LYCOMING™

Engine Installation and Operation Manual

HIO-390-A1A Engine

October 2017

Part No. IOM-HIO-390-A1A

HIO-390-A1A Engine
Installation and Operation Manual

Lycoming Part Number: IOM-HIO-390-A1A

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RECORD OF REVISIONS

Revision	Revision Date	Revised By	Revision Description
Original			Original Release of Installation and Operation Manual - Part No. IOM-HIO-390-A1A

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SERVICE DOCUMENT LIST

NOTICE: The following is a list of service documents referenced in or incorporated into the information in this manual. Always refer to the latest revision of any service document for changes or additional information.

Number	Incorporation Date	Subject
S.B. 369	10/17	Engine Inspection after Overspeed
S.B. 480	10/17	I. Oil and Filter Change and Screen Cleaning II. Oil Filter Screen Content Inspection
S.B. 533	10/17	Recommended Action for Sudden Engine Stoppage, Propeller/Rotor Strike or Loss of Propeller/Rotor Blade or Tip
S.I. 1009	10/17	Recommended Time Between Overhaul Periods
S.I. 1014	10/17	Lubricating Oil Recommendations
S.I. 1070	10/17	Specified Fuels
S.I. 1094	10/17	Fuel Mixture Leaning Procedures
S.I. 1098	10/17	Propeller Flange Bushing Location
S.I. 1132	10/17	Magneto Drop-off
S.I. 1154	10/17	FAA Approved Starter and Alternators
S.I. 1241	10/17	Pre-oil the Engine Prior to Initial Start
S.I. 1304	10/17	Engine Nameplate Replacement
S.I. 1409	10/17	Lycoming Engines P/N LW-16702, Oil Additive
S.I. 1427	10/17	Lycoming Reciprocating Engine Run-In and Oil Consumption
S.I. 1443	10/17	Approved Slick Magnetos on Lycoming Engines
S.I. 1472	10/17	Removal of Preservative Oil from Engine
S.I. 1481	10/17	Factory Engine Preservation
S.I. 1505	10/17	Cold Weather Starting
S.I. 1528	10/17	Aircraft Engine Starter Recommendations
S.I. 1530	10/17	Engine Inspection in a Particulate Laden Environment (Volcanic Ash, Sand, Dust, Airborne Debris)
S.I. 1532	10/17	Approved Fuel Injectors, Fuel Manifold Assemblies, and Fuel Nozzle Assemblies for Lycoming Engines
S.I. 1566	10/17	Lycoming Engines Approves the Use of Safety Cable
L 114	10/17	Reciprocating Engine and Accessory Maintenance Publications
L180	10/17	Engine Preservation for Active and Stored Aircraft
L193	10/17	Engine Firing Order

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ABBREVIATIONS AND ACRONYMS

A	
Amp	Ampere
B	
BHP	Brake Horsepower
BSFC	Brake Specific Fuel Consumption
BTC	Before Top Center
Btu	British Thermal Unit
C	
C	Celsius
CHT	Cylinder Head Temperature
cm	Centimeter
E	
EGT	Exhaust Gas Temperature
EPA	Environmental Protection Agency
F	
F	Fahrenheit
FAA	Federal Aviation Administration
FAR	Federal Aviation (and Space) Regulation
FOD	Foreign Object Debris
Ft.-lb	Foot Pound (torque)
G	
G	Force of Gravity
Gph	Gallons per Hour
H	
HET	Hartzell Engine Technologies
Hg	Mercury
HP	Horsepower
I	
ICA	Instructions for Continued Airworthiness
in.-lb	Inch Pound (torque)
in.	Inch, inches
In-Hg	Inches of Mercury
L	
lb	Pound
LL	Low Lead (fuel)

ABBREVIATIONS AND ACRONYMS (CONT.)

K	
kPa	Kilopascal
M	
mm	Millimeter
MSB	Mandatory Service Bulletin
N	
Nm	Newton Meter
P	
P/N	Part Number
POH	Pilot's Operating Handbook
ppm	Particles per Million
psi	Pounds per Square Inch
R	
rpm	Revolutions per Minute
S	
SA	Special Advisory
SAE	Society of Automotive Engineers
SB	Service Bulletin
SI	Service Instruction
STC	Supplemental Type Certificate
V	
V	Volt, Voltage

INTRODUCTION

Engine Model Nomenclature

The table below identifies the basic nomenclature for the HIO-390 engine model. Hyphenated numbers and letters in the suffix (A1A) of the engine model number are configuration designations associated with the core engine.

Model Number	Meaning
H	Horizontal Helicopter
I	Fuel Injected
O	Horizontally Opposed
390	Displacement in cubic inches

Scope of this Manual

This manual supplies instructions (in compliance with Federal Aviation Regulations FARs 33.5 and 21.50) for engine description, uncrating procedures, acceptance check, engine lift procedure, engine preservation and storage, depreservation, engine installation requirements, engine installation, operation and stop procedures, engine initiation (break-in/flight test), fuels and oil to be used, and operating specifications for HIO-390-A1A Lycoming engines.

The installation instructions in this manual are basic guidelines. When installing the engine in the airframe, follow the airframe manufacturer's installation instructions.

For required maintenance procedures, such as: oil changes, oil addition, oil filter replacement/oil pressure screen cleaning, routine time-interval inspections, routine service, spark plug replacement/inspection procedures, cylinder inspection, fuel system inspection, scheduled servicing procedures, airworthiness limitations, fault isolation guidelines and procedures to replace components and to disassemble and assemble the engine, refer to the ***HIO-390-A1A Engine Maintenance Manual.***

For spare parts information, refer to the ***HIO-390-A1A Illustrated Parts Catalog***.

Refer to the latest revision of the ***Service Table of Limits - SSP-1776***, for dimensions, clearances, measurements, and torque values.

Service Bulletins, Service Instructions, and Service Letters

As advancements in technological applications on this engine continue, Lycoming Engines will make future revisions to this manual. However, if more timely distribution is necessary, Lycoming Engines supplies up-to-date Service Bulletins (SBs), Service Instructions (SIs) and Service Letters (which are abbreviated with a capital "L" followed by the number, example L180). Special Advisories (SAs) are supplied as necessary.

For additional publication information, look on Lycoming's website (Lycoming.com) or speak to Lycoming Engines by telephone: U.S. and Canada toll free: +1(800) 258-3279; or Direct: +1 (570) 323-6181.

Applicable information from Lycoming Engines' Service Bulletins, Service Instructions, and Service Letters are included in this manual at the time of publication. Any new service information will be included in the next update of the manual.

Reminder: Unless otherwise specified, Lycoming Engines' service documents (which have a later date than this manual) that pertain to the engine models in this manual supersede procedures in this manual.

For reference and future updates, the Service Document List at the front of this manual identifies the service documents included in this manual.

Instructions for Continued Airworthiness

The ***HIO-390-A1A Engine Maintenance Manual***, latest revision of the ***Service Table of Limits - SSP-1776,*** service documents, and related publications make up the complete set of Instructions for Continued Airworthiness (ICAs). The ICAs are prepared by Lycoming Engines and are approved by the Federal Aviation Administration (FAA).

