NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594

May 17, 2006

POWERPLANTS GROUP CHAIRMAN'S FACTUAL REPORT

NTSB ID: DCA06MA010

A. ACCIDENT

Location:	Miami, Florida
Date:	December 19, 2005
Time:	1439 eastern standard time (EST)
Aircraft:	Grumman Mallard G73T, Reg. No. N2969; Operator: Flying Boat, Inc. dba Chalk's Ocean Airways, Flight 101

B. POWERPLANTS GROUP

Chairman:	Carol Horgan National Transportation Safety Board Washington, District of Columbia
Member:	John F. (Ian) Dargin Federal Aviation Administration Burlington, Massachusetts
Member:	Tom McCreary Hartzell Propeller Inc. Piqua, Ohio
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C. SUMMARY

On December 19, 2005, about 2:39 p.m. eastern standard time, a Grumman G-73T Turbo Mallard seaplane, N2969, operated by Flying Boats Inc. doing business as Chalks Ocean Airways, as Flight 101, experienced an in-flight breakup and crashed near Miami, Florida. The flight had just departed from the Watson's Island seaplane base (X44) and was en route to Bimini, Bahamas. Witnesses, photos and video, and examination of the wreckage indicate that the right wing separated in flight, and an ensuing fire, prior to the seaplane descending into the water near a rock jetty. The 2 crewmembers and 18 passengers, including 3 infants, were fatally injured. The flight was operating under the provisions of 14 Code of Federal Regulations Part 121. Visual meteorological conditions prevailed at the time of the accident.

The wreckage was located in the cruise ship channel known as Government Cut. The No. 1 engine was recovered with the fuselage and main wreckage. The No. 1 propeller was located nearby. The No. 2 engine and propeller remained attached to a section of the right wing that was recovered from shallower water adjacent to the jetty.

The engines and propellers were examined at the Watson's Island seaplane base on December 21, 2006 and were further documented at Atlanta Air Salvage, in Griffin, Georgia, February 9-10, 2006.

D. DETAILS OF THE INVESTIGATION

1.0 Powerplant information

The Grumman G-73T Turbo Mallard is a turbine conversion seaplane powered by two Pratt & Whitney Model PT6A-34 gas turbine engines, each driving a Hartzell Model HC-B3TN-3D three-bladed propeller. [1]

1.1 Powerplant description

The PWC PT6A-34 is a reverse-flow turbopropeller engine rated at 750 takeoff shaft horsepower. Its gas generator features a three-stage axial, one-stage centrifugal compressor, an annular-type combustion chamber, and a single stage compressor turbine (CT). A single stage power (free) turbine (PT) drives a reduction gear assembly and power output drive flange.

The Hartzell Model HC-B3TN-3D is a hydraulically operated, steel hub, constant-speed propeller with full feathering and reversing capabilities.[2] Oil pressure from a propeller governing unit is used to move the blades toward low pitch (high RPM).[3] Blade-mounted counterweights and a feathering spring actuate the blades toward high pitch (low RPM) in the absence of governor oil pressure. The blades are of aluminum construction.

[1] N2969 was converted in 1979 by Frakes Aviation under the authority of Supplemental Type Certificates SA2323WE and SA4410SW.

[2] A constant-speed propeller system is one in which the propeller blade angle is automatically adjusted by a governor unit to maintain a selected RPM. A feathering propeller is a constant-speed propeller with the additional capability of rotating the propeller blades to an extreme blade angle that will eliminate aerodynamic drag in the event of an engine failure. There is no low RPM stop, which allows the blades to feather after the engine is shut down. A reversing propeller is a constant-speed, feathering propeller that can also produce reverse thrust by rotating the blades to a negative blade angle, forcing air forward rather than rearward.

[3] Blade angle or blade pitch refers to the angle between the blade section chord line and the plane of rotation of the propeller. This angle represents the theoretical distance that an aircraft will move forward in one revolution of the propeller.

