TELEDYNE CONTINENTAL® AIRCRAFT ENGINE

CATEGORY 4

SERVICE INFORMATION DIRECTIVE

SID97-2B

Compliance Will Enhance Safety, Maintenance or Economy Of Operation

FAA APPROVED

SUBJECT: **THIS SERVICE INFORMATION DIRECTIVE (SID) SUMMARIZES INFORMATION PERTINENT TO THE DESIGN, OPERATION, MAINTENANCE AND WARRANTY FOR TCM CYLINDERS.**

PURPOSE:

1. To provide information to assist in obtaining maximum cylinder assembly service life.
2. To assist in inspecting for and identifying certain cylinder problems.
3. To provide information related to product improvement in TCM cylinders.
4. To introduce TCM's TopCare® Program and TopCare Cylinder Warranty.

COMPLIANCE: TCM recommends that the TopCare Health Check® Inspection be performed at time of engine or cylinder installation and annually thereafter in conjunction with a regularly scheduled inspection.

MODELS AFFECTED: All TCM engine models. The information is especially critical to the higher output and larger displacement engines such as the IO-520, TSIO-520, GTSIO-520, IO-550, TSIO-550 and TSIOL-550 series.

INTRODUCTION:

The information presented is pertinent to obtaining maximum service life for all cylinder assemblies, the larger and higher output 520 and 550 series engine cylinders are more susceptible to premature service life issues identified in this SID. These TCM engine series have been used in a large number of engine installations that have been in service for many years. They are also frequently employed as power upgrades to older aircraft. These installations require careful control of cooling as margins can be quickly eroded by deviations from nominal baffling performance, improper fuel system setup and inadequate maintenance.

Improperly maintained and low-usage aircraft are the most susceptible to premature cylinder service issues. Many of the factors which lead to these problems are within the control of operator and maintenance personnel and are detectable during routine inspections, if the proper preventive checks are performed. Even with cylinder design and manufacturing process improvements, decreased cylinder life can occur if proper attention is not given to the various factors identified in this SID.

When operated regularly in a properly designed and maintained installation, current TCM cylinders provide excellent reliability and durability. In specific fleet applications, TBO extensions based on condition inspections have been regularly obtained.

TCM has invested heavily in the development of improved cylinder designs and manufacturing processes. So that we can continue to deliver increased value to our engine and cylinder customers.

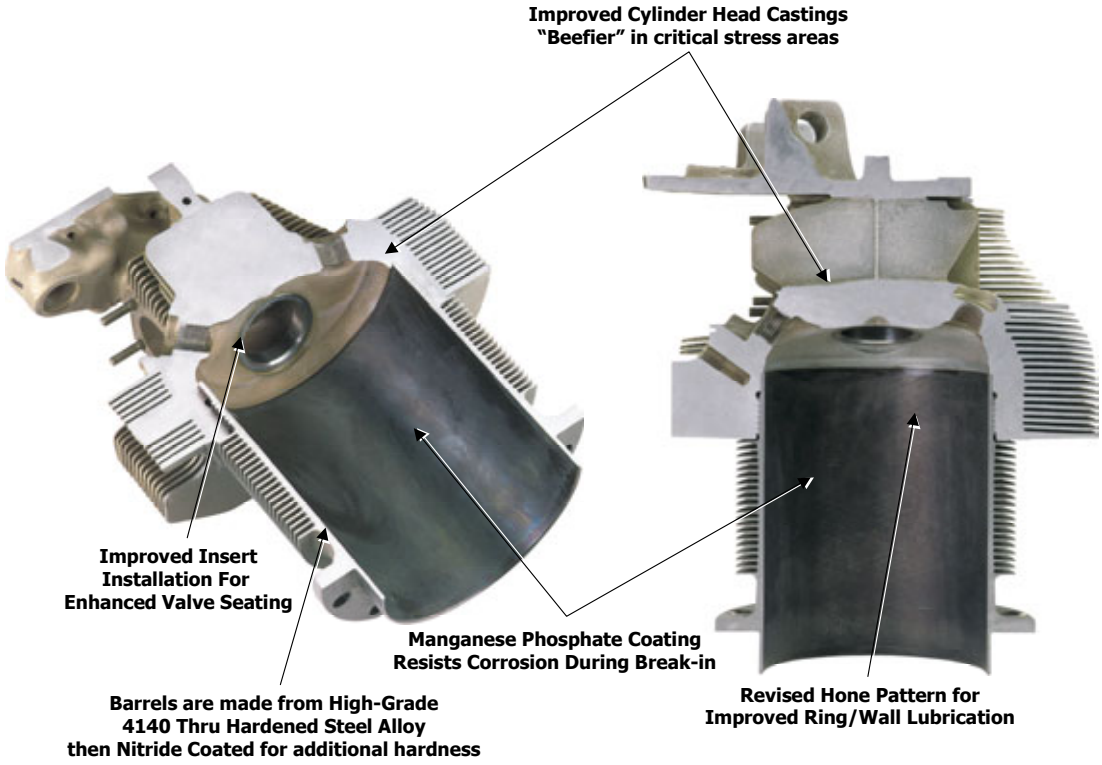


Figure 1. TopCare Cylinder Improvements

TCM TopCare Program

TCM TopCare Product Improvements: Beginning in February 1997, TCM introduced 520 and 550 cubic inch cylinders which include a revised hone pattern for improved piston ring and wall lubrication, reduced oil ring tension for increased oil flow to cylinder walls, coated pistons for increased scuffing protection and manganese phosphate coated cylinder barrels to provide corrosion protection for the first hours of cylinder operation. TCM has also improved valve seat installation and implemented cylinder head casting improvements in areas where cracking has been observed. These improvements have been incorporated into the complete line of TCM cylinders effective March 1997. The product improvements are intended to provide additional durability to address a complex combination of operational, maintenance and fleet aging factors. All cylinders released from the TCM Factory since March 1997 are brand new and have incorporated the TopCare improvements and are eligible for the new TopCare warranty, which became effective August 1999.

TCM TopCare Health Check Inspection - Two of the purposes of this SID are to assist in identifying problems with cylinders in service and to provide a preventive maintenance checklist to utilize in identifying and correcting factors which, if not addressed, can lead to reduced cylinder service life. The TCM TopCare Health Check Inspection is intended to supplement the checks normally prescribed by TCM and the airframe manufacturer relating to factors affecting cylinder life and should be conducted at least once per year in conjunction with a regularly scheduled inspection.

TCM TopCare Cylinder Warranties - Aircraft owners who participate in the TopCare Program can be eligible for special warranty coverage, provided certain eligibility requirements are met. The TopCare Cylinder Warranty applies to cylinder assemblies manufactured or supplied by TCM which incorporate the applicable TopCare cylinder improvement package. Additionally, any engine presently covered by the Gold Medallion Standard Aircraft Engine Warranty or the Gold Medallion Plus II Aircraft Engine Warranty but without the TopCare cylinder improvement package may qualify for additional warranty coverage. A summary of TCM TopCare Warranties is presented on page 23 of this SID. Any engine that does not qualify for coverage under the TopCare warranties will continue to be covered under the terms of the Gold Medallion Standard Aircraft Engine Warranty, the Gold Medallion Plus II Aircraft Engine Warranty or the Aircraft Engine Part, Component & Accessory Warranty, as applicable. It should be noted, however, that the issues addressed in this SID relate to the proper installation, operation and maintenance of TCM engines. The discrepancies discussed in this SID may adversely affect the engine and any resulting damage will not be eligible for coverage under any TCM warranty.

TCM TopCare Health Check Inspection

TCM recommends that each operator of a TCM powered aircraft have the TopCare Health Check Inspection performed annually in conjunction with a regularly scheduled inspection to identify cylinder condition and installation items which can result in reduced cylinder life.

The points of the TopCare Health Check are:

- Cylinder Differential Compression Check And Trend Monitoring
- Cylinder Borescope Inspection, As Required
- Oil Consumption Trend Monitoring
- Oil Analysis Trend Monitoring
- Baffle Condition Inspection
- Induction System Examination
- Cowling Inspection And Cowl Flap Operational Check
- Ignition System Inspection
- Fuel System Setup
- Verification Of Accuracy Of Engine Gages
- Flight Test

Minimum Tool Requirements For Performing TCM TopCare Health Check Inspection:

- Basic Mechanic's Hand Tools
- Calibrated Torque Wrench
- Inspection Light and Mirror
- Calibrated Differential Compression Tester
- Master Orifice Tool, P/N 646953
- Borescope
- Magneto Timing Light, Protractor and TDC Plug
- Calibrated Fuel System Adjustment Gages
- Tachometer Tester
- CHT / EGT Tester

1. CYLINDER DIFFERENTIAL COMPRESSION CHECK

Wearing of cylinder walls, ring surfaces, and valve seats occur throughout the life of an engine. At regular maintenance or when condition inspections are indicated, differential compression checks should be made and recorded for trend monitoring. The latest version of the TCM Service Bulletin SB03-3 concerning cylinder compression checks describes the necessary equipment, procedures, and recommended actions.

It is important to note that differential compression checks are used to identify cylinder leakage rates and the source of the leakage. This check cannot be directly related to engine horsepower. ENGINE TESTING HAS SHOWN THAT CERTIFICATION HORSEPOWER RATINGS WILL CONTINUE TO BE DELIVERED EVEN WHEN ALL CYLINDERS ARE AT OR BELOW THE MINIMUM ALLOWABLE CALIBRATED COMPRESSION READING AS ESTABLISHED BY THE MASTER ORIFICE TOOL.