Compliance Requirements

⚠ WARNING: OPERATE THIS ENGINE IN ACCORDANCE WITH SPECIFICATIONS IN APPENDIX A OF THIS MANUAL. OPERATING THE ENGINE BEYOND SPECIFIED OPERATING LIMITS CAN CAUSE PERSONAL INJURY AND/OR DAMAGE TO THE ENGINE.

YOU ALSO MUST COMPLETE THE NECESSARY SERVICE PROCEDURES IDENTIFIED IN LYCOMING ENGINES' MAINTENANCE MANUAL FOR THIS ENGINE AS WELL AS ANY APPLICABLE SERVICE DOCUMENTS. LYCOMING ENGINES' SERVICE DOCUMENTS OVERRIDE PROCEDURES IN THIS MANUAL UNLESS OTHERWISE SPECIFIED.

PROCEDURES IN THESE MANUALS AND SERVICE DOCUMENTS MUST BE DONE BY QUALIFIED PERSONNEL WITH THE REQUISITE CERTIFICATIONS.

Warning, Cautions, and Notices

Be sure to read and obey the Warnings, Cautions and Notices in this manual and in service documents. Although Lycoming Engines cannot know all possible hazards or damages, it makes a reasonable effort to supply the best possible guidance and recommended practices for safe operation and maintenance of its engines.

The table below defines the four types of safety advisory messages used in this manual per the American National Standard and ANSI Z535-6-2006.

Safety Advisory Conventions	
Advisory Word	**Definition**
DANGER:	Indicates a hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
⚠ WARNING:	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION:	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. It can also be used without the safety alert symbol as an alternative to **"NOTICE."**
NOTICE:	The preferred signal word to address practices not related to personal injury.

NOTICE: In this manual, the word "recommended" refers to "best practices."

Simplified Technical English

The text in the manual is written in the form of Simplified Technical English in compliance with FAA requirements and to make translation into other languages easier.

Figures

Figures in this manual are for conceptual illustrative purposes only. Figures always start as Figure 1 in each chapter.

Copyright

Environmental Compliance

Lycoming Engines recommends that engine owners and engine service personnel be in compliance with all federal, state, and local environmental regulations when solvents, paint, fuel, oil, chemicals, or other consumables are used in engine service.

Supplemental Service Information

Refer to the latest revision of Service Letter No. L114 for a list of Lycoming publications available for purchase.

Feedback

To supply comments, suggestions, or corrections to this manual, either call Lycoming Engines Product Support at the phone number below or use the Lycoming.com website.

Product Support

Lycoming has a Product Support Hot Line to supply information and assistance to owners, operators, and maintenance personnel servicing Lycoming engines.

Phone:
Lycoming's regular business hours are Monday through Friday from 8:00 A.M. through 5:00 P.M. Eastern Time (-5 GMT).

Factory	U.S. and Canada Toll Free:	+1 (800) 258-3279
	Direct:	+1 (570) 323-6181

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Change of Address Notification

The owner of the manual is responsible to supply of a change of address to Lycoming Engines.

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SYSTEM DESCRIPTION

The Lycoming HIO-390-A1A engine (Figure 1) is a direct-drive four-cylinder, horizontally opposed, fuel-injected, air-cooled engine. It has tuned induction, and a down exhaust.

NOTICE: Refer to Appendix C for engine performance data.

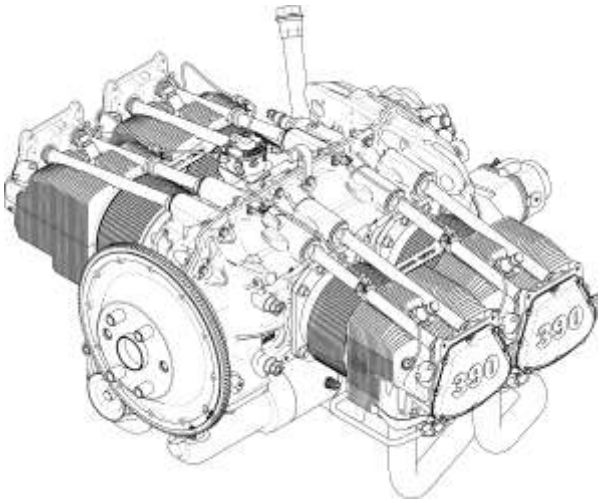

Figure 1
HIO-390-A1A Engine

Cylinders

There are four cylinders on this engine. Each cylinder (Figure 2) contains a cylinder head, barrel, piston, angled intake and exhaust valve guides and valve seats, rocker shafts, rocker covers, and fins.

Fuel and air enter the cylinder through the cylinder head for mixing and combustion within the cylinder.

The engine has intercylinder cooling baffles.

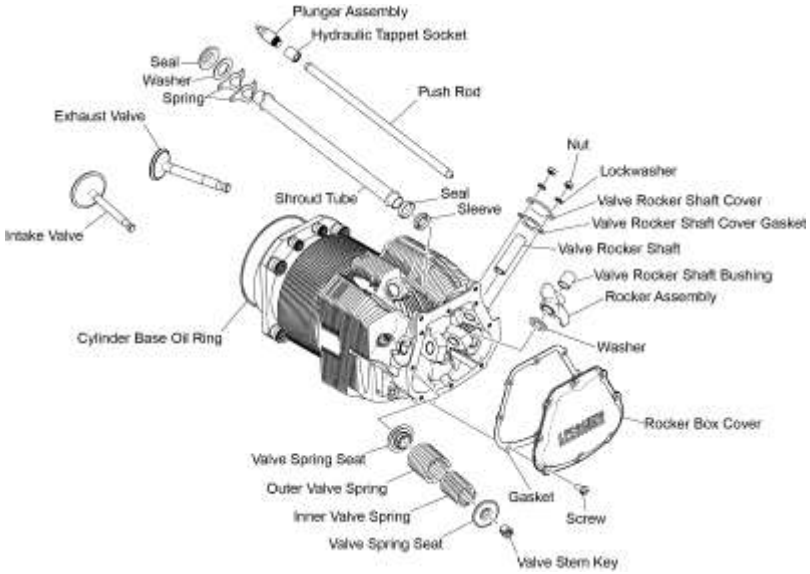

Figure 2
Engine Cylinder

Crankcase

The crankcase (Figure 3) is made up of two casting halves attached by a series of through-studs, bolts and nuts.

The crankcase forms the bearings for the camshaft. The camshaft operates the roller tappets which control opening and closing of the intake and exhaust valves.

The main bearing bores are machined for precision-type main bearing inserts. The crankshaft main-bearings are pairs of inserts installed in the crankcase at each journal.

The crankshaft (Figure 4) is within the crankcase. The crankshaft has journals to attach connecting rods and pistons.

Four oil nozzles in the crankcase, one for each piston, supply oil for internal piston cooling.

