Title: **BREAK-IN INSTRUCTIONS FOR ENGINE OVERHAUL OR CYLINDER REPLACEMENT**

Technical Portions are FAA DER Approved.

1.0 **PURPOSE**: To establish Break-In Instructions for engine overhaul, cylinder replacement, filtration and lubrication.

2.0 **Critical Precautions for New and Overhauled Engines**

Airplane owners, builders of aircraft engines, and component suppliers such as Engine Components, Inc. have a mutual interest in engine break-in. All want the engine to perform and give long and satisfactory service life.

CAUTION: *If your engine has been carefully overhauled to airworthiness standards, it should provide excellent service if certain steps are taken by the mechanic making the installation and the pilot(s) operating the airplane. Following is a list of causes for an aircraft engine to fail early in service, and suggested procedures to optimize operating life and safety.*

When an engine fails to give satisfactory service, it is frequently due to: unseated piston rings due to improper break-in, uneven cooling due to improper baffling, poor fuel distribution, incorrect timing, damaged or perforated piston heads caused by detonation or preignition, piston scuffing or seizing usually caused by overheating or unseated rings that allow blow-by to displace the oil film between the piston and cylinder bore, bearing and crankshaft wear caused by under-lubrication or dirt, excessive piston and cylinder wear caused by dirt, ineffective air filtering or excessively rich or lean-air-fuel mixture.

We Strongly Recommend These Precautions:

1. Pressure oil the engine before the first start-up after the engine has been installed in the airplane. There are numerous systems that will accomplish this task, which range from homemade to sophisticated production equipment.

   Unfortunately, pressure oiling does not lubricate cylinders, pistons and rings. Therefore, ECi recommends that spark plugs be removed and the cylinders themselves should be oiled before start-up. If the engine is equipped with a spin on type oil filter, it is beneficial to fill the oil filter with engine oil before start-up. The filter must be properly installed, torqued and safety-wired. All pre-oiling equipment and activities must be maintained and performed in a manner that does not introduce contaminants into the engine.

2. Proper air-fuel ratio is vital in today's engines. Be sure the carburetor or fuel injection system meets the manufacturer's specifications. Air seepage in the intake system can cause lean air-fuel ratio which causes detonation. A defective compressor in a turbocharger can produce excessively hot air to the cylinders which reduces the combustion detonation margin, inhibit cylinder break-in, increase blow-by, etc.

3. The ignition system supplied with the engine should be checked and the system tested. Particular attention to the points and "E" gap setting is warranted. Magneto timing to the engine should be set and verified according to approved data.

4. Be sure to use spark plugs of the correct heat range and gap as specified by the engine manufacturer.

5. Check all fuel and oil lines for security and leaks. All hard lines must be adequately supported to prevent fatigue. Make sure that check valves are installed properly. Insure that heat protection for the fuel and oil lines is correctly installed.

Corporate Office • 9503 Middlex • San Antonio, TX 78217 • Tel (210) 820-8100 • Fax (210) 820-8103 • 800-ECi-2FLY (800-324-2359)
www.eci2fly.com • sales-service@eci2fly.com • FAA Repair Station #AG2R689K
Airmotive Steel, Classic Cast, CermiNil, Cermicrome, CermiSteel, Double Band, Engine Redi, Electro-Fusion, EC Focus, Freedom, IFR, Nerodize, Q3, Q4, Q5 & TITAN are Trademarks of ENGINE COMPONENTS, INC.

6. **NOTE:** *Do not put Textron Lycoming oil additive P/N LW-16702 in O-320H and O/LO-360E engines for break-in. This oil additive will inhibit break-in so it should only be added after break-in has occurred. (See Lycoming S.I. No. 1014M Part II.B)*

7. **IMPORTANT:** *Replace oil filter or check and clean oil screen. Thoroughly check all engine accessories and installation.*

8. Always preheat the engine in weather 30° F or less.

9. Always use caution around the propeller.

10. Heat is both the source of power and the enemy of an engine and is definitely worse during the early stages of break-in. Careful inspection, adjustment, repair, etc. of the cooling system (cowling, baffles, etc.) is essential for every new installation or top overhaul.

11. Should you encounter problems, refer to ECi Service Instruction No. 89-5-1, "Engine Trouble Shooting Guide". To receive a copy, call Customer Service at 1-800-ECi-2FLY or go to our website for a complete listing of Service Instructions at http://www.eci2fly.com.

