



April 30, 2017

Christopher J. Richards
Aerospace Engineer, Standards Staff
FAA Engine and Propeller Directorate
1200 District Ave.
Burlington, MA 01803

Dear Mr. Richards,

In a December 9, 2016 letter and Airworthiness Concern Sheet (ACS) regarding camshaft gear teeth failures of multiple Continental Motors, Inc. (CMI) camshaft gear P/N 655516 & 656031, you requested AOPA to disseminate the technical information to the general aviation community and requested a response. The agency was interested in proposed alternative inspection or repair procedures, cost impacts, etc. The ACS included CMI Service Bulletin SB05-8A attached for additional information.

In response to the ACS, AOPA published a story on our website, informing members of the airworthiness concern and encouraging them to contact AOPA with information. SB05-8A had been out for some time and the community was familiar with it, which resulted in few comments and/or concerns with the ACS. Subsequently, on March 28, 2017, CMI raised it to a Mandatory Service Bulletin MSB05-8 which triggered many comments and concerns from both members and effected stakeholders.

In response to that elevation, AOPA coordinated a discussion with the Engine and Propeller Directorate, Atlanta ACO, American Bonanza Society (ABS), Cirrus Owners & Pilots Association (COPA), Savvy Aviation, and the Twin Cessna Flyer (TTCF) to better understand the issue and help quantify the risk the ACS is trying to mitigate. Key to that understanding is the need to identify the number of failures (numerator) balanced by the hours of operation (denominator) – a value needed for safety risk management.

Attached are detailed comments from the stakeholders identified above which AOPA fully supports.

Thank you for the opportunity to submit comments. Collectively, we stand ready and willing to continued discussions and mitigations of this issue.

Sincerely,

David Oord
Senior Director, Regulatory Affairs

Enclosure: American Bonanza Society Air Safety Foundation Comments
Cirrus Owners and Pilots Association Comments
Savvy Aviation Comments
The Twin Cessna Flyer Comments

Cc: Mr. Scott Hopper, FAA Atlanta ACO

April 26, 2017

RE: Continental Motors MSB05-08B

The American Bonanza Society represents over 9100 owners and operators of Beechcraft Bonanza, Debonair, Travel Air and Baron airplanes in the United States and around the world. We estimate that approximately 7500 of our members' engines are affected by release of this Bulletin.

To the best of our knowledge there has been only one inflight engine failure attributed to failure of the Continental Motors camshaft gear addressed by this latest Bulletin. Continental Motors representatives at Sun n Fun 2017 told ABS' Technical Advisors (highly experienced A&P/IA mechanics who own or have owned Beech-specific maintenance facilities) that they knew of only five failed camshaft gears including the one inflight event. This is among a population of tens of thousands of engines identified by MSB05-08B. The single inflight event involved an IO-550B powered A36 Bonanza, and resulted in no injuries. There is no public indication of whether failure of the camshaft gear was the precipitating event, or if the gear failure was the result of some other issue such as a failed lubricating system, propeller imbalance, an earlier propeller sudden stoppage or some other fatigue-inducing stress.

ABS members are concerned for many reasons:

1. Continental Motors followed its standard practice of noting "Subject Matter of this Document may be Incorporated, in Whole or in Part, in an FAA Issued Airworthiness Directive," at the top of the MSB. FAA has informally indicated to us that it did not request an AD, while in later communications Continental states it had not requested an AD either. We believe use of this standard statement on the MSB may have introduced confusion which caused both parties to believe the other has requested airworthiness action.
2. The MSB calls for replacement of certain camshaft gear parts numbers without substantiation. Earlier versions of the same non-"mandatory" Service Bulletin identified only one part number, P/N 655516 as being affected. Despite four parts numbers called out for replacement in the Bulletin's Scope, the Safety Intent of MSB05-08B still limits the issue to a single part number:

III. Safety Intent

Remove camshaft gear, P/N 655516, from service to eliminate possibility of gear tooth fracture and replace with camshaft gear, P/N 656818.

3. The MSB calls for replacing the gear at 100 hours of operation after publication of the Bulletin, without any substantiation for the immediacy of such drastic action.
4. The MSB incorporates Continental's 12-year Time Between Overhauls (TBO) recommendation as a firm requirement. This 12-year period is designed to address issues related to corrosion, but both the FAA and Continental Motors have stated that is not the issue in this case.
5. The MSB calls for a complete "engine overhaul," not simply engine reassembly, to return the engine to service after replacing the camshaft gear.
6. Raising the status of this bulletin to "Mandatory" makes it required for aircraft registered in many countries outside the United States, including approximately 300 members of the American Bonanza Society with affected engines. It also makes immediate action mandatory for commercial operators who have compliance with MSBs included in their approved Operating Specifications.
7. The cost/benefit analysis of mandatory replacement has not yet been made, or it has been computed but not yet made public. The very limited number of known camshaft gear failures does not appear to warrant the historic risks of overhauling large numbers of engines in a short period of time, especially for Permold engines that require a crankcase modification in order to replace the camshaft gear.

