NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

AIRWORTHINESS GROUP CHAIRMAN'S FACTUAL REPORT

June 20, 2016

A. ACCIDENT ANC15MA041

Location:	Ketchikan, Alaska
Date:	June 25, 2015
Time:	1215 Alaska Daylight Time (ADT)
Operator:	PM Air, LLC
Aircraft:	deHavilland DHC-3, N270PA

B. AIRWORTHINESS GROUP

Chairman:	Clinton R. Crookshanks National Transportation Safety Board Denver, Colorado
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Member:	Roy Dunn Federal Aviation Administration Ketchikan, Alaska
Member:	Bob Grace PM Air, LLC Ketchikan, Alaska
Member:	Les Doud Hartzell Propeller Piqua, Ohio

C. SUMMARY

On June 25, 2015, about 1215 Alaska daylight time, a single-engine, turbine-powered, float-equipped deHavilland DHC-3 (Otter) airplane, N270PA, sustained substantial damage when it impacted mountainous, tree covered terrain about 24 miles northeast of Ketchikan, Alaska. The airplane was being operated under the provisions of 14 *Code of Federal Regulations (CFR)* Part 135, as an on-demand, visual flights rules (VFR) sightseeing flight when the accident occurred. The airplane was owned by Pantechnicon Aviation of Minden, Nevada, and operated by PM Air, LLC, of Ketchikan. The commercial pilot and eight passengers were fatally injured. Marginal visual meteorological conditions were reported in the area at the time of the accident. The flight departed a floating dock located in Rudyerd Bay about 44 miles northeast of Ketchikan about 1200, for a tour through Misty Fiords National Monument Wilderness. A company VFR flight plan was in effect. At the time of the accident, the flight was returning to the operator's base at the Ketchikan Harbor Seaplane base, Ketchikan.

D. DETAILS OF THE INVESTIGATION

1.0 Aircraft

Manufacturer's Serial Number (MSN): 270

The deHavilland DHC-3 Otter is a single engine, propeller driven, single pilot, high wing, short take-off and landing (STOL) airplane originally designed in the early 1950's (Figure 1[1]). The airplane is equipped with a cruciform tail and either conventional landing gear or floats. The airplane is 45 feet, 10 inches long, 12 feet, 6.6 inches high at the tail and has a wing span of 58 feet. The original airplane was powered by a single reciprocating radial engine but could be converted to turbine engine power by Supplemental Type Certificate (STC). The accident airplane was powered by a Pratt & Whitney Canada PT6A turboprop engine in accordance with Vazar, Inc. STC SA3777NM and equipped with Edo 7490 floats in accordance with A.M. Luton STC SA 4375NM. The type certificate for the airplane is currently owned and maintained by Viking Air Limited, Sidney, British Columbia, Canada.

1.1 Aircraft Examination On-Scene

The airplane impacted near vertical tree-covered terrain above the southwestern shore of Ella Lake in the Misty Fiords National Monument Wilderness. Access to the site was extremely difficult so limited examination of the wreckage occurred on-scene. The entire airplane was accounted for at the main impact site (Figure 2). The airplane impacted several trees of varying sizes within about 50 feet of the terrain impact point.

The terrain impact point was on a vertical rock face about 35 feet above the final resting point of the fuselage. The propeller was separated from the engine and located between the fuselage and the initial impact point. The propeller blades exhibited curling of the tips, chunking and gouging of the leading edges, and chordwise scratching on the forward faces of the blades. The tips of two propeller blades were separated and found adjacent to the propeller. The fuselage was mostly intact with significant

[1] All figures are presented in Appendix A.

crushing damage at the forward end. The passenger cabin was mostly intact. Four of the passenger seats on the right side and one seat on the left side were still partially attached at either the floor or wall. The remaining passenger seats were separated from their mounting points. The empennage remained partially attached to the fuselage but was deformed to the left and rotated counter-clockwise (as viewed from the aft looking forward). The fuselage forward of the empennage was fractured along the right side and buckled along the left side. The right elevator remained partially attached to the empennage at the torque tube on the inboard end. The leading edge of the right elevator horn was crushed and deformed. The left elevator remained installed with minor damage. The rudder remained installed and was undamaged. The right wing was separated from the fuselage at the wing root. The right forward wing attach point was fractured on the wing side of the fitting. The right aft wing attach point was intact and a portion of the aft spar structure was fractured from the wing. The right wing strut was separated from the wing but remained attached to the fuselage. The outboard portion of the right wing was separated and was located about 100 feet below the main wreckage (blue arrow in Figure 2). The left wing remained attached to the fuselage at the left aft wing attach point and the forward attach point was fractured on the wing side of the fitting. The left wing strut was attached to the wing and fuselage. The floats were separated from the fuselage and located below the fuselage (yellow arrows in figure 2).