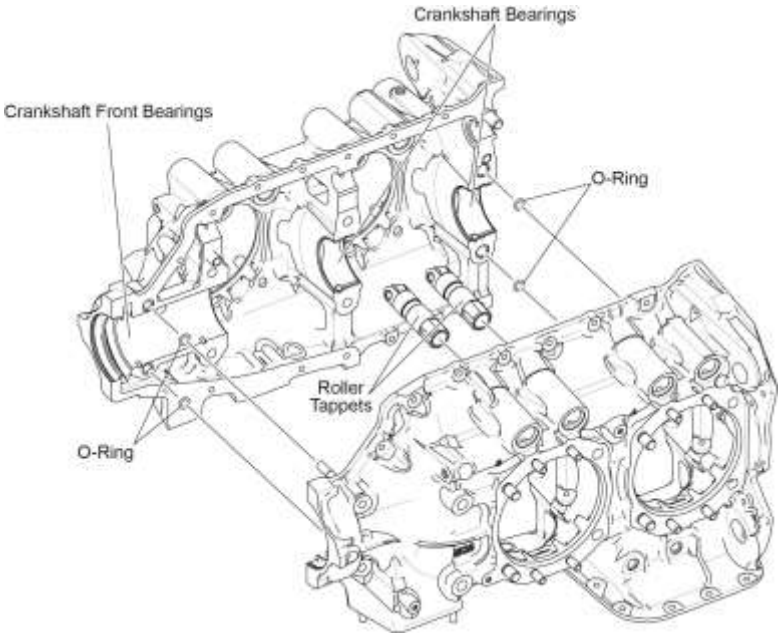

Figure 3
Crankcase

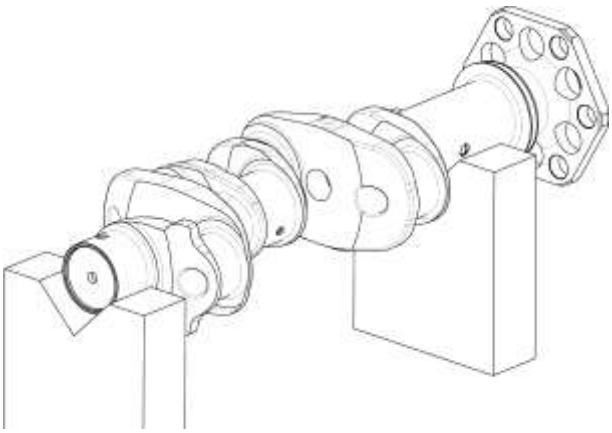

Figure 4
Crankshaft

Ignition System

The all weather-shielded ignition system (Figure 5) includes:

- Eight spark plugs (two per cylinder)
- Ignition harness
- Two magnetos (identified in Appendix A).

One magneto can have one retard breaker (left) magneto and one plain (right) magneto. The plain magneto must be grounded during the start cycle.

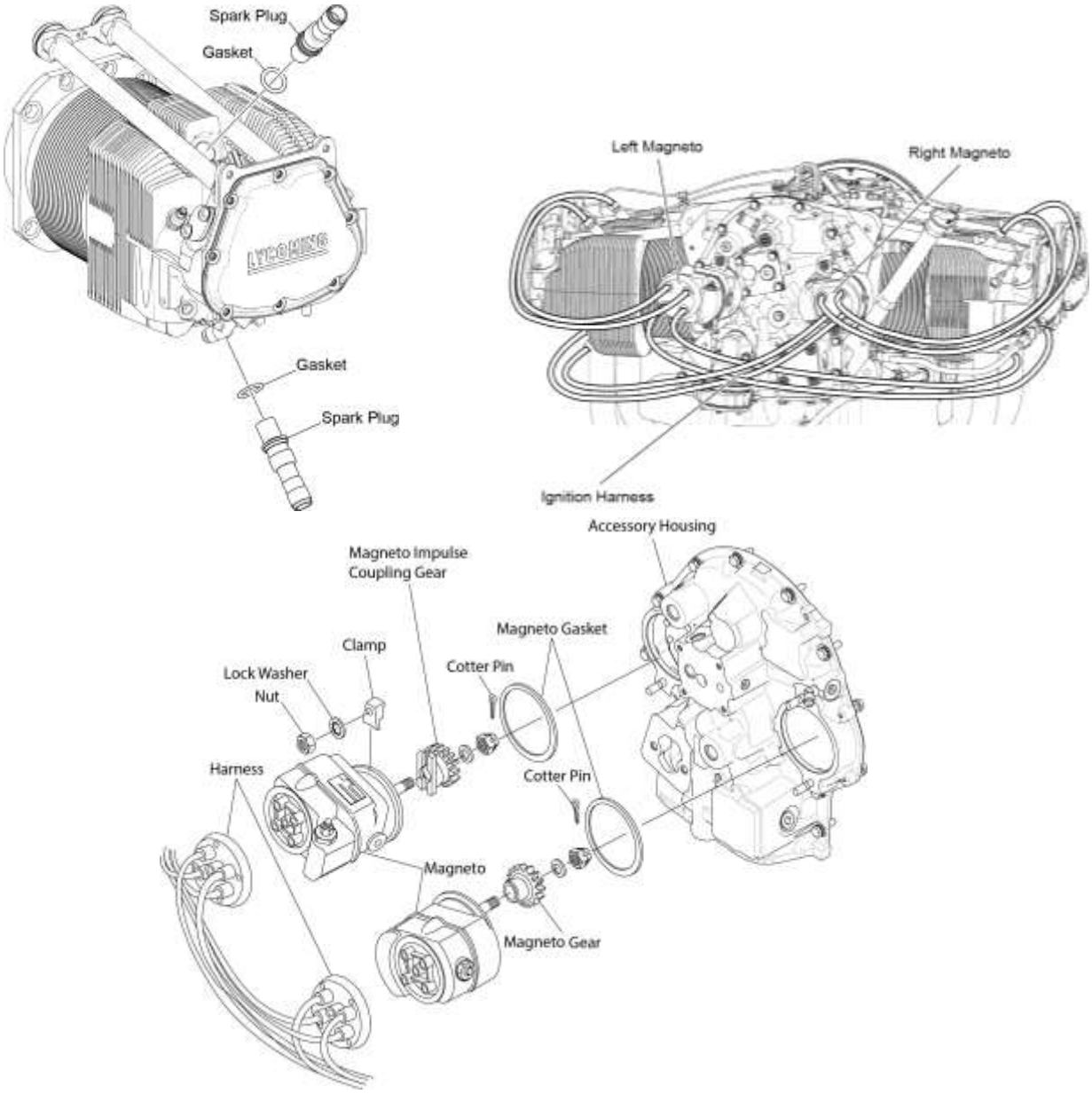

Figure 5
Ignition System

Starter and Alternator

The engine can have either a 12V geared starter or optional 24V starter (Figure 6). Refer to Appendix A.

A 12V 60 and 70 amp or a 24V 70 amp alternator is available as an option.

The alternator blast tube must be connected to a source of sufficient cooling air to prevent overheating.