Continental Motors issued a follow-on press release on April 20th that signals its intent to revise the MSB again and (quoted verbatim from the press release):

- Change the mandatory replacement of the camshaft gear to a visual inspection procedure allowing “on condition” operation until the engine is overhauled, replaced, or the gear is accessible.
- Change the time limit imposed by MSB05-8B, to values that still ensure that the appropriate level of safety is attained, but does not dictate a mandatory overhaul time limit.
- Publish alternative means of compliance, to allow camshaft gear replacement without complete engine disassembly.

ABS suggests the following mitigations for Continental’s concerns regarding certain pre-2005 Teledyne Continental Motors camshaft gears:

- Publication of a new revision to the subject Service Bulletin to reflect the statements Continental Motors made in its April 20th press release.
- Non-invasive visual inspection of the P/N 655516 camshaft gears that Continental Motors singles out in MSB05-08B as being the safety concern.
- Replacement of P/Ns 631845, 655430, 655516, or 656031 camshaft gears with the post-August 2005 P/N 656818 gear at the next condition-based or Federally mandated engine overhaul, or when the engine crankcase is opened for any other reason, whichever occurs first.

Thank you for giving ABS and our fellow Type Clubs the opportunity to speak with you and to follow up in writing on behalf of our memberships.

Respectfully submitted

A handwritten signature in black ink, appearing to read "Thomas P. Turner", with a long horizontal line extending to the right.

Thomas P. Turner
Executive Director
ABS Air Safety Foundation



April 20, 2017

I represent the Cirrus Owners and Pilots Association (COPA). COPA represents 4613 members who own and operate Cirrus aircraft. There are approximately 6600 Cirrus airframes delivered to date. COPA represents a substantial portion of that fleet in 53 countries. We estimate there are 6.8 million flight hours on this engine and airframe combination with an outstanding reliability and safety record.

As COPA President, an A&P/IA and long serving Technical Liaison with Cirrus Aircraft, I feel that fleet insight and field experience is important as you deliberate the correct course of action on Continental's (CMI) MSB05-08B.

The Cirrus SR22 airframe has utilized a variant of the CMI IO-550 (N or K variants) engine since its inception in 2001. If you look at production volumes, we represent the largest factory installed, modern and concentrated fleet using engines affected by this MSB. If you look at our data, we have had our share of incidents over 16 years. As of this writing, there is not one incident that **has been attributed** to the cam gear.

Specifically, when looking at the cam gears that should have been installed in our airframe, we have a couple of years of high volume production using the 655516 gear. Since I do not know precisely when the 656031 gear was phased in, I will simply estimate all production during 2001 and 2002 to have the 655516 gear. That would suggest something approaching 400 engines. Then assuming all 2003 until August 2005 engines had the 656031 gear there are approximately 1500 airframes in that era produced with that gear.

That yields roughly a couple thousand engines. That represents almost 30% of the fleet of Cirrus IO-550 equipped airframes. Since that population is the oldest portion of the Cirrus fleet those aircraft simply have to represent more flying hours than the 30% of the fleet portion it represents. It is easy to conclude we have millions, probably 3 million or more flight hours on those two gears without any incidents. Cost of MSB05-8B as written would cost tens of millions of dollars for no failures.

Under those circumstances, it is unfathomable that we would subject this fleet to an incredibly expensive and intrusive AD to remove what might be the most reliable part in the engine. I wish magnetos were as reliable. I would urge the FAA to consider a less onerous response than the MSB sets forth.

The other problem MSB-08B causes is impact in countries that require compliance with mandatory service bulletins. We would be very happy to see the MSB say removal at engine overhaul, but the current reaction is analogous to using a sledgehammer on a tack.

We would propose a more deliberate method to ensure safety. Examples:

1. Time does not cause gears to fail, hours of operation do. Drop the 12 year OH requirement from the MSB.
2. The approval of some sort of inspection process at logical period's vs outright replacement. Fortunately, this is a reasonably accessible gear and borescopy or other non-destructive inspection techniques make this possible.
3. Develop methods and permit field approved methods to replace the gear. Consider allowing the gear part numbers with the best service record to be substituted for the 655516 gear (the gear singled out in the MSB) to eliminate the need for crankcase modifications in the field.
4. Require gear replacement whenever the crankcase is opened for other reasons.

