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National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Date: February 11, 1986

In reply refer to: A-86-04 and -05

Honorable Donald D. Engen
Administrator
Federal Aviation Administration
Washington, D. C. 20591

On February 6, 1985, a Cessna Model 402B, N5780M, operated by Altus Airlines, Incorporated, crashed at Altus, Oklahoma, killing both persons aboard. The airplane had departed the Altus Municipal Airport only minutes before as a scheduled commuter flight when the pilot declared an emergency due to a fire in the left engine. Subsequently, the pilot was provided with radar vectors toward Altus Air Force Base for an emergency landing, but the airplane crashed several minutes later, just before reaching the base. Although maintenance records for N5780M indicate that the exhaust system had been inspected in accordance with Airworthiness Directive (AD) 75-23-08 about 15 hours before the accident, the National Transportation Safety Board's investigation disclosed that the fire was precipitated by a broken flange on the inboard side of the engine exhaust manifold header assembly. (This assembly has inboard and outboard flanges connecting the respective engine exhaust stacks to the turbocharger.) The broken flange allowed hot exhaust gases to enter the interior of the engine nacelle and to burn through fuel and oil lines and the engine-mounting structure. The inboard flange of the exhaust manifold header on the right engine contained areas that had corroded completely through the wall thickness, and the outboard flanges of both manifold header assemblies were corroded and worn very thin due to exhaust gas erosion. Failure of the latter flanges also appeared imminent.

On May 15, 1985, another Cessna 402, N402CS, crashed at Pocatello, Idaho, after sustaining a catastrophic engine fire similar to the one sustained by N5780M. The pilot, the only occupant aboard the airplane, was also killed. The Safety Board's investigation of this accident disclosed that a portion of the right engine exhaust manifold tube assembly, which connects directly to the manifold header, had ruptured and blown out. This allowed the hot exhaust gases escaping to act as a blowtorch and to melt the adjacent airplane wing spar and engine support structure. Subsequently, the right wing outboard of the engine nacelle failed and separated from the airplane. Maintenance records indicate that N402CS had been operated for a total of 5,862 flight-hours and that the airplane had been inspected in accordance with AD 75-23-08 only 25 hours before the accident. Nonetheless, examination of the failed tube assembly, after removal from the engine exhaust system, revealed substantial erosion of the tube's wall and several areas where small cracks and holes existed.

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On May 2, 1985, and August 2, 1985, engine fires in Cessna Models C-414, N2274G, and C-320D, N3322Q, were caused, respectively, by virtually the same circumstances as those which caused the engine fires in N5780M and N402CS. The problem with N2274G involved a broken exhaust wye assembly, while N3322Q sustained a ruptured manifold tube. (The exhaust wye on the Model C-414, alternately referred to as the exhaust collector assembly or turbo inlet elbow assembly on other Cessna models, is similar to the exhaust manifold header on the Model C-402.) Fortunately, the pilots in these cases were able to land safely, but the Safety Board believes that catastrophes similar to those involving N5780M and N402CS were only narrowly averted. For example, the Service Difficulty Reports (SDRs) relating to these incidents stated, respectively, that:

Left engine exhaust turbo wye failed approx. 1/8 inch from right hand marmon clamp on right side of turbocharger. Exhaust leak acted like a blow torch and cut through the left engine right mount beam. Pilot feathered prop and shut down the left engine when he noticed a drop in manifold pressure. The left engine was sagging from the remaining mount beam upon landing. NOTE: AD 75-23-08 applies but submitter states this area not visible during inspection.

and

The exhaust manifold split along a welded seam allowing hot exhaust gasses to erode the right engine inboard support beam (PN 0851121-202). The submitter states that the pilot had noticed a loss of manifold pressure during the flight. After landing, inspection of the engine revealed a discolored cowl and major damage to the engine mount. This exhaust system had been pressure tested only 3 hours prior to the occurrence. The submitter believes an engine backfire caused the exhaust split.

A review of 248 SDRs from the Federal Aviation Administration's Maintenance Analysis Center relating to engine exhaust systems on Cessna T310, 320, 340, 401, 411, 402, 414, and 421 series airplanes disclosed that cracked or otherwise defective exhaust manifold, wye, collector, or turbo inlet elbow assemblies were reported frequently. From January 1, 1980, through September 4, 1985, there were a total of 69 such reports applicable to these airplanes with the Models 340, 340A, 414, and 421C cited most frequently. The Safety Board believes that these reports reflect a failure to adequately inspect and/or promptly replace these exhaust components. For example, maintenance records for N5780M indicate that new exhaust pipes, slip joints, etc., had been installed about 2 years before the accident. However, the exhaust manifold header, reportedly considered a part of the turbocharger rather than the exhaust system, apparently had never been replaced and had been in service for about 6,100 flight-hours since the aircraft was manufactured 12 years earlier.

