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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: December 20, 1996

In reply refer to: A-96-178 and -179

Honorable Linda Hall Daschle
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On June 17, 1996, about 2100 eastern daylight time, a Tower Air, Inc., Boeing 747-136, N606FF, flight 22, sustained minor damage when the No. 2 engine accessory gearbox caught fire during the aircraft's descent to land at the John F. Kennedy International Airport (JFK) in New York. The flightcrew declared an emergency and landed at JFK without further incident. None of the 17 crewmembers and 397 passengers were injured. Instrument meteorological conditions prevailed, and an instrument flight rules flight plan had been filed. The flight originated from the Los Angeles International Airport and was conducted under the provisions of Title 14 Code of Federal Regulations (CFR) Part 121 as a domestic, scheduled passenger flight.

The pilots said that at flight level 350, just before the top of their descent into JFK, both the generator open [off] and constant speed drive (CSD)[1] low oil pressure warning lights illuminated on the No. 2 engine. The flight engineer noted that the CSD oil temperature was high, and the generator kilowatt output was low. He attempted to disconnect the CSD but was unsuccessful. The pilots also noted that the oil pressure on the No. 2 engine was low and dropping. The pilots shut down the engine. Moments later the fire warning sounded, and the pilots discharged both No. 2 engine fire bottles; however, the fire continued. The captain declared an emergency, briefed the cabin crew, and proceeded to JFK for landing. Airport rescue and fire fighting personnel were standing by and extinguished the fire after the aircraft came to a stop.

On June 20, 1996, investigators from the National Transportation Safety Board examined the airplane; they specifically focused on the No. 2 engine accessory gearbox, CSD, and generator. The cockpit CSD disconnect switch was operationally checked, and the electrical continuity between the switch and the disconnect solenoid was checked with no problems noted. The examination of the No. 2 engine revealed that the lower cowling next to the gearbox was scorched, sooted, and burned through. The generator was removed from the gearbox, and the

[1] A CSD is a hydro-mechanical device mounted on the engine gearbox that drives a 400-hertz (cycles per second), alternating current (AC) aircraft electrical generator. The CSD takes the variable rotational speed input from the engine and provides a constant rotational output speed.

input quill shaft was found separated near the base of the generator. Examination of the connecting shaft, which links the generator quill shaft to the CSD output drive through the accessory gearbox, indicates that the friction caused by the connecting shaft rotating against the interior wall of the CSD drive gearshaft had melted a section of the connecting shaft. The heated connecting shaft most likely ignited the gearbox oil and burned the magnesium accessory gearbox case next to the generator.

The CSD was also removed. The CSD data plate indicated that the unit had been manufactured by the Sundstrand Aerospace Company, and information on the lead inspector seals indicated that the unit had been overhauled by UNC Accessory Services at its Fort Lauderdale, Florida, facility.

On July 23, 1996, representatives from the Safety Board, Tower Air, Boeing Commercial Airplane Group, Federal Aviation Administration (FAA), and Sundstrand Aerospace disassembled and examined the CSD at Sundstrand Aerospace. The maintenance records indicated that the CSD had accrued 3,758 hours since its overhaul and had been overhauled by UNC's Fort Lauderdale facility in December 1994.

The examination of the CSD revealed that the electrical harness and disconnect solenoid operated normally during a functional test and during tests at elevated temperatures and low voltage. During disassembly, it was discovered that three of the four output gear bearing support mounting screws had come out of their respective holes, and the fourth mounting screw was loose. The screws securing the governor bearing support and charge pump were also loose. The output gear had disengaged from the idler gear, which disabled the scavenge pump. Additionally, the output gear bearing support mount locking helicoils[2] were worn, and some of the screws were found to be shorter than those specified in the Sundstrand overhaul manual.

Tower Air provided investigators with another CSD that had also been overhauled by UNC's Fort Lauderdale facility (in December 1993). This unit had accrued 4,436 hours since overhaul. The examination revealed that the end cover was attached with five screws, four of which were shorter than those specified in the Sundstrand overhaul manual. Additionally, safety wire was used on the attachment screws on the bearing support, scavenge pump, and governor trim head to governor support, and liquid locking compound was used on the remaining screws within the unit. The majority of the helicoils throughout the unit were worn and had lost their locking feature.[3]

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[2] Sundstrand uses screws with self-locking helicoils as fasteners during assembly. A helicoil is fabricated from diamond-shaped wire that is tightly coiled into a threaded bushing such that the helicoil is threaded into a hole, and a screw is then threaded into the helicoil. Helicoils are used to replace worn threads, provide a locking feature to prevent screws from loosening, or provide a hardened thread material for soft materials such as plastic or aluminum.