I appreciate the opportunity to offer up the Cirrus Owners perspective on this problem. Thank you.

Sincerely,
Roger Whittier
President, Cirrus Owners and Pilots Association
A&P/IA



The TWIN CESSNA Flyer™

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April 27, 2017

The Twin Cessna Flyer is the owners group for all piston-powered twin engine Cessna aircraft (except the 337 series.) We have 1,500 members in 21 countries. Since our airplanes are twins, we represent 3,000 engines - most of which would be impacted by Continental Motors mandatory service bulletin MSB05-08B should it become an AD.

Our Technical Advisor is Tony Saxton, owner of TAS Aviation in Defiance, OH. His shop specializes in Twin Cessnas and works on over 200 aircraft each year. Frankly he and I were both stunned by the issuance of this MSB as written.

As President of our group, I am the first to hear about problems with our airplanes. Every week I get calls from members and shops about various engine issues involving just about every conceivable engine part. In my eight years as head of the group, I have never heard a single report of a problem with the camshaft gear that is the subject of the MSB, nor has our Tech Advisor ever identified it as a major, recurring problem.

All indications are that the gear is at least as reliable, if not more reliable, than many other parts of an engine. My understanding is that only one in-flight failure has ever occurred.

We applaud Continental for developing an improved part but the compliance steps specified by the MSB are grossly out of proportion to the small amount of risk involved. Moreover, given the invasive nature of the gear replacement, we believe the MSB as written would increase overall risk, not reduce it.

Continental's post-MSB press release was a step in the right direction but based on our extensive field experience with these engines, we recommend the following modifications to the MSB:

1. Remove the mandatory 12 year overhaul requirement. It's clear that calendar time does not impact this part.
2. Require gear replacement with the improved part whenever the engine is overhauled or the crankcase is opened for other reasons.
3. If a gear needs replacement prior to an overhaul or case splitting event, allow for field approved methods that do not require complete engine disassembly.

These steps would ensure the affected fleet would be updated with the new gear in a way that is consistent with the risk involved in continued operation with the older part.

Sincerely,

Robert D. Thomason, President



Savvy Aircraft Maintenance Management, Inc.

4801 Braeburn Drive
Las Vegas, NV 89130

April 30, 2017

To: Christopher J. Richards, FAA Engine & Propeller Directorate
Scott Hopper, FAA Atlanta Aircraft Certification Office

Re: Response to ACS concerning CMI 520/550 camshaft gear, and CMI MSB05-8B

Gentlemen,

Savvy Aircraft Maintenance Management, Inc. manages the maintenance of approximately 600 aircraft powered by Continental 520- and 550-series engines using the camshaft gears that are the focus of the FAA's December 2016 Airworthiness Concern Sheet and Continental Motors' Mandatory Service Bulletin MSB05-8B. For the past month (since Continental published its MSB on March 28, 2017), we have been working diligently in collaboration with other stakeholders (Aircraft Owners & Pilots Association, American Bonanza Society, Cirrus Owners & Pilots Association, Twin Cessna Flyer) to understand the safety risk associated with these camshaft gears and what corrective action (if any) may be warranted to mitigate such risk.

Our first concern was to determine the severity and frequency of camshaft gear failures. It is obvious that the severity of such failures is very serious: Failure of the gear is almost certain to result in total loss of engine power. But how often do such failures occur? In the informal GoToMeeting session that our stakeholder group had with representatives of the FAA E&PD and Atlanta ACO on April 14, 2017, the FAA represented to us that it was aware of three failures of the subject gear, none of which were "new." We conducted a diligent search of the FAA's SDR database and found 13 SDRs concerning the older-style Continental camshaft gears. Most of these SDRs documented abnormal wear and/or corrosion of the gears, not failures of the gears.

Even if one were to assume that every one of the gears reported in those 13 SDRs would have ultimately failed in service had they not been detected and removed from service before failure, that would still represent an extraordinarily low failure rate. Given that these older-style camshaft gears have been in service for approximately four decades, we calculate that 13 failures would represent a mean time between failures of roughly seven million engine hours. This would make the subject camshaft gears one of the most reliable ferrous metal parts of the engine. Connecting rods and crankshafts fail considerably more often than that, and we're aware of no discussion of need for corrective action for those components. Indeed, the fleet of 600 Continental-powered airplanes managed by Savvy has suffered several connecting rod failures in the past nine years, but

not a single camshaft gear failure. Stakeholders representing other substantial populations (Cirrus Owners & Pilots Association and Twin Cessna Flyer) report similar experiences.