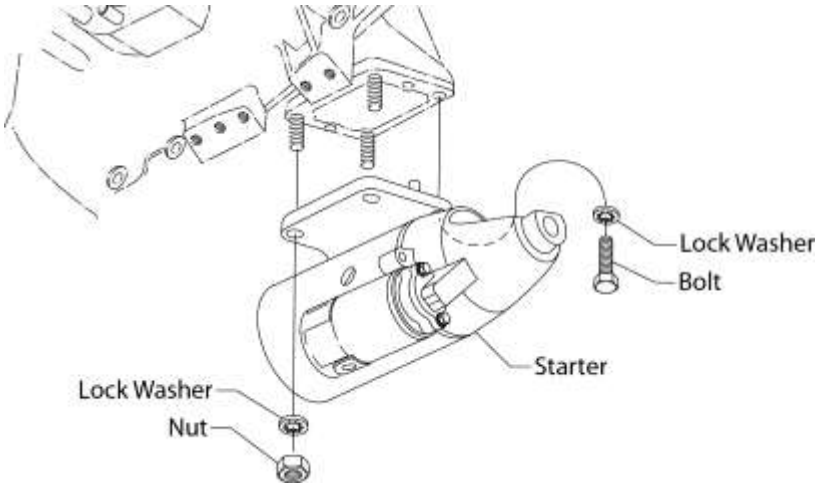

Figure 6
Starter

Fuel Injection System

The fuel injection system (Figure 7) includes: a fuel manifold and a rear-mounted servo regulated continuous flow-type fuel injector, four injection nozzles (one per cylinder), a diaphragm-type fuel pump, and fuel lines which connect the fuel injectors to the fuel manifold. The fuel injector meters fuel in proportion to induction air flow and provides fuel priming. Refer to the fuel flow and consumption curves in Appendix C.

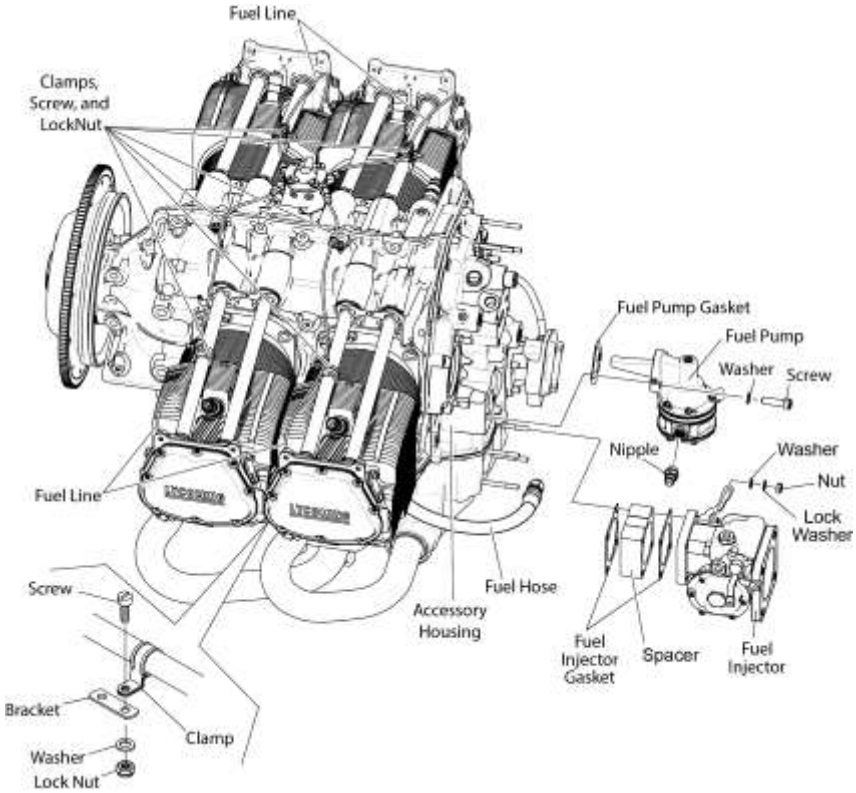

Figure 7
Fuel Injection System

Lubrication System

The lubrication system (Figure 8) includes a wet sump, oil pump, oil fill/dipstick, oil suction screen, remote oil filter, oil cooler, and oil lines. Two filler extensions are available. As an option to the remote oil filter, this engine can be configured with an accessory housing-mounted oil filter or pressure screen.

There are two drain plugs on the oil sump. Another plug at the rear of the oil sump is for removal of the oil suction screen.

