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NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

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Forwarded to:
Honorable J. Lynn Helms
Administrator
Federal Aviation Administration
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)

A-82-17 through -23

On January 21, 1982, a Cessna Model P-210N, N4947K, crashed in instrument meteorological conditions, near Boise, Idaho. All four persons aboard the aircraft were killed. About 20 minutes after departing Boise, the pilot had indicated to the air traffic controller that he was "losing his gyros," and requested assistance in returning to Boise. Shortly thereafter, the aircraft broke up in flight. Examination of the pressure/vacuum pump revealed that the (frangible) plastic drive shaft had sheared.

On November 20, 1981, a Cessna Model T-210N, N4823C, crashed at Charleston, West Virginia. All three persons aboard, including two instrument rated pilots, were killed. After indicating that he had experienced a complete loss of vacuum, the pilot had operated the aircraft in the emergency partial panel mode for about 20 minutes. However, during an attempted instrument landing system (ILS) approach, the aircraft struck a ridge at a steep angle of bank. Examination of the pressure/vacuum pump disclosed a sheared drive shaft.

On September 25, 1981, a Cessna Model T-210L, N94136, crashed at Big Timber, Montana, while on an instrument flight rules (IFR) flight plan; the pilot was killed. The aircraft was above the clouds at 19,000 feet when it was cleared to descend to 13,000 feet. The pilot lost control of the aircraft shortly after entering the clouds and the aircraft broke up in flight. The investigation disclosed that the pressure/vacuum pump shaft had sheared.

On February 22, 1981, a Mooney Model M20F, N1919T, crashed at Montgomery Township, New Jersey; all four persons aboard were killed. The aircraft was on an IFR flight plan from Hilton Head, South Carolina, to Teterboro, New Jersey. Shortly before the accident, the aircraft had been flying above the clouds when the pilot reported a vacuum malfunction and inoperative attitude and directional gyros. The pilot continued to fly toward his planned destination and was subsequently cleared to descend into the clouds. Shortly thereafter, the aircraft crashed in a steep, high speed, nose down attitude.

On December 2, 1980, a Cessna Model T-210N, N4846C, crashed at Tazewell, Tennessee, killing all four persons aboard. The aircraft had departed Peachtree City, Georgia, on an IFR flight plan to Mansfield, Ohio. When the aircraft was at 12,000 feet, the pilot had called the Atlanta Air Traffic Control Center, saying "46C has lost vacuum, I would like to have immediate clearance back to Knoxville." The pilot was cleared to proceed directly to Knoxville and to descend and maintain 8,000 feet. However, the pilot did not begin a descent until several minutes later, at which time the center asked if he needed special handling. The pilot declined and said "...everything's okay except for the vacuum." Shortly after entering the clouds, with tops at approximately 10,000 feet, the pilot lost control of the aircraft. An examination of the wreckage revealed that the right wing and empennage had separated in flight. The examination also disclosed that the drive shaft of the pressure/vacuum pump had failed for unknown reasons.

All the accidents involved spatial disorientation of instrument-rated pilots who attempted to control and maneuver their aircraft in clouds without operative attitude and directional gyros. Most general aviation single engine aircraft are not equipped with gyro instrument redundancy, other than the turn indicator, in the event of failure of the primary gyro instruments or the pressure/vacuum pump. At least four of the pilots recognized a vacuum system malfunction and were attempting to use emergency partial panel procedures (the electric turn indicator, the inclinometer, and the pitot-static instruments, i.e., airspeed indicator, altimeter, and vertical speed indicator) when the aircraft crashed. Three of the Cessna Model 210 aircraft were equipped with pneumatic deicer boots.

Although FAR 61.65(c)(5), "Instrument Rating Requirements," requires that pilots demonstrate competence in handling simulated emergencies involving equipment or instrument malfunctions, none of the accident pilots was prepared to cope with actual emergencies when encountered under instrument meteorological conditions. Moreover, there are no requirements under the regulation relating to partial panel navigation, maneuvering, or approaches -- all critical operational tasks and one or another of which was involved in the above accidents. While the maintenance of straight and level flight using partial panel is practiced routinely during initial instrument instruction and certification, the Safety Board believes that insufficient emphasis is placed on the aforementioned critical tasks when instructional instrument approaches to minimum altitudes are conducted. Consequently, the Safety Board believes that specification of such partial panel operations in FAR 61.65(c)(5) is essential.

The Safety Board believes that pilots generally do not maintain an adequate level of partial panel proficiency subsequent to receiving their instrument rating, but rather tend to become overly reliant on the use of the attitude gyro. However, a review of the small aircraft malfunction/defect report data from the Federal Aviation Administration's (FAA) Maintenance Analysis Center indicates that such overreliance on this vacuum pump-dependent instrument is not justified. Between January 1, 1978, and February 15, 1981, at least 325 pressure/vacuum pumps produced by the Airborne Manufacturing Company and the Edo-Aire Manufacturing Company (the only companies currently producing such pumps) failed for unknown reasons. According to comments accompanying the data, e.g., "Shaft sheared at 126 hours, ...shaft sheared after 15 hours of operation, ...pump locked up and sheared drive at 129 hours, ...pump failed after 5 hours of operation," some of the failures occurred prematurely. The actual number of pressure/vacuum pump failures is probably much larger than indicated since only a relatively small percentage of such failures or malfunctions are ever reported. (A report of this type of failure to the FAA is discretionary.) Therefore, the Safety Board believes that an engineering evaluation should be conducted to ascertain the design adequacy and reliability of these pumps and to determine the cause or causes for what appears to be an inordinate failure rate.

