piston engine aircraft

# Operation and Service Tips

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**Better Parts** make
**Better Engines**

RAM™

Fellow Pilots,

Proper routine service of your airplane engines and close attention to operations ultimately determines the success of owning and flying your airplane. As an engine overhaul and service center for both Beech and Cessna piston engine twins since 1976, RAM continuously makes every effort to share engine, service and operational information that can help you extend the life of your engines and make flying more reliable.

In addition to routinely reading and reviewing all the aircraft and equipment flight manuals associated with your airplane, we encourage you to review the enclosed information collected and documented by RAM for many years. Following the information presented in these brief operation and service tips may save you money and help ensure improved engine reliability and airplane performance.

Because RAM understands big bore TCM engines, we also understand the value of you having as much knowledge available as possible; thus, we provide some of the enclosed information just so you might better understand why some things happen when operating aircraft engines.

As you have additional questions about the subjects covered in this booklet, we encourage you to personally contact one of our experienced multi-engine pilots or customer service managers.

RAM wants to remind pilots that aircraft performance should always be calculated per flight environment, and the aircraft operated strictly per the Aircraft Manufacturer's Pilots Operating Handbook, including applicable Flight Manual Supplements for the airplane being flown.

Please talk to RAM when ordering your next engine overhaul, or when needing parts...whether new, PMA new or quality overhauled. RAM inventories thousands of parts ready for immediate shipment. Be sure to also ask for a free RAM Parts Catalog. It is illustrated and printed in color to help you better identify the parts you need and the many products we have available.

Visit our web site: www.ramaircraft.com

Sincerely,

The Staff & Management Team
RAM Aircraft. LP

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## Oil Pressure - The First Thing You Check

**Oil Pressure**
within 15 to 20 Seconds
Left Engine

**Oil Pressure**
within 15 to 20 Seconds
Right Engine

**Stop starting engines without oil pressure.** ***If no pressure, then stopping and immediately attempting a second re-start is even more destructive.***

### Pilots

**Attention should always be paid to oil pressure coming up at every start within 15 to 20 seconds. If you do not have a positive indication you must abort the start. Do not attempt another start until the problem is corrected.**

### Aircraft Mechanics

After an engine installation, oil pressure must be established on the engine prior to initial start.

### Oil Pressure Anomalies

All aircraft piston engines are subject to oil pressure anomalies, primarily due to a loss of prime that normally occurs after one of these:

- Engine Installation
- After an Oil change
- After Periods of Inactivity
- After Major Weather Changes

**Engines are especially vulnerable immediately after installation.**

### Installing an Engine - Avoid Internal Damage

- Attention must be paid to oil pressure anomalies. If not, internal damage and ultimate failure will occur.
- Pre-oiling with a pressure pot is recommended. With spark plugs removed, turning the engine through with the starter is an acceptable method, but use extreme caution around the moving propeller.
- Note: Bleeding the oil line from the engine to the oil pressure gauge at the fitting will help the gauge show real time pressure much quicker. While running the engine, have an assistant catch the residual oil in a cup at the gauge end. Dispose of properly.

**Oil Pressure - The First Thing You Check**

# Oil Recommendations

## Mineral Oil & Mineral Based Oils

Break-in procedures: RAM uses Mineral Oil.

Normal operations: RAM uses Mineral Based Ashless Dispersant (AD) oils.

### Ashless Dispersant (AD) Oil

Ashless Dispersant Oil could be written as Ashless and Dispersant Oil. There are two distinct features to remember about AD oil. Ashless stems from a requirement to clarify that the oil does not leave behind any ashes, or burning embers as it cleans. Decades ago in aviation history, oils that cleaned involved metallic cleaning particles that left embers. Such glowing metallic embers contributed to pre-ignition. Detergent oils have long since been removed from aviation piston engines. Aviation oils that clean are required to be Ashless. When an oil has Dispersant qualities, the particles created and removed by cleaning are suspended (dispersed) within the oil. Being dispersed, they are collected better by the oil filter. During the initial engine break-in period, RAM believes that AD cleansing is premature. RAM recommends a non dispersant Mineral Oil during the initial twenty-five hour break-in period of an aircraft piston engine, or replacement cylinder.

### Break-in Oil

Break-in procedures should be followed whether replacing one cylinder or six, and that includes using a Multi-Viscosity Mineral Oil such as SAE 20W-50 Phillips Type-M. The minimum break-in period should be considered at least the first twenty-five hours of operation (and can continue to as much as 100 hours depending on the cylinder bore material used). The oil should be changed as soon as oil consumption stabilizes, but no later than the first twenty-five hours of operation. At that time, oil should be changed to an Ashless Dispersant (AD) Mineral Based Oil.

### Single Viscosity -- Mineral Based AD Oil

RAM recommends Single Viscosity Mineral Based (AD) Oils such as: Aeroshell W100 and W100 Plus Antiwear (SAE 50 wt.) when typical ground level engine starting temperatures are not less than 40° F. When operating in colder environments Aeroshell W80 or W80 Plus Antiwear (SAE 40 wt.) and, of course preheating is recommended. [RAM service history records indicate that Mineral Based AD oils perform significantly better than synthetic and semi-synthetic oils.]


### Multi-Viscosity -- Mineral Based AD Oil

Differing operating conditions and / or availability may warrant the use of multi-viscosity oils. Most important to RAM is that the oil be mineral based. RAM recommends a multi-viscosity ashless dispersant mineral based oil such as Phillips 66 X/C 20W-50. [RAM service history records indicate that Mineral Based AD oils perform significantly better than synthetic and semi-synthetic oils.]

### Preheat

Preheat is recommended when engine starting temperatures are below 40º F. Preheat equipment can be purchased through numerous aviation supply companies, as well as through RAM's Parts Catalog.

### Oil & Filter Change

RAM recommends changing the oil every 25 hours or 4 months whichever occurs first. RAM prefers an oil filter change at each 25 hour oil change interval but certainly you should not exceed 50 hours before changing your filter.

Two major reasons for frequent oil changes are:

(1) Flush out metal particles.

(2) Flush out acid contamination.

Continued on the next page...

## Oil Recommendations

### Frequent Oil Changes

**• Flush out metal particles**

Both Lycoming and Teledyne Continental Motors (TCM) engines include parts that have a proven history of normal wear that deposits normal wear particles of metal into the oil. Oil filters contribute significantly to capturing these wear particles, but not as effectively as frequently changing the oil.

**• Flush out acid contamination**

With four-cycle gasoline engines it is an unavoidable fact that acids collect in the oil. Acids are formed when combustion by-products and unburned gasoline leak past (blow-by) the piston rings into the crankcase. Acids are corrosive. They cause rust as well as pitting of lifter faces. Acids are not removed by oil filters or by changing filters. The only way to remove acids is to remove the oil that has become acid contaminated.