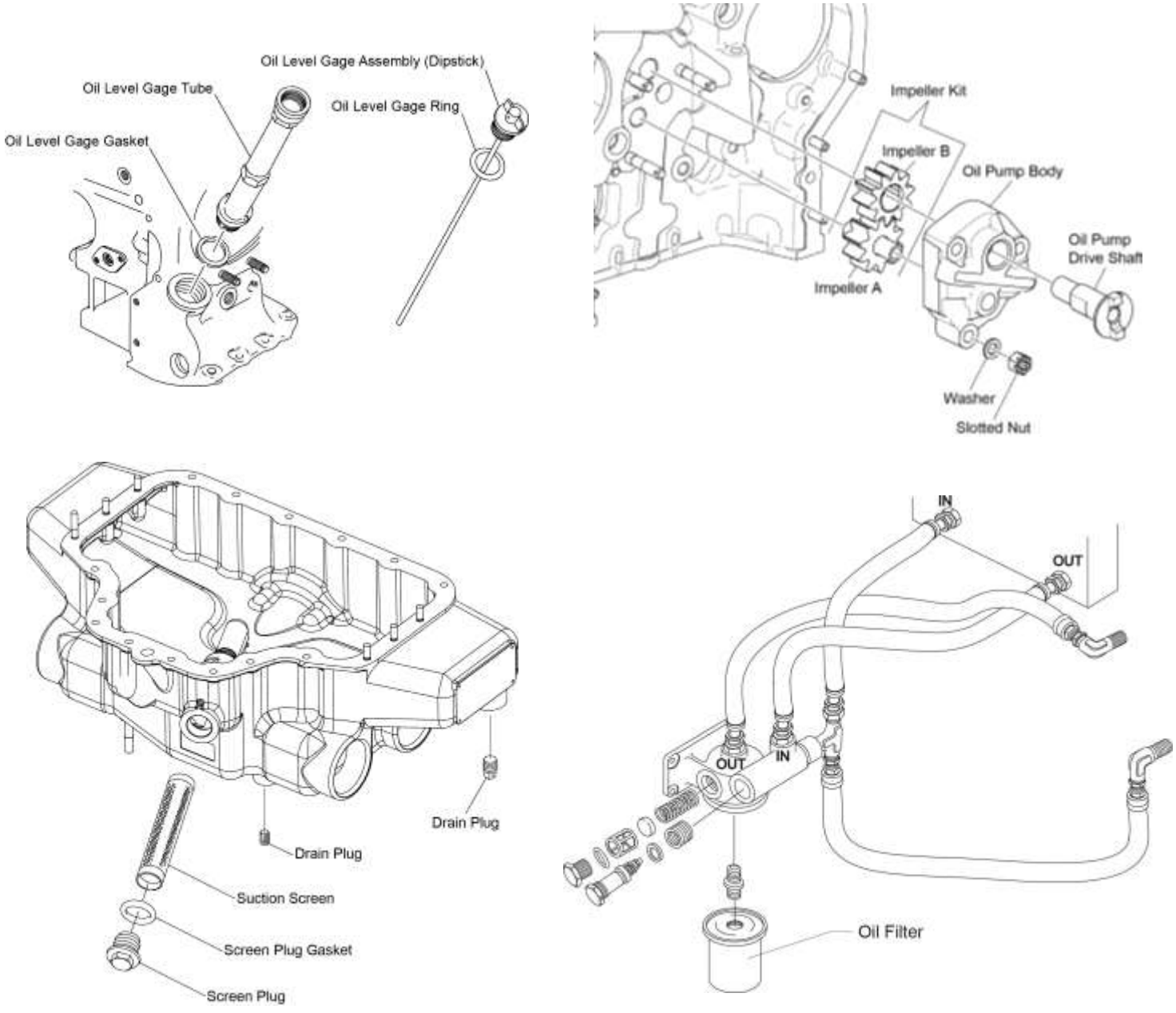

Figure 8
Lubrication System for HIO-390-A1A Engines

Cylinder Number Designations

- The crankshaft flange is at the front of the engine and the accessories are at the rear of the engine.
- When viewed from the top of the engine, the left side cylinders are 2-4. Cylinder 2 is at the front of the engine (Figure 9).
- When viewed from the top of the engine, the cylinders on the right are 1-3. Cylinder 1 is at the front of the engine.
- The firing order of the cylinders is 1-3-2-4.

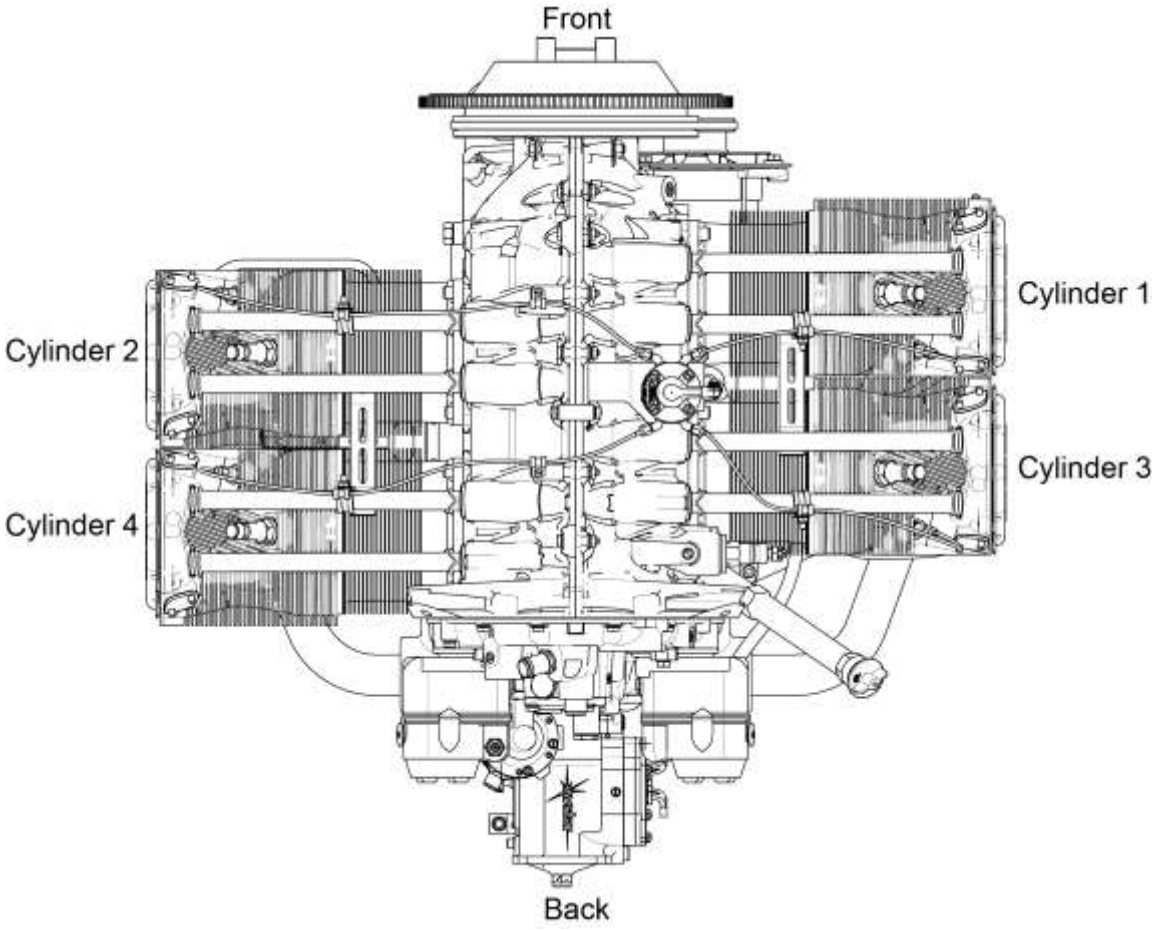

Figure 9
Cylinder Number Designation

ENGINE RECEPTION AND LIFT

Uncrate Procedure for a New, Rebuilt, or Overhauled Engine

1. When the engine is received, make sure that the shipping container or box is not damaged. If the engine crate is damaged, speak to Lycoming Engine's Service Department and the freight shipper.

NOTICE: Box crating can vary at times. Figure 1 shows a typical example.
These engines are usually sent in a box where the engine is attached to a pallet within the box. The engine can be in a plastic bag or wrapped and it could have a top foam pillow.

2. If the crate is not damaged, remove the engine from the crate. To uncrate the engine:
   A. Remove the staples at the bottom perimeter around the box (Figure 1).
   B. Remove a few top slats of the crate.

⚠ CAUTION: DO NOT TURN THE CRANKSHAFT OF AN ENGINE WITH PRESERVATIVE OIL BEFORE REMOVAL OF THE PLUGS FROM THE SPARK PLUG HOLES. OTHERWISE ENGINE DAMAGE, CAUSED BY HYDRAULIC LOCK, CAN OCCUR.

   C. Look for any fluid (oil or fuel) on the skid or below the engine. If fluid is found, identify the source.

Figure 1
Example of Engine Box/Crate

Acceptance Check

1. Every engine sent from the factory is identified by a unique serial number. The engine serial number is identified on the engine data plate (Figure 2). Do not remove the engine data plate.

NOTICE: If an engine data plate is ever lost or damaged, refer to the latest revision of Service Instruction No. SI-1304 for data plate replacement information.

2. Make sure that the engine serial number and model number on the engine data plate (Figure 2) are the same as specified in the engine logbook and on the packing slip.

Figure 2
Engine Data Plate

3. Examine the engine for damage or corrosion before lifting. If the engine is damaged or has corrosion, identify the areas of damage and corrosion. Speak to Lycoming Engines' Product Support and the freight shipper.