Experience of Overhaul Shops

We spoke to numerous Part 145 engine repair stations to determine what their experiences had been with the subject older-style camshaft gears. These ranged from the largest engine shops (RAM Aircraft, Western Skyways) to smaller ones (Alaskan Aircraft Engines, Poplar Grove Airmotive, Zephyr Aircraft Engines). All of these repair stations were unanimous in their opinions that they were not seeing any serious problem with these older-style camshaft gears, were very comfortable reusing them at overhaul after undergoing appropriate visual inspection and NDT, and saw no valid reason for them to be replaced with newer-style gears at overhaul. Every single engine repair station we spoke with told us that they considered Continental's MSB05-8B to be unwarranted.

RAM Aircraft in Waco, Texas was particularly forthcoming on this subject. RAM specializes in overhauling Continental TSIO-520/550 engines, which are the highest horsepower variants of the affected group, and therefore would be expected to suffer the highest gear failure rates. RAM is unusually diligent in its inspection and testing of these gears during overhaul, and has a 10-page section of its FAA-approved Repair Station Manual devoted solely to gear inspection procedures and rejection criteria. Every camshaft gear that RAM has received since the mid-1990s has undergone both detailed visual inspection under magnification and magnetic particle inspection. RAM told us that it rejects about 5% of the camshaft gears it inspects in direct-drive Continental engines due to wear and/or corrosion. (The reject rate has been substantially higher for the higher-horsepower GTSIO-520 engines which are not subject to MSB05-8B.) However, in the 20+ years that RAM has been using this enhanced gear inspection procedure, it has not found a single gear that exhibited any detectable fatigue cracking.

This is not as surprising as it may seem at first. Using very conservative assumptions, we calculate that each tooth of the camshaft gear in a direct-drive Continental engine undergoes approximately 13,000,000 full-power repetitive-stress cycles during a 1,700-hour TBO. The traditional metallurgical technique for defining the fatigue limit of a ferrous metal component is the highest stress that the component can tolerate for 10,000,000 cycles without cracking. Thus, if a camshaft gear endures one TBO without cracking, that proves that it is operating within its fatigue limit and therefore should theoretically survive an infinite number of repetitive stress cycles at the same stress level without cracking. What the overhaul shops are reporting agrees with this theoretical expectation.

The bottom line is that neither the aircraft owner stakeholders who fly behind these engines nor the Part 145 repair stations that have the most experience inspecting these gears are aware of any unsafe condition that would warrant corrective action by the FAA.

However, if the FAA concludes that an unsafe condition does exist, then it will need to weigh the various corrective action alternatives available. Therefore, we looked carefully at those alternatives.

Corrective Action Alternatives

Continental's MSB05-8B calls for pre-emptive replacement of the older style camshaft gears within 100 hours time-in-service, or immediately if the engine has been in service for more than 12 years. During the informal discussion with the FAA on April 14, 2017, it appeared that our stakeholders' group and the FAA representatives were in agreement that such action was inappropriately harsh and burdensome. Six days later, on April 20, 2017, Continental Motors issued a press release indicating that it intended to revise MSB05-8B within 15 days to permit the older-style gears to remain in service until the next time the engine is overhauled or disassembled for some other reason so that the camshaft gear is accessible, provided the camshaft gear undergoes on-condition inspection.

Although our stakeholders do not believe that an unsafe condition exists with the older-style camshaft gears for the reasons stated above, we would not object to a mandate that such gears be replaced with the newer-style gear at overhaul or whenever the case is split for some other reason. Indeed, we do not believe that an Airworthiness Directive is necessary to implement such a mandate. All that needs to happen is for Continental to require such gear replacement in its applicable maintenance and overhaul manuals. 14 CFR 43.13(a) already requires maintenance personnel to conform with the methods, techniques and practices prescribed by the manufacturer in its current maintenance manual or instructions for continued airworthiness. Therefore, Continental can mandate such gear replacement during overhaul or repair without help from the FAA. Having said that, we would not object to an AD that mandated such replacement—provided it allowed the replacement to be with either Continental Motors p/n 656818 or a PMA equivalent from an alternate supplier.