AD 75-23-08, which applies to Cessna T310, 320, 340, 401, and 411 series airplanes and to Model 402, 402A, 402B, 414, 421, 421A, and 421B airplanes, was issued to combine in one document requirements for inspection and parts replacements of previous ADs and to require available modifications that would increase the reliability of the exhaust systems on the affected airplanes. However, while the AD provides for repetitive general exhaust system inspections on these airplanes, it does not provide for specific, detailed inspection or routine replacement of engine exhaust manifold header assemblies, wye assemblies, collector assemblies, or turbo inlet elbow assemblies. (N5780M had been inspected in accordance with the AD only weeks before the accident.) Moreover, the AD contains the note "Do Not Remove Clamps" in connection with the general visual inspection of the complete exhaust system. As a result, and because of the relative

obscurity of these assemblies in the aft portion of the engine beneath the turbocharger, cracked flanges (manifold, wye, or collector) or cracked tube assemblies cannot readily be detected, nor can the loss of structural integrity of these components due to the erosive effect of exhaust gases be determined. As a result, these assemblies are likely to be replaced only after a gross malfunction or in-flight incident occurs.

Cracked or eroded tube walls or flanges on these assemblies increase the potential for catastrophic failure particularly during engine startup or backfire when engine rotational inertia or torque can result in the transmittal of significant structural loads to these parts. Such a failure is believed to have occurred in N5780M. Therefore, because of the incidents, accidents, and SDRs involving broken engine exhaust manifold headers, wye assemblies, turbo inlet elbows, and collector assemblies, and the potential for recurring catastrophic failures, the Safety Board believes that AD 75-23-08 should be amended either to provide for a supplemental detailed inspection of these assemblies for cracks and exhaust gas erosion or to require their replacement at appropriate periodic intervals.

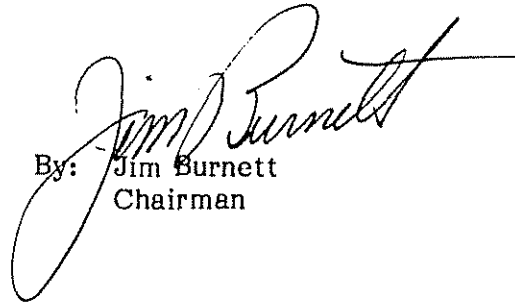
According to Cessna, AD 75-23-08 does not apply to the Cessna Model 421C because the complete exhaust system on this airplane is constructed of Inconel rather than stainless steel. This material, a nickel-based alloy, is used in place of stainless steel primarily to improve material strength and corrosion resistance at elevated temperatures. Nevertheless, 73 of the aforementioned 248 exhaust system SDRs applied to the Model 421C alone, far more SDRs than applied to any other individual airplane model in the 400 series group. Moreover, 17 of these 73 reports involved the engine exhaust collector assembly. Therefore, despite the Inconel construction, the Safety Board believes that the exhaust system on the Model 421C does not reflect sufficient structural integrity to warrant exclusion from the general inspection provisions of AD 75-23-08.

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

Amend Airworthiness Directive 75-23-08 applicable to Cessna T310, 320, 340, 401, and 411 series airplanes and to Model 402, 402A, 402B, 414, 421, 421A, and 421B airplanes to: (a) require a supplemental detailed inspection of engine exhaust manifold assemblies, wye assemblies, turbo inlet elbow assemblies, and collector assemblies for cracks or significant material degradation due to exhaust gas erosion; or (b) require replacement of engine exhaust manifold assemblies, wye assemblies, turbo inlet elbow assemblies, and collector assemblies at appropriate periodic intervals. Inspection should require removal of attaching clamps and assembly components, or complete assemblies as necessary, at appropriate periodic intervals. The discovery of cracks, excessively worn flanges, substantial tube wall erosion, or other defective conditions should require the repair or replacement of affected components or assemblies before further flight. (Class II, Priority Action) (A-86-04)

Amend Airworthiness Directive 75-23-08, applicable to Cessna T310, 320, 340, 401, and 411 series airplanes and to Model 402, 402A, 402B, 414, 421, 421A, and 421B airplanes, to include the Cessna Model 421C. (Class II, Priority Action) (A-86-05)

BURNETT, Chairman, GOLDMAN, Vice Chairman, and LAUBER, Member,
concurred in these recommendations.



By: Jim Burnett
Chairman