The two Chelton multi-function display units were removed from the instrument panel and sent to the NTSB laboratory for download. The units were intact with very minor damage.

1.2 Aircraft Examination in Hangar

The airplane wreckage was recovered to a hangar in Ketchikan where the group examined the wreckage August 17-20, 2015.

Fuselage

The fuselage was mostly intact from the nose to about fuselage station[2] (FS) 398 with significant damage. All of the engine cowling was separated from the airplane. The lower forward fuselage had extensive crushing damage below the level of the cabin windows and forward of the wing strut attach points. The nose of the airplane was crushed and deformed upward and aft. The engine remained attached to the engine mount but the mount was bent and fractured in several places. The upper fuselage was buckled laterally between the left and right aft wing attach points. The upper fuselage structure forward of the passenger entry doors was displaced forward relative to the lower fuselage such that the window posts were all deformed forward. The windshield and all the cabin windows were fractured into multiple pieces and separated. The right single passenger entry door and the left aft passenger entry door remained attached to the fuselage. The left forward passenger entry door was separated at the hinges. The right and left sides of the fuselage had some buckling damage between the forward edge of the passenger entry doors and the aft edge of the cabin windows. The two cockpit doors were essentially intact but had fractured from the fuselage at the hinge points. The right wing strut remained attached to the fuselage at the lower end and the fuselage structure was fractured and deformed around the fitting location. The left lower wing strut fitting remained intact and attached to the fuselage. The left strut had been cut about 10 inches above the attach point during recovery.

Empennage

[2] Fuselage stations are measured in inches from the datum located 60 inches forward of the firewall.

The empennage was attached to the fuselage at the impact site with minimal damage but was removed during the recovery. The empennage was intact but damaged from FS 398 to the tail end. The rudder remained attached to the trim and control push-pull tubes. The lower rudder hinge was fractured and the center and upper rudder pins were intact but the rudder had separated from the pins. There was some crushing damage to the lower portion of the rudder and the rudder trim tab. The horizontal stabilizer was intact with some minor damage to the leading edges. The left elevator and flap/elevator interconnect tab were attached to the horizontal stabilizer. There was some buckling damage on the outboard half of the left elevator. The right elevator was present at the accident site but had separated from the empennage during recovery and was not recovered. The right upper flange on the elevator torque tube was fractured and the right lower flange was deformed inboard. The bolt remained installed in the right lower flange. The right elevator center and outboard hinge pins were intact and deformed down and aft. The two elevator servo tab control rods remained attached to the horizontal stabilizer rear spar but were fractured in the center portions of the rods. The aft ends of the control rods were not recovered.

Wings

The right wing was separated from the fuselage at the attach points and recovered in 5 major pieces. The clevis flanges on the right wing forward attach fitting were fractured and the fractured portions remained with the fuselage side of the fitting. The right wing forward attach bolt was intact and installed in the lug on the fuselage. A portion of the aft spar about 5 inches long including the right wing aft attach fitting was fractured from the wing and remained attached to the fuselage. Both of the fittings and the rear attach bolt were intact. The right wing was mostly intact from the wing root at wing station[3] (WS) 34 to about WS 128. There was significant wing damage between about WS 128 and WS 221. The upper and lower wing skins and ribs showed significant damage, rearward crushing, and deformation in this area. Two pieces of wing skin were separated in this area. A portion of the forward spar about 5.5 feet long (WS 140-210) was torn from the wing and remained attached to the upper end of the right wing strut. The right wing was mostly intact from WS 221 (pulse light) to the wing end rib at WS 335. The right wing fiberglass tip was fractured into multiple pieces. There was a large semi-circular impression in the leading edge about 12 inches in diameter centered about WS 317. The right aileron and fore flap assembly was separated from the wing at the hinges. The aileron and the inboard half of the fore flap were intact but damaged and deformed. The outboard half of the fore flap was separated between the center and outboard hinges. The inboard aft flap and fore flap assembly remained attached to the wing at the center and outboard hinges. The inboard end of the aft flap was fractured from the hinge. The inboard flap hinge remained attached to the fuselage. The right wing strut was mostly intact and attached to the fuselage with little damage.