As installed in a Grumman Mallard G73T aircraft, selected propeller positions will result in the following blade angle settings:

reverse:	-11.0°	±0.4° blade angle
flight idle:	20.5°	± 0.1° blade angle
feather:	87.0°	± 0.5° blade angle

1.2 Powerplant data

position	*component*	*model*	*serial number*	*date of manufacture*	*TSN (hours)*	*TSO (hours)*	*last overhaul*
No. 1	Engine	PWC PT6A-34AG*	PCE-PH0044	12/1996	7515.6	1154.6	03/03/2005 Turbines Inc. Terre Haute, IN
	Propeller (hub)	Hartzell HC-B3TN-3D	BUA28996	06/2004	11117.0	1154.6	3/16/2005 Propellers, Inc Opa Locka, FL
No. 2	Engine	PWC PT6A-34**	PCE-57465	09/1992	9035.8	3037.1	07/08/2004 United Turbine Miami, FL
	Propeller (hub)	Hartzell HC-B3TN-3D	BUA21098	06/1998	17995.3	2657.1	10/11/2003 Propellers, Inc Opa Locka, FL

* The Supplemental Type Certificates indicate that the PT6A-34AG is an approved installation for the aircraft.

** The engine data plate indicates the model number as “PT6A34AG” with hash marks crossing out “AG.” However the engine logbook indicates the engine configuration was certified as PT6A-34 at overhaul by reference to a conversion service bulletin.

Table 1. Powerplant data

2.0 Powerplants examinations

The powerplants were examined on December 21, 2006 following recovery to the Watson's Island seaplane base (X44).

2.1 No. 1 Engine, S/N PCE-PH0044

2.1.1 External condition

The No. 1 engine was submerged in 15–25 foot salt water for approximately 46 hours. External inspection found no evidence of uncontainment, engine fire, or pre-impact mechanical failure. (See Figure 1.)

2.1.2 Compressor inlet inspection

The 1st stage compressor blades were intact. Circumferential scoring was evident along the shroud.

2.1.3 Housings

The reduction gearbox (RGB) forward housing was fractured just forward [4] of the A flange.[5] The exposed gearing was intact, with corrosion damage but no evidence of operational distress. The housing was eroded by corrosion consistent with exposure to salt water. The exhaust duct housing was deformed and fractured with multiple cracks between 12 and 9 o'clock.[6] The right hand exhaust stub was deformed. There was compression deformation to the gas generator case forward of the engine mount collar and at the compressor housing. The inlet screen was deformed and the compressor inlet support struts were fractured. The C flange bolts were fractured and the flange was partially separated between 7 and 3 o'clock. The accessory gearbox (AGB) housing was intact, with signs of surface corrosion consistent with exposure to salt water.

2.1.4 Systems and accessories

The starter-generator, fuel pump/fuel control, and airframe hydraulic pump had fractured from their mounting bosses on the AGB and were not recovered. The propeller governor and the overspeed governor remained attached at their mounts on the RGB forward housing. The ignition exciter was intact and the ignition harness was continuous to the ignitors. The fuel manifold was intact and the fuel lines were continuous to the rear fire seal. The Np tachometer generator was fractured at the mounting boss and was not recovered. The oil cooler lines were deformed but continuous to the AGB. The forward oil transfer tubes were separated.

Figure 1. No. 1 engine recovered to Watson's Island wharf

2.1.5 Pneumatic lines

The P3 tube was continuous from the gas generator case fitting to the rear fire seal fitting; the line aft of the fitting was not recovered. The Py tube was continuous to a separation adjacent to A flange aft of rear fire seal fitting. The propeller governor B-nut was deformed and its lockwire was separated; the fitting was finger tight.

2.1.6 Power control and reversing linkages

The power control linkage was fractured forward of the A flange fitting but was continuous to the rear fire seal fitting. Its aft section and cambox were missing. The forward linkage was attached to the

[4] All references to position are aft looking forward unless otherwise noted.