3.0 Run-In vs. Break-In

Typically, most engine overhaul shops run-in all opposed engines for a period of 1 to 2 hours prior to release for installation. However, this run was never intended to be a break-in run. The objective of the run-in test is to:

1. Prove that the engine will produce rated power.

2. Correct any oil, fuel, or induction leaks.

3. Check general operation of the fuel system.

4. Allow engine oil pressure to be set.

5. Provide initial stage of break-in.

After run-in, the engine is released to the installer who deals with installation, baffling, fuel settings, additional break-in and other unique considerations which can only be dealt with on the actual airframe where this engine is to operate.

We recommend these procedures to run-in an overhauled engine in a test cell or when using a properly designed shroud similar to the one shown in the photograph on the next page.

NOTE: *The following information applies to all types of cylinder bores*:

STEEL/CAST IRON - Plain, nitrided, through hardened
CHROME - Porous, silicon carbide impregnated
NICKEL COMPOSITE - CermiNil® process or Nickel+Carbide™

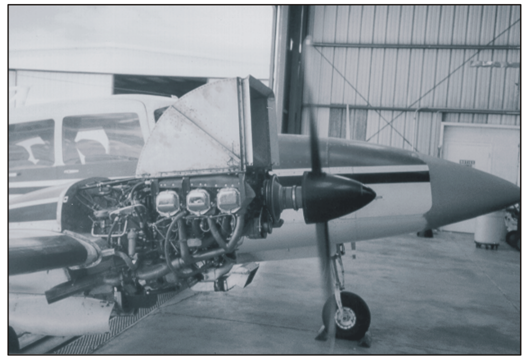
1. Regardless of technique used, the major consideration during run-in is adequate cooling of the cylinders and oil. Inner cylinder baffles must be used to assure that the cylinders are cooled on the down wind side as well as the side facing the cooling air. The shroud and baffles must be appropriate to the type engine and propeller to be used. Test club type propellers are generally much shorter than flight propellers, and force the air close to the engine. When using a flight propeller for run-in, the shroud should be much taller to capture as much cooling air as possible.

2. Forced air cooling systems used with dynamometers must provide all the cooling air required during the run-in test and should be able to maintain cylinder temperatures below 400°F. (204°C.) at any point in the process. Inner

cylinder baffles are normally required, and the cooling system should be capable of maintaining at least 6 inches of water static pressure differential between the cooling air intake and outlet.

3. Engine operation parameters for test cell run-in are provided in the engine manufacturer's overhaul and service data. Engine Components, Inc. recommends that the operator follow the procedures established for the specific type of engine being tested.*

***CAUTION**: *The operator should be aware that the porous type chrome plated cylinder bores have more critical cooling requirements than other cylinder bore surfaces.*



Example (Run-in using cooling shroud)

Engine Components, Inc. recommends the use of a test stand or cell with appropriate test clubs and shrouds or forced air cooling. However, carefully followed procedures can provide adequate run-in on an airplane. We must caution, however, that run-in on an airplane entails some risk that should be considered by the overhauler/installer. In addition to the risk due to test flying, overheating the engine on the ground must be considered by the overhauler/installer. In some cases of extreme engine overheating, the pistons will expand to a diameter larger than the cylinder bore, and will result in severe scoring**. Overheating of the cylinder barrel during run-in is not always indicated on cylinder head temperature gauges before the damage has been done because the thermocouple is on the head rather than the barrel.** Improper ring seating causes increased blow-by which heats the internal components of the engine and the oil supply. Prolonged operation with excessive blow-by can cause premature failure of camfollowers and camshaft lobes.

We recommend these procedures to run-in an overhauled engine installed in an airframe:

NOTE: *The following information applies to all types of cylinder bores:*

STEEL/CAST IRON - Plain, nitrided, through hardened
CHROME - Porous, silicon carbide impregnated
NICKEL COMPOSITE - CermiNil® process or Nickel+Carbide™

1. Assure that all precautions contained in Section 2 have been observed.

2. Each cylinder should be instrumented to measure temperature.

3. Head aircraft into the wind for ground runs.

4. Limit initial run to 3 minutes. Hold initial engine RPM to 1200 to obtain oil pressure, and then increase to 1800 RPM to minimize cam lobe stress. If oil pressure is not obtained within 30 seconds, shut down and investigate cause.