NOTICE: Do not lift, install or store a damaged or corroded engine (prior to receiving instructions from Lycoming Engines or the freight shipper).

4. If the engine is not damaged and is without corrosion, it can be installed or stored. If the engine is to be installed within 5 days after uncrating, refer to the section "Step 1. Prepare the Engine" in the "Requirements for Engine Installation" chapter. If the engine is to be stored, refer to the "Engine Preservation and Storage" chapter in this manual.
5. Refer to the section "Lift the Engine" in this chapter and lift the engine.

Engine Preservative Oil Removal

The engine is sent with preservative oil in the cylinders and preservative oil in the crankcase. Refer to the "Prepare a New, Rebuilt, or Overhauled Engine for Installation" section in the "Requirements for Engine Installation" chapter in this manual.

Lift the Engine

NOTICE: The hoist must have a capacity to lift a minimum of 750 lb (340 kg).

1. Connect the hoist and chains to the lifting straps (Figure 3) on the engine and remove any slack in the chain.

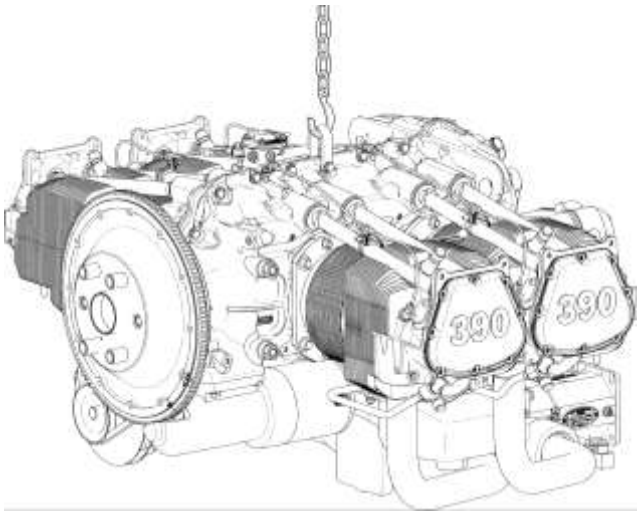

Figure 3
Engine Lift

⚠ **CAUTION:** MAKE SURE THE AREA IS CLEAR WHEN LIFTING THE ENGINE. DO NOT LIFT FROM THE FRONT, REAR, SIDES OR BOTTOM OF THE ENGINE. DO NOT LET THE ENGINE HIT ANY OBJECTS TO PREVENT DAMAGE TO THE ENGINE OR ITS COMPONENTS.

2. Lift the engine slowly and vertically.
3. When the engine has preservative oil, complete the preservative oil removal procedure now while the engine is lifted. Refer to the section "Prepare a New, Rebuilt, or Overhauled Engine for Installation" section or "Prepare a Stored Engine for Installation" in the "Requirements for Engine Installation" chapter in this manual.

REQUIREMENTS FOR ENGINE INSTALLATION

Overview

NOTICE: All requirements identified in this chapter must be completed before the engine can be installed. These requirements are for a new, rebuilt, overhauled, or stored engine to be placed into service.

As an overview, Table 1 identifies the necessary steps that must be done before the engine can be installed.

Table 1
Prerequisites for Engine Installation

Step	Section References in This Chapter
1	Prepare the Engine
2	Supply Interface Items
3	Remove Components
4	Install Aircraft-Supplied Engine Mounts
5	Prepare the Aircraft Engine Harness
6	Make Electrical Interface Connections

Step 1. Prepare the Engine

To prepare a new, rebuilt, or overhauled engine	Refer to the section "Prepare a New, Rebuilt, or Overhauled Engine for Installation" in this chapter.
To prepare an engine that has been in storage	Refer to the section "Prepare a Stored Engine for Installation" in this chapter.

Prepare a New, Rebuilt, or Overhauled Engine for Installation

NOTICE: The engine is sent from the factory with preservative oil in the cylinders and in the crankcase. A preservation date stamp (usually on the engine box) identifies the date this oil was added; preservation is good for 60 days afterward. If an intake valve was open, the preservative oil can get into the induction system of the engine. All preservative oil must be removed per this procedure.

⚠ **CAUTION:** DO NOT TURN THE CRANKSHAFT OF AN ENGINE WITH PRESERVATIVE OIL BEFORE REMOVAL OF THE BOTTOM SHIPPING OR SPARK PLUGS. OTHERWISE, ENGINE DAMAGE, CAUSED BY HYDRAULIC LOCK CAN OCCUR.

To prepare the new, rebuilt, or overhauled engine for installation in the airframe:

1. Lift the engine. Refer to the section "Lift the Engine" in the "Engine Reception and Lift" chapter in this manual.

⚠ **CAUTION:** IF PRESERVATIVE OIL TOUCHES PAINTED SURFACES, REMOVE THE OIL IMMEDIATELY TO PREVENT DAMAGE TO THE PAINT.

NOTICE: To touch-up paint, refer to Chapter 72-10 in the ***HIO-390-A1A Engine Maintenance Manual.***

2. Complete the depreservation procedure as follows:
   A. Remove desiccant bags.
   B. If any of the dehydrator plugs (which contain crystals of silica gel) break and the crystals fall into the engine, complete the following procedures per the ***HIO-390-A1A Engine Maintenance Manual.***
      - Disassemble the affected portion of the engine.
      - Clean the engine.
   C. Put a container under the engine to collect the cylinder preservative oil.
   D. Remove the shipping plugs installed in the lower spark plug holes.
   E. Remove the desiccant plugs from the upper spark plugs holes.
   F. Turn the crankshaft through three or four complete revolutions to remove the cylinder preservative oil from the cylinders.
   G. Collect the cylinder preservative oil as it drains out of the lower spark plug holes.
   H. Tilt the engine to one side until the spark plug holes on that side are vertical.
   I. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.
   J. Tilt the engine to the other side until the spark plug holes on that side are vertical.
   K. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.
3. Examine the cylinder bores with a borescope for rust and contamination. Refer to the ***HIO-390-A1A Engine Maintenance Manual***.
4. If any corrosion or unusual conditions are found, speak to Lycoming Engine's Service Department.
5. Drain preservative oil from the oil sump:
   A. Put a 15-quart (14-liter) capacity container under the oil sump.
   B. Remove the safety wire/cable from the oil sump drain plug. Discard the safety wire/cable.
   C. Remove the oil sump drain plug.
   D. Drain the remaining preservative oil from the oil sump into the container.

   NOTICE: If some preservative oil stays in the engine, it will not damage the engine. The preservative oil will be removed after the first 25 hours of operation during the oil change.