### Oil Viscosity

Points made are well taken on both sides of the issue of whether to use single or multi grade oils. In the final analysis, you know that your aircraft is subjected to extreme temperature variations and starting conditions. Many aircraft fly frequently. Many aircraft don't fly enough. Successes and lack of successes, suggests there is simply not one viscosity that is always the best for all flight environments. In general RAM sees the following:

- Multi-Viscosity Mineral Based (AD) oil performs well in high usage airplanes.
- Single Viscosity Mineral Based (AD) oil performs well in high or low usage airplanes.

### Synthetic & Semi-synthetic *vs.* Mineral Based Oil

RAM service history records are much less favorable for engines that have a history of being operated on synthetic blends or semi-synthetic oil products. RAM encourages using Mineral Based (AD) Oils only, single or multi-viscosity as conditions require.



## Air Filters

*RAM recommends replacement every 12 months or 300 hours - whichever occurs first.*

Turbocharged fuel injected aircraft engines process large amounts of air. The air comes from the haze layers we occasionally fly through containing significant dust particles. A few areas of the country are especially dusty, and air filter changes are recommended every 100 hours in those environments. RAM has observed that the likelihood of premature engine wear can be minimized by paying attention to air filter condition. Following cleaning and inspection, the air filter may simply need to be replaced. In all cases, RAM recommends that air filters be cleaned every 50 hours. As applicable following inspections, air filters may simply need to be replaced.

RAM advises that air filters being used with RAM engines should be replaced every 12 months or 300 hours - whichever occurs first. A logbook entry is applicable. Not complying may damage the engine and be reason for reduced RAM warranty benefits. The FAA issued Airworthiness Directive AD 84-26-02 effective 1/29/85 regarding air filters. In it the FAA requires replacing the aircraft engine air filter every 500 hours. Such advise is the result of reports involving engine problems caused by disintegrated air filters. RAM believes that replacing the air filter every 12 months, or 300 hours, will increase engine longevity.

## Turbo Wastegates

Turbocharger wastegate and actuator assembly:

The turbocharger wastegate and actuator assembly is at least partially responsible for eighty percent of the manifold pressure related problems with today's turbocharged aircraft engines, yet very little preventative maintenance literature can be found on the subject of wastegates. Various troubleshooting guides generally ignore the wastegate when dealing with manifold pressure abnormalities. A TCM film strip training program is available that addresses the subject. It is recommended for maintenance personnel. Quite often, mechanics in the field make adjustments to the fuel injection and turbo controller components to compensate for problems that are actually partially or totally those of the wastegate.

Mouse Milk Penetrating Oil - Every 50 Hours:

RAM strongly recommends that the wastegate butterfly shaft and the wastegate actuator shaft be thoroughly lubricated with Mouse Milk penetrating oil every fifty hours, or at any time the manifold pressure seems sluggish. The Mouse Milk can be applied using a common oil squirt-can.
Mouse Milk penetrating oil is available at most aviation supply houses.


The manufacturer of Mouse Milk is:

Worldwide Filter Company • 1685 Abram Court • P.O. Box 1758
San Leandro, California 94577 • (510) 483-5122.
**Note:** Penetrating lubricants that work well on a short term basis can eventually hinder the wastegate operation after the initial penetrating effect has worn off. Mouse Milk has lasting lubricating qualities.

## Save-A-Turbo - Berryman's B12 Chemtool

Turbochargers are simple one-moving-part machines that provide immense increases in piston-powered aircraft performance and capability. Pressurization, pressurized heated air, and sea level horsepower at altitude are efficiently available for turbocharged piston engine aircraft. Turbochargers will usually last through the life of the engine with good maintenance such as: proper leaning, ample run-down time for bearing and lubricant cool-down, timely engine oil and filter changes. Since maintenance and operational practices are not always known qualities, the following is recommended on an annual basis to help keep the turbo bearings and seals clean. Following these steps may save your turbo from premature replacement.

- To apply B12, cap the turbo scavenge port and fill the turbo oil cavity with Berryman's B12 Chemtool.
- Cap the turbo oil supply port and allow the solution to remain in the turbo cavity for at least 24 hours. Turn the turbo through several revolutions by hand at least twice during the soaking process.
- After the soaking period is completed, drain the turbo cavity and flush with mineral spirits. Hook up the oil scavenge line. Prime the turbo cavity with a cup of engine oil and connect the oil supply line. The turbocharger depends on engine oil pressure for lubrication and cooling of the bearing and seals.
- Taxi at idle, or idle the engine for a minimum of three minutes before shutdown. This allows time to cool the turbo bearings and seals so as to minimize and prevent coking of the oil. Coking causes stuck bearings and results in a dragging turbo with probable oil leaks. This same procedure will often correct an oil leak at the compressor or at the turbine bearing seals. Berryman B12 is available at most Auto Parts Houses, or through RAM's Parts Catalog Sales Departnment.


For further information: Berryman Products, Inc. • 3800 E. Randol Mill Road
Arlington, Texas 76011 • 817-640-2376

## Pressurized Magnetos

*Out of Sight… Out of Mind?*

Magnetos, especially pressurized magnetos, require a consistent and routine approach to proper maintenance. Operating procedures and conditions for a particular magneto can and do vary greatly. Slick recommends an inspection every 100 hours, which is also consistent with the section of AD 88-25-04 pertaining to aircraft being operated for hire.

You should review the AD with your mechanic. It pertains to moisture within magnetos. The AD requires aircraft operating under FAR 91 to have the magnetos checked at each annual. The slick service manual calls for complete service of the magnetos every 500 hours. Slick warranty is void if the prescribed maintenance schedules are not followed.

Especially noteworthy are the 100 hour inspections of the magneto air supply filter. Slick recommends replacement of the air supply filter at 250 hours. RAM recommends that aircraft operating in salt air coastal environments have the filter replaced more frequently, such as at the regular engine oil change interval. RAM offers an improved in-line air filter which has a moisture drain hole and drain tube added. It is a Balston "microfibre filter tube." It is also available through RAM's Parts Catalog Sales Department as RAM P/N 1396-2. Overhaul of Slick magnetos is required at engine TBO or "when conditions indicate." This could be during one of the 100 hour inspections, or the 500 hour service. RAM's policy is to replace old magnetos with New Slick magnetos featuring numerous improvement benefits. These improvements are reviewed in RAM's Parts Catalog. Proper magneto overhauls involve close to two dozen parts, time consuming labor and exacting pressure testing. If necessary to field overhaul, it is approved by Slick only if all the prescribed items are replaced with Slick manufactured service parts; however, the Slick warranty does not extend to magnetos unless they are rebuilt at Slick.

RAM recommends following the prescribed service and maintenance outlined in Slick SB1-88, 5B2-80A and the latest issue of Slick's Maintenance & Overhaul Manual. RAM recommends installing new magnetos when extensive overhaul appears necessary.