Specifically, differential compression checks are designed to identify cylinder leaks that are occurring by the piston rings or in the valve/seat areas. The use of a calibrated differential gage as described in the latest version of the TCM Service Bulletin SB03-3 concerning differential compression checks is mandatory for accurate readings. If the leakage value is greater than the minimum allowable calibrated compression reading established by the Master Orifice Tool, no further action is indicated unless leakage is by either valve. If the leakage value is less than the minimum allowable calibrated compression reading, further investigation in accordance with the latest version of TCM Service Bulletin SB03-3 should be followed prior to cylinder removal.

2. CYLINDER BORESCOPE INSPECTION:

Cylinder borescope inspections are recommended when reported oil consumption is high, or as routine inspections to monitor cylinder condition. Conducting meaningful borescope inspections requires practice and experience to properly interpret the limited view available.

When conducting the TopCare Health Check borescope inspection, the maintenance technician should examine the cylinder for the presence of rust and overall condition of the cylinder bore and valve area. Refer also to the latest version of TCM Service Bulletin SB03-3 for procedures and recommended test equipment necessary to borescope the cylinder barrel and valve area condition.

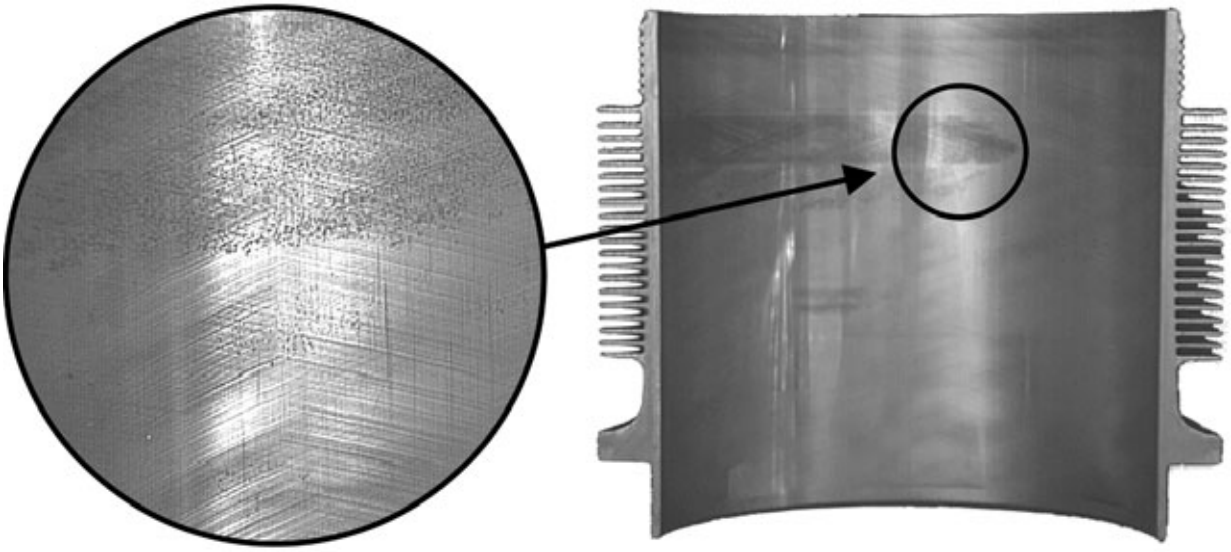
A. RUST EXAMINATION:

To achieve long cylinder life, TCM cylinder barrels are constructed of through-hardened steel with a nitrided surface. Regular use of the aircraft in normal operation is usually sufficient to provide an oil coating which prevents excessive rust formation in the cylinders. However, new cylinders are particularly sensitive to rust formation if not used frequently or preserved during periods of inactivity.

To provide improved rust formation protection in new cylinders, TCM cylinders produced beginning in February and March 1997 (depending on the model) have a manganese phosphate coating. Cylinders produced after these dates also have an advanced multi-step hone pattern to aid in oil retention. Note that the phosphated cylinder bore will have a dark gray to brownish color that will wear away as hours in service are accumulated.

Infrequent or irregular use of the aircraft can easily lead to rust formation which may result in reduced cylinder life if the engine is not properly preserved in accordance with the latest revision of the TCM Service Information Letter SIL99-1 concerning engine preservation.

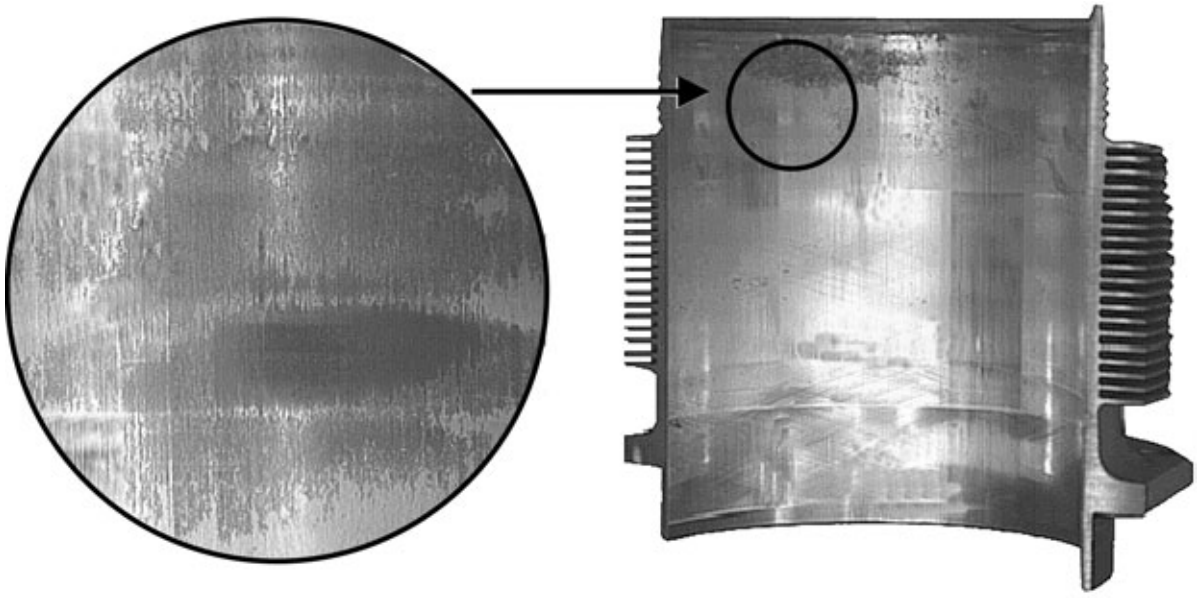
Caution: The practice of ground operation of the engine as a substitute for regular use of the aircraft is unacceptable. Ground running does not provide adequate cooling for the cylinders. In addition, ground running introduces water and acids into the lubrication system which can cause substantial damage over time to cylinders and other engine components such as camshafts. Turning the propeller by hand is not recommended as this wipes off the residual oil.



Light Rust Formation, Hone Not Affected

FIGURE 2

Light rust signatures which have not pitted the cylinder wall, or rust indications above the top ring travel area, are not usually cause for concern. See Figure 1. Severe rust will pit the barrel wall and can damage rings. See Figure 2. Such damage will usually be evident by low differential compression checks and high oil consumption. TCM'S WARRANTY DOES NOT COVER DAMAGE FROM RUST. Rust damage must be prevented by the operator and/or maintenance facility.



Heavy Rust Formation, Surface Pitting Has Altered Honed Pattern

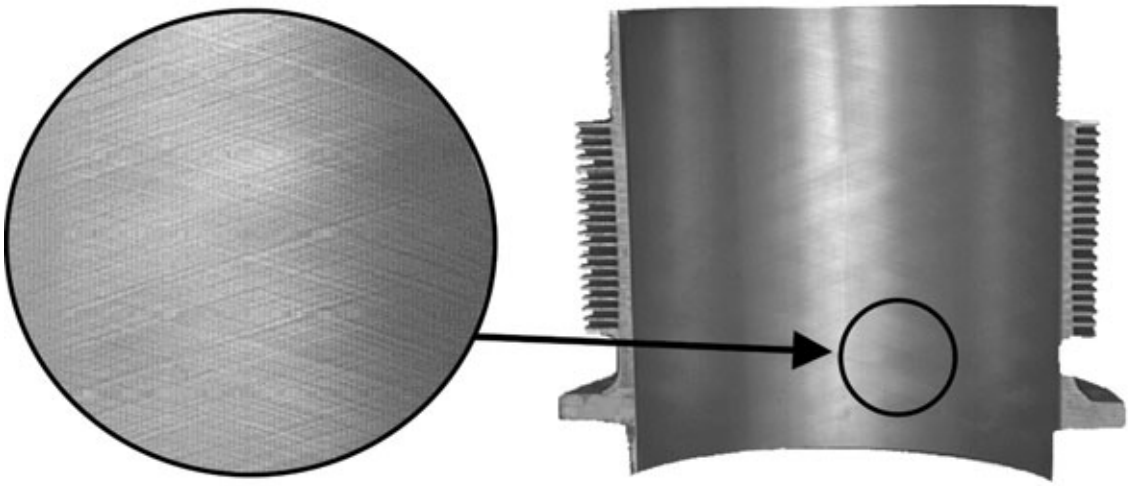
FIGURE 3

B. CYLINDER WALL EXAMINATION

Borescope inspections of the cylinder wall are performed to assess the condition of the hone pattern and identify abnormal wear patterns which can contribute to low differential compression readings or increased oil consumption.

