National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: October 1, 2009

In reply refer to: A-09-108 through -111

The Honorable J. Randolph Babbitt
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On November 8, 2005, about 0725 eastern standard time, an Embraer 110P1, N7801Q, operated by Business Air, Inc., as AirNow flight 352, crashed into a department store garden center shortly after takeoff from Manchester-Boston Regional Airport (MHT), Manchester, New Hampshire.[1] The airplane was destroyed, and the certificated airline transport pilot was seriously injured. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed for the 14 *Code of Federal Regulations* (CFR) Part 135 unscheduled cargo flight from MHT to Bangor International Airport, Bangor, Maine.

According to the pilot, the airplane took off with a flaps setting of 25 percent, per Business Air's procedures at the time. He stated that, immediately after raising the landing gear after takeoff, he heard an explosion and saw that all gauges for the left engine pointed to zero, indicating a loss of power to the left engine. He also noted that the left propeller had completely stopped so he added full power to the right engine, left the flaps at 25 percent, and left the landing gear up. He further stated that, although he "stood on the right rudder," he could not stop the airplane's left turning descent. The pilot later noted that, after the left engine lost power, he "couldn't hold V speeds" and "the stall warning horn was going off the whole time."

Postaccident examination of the accident airplane's left engine revealed that it had failed and that the propeller had been feathered. Examination of the trim positions revealed that the rudder was at neutral trim and the aileron was at full left trim. Although these trim positions could have been altered when the wings separated from the fuselage during ground impact, the pilot's comment that he "stood on the rudder" suggests that he either had not trimmed the airplane after the engine failure or had applied trim opposite the desired direction. The activation of the stall warning horn and the pilot's statement that he "couldn't hold V speeds" indicate that he also did not lower the nose sufficiently to maintain best single-engine rate of climb or best single-engine angle of climb airspeed. In addition, a performance calculation conducted during the National Transportation Safety Board's (NTSB) investigation revealed that the airplane, with

[1] More information about this accident, NYC06FA027, is available on the National Transportation Safety Board's website at <http://www.ntsb.gov/ntsb/query.asp>.

flaps set at 25 degrees, would have been able to climb at more than 400 feet per minute if the pilot had maintained best single-engine rate of climb airspeed and if the airplane had been properly trimmed.

Postaccident examination of the failed left engine revealed fatigue fracturing of the first-stage sun gear.[2] According to the airplane's maintenance records, during an October 1998 engine overhaul, the first-stage planet gear assembly was replaced due to "frosted and pitted gear teeth." The planet gear assembly's mating sun gear was also examined during the overhaul but was found to be serviceable and was reinstalled with the new planet gear assembly, which was an accepted practice at the time. However, in Service Information Letter PT6A-079, dated September 2, 1999, Pratt and Whitney Canada (P&WC), the engine manufacturer, advised that if either the sun gear or planet gear assembly needed to be replaced with a zero-time component, the corresponding mating gear/assembly must also be replaced with a zero-time component; otherwise, the different wear patterns on the gears could potentially cause "distress" to one or both of the components.

The NTSB determined that the probable cause of this accident was the pilot's misapplication of flight controls following an engine failure. Contributing to the accident was the failure of the sun gear, which resulted in the loss of engine power. Contributing to the sun gear failure were the engine manufacturer's grandfathering of previously recommended, but less reliable, maintenance standards, the Federal Aviation Administration's (FAA) acceptance of the engine manufacturer's grandfathering, the operator's inadequate maintenance practices, and the FAA's inadequate oversight of the operator.

Consistent Reliability Standards for PT6A-34, -35, and -36 Engines

P&WC previously supported the use of on-condition maintenance programs[3] to extend time between overhaul (TBO) beyond a "basic industry TBO" of 4,000 hours for PT6A-34, -35, and -36 engines. However, on April 12, 2002, P&WC issued Service Bulletin (SB) 1403 Revision 7, which no longer mentioned these programs. In addition, SB 1403R7 required, for the first time for other TBO extension options, the replacement of a number of PT6A-34, -35, and -36 life-limited engine components, including the first-stage sun gear at 12,000 hours total time since new. The first-stage sun gear on the accident airplane failed at 22,064.8 hours.

In November 2005 (when the Manchester accident occurred), Business Air was operating under an engine on-condition maintenance program that did not incorporate the up-to-date PT6A-34, -35, and -36 reliability standards for the life-limited parts listed in SB 1403R7 because the SB did not address previously approved on-condition maintenance programs. Three months later, in a February 22, 2006, e-mail message to Business Air, P&WC stated that it would continue to "endorse" Business Air's engine on-condition maintenance program.

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[2] A sun gear is the center gear around which an engine's planet gears revolve. Together, the sun gear and planet gear assembly provide a means of reducing the engine rpm to a lesser propeller rpm. A PT6A-34 engine (like the accident airplane's failed engine) uses two sets of sun and planet gears to reduce rpm; each set is known as a stage.

[3] According to FAA Advisory Circular (AC) 120-17A, "Maintenance Control by Reliability Methods," under on-condition maintenance programs, components are required to be periodically inspected or checked against some appropriate physical standard to determine whether they can continue in service.

The NTSB concludes that, while SB 1403R7 improves PT6A-34, -35, and -36 engine reliability standards, allowing grandfathered on-condition maintenance programs for these engines is less restrictive and does not offer the same level of reliability. Therefore, the NTSB recommends that the FAA require all operators of PT6A-34, -35, and -36 engines, including those using on-condition maintenance programs, to incorporate the reliability standards, particularly those concerning life-limited components, noted in the most current SB into their engine maintenance programs.

Inadequate Federal Aviation Administration Oversight

The NTSB's review of maintenance records revealed numerous deficiencies in Business Air's on-condition engine maintenance program that appear to have gone undetected by the Portland, Maine, Flight Standards District Office (FSDO), which is in charge of monitoring Business Air's operations. It was found that Business Air did not specify which parts were included in its on-condition maintenance program and which would have been removed by other means, such as hard-time scheduling.[4] In addition, although the operator used engine condition trend monitoring as part of determining engine health, a review of those records revealed missing data, inaccurate data input, a lack of regular trend analyses, and a failure to update trends or reestablish baselines when certain maintenance was performed.

Records also showed that Business Air used a program to track, among other things, time-controlled maintenance actions, including inspection intervals, and time-controlled components; however, some component times could not be tracked from time since new, which hampered the ability to know when they needed to be replaced. An NTSB review also found that, during a 10-year span, 14 inactive engines under Business Air's maintenance program lacked evidence that required preservation procedures had been performed before the engines' induction into Business Air's maintenance program. Three of the 14 engines were inactive for longer than 1 year, and two engines were inactive for 2 years. Additionally, there was no documentation showing that any of the engines underwent required test cell runs before they entered service at Business Air. Also, on the "Highlights of Revision" page of Business Air's PT6A-34 Engine Maintenance Program, at least 10 maintenance requirements had been either deleted or lessened; however, records did not include documented justification for the changes, as required by FAA orders.

In addition, although Business Air had an engine-oil analysis program in place, the time it took to send samples for testing and receive results was lengthy. According to maintenance records, the operator took an oil sample from the accident engine more than 2 weeks before the accident and sent it for testing. The oil sample, which revealed increased iron levels, would have provided valuable information about the engine's health; however, the results were not received until days after the accident.

If the FAA had been properly monitoring Business Air's maintenance program, it may have been aware of the operator's inadequate maintenance practices that allowed, among other things, an engine with a sun gear well beyond what the manufacturer considered to be a reliable

[4] According to AC 120-27A, under hard-time maintenance programs, components should be "periodically overhauled in accordance with the carrier's maintenance manual or … be removed from service."

operating timeframe to continue operation. Although the FAA presented a consent order[5] to the operator, in which both parties acknowledged the operator's ongoing maintenance inadequacies and the required corrective actions, it took more than 2 1/2 years after the accident for this to occur. The NTSB is concerned that the Portland FSDO's inadequate oversight may allow other operators to follow inadequate maintenance programs. Therefore, the NTSB recommends that the FAA evaluate the effectiveness of the Portland FSDO's surveillance of maintenance programs and implement necessary changes so that inadequate maintenance programs are identified and improved.