[3] During overhaul, mechanics are required to determine if helicoils are worn and if they are, replace them if necessary.

Because UNC's Fort Lauderdale facility also overhauls integrated drive generators (IDGs),[4] Safety Board investigators reviewed Sundstrand's overhaul procedures for both components. A review of the Sundstrand CSD and IDG overhaul manuals revealed that screw size, type, and location are specified with no reference to safety wire or liquid locking compound. Sundstrand does not recommend the use of safety wire internal to the CSD or IDG to avoid contamination and because of its difficulty to install. Exceptions in the use of safety wire are when components are assembled outside the CSD or IDG and installed as an assembly. Sundstrand reports that loose screws or screws backing out of their respective holes have not been reported as a problem.

Records at the FAA Flight Standards District Office (FSDO) in Fort Lauderdale indicated that the FAA found during a June 1991 inspection of UNC's Fort Lauderdale facility (then ARDCO, Inc.) that the training of inspectors and other personnel was being accomplished by the manager of maintenance-production and shop supervisors and was being monitored by quality control personnel. The FSDO's inspection also found a recordkeeping system to track components throughout the repair process. However, the company was not reporting defects, unairworthy conditions, or service difficulty reports (SDRs) as required by 14 CFR Part 145.63(a).[5] The FAA issued findings from the June 1991 inspection to UNC regarding the overhaul manual, organizational responsibilities, facilities description, and malfunction or defect reports. The June 1991 report by the FAA and a letter from UNC to the FAA in September 1991 indicate that all the corrective action had been taken.

On August 7, 1996, investigators from the Safety Board visited UNC's Fort Lauderdale facility. The investigators learned that the Director of Engineering and Quality at this facility holds the same position and title at the UNC facilities in Texas, New Jersey, and New York. Additionally, the investigators confirmed that UNC's Fort Lauderdale facility was not generating SDRs as required by the regulations. Further, investigators discovered incomplete records on the two CSDs disassembled for this investigation. The teardown reports following overhaul of both CSDs were incomplete, the dimensional measurements taken during overhaul were not recorded, there was no record of who performed the measurements, and there were no functional test[6] results following overhaul on the incident CSD.

Safety Board investigators conducted informal interviews with some of the technicians performing the overhaul and repair of the CSD and IDG units in the presence of the general manager and one of the shop supervisors at UNC's Fort Lauderdale facility. It was revealed that the majority of the shop supervisors were either FAA-certified airframe and powerplant (A&P) mechanics,[7] FAA-certified airframe mechanics, or FAA-certified repairmen. Four of the

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[4] An IDG is a constant speed drive and a generator manufactured as a single unit.

[5] 14 CFR Part 145.63(a) states the following: Each certificated domestic repair station shall report to the [FAA] Administrator within 72 hours after it discovers any serious defect in, or other recurring unairworthy condition of, an aircraft, powerplant, or propeller, or any component of any of them. The report shall be made on a form and in a manner prescribed by the [FAA] Administrator, describing the defect or malfunction completely without withholding any pertinent information. Currently, these reports are called service difficulty reports (SDR).

[6] Functional tests are performed before returning a component to service.

[7] An A&P mechanic is one that has fulfilled all the eligibility and experience requirements and has demonstrated the requisite knowledge set forth in 14 CFR Part 65 Subpart D.

supervisors were company-designated inspectors. None of the interviewed technicians were certified A&P mechanics.

Also, it was revealed that all of the technicians had previous experience in the overhaul and repair of CSD and IDG units. The interviewed shop supervisor received factory training on CSD and IDG units before he was employed at UNC's Fort Lauderdale facility. The interviewed technicians received informal on-the-job training (OJT) on the overhaul and repair of CSD and IDG units at UNC's Fort Lauderdale facility; however, none of the technicians had received any formal training on the overhaul and repair of the units.