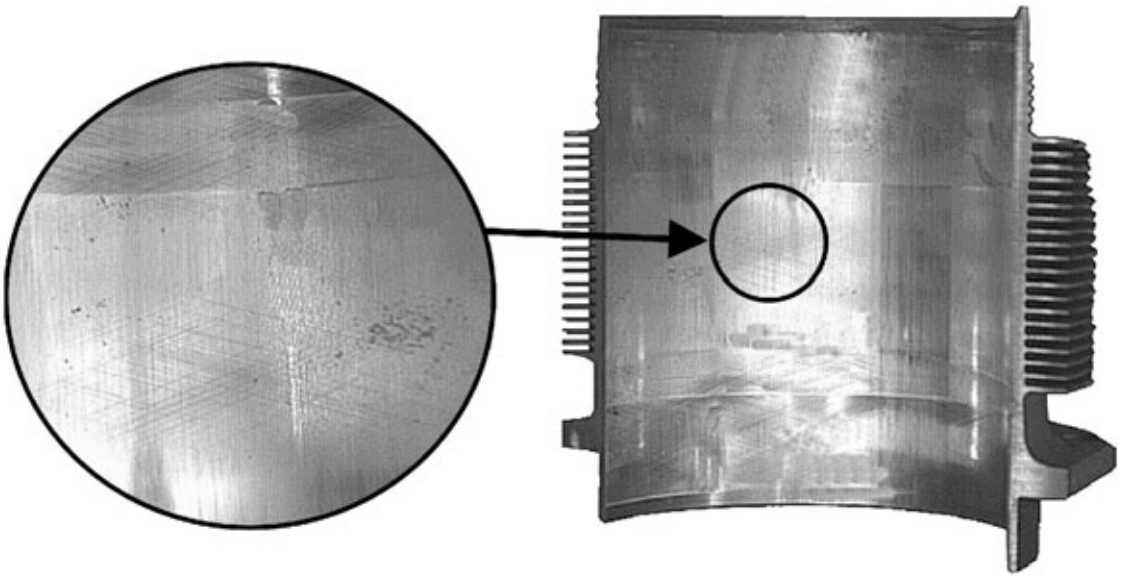
The cylinder wall hone pattern consists of a carefully applied pattern of surface "scratches" introduced at the time of manufacture. These scratches aid in ring seating by allowing the ring and wall surface to wear into conformity to each other and provide a reservoir of oil for lubrication during ring travel. The cylinder walls and rings are designed to wear over the life of the engine, particularly in the high pressure and temperature combustion area. The visible hone pattern in the upper portion of the bore may disappear during normal operation. SUCH NORMAL PATTERNS ARE NOT CAUSE FOR CYLINDER REMOVAL.

The following figures show hone patterns in a new cylinder and at TBO for typical TCM cylinders. As can be seen from the photograph at TBO (Figure 4), cylinders which have a very light or no hone pattern in the upper portion of the bore can function normally, have normal oil consumption and have acceptable differential compression checks. For this reason, the borescope inspection should be used in conjunction with differential compression checks and oil consumption trends to assess engine condition.



New Steel Cylinder Bore

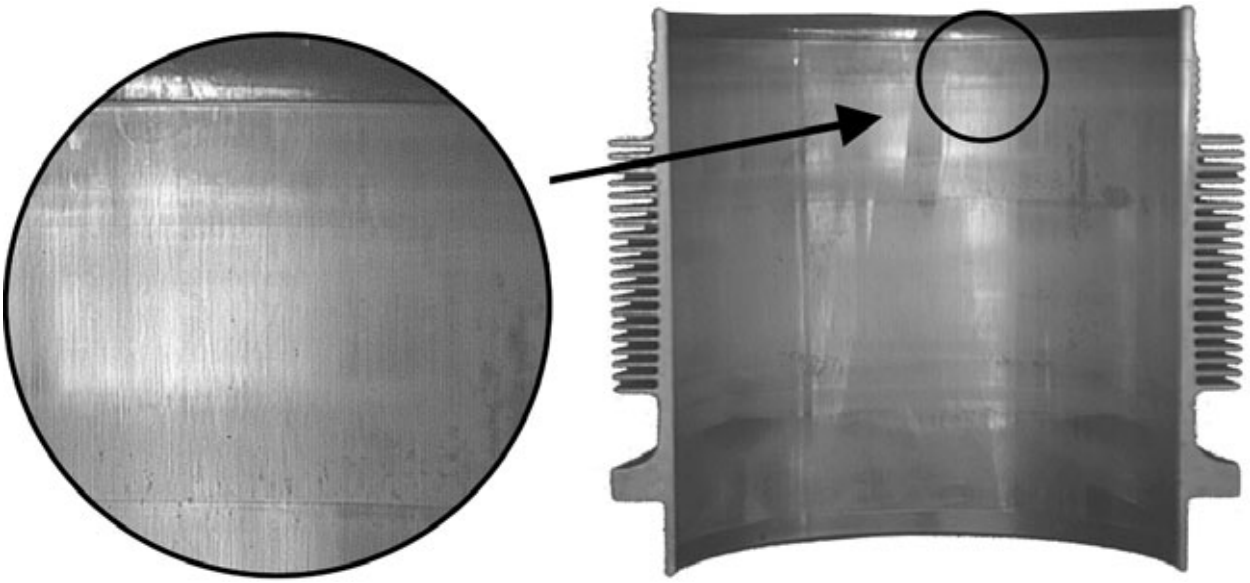
FIGURE 4



Typical Cylinder Bore At TBO

FIGURE 5

Scratches or grooves that extend in the direction of piston travel can result from contamination and may lead to low differential compression checks and high oil consumption. Heavy bore wear with a complete loss of visible hone pattern over the full ring travel can result from over-temperature operation or abrasive wear. See Figure 5. These signatures, in conjunction with low differential compression checks or high oil consumption, generally indicate cylinder repair or replacement or, at minimum, call for more frequent condition inspections.



Heavily Worn Cylinder Bore

FIGURE 6

Over time, the cylinder wall may develop a glazed coating which is generally beneficial to cylinder life as a rust inhibitor. The glaze is a residue of hydrocarbon constituents and lead deposits which serve as both a rust inhibitor and lubricant. Changes and variations in fuel constituents and types of oil used in recent years may impact this beneficial coating. TCM's revised hone pattern, reduced oil control ring tension and manganese phosphate coating are intended to offset this impact.

3. OIL CONSUMPTION TREND MONITORING

Aircraft piston engines continuously wear over their service life. One indication of the rate of wear, or indication of the need for inspection or service, is found in oil consumption trends. Every owner/operator and maintenance facility should maintain formal records on oil consumption in the aircraft log book.

Oil consumption can be expected to vary with each engine depending on the load, operating temperature, type of oil used and condition of the engine. A differential compression check and borescope inspection should be conducted if oil consumption exceeds one quart every three hours or if any sudden change in oil consumption is experienced and appropriate action taken.

It is important to note that the current technology of general aviation aircraft reciprocating engines requires a certain level of oil consumption to assure proper lubrication of the cylinder walls and rings. Aircraft engines operate under much greater loads and at higher temperatures than automotive engines and require correspondingly greater oil use. In addition to lubrication, oil serves as a coolant and as a means to transport contaminants, wear particles, acids and moisture from the engine at oil changes. Frequent oil changes based on operating hours or calendar time are critical to engine life. Approved oils are listed in the latest version of the TCM service bulletin concerning approved fuel and oil grades.

TCM cylinder assemblies produced after February 1997, for 520 and 550 engines have revised oil ring tensions to produce improved cylinder bore lubrication characteristics.

The TopCare Health Checklist Form at the end of this SID contains a means to record oil consumption that should be completed and maintained with the engine logbook. OIL CONSUMPTION TRENDS ARE EXCELLENT INDICATORS OF CYLINDER BORE AND RING CONDITION.

4. OIL ANALYSIS TREND MONITORING

Oil analysis is a tool to monitor wear material and contaminants in the engine. To be effective, a baseline of at least three analyses must be established from a single source to provide trend characteristics. For those engines with an established oil analysis profile, changes in iron, copper and other tracked elements can indicate unusual wear. In such cases, other diagnostic tools such as differential compression checks, borescope inspections, oil filter/screen examination and oil consumption trends can be useful in identifying the problem. Oil analysis can also detect air filtration or induction system leaks indicated by high silicon content. Note that oil analysis does not provide any indication of cracks, leaks or similar situations that could result in engine problems.

NOTE: To establish a meaningful data base for comparison, the oil samples must be taken on a regular schedule using the same sampling technique and laboratory. The engine must have operated long enough to obtain normal operational temperatures and the oil sample taken within 30 minutes after engine shut down. The tube or funnels used to drain the oil from the oil sump must be clean and free of any foreign material or residue. If the oil sample is taken from the oil as it drains from the sump, allow approximately 1/3 of the oil to drain prior to taking the sample. If the sample is taken via the oil filler or other location using a sampling tube it is critical that the sample not be taken from the bottom of the sump, but at a location 2 to 3 inches above the bottom of the sump. Under no circumstances should an oil sample be taken from the oil filter canister.

The TCM LINK Aviator Services program provides a mechanism for recording and tracking oil analysis through the software supplied to Aviator Services members. For additional information on Aviator Services, contact TCM LINK Aviator Services Desk at 1-888-826-5465.