The left wing was fractured into two major pieces The largest piece was about 20 feet long and extended from the wing root at WS 34 to about WS 277. The outboard piece extended from about WS 277 to the wing end rib at WS 335. The left wing fiberglass tip was separated from the wing but was intact with little damage. There was a large semi-circular impression in the leading edge about 18 inches in diameter centered about WS 50 near the wing root. The wing root area had significant damage. There was a large semi-circular impression in the leading edge about 13 inches in diameter in the outboard wing piece centered about WS 300. There was an area of significant wing damage from about WS 171 to WS 224. The leading edge was deformed aft and the lower skin was fractured at each end. The upper wing skin was also fractured at WS 224. There were small semi-circular impact

[3] Wing stations are measured in inches from the datum located at the centerline of the airplane.

impressions in the leading edge at WS 164, WS 171, and WS 224. The left wing strut was complete but folded in half and remained attached to the wing. The strut was cut near the fuselage during recovery. There were several small dents in the leading edge of the strut and the strut was crushed near the mid-point. The clevis flanges on the left forward wing fitting were fractured and the fractured portions remained with the fuselage side of the fitting. The forward attach bolt was intact and installed in the lug in the fuselage fitting. The aft attach point was intact and a section of the wing about 3 feet wide (spanwise) and 2.5 feet long (chordwise) including a section of rear spar remained attached to the fuselage. The inboard fore flap and aft flap assembly remained attached to the wing at the center and outboard hinges but was damaged and deformed. The outboard half of the left aft flap was separated between the center and outboard hinges. The inboard half of the outboard fore flap remained attached to the wing between the inboard hinge and center hinge. The outboard half of the outboard fore flap was separated and had damage coincident with the wing damage. The inboard half of the aileron was separated from the wing but had relatively minor damage. The outboard half of the aileron was not recovered. The pitot tube was separated from the left wing but mostly intact.

Cockpit

The cockpit area had significant damage. The floor was deformed upward and aftward, the instrument panel was deformed aft and the windshield center post was fractured. The flight instruments, switches, and circuit breakers were documented with the exception of the Chelton display units that were previously removed. The Terrain Awareness Warning System (TAWS) switch was in the INHIBIT position and the switch handle was deformed up slightly (Figure 3). The glass in the altimeter was broken and the longest needle (10's) was separated from the unit. The pressure was set between 29.88 and 29.90 and the remaining needles indicated 700 feet (Figure 4). The airspeed indicator and attitude indicator were separated from the instrument panel with significant crushing damage. The airspeed indicator face was recovered and had a red radial line at 133 mph. The Hobbs meter indicated 6874.4 hours and there was a yellow sticker on the face of the indicator with "6891.3 July 11" hand-written on it. On the center quadrant the EMERGENCY POWER LEVER was in the OFF position and the safety wire was intact. There was a folded napkin in the lever slot. The POWER LEVER was set to the IDLE position, the PROPELLER lever was in the normal range about ¾ the travel length toward DECREASE, and the CONDITION LEVER was at the low idle gate. The PROPELLER lever was between DECREASE and FEATHER on-scene prior to recovery. The instrument panel above the center quadrant was deformed down into the levers (Figure 5).

The stabilizer trim indicator was between 0 and 1 in the NOSE UP direction. The flap selector lever was above the flaps up gate and the flap indicator was in the up position. The rudder trim indicator was about halfway between center and right.

Flight Controls

The control column was cut above the boot installed on the cockpit floor in order to remove the victims. There was continuity between the left and right yokes. The aileron chain was attached to the yoke cables but one link was cut at the level of the cut in the column.

The forward left aileron control cable was intact from the quadrant below the cockpit floor to the quadrant in the cabin roof. The left wing aileron control cable was attached to the quadrant in the cabin roof and was broken at the left wing root (side of body). The remaining portion of the left wing aileron control cable was in the left wing and intact out to the aileron. The forward right aileron control

cable was attached to the quadrant in the cabin roof and intact to a point behind the co-pilot seat. The remaining portion of the forward right aileron control cable could not be examined due to the deformation of the lower forward fuselage. The right wing aileron control cable was attached to the quadrant in the cabin roof and intact for about 20 feet. The aileron control cable was broken at the aileron quadrant in the right wing. The aileron balance cable was attached to the aileron quadrant in the right wing and broken near the wing root. The remaining portion of the aileron balance cable was attached to the left wing. The breaks in the aileron cables all had a splayed appearance consistent with tension overload. The turnbuckles in the aileron cables were intact with the safety wire in place.