5. Allow engine to cool (below 100° F. CHT), and repeat short runs up to 2000 RPM to assure discrepancies are corrected. Note that low RPM increases stress on cam lobes. Under no circumstances should high power be used to adjust fuel flow (flight without proper fuel flow is damaging to the engine). Engine runs should be limited to 3 minutes when using porous chrome plated cylinders.* Runs on all other cylinder types should be limited to 4 minutes to prevent overheating. During the last run before flight, a short full power application of 10-20 seconds is advisable to assure take-off power is available. An idle mixture check is also advisable (reference the appropriate engine overhaul/service data).
   ***CAUTION:** *The operator should be aware that the porous type chrome plated cylinder bores have more critical cooling requirements than other cylinder bore surfaces.*

6. The engine installation should be thoroughly inspected prior to the first flight. Fuel and oil leaks should be corrected and all baffles and cowling should be reinspected. The oil should be checked to assure that blow-by has not darkened it excessively, and to verify the quantity.

7. Cycling the propeller can place unnecessary stresses on the cylinders, and should be minimized prior to first flight. We recommend that the propeller be cycled sparingly, and only to verify that oil has filled the propeller dome and propeller control has been achieved.

8. Initial flight when OAT is above 90° F is not recommended.

9. Keep aircraft weight to a minimum. Only required crew should be aboard the airplane for the test flight.

10. On take-off, use minimum power to reach 40 MPH (IAS) before applying required take-off power.

CAUTION: *Determine that there is sufficient runway remaining in order to reach take-off airspeed.*

11. Use take-off power only as long as necessary to get to **BEST CLIMB SPEED**. Reduce manifold pressure to minimum required for clean in-flight attitude. Leave propeller in flat pitch for at least 5 minutes after take-off. For aircraft not equipped with a variable pitch propeller or manifold pressure gauge, reduce power to 75%. Use minimum rate of climb with maximum air speed consistent with terrain.

12. When desired altitude is reached and cylinder head and oil temperatures are satisfactory, aircraft should be operated at 75% power until 20 - 30 minutes of flight time have elapsed. The engine should then be operated at various power settings and engine operating parameters observed until at least 45 minutes of flight time have elapsed. All power changes should be made very gradually, especially power reductions.

13. During the test flight, any time that a persistent high oil or cylinder head temperature is noted, a precautionary landing and inspection should be made to determine the cause.

14. On initial flight after at least 30 minutes of satisfactory flight time have been accumulated, the aircraft should be landed and the engine be reinspected. Oil consumption should be noted; and, if excessive, should be investigated before further flight.

15. Test flight and results should be entered in the engine log books before the airplane is released to service. Operators should be cautioned against long ground runs and prolonged climbs at low air speeds.

16. Ground operations and continuous climb at low airspeed should be minimized until the engine has accumulated at least 25 hours operating time. Cylinder overheating can cause cylinder bore glazing and/or piston scuffing at any time during engine operation but cylinder assemblies are most susceptible to these problems during the first 25 to 50 hours of operation. Whenever glazing and/or scuffing become severe, the only remedy is to remove the offending cylinder(s), mechanically remove the glaze, replace the piston if necessary and install a new set of rings.

4.0 Fuel for Run-In and Break-In

IMPORTANT: Use only 100LL for engine run-in and break-in for an engine that was designed, tested and certified on 100LL or 80/87. Under no circumstances should unleaded auto gas (mogas) be used when breaking in an engine.

Facts:

- Lead in fuel serves as a lubricant, raises the octane rating and serves as a cushion for the valve/seat interface.
- Most STC's, e.g. Peterson, for use of auto gas (mogas) in a certificated engine exclude the use of auto gas during the run-in and break-in process.