It was also learned that the technicians were not using the overhaul manual to verify screw type or length before installation. Additionally, the technicians said that they sometimes installed safety wire on screws with safety wire holes, sometimes installed screws with liquid locking compound, and did not routinely replace helicoils. The technicians reported that loose screws were sometimes found inside some CSD and IDG units upon disassembly. According to the technicians and the general manager, the units were not reviewed by quality control personnel until the units were assembled.

A review of the overhaul and machine shops at UNC's Fort Lauderdale facility revealed that components sent to the machine shop for rework were tagged to indicate the unit serial number and responsible mechanic. However, no formal job instruction cards or shop travelers[8] were found associated with any of the components in the machine shop for rework.

As a result of the findings by the Safety Board investigators, inspectors from the FAA's Fort Lauderdale FSDO inspected UNC's Fort Lauderdale facility on August 9, 1996, and examined components that had been overhauled. Although the findings of that inspection have not been released, UNC has voluntarily ceased all work at that facility until corrective actions are accomplished. Additionally, because the Director of Engineering and Quality at UNC's Fort Lauderdale facility was also the Director of Engineering and Quality at the UNC facilities in Texas, New Jersey, and New York, the FAA has inspected those facilities. The Safety Board is pleased that the FAA has inspected those facilities and encourages the UNC facilities in Texas, New Jersey, and New York to make appropriate safety changes consistent with the findings with those inspections.

On July 30, 1996, Tower Air initiated a fleet-wide campaign to remove, inspect and overhaul, as required, all CSDs in its inventory that had been previously overhauled at the UNC's Fort Lauderdale facility. (Tower Air does not use IDGs.) Although the Safety Board notes this initiative and the temporary end of production pending corrective action at the UNC Fort Lauderdale facility, the Board is concerned that other CSD and IDG units previously overhauled by UNC's Fort Lauderdale facility may have been improperly assembled. Therefore, the Safety Board believes that the FAA should require operators of CSDs and IDGs overhauled by UNC's

[8] Such documents, typically known as "process sheets," break down the overhaul and inspection process of a component into individual tasks, which include excerpts or references to the appropriate manual, service bulletin, or job instruction card and a signature block for the technician or inspector performing the task.

Fort Lauderdale facility to remove the units from service, inspect and overhaul them as needed, on a priority basis.

A review of FAA SDR data from January 1, 1990, through August 27, 1996, was conducted to determine the number of failures of selected Sundstrand CSD models used on jet transport airplanes. The SDR data did not provide information related to the failure mechanism or the overhaul and maintenance history. The SDR data revealed that there were a total of 51 CSD failures, 37 of which resulted in unscheduled landings, and 10 resulted in rejected takeoffs. The reports cited 10 successful CSD disconnects, 9 unsuccessful CSD disconnects, 9 engine shutdowns, 28 CSD low pressure warnings, 20 CSD high temperature indications, 7 fluctuating or low CSD revolutions per minute output, and 12 CSDs that stopped rotating.

Sundstrand indicated that the problems found in the CSDs disassembled during this investigation have not been previously reported. However, the high percentage of worn helicoils found on CSD units returned to UNC, the large number of SDR reports related to CSD failures, and the lack of information related to those failure mechanisms raise concern that the issues and problems uncovered during this investigation may not be unique to UNC. As a result, the FAA has requested that Sundstrand examine the CSDs and IDGs during overhaul and document the condition of the fasteners and helicoils. The Safety Board concludes that Sundstrand should also identify the failure mechanism of each unit and provide that data to the FAA for review and development of corrective action if necessary. Therefore, the Safety Board believes the FAA should review fastener, helicoil, and failure mechanism data after they are collected by Sundstrand during the overhaul of CSDs and IDGs and develop corrective actions if necessary.

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

Require operators of constant speed drives and integrated drive generators overhauled by UNC Accessory Services' Fort Lauderdale facility to remove the units from service, inspect and overhaul them as needed, on a priority basis. (A-96-178)

Review fastener, helicoil, and failure mechanism data after they are collected by Sundstrand during the overhaul of constant speed drives and integrated drive generators and develop corrective actions if necessary. (A-96-179)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman