



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: March 25, 1992

In reply refer to: A-92-16 and -17

Honorable Barry L. Harris
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On October 30, 1990, at about 8:05 a.m. eastern standard time, a Cessna 150G, N3220J, experienced a partial loss of engine power during an instructional flight and crashed while returning to land at Marathon Airport, Marathon, Florida. Visual meteorological conditions prevailed at the time and no flight plan was filed. The student pilot was killed, the commercial-rated flight instructor received serious injuries, and the airplane was destroyed in the impact. The investigation indicated that, while turning to the final approach, the airplane overshot the final approach, then banked steeply to line up with the runway. The aircraft then stalled, entered an uncontrolled descent, and crashed.

Postaccident examination of the Teledyne Continental Motors (TCM) O-200 engine revealed that the three rocker shaft bosses had separated from the head of the No. 3 cylinder. These separations released the No. 3 cylinder rocker arm shaft and rocker arms, and resulted in inoperative valves and the partial loss of engine power. Metallurgical examination of the No. 3 cylinder at the Safety Board's materials laboratory revealed the presence of fatigue cracking on the boss fracture surfaces. The primary fatigue crack initiated from stamped characters on the top of the center boss. Once the center boss failed, the two outer bosses separated.

According to a representative of TCM, the cast-iron cylinder head, when new, allows the rocker arm shaft to ride in the bosses without any bushings between the shaft and the rocker shaft bosses. Over time, the rocker shaft bosses wear, and a loose fit develops between the shaft and the bosses. Overhaul facilities can then ream out the hole, smooth the hole surface, and install bushings in the hole. The separated rocker shaft bosses from the No. 3 cylinder of the engine from N3220J had been reamed and bushings had been installed in this manner.

In 1973, TCM issued Continental Aircraft Engine Service Bulletin (SB) M73-13, applicable to all engines that use the cylinder involved in the Marathon, Florida, accident. The SB describes the recommended procedures for reaming the boss holes and for installing bushings, and lists warnings on maintaining the proper wall thickness and surface finish. The bulletin states that the thickness between the hole wall and the outside surface of the boss should be at least 0.25 inch prior to reaming and should be at least 0.18 inch after reaming. However, one portion of the center boss from the No. 3 cylinder from N3220J was found to have a wall thickness less than the 0.18 inch minimum recommended by SB M73-13. Also, calculations by a Safety Board engineer indicate that the before-reaming wall thickness in this area was less than the recommended 0.25 inch minimum, suggesting that this cylinder should have been scrapped instead of reworked. Although the fatigue cracking did not initiate in the area where the wall thickness was less than the minimum recommended by SB M73-13, the Safety Board is concerned that cracking could initiate if the wall thickness is insufficient and that this cracking could lead to additional separations of rocker bosses. The Safety Board therefore believes that the provisions of SB M73-13 should be mandatory whenever reaming is done.

Laboratory examination further revealed that a portion of the fracture on the exhaust valve side boss contained several casting flaws, in the form of smooth-wall voids and microporosity. This area also contained baked-on oil residue, which strongly suggests that this portion of the boss had been partially separated and exposed to engine oil for some time. Although no evidence of fatigue propagation from this area was noted, the Safety Board is concerned that cracking could develop from an area that contains such defects.

Fatigue cracking of the cylinder head bosses can also initiate from mechanical damage. During the Safety Board investigation of a 1988 accident involving a TCM O-200 engine with separations of rocker shaft bosses, laboratory examination determined that fatigue cracking had initiated from longitudinal scratches that occurred when bushings were installed in the rocker shaft bosses.

Based on evidence from its investigations of N3220J and the 1988 accident, the Safety Board concludes that rocker shaft bosses could separate as a result of fatigue cracking that can initiate for a variety of reasons, including the presence of stamped characters on the bosses, insufficient wall thickness after the boss holes are reamed, the presence of casting flaws such as large voids and microporosity, and scratches created during installation of bushings. Because cracking may develop from a variety of defects or damage, the Safety Board believes that rocker shaft bosses should be inspected, using a nondestructive inspection method such as a penetrant inspection, to detect cracking that develops from any source. The Board has not determined the number of hours of operation needed to propagate a crack in a cylinder head boss from a detectable size to failure; nevertheless, the Board believes that head bosses should be inspected, as a minimum, each time the engine or cylinder is overhauled.

According to representatives of TCM, the cylinder model from N3220J and the 1988 accident airplane, part number 641917, is currently used in the C-75, C-85, C-90, C-145, O-200, and O-300 model engines. Based on information supplied by TCM, these model engines have been installed on more than 25,000 small airplanes. Prior versions of the cylinder (with superceded part numbers) are still allowed in service and are interchangeable with the current part number cylinder.


Records retained at the Safety Data Branch of the Federal Aviation Administration (FAA) in Oklahoma City, Oklahoma, were searched for incidents that occurred between January 1, 1986, and July 19, 1991, involving P/N 641917 and earlier versions of the cylinder. The records contained 10 aircraft accident or incident reports and 38 service difficulty reports (SDR) that identified separations of cylinder rocker shaft bosses. However, the cylinders are not marked with the part number; therefore, it could not be determined if the separations occurred in the P/N 641917 cylinder or in earlier versions. Further, the reports do not identify the cause of separation, nor do they include the separated cylinder from N3220J. The Safety Board is aware that the FAA data system does not include information of all incidents, and that the data may identify only a fraction of the actual number of separations that occur. According to the manager of an overhaul facility in Miami, Florida, the facility commonly receives cylinders with separated rocker shaft bosses. These cylinders are normally returned to TCM as cores.

The Safety Board is concerned about the number of separations involving rocker shaft bosses of P/N 641917 or earlier versions of the cylinder and about the potential for separations to occur as a result of fatigue cracking that can develop from a variety of defects or damage. Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an airworthiness directive to require that the rocker shaft bosses on the head of Teledyne Continental Motors P/N 641917 cylinders and earlier versions of the cylinder be subjected to periodic nondestructive inspections, using a method such as a penetrant inspection, to detect the presence of cracks or other defects. The bosses should be inspected, as a minimum, each time the cylinder or the engine containing the cylinder is overhauled. Cylinder heads with bosses that are found to contain cracks or defects should be removed from service. (Class II, Priority Action) (A-92-16)

Issue an airworthiness directive to require compliance with the provisions of Teledyne Continental Motors (TCM) Service Bulletin M73-13 when bushings are installed in the rocker shaft bosses on the heads of TCM P/N 641917 cylinders and earlier versions of the cylinder. (Class II, Priority Action) (A-92-17)

Acting Chairman COUGHLIN, and Members LAUBER, HART, HAMMERSCHMIDT, and KOLSTAD concurred in these recommendations.


By: Susan M. Coughlin
Acting Chairman