Contradictory FAA Philosophy Regarding On-Condition Maintenance

The accident airplane's engines were maintained, in part, under an FAA-approved "on-condition" maintenance program.[6] According to FAA Advisory Circular (AC) 120-17A, "Maintenance Control by Reliability Methods," which was issued in 1978, on-condition maintenance is:

> … a preventive primary maintenance process. It requires that an appliance or part be periodically inspected or checked against some appropriate physical standard to determine whether it can continue in service. The purpose of the standard is to remove the unit from service before failure during normal operation occurs.

This AC also states that hard time, on-condition, or condition monitoring are the primary aircraft maintenance processes. As written, the AC was intended to provide conceptual guidance for operations conducted under 14 CFR Parts 121 and 127. However, no ACs specifically address on-condition concepts for Part 135 operators such as Business Air.

AC 120-16E, "Air Carrier Maintenance Programs" (another active AC), conflicts with AC 120-17A in regard to FAA on-condition maintenance philosophy. According to AC 120-16E, paragraph 602a(2), Parts 119, 121, and 135[7] air carriers "should not use terms such as hard time, on-condition, or condition monitored in [their] maintenance schedule." The AC further states that "these terms represent obsolete 1960s methodology [and] are vague" and that use of these terms runs the risk that needed maintenance may not be performed according to a set schedule.[8]

Although AC 120-7A (as written) was not intended to provide guidance to Part 135 operators, both ACs are intended for Part 121 operators, and thus the NTSB is concerned about the differing guidance that is provided to operators. Therefore, the NTSB recommends that the FAA resolve the differences between AC 120-17A and AC 120-16E in regard to FAA philosophy and use of on-condition maintenance programs. Further, once the differences noted in Safety

[5] A consent order is a voluntary agreement worked out between two or more parties to a dispute. It generally has the same effect as a court order and can be enforced by the court if anyone does not comply with the orders.

[6] The FAA approved Business Air's engine on-condition maintenance program in May 1995.

[7] For Part 135 operations, this AC applies only to operations conducted with aircraft that are type-certificated for 10 or more seats, excluding the pilot's seat. Embraer 110P1s like the accident airplane were originally type-certificated with 19 seats.

[8] At the time of the accident, AC 120-16D was in effect. It applied to the same carriers and also stated that the terms "hard time," "on condition," and "condition monitored" are vague and should not be used in maintenance schedules.

Recommendation A-09-110 are resolved, the NTSB recommends that the FAA review existing on-condition maintenance programs to ensure that they are compatible with the most current accepted philosophy.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Require all operators of PT6A-34, -35, and -36 engines, including those using on-condition maintenance programs, to incorporate the reliability standards, particularly those concerning life-limited components, noted in the most current service bulletin into their engine maintenance programs. (A-09-108)
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> Evaluate the effectiveness of the Portland Flight Standards District Office's surveillance of maintenance programs and implement necessary changes so that inadequate maintenance programs are identified and improved. (A-09-109)
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> Resolve the differences between Advisory Circular (AC) 120-17A and AC 120-16E in regard to Federal Aviation Administration philosophy and use of on-condition maintenance programs. (A-09-110)
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> Once the differences noted in Safety Recommendation A-09-110 are resolved, review existing on-condition maintenance programs to ensure that they are compatible with the most current accepted philosophy. (A-09-111)

In response to the recommendations in this letter, please refer to Safety Recommendations A-09-108 through -111. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address: correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us asking for instructions on how to use our secure mailbox. To avoid confusion, please use only one method of submission (that is, do not submit both an electronic copy and a hard copy of the same response letter).

Chairman HERSMAN, Vice Chairman HART, and Member SUMWALT concurred in these recommendations.

[Original Signed]

By: Deborah A.P. Hersman
Chairman