Discussion: Aircraft piston engine valve seats, especially the exhaust, operate at much higher temperatures than automotive, motorcycle or other altitude challenged motors. Elevated temperatures present three challenges to the design requirements for exhaust valve seats, 1.) the oxidation resistance of the material must stand up to the harsh environment created by exhaust gases, 2.) the coefficient of expansion for the material must be close enough to aluminum so that the seat does not fall out, and 3.) the material must resist micro welding to the valve face when the valve closes on the seat. These three requirements severely limit the number of candidate materials from which to choose. A common characteristic of all of the candidates, however, is that they have a high nickel content, a material that forms a spongy oxide on the surface at elevated temperatures.
In the early days of air-cooled aircraft engine design, it was discovered that the spongy oxide absorbs lead that is left behind from the combustion of leaded fuel. The oxide matrix filled with lead forms a layer that not only cushions the valve face when it closes on the seat but also serves as a high temperature lubricant so the seat and valve face do not weld together. When the nickel oxide layer is not filled with lead, premature wear of the seat is a high probability. It is extremely important to have lead present in the combustion chamber during the initial hours of operation if the design life of the cylinder is to be realized. This is especially true for higher compression ratio or turbocharged engines. Once the lead/oxide layer has been created during run-in and break-in, it will maintain itself reasonably well even if auto gas is burned for several fill-ups. Based on experience, ECi strongly recommends the use of leaded fuel at least every few tanks so that the lead/oxide layer is maintained. The higher the compression ratio, the more important the use of leaded fuel becomes.

On the other hand, lower compression engines are plagued by lead compound build-ups in the valve guides that can lead to valve sticking. The 80-87 fuel these engines were designed to use is not universally available, and some of the available 80-87 fuel has zero lead content. The original version of this fuel had up to .5 ml/gal of tetraethyl lead, which was just about right for these engines. The 2 ml/gal of tetraethyl lead in 100LL fuel is a real challenge for engines like the C-85, O-200 or O-235.

Auto gas (mogas) has greater variables for chemistry, vapor pressure, contaminants, etc. which change with locale and season. It is not a source controlled product such as aviation gas. The adverse effects for aircraft piston engines that can be attributed to auto gas are well documented by gasoline companies and ECi as well as the engine manufacturers caution all owner operators to use auto gas only with full knowledge of the problems, appropriate care and consideration of possible limits to warranty.

ECi's Limited Warranty for the use of auto gas: In the event a warranty claim is made, ECi reserves the right to deny the warranty claim if, in their sole judgment, the defect or problem giving rise to the claim resulted from the use of auto gas.

5.0 <u>Lubrication for Run-In and Break-In</u>

<u>**NOTE**</u>: *The following information applies to all types of cylinder bores*:

STEEL/CAST IRON - Plain, nitrided, through hardened
CHROME - Porous, silicon carbide impregnated
NICKEL COMPOSITE - CermiNil® process or Nickel+Carbide™

The lubrication demands imposed upon your engine during run-in and break-in period are different from its operational needs.

During run-in and break-in your lubricant should:

1. Provide immediate oil flow and pressure for start-up protection.
2. Provide protection against extreme temperature changes.
3. Eliminate oil related by-product deposits.
4. Suspend contaminants.
5. Enhance the engine's break-in processes.

Phillips SAE20W-50 multiviscosity oil provides quick lubrication for improved start-up with the SAE20W low temperature viscosity. All multi grade oils lubricate three times faster than straight weight, yet its full bodied SAE 50 viscosity will completely protect the engine at high temperatures and operational loads. The ashless dispersant (AD) in this oil keeps your engine's lubrication system free from oil related contaminants. The dispersant additive further enhances the system by suspending contaminants and operational wear metals in solution rather than allowing them to settle to the bottom of your crankcase forming harmful engine sludge. Finally this 100% mineral product will enhance the mating of all the parts involved in systems requiring operational wear-in.

For your convenience and future reference we recommend the following lubrication schedule:

Hours on Overhaul	Description	Lubrication Package
0	Initial fill-up	Phillips X/C SAE 20W-50
10	Change Oil and Filter	Phillips X/C SAE 20W-50
35	Change Oil and Filter	Phillips X/C SAE 20W-50
60	Change Oil and Filter	Phillips X/C SAE 20W-50
Every 50 Hrs. or 3 Months whichever comes first.	Change Oil and Filter	Phillips X/C SAE 20W-50 is recommended
Thereafter**		

*Should you ever need to change out a cylinder you will not need to switch to a mineral oil for break-in. Since Phillips X/C20W-50 is 100% mineral it will ensure the break-in process for newly installed cylinder(s).
**Without filter reduce intervals to 25 hours or 3 months whichever comes first.