## Shock Cooling

*Turbocharged and Fuel Injected Aircraft Engines*

Shock cooling is often thought of as a significant power reduction, aggravated by simultaneously dropping the nose, both causing the engine to cool rapidly and unevenly. The front of the engine is exposed to more cooling air than the rear of the engine. This is a frequent situation and certainly undesirable. However, there are two other forms of *shock cooling* that need to be understood. They are reduced power settings at full rich mixture, and excessive temperature variations during ground maintenance.

1. Reduced Power Settings
   - At reduced power settings during descent, approach, and landing, the fuel flow per horsepower increases. A full rich mixture results in excess cold fuel entering the hot cylinders. The result is rapid and uneven cooling in the area of the fuel injection nozzle. This condition can cause a crack between the fuel injection nozzle and the spark plug hole.
   - Corrective action is to maintain an acceptable lean mixture during descent and landing, usually 1200° F to 1400° F. This can best be accomplished using a range marked and calibrated E.G.T. There should normally be no need to fully enrichen the mixture until on the runway with the throttles at idle.
2. Ground Maintenance Uneven Cooling
   - Although running the engines on the ground with the engine cowling off for maintenance is more likely associated with poor cooling air distribution and heating, unfortunately it is also an unfavorable conditions for shock cooling. Rapid and uneven power testing causes uneven cooling. During a ground run, the cooling air is not being evenly deflected and directed around all the cylinders.
   - If you must make a brief ground run, consider a limit of two minutes at 1200 rpm, 400° F CHT, and 200° F oil temperature to be the maximum allowable. Power test runs should not be considered.
     For additional RAM recommendations, refer to RAM Maintenance Tip *"Ground Runs At High Power - Caution."*

# Engine Shock Heating During Takeoff

Conversations often center around "shock cooling." So what is shock heating?

Shock heating is the situation that exists when a pilot almost instantly applies full power to the engines as he begins his takeoff. It comes as quite a shock to the engines. Remember, the majority of engine failures take place during power changes - takeoff and landing. The pilot uses gear, flaps, speed brakes, gradual power reductions, and 1200°F to 1400°F EGT mixture settings to control shock cooling during rapid descents. RAM suggests the same degree of attention when applying takeoff power.

A rapid advance to takeoff power can be as hard or harder on the engines as shock cooling. Even at fast idle while the aircraft is taxied to the runway, the internal cylinder temperatures are only warm. Numerous engine components are not yet up to the heat and pressures of full power. The oil may be warm, but it’s still cool enough to be at a higher than normal pressure. This situation sends misleading feedback pressures to the internal engine control systems. It takes time for the engine systems to perform their function and to adjust for the heat.

Bursting into full takeoff power can be compared to spilling an entire pot of hot coffee on your legs *vs.* one small cup. Although both have the same temperature, the full pot of coffee contains a tremendous quantity of heat. Damage results anytime anything is forced to absorb a large quantity of heat quickly - rather than gradually. RAM acceptance and test pilots use the following takeoff technique to help smooth their transition to higher cylinder temperatures and system pressures.

- Always Assert Your Pilot In Command Authority To Ensure The Safe Operation Of Your Aircraft And Passengers.
- When lined up on the runway centerline for takeoff, hold the brakes and smoothly advance the throttles to 27-30 inches of manifold pressure. Allow the MP to stabilize 3-5 seconds. During that time, scan the engine instruments. Verify that they are normal.
- Release the brakes and smoothly advance the throttles to takeoff power manifold pressure. Remember, oil pressures and feedback signals to the controllers are adjusting as the temperatures rise. Pilots should allow engine systems time to function.
- Again, scan the instruments and make any necessary final throttle adjustments.
- Should an immediate takeoff be required upon arrival at the runway, the same procedures can be followed during the takeoff roll instead of holding the brakes - if runway length is suitable: partial power, stabilize, then full power.
- As you takeoff, cross checking fuel flow, RPM, MP and EGT is essential. It enables you to recognize and react to critical or premature instrument readings in a timely manner. Plus, it helps you remember the exact numbers when later communicating with your aircraft mechanic. Your aircraft mechanic needs to know specifics in order to effectively troubleshoot.
- Of further benefit, there should be no more surging and overboosting when using the above technique for smoother throttle advancement.
- Most importantly, smooth power increases will allow the cylinder combustion chambers to experience a more constant and orderly transition to the high temperature range of their design limits.

## Ground Run-Up at High Power

Ground run-ups of TSIO-520 series engines often occur during the process of adjusting the turbocharger, the prop governor, or the fuel injection system. The top cowl is usually removed. Ground runs at high power (with the cowl removed) increase the probability of cracked cylinder heads. The cooling air is not adequately being directed around and down through the cylinder head fins. The result is uneven cooling which causes damaging thermal stress in the cylinder head casting. It can happen quickly. The correct procedure for ground running an engine is the temporary installation of a partial top cowl, with only the aft portion removed. Such a configuration allows for access to make adjustments to the turbocharger and fuel injection systems.
Partial / fabric run-up top cowls are sold through RAM's Catalog Sales Department.
The fabric run-up cowling fits these models: Cessna T310, T320, 340, 340A, 402B, 402C, 414 and 414A.

If you must, RAM advises the following run-up limits when the top cowl is removed:

- Extreme Caution is essential anytime an engine is being run-up on the ground.
- At all times 400°F CHT and 200°F oil temperature are maximum allowable.
- Looking for fuel or oil leaks, limit run-up to two minutes maximum and 1200 rpm.
- Testing adjustments to fuel injection system or turbocharger should not be done with cowling off.
- With left nose cowl off to adjust governor, limit 1 to 4 seconds at high power.
- Cowling installed and cowl flaps open, no time limit within reason, keeping in mind that 400°F CHT and 200°F oil temperature is maxi-mum allowable.

## Protect Steel Cylinders

Steel cylinder refers to the barrel, or wall within the cylinder assembly. Although other RAM maintenance tips discuss the protection of the cast aluminum cylinder head assembly, it is also essential to maintain the integrity of the steel barrels, especially new steel barrels. After a major overhaul, new steel barrels need to be operated approximately fifty (50) hours to build up a deposit of varnish sufficient to offer protection against rust.

Unfortunately, right after major engine work it also seems like a good time to leave the aircraft out of service for new paint, new interior and avionics work. Anytime aircraft engines sit inactive, the steel barrels begin to rust as a natural result of the moisture in the atmosphere. This situation is even more serious in coastal areas or locations having high moisture.

The result of steel barrels rusting is pitting. With pitting comes a loss of compression and a loss of optimum power. The best method of preventing steel barrel rust is to fly the aircraft frequently. After an overhaul, try to fly the aircraft fifty (50) hours before taking it out of service for a long period of time. Subsequently, throughout the life of the engines, fly the aircraft at least once each week - long enough to reach normal operating temperatures. This is critical in order to ensure that all the moisture is vaporized.