[5] The A flange attaches the front and rear RGB housings to the engine exhaust case.

[6] O'clock locations refer to approximate circumferential locations in a clockwise direction, viewed from the rear of the engine looking forward.

propeller governor and was continuous to the beta link arm. The propeller governor linkage was fractured adjacent to the governor input arm.

2.2 No. 1 Propeller, S/N BUA28996

The No. 1 propeller was recovered separately. (See Figure 2.) It had been submerged in 15–25 feet of salt water for approximately 46 hours. The propeller blades and associated hardware were reference marked as L1, L2, and L3.[7]

Figure 2. No. 1 propeller recovered to Watson's Island wharf

2.2.1 External inspection

The fractured forward section of the engine RGB front housing forward flange remained secured to the propeller hub. The spinner dome was crushed/fragmented on one side and had deformed over the piston. The spinner bulkhead was bent aftward.

The spinner dome was removed. The hub serial number was located between the L1 and L3 blades. The piston/cylinder was separated from the hub but was retained by the L3 link arm and beta rods. The feather spring was extended and the piston/cylinder was at the feather position. The L1 and L2 link arms had disconnected. The L1 blade/clamp had disconnected and the blade could be manually rotated. The L2 and L3 blades/clamps were at extreme reverse pitch positions.[8] All three blades were attached and exhibited aftward bending damage, and the L1 blade has significant tip tearing. There was no evidence of pre-impact mechanical failure.

2.2.2 Blade/clamp rotation

The L1 blade had rotated approximately 10° in its clamp, in the low pitch direction. The L2 blade

[7] **Propeller components are described as viewed from the rear of the propeller in the direction of rotation (clockwise).**

[8] **Blade angles were measured at the 30-inch blade station (30 inches from the center of the hub).**

had not rotated in its clamp. The L3 blade had rotated approximately 20° in its clamp, in the low pitch direction.

2.2.3 Feather and reverse stops

Neither the feather stops nor the reverse stops were inspected.

2.2.4 Piston

The piston appeared undamaged.

2.2.5 Link arms

The L1 link arm was slightly bent and abraded, and had disconnected from its link screw. The L2 link arm was undamaged. The L3 link arm showed was bent.

2.2.6 Cylinder

The cylinder attachment threads were stripped.

2.2.7 Feathering spring assembly

The feathering spring assembly was not disassembled.

2.2.8 Pitch change rod

The pitch change rod was not inspected.

Figure 3. No. 2 engine recovered from Governor's Cut

2.2.9 Clamps and counterweights

The clamps and the counterweights of all three blades were intact. The L1 link screw was damaged on its outer end; the L2 and L3 link screws were undamaged.

2.2.10 Hub unit

The hub mounting flange appeared undamaged. The cylinder attachment threads were stripped.

2.2.11 Blades

The L1 blade was bent aft approximately 45° at mid-blade and was twisted toward low pitch. The outer two inches of the tip were partially torn and exhibited leading edge (LE) damage. There was rotational scoring in the paint on the camber side.

The L2 blade was bent aft approximately 20° at the $^1/_3$ radius. It was slightly twisted toward low pitch.

The L3 blade was bent aft approximately 45° at the ¼ radius. There was LE damage to the outboard 10 inches of the blade.

2.3 No. 2 Engine, S/N PCE-57465

2.3.1 External condition

The No. 2 engine was submerged in 5 – 10 feet salt water for approximately 26 hours. It was recovered still attached to a section of the right wing. (See Figure 2.) The mount structure was deformed. There was no evidence of uncontainment, engine fire, or pre-impact mechanical failure. The compressor 1st stage blades were intact. Circumferential scoring could be seen along the shroud.

