National Transportation Safety Board
Aviation Accident Final Report

Location:	HONOLULU, HI	**Accident Number:**	LAX95LA137
Date & Time:	03/16/1995, 0315 HST	**Registration:**	N37ST
Aircraft:	de Havilland DHC-6-200	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	3 None
Flight Conducted Under:	Part 91: General Aviation - Ferry		

Analysis

THE AIRCRAFT DEPARTED OVERWEIGHT FOR A 17-HOUR FERRY FLIGHT. EARLY IN THE FLIGHT THE CREW EXPERIENCED SOME FUEL PROBLEMS AND DECIDED TO CONTINUE WHEN THEY RESOLVED THE PROBLEM. THE CREW INDICATED THE EN ROUTE WINDS WERE CLOSE TO FORECAST. THE FERRY FUEL SYSTEM IS A SIMPLE 5-TANK GRAVITY FUEL FEED INTO THE FORE AND AFT MAIN TANKS. ABOUT 6 HOURS FROM DESTINATION, THEY REALIZED THE FERRY TANKS WERE NOT FLOWING INTO THE MAIN TANKS AS PLANNED. THEY BEGAN MANUALLY TRANSFERRING FUEL FROM THE REAR FERRY TANK TO THE FORWARD FERRY TANK, AND SHUT DOWN THE RIGHT ENGINE TO REDUCE FUEL CONSUMPTION. THIS DID NOT STOP THE NEGATIVE FUEL FLOW FROM THE MAIN TANKS. AT THE TIME OF DITCHING, THE CREW ESTIMATED THE FUEL REMAINING IN THE FERRY TANKS WAS ABOUT 170 GALLONS, MOST OF WHICH WAS IN THE 3 AFT FERRY TANKS. AN AERO ENGINEER CALCULATED THAT THE AIRCRAFT WAS AT LEAST 10 INCHES BEHIND THE MAXIMUM AFT CG AT THE TIME OF DITCHING, AND SUGGESTED THAT THE FERRY FUEL SYSTEM WAS NOT MANAGED TO MAINTAIN THE CG WITHIN THE ALLOWABLE LIMITS, A TASK MADE MORE DIFFICULT WITH THE REAR FUSELAGE CARGO.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Intentional ditching due to the flightcrew's failure to properly manage the fuel system, and operation of the airplane in an excessively overweight condition.

Findings

Occurrence #1: DITCHING
Phase of Operation: EMERGENCY LANDING

Findings
1. FUEL SYSTEM - STARVATION
2. (C) FUEL MANAGEMENT - IMPROPER - FLIGHTCREW
3. (C) AIRCRAFT WEIGHT AND BALANCE - EXCEEDED - FLIGHTCREW
4. TERRAIN CONDITION - WATER

Factual Information

On March 16, 1995, at 0315 hours Hawaiian standard time, a DeHavilland DHC-6-200, N37ST, ditched into the Pacific Ocean about 175 nautical miles (nm) northeast of Honolulu, Hawaii, after the crew declared a fuel emergency. The aircraft floated for a few moments before sinking and the three persons onboard escaped uninjured and were rescued about 30 minutes later. The aircraft departed from Oakland, California, at 1230 Pacific standard time on March 15,1995, for a 17-hour ferry flight to Hawaii. The final destination was Auckland, New Zealand. The owner and operator was Great Barrier Airlines in Auckland.

The crew reported experiencing fuel transfer problems and eventually declared an emergency approximately 14 hours into the flight when they were about 400 nm northeast of Honolulu. Several military aircraft responded to the distress call and intercepted the aircraft prior to its ditching. A nearby ship was directed to the site and rescued the occupants.

The aircraft was equipped with 5 ferry tanks in addition to the normal aircraft forward and aft fuel tanks. The ferry tanks had a capacity of 1,076 gallons of fuel and the normal fuel system had a capacity of 366 gallons. All 5 ferry tanks could be individually selected and gravity fed into either the aircraft's forward or aft fuel tanks. According to the crew, all fuel tanks were filled to capacity prior to takeoff. The installer of the ferry fuel system indicated that they installed new, black 1/2- inch hose to the fuel distribution system and they were secured to their respective fittings with new camlock clamps.

Prior to the takeoff from Oakland, the crew flew the aircraft from Hayward, California, which is located about 5 miles to the south of Oakland. While en route, each ferry tank was individually selected and fuel was observed to be flowing into the necks of both the forward and aft tanks. After landing at Oakland and during the course of refueling, the ferry system was tested again and the pilots observed the fuel flowing strongly from each ferry tank to the main tanks.

According to the ferry permit issued by the FAA for this aircraft, the maximum authorized takeoff gross weight was 15,053 pounds, or 30 percent over the original certificated weight of 11,579 pounds. The maximum quantity of fuel carried in the ferry tanks was not to exceed 7,209.2 pounds, and the center of gravity (cg) was not to exceed 203.54 inches forward and 216.32 inches aft of the datum plane.

There were two weight and balance forms prepared by the company who installed the ferry tank system. One form indicated the aircraft weighed 15,017.45 pounds, with a cg of 206.11 inches for the takeoff from Oakland. The second form indicated that with all the fuel tanks filled to capacity, the gross weight of the aircraft was 18,408.55 pounds. This weight did not include the third crewmember (170 lbs) and other cargo, such as the passenger seats and other miscellaneous items. The cg was calculated to be at 210.44 inches. The second weight was estimated by a registered engineer in New Zealand to be about 60 percent over the certificated gross weight.