Ground running the engines produces condensation and is not acceptable. Also remember, replacing just one cylinder still requires the same procedures and precautions as applicable to a new engine or fresh overhaul. See RAM Maintenance Tip *"Engine Break-in Procedures."*

Teledyne Continental Motors (TCM) has published Service Bulletin M84-10 Rev. 1, addressing this problem. It gives detailed information concerning the preservation of engines, especially during periods of inactivity. RAM recommends that all operators and mechanics read this bulletin and comply with it as applicable.

## WARNING - NO OIL PRESSURE - NO ENGINE

1. New and overhauled aircraft piston engines are subject to oil pressure anomalies, primarily due to loss of prime that normally occurs after one of these conditions:
   - engine installation
   - after oil change
   - after periods of inactivity
   - after major weather changes

2. After an engine installation, oil pressure must be established on the engine prior to the initial start up.

3. Attention should always be paid to oil pressure coming up at every engine start...within 15 to 20 seconds.

4. Extreme attention must be paid when the above mentioned conditions exist in order to avoid internal damage and ultimate failure of the engine.

5. Pre-oiling with a pressure pot is highly recommended. With the spark plugs removed, turning the engine through with the starter is also an acceptable method, but use extreme caution around the moving propeller.

6. Note:
   Bleeding the oil line from the engine to the oil pressure gauge at the fitting will help the gauge show real time pressure much quicker. While running the engine, have an assistant catch the residual oil in a cup at the gauge end.

## STOP CONTAMINATION
### DURING ENGINE, PROPELLER & ACCESSORY REMOVAL AND INSTALLATION

1. Follow exactly the applicable STC and Service Manual procedures for installation.
2. Used propellers must be flushed thoroughly.
3. Propeller Handling
   - Do not leave un-installed propellers open.
   - Cap off all oil inlets and threaded studs.
   - Ensure blades are well protected.
4. O-ring Installation
   - Verify the o-ring is installed.
   - Lubricate groove area.
   - Install on crankshaft flange evenly.
   - Verify groove area is not cut or scored.
5. Crankshaft and Propeller
   - Verify clean and lubricated.
   - O-ring area smooth.
   - Do not allow prop attach studs to cut or bind in the crankshaft holes.
   - Torque up prop evenly per service manual or propeller placard.
   - Safety wire the studs on Hartzell props. apply torque seal to studs and nuts.
6. Engine Installation Procedures
   - All re-used oil lines and hoses must be flushed.
   - The propeller governor must be flushed if re-used.
   - All other components such as the turbocharger, the turbo controller, the wastegate, and the air-oil separator canister must be flushed.
7. Engine RPM Fluctuations
   - If fluctuations occur, discontinue operation as soon as practical. Contact a customer service advisor.

**CRITICAL TO SAFETY**

- **Oil Pressure within 15 to 20 Seconds**
- **Stop Installation Contamination**

## Fuel Nozzle Head Cracks

Properly treated, fuel injector nozzles need not contribute to a cylinder head crack. However, an area where cylinder head cracks appear is between the threads of the fuel injector nozzle and the threads of the spark plug. The area is structurally irregular. It is a natural metallurgical environment for a crack to develop - when excess stresses are imposed. The pointed thread grooves allow stresses to concentrate. When irregular forces are applied to the fuel injector nozzle, they are transferred to the threads, which in turn leads to a concentration of forces and eventually a crack. The situation can be avoided. Refer to Drawings A, B & C.

### RAM Recommends The Following:

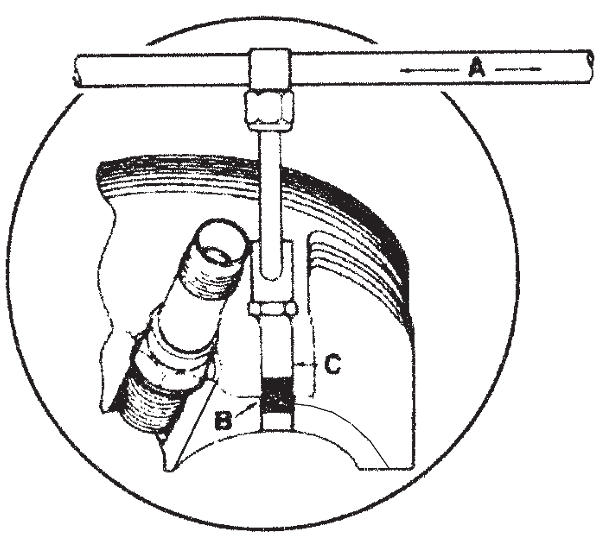
1. Do not apply external forces to the air reference line "A." See illustration below.
   The force is passed through to the fuel injector nozzle threads "B." See illustration below.

2. Do not over torque the fuel injector nozzle "C." It has a tapered pipe thread which exerts excessive stress the further it is tightened into the cylinder. See illustration below.

3. Cowling side doors should never be tied to the air reference line "A" during service work. If the cowling side door is to be tied to something, it can be tied to the large fuel injection line support brace. It is six to eight inches across and securely attached to the metal baffles of cylinders three and four. Never use the air reference line "A" as a place to tie the engine cowling back out of your way. See illustration below.

4. Fuel injector nozzles are only to be installed using a torque wrench. It is a RAM practice to torque the nozzle to 55 inch pounds. (TCM allows 55 to 65 inch pounds when using TCM Anti-Seize #646943 on the male threads only.)

5. When evaluating the significance of fuel stains around the fuel injection nozzle, consider these steps:
   a. Check nozzle to be tight between 55 and 65 inch pounds. Look for positive signs that a sealing compound was used.
   b. Remove and clean nozzle and threads. Use a soft and fine wire brush to avoid damage to the threads.
   c. Visually inspect the port area for cracks visible to the naked eye.
   Note: A previously welded area can present a metallurgical pattern change which is not necessarily a crack.
   d. Consider swapping the nozzle with one from another cylinder. They may both fit better.
   e. When reinstalling the nozzle, apply TCM Anti-Seize # 646943.
   Apply to the male surface only, then torque the nozzle to 55 inch pounds. Increase the torque to 60 inch pounds if required, and never more than 65 inch pounds. If the threaded area runs out, you should replace the nozzle.



# Manifold Pressure

## Induction & Exhaust Leak Checks

Before over reacting to a loss of manifold pressure at altitude, consider minor sources for leaks before replacing expensive components. Also consider the phenomenon of “Bootstrapping.” Cessna defines bootstrapping as "the unstable manifold pressure condition that occurs when the wastegate closes under high altitude and low RPM operation." In other words, it is the RPM below which the engine will no longer maintain cruise manifold pressure at altitude. This problem is frequently noticed when the pilot tries to operate the engine at low cruise RPM. Doing so reduces the available exhaust gases required to spin the turbocharger. Increasing RPM by as little as 25 RPM may be enough to restore desired manifold pressure.