The control cables for the elevator, rudder, stabilizer trim, flap/tab interconnect, and rudder trim were cut near FS 398 during recovery. Control cable continuity for the rudder and elevator was established between the cut forward to a point on the lower right side of the fuselage near the right wing strut attach point. The elevator and rudder cables could not be traced from the strut to the control quadrant below the cockpit due to the damage and deformation of the lower fuselage. The flap/tab interconnect cables were intact from the cut forward to the quadrant in the upper cabin. The rudder trim cables were intact from the cut forward to the trim knob on the cockpit roof. The chain on the forward end of the rudder trim cables was off the sprocket at the trim knob. The stabilizer trim cables were intact from the cut forward to the trim drum in the cockpit. The stabilizer trim, rudder trim and flap/tab interconnect linkages were all intact in the tail and continuity was established between the cut aft to the control surfaces. The cables for the elevator and rudder were intact from the cut at FS 398 aft to the control horns in the empennage.

The elevator screw jack was extended 7/16-inch and was attached at the upper and lower ends. Full travel is 2-1/16 inches. The flap actuator was fully retracted in the upper cabin roof.

Floats

The floats were separated from the airframe at the fuselage attach fittings. All of the fittings were fractured with portions remaining attached to the fuselage and the float struts. The aft flying wires were intact and remained attached to the fuselage. The attach brackets for the aft flying wires were fractured from the floats.

The forward half of the left float was deformed upward and the left side was separated. The left float left side skin was deformed in an accordion pattern. The left forward strut was intact and attached to the separated left float side skin. The left aft strut was intact and attached to the left float. The left diagonal strut was intact and attached to the fitting at the upper end of the forward strut. The clevis was fractured at the aft end of the diagonal strut where it attaches to the aft strut.

The forward half of the right float was deformed downward and the right side was damaged and deformed. The right forward strut was fractured into 3 pieces. The lower portion was attached to the right float. The right aft strut was intact and attached to the right float. The right diagonal strut was intact but separated from the float. The clevis fittings at each end of the right diagonal strut were fractured.

The aft spreader bar was separated from the floats. The right aft spreader bar fitting was pulled from the right float and the left aft spreader bar fitting was pulled from the spreader bar. The left side of the aft spreader bar was deformed forward. The forward spreader bar was separated from the floats and

fractured into 2 pieces. The left and right forward spreader bar fittings were pulled from the float. The trim wires were intact and attached to the fittings at the aft struts. The forward flying wires were intact and attached to the fittings at the lower end of the forward struts.

Engine

The airplane was equipped with a Pratt & Whitney Canada (P&WC) PT6A-135A, S/N 35056, turboprop engine. The engine was removed from the wreckage and shipped to the manufacturer. A tear down inspection under the supervision of the NTSB was performed November 17-18, 2015, at the P&WC Service Investigation facilities in St. Hubert, Quebec, Canada. See Attachment 3 to this report for P&WC Report No. 15-064 summarizing the examination and including photos of the tear down.

The engine was mostly intact (Figure 6). The propeller shaft was fractured from the engine immediately aft of the propeller mounting flange. The forward end of the engine was deformed downward about 30 degrees relative to the engine centerline in the exhaust duct area. The gas generator and power section rotors could not be rotated. The lower portion of the reduction gearbox was damaged, the gas generator case was intact, and the accessory gearbox was intact with some damage to the mounted accessories. The reduction gearbox chip detector mounting boss was fractured and the chip detector was not recovered. The oil filter, fuel filter, and fuel pump inlet screen did not show any evidence of dirt or debris.

Loose soil was found in the 1st, 2nd, and 3rd compressor stages and through the centrifugal impeller. Rotational scoring was noted throughout the compressor assembly. All of the compressor rotor and stator blades were intact with rubbing damage to the tips. Axial cracks were noted at the through bolt locations on the 1st stage spacer. The centrifugal impeller vanes and shroud exhibited rotational scoring, heat discoloration, and material smearing. The No. 1 bearing and air seals were intact with no indications of distress. The No. 2 bearing was intact with no indications of distress and the air seals exhibited rotational scoring.

The combustion chamber liner, large exit duct, and small exit duct were intact with no indications of operational distress. The flame pattern indications in the large exit duct appeared normal. There was some minor heat erosion noted in the small exit duct. Evidence of rotational scoring, heat discoloration, and material smearing was noted on the compressor turbine guide vane ring, shroud, disc, and blades. The compressor turbine blades were intact with no signs of operational distress to the airfoils.

The power turbine housing and components exhibited significant damage, rotational scoring, heat discoloration, and material smearing consistent with the deformation of the exhaust duct and power turbine shaft. All of the power turbine blades were fractured and blade debris was found in the deformed exhaust duct. The lower portions of the blades were displaced forward in their serrated fixings in the disc. The blade fracture faces exhibited a coarse, granular appearance consistent with overstress separation with no indications of pre-existing cracking. Deformation prevented disassembly of the power turbine shaft and housing including the No. 3 bearing. One displaced No. 3 bearing roller was located in the reduction gearbox oil sump.