2.3.2 Housings

The reduction gearbox housing exhibited surface erosion. The oil transfer lines were continuous. The left hand exhaust stub was deformed. The exhaust duct was deformed. The gas generator case was deformed. The accessory gearbox housing was intact, and exhibited surface erosion. The compressor housing was deformed. The compressor inlet case was fractured.

2.3.3 Systems and accessories

All the accessory gearbox-mounted and reduction gearbox-mounted components were intact and in place. All connections were continuous to the firewall. The fuel manifold was intact, and the fuel lines were continuous to the fuel control.

2.3.4 Pneumatic lines

The P3 and Py lines were continuous, with intact lock wire.

2.3.5 Power control and reversing linkages

The power control linkage was continuous. The propeller control linkage was continuous to the airframe connection, with intact locking devices.

2.4 No. 2 Propeller, S/N BUA21098

2.4.1 External inspection

The No. 2 propeller was submerged in 5–10 feet of salt water for approximately 26 hours. It remained attached to the engine.

The propeller was removed from the engine and the propeller blades and their associated hardware were reference marked as R1, R2, and R3.

The spinner dome was removed. The hub serial number was located between the R1 and R2 blades. The R1 and R2 link arms had disconnected from their link screws and their blades/clamps were at low pitch positions. The R3 link arm had disconnected from its link screw and the blade/clamp was at an extreme reverse position. The feedback ring was intact; the piston position was 1 $^{2}/_{32}$ inch - $^{14}/_{32}$-inch from the beta mechanism flight idle pickup nuts. According to Hartzell, this equates to a piston position that would result in an approximate 32° - 34° blade angle. All three blades were attached and exhibited significant impact damage. There was no evidence of pre-impact mechanical failure. (See Figure 4.)

2.4.2 Blade/clamp rotation

None of the blades were rotated in their clamps.

2.4.3 Feather and reverse stops

Neither feather stops nor reverse stops were inspected.

2.4.4 Piston

The piston appeared undamaged. The aft end of the piston was $1^{20}/_{32}$ inches from the guide collar.
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2.4.5 Link arms

The R2 and R3 link arms had disconnected and their link screw holes were elongated. The R1 link arm was intact and undamaged.

2.4.6 Cylinder

The cylinder appeared undamaged.

2.4.7 Feathering spring assembly

The feathering spring assembly was not disassembled.

2.4.8 Pitch change rod

The pitch change rod was not inspected.

2.4.9 Clamps and counterweights

All of the clamps and counterweights were intact. The outer end of the R2 link screw was damaged. The R3 link screw was missing.

Figure 4. No. 2 engine and propeller recovered to Watson's Island wharf

2.4.10 Hub unit

The hub mounting flange appeared undamaged.

2.4.11 Blades

The R1 blade was bent aft approximately 30° at mid-blade. It was curled and bent further aft at its ¾ radius. It was twisted toward low pitch. A 2-inch tip section was partially torn off. There was a large gouge on the LE 9–12 inches from the tip. The outer $^{1}/_{3}$ of the camber side of the blade was abraded and missing paint.

The tip area of the R2 blade was bent aft approximately 45°. The outer four inches of the tip was torn off. There were LE and trailing edge (TE) dents and gouges on the outer $^{1}/_{3}$ of the blade.

The R3 blade was bent forward approximately 20°, with a large radius bend at mid- blade. It had additional forward bending in the tip area. The outer five inches of the tip was torn off with aft bending and damage at the TE. The LE was torn and dented 10–13 inches from the tip.

3.0 Partial disassembly inspections

The engines and propellers were further examined at Atlanta Air Salvage in Griffin, Georgia, February 9-10, 2006.

3.1 No. 1 engine

The engine C flange was separated to permit limited visual inspection of the CT and PT assemblies.

3.1.1 CT rotor

The CT blade airfoils were intact. The downstream side blade platforms displayed circumferential rubbing and light bluing. The disk hub spigot displayed heavy circumferential rubbing and deformation.