   E. Remove, examine, clean, and reinstall the oil suction screen per the "Oil Suction Screen Removal/Inspection/Cleaning/Installation" section in Chapter 12-10 of the ***HIO-390-A1A Engine Maintenance Manual.***
   F. Apply one to two drops of Loctite® 564™ or equivalent to the threads of the oil sump drain plug and install the oil sump drain plug in the oil sump. Torque the drain plug in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

   ⚠ **CAUTION:** MAKE SURE THAT THE OIL SUMP DRAIN PLUG AND OIL SUCTION SCREEN PLUG ARE TORQUED CORRECTLY AND ARE SECURE. IF THE DRAIN PLUG AND OIL SUCTION SCREEN PLUG ARE NOT INSTALLED SECURELY AND LEAK, ENGINE FAILURE CAN OCCUR.

   G. Safety wire/cable the oil sump drain plug and oil suction screen plug in accordance with the standard practices per the latest revision of AC43.13-1B or the latest revision of Service Instruction No. SI-1566.

6. Drain the fuel pump:
   A. Put a collection container underneath the fuel pump.
   B. Remove the shipping cap installed on the main fuel inlet on the fuel pump.
   C. Let any preservative fluid drain from the fuel pump into a collection container.
   D. Remove the collection container.
   E. Reinstall the shipping cap on the main fuel inlet on the fuel pump.
   F. Install all shipped loose components of the fuel system.
   G. Connect the fuel lines to all fuel system components. Refer to Chapter 73-10 in the ***HIO-390-A1A Engine Maintenance Manual***
7. Remove the plug in the induction system (Figure 1).
8. Drain any preservative oil from the induction system.
9. Apply a coating of Loctite® 564 thread sealant or equivalent to the threads of the plug.
10. Install the plug in the induction system. Torque the plug to 40 in.-lb. (4.5 Nm).

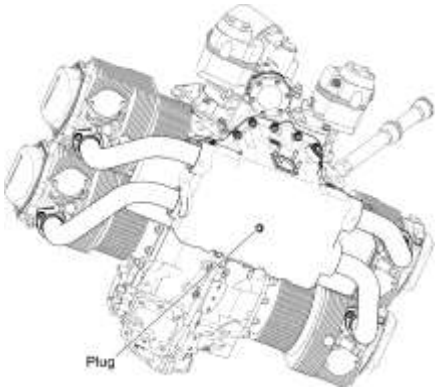

Figure 1
Induction System Drain Plug

11. Refer to Chapter 74-20 in the ***HIO-390-A1A Engine Maintenance Manual*** to:
   A. Examine the spark plugs.
   B. If spark plugs are acceptable, install them with a new gasket. If the spark plugs are dirty, clean them per the procedure in Chapter 05-30 of the ***HIO-390-A1A Engine Maintenance Manual.*** If the spark *plugs* are not acceptable, install new spark plugs with a new gasket.
   C. Remove the protectors on the ignition lead ends.
   D. Connect the ignition lead ends.
12. Remove the fuel inlet strainer and clean it with a hydrocarbon-based solvent such as mineral spirits or equivalent. Re-install the fuel inlet strainer.
13. Examine the fuel supply lines, fuel manifold, and throttle body, to make sure they are clean and dry.

NOTICE: During the first 50 hours of engine operation of new, rebuilt, or overhauled engines operate this engine with mineral oil until oil consumption stabilizes.

14. Add mineral oil to a new, rebuilt, or overhauled engine. Refer to Appendix A for the oil capacity. Refer to the "Add Oil" procedure in the "Engine Installation" chapter in this manual.
15. Use the correct disposal procedure for collected oil in accordance with local regulations and environmental protection policy.

Prepare a Stored Engine for Installation

NOTICE: If the engine had been stored at temperatures below +10°F (-12°C), put the engine in an environment of at least 70°F (21°C) for 24 hours before completing this depreservation procedure. If this thawing is not possible, apply heat to cylinders with heat lamps.

Since an engine in storage has preservative oil, complete this depreservation procedure to prepare the engine for installation into the airframe:

1. Lift the engine. Refer to the section "Lift the Engine" in the "Engine Reception and Lift" chapter in this manual.
2. Put a container under the engine to collect the cylinder preservative oil.

⚠ **CAUTION:** DO NOT TURN THE CRANKSHAFT OF AN ENGINE WITH PRESERVATIVE OIL BEFORE REMOVAL OF THE PLUGS IN THE BOTTOM SPARK PLUG HOLES. ENGINE DAMAGE CAUSED BY HYDRAULIC LOCK CAN OCCUR.

3. If the engine has been preserved and/or has been in long-term storage, remove the items used in preservation as follows:
   A. Remove and discard the seals.
   B. Remove tape residue with solvent.
   C. Remove and discard the dehydrator plugs (if installed).
   D. Remove and discard the desiccant bags for the intake and exhaust ports.

NOTICE: If any of the dehydrator plugs break and the crystals fall into the engine, complete the following procedures per the ***HIO-390-A1A Engine Maintenance Manual.***

- Disassemble the engine
- Clean the engine

4. Examine the engine for any damage.
5. If the engine is not damaged, go to the next step. If damage is found, identify and correct or repair the problem. Record findings and corrective action in the engine logbook.
6. Remove the spark plugs or protective plugs from the top and bottom spark plug holes per instructions in Chapter 74-20 in the ***HIO-390-A1A Engine Maintenance Manual.***
7. Remove any other moisture-prevention seals and covers from the engine.

⚠ **CAUTION:** IF PRESERVATIVE OIL TOUCHES PAINTED SURFACES, REMOVE THE OIL IMMEDIATELY TO PREVENT DAMAGE TO THE PAINT.

NOTICE: To touch-up paint, refer to Chapter 72-10 in the ***HIO-390-A1A Engine Maintenance Manual.***

8. Complete the depreservation procedure as follows:
   A. Turn the crankshaft through three or four revolutions to remove the cylinder preservative oil from the cylinders.
   B. Collect the cylinder preservative oil as it drains out of the lower spark plug holes.
   C. Tilt the engine to one side, until the spark plug holes on that side are vertical.
   D. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.
   E. Tilt the engine to the other side until the spark plug holes on that side are vertical.
   F. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.
9. Examine the cylinder bores with a borescope for rust and contamination. Refer to Chapter 72-30 in the ***HIO-390-A1A Engine Maintenance Manual.***

10. If any corrosion or unusual conditions are found, speak to Lycoming Engine's Service Department.
11. Drain preservative oil from the oil sump:
    A. Put a 15-quart (14-liter) capacity container under the oil sump.
    B. Remove the safety wire/cable from the oil sump drain plug. Discard the safety wire/cable.
    C. Remove the oil sump drain plug.
    D. Drain the remaining preservative oil from the oil sump into the container.

    NOTICE: If some preservative oil stays in the engine, it will not damage the engine. The preservative oil will be removed after the first 25 hours of operation during the oil change.

    E. Remove, examine, clean, and reinstall the oil suction screen per the "Oil Suction Screen Removal/Inspection/Cleaning/Installation" section in Chapter 12-10 of the ***HIO-390-A1A Engine Maintenance Manual.***
    F. Apply one to two drops of Loctite® 564™ or equivalent to the threads of the oil sump drain plug and install the oil sump drain plug in the oil sump. Torque the drain plug in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

    ⚠ **CAUTION:** MAKE SURE THAT THE OIL SUMP DRAIN PLUGS AND SUCTION SCREEN PLUG ARE TORQUED CORRECTLY AND ARE SECURE. IF THE DRAIN PLUGS AND SUCTION SCREEN PLUG ARE NOT INSTALLED SECURELY AND LEAK, ENGINE FAILURE CAN OCCUR.