The reduction gearbox was mostly intact. Upon disassembly, the 1st stage planet gear carrier spline

coupling to the 2nd stage sun gear was found fractured at the carrier web. The fracture exhibited features consistent with overstress separation. Rotational scoring and heat discoloration was noted on the 1st and 2nd stage carrier webs. There were no indications of operational distress noted in the 1st and 2nd stage gearing.

The high pressure fuel pump, fuel control unit, compressor bleed valve, fuel heater, and fuel nozzles were removed from the engine and functionally tested. Some of the fuel nozzles exhibited streaking of the nozzle flows in excess of the return to service specifications. No other discrepancies were noted. The fuel control unit, flow divider valve, and propeller governor were disassembled and inspected. No conditions that would preclude normal operation were noted.

Propeller

The airplane was equipped with a Hartzell HC-B3TN-3DY, S/N BUA30604, 3-blade propeller. This model propeller is a single acting, hydraulically operated, constant speed model with feathering and reversing capabilities. It is equipped with a steel hub, steel blade clamps and aluminum blades. The propeller rotates clockwise as viewed from the pilot seat. The propeller was manufactured in June 2006.

The propeller separated from the engine during impact (Figure 7). The propeller mounting flange remained attached to the propeller and the propeller shaft was fractured just aft of the flange. All three blades remained attached to the propeller hub. Approximately 5 inches of blade fractured off the tips of two blades and the tip fragments were recovered at the main wreckage site. About 95% of the spinner dome had fractured from the spinner bulkhead. Approximately one-third of the spinner bulkhead was fractured from the propeller assembly. All the blade clamps and counterweights were intact. The piston-cylinder assembly was fractured/pried off but remained attached to the propeller assembly by two link arms and two beta rods. The beta ring was pulled forward and crushed but remained attached to two of the beta rods. The feathering springs remained intact and were retained by the spring keepers. The aft two inches of the pitch change rod was bent approximately 30 degrees off the rotation axis. All three blades exhibited chordwise scoring and leading edge impact gouges. The blade that was oriented down at the impact site also exhibited spanwise scoring. All three blades exhibited bending aft. All three start lock assemblies were not engaged.

The propeller was torn down in the hangar with the assistance of a representative from Hartzell Propeller by removing and disassembling the spinner fragments, blades, clamps, and the piston-cylinder assembly. See Attachment 4 to this report for Hartzell Propeller Report No. 150625 summarizing the examination and including photos of the tear down. One blade exhibited blade butt contact marks indicating impact forces in the aft direction, one blade exhibited blade butt contact marks in both an aft and lead-to-trail direction, and one blade did not exhibit any blade butt contact marks. Each of the blade butt contact marks were matched with the corresponding blade arm contact marks on the hub arm flange and indicated all three blades were in the low pitch range. Internal contact marks in the piston-cylinder assembly were consistent with a blade angle of about 26º.

2.0 Maintenance Records Examination[4]

MSN: 270

[4] See Attachment 1 to this report for the pertinent maintenance records.

Airframe: 24,439.5 hours (end of day 6/24/15)
Engine: 14,575.9 hours (end of day 6/24/15)
Propeller: 3,700.4 hours (end of day 6/24/15)
Otter DHC-3, Manufactured 1958

The method, procedures, and forms utilized by PM Air, LLC, for the maintenance of their airplanes were documented in the General Maintenance Manual (GMM). Revision 6 of the GMM was current at the time of the accident and was dated February 1, 2013. The GMM was accepted by the FAA on June 19, 2013. The accident airplane was maintained under an Approved Airplane Inspection Program (AAIP) that was published as Annex A to the GMM. According to the GMM and the AAIP, the AAIP is an FAA approved document that contains the detailed timing and tasks associated with the maintenance of the accident airplane. Revision 5 of the AAIP was current at the time of the accident and was dated February 1, 2013. The List of Effective Pages page in Annex A, DHC-3T, AAIP-General was stamped *accepted* by the FAA on June 19, 2013. There was no record of *approval* for the AAIP contained in the document. The FAA stated that the AAIP was likely stamped incorrectly by the Flight Standards District Office during the review process.

The AAIP defines 6 inspections for the airplane as follows. Any discrepancies noted during any of the inspections should be recorded on a non-routine form.

AAIP-O – The overnight inspection is normally accomplished at the end of each day of operation. The published checklist for the inspection is utilized but there is no permanent record kept of the inspection.

AAIP-MM – The mini monthly inspection is scheduled every month (up to 31 days) and provides for a more detailed inspection than the overnight inspection. This inspection is generally utilized during the slower times of operation. The inspection checklist is signed off and retained until the inspection is repeated but is not entered in the aircraft logbooks.