6.0 Break-In Procedures (First 100 Hours)

A new or overhauled engine is an expensive investment. Break-in is the most important time in the life of your engine and is critical in determining its performance capability. Seventy-five (75%) percent of the total normal wear of an engine occurs during the break-in period. According to Federal-Mogul (the leading authority for engine bearings throughout aviation's development era) new piston rings, pistons, and refinished cylinder bores will be more sensitive to break-in than any bearings. Any break-in procedure acceptable for rings and bores will be agreeable to the bearings. Therefore, the first consideration in the break-in mode should be to accomplish the ring to bore seating.

The operator should become informed about the type of ring faces and cylinder bore materials which are installed on the overhauled engine. The value of the information lies in two areas, 1) the susceptibility to overheating, and 2) the time in the break-in period when oil consumption will most likely stabilize.

Porous chrome plated cylinder bores are the most susceptible to overheating. Depending on the grade of cast iron used in the top compression ring, the degree of taper on the face of the ring, the ring tension, the geometry of the cylinder bore, ring finish and a great many other factors, experience has shown that porous chromium is the least forgiving. Therefore, proper break-in procedures must be followed if optimum oil consumption levels are to be realized over the life of the engine. On the other hand, cylinder bore surfaces other than porous chrome, i.e. steel, impregnated chrome, Nickel+Carbide™ and CermiNil® process, can tolerate some deviation from ideal break-in conditions and still give exceptional performance.

While ring to bore seating will normally take place within the first several hours of operation, optimum oil consumption is frequently not achieved until 50 hours or more of operation have been accumulated. However, there are times when cylinders will glaze or prematurely lose their ability to “grind-in” the ring face. This condition is usually marked by lack of any reduction of oil consumption (oil is usually found on the belly of the airplane due to a pressurized crankcase) during the first 10 hours of operation. By removing the spark plugs and checking for fouled electrodes, the offending cylinder(s) can be identified. The recommended remedy is to remove the cylinder(s), rehone the bore for ring finish and reinstall using new rings.

CAUTION: *The operator should be aware that the porous type chrome plated cylinder bores have more critical cooling requirements than other cylinder bore surfaces.*

There are many techniques that have been advocated to enhance break-in or rejuvenate porous chromium plated cylinders over the years. We do not recommend any techniques beyond the procedures put forth herein.

We recommend these procedures to break-in a new or overhauled engine:

NOTE: *The following information applies to all types of cylinder bores*:

STEEL/CAST IRON - Plain, nitrided, through hardened
CHROME - Porous, silicon carbide impregnated
NICKEL COMPOSITE - CermiNil® process or Nickel+Carbide™

1. Verify that the engine has been run-in (See Section 3, "Run-In vs. Break-In"). If this procedure has not been performed, follow run-in instructions contained in Section 5.

2. Assure that all precautions contained in Section 2 have been observed.

3. For the initial flight, fast idle (850-1,000 RPM) engine for 3-4 minutes. Shut down and inspect for oil leaks. During ground runs, do not permit cylinder head temperatures to exceed 400°F or oil temperature to exceed 200°F.

4. Start engine, run up normally, taxi and take off immediately. (Minimize ground time.) Reduce manifold pressure as soon as practical. Slowly reduce engine speed to maximum continuous RPM (top of green) for fixed pitch propellers, reduce power to 75%.

5. Cycle the propeller only enough to verify control. This will ensure the propeller hub has oil pressure prior to take-off.

6. Maintain a shallow climb to keep cylinder head temperatures as low as possible.

7. Level off at altitude and maintain 75% power for at least 30 minutes. During the first 50 hours of the break-in period, piston rings will seat best if cruise is maintained at 65% to 75% power. Oil consumption will also be optimized under these operating conditions. Normal ground idle may be used after the engine temperatures and oil consumption have satisfactorily stabilized.

8. Keep flying weight to a minimum to reduce power requirements during take off.

9. Follow break-in lubrication procedures (Section 5).

10. Should you encounter problems, refer to ECi Service Instruction No. 89-5-1, "Engine Trouble Shooting Guide." To receive a copy, call Customer Service at 1-800-ECi-2FLY or go to our website for a complete listing of Service Instructions at http://www.eci2fly.com.