3.1.2 PT guide vane ring and interstage baffle

The vane airfoils were intact. The upstream side inner drum and baffle face displayed circumferential rubbing, with bluing. The downstream side inner drum and baffle face displayed circumferential rubbing and scoring. The downstream baffle was displaced aft and the baffle inner cup displayed circumferential rubbing and scoring, and deformation.

3.1.3 PT shroud

The shroud displayed circumferential rubbing along the PT blade tip path.

3.1.4 PT rotor assembly

The disk was displaced slightly aft where the exhaust duct had deformed. The blade platforms were displaced approximately $^{1}/_{2}$-inch in their fir tree slots. Several blades were displaced completely and two blades were fractured at approximately mid-span. The separated portions of the blades were located in the exhaust duct. The upstream side blade platforms and blade tip shrouds were circumferentially rubbed. The disk hub spigot was circumferentially rubbed and deformed.

3.2 No. 1 propeller

The propeller was disassembled and the hub assembly was examined for evidence of a power setting at initial impact.[9] The feathering spring assembly was not disassembled.

There was an internal mark 2 $^{3}/_{8}$ inches from the aft end of the piston ID consistent with contact by the forward end of the cylinder. According to Hartzell, a mark in this location equates to an approximate 24° blade angle.[10]

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[9] Blade angle witness marks are internal contact marks that result from abnormal propeller loading and can be used to fix the blade angle setting at the time the loading occurred. A pre-impact blade angle setting can sometimes be derived. However, witness marks may also reflect blade angles associated with secondary damage that occurred in later stages of the impact sequence.

[10] Propeller blade angles derived from witness marks have an error tolerance both in measurement and in

There were no impression marks from blade contact that could be used to calculate a blade angle.

3.3 No. 2 engine

The engine C flange was separated to permit limited visual inspection of the CT and PT assemblies.

3.3.1 CT rotor

The CT blade airfoils were intact. The downstream side blade platforms displayed circumferential scoring.

3.3.2 PT guide vane ring and interstage baffle

The vane airfoils were intact. The upstream side inner drum and baffle face displayed an arc of rubbing from 5 to 7 o'clock. The downstream side inner drum and baffle face displayed rubbing and scoring from 2 to 9 o'clock. The downstream baffle inner cup was circumferentially rubbed and radially deformed. The downstream side vane ring outer drum displayed an arc of rubbing and scoring between 3 and 8 o'clock.

3.3.3 PT shroud

The shroud showed circumferential rubbing in the area of the PT blade tip path.

3.3.4 PT rotor assembly

The disk was displaced slightly at 10 o'clock where the exhaust duct had deformed. The blade airfoils were intact. The upstream side blade platforms and blade tip shrouds were circumferentially rubbed. The disk hub spigot was circumferentially rubbed.

3.4 No. 2 propeller

The propeller was disassembled and the hub assembly was examined for evidence of a power setting at initial impact. The feathering spring assembly was not disassembled.

The aft end of the piston was located 1-$^{20}/_{32}$ inches from the guide collar. According to Hartzell, this equates to an approximate 38° blade angle.

The beta mechanism was intact and the piston position was $^{12}/_{32}$- to $^{14}/_{32}$-inch away from the flight idle pickup nuts on the beta rods. According to Hartzell, this would equate to a piston position of 32°-34°, assuming the feedback collar was in its normal position.

There was an internal mark 2 $^{8}/_{32}$ inches from the aft end of the piston ID consistent with contact by the forward end of the cylinder. A mark in this location equates to an approximate 19° blade angle.

The piston guide collar was gouged in two places from contact with the link screws. According to Hartzell, the blades/link screws were in a reverse position when the marks were made.

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the accuracy of the reference point used for measurement.

A mark found on the R2 hub arm was consistent with contact with the butt end of the R2 blade. According to Hartzell, the location of the mark correlates to a blade position at or near feather when the mark was made.

Carol Horgan
Powerplants Group Chairman