5. BAFFLE CONDITION INSPECTION

Investigations into cylinder service life issues found that maintenance of cylinder and oil cooling systems (incorrect and improperly fitting baffles) were factors in premature cylinder removals. To understand the importance of this cooling control, note that approximately one third of the energy of the fuel used is transferred as heat to the structure (cylinder head, barrel, crankcase, etc.) and oil. THE AMOUNT OF HEAT ENERGY THAT MUST BE REMOVED BY THE COOLING AIR IS APPROXIMATELY EQUAL TO THE HORSEPOWER THAT IS DRIVING THE PROPELLER. This is why failure of the cooling baffles to perform efficiently can lead to rapid and significant deterioration of the cylinders and other engine components.

To remove this heat, cooling airflow is directed by a series of baffles and ducts so that the airflow passes over cooling fins or directly to components requiring cooling. IT IS IMPORTANT TO UNDERSTAND THAT THE PRESSURE DIFFERENTIAL IN THE COWLING IS SMALL AND SLIGHT IRREGULARITIES IN THE BAFFLES CAN EASILY HAVE AN ADVERSE AFFECT ON ENGINE COOLING.

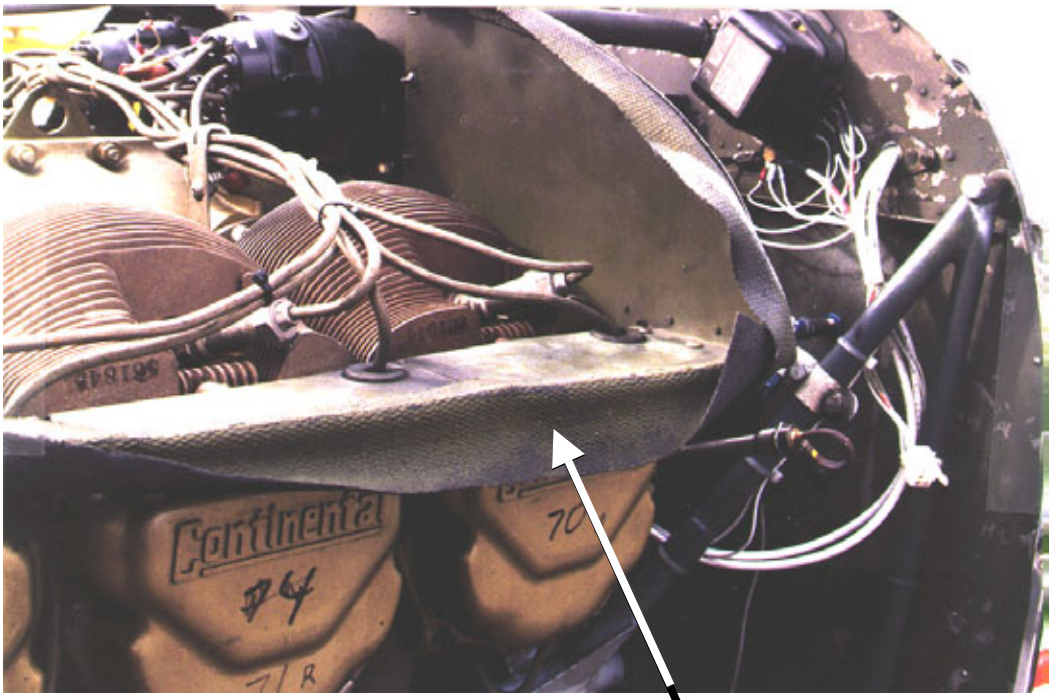
Field inspections indicate that critical baffles are often poorly maintained or deteriorate with age. In some cases, multiple engine removals have been made over the aircraft life without the replacement or repair of baffles and seals. In such cases, operators may have experienced excellent durability on early engines but have experienced less favorable results on later engine installations due to loss of cooling control.

In addition to the age of the aircraft, many engines have been installed as power upgrades through the Supplemental Type Certificate (STC) process. All of these installations should be thoroughly examined to ensure completeness of baffling and the replacement of old and potentially dysfunctional baffles. THE QUALITY OF DOCUMENTATION FOR STC INSTALLATIONS CAN VARY WIDELY, AND IF THE INSPECTION REVEALS INSTALLATION PROBLEMS THAT COULD AFFECT ENGINE COOLING OR OPERATION, THE STC HOLDER MUST BE CONTACTED FOR RESOLUTION.

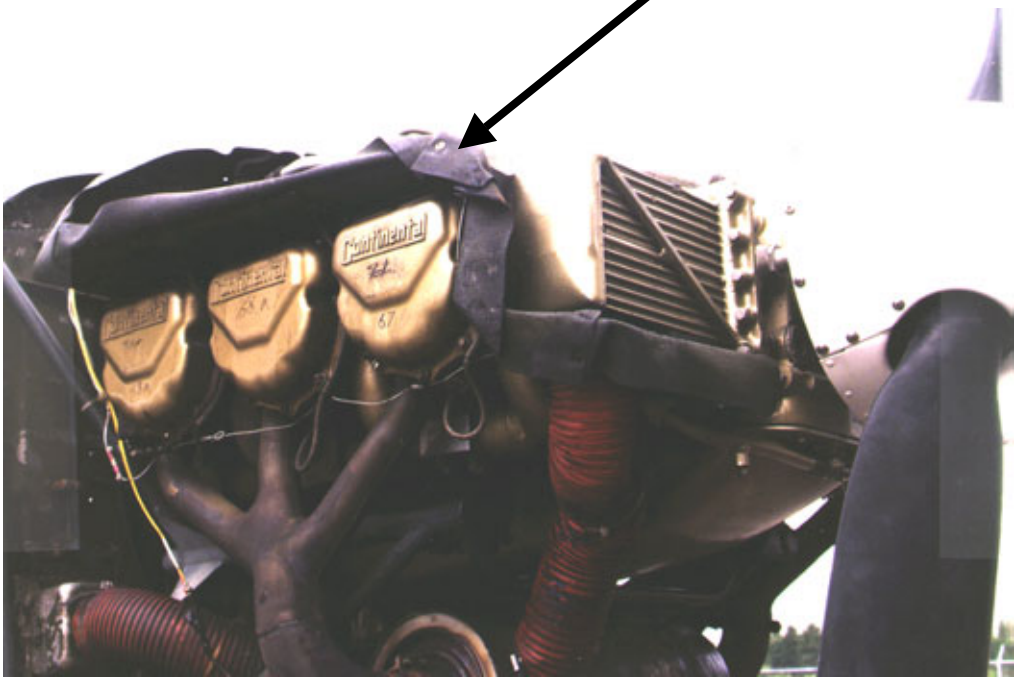
FOR THESE REASONS, IT IS IMPORTANT THAT ALL AIRCRAFT BAFFLES BE INSPECTED ANNUALLY.

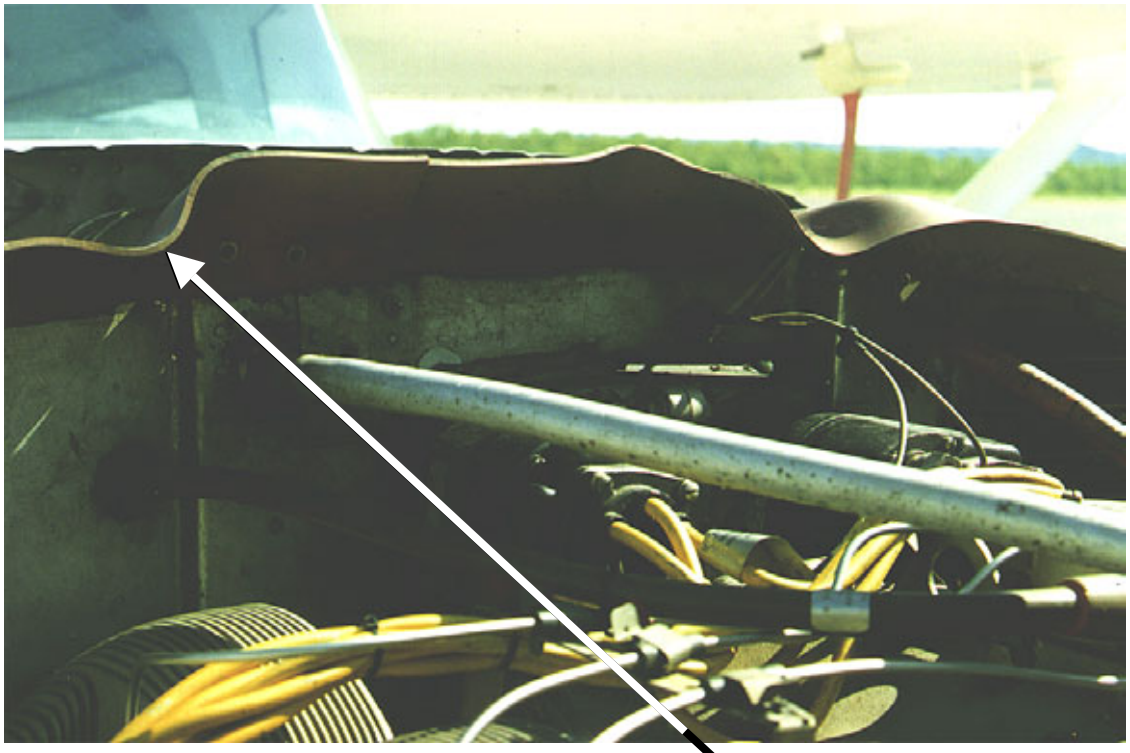
Some manufacturers, conversion shops, and maintenance facilities have developed baffle kits with improved, more flexible material that can provide excellent engine cooling airflow. Such kits may be particularly beneficial for older aircraft. Groups such as the American Bonanza Society and the Cessna Pilots Association can be useful sources for information about kits for specific aircraft.