Applicable Cessna Service Manuals outline a test normally entitled "Turbocharger Operational Flight Check Procedure" which allows the pilot and mechanic to determine if the engine is operating properly. Should the engine fail this test, many times the problem is a result of exhaust and/or induction leaks, not a faulty component. Normally, an inspection as outlined in AD71-09-07 R1 and AD75-23-08 R5, a simple leak check, and a repair of leaks can solve this problem. Such will save the aircraft operator from needlessly replacing costly components.

### To inspect the Exhaust system:

A. Plug overboard exhaust and wastegate overboard pipes (when applicable) with suitable plugs and/or tape.

B. Using a compression test adapter, pressurize a cylinder on the exhaust stroke with shop air. The exhaust valve should be open with the piston at the bottom of its travel. Use caution around the propeller while the exhaust system is pressurized.

C. Use a soapy water solution to inspect the entire exhaust system for leaks. Pay particular attention to weld areas in the turbo wye duct area, couplings, and turbocharger housing. Any leakage will be detected by soap bubbles and is cause for further inspection. Some very slight leakage is normal around sealless slip joints and exhaust risers. When testing sealless slip joints and exhaust risers, if the soapy water solution is being blown away (instead of bubbling) then the leak is excessive. The part needs to be inspected further.

D. Remove all plugs and tape at the conclusion of the test procedure.

### To inspect the Induction system:

A. Remove the engine induction air filter and tape over the turbo scroll area to prevent air loss.

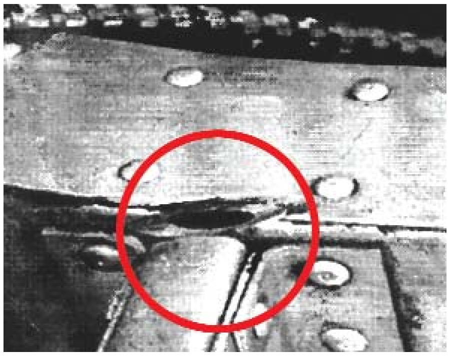
B. Using a compression test adapter, pressurize cylinder on the intake stroke with shop air. The intake valve should be open with the piston at the bottom of its travel. Use extreme caution around propeller while induction system is pressurized.

C. Use a soapy water solution to inspect the entire induction system for leaks. Pay particular attention to all intake manifold hoses, throttle body to intercooler connections, magneto pressurization (if applicable), air reference lines, and intercooler. The intake system should be leak free. Any sign of leakage should be inspected further. A nominal amount of leakage may be present at the butterfly shaft on the throttle body. Pay particular attention to the intake manifold hose body, in addition to the clamp sealing area. These hoses have a tendency to deteriorate due to heat from the exhaust system. Many times they can be found to be leaking through the middle of the hose body. Examine induction flex elbows closely for cracks or holes that have been chafed into them. Intercooler to throttle body "0" rings will also deteriorate due to heat. Such deterioration can cause leakage. Any leakage noted in these areas requires replacement of the hoses or "0" rings. Leaking alternate air doors and transition ducts should be inspected. They can be a source of hot engine compartment air being ingested into the engine instead of the cooler outside air. Hot air can cause a decrease in performance very similar to an induction or exhaust leak.

D. Remove all tape. Reinstall the filter at the conclusion of your test procedure. Should these simple tests prove the exhaust and intake systems to be secure, then further troubleshooting is appropriate. The aircraft mechanic can proceed to determine which major component needs replacing.

## Avoid Engine Beam Damage

Improperly secured propeller cables can cause major damage to engine beams. The FAA issued Exhaust AD 2000-01-16 regarding potential exhaust damage and applicable inspections of engine beams. It applies to the majority of all Cessna piston twin aircraft. In that AD, the significance of engine beam damage from exhaust leaks is made clear, yet similar critical damage can also be taking place due to the wear caused by propeller cables. While performing the exhaust damage inspections, it is a good time to check for propeller cable wear.



Care taken when installing a propeller cable can help avoid expensive future damage requiring an engine beam replacement. RAM Service Managers have observed several incidents of propeller cable related beam damage on aircraft arriving at RAM for engine installations. The stainless steel cable housing can cut/saw completely through the engine beam if left neglected long enough. See photo at right. This kind of damage can require replacement of the entire beam, costing thousands of dollars.

Help avoid this damage opportunity. Properly securing the propeller cable during initial installation is essential. The use of firesleeve over the cable housing will also help protect the beam and prolong the life of the cable. Even with firesleeve installed, the entire cable crossing and sleeving should be recurrently checked and corrected as necessary.

## Protect Heat Exchangers

Heat exchangers must be protected while other services are being performed on the aircraft. Intercoolers, oil coolers, air conditioner condensers, and the radiators on liquid-cooled engines are all subject to becoming clogged with dirt, dust, paint, paint overspray, paint stripper residue and dry paint stripper beads.

Heat exchanger fins are very small and closely spaced. When they become clogged, heat exchanger performance can be severely impaired. The result is overheating of the air, oil, or coolant involved. The further consequence is loss of a component, an engine, or aircraft performance. Sustained abuse can result in permanent damage to all equipment involved.

To ensure efficient heat exchanger operation:

1. During Stripping and Painting:
   The heat exchangers must be masked during paint stripping and painting operations. Caution: If paint or paint overspray gets on a heat exchanger, it may be impractical to remove the paint thus requiring replacement of the heat exchanger.

2. Inspection:
   At each 100 hour inspection (or more often if there is cause to suspect contamination) visually inspect air passages of heat exchangers for trash, dust, dirt, bird nests, and other debris.

3. Dust Removal:
   To remove dust and dirt, wash heat exchangers with hot soapy water and rinse with hot water.

4. Annual Inspection:
   At annual inspection, flush the radiator air passages with MEK. Flush the oil cooler and intercooler air passages with hot soapy water followed by a hot water rinse. Note: Solvents other than MEK may leave a film residue which will collect dust and further clog the heat exchanger fins.

