST AIRLINES INC	<b>Operating Certificate(s) Held:</b>	Flag carrier (121)
<b>Operator Does Business As:</b>	Northwest Airlines Inc.	<b>Operator Designator Code:</b>	NWAA

## Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Night
Observation Facility, Elevation:		Distance from Accident Site:	
Observation Time:		Direction from Accident Site:	
Lowest Cloud Condition:	Clear	Visibility	
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	/	Turbulence Type Forecast/Actual:	/
Wind Direction:		Turbulence Severity Forecast/Actual:	/
Altimeter Setting:		Temperature/Dew Point:	
Precipitation and Obscuration:			
Departure Point:	Detroit, MI (DTW)	Type of Flight Plan Filed:	IFR
Destination:	Narita (NRT)	Type of Clearance:	IFR
Departure Time:	1403 EDT	Type of Airspace:	Class A

## Airport Information

Airport:	Ted Stevens International (PANC)	Runway Surface Type:	Unknown
Airport Elevation:		Runway Surface Condition:	Unknown
Runway Used:		IFR Approach:	ILS
Runway Length/Width:		VFR Approach/Landing:	None

## Wreckage and Impact Information

Crew Injuries:	18 None	Aircraft Damage:	None
Passenger Injuries:	386 None	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	404 None	Latitude, Longitude:	61.174444, -149.996389

## Administrative Information

Investigator In Charge (IIC):	Lawrence R Lewis
Additional Participating Persons:	Glenn R Smith; Anchorage FSDO-03; Anchorage, AK
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at <a href="mailto:pubinquiry@ntsb.gov">pubinquiry@ntsb.gov</a> , or at 800-877-6799. Dockets released after this date are available at <a href="http://dms.nts.gov/pubdms/">http://dms.nts.gov/pubdms/</a> .