AAIP-M125 – The mini 125 hour inspection is scheduled every 125 flight hours and provides for a slightly more detailed inspection than the mini monthly inspection. This inspection is generally utilized during the busier times of operation when the airplane can accrue up to 150 hours per month. The inspection checklist is signed off and retained until the inspection is repeated but is not entered in the aircraft logbooks.

AAIP-A, B, C – The A, B, and C inspections are scheduled every 250 hours, 500 hours, and 1000 hours, respectively. Each inspection is progressively more detailed than the previous and all the items from the MM and M125 inspections are incorporated into these inspections. The inspection checklist is signed off and retained until the inspection is repeated and is entered in the aircraft logbooks.

The AAIP-Limitations section defined inspection intervals for those items that did not coincide with the intervals in the regular AAIP inspections listed above. Additionally, AAIP-Limitations defined the component overhaul or replacement times for the time controlled items installed on the airplane. All of the items in AAIP-Limitations were given a unique tracking number and input into a computerized tracking program. Additional detailed information on the life limited components installed on the airplane was contained in section 5.400 of the GMM.

The engine maintenance program was documented in section 2.400 of the GMM. The original revision of section 2.400 was current at the time of the accident and was effective October 21, 2005.

The FAA had approved an on-condition maintenance program for the turbine engine on the accident airplane with no hard time between overhauls (TBO). According to the Director of Maintenance, the accident engine had always been maintained on condition since they acquired the airplane and engine. Per the operator's GMM, the modular engine design concept of the PT6A engine in conjunction with condition trend monitoring, on the wing maintenance and inspections, and component time/cycle limitations, allowed for maintenance and overhaul on an as-needed basis. P&WC defines two sections for the PT6A engine for inspection and maintenance purposes; the gas generator section that includes the accessory gearbox, compressor stages, compressor turbine, and combustion chamber, and the power section that includes the power turbines, exhaust ducts, and reduction gearbox. The operator broke the gas generator section down further into two sections for the purposes of their maintenance program outlined in the GMM. The compressor section included the compressor stages and accessory gearbox and the hot section included the compressor turbine and combustion chamber. The power section was the same as defined by P&WC. The operator could separate the engine into the serialized power section, serialized compressor section, and hot section, allowing for maintenance of only those necessary items in each section. The engine serial number was the compressor (gas generator) section serial number since it carried the engine data plate. The operator was required to perform trend monitoring of the engine using a P&WC approved vendor in accordance with the procedures in the GMM. PM Air contracted with The Trend Group[5] for P&WC Engine Condition Trend Monitoring (ECTM) services. Pilots recorded specific trend data on a form provided in the aircraft once each day. Data was recorded twice a day if the airplane was flown more than 8 hours. The recorded trend data was supplied to the vendor on a weekly basis for analysis and any abnormalities or recommended corrective action was supplied to the Director of Maintenance for disposition. In addition to trend monitoring, the operator was required to perform oil analysis, vibration analysis, propeller balancing, and borescope inspections to support the on-condition maintenance of the engine as documented in section 2.400 of the GMM at intervals defined in AAIP-Limitations. The following Table 1 lists the engine maintenance items contained in the AAIP-Limitations.

[5] The Trend Group is listed as a Pratt & Whitney Canada Designated Analysis Center for ECTM services in Service Information Letter GEN-055R4.

Component	Action	Interval*
Propeller	Overhaul	3000H/72M
Engine	Overhaul	OC
Power Section	Overhaul	OC
Disk, Power Turbine	Replace	20000C/30000C**
RGB Bearings	Inspect	8000H
Gas Generator	Overhaul	OC
Hub, Compressor (1st Stage)	Replace	19000C
Hub, Compressor (2nd Stage)	Replace	24000C
Hub, Compressor (3rd Stage)	Replace	25000C
Impeller	Replace	19000C
Hot Section Inspection	Overhaul	OC
Disk, Compressor Turbine	Replace	16000C
Blades, Compressor Turbine	Overhaul	3000H/5000H**
Oil Filter Replace	Replace	1000H
Propeller Balance	Test	12M
Fuel Nozzles/Borescope	Test	400H
Oil Filter Analysis	Test	200H
* H=Hours, M=Months, C=Cycles, OC=On Condition ** Time dependent on part number installed		

Table 1 – Engine maintenance items

The most recent AAIP inspection of the airplane was an AAIP-MM inspection. The inspection was performed on June 10, 2015 at 24,395.8 airframe hours, 14,532.2 engine hours, and 3,656.7 propeller hours. At this time the engine had accrued 10,361.8 hours since overhaul and the propeller had accrued 793.6 hours since overhaul. The only discrepancy reported during the inspection was an inoperative strobe light that was replaced.