On the other hand, the on-condition inspection protocol promised by Continental Motors in its next revision to MSB05-8B gives us great cause for concern. Of course, we don't yet know exactly what inspection protocol Continental will prescribe, but we've considered the obvious alternatives and feel compelled to share our concerns with the FAA:

1. We are convinced that any *in situ* initial and/or or repetitive inspection protocol that Continental proposes will serve no useful purpose because it will detect precisely ZERO cracked gears. We know this because for decades, overhaul shops have been inspecting these gears using far more sensitive inspection methods (magnetic particle and high-magnification visual) that can be performed *in situ* and have detected no fatigue cracks. Now, it is possible that such *in situ* inspections might occasionally detect corrosion or wear, but Continental has been

clear that the safety concern that prompted MSB05-8B is fatigue cracking. No one has suggested that the newer-style p/n 656818 camshaft gear is any more resistant to corrosion or wear than the older-style p/n 631845, 655430, 655516 or 656031 gears; they're not. Nor to our knowledge has anyone suggested that corrosion or wear has been a problem responsible for any camshaft gear failures; we know of none.

2. Even if a feasible method of *in situ* inspection existed that could detect some nonzero number of camshaft gear fatigue cracks (and the evidence strongly suggests otherwise), such inspections would not accomplish anything useful unless the inspection interval was sufficiently short to assure that cracks could be detected in time to prevent gear failure. Therefore, it is necessary to have at least a rough idea of the time interval between when a fatigue crack first becomes detectable using that inspection method and the time that it progresses to the point of component failure. (This is the "P-F interval.") If we know the approximate P-F interval and we inspect repetitively at half that interval or less, then we can be reasonably confident that we'll detect potential failures before they become actual failures. The problem is that nobody seems to have any good data about what the P-F interval is for fatigue failures of these camshaft gears. Is it 5 minutes? 5 hours? 50 hours? 500 hours? Nobody seems to know. Given the extremely high cycle rate of these gear teeth during engine operation, most of the engineers we've spoken with seem to think that the P-F interval is probably so short that repetitive on-condition inspection for fatigue cracks is infeasible. They tell us that one might be able to estimate the P-F interval by (1) creating a finite-element model of the crankshaft/camshaft/gear system, (2) determining the intensity, frequency, and duty cycle of the peak stresses on the camshaft gear teeth during engine operation, (3) determining the minimum detectible flaw size of the proposed inspection protocol, and (4) plugging all this into the AFGROW or NASGROW fracture analysis software that predicts fatigue crack propagation rate. However, we're not aware that such an analysis has been done for the old-style camshaft gear by Continental or anyone else. We believe the FAA should insist on such an analysis of the P-F interval before mandating any inspection protocol that might well prove futile in detecting cracks in time to prevent failures.
3. In performing its cost-benefit analysis of any such repetitive inspection protocol that Continental may propose to require, we think it's essential for the FAA to be mindful of the fact that the cost burden of any such inspection will vary widely depending on what make and model of aircraft the engine is mounted in. Any inspection protocol will require removal of the engine's starter drive adapter in order to gain access to the camshaft gear for inspection, and then reinstallation of the starter drive adapter after the inspection is complete. For some aircraft like the Cirrus SR22, removal and reinstallation of the starter adapter is relatively easy (approximately 4 labor hours). For other aircraft like the turbonormalized Beech Bonanza, access is much more difficult and the procedure takes much longer

(approximately 8-10 labor hours). For still other aircraft like the Cessna 400-series and the Lancair IV, the starter adapter cannot be removed without hoisting the entire engine from its mount and moving it forward to provide enough clearance between the engine and the firewall to accomplish removal (so the task might require 16 labor hours). If the inspection itself requires an additional two labor hours, the burden of performing each on-condition inspection might cost the owner of a single-engine airplane anywhere from \$6,000 to \$18,000; double those figures for owners of twins.

4. For those aircraft makes and models that require extensive disassembly or even engine removal in order to remove and reinstall the starter adapter to facilitate camshaft gear inspection, the risk of maintenance-induced failure rises significantly. We think it's essential that the FAA be mindful of this, and make sure that for any corrective action it mandates the cure is not worse than the disease.

For these reasons, we have serious concerns that any initial or repetitive condition inspection that Continental may propose will turn out to be just a futile exercise unlikely to prevent even one failure, but that will unquestionably place a severe cost burden on owners of Continental-powered aircraft (particularly certain makes and models).

Thank you in advance for your consideration of these comments and those of our fellow stakeholders. All of us in aviation—regulators, manufacturers, repair stations, and owners/operators alike—are deeply committed to aviation safety. We look to the FAA to address this issue in a fashion we all can support enthusiastically.

Very truly yours,



Michael D. Busch A&P/IA
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Savvy Aircraft Maintenance Management, Inc.
2008 National Maintenance Technician of the Year

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