## Replacement Cylinder Break-in Flight Procedures:
## RAM Nickel Process Cylinders - One Flight Only.

- When even one cylinder is replaced, the replacement cylinder must be broken-in with the same care as was given to all the original cylinders when the engine was broken-in the first time in the engine test cell.
- Break-in oil, break-in procedures should be followed whether replacing one cylinder or six, and that includes using a Multi-Viscosity Mineral Oil such as SAE 20W-50 Phillips Type-M. The minimum break-in period should be considered the first twenty-five hours of operation. Turbocharged engines typically break-in sooner due to higher peak cylinder pressures. Therefore, the oil should be changed as soon as oil consumption stabilizes, but no later than the first twenty-five hours. At that time, the oil should be changed to an (AD) Ashless Dispersant Mineral Based Oil.
- ONLY ONE BREAK-IN FLIGHT IS REQUIRED.
- There should be a replacement cylinder break-in flight based upon the following steps.
- Information presented in this maintenance tip is as performed by RAM when breaking-in a TCM TSIO-520, GTSIO-520 or IO-520/550 replacement nickel process cylinders.
- The cylinder break-in flight should be performed in day VFR conditions.
- FULL POWER SHOULD ALWAYS BE USED AS REQUIRED IN THE EVENT OF AN EMERGENCY.
- Avoid excess weight. Required Crew Only.
- Ample runway length and environmental conditions are considered essential, and are the responsibility of the pilot in command.
- Keep initial ground run to a minimum, only long enough to verify no fuel or oil leaks prior to the break-in flight.
- Handle radio and flight plan work prior to engine start.
- Once the engine is started, remain in motion for maximum air flow through the cowling to support engine cooling.
- DO NOT GROUND CYCLE THE PROPELLER.
- Perform "Before Takeoff" check list during taxi - as practical. If landing traffic requires you to hold before taking position on the runway for takeoff, face into the wind in the run-up area.
- DO NOT GROUND CYCLE THE PROPELLER. Prop cycling induces excessive pressure on the new replacement cylinder.
- FULL POWER SHOULD ALWAYS BE USED AS REQUIRED IN THE EVENT OF AN EMERGENCY.

## The Replacement Cylinder Break-in Flight:
## First 15 Minutes and Initial Stages - One Flight Only.

- DO NOT GROUND CYCLE THE PROPELLER.
- Apply power slowly and smoothly.
- Limit manifold pressure to 30" inches for TSIO/GTSIOs and full power for IO engines.

1. First 15 minutes of departing the airport: (Cowl flaps - open)
    - MP remains: 30" MP.
    - RPM: Takeoff redline.
    - Fuel Flow: Full Rich

2. After first 15 minutes, rotate RPM during the cruise climb every 5 minutes between full redline RPM and climb power RPM. Set Manifold Pressure as recommended for climb on IO engines. MP remains at 30" for TSIO and GTSIO engines.

    - FULL POWER SHOULD ALWAYS BE USED AS REQUIRED IN THE EVENT OF AN EMERGENCY.

3. When appropriate altitude is reached, set up 75% power @ 100°F - Rich of Peak. Cruise for approximately 45 minutes, rotating rpm every 5 minutes in increments of 100 rpm within your recommended cruise rpm range.

Continued...

## Replacement Cylinder Break-in Flight Procedures: RAM Nickel Process Cylinders - One Flight Only.

### Replacement Cylinder Break-in Descent and Return to Base:

- Advance props to 2700 rpm on TSIO and IO, or 1900 rpm on GTSIO. Slowly reduce the throttles to 23" inches Manifold Pressure on TSIO-520, or 25"on GTSIO-520 engines and as required on IO-520/550 for descent.
- Lean the mixture to maintain approximately the same EGT as demonstrated during the cruise break-in period.
- Adjust airspeed as required to maintain 300 fpm to 500 fpm rate of descent through the landing approach.
- Full rich mixtures should not be necessary until the aircraft is on the ground.
- **FULL POWER SHOULD ALWAYS BE USED AS REQUIRED IN THE EVENT OF AN EMERGENCY.**

### Post Break-in Flight and Future Flights:

- After completing the above break-in procedures, the replacement cylinder break-in flight is finished. All future flights may be flown as normal.
- Inspect for leaks. Review the flight data with your aircraft mechanic. Correct accordingly.

## Prevent Exhaust Leak Damage

Engine beams and canted bulkheads are victims of the corrosive action of exhaust. The damage is severe. Usually, it could have been prevented. So often the concern for the immediate consequences of an exhaust leak center around fuel and oil lines, but the long range concern is structural damage to the engine support structure. Aircraft owners and mechanics are aware of the corrosive nature of hot exhaust on the bottom of the wings and in the flap area. The same thing happens to an engine beam when subjected to exhaust leaks.

When performing exhaust leak checks, be sure to examine the adjacent air frame structures. Using solvents, thoroughly clean the structures. Look for damage in the form of distortion, buckling, pitting or flaking of the aluminum. Check for missing rivet heads. Inspect the inboard and outboard engine beam assemblies as well as the canted bulkhead.


Engine Beam Damage

Check the aft web, the structure on which the turbo mount is attached. Also, inspect the cap assembly and web for heat damage. These areas are subject to high temperatures. Even if not yet exposed to exhaust leaks, they may be damaged due to their proximity to extreme temperature. The corrosive effect of a future exhaust leak will thus lead to greater damage and the potential for structural failure. For further information on exhaust hazards and leak checks, consult FAA Airworthiness Directives AD71-09-07R1 and AD75-23-08R5.

## Sealless Exhaust Slip Joints

*Exhaust Slip Joints Need Lubrication*

Sealless Exhaust Slip Joints are not permanently lubricated. RAM recommends lubricating sealless exhaust slip joints at Annual Inspection and anytime they are removed for other engine work. Lubricate them immediately if they are suspected of binding.

Essentially maintenance free when compared to the older style slip joints, sealless slip joints still need lubrication. Lubricating a few sealless slip joints is still a bargain when compared to the expense of re-packing the carbon type seals or replacing the bellows units. When sealless exhaust slip joints are left unattended, the consequence can be binding. Binding leads to increased engine vibration being transferred throughout the airframe.

While lubricating, always inspect the slip joint units for freedom of movement and no distortion. To lubricate properly, separate the two halves and clean them thoroughly. Coat both sealing surfaces with Never-Seez compound, or an equivalent anti-seize compound. Never-Seez compound contains fine particles of nickel, graphite and other additives.

Never-Seez is manufactured by: Bostik in Middleton, MA 01949.
Bostik Catalog number is NSN165. It is sold in a 1 lb. can.
Never-Seez is also sold through RAM's Parts Catalog.

## Oil Content Reports

Should I use oil content reports? RAM reminds aircraft operators that one report, especially one deviation from normal report, is not necessarily sufficient reason to become alarmed. There are a number of considerations associated with taking an oil sample as well as preparing the report; plus, there are a number of mechanical considerations associated with estimating engine reliability.

Background: Certain parts of both Continental (TCM) and Lycoming engines, such as rocker shafts and piston rings, typically wear and deposit small quantities of normal wear particles in the oil. It is a function of engine design.

The Oil Content Report Sample: The quality of the oil sample has a great deal to do with the report. The individual taking the oil sample should use caution not to take the first oil out of the drain, because the majority of the wear metals could have settled to the bottom of the oil pan. Such a procedure could result in an erroneous reading of the metal concentration. In addition, oil samples should only be taken from hot oil. Preferred engine warm-up should be done slowly, beginning at idle RPM for a brief period limiting idle to 1200 RPM. If a dip tube is used, it must not make contact with the bottom of the oil pan where concentrations of wear metals are likely to be exaggerated.