The crew had estimated that the time en route would be about 17 hours, with about 2 hours of fuel remaining. The route of flight was from Oakland along R464 to Honolulu, a distance of approximately 2,250 nm. The en route winds were forecast to be a headwind component of 3 knots at 5,000 feet and 8 knots at 10,000 feet. The operator reported that the crew experienced an average headwind of 4.2 knots. The altitude of the flight ranged between 2,500 feet and 9,000 feet.

In the crew's written statement, they indicated that they first noticed some minor difficulties with the fuel system when about 380 nm from Oakland. After a series of adjustments in selecting fuel tanks, a good fuel flow was observed from the ferry tanks into the main tanks and they continued the flight.

When about 6 hours and 30 minutes from Honolulu and 1,600 pounds of fuel in the main tanks, the crew noticed a negative net fuel flow from the main tanks. They were not overly concerned at this time because the fuel consumption was 450 pounds per hour and they could access another 1,400 pounds of fuel from the ferry system to make Honolulu, provided the negative net fuel flow from the main tanks did not exceed 245 pounds. Over the next and subsequent half hours, the negative fuel flow was observed to be 90, 100, 120, then 130 or 260 pounds per hour.

The crew said they focused on the No. 5 ferry tank which was over half full and had ceased draining. It was also the easiest to access and they began to transfer fuel from this tank to the No. 1 tank by the use of empty water bottles. They also jacked up the No. 4 tank onto some seats in an attempt to increase the head pressure. At this time, the indicated fuel consumption was now 290 pounds per hour and very little fuel was draining from the ferry system into the main tanks. The crew decided to shut down the port engine to conserve fuel and declared the emergency.

About 1/2-hour prior to the ditching, the crew restarted the engine for stability and ditching purposes. The crew reported that at the time of ditching the fuel remaining in the ferry system was: 50 U.S. gallons in the No. 5 tank; 50 gallons in the No. 4 tank; 45 gallons in the No. 3 tank; 5 gallons in the No. 2 tank; and, 20 gallons in the No. 1 tank. They estimated this by visual inspection and by using an improvised dipstick.

The engineer in New Zealand calculated the cg of the aircraft using the crew's estimated fuel remaining in the respective ferry tanks at the time of ditching. He indicated that the cg at the time of ditching was at 226.27 inches, and was considerably behind the permitted aft cg of 216.32 inches for this aircraft. This engineer states that the residual fuel quantities suggests the ferry fuel system was not managed to maintain the aircraft center of gravity within allowable limits, a task made more difficult with the rear fuselage cargo.

In November, 1995, the operator furnished the Safety Board a report they had prepared by a mechanical engineer in New Zealand. This report concluded that the crew statements were consistent, and there should have been sufficient fuel to complete the flight had the fuel been available to use. The aircraft had about 1.5 hours to go with at least 2.5 hours of fuel remaining.

The report further states that the crew was unable to feed the ferry fuel into the main tanks because of the fuel pressure losses caused by the use of long lengths of small bore tube (3/8 inch vs 1/2 inch) This would not be apparent unless the ferry system had been tested by selecting individual tanks with low tank contents and observing the fuel flow. The brief flight test carried out by the crew did not test the critical condition which was the ability to empty the rear tanks.

This report concluded that although the aircraft was operated well above the weight authorized by the FAA special ferry permit, this did not contribute to the accident. At the weight approved for the operation, the aircraft would not have been able to carry sufficient fuel for the flight.

These two reports were sent to the aircraft manufacturer for comment. In their response (see

attached letter), they stated that given a properly installed and tested long range fuel system, and with proper monitoring and management of that system, there should not have been a fuel feed interruption of flow between the long range fuel system and the aircraft main fuel tanks caused by the aircraft attitude during the flight.

Pilot Information

Certificate:	Commercial	**Age:**	28, Male
Airplane Rating(s):	Multi-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	08/17/1994
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:	1100 hours (Total, all aircraft), 200 hours (Total, this make and model), 600 hours (Pilot In Command, all aircraft), 120 hours (Last 90 days, all aircraft), 40 hours (Last 30 days, all aircraft), 16 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	de Havilland	**Registration:**	N37ST
Model/Series:	DHC-6-200 DHC-6-200	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Special Flight	**Serial Number:**	207
Landing Gear Type:	Tricycle	**Seats:**	5
Date/Type of Last Inspection:	Unknown	**Certified Max Gross Wt.:**	11579 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Prop
Airframe Total Time:		**Engine Manufacturer:**	P&W
ELT:	Installed, activated, did not aid in locating accident	**Engine Model/Series:**	PT-6
Registered Owner:	GREAT BARRIER AIRLINES	**Rated Power:**	550 hp
Operator:	GREAT BARRIER AIRLINES	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Night/Bright
Observation Facility, Elevation:	, 0 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	0000	**Direction from Accident Site:**	0°
Lowest Cloud Condition:	Clear / 0 ft agl	**Visibility**	15 Miles
Lowest Ceiling:	Broken / 2000 ft agl	**Visibility (RVR):**	0 ft
Wind Speed/Gusts:	Light and Variable /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	Variable	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	16°C
Precipitation and Obscuration:			
Departure Point:	OAKLAND, CA (OAK)	**Type of Flight Plan Filed:**	IFR
Destination:	, HI (HON)	**Type of Clearance:**	IFR
Departure Time:	1230 PST	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	3 None	**Aircraft Damage:**	Destroyed
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 None	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	R. G MUCHO	**Report Date:**	01/29/1996
Additional Participating Persons:	MURRAY POPE; AUKLAND, NZ RAY EVANS; LONG BEACH, CA GARY DEUTSCH; HONOLULU, CA		
Publish Date:			
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 pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		