7.0 Lubrication for Normal Operation

NOTE: *The following information applies to all types of cylinder bores*:

STEEL/CAST IRON - Plain, nitrided, through hardened
CHROME - Porous, silicon carbide impregnated
NICKEL COMPOSITE - CermiNil® process or Nickel + Carbide™

Air-cooled aircraft engines typically encounter far more stress and strain than any other kind of reciprocating engines. Therefore, the operational lubrication needs are four-fold.

Reduced to its simplest tasks, oil has four major functions: to lubricate, to suspend dirt and wear particles between oil changes, to aid in cooling, and to seal, thus it offers protection against heat, pressure, corrosion, oxidation and contamination.

Oil in piston aircraft engines must work in an environment that is radically different from those found in automobile, industrial and agricultural engines. One major difference is that aircraft engines are air-cooled.

Air cooling has evolved as the simplest and most effective method of regulating engine and cylinder temperatures in an aircraft engine, which must operate in extremes of altitude and temperature. While it provides lighter weight and less complexity in its systems, an air-cooled aircraft engine typically sees a wider range of temperature than its liquid-cooled counterpart.

The widely varying operational boundaries experienced by aircraft engines dictate that components for their oils be different from those used in other applications, and the best way to understand their roles is to review the evolution of aviation oil.

Early Aviation History . . .

Although automotive history predated aviation by only a few years, the mass availability of the automobile demanded that lubrication of its engines match the on-going improvements in powerplant efficiency, reliability and life span. But until the closing years of World War II, aviators were relegated to using virtually the same straight-grade mineral oil as the Wright brothers had used. Practically the only research and development being done then for piston-powered aircraft engine oil was by aviation's biggest customer, the military. They developed the oil specifications that were also generally accepted in civil aviation.

These specifications, MIL-L-6082 (straight grade) and MIL-L-22851 (multiviscosity) were established in 1944 and 1961. Given FAA and manufacturer acceptance of military standards and the operational requirements for aviation oils, ECi confidently recommends Phillips 66 X/C Aviation Multiviscosity Oil SAE20W-50.

CAUTION: *Do not use any oil containing anti-scuffing additives during break-in*.

Using an oil formulation of multiviscosity and ashless dispersant will reward your engine with the following benefits:

a. It assures lubrication and engine protection with the extreme temperature changes encountered in cross country flight.

b. It provides ashless dispersant type multiviscosity aviation oil for aircraft piston engines, both opposed piston or radial types.

c. While SAE20W low temperature viscosity offers improved start-up with quick lubrication, full-bodied SAE50 gives complete protection at high engine temperatures and high load operations.

d. It minimizes engine-related flight problems of deposit induced preignition and spark plug fouling, and also reduces troublesome piston, rocker box, and crankcase deposits.

e. It is approved by Teledyne Continental Motors specification MHS-24B, Textron Lycoming Specification 301F, Pratt & Whitney Bulletin No. 1183 (Revision “S”); and the additive treatment package meets the performance requirements of MIL-L-22851C.

f. It is compatible with other approved aircraft engine oils.

8.0 Cylinder Replacement

Cylinder replacement during the life of a first run or overhauled engine poses special run-in, break-in and lubrication problems. But it is a fact that the airplane operator must make choices from a rather lengthy list of options:

1. Should I replace just the faulty cylinder(s) or all of them (top overhaul)?

2. What cylinder barrel surface should be on the replacement cylinder(s)?

3. Can I use oversized replacement cylinders along with standard sized cylinders on the same engine?

4. If the reason for cylinder replacement is excessive guide wear, can I replace the valves and guides and put the cylinder back on the engine with the same piston and rings?

5. Should I change my oil and if so, to what?

To give an informed answer to these questions requires knowledge of the specific situation because any of the foregoing questions can be answered "yes" or "no" depending on the facts. Therefore, we believe that most decisions are based on economics rather than technical considerations, a belief which is further strengthened by the fact that most cylinder replacements are unscheduled. Help with these questions can be obtained by dialing 1-800-ECi-2FLY and speaking with a Customer Service representative or go to our website at: http://www.eci2fly.com

Precautions:

1. While economics guide the cylinder replacement decision, every replacement cylinder must meet the airworthiness test. All cylinder repairs must be performed by the factory, by FAA certificated repair shops, or by FAA licensed mechanics. All replacement parts must be approved by the FAA and have traceability to their origin.