How much is too much? What is considered a high concentration of wear metal particles? Remember, an oil content report is measured in parts per million (ppm). Imagine a truck filled with 1,000,000 baseballs. If 20 of them have a flaw it is listed as 20 ppm. Many engines have remained in service through TBO, even though they had one or more abnormal metal particle reports.

Recently overhauled engines: May have higher than normal metal particle reports; however, most laboratories are aware of these situations and usually make appropriate adjustments to their reports when so advised of the recent overhaul.

## Detonation is Expensive

*Prevention Requires Proper Fuel Flow During Takeoff*

Detonation is the almost instantaneous release of heat energy from fuel in an aircraft engine. It is caused by the fuel and air mixture reaching its critical pressure and temperature. An explosion takes place rather than a smooth burning process. Detonation will cause premature cylinder damage, primarily in the valve train area. Severe cases of detonation will actually cause piston melt-down. Detonation can be avoided with proper attention to takeoff power fuel flow.

At RAM, we have noted that many Cessna T210 and T206 fuel flows have been adjusted downward to alleviate the possibility of an over-rich condition during the initial stages of the takeoff. An aircraft mechanic has been instructed to set the engine adjustments such that when the pilot places the panel mixture control full forward and applies takeoff power, the fuel flow goes up to red line only, rather than go over it slightly.

This *just right* situation is temporarily satisfactory, but shortly after rotation while climbing, the engine starts to reach in-flight operating temperatures. This is where detonation will occur. When the fuel flow (at full rich panel mixture control) is set to be *just right* during a ground run, the engine will be lean 10 lbs. to 20 lbs. once in-flight operating temperatures are reached. The elapsed time in attaining these temperatures will vary according to atmospheric conditions. Note: It is not possible to simulate in-flight temperature distribution on the ground.

To ensure proper fuel flow at all times, the pilot must be included in handling fuel management. The panel mixture control, at full rich, should permit fuel flow to exceed red line by several gallons. The pilot then has the latitude to add fuel or reduce fuel to ensure 186 lbs./hr. (32 gal/hr) is attained and maintained during takeoff power.

This pilot-in-control procedure is in conformity with the Cessna Owners Manual, which states *"On any takeoff, the manifold pressure should be maintained and throttle set to provide 36.5 inches Hg. Then for maximum engine power, the mixture should be adjusted during the initial take-off roll to 186 lbs./hr."* RAM considers it essential that all pilots follow the recommendations of their Cessna Owners Manual.

A related subject is the propensity to over boost during the takeoff roll (exceed 36.5 inches of manifold pressure). This is caused by less than in-flight operating temperature of the oil in the wastegate actuator. It takes time for the engine systems to absorb and react to the heat that is being added so quickly. Pilot adjustments of the manifold pressure, during the early stages of takeoff, are considered normal and proper at RAM. The 310 hp Cessna Owners Manual for a Cessna T206/T210 can be valuable in helping you attain a good service life from your engine. Also, please see RAM Maintenance Tip *"Shock Heating During Takeoff."*

## Spark Plugs - Fine Wire *vs.* Massive

For turbocharged piston twins flying at high altitude, fine wire spark plugs are more effective at igniting a fuel air mixture. They induce less strain on the magnetos and simply prove to last longer.

Operators have advanced their conviction that certainly a set of fine wire plugs are good for 1,000 hours. Other operators have suggested even longer periods. We note that since advising operators of our 350 hp liquid-cooled engines to switch to fine wire plugs, our service managers do not recall any customer contacts regarding ignition performance at altitude.

There are two primary reasons why fine wire plugs are more effective than massive plugs. First, the massive electrode's shear size shields its own spark from some of the fuel / air mixture around it. The result is less than even ignition which is less efficient. Second, the iridium alloy used in the fine wire plug allows the use of a larger spark gap. The larger gap results in a hotter more powerful spark.

Continued on the next page...

continued...

## Spark Plugs - Fine Wire *vs.* Massive

Further, the gap of any electrode is vulnerable to erosion and melt down. The massive plug is especially susceptible due to the medium melting point alloy used in manufacturing it. The alloy has a tendency to erode at a less than cost effective rate, when compared to the longer life of the fine wire electrode. (In both cases, comparison is made when the spark gaps are set for optimum performance.)

Durability is also achieved with proper inspection, cleaning and gapping, when done in accordance with the guidance published by Champion Spark Plugs and Autolite® Aviation Spark Plugs by Unison. For example, following proper maintenance procedures, Auburn Spark Plugs Corporation advertises their plug life to be 400 hours for their Massive plugs (medium temperature alloy) and they suggest 1200 hours for fine wire spark plugs (high temperature alloy). However, without periodic re-gapping (typically done at 100 hour inspections) spark plug life may be reduced to half those recommended numbers.

RAM flight test data shows fine wire spark plugs to be 2.2% more efficient than massive electrode spark plugs. The TSIO-520-NB engine at high cruise or climb power (232 hp at 2400 RPM; EGT at Peak +100°F rich @ 10,500 ft.) yielded a Brake Specific Fuel Consumption of .498 for Fine Wire and .509 for massive plugs (BSFC = lbs. of fuel/hp/hour) (Both spark plugs had the same gap settings of .018 inches). The 2.2 % fuel savings (.498 *vs.* .509) could vary with other engine models. Fuel savings of 1% on various other engines seems a reasonable expectation. After testing fine wire spark plugs, and after noting the added efficiency, RAM recommends fine wire spark plugs.

## Avoid Over-Servicing Engine Oil

*TSIO-520 & GTSIO-520 Engines*

If soon after shutdown you add oil to your engine in an effort to get the oil quantity/level indication back up to the full mark on the dipstick, you will most likely be over-servicing your GTSIO-520 or TSIO-520 engine. In some cases, by as much as 2 quarts. At such a higher oil level, during your next flight the crankshaft accessory drive gear (that projects below the top of the oil surface in the oil pan) will revolve through the surface of the oil and make vapor. The vapor will exit through the oil breather system and thus be spread over areas of the aircraft. To avoid such mess and reduce the anxiety of blowing oil vapor overboard, (concerned that you are using oil), these six oil servicing guidelines should be followed:

1. Aircraft should be as level as possible when checking the oil. Use the same level area, as often as practicable, when checking oil at your home airport.
2. Properly install the right-hand dipstick in the right-hand engine, and the left-hand dipstick in the left-hand engine. There is a difference between the two--allowing calibration for the different engine cant angles.
3. Note and mark the dipstick's top orientation after properly servicing the engine with a known quantity of oil. Maintain that orientation throughout future oil checks. Readings can vary by as much as 1/2 quart simply by having the dipstick's orientation 180° in error.
4. Calibrate each dipstick. Immediately after draining the oil completely, add back your normal operational quantity of oil; for example, 10 quarts. Insert the dipstick and note the oil level indicated. Often off as much as 1 or 2 quarts, the dipstick may indicate 8.5 quarts. In the future, remember that such 8.5 quarts level represents the 10 quarts level.
5. Measure oil drain-down quantity. Do so by measuring the oil quantity immediately after shut down, then again 12 hours later. Note the increased indication of oil level after the 12 hour period--typically due to oil draining from the oil filter, the oil cooler and engine oil passages.
6. For long flights, especially over water, service the engine to its full capacity. Knowing that at full capacity some oil will be blown overboard, expect to wipe off the airframe accordingly without becoming anxious about seeing excess oil.