Baffles in the conditions shown in the following photographs indicate problems found in the field that will shorten cylinder life by causing inadequate cooling airflow. The TopCare Health Check list indicates areas to be checked such as intercylinder baffles, perimeter baffles, cowl seals, cooling ducts, and any other seals or areas that direct or control airflow. Ensure that all holes and cracks that may waste cooling air are sealed.

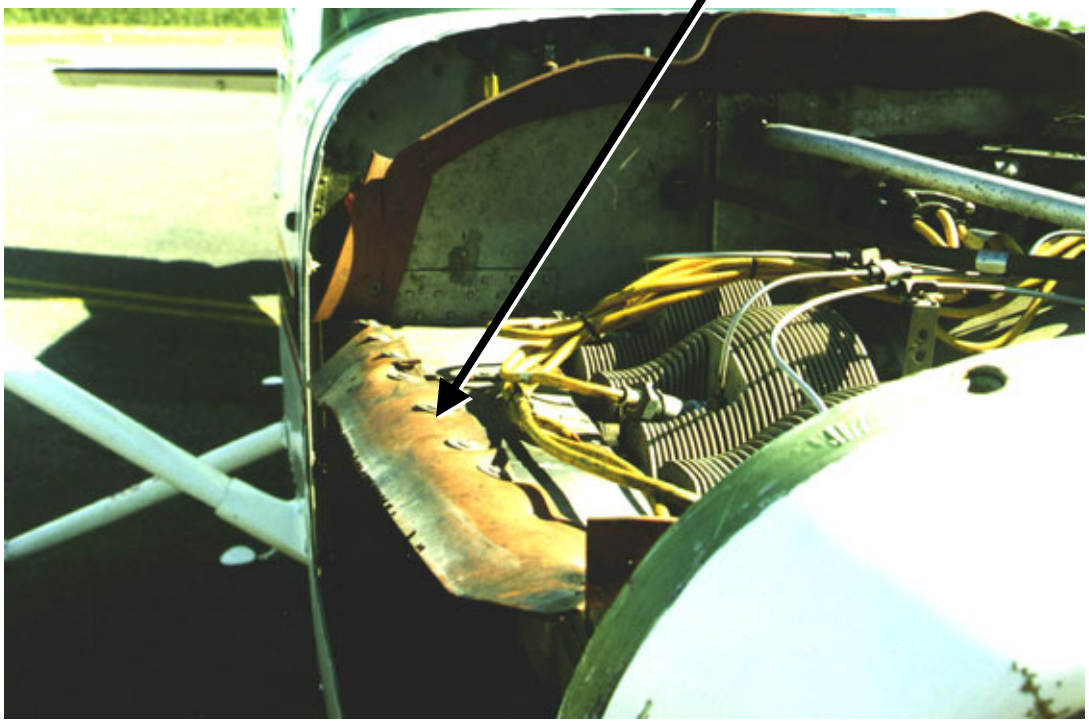


Peripheral Baffle Seals Improperly Positioned





Aft and Side Peripheral Baffle Seals Not Sealing Properly



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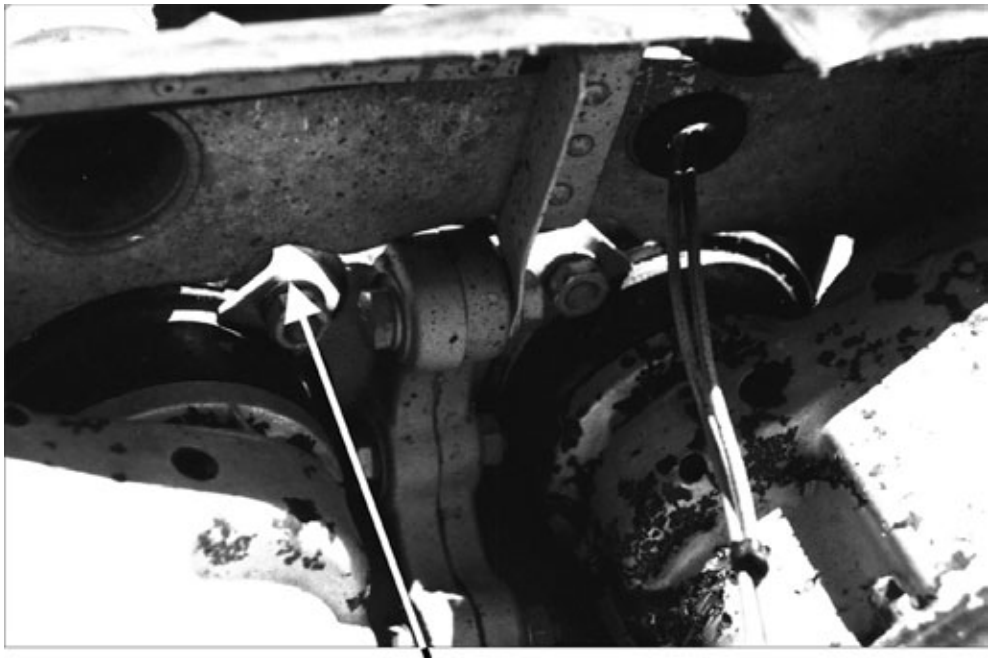
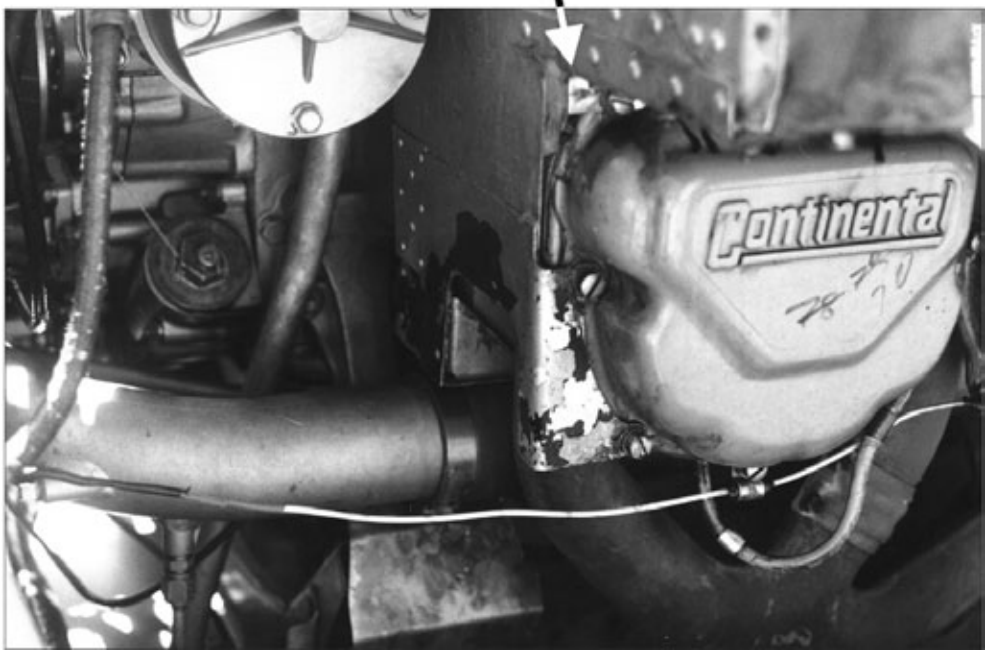
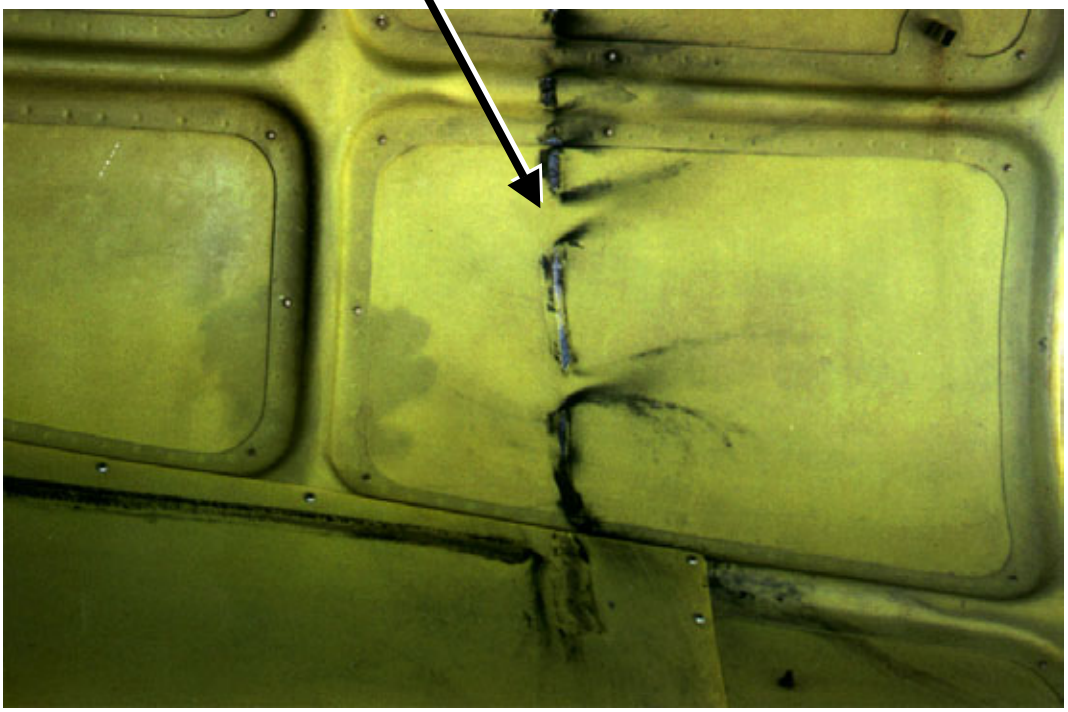


Aft and Side Baffles with Air Gaps



Cooling Air Loss Due to
Gaps in Baffle Seal



6. INDUCTION SYSTEM EXAMINATION

Improper or inadequate maintenance of the air induction components of the aircraft engine installation can and often does result in the engine breathing unfiltered air. Unfiltered air contains particulates, which are abrasive to the engine, especially to the cylinder walls and ring faces. Induction system maintenance that emphasizes properly sealed filters, alternate air doors, and air ducts can prevent much of that damage. Induction system deficiencies can often be detected through oil analysis which identifies the contamination.