The most recent AAIP-A, B, or C inspection of the airplane documented in the airframe, engine, and propeller logbooks was an unidentified inspection completed on May 11, 2015 at 24,334.3 airframe hours, 14,470.7 engine hours, and 3,595.2 propeller hours. The records package for the most recent AAIP-B inspection indicated the airplane was down for maintenance between February 25, 2015, and May 11, 2015, when the AAIP-B inspection was signed off. In addition to the AAIP-B inspection items, the following AAIP-Limitations items were completed during this maintenance visit.

-Yearly Symmetry Inspection
-Yearly Rigging Inspection
-Yearly Cable Tension Inspection
-12-month CPCP[6] and Structure Inspection
-Control System and Cable Inspection
-First Aid Kit Inspection
-Replace Elevator and Rudder Cables
-Wing Strut, End Fittings, Links, and Lug Inspection
-AOG Gross Weight Kit Strut Cuff Inspection
-Prop Balance, Vibration Analysis and Power Run

[6] Corrosion Prevention and Control Program

-Fuel Nozzle Replacement and Borescope Inspection
-Life Jacket Inspection/Replacement
-Single Cell Personal Flotation Device Inspection
-ELT Inspection/Test or Battery Replacement
-Portable Fire Extinguisher Inspection
-Elevator Screw Jack Rebuild

The non-routine forms for this maintenance indicated that one of the rudder cables was found broken. The Prop Balance block on the non-routine form was not signed off although the detailed worksheet was signed. The horizontal stabilizer trim drum was found seized and repaired. Non-routine items for windshield replacement, installation of a new starter switch, removal and replacement of nav flasher unit and switch, painting of the glare shield, installation of an arm rest, and repair of heasdset jacks were noted as "non airworthy will reschedule". No corresponding completion paperwork or sign off for these items was found in the records.

The most recent AAIP-M125 inspection was signed off on August 21, 2014, at an airframe time of 24,242.8 hours. The most recent AAIP-A inspection was signed off on July 23, 2014 at 24,130.9 airframe hours, 14,267.3 engine hours, and 3,391.8 propeller hours. The most recent AAIP-C inspection was signed off on March 28, 2014 at 23,891.5 airframe hours, 14,027.9 engine hours, and 3,152.4 propeller hours.

The HC-B3TN-3DY propeller, S/N BUA30604, was overhauled on December 5, 2012, and installed on the airplane on July 8, 2013, at an airframe time of 23,602.2 hours. The propeller had 2,863.1 hours total time when it was installed. As of the end of the day on June 24, 2015, the propeller had accrued 3,700.4 hours total time and 837.3 hours since overhaul.

The PT6A-135A engine, S/N 35056, was last overhauled on January 4, 1999, and installed on the airplane on May 20, 1999, at an airframe time of 14,034.0 hours. This overhaul was accomplished before the operator acquired the airplane and it is unknown what the power section S/N was as that time. The engine had accrued 4,170.4 hours since new at the time of installation after the overhaul.

At the time of the accident the engine was comprised of the compressor section with S/N 35056 and the power section with S/N 92466. The hot section on the accident engine was installed on February 11, 2011, at an airframe time of 22,407.1 hours and an engine time of 8,373.1 hours since overhaul. The compressor turbine (CT) disk in the hot section had 8,595 cycles since new and the CT blades had 1,660.0 hours since new at the time of hot section installation. As of the end of the day on June 24, 2015, the compressor section had accrued 14,575.9 hours total time and 10,405.5 hours since overhaul, the power section had accrued 13,450.5 hours total time and 9,626.4 hours since overhaul, and the hot section had accrued 2,032.4 hours total time. The most recent borescope inspection and replacement of the fuel nozzles was accomplished on May 11, 2015, at an engine time of 14,470.7 hours total time and 10,300.3 hours since overhaul. As of June 22, 2015, at the last time data was available, the 1st stage compressor hub, 2nd stage compressor hub, 3rd stage compressor hub, and 4th stage compressor impeller had accrued 18,159 cycles since new. The CT disc had accrued 13,379.2 cycles since new, the power turbine (PT) disc had accrued 22,688.3 cycles since new, and the CT blades had accrued 3,685.7 cycles since new.

The most recent weight and balance was calculated on July 22, 2010, and listed a Basic Weight of

4885.6 pounds, a Basic center of gravity (CG) at 135.84 inches, a Basic Moment of 663,657 pound-inches, and an Index at 17.8 inches. The airplane was last weighed on May 21, 2007, and listed a Net Weight of 6680.0 pounds and a CG at 143.80 inches.

