

 Service Instruction ENGINE COMPONENTS, INC.	S.I. No.: 94-7-1
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Title: EFFECTS OF CONTAMINATED FUEL ON AIRCRAFT PISTON ENGINES <i>Technical Portions are FAA DER Approved.</i>	Issued: 04/08/97 Revision: 2 (09/01/01)

Problem: Contaminated fuel, detonation and preignition can seriously damage engine cylinders by creating high operating temperatures and loads.

Preignition and/or detonation may have various causes which must be determined and corrected in order to maintain airworthiness. When detonation and preignition are detected, fuel contamination must always be investigated as a possible cause. Contaminated aviation gasoline (Avgas) is nearly always of lower octane (performance number) than uncontaminated fuel, particularly when the contaminant is a heavier distillate, such as jet fuel. Frequently this reduction in octane leads to preignition and/or detonation, either of which can produce very serious damage to cylinders, crankcases and other engine parts.

Possible Damage: Preignition and detonation may damage cylinder assemblies due to high temperatures and abnormal combustion pressures. These conditions can overheat and distort valves, damage pistons and rings and soften or crack aluminum head castings. Crankcases may be damaged from overstress and yielding of studs which may cause stud fractures, crankcase fretting and crankcase cracks. All of these conditions reduce fatigue life and pose a safety risk. While cracks and fractures may be identified using state of the art nondestructive inspection techniques, metallurgical deterioration is much more difficult to detect. Unless metallurgical deterioration of component parts is corrected, fatigue life of these parts cannot be assured.

There are only two ways to address these types of damage. One way is to scrap all damaged parts and replace with new parts. Another way is to comply with FAR Part 43.2, which requires complete disassembly, cleaning, inspection, repair as necessary, reassembly and testing with approved standards and technical data.

Technical Issues for Cylinders that are Suspected to have operated with contaminated Fuel:

1. Detonation, preignition or other abnormal combustion will generally affect exhaust valves, and sometimes intake valves. The indications found include a red hue (color) on the combustion chamber side of the valve head, and sometimes on the back side toward the stem. This coloring is due to overheated lead deposits or lead salts, and is also found when an engine is operated for extensive periods at very lean mixtures. Most current exhaust valves are made from a material known as Nimonic 80A. This is a high nickel alloy, and will hold strength to high temperatures. However, when temperatures are high enough, the exhaust valve will start deforming. Each valve has a precise dimension between a reference diameter on the valve face and valve tip. Overheated valves will often stretch or tulip, and continued operation can result in valve failure.
2. Detonation can result in melting of the cylinder head in the combustion chamber. Fortunately, the melting and resolidifying of metal is readily discernible, and may require the cylinder head to be scrapped.



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3. The structurally critical thread and seal band area between the cylinder head and barrel can be cracked, loosened or otherwise damaged. The cylinder head and barrel must be disassembled, cleaned and thoroughly inspected to insure airworthiness. The process is part of a major repair that requires adherence to FAA Approved data in compliance with FAR Part 43 Appendix A, FAR Part 65.95 and FAR Part 145.51.
4. Many cylinder head cracks and other structural defects may be repaired through welding. However, if the cylinder head is to be heat treated, the welding filler must be both compatible with the casting alloy and heat treatable.
5. Regeneration of the fatigue strength of the cylinder head requires solution heat treatment. This process involves soaking the casting at solution temperatures (approximately 1000 °F) sufficiently long to bring all alloying elements back into solution with the aluminum, cooling the casting in a prescribed manner to “freeze” the alloying elements in solution, and then an “aging” cycle to precipitate the alloy elements in an optimum manner for strength and thermal stability. Again, this is a major repair process requiring FAA approved data.
6. The cylinder barrel must be cleaned and inspected to insure the structure has not been degraded through abnormal service. The barrel should be visually and magnetic particle inspected after removal from the cylinder head. Particular attention is required in the thread and seal band area.
7. Restoration of the cylinder barrel bore is normally required to provide proper running clearances with the piston and rings.
8. Assembly of the cylinder head and barrel requires verification of the fit of the thread and seal band and fit restoration if required. The assembly process must not adversely affect the aging process which followed heat treatment of the cylinder head.
9. All reciprocating parts (valves, springs, pistons, etc.) should be replaced with new parts. In addition to other inspections, the cylinder assembly should be pressure tested in order to ensure proper fit, function and airworthiness.

The Engine Components, Inc. Freedom™ brand cylinder, employing the Improved Fatigue Resistance™ (IFR) process addresses all of the technical issues delineated above. Not all cylinders can be saved, but most cylinders that are suspected of being operated with contaminated fuel can be saved through FAA approved processing.

Lower End Concerns:

Any time there is a possibility of preignition or detonation the engine crankcase, bearings, connecting rods, etc. should be checked. If there are no significant indications of detonation in the cylinders, then an external check of the crankcase may suffice. However, the connecting rods should be removed and checked for alignment, and the connecting rod bearings should be inspected closely to determine if there are any indications of hammering or overload. A close look at the pistons and piston pins is also necessary, and should there be any evidence of metal deterioration around the top of the piston or between the ring lands, they should be scrapped.