In addition to using the engine manuals, also consult the aircraft maintenance manual for information. The TopCare Health Check Inspection contains the basic elements that should be considered as a minimum to inspect induction system integrity.

7. COWLING INSPECTION AND COWL FLAP OPERATIONAL CHECK

In addition to baffle conditions, other components that affect airflow though the cowling must be reviewed. Supplemental equipment or modifications must not restrict cowl openings and exit areas. Abnormal temperatures can result from airflow blockage or restrictions, which can lead to cylinder damage. Cowl flap operation is also an integral part of engine cooling control. The TopCare Health Check Inspection recommends verification of the correct opening, rigging, and operation of the cowl flaps.

8. IGNITION SYSTEM INSPECTION

Advanced magneto to engine timing can cause elevated cylinder head temperatures. Maintain and adjust magnetos in accordance with the engine or magneto service instructions. Inspect the magneto harness and spark plugs and replace if needed.

9. FUEL SYSTEM SET-UP

Improper maintenance and adjustment of the fuel system can be a significant factor in premature cylinder removal. Engine operation and cooling are directly related to the correct set-up of the fuel system. In addition, improper fuel system settings can affect engine performance in terms of both power and response to throttle movement. For most installations, the available airflow is insufficient to cool the engine during high-power operation and additional fuel is required to provide supplemental cooling. Mixture control can also be used in cruise to maintain correct cylinder head temperatures. Full rich fuel flows must be set properly in order to provide designed cooling margins.

Refer to the latest version of TCM Service Bulletin SID97-3 concerning fuel system set-up instructions. Use the aircraft manuals and, if the installation is an STC, use the instructions provided with the STC.

Caution: When performing fuel system set-up or adjustment, it is essential that the applicable manufacturer's and/or STC holder's published instructions be followed. It is also essential that proper tools, equipment and calibrated test gages be utilized. Do not rely on aircraft fuel flow pressure gages for fuel system set-up or adjustment. Aircraft tachometer and manifold pressure gages must be verified for accuracy.

To assist in this critical system adjustment, TCM has produced a video about the setup and maintenance of TCM fuel injection systems as a supplement to existing information. The video (P/N X30650) may be ordered by contacting the TCM Customer Service Department.

10. AIRCRAFT ENGINE GAGE VERIFICATION

To ensure that the engine is operating within recommended limits for normal operation, the aircraft engine gages must be verified for correct indications and any discrepancies rectified. Engine gages include the tachometer, manifold pressure, fuel flow, oil pressure, oil temperature, cylinder head temperature (CHT) and exhaust gas temperature (EGT).

Caution: Inaccurate aircraft engine related gages can cause operation outside of engine certification and specification limits and can lead to decreased cylinder life. Aircraft gage calibration errors can be particularly harmful for high horsepower engines. Gages must be re-marked for modified (STC) engines.

WARNING

SIGNIFICANT AIRCRAFT ENGINE GAGE INACCURACIES CAN LEAD TO CYLINDER DETONATION WHICH CAN RESULT IN ENGINE STOPPAGE.

11. FLIGHT TEST

At the conclusion of the inspections, repairs and adjustments, conduct a test flight to verify normal operation of the engine and related systems. The instructions in TCM Service Bulletin M89-7R1 provide ground runup and test flight procedures.

Caution: Ground running during adjustments must be carefully monitored to avoid high and potentially harmful cylinder head temperatures. Extended and full power ground operations must be held to a minimum, especially on newly installed cylinders.

PILOT OPERATIONAL AWARENESS

The aircraft operator can significantly influence the service life of the cylinders and other components by an increased awareness of engine requirements. Example: Rust prevention by frequent operation or by following recommended preservation procedures if the aircraft is inactive.

Using the correct type and grade engine oil and requiring frequent oil changes are important areas where an informed owner/operator can extend engine life. In general, becoming knowledgeable about all of your aircraft's maintenance requirements will help you make informed decisions. Membership in TCM LINK Aviator Services provides an outstanding means of obtaining information and recommendations for operation and maintenance of your engine.

The life of cylinders and cylinder components is highly dependent on correct operating temperatures. Control of operating temperatures is a function of installation design and maintenance, and operator control of fuel flow and cowl flaps. During high power and slow speed aircraft operations, the fuel/air mixture must be rich to supplement air cooling. Enriched fuel flow is a powerful way of controlling combustion temperatures and, therefore, cylinder, piston, and ring temperatures.

The highest combustion temperatures occur near the ideal fuel/air ratio of about one pound of fuel for 15 pounds of air. Combustion temperatures drop on both the lean side and rich side of this point. However, on the lean side of peak, the reduction in power with leaning is rapid and lean misfire occurs on many engines about 100 degrees F lean of peak. On the rich side, power is very stable with changes in fuel flow. This characteristic allows the engine to obtain rated power with rich mixtures where the combustion temperatures are substantially reduced. This additional fuel at takeoff is required to maintain control of cylinder structure and oil cooling.

In cruise, operating rich reduces combustion temperatures and should be used to control engine temperatures. For maximum range, operation on the lean side of peak or at peak is permitted at low cruise power on some engine models. For normal operation, it is good practice that mixtures be controlled so that the hot cylinder is 50 to 100 degrees F rich of peak at cruise settings.

In addition, rapid temperature changes should be avoided. Warm-up and cool down periods at the start and end of flights are also recommended. Leaning recommendations and fuel flow limits are found in the Airplane Flight Manual, or supplemental Airplane Flight Manual if you have an STC installation. These recommendations should be followed with pilot control of fuel flows and cowl flaps used to maintain temperature control.

COMMENT ON ENGINE TOP OVERHAUL PROCEDURES

If the results of the TopCare Health Check Inspection indicate that one or more cylinders should be removed from the engine, it is extremely important the cylinder removal, repair or replacement, and installation be conducted according to the instructions contained in the appropriate aircraft manufacturer's instructions, TCM Overhaul Manuals and other related TCM service documents for the aircraft and engine under service.

Evaluations of engine service issues and incidents in the field indicate that a number of engines that experience reduced service life can be attributed to improper field top overhaul procedures. Improper torque sequencing or procedures employed during reassembly can result in loss of engine crankcase through-bolt torque.

WARNING

THE USE OF IMPROPER PROCEDURES FOR CYLINDER REMOVAL AND REPLACEMENT CAN LEAD TO LOSS OF MAIN BEARING CRUSH AND ENGINE FAILURE.

To assist with the understanding of the proper procedures for engine top overhaul, TCM has produced a video that highlights the critical elements of a field top overhaul. The top overhaul video (P/N X30562) may be ordered by contacting the TCM Customer Service Department.

Anyone can contact TCM Customer Service and order the video for a nominal charge.

TCM TopCare Health Checklist

NOTE: In order to perform the TopCare Health Check Inspection, all applicable aircraft, engine, and STC holder's manuals, instructions and service information must be available and utilized. Use the TopCare Health Checklist Form to document the results of the following inspections and required repairs and adjustments. The latest version of TCM Service Bulletin SB96-12 provides additional cylinder inspection criteria that should be performed in addition to the inspections called for in this SID.

1. DIFFERENTIAL COMPRESSION CHECK

a. Perform Differential Compression Check in accordance with the latest revision of TCM Service Bulletin SB03-3 and record the master orifice tool reading.

1. For cylinders with differential pressures greater than the minimum allowable calibrated compression reading, and borescope inspection reveals no abnormalities, then continue in service.

2. For cylinders with differential pressures less than the minimum allowable calibrated compression reading, a borescope examination must be performed and the aircraft flown at power with a re-check of the suspect cylinder. If the cylinder leakage rate is still below the minimum allowable calibrated reading, the leakage source must be determined and corrected.

3. For cylinders where leakage by the valves is identified, perform a borescope inspection of the affected cylinder(s). If the leakage rate is above the minimum allowable calibrated compression reading, and borescope examinations reveal no abnormalities, continue in service. If the leakage rate is below the minimum allowable calibrated compression reading, and borescope examinations reveal no abnormalities, operate the engine to normal temperatures and recheck cylinder differential leakage.

4. For cylinders where leakage by the rings or valves is less than the minimum allowable calibrated compression reading, further investigation in accordance with the latest version of TCM Service Bulletin SB03-3 should be followed prior to cylinder removal.

b. Record differential compression values for each cylinder and reference pressure value.