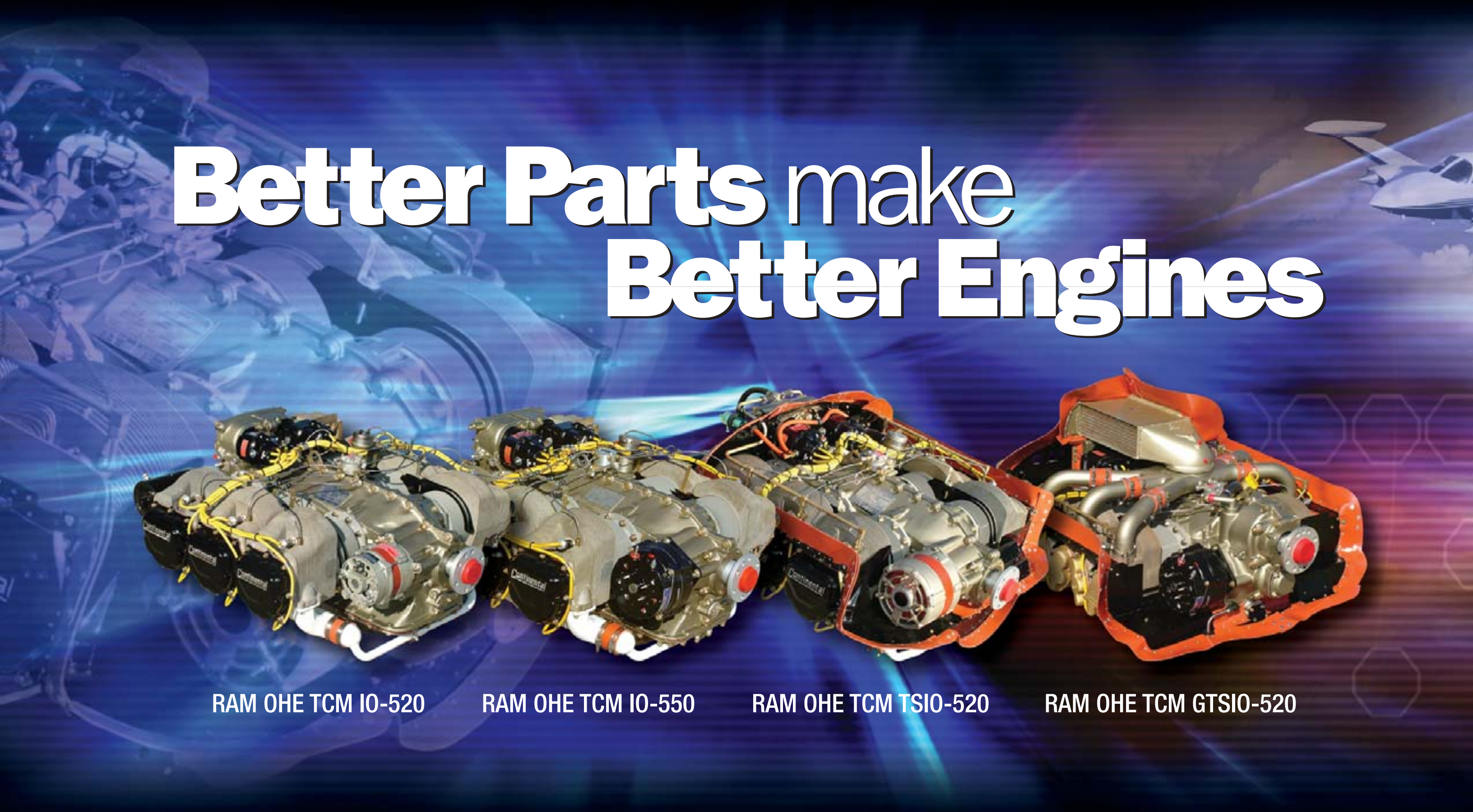
## Mixture Management - Cruise Operations

RAM has maintained a long standing position on mixture management at cruise power, which has always been to operate the engine(s) at rich-of-peak (ROP) as opposed to operating at either Peak, or Lean-of-peak (LOP). A rule of thumb for TCM 520 Series engines has been: at 75% power set mixtures 100° rich-of-peak; at 65% power set mixtures 75° rich-of-peak; at 55% power set mixtures 50° rich-of-peak for all cruise operations. Such mixtures will increase the life of the exhaust system, turbocharger, engine valves and rings, reference Cessna Model 340A POH, Section 4, Normal Procedures (amplified procedures), page 4-21, issued 1, Nov. 1977, Revision 1 - 1, April 1978.

This RAM recommendation includes all engines overhauled by RAM. Additionally, RAM OHE engines operating under a RAM Supplemental Type Certificate (STC) are FAA approved to operate only on the rich side of peak (ROP) in accordance with FAA Approved engine calibration, 150 hour engine endurance, durability, and detonation testing conducted by RAM under 14 CFR Part 33, Sections 33.45, 33.47, 33.49, and 33.19.

RAM is aware that some aircraft engines are designed and have FAA approved procedures to operate at lean-of-peak settings, and RAM knows that there are advocates for LOP operations whenever balanced fuel nozzles are installed. RAM supports the installation of balanced or matched fuel flow nozzles, but does not, in fact cannot, condone or approve their use to operate an engine at an unapproved mixture setting. RAM's position is that LOP is not suitable for all airplanes, engines, or pilots. A major engine manufacturer has made a point that it only takes a brief episode of mis-management to bring about deep internal damage, and they point out that pilots don't always realize when it happens, since their engine continues to operate. They suggested that lean-of-peak can be akin to operating on the edge, and that doing so requires pilots to be very precise, have good instrumentation, and watch their engine mixture and throttle full time. RAM agrees.

RAM reminds pilots that mis-management at LOP settings can cause both dynamic stresses and thermal stresses that hammer main and rod bearings, burn pistons, burn valves, and cause cumulative exhaust system damage. RAM encourages pilots wishing RAM would recommend other than (ROP) rich-of-peak to research the numerous White Papers and Engine Manufacturer's Publications addressing the advocacy issue of LOP *vs.* ROP. RAM reminds it's customers and friends in General Aviation that mixture management of a turbocharged Cessna 414A at FL230 is more demanding than the mixture management required of a normally aspirated Cessna 210 at 9,500 feet. Again, RAM cannot recommend LOP operation for any aircraft piston engine not authorized to do so by its manufacturer or an appropriate FAA approved flight manual supplement (AFMS).

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