The following recurring airframe Airworthiness Directives (AD's) were listed and signed off in the records.
AD 83-04-05 Control Column Lower Weld, 6/10/2015
AD 83-02-01 Wing Strut Tie-Bar, 5/11/2015
AD 2011-18-11 Elevator Control Tab Play, 6/10/2015

The following one-time AD's were listed and signed off in the records.
AD 2014-17-01 Screw Jack Inspection, 5/8/2015

The engine and propeller AD list was examined and all applicable AD's were either complied with or not applicable.

The following Supplemental Type Certificates (STC's) were installed based on the records.
STC SA4345NM – 1-9 Pax seats, 7/25/14
STC SA00438NY – AOG 400lb Upgross Wing Strut Kit, 5/25/10
STC SA03-99 – Redundant Servo Tab, 6/22/04
STC SA02203AK – Chelton EFIS, 2/24/05
STC SA02217AK – Garmin Datalink, 2/24/05
STC SA615EA – Anti-Collision Lights, 3/11/02
STC SE615GL – Fuel Flow Transducer, 5/18/93
STC SA4375NM – Edo 7490 Floats, 5/18/93
STC SA3777NM – PT6 Engine, 5/12/93
STC SA4005NM – Pulse light installation, unknown

3.0 FAA Information

The FAA publishes Order 8900.1 Flight Standards Information Management System (FSIMS) as the repository for all policy and guidance for aviation safety inspectors in carrying out their job duties. Volume 3, Chapter 38, Section 1 of the FSIMS provides the policy and guidance for evaluating and approving an operator's AAIP under Part 135, nine seats or less. The regulatory requirements of the order state the "Federal Aviation Administration (FAA) approves the AAIP and authorizes the use of that approved program through the issuance of operations specifications (OpSpecs)" in section 3-3734 A. Once the AAIP has been evaluated by the FAA to determine if it meets all regulatory requirements, "approval is granted by a stamp of approval and the PMI/PAI signature on the List of Effective Pages (LEP)" as stated in section 3-3738 C2. In general, FAA approval of a document is granted when the FAA has specifically evaluated a document that is required by regulation. The FAA will accept those documents that are not required by regulation.

The FAA issued 6 Operations Specifications for maintenance in Part D[7]. Operations Specification D073 authorized PM Air to use the accident airplane for their Title 14 CFR Part 135 operations provided it was maintained in accordance with the AAIP. The accident airplane was listed in the

[7] See Attachment 2 to this report for the Operations Specifications.

aircraft listing in Operations Specification D085. Operations Specification D101 contained the additional maintenance requirements for the engine and propeller installed on the accident airplane. The time-in-service interval for the P&WC PT6A-135A engine was "On Condition per PM Air, LLC General Maintenance Manual section 2.400. Time Limitations per Section 5.100"[8]. The time-in-service interval for the Hartzell HC-B3TN-3DY propeller was "3000 hours or 72 calendar months whichever occurs first".

The Operations Specification identified Section 5.100 in the PM Air GMM for the listing of time limitations on the engine, however, this section in the GMM was blank and had no time limitations. According to the operator, the time limited items in section 5.100 were incorporated into AAIP-Limitations in 2013.

4.0 Engine and Propeller Manufacturer Recommendations

Hartzell Propeller recommends a time between overhaul of 3,000 hours or 60 months for the HC-B3TN-3DY propeller.

Pratt & Whitney Canada recommends a basic operating time between overhaul (TBO) of 3,600 hours for the PT6A-135A engine in Service Bulletin (SB) 1803R6. Per the SB, "the TBO interval may be extended with the approval of the operator's Airworthiness Authority." Recommendations are also provided in the SB to extend the TBO beyond the basic for those operators with an average utilization higher than 300 hours per year. One option provides for a fleet wide TBO extension based on hardware condition from engine overhauls and the second option provides for engine specific TBO extensions based on the configuration, condition, and method of operation of the engine. Each option provides for a maximum TBO with extensions of 8,000 hours for the fleet wide option and 6,000 for the engine specific option provided that other provisions and service bulletins are incorporated. Section 3(B)(2) states "P&WC No longer endorses on-condition TBO programs on the PT6A engine models". The SB also recommends that hot section inspection of the engine should occur every 1800 hours but allows for a change in frequency based on ECTM in accordance with Service Information Letter GEN-055.

[8] The same time-in-service interval was listed in the Operations Specifications for the PT6A-34 engines operated by PM Air, LLC.