The FAA data suggest that failure of the pressure/vacuum pump is more likely in aircraft such as the Cessna Model 210N with deicing systems where a single high capacity pressure/vacuum pump is used for high-pressure, multipneumatic requirements. The pumps in these aircraft supply power to the gyro instruments, as well as the deicer boots. The mean time to failure of these pumps is reduced substantially because of higher operating pressures, altitudes, and cylic loads. The Airborne Manufacturing Company, which produced the pumps installed in the Cessna Model 210N, warrants its high-capacity models for 400 hours and its lightweight, low-capacity pumps, like those in the Mooney Model M20F, for 1,000 hours. The low-capacity pump in the Mooney Model M20F supplies power to the gyro instruments, the retractable step, and a wing-leveling device. Similar pumps installed in other aircraft supply power only to the gyro instruments.

The Safety Board has become increasingly concerned regarding the propensity for failure of pressure/vacuum pumps in Cessna Model 210N aircraft equipped with deicing systems. The Model 210 aircraft were certificated for flight in known icing conditions in 1979 after Cessna developed a complete deicing package for the series N aircraft (pneumatic deicing boots, windshield heat, stall warning heater, etc.). Cessna has installed pneumatic boots on previous Model 210 series aircraft, but only on a no-hazard basis, i.e., that the installation has no significant effect on aircraft operation or safety. The configuration of these boots, as well as the boot cycling schedule, differs markedly from that on Model 210N aircraft. The demands of the new 3-cycle, split-boot deicing system for series N aircraft may have significantly affected the reliability of the pressure/vacuum pump. Therefore, the Safety Board believes that the FAA should conduct a design certification review of the pneumatic portion of the system.

Currently, dual vacuum pumps are installed as standard equipment on all 1982 Cessna Model 210 aircraft with deicing systems. One of the pumps provides a separate, independent source of vacuum for the gyro flight instruments and the other powers the deicing system. The dual pumps are offered as an option on all other 1982 model 210's and should be available by February 15, 1982, for installation on 1978-1981 model 210's. The Safety Board believes that an Emergency Airworthiness Directive should be issued requiring installation of these dual pumps on all Cessna Model 210N aircraft with deicer boots as a requirement for flight into known instrument meteorological conditions.

In addition, turbocharged aircraft, such as the Cessna Model T-210L, which utilize Airborne's low-capacity model 212-cw pump, can operate routinely at relatively high altitude. Since the pump has to work harder at high altitudes, it becomes hotter, thus, increasing the potential for internal binding or seizure and consequent failure. Because of this and other adverse effects on pump life, the Airborne Manufacturing Company recommends that vacuum application of the model 212-cw pump be limited to maximum operating cruise altitudes of 15,000 feet or less. The Safety Board believes that aircraft system designers should consider the use of positive pump pressure for gyros that will operate above this altitude or the use of a larger, finned vacuum pump with appropriate provisions for cooling.

On March 26, 1976, the Safety Board recommended that the Federal Aviation Administration issue an Advisory Circular to inform pilots of: (1) procedures they should use to determine the operability of gyroscopic instruments, (2) the importance of instrument crosschecks during IFR flight, and (3) the importance of staying proficient in partial-panel emergency operation. (Safety Recommendation No. A-76-30.) The FAA responded by issuing Advisory Circular (AC) 91-46, "Gyroscopic Instruments—Good Operating Practices."

AC 91-46 directed pilots to include the vacuum gauge and ammeter/load meters in their instrument crosscheck to assure early detection of a malfunctioning instrument system power source and to be prepared to transition immediately to partial panel operation if necessary. Because an undetected failure of the vacuum pump may have been a critical factor in the Montana accident on September 25, 1981, the Safety Board believes that any general upgrading of instrument rating requirements should, in accordance with AC 91-46, place additional emphasis on the detection of failures of the pressure/vacuum system.

Because accidents involving loss of control during emergency partial panel operations are characteristically fatal as evidenced by the five accidents cited, the Safety Board believes that a special effort is warranted to reduce the numbers of such accidents. Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an Emergency Airworthiness Directive specifying the installation of the dual vacuum pump accessory kit in all Cessna Model 210N aircraft equipped with deicer boots as a requirement for flight into known instrument meteorological conditions. (Class I, Urgent Action) (A-82-17)

Conduct a design certification review of the pneumatic portion of the deicing system in Cessna Model 210N aircraft and take appropriate remedial measures to improve system reliability. (Class II, Priority Action) (A-82-18)

Amend FAR 61.65(c)(5), "Instrument Rating Requirements," to make simulated emergency operations on partial panel more rigorous and specific, and to include the detection of failures of the pressure/vacuum or flight instrument system, and navigation/maneuvering/approach techniques. (Class II, Priority Action) (A-82-19)

Amend FAR 61.57(e), "Recent Flight Experience: Pilot In Command," to require experience during the preceding 24 months in instrument approaches using partial panel techniques as a prerequisite to exercising instrument privileges in aircraft which do not have redundant or dual, independently powered gyro systems. (Class II, Priority Action) (A-82-20)

Conduct an engineering evaluation to determine the failure mode and design adequacy of aircraft vacuum pumps produced by the Airborne Manufacturing Company and the Edo-Aire Manufacturing Company. (Class II, Priority Action) (A-82-21)

Require, in subsequent certification of all single-engine airplanes equipped with pneumatic deicing equipment, cabin pressurization, or autopilots, that aircraft attitude and direction indicators be operated independently by a separate pressure/vacuum pump or other source of power. (Class II, Priority Action) (A-82-22)

Conduct an engineering evaluation of the effect of high altitude operations on the life and reliability of light weight, low-capacity vacuum pumps in turbocharged aircraft. (Class II, Priority Action) (A-82-23)

BURNETT, Acting Chairman, and McADAMS, GOLDMAN, and BURSLEY, Members, concurred in these recommendations.

Jim Burnett

By: Jim Burnett
Acting Chairman