2. Properly identify cylinder(s) to be replaced and be sure to reinstall an exact replacement. The ECi Class Reference Manual is a good document to use for accomplishing this task. Visit ECi's web site at http://www.eci2fly.com or call us at 1-800-ECi-2FLY for further information.

3. If the removed cylinder(s) is reinstalled, first determine the type of bore surface and then follow the appropriate installation steps described below:

    POROUS CHROME: Visually inspect the bore to be sure that channels are visible. If channels are not visible, the bore must be replated. Impart a ring finish to the bore and fit new rings to the piston.

    STEEL/NITRIDED/CAST IRON: Impart a ring finish to the bore and fit new rings to the piston.

    CERMINIL® PROCESS or Nickel+Carbide™. Impart a ring finish to the bores using procedures contained in ECi Service Instruction 92-9-6, "Cylinder Removal and Reinstallation" or its subsequent revision. New rings must be fitted to the pistons.

4. Rings and bore surfaces must be compatible. **CAUTION**: *Do not under any circumstances put chrome-faced rings into chrome-plated cylinder bores.* Any orange paint on the outside of the cylinder is a good visual clue that the bore has been chrome plated. See ECi Service Instruction 94-4-1, "ECi Piston Ring Sets - Applications, Fitting Instructions and Reference" (Rev. 6) or its subsequent revision.

5. Assure proper ring fit and gap. See Manufacturer's Overhaul Manual.

6. Cleanliness is imperative. Debris from applying the ring finish, gapping piston rings, grinding seats, reaming guides as well as airborne contamination can cause severe damage to the engine.

7. Lubricate bores, pistons and rings with a properly formulated assembly lube.

8. Reinstall cylinder(s) in accordance with the manufacturer's recommended procedures.

9. We recommend that you not attempt to run-in replacement cylinders with oils containing synthetics or oils that do not have an ashless dispersant (AD) component. Synthetic oils will interfere with the ring and bore mating process which we want to occur as quickly as possible. Because the lower end of the engine is already well broken in, AD oils will keep debris from break-in in suspension so that it can be filtered out and not reach the critical bearing surfaces. See ECi Service Instruction 92-9-6, “Cylinder Removal and Reinstallation”.

We recommend these procedures to run-in replacement cylinder(s):

1. Drain oil and replace with a multiviscosity ashless dispersant (AD) oil such as Phillips X/C20W-50. **CAUTION**: *Do not use any oil containing anti-scuffing additives during break-in. Install a new filter element.*

2. Even when replacing one cylinder the engine should be run-in according to recommendations contained in section entitled, Run-In vs. Break-In.

3. Change oil and filter after 25 hours of operation and replace oil with Phillips X/C 20W-50.

4. Change oil and filter after the second 25 hours of operation and replace oil with all-mineral aviation oil.

9.0 Oil Filtration

High temperatures associated with normal air-cooled engine operation produce two contaminants which end up in lubricating oil: oxidation by-products and coke. In addition to combustion-generated contaminants, the engine takes in a significant quantity of dirt by breathing it into the cylinders during engine operation.

The use of a lubricating oil with an AD additive is very helpful in keeping the solid contaminants in suspension but when all of the AD is tied up with dirt and coke, additional contaminants introduced into the engine are free to deposit in unwanted locations. There are only two ways to prevent solid contaminants from depositing in the engine when the oil is overloaded: 1) change oil and 2) install a filter.

First, it must be said that a filter will do nothing to remove oxidation by-products, i.e. sludge, varnish, acids and water. Water can be vaporized by operating the engine for sufficiently long periods of time in order to dry out the oil but liquid contaminants will pass right through a filter and remain in the oil no matter how good the filter media is on the filter. Draining the oil is the only way to get rid of the liquid contaminants.

Solid contaminant loading in the oil can be minimized with a full flow filter. While most aircraft piston engines come equipped with an oil screen, these screens have limited filtering efficiency. By pumping oil through a filter, particles are lodged in the filter thereby permanently taking them out of the system.

Data would suggest that a spin-on oil filter with the paper element is the most effective method to remove solid contaminants. ECi strongly recommends that engines without spin-on filters be retrofitted with an ECi oil filter adapter. It is important to match the size of the filter cartridge (long or short) with the output capacity of the oil pump on the engine.

Of course, the oil filter should be changed every time the oil is changed.