2. CYLINDER BORE INSPECTION CHECK LIST

a. In addition to the procedures listed here, refer also to the latest revision of TCM Service Bulletin SB03-3 for cylinder barrel and valve area borescope examination procedures. Inspect each cylinder for signatures of normal wear. See Figure 4. Cylinder walls which appear to have minimum or no hone pattern are acceptable if the cylinder has acceptable differential compression readings and the engine has acceptable oil consumption.

b. Inspect each cylinder for signatures of light rust. See Figure 1. Light rust which has not resulted in excessive pitting of the cylinder wall is acceptable. Several small, localized areas less than 1/16 inch in diameter are acceptable as long as the total affected areas in any one cylinder does not exceed 1 inch in diameter. The affected areas must be separated by at least 1/2 inch. Rust above the top ring travel is inconsequential and not cause for cylinder removal. Surface discoloration or staining is acceptable and will not result in any damage to the cylinder barrel or to the piston rings.

c. Inspect each cylinder for signatures of heavy rust. See Figure 2. Cylinder walls which show heavy rust as characterized by pitting of the cylinder wall surface should be removed for repair or replacement if the cylinder has low differential compression or the engine oil consumption is high. Areas of corrosion where the honed surfaces have been altered are of primary concern. These areas are normally very dark in contrast to the surrounding areas. Small localized areas less than 1/2 inch in diameter are acceptable as long as there are no signatures of scoring or material pick up.

d. Inspect each cylinder for signatures of heavy wear. See Figure 5. Heavy bore wear is identified as a complete loss of visible hone pattern over the full ring travel and will normally have associated low cylinder differential compression and/or high oil consumption. This generally will indicate a need for cylinder repair or replacement or, at minimum, call for more frequent condition inspections.

e. Inspect each cylinder for signatures of scoring. A predominant amount of cylinder bore scratches or grooves that extend in the direction of piston travel will normally lead to low differential compression checks and high oil consumption. This may also be identified by burnt or blistered paint on the exterior of the cylinder barrel. This will indicate a need for cylinder repair or replacement.

3. OIL CONSUMPTION TREND MONITORING

a. A formal oil consumption record should be generated for the engine installation. If oil consumption is more than one quart every three hours of operation or if the oil consumption trend has changed substantially, conduct the differential compression and borescope examinations defined by sections 1 and 2 of the TopCare Health Checklist. If the oil consumption trend is stable and the oil consumption is less than one quart every three hours, continue with the TopCare Health Checklist.

b. Record type of oil used.

c. Record the number of quarts of oil added.

d. Record oil change interval.

e. At every oil change, strain the oil and examine for debris. Also, cut open the oil filter and examine it for unusual material content. Record examination results of the strained oil, oil filter or screen. The presence of a heavy amount of material will require investigation to determine the source prior to further engine operation.

4. OIL ANALYSIS TREND MONITORING

a. If an oil analysis profile has been established, review the results for indications of wear or contamination.

b. Based on the latest oil analysis, record the results of the profile trend. If the trend indicates an abnormal increase in material amounts, reference the recommended actions provided by the oil analysis laboratory.

c. If no prior oil analysis exists, initiate sampling according to the instructions you receive with the oil analysis kit.

5. BAFFLE CONDITION INSPECTION

a. Check baffles for condition, correct position, and proper contact with cowl.

b. Repair or replace worn or distorted baffles.

c. Check and adjust inter-cylinder baffles to ensure a tight fit.

d. Seal holes and cracks that would allow cooling airflow to be wasted. This may be accomplished by applying a non-corrosive silicone adhesive/sealant. Consult the aircraft manufacturer for application instructions.

e. Check the integrity of all cooling ducts, heater ducts, etc. and repair as necessary.

6. INDUCTION SYSTEM EXAMINATION

a. Check the air filter for cleanliness, normal operation and the absence of gaps or leaks in the filtering element. Check the air filter seal for potential bypass circuits from the filter. Correct or replace as necessary.

b. Verify the integrity of the airbox by examining for alternate air circuits which can bypass the filtering system. Any holes or bypass circuits found behind the filtering element should be repaired as required.

c. Verify the operation of the alternate air door and the integrity of the seal when in the closed position. Verify the door operating mechanism for security when in the closed location. Replace or repair as necessary.

d. If the operator conducts regular oil analyses, use the silicon content of the most recent analysis and the overall silicon trend to further assess the possibility of induction system leaks or pilot operational issues such as extensive use of carburetor heat or alternate air during ground operation.

e. Identify induction system inspection requirements for the specific aircraft in service and comply with all requirements for inspection and maintenance of the induction system.

7. COWLING INSPECTION & COWL FLAP OPERATION CHECK

a. Verify that equipment such as add-on accessories and their associated hardware does not restrict cowl inlet, cowl outlet, and air flow through the cooling fins.

b. Verify cowl flap rigging and operation in accordance with the appropriate aircraft maintenance manual as applicable.

8. IGNITION SYSTEM INSPECTION

a. Check magneto timing and adjust to specification. Refer to the latest revision of TCM Service Bulletin MSB94-8A concerning magneto to engine timing.

b. Clean, gap and test spark plugs; replace as needed.

CAUTION: Always use new spark plug gasket. Failure to install a new spark plug gasket each time the spark plug (s) are installed may result in incomplete sealing of the combustion chamber, loss of spark plug heat transfer, spark plug over heating, possible pre-ignition / detonation and internal engine damage.

c. Inspect ignition harness leads for damage; replace as needed.

9. FUEL SYSTEM SETUP

a. Adjust fuel system in accordance with the latest version of TCM Service Bulletin SID97-3 concerning fuel system adjustment and STC instructions, if applicable.

b. Calibrated test gages, not aircraft gages, must be used and the published recommendations shall be followed.

10. AIRCRAFT ENGINE GAGE VERIFICATION

a. In addition to the verification of accuracy of the tachometer and manifold pressure gage required for fuel system setup, verify that the fuel flow, cylinder head temperature (CHT) and exhaust gas temperature (EGT) gages are providing accurate indications.

11. FLIGHT TEST

a. Refer to TCM Service Bulletin M89-7R1 for guidelines for initial operation and flight test after maintenance.

b. Conduct flight test as called for in TCM Service Bulletin M89-7R1.

c. Make adjustments as indicated by the flight test.

d. Follow the limitations and operating instructions provided in the Airplane Flight Manual or supplemental Airplane Flight Manual.

e. Under standard atmospheric conditions, typical full rich climb cylinder head temperatures should be 380 to 420 degrees F and oil temperatures should be 180 to 220 degrees F.

f. Under standard atmospheric conditions, typical lean cruise cylinder head temperatures should be 340 to 380 degrees F and oil temperatures should be 170 to 190 degrees F.

PILOT OPERATIONAL AWARENESS

In addition to the items contained in the TopCare Health Checklist, the maintenance facility should also provide the owner information concerning the following:

a. Rust - Refer to latest revision of TCM Service Information Letter SIL99-1 for engine preservation instructions. Frequent use for periods that ensure at least 30 minutes of flight operation after oil temperatures have stabilized is the best routine. DO NOT SUBSTITUTE GROUND RUNNING FOR FLIGHT OPERATION.

b. Lubrication - Use only oils approved for aircraft engines. Refer to the latest revision of TCM Service Information Letter SIL99-2 concerning recommended fuel and oil grades. Oil changes at intervals not to exceed 50 hours of operation (25 hours for engines with oil screens) or 6 months, whichever occurs first, is considered good practice.

c. Cooling Control - Follow the leaning recommendations and fuel flow limits in the Airplane Flight Manual or supplemental Airplane Flight Manual if an STC installation. Pilot control of fuel flow and cowl flap position to maintain temperature within the guidelines is recommended practice.

TCM LINK Aviator Services - This free owner information service provides direct exchange of information with TCM and provides reference information such as TCM service bulletins and FAA Airworthiness Directives related to specific TCM engines and ignition systems. Register for Aviator Services on-line in a matter of minutes; you may call the TCM Link Aviator Services Desk at 1 -888-TCM-LINK (826-5465) to register or you can register on-line, just go to http://www.tcmlink.com/registration/aviatorservices.cfm and receive the following programs available to you 24 hours a day:

Aviator Member & Engine Profile
TCM Engine & Ignition Service Bulletins
Scheduled Maintenance Checklists
Oil Analysis Tracking Program
Electronic Illustrated Parts Catalog
FAA Airworthiness Directives
Troubleshooting Guide & Technical Briefs
SB/AD Compliance Matrix

Summary of TCM TopCare Warranties

1. TopCare® CYLINDER WARRANTY

For complete TopCare cylinder warranty information and coverage see the latest revision of TCM TopCare™ Cylinder Warranty Form, X30684. You can also obtain a free copy of this warranty at our web site address http://www.tcmlink.com/warranty.html .

2. ENROLLMENT INTO THE TOPCARE® WARRANTY PROGRAM

Each new aircraft powered by an engine which incorporates the TopCare cylinder improvement package is covered and no enrollment is required. For other than new aircraft, enrollment into the TopCare Warranty Program must be accomplished by performing the initial TopCare Health Check at time of engine (or cylinder) installation and correcting any discrepancies. The initial TopCare Health Check Form must be completed, signed by the inspecting mechanic and returned along with the attached TCM TopCare Warranty Enrollment Form to:

Teledyne Continental Motors
Attn. Warranty Services
P.O. Box 90
Mobile, AL 36601
Fax Number 251-432-7352.

To maintain coverage, the TopCare Health Check Inspection must be performed annually and any discrepancies corrected at that time. The TopCare Health Check Form must be completed for each inspection, signed by the inspecting mechanic and retained by the owner for submittal to TCM with any warranty claim under the TopCare warranty.

Any FBO facility having all of the minimum tools required for performing the TopCare Health Check Inspection as identified on page 4 of this SID and the capability to properly perform the TopCare Health Check Inspection may contact TCM Service Department at 1-888-826-5465 and request that they be included on a list to be maintained by TCM to assist customers in identifying facilities capable of properly performing the TopCare Health Check Inspection. TCM reserves the right to audit both the equipment and capability of any FBO facility requesting to be included on the list and may require demonstration of capability and/or training for continuation on the list.

The aircraft owner/operator must select an FBO facility that has the equipment and capability to properly perform the TopCare Health Check Inspection. Any owner/operator desiring the name of an FBO facility in a particular geographic region having the equipment and capability required to perform the TopCare Health Check Inspection may contact TCM Service Department at phone number (251) 438-3411 or (888) 826-5465. Any FBO identified by TCM will be based upon information and representations provided by the FBO. The FBO's capability to properly perform the TopCare Health Check Inspection must be confirmed by the owner/operator prior to having the inspection performed. The expanded TopCare Cylinder warranty requires that the inspection be properly performed for warranty coverage to apply.

Table 2 – TopCare Cylinder Warranty Reference Guide

Type Warranty	Full Coverage Period	Type Coverage	Additional Coverage Period	Pro-rata Calculation
TopCare Cylinders. (Shipped prior to 8/1/99).①	12 Months or 480 hours, whichever occurs first.	Parts & Labor	Pro-Rated to TBO of engine or 48 months, whichever occurs first.	Actual hours or 25 hours per month, which ever is greater.
TopCare Cylinders. (Shipped on or after 8/1/99).①	12 Months or 1000 hours, whichever occurs first.	Parts & Labor	Parts only for 24 months or 1000 hours, whichever occurs first, after the initial 12 month period.	Not Applicable.
Existing Cylinders on Engines Covered Under Gold Medallion Warranty With Required TopCare Health Check Inspection.①	Per Gold Medallion.	Parts & Labor	*ENGINES* To TBO based on Actual hours or 40 hours per month whichever occurs first.	TopCare Cylinders Actual hours or 25 hours per month, whichever is greater.
Existing Cylinders on Engines Covered Under Gold Medallion Plus II Warranty With Required TopCare Health Check Inspection.①	Per Gold Medallion Plus II.	Parts & Labor	*ENGINES* To TBO based on Actual hours or 30 hours per month whichever occurs first.	TopCare Cylinders Actual hours or 25 hours per month, which ever is greater.
New Engines (shipped after 8/1/99)①	One (1) year or 1000 hours	Parts and Labor	Full Parts years 2 and 3, no labor, no pro-rated or 1000 hours	Not applicable
Rebuilt Engine (shipped after 8/1/99)①	One (1) year or 500 hours	Parts and Labor	Remainder of TopCare Cylinder Warranty①	Not Applicable

① For a full explanation of the TCM TopCare™ Cylinder Warranty Policy see page 22 of this bulletin "Summary of TCM TopCare Warranties" and our web site at www.tcmlink.com.

NOTE

On all engines other than those installed in new aircraft, the TopCare™ Warranty Enrollment Form must be received by TCM to validate the TopCare™ cylinder warranty.

TCM TopCare® Warranty Enrollment Form

Owner Name:	Aviator Services Membership #:	Date:
Address:		
City:	State/Country:	Zip Code:
Aircraft Registration #:	Make/Model:	S/N:
Engine Model:	Serial Number:	Position: L – R – S
Date Installed:	Time Since Major O/H:	Time Since Top O/H:
Engine Model:	Serial Number:	Position: L – R – S
Date Installed:	Time Since Major O/H:	Time Since Top O/H:

I wish to enroll in the TCM TopCare Warranty. I understand that TCM requires me to complete and maintain custody of periodic TopCare Health Checklist Forms for the purpose of proof of accomplishment for warranty and that TCM has no responsibility to review any of the forms submitted nor make any comment, recommendation or otherwise contact the owner regarding the contents thereof. The continued airworthiness of the aircraft remains the responsibility of the aircraft owner.

I understand that if I make a claim under the TCM TopCare Warranty, I will be required to supply a copy of each of the TopCare Health Checklist Forms to TCM at the time the warranty claim is made.

NOTE: Complete a copy of this form for each aircraft for initial TopCare enrollment. Return a completed copy of this TopCare Warranty Enrollment Form and the TopCare Health Checklist Form to:

Teledyne Continental Motors
Attn: Warranty Services
PO Box 90
Mobile, Alabama 36601
Fax Number 251-432-7352

Owner's Signature: _____

Date: _____

TCM TopCare® Health Checklist Form

Inspecting Agency: _____ Date: _____

Inspecting Mechanic: _____ Aviator Services Member #: _____
(As Applicable)

Aircraft Owner: _____

Aircraft Make/Model: _____ Aircraft Serial #: _____

Aircraft Year: _____ Registration #: _____

Engine Model: _____ Engine Serial #: _____

Engine Hours: Time since major O/H _____ Time Since Top O/H: _____

1. Differential Compression Check — Record Readings

1a. Master Orifice Reading ..... _____

1b. Record Differential Compression Values for Each Cylinder .....
#1 _____
#2 _____
#3 _____
#4 _____
#5 _____
#6 _____

2. Cylinder Bore Inspection — Check ☑ Inspection Results for Each Cylinder

	2a - Normal Wear	2b - Light Rust	2C - Heavy Rust	2d - Heavy Wear	2e- Scoring
Cylinder #1	☐	☐	☐	☐	☐
Cylinder #2	☐	☐	☐	☐	☐
Cylinder #3	☐	☐	☐	☐	☐
Cylinder #4	☐	☐	☐	☐	☐
Cylinder #5	☐	☐	☐	☐	☐
Cylinder #6	☐	☐	☐	☐	☐

3. Oil Consumption Trend Monitoring — Record Information

3a. Record Oil Consumption - One (1) Quart Every ..... _____ Hours

3b. Type of Oil Used ..... _____

3c. Record the Number of Quarts Added ..... _____

3d. Record Oil Change Interval ..... _____ Hours

3e. Sump Oil Strained and Filter Contents Examined and Found to be:
☐ Clean
☐ Light Material
☐ Heavy Material

4. Oil Analysis Trend Monitoring — Check ☑ as Applicable

4a. Oil Analysis Profile Established ..... ☐ Yes ☐ No

4b. Latest Oil Analysis Indicates ..... ☐ Normal Trend
..... ☐ Abnormal Trend

4c. Oil Analysis Sampling Initiated ..... ☐ Yes ☐ No

Oil Analysis Lab Used _____

5. Baffle Condition Inspection — Check ☑ as Applicable

- 5a. Baffles in Good Condition, Correct Position and Proper Contact ☐
- 5b. Replaced or Repaired Baffles ☐
- 5c Inter-Cylinder Baffles Installed Properly ☐
- 5d. Holes and Cracks Sealed ☐
- 5e. Cooling / Heating Duct Condition Correct or Repaired ☐

6. Induction System Examination — Check ☑ as Applicable

- 6a. Air Filter Clean and Properly Installed ☐
- 6b. Air Box Inspected and Repaired as Required ☐
- 6c. Alternate Air Door Sealing and Functioning Properly ☐

7. Cowling Inspection and Cowl Flap Operation — Check ☑ as Applicable

- 7a. No Restrictions in Cowling Inlet, Outlet or Cooling Fins ☐
- 7b. Proper Cowl Flap Rigging and Operation Verified ☐

8. Ignition System Inspection — Check ☑ as Applicable

- 8a. Magneto to Engine Timing Set at _____ Left and _____ Right Degrees BTDC
- 8b. Spark Plugs Cleaned, Gapped, Tested and Replaced as Necessary ☐
- 8c. Ignition Harness Inspected for Damage and Leads Replaced as Necessary ☐

9. Fuel System Setup — Check ☑ as Applicable

- 9a. Idle Unmetered Fuel Pump Pressure Set at _____ PSI at _____ RPM
- Idle Fuel Mixture RPM Rise at Idle Cutoff = 25/50 RPM ☐
- Full Throttle Metered Fuel Set at _____ GPH/LBS-HR at _____ RPM

10. Aircraft Engine Gage Verification

- 10a. Verified accuracy of Tach, MP, Fuel Flow, CHT and EGT Gages ☐

11. Flight Test

- Flight Test Performed and All Parameters Within Specification _____ _____ ☐

If Cylinder Repair or Replacement was Required Due to Results of the Preceding Inspections, Indicate Below.

	Low Compression	Rust	Scored	Oil Consumption	Other
Cylinder #1	☐	☐	☐	☐	☐
Cylinder #2	☐	☐	☐	☐	☐
Cylinder #3	☐	☐	☐	☐	☐
Cylinder #4	☐	☐	☐	☐	☐
Cylinder #5	☐	☐	☐	☐	☐
Cylinder #6	☐	☐	☐	☐	☐

Comments: _____

I hereby certify that I have performed the TopCare Health Check and any of the items identified above that required repair, replacement or verification have been repaired, replaced or verified. I also understand that TCM requires submission of this form for purposes of proof of accomplishment for warranty and that TCM bears no responsibility for the review or action on the actual details of this checklist form.

Mechanic's Signature: _____ Date: _____