    G. Safety wire/cable the oil sump drain plugs and oil suction screen plug in accordance with the standard practices per the latest revision of AC43.13-1B or the latest revision of Service Instruction No. SI-1566.

NOTICE: If the engine is equipped with an accessory housing-mounted oil filter or pressure screen, refer to Appendix A in the ***HIO-390-A1A Engine Maintenance Manual*** for instructions to remove and install the oil filter or remove, clean, and install the pressure screen.

12. Remove the oil filter and install a new oil filter. Refer to the aircraft manufacturer's maintenance manual for instructions.
13. Refer to Chapter 74-20 in the ***HIO-390-A1A Engine Maintenance Manual*** to:
    A. Examine the spark plugs.
    B. If spark plugs are acceptable, install them. If the spark plugs are dirty, clean them in petroleum solvent. If the spark plugs are not acceptable, install new spark plugs.
    C. Remove the protectors on the ignition lead ends.
    D. Connect the ignition lead ends.
14. Remove the fuel inlet strainer and clean it with a hydrocarbon-based solvent such as mineral spirits or equivalent.
15. Examine the fuel supply lines, fuel manifold, and throttle body to make sure they are clean and dry.
16. Add specified oil in Appendix A. Refer to the ***HIO-390-A1A Engine Maintenance Manual.***
17. Use the correct procedure for disposal of drained oil and fuel in accordance with local, state, federal, and environmental protection regulations.

Step 2. Supply Interface Items

1. Table 2 contains available equipment options, recommendations and requirements for the airframe manufacturer to prepare for engine installation.

Table 2
Optional Equipment, Recommendations,
and Requirements to Prepare the Engine for Installation

Issue	Recommendation/Requirement
Installation drawings and wiring diagrams	Installation drawings are available from Lycoming Engines. Refer to Appendix B.
Magnetos	Refer to the magneto manufacturer's documentation for information on various vibrator and switching arrangements.
	If different magnetos, other than those identified in Appendix A, are necessary refer to the latest revision of Service Instruction No. SI-1443.
Alternators	If a different alternator is necessary, refer to the latest revision of Service Instruction No. SI-1154.
Cylinder head temperature measurement	Airframe manufacturer-supplied bayonet thermocouples with AN-4076 fittings for installation on each cylinder head.
Oil cooler	Provision is made for aircraft manufacturer-supplied full flow oil cooler. Oil flow through the cooler system will be approximately 7.5 gallons per minute (28.4 liters minute) and heat rejection will not exceed 820 Btu per minute. The oil cooler must withstand continuous pressure of 150 psi (1034 kPa) and have a minimum proof pressure of 400 psi (2758 kPa). A thermostatic bypass valve and pressure relief valve are optional. The pressure relief valve limits the pressure drop between cooler connections to 35 psi (241 kPa). The valve closes at 185ºF (85ºC) routing all engine oil flow through the cooler. If pressure drop across the oil cooler system is more than +75 psi (517 kPa) ±15 psi (103 kPa), the pressure relief valve opens to bypass the cooler.
Remote oil filter	Provision is made for aircraft manufacturer-supplied remote oil filter or as an option the engine can be equipped with an accessory mounted oil filter or pressure screen.
Oil pressure gage	There is a provision for installation, by the aircraft manufacturer, of an oil pressure gage connection (refer to the installation drawing referenced in Appendix B.)
Oil temperature	A thermometer well is provided in the accessory housing for installation of an MS 28034-1 or equivalent type thermometer.
Fuel supply hose	Correctly-sized hose for the fuel pump supply and return vent line back to the airframe.
Crankshaft Flange	Conforms to specification AS127, Type 2 (Refer to the Installation Drawing identified in Appendix B.)
Mounting	Airframe manufacturer-supplied rear Type 2 Dynafocal mounting – four mounting bosses
Air cleaner	Air cleaner at rated power is 1150 lb of air per hour; pressure drop not to exceed 6 in. of water.
Exhaust system	Airframe manufacturer-supplied exhaust system. Back pressure should not exceed 2 in-Hg at any cylinder
Exhaust collector	There is a provision for the airframer to install an exhaust collector. Stainless steel or low carbon steel-type exhaust flanges are available as optional equipment.

Step 3. Remove Components

It could be necessary to temporarily remove a component, to install the engine in its compartment on the aircraft.

Remove only the components necessary to enable engine installation.

The component(s) will be re-installed after the engine is installed.

Step 4. Install Aircraft-Supplied Engine Mounts

The airframer is to supply bonded rubber mounts and bolts for attachment to the Dynafocal engine mounts. There are four mounting bosses integral to the crankcase. Refer to the respective Installation Drawing identified in Appendix B for the HIO-390-A1A engine.

Step 5. Prepare the Aircraft Engine Harness

Lycoming Engines can supply a wiring diagram to the aircraft manufacturer, which is used to prepare the aircraft engine harness.

Step 6. Make Electrical Interface Connections

Make electrical interface connections.

Grounding Requirements

Install grounding jumpers from the engine case to the engine mounting frame. (The engine mount must also be grounded to the airframe).

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ENGINE INSTALLATION

Engine Installation Overview

The installation instructions in this manual are basic guidelines. When installing the engine in the airframe, follow the airframe manufacturer's installation instructions.

NOTICE: All requirements identified in the chapter "Requirements for Engine Installation" must be completed before engine installation.

NOTICE: Installation drawings for this engine are available from Lycoming Engines. Refer to Appendix B for ordering information.

To install the engine, refer to the section reference in this chapter for each step in Table 1.

Table 1
Engine Installation Steps and References

Step	Section References in This Chapter
1	Install the Engine on Mounts
2	Connect the Wiring Harness
3	Install External Accessories (as necessary)
4	Connect the Linkages
5	Install Baffling
6	Install the Compressor Belt (as necessary)
7	Connect Fuel Lines
8	Connect Oil Lines
9	Install Components That Had Been Removed Before Engine Installation and Any Additional Ship Loose Components
10	Add Oil
11	Engine Pre-Oil Procedure
12	Add Fuel
13	Final Installation Inspection
14	Close the Engine Compartment

Step 1. Install the Engine on Mounts

⚠ **CAUTION:** MAKE SURE THAT THE ENGINE MOUNTS ARE ALIGNED AND NOT BENT OR DEFORMED. IF THE ENGINE IS INSTALLED ON DEFORMED ENGINE MOUNTS OR MISALIGNED, THE ENGINE CAN BE PUT UNDER UNUSUAL STRESS WHICH CAN CAUSE MALFUNCTION.

1. Lift the engine and put it into the airframe. Refer to the "Lift the Engine" section in the "Engine Reception and Lift" chapter in this manual.
2. Install hardware to securely attach the engine to the airframe and isolation mounts.
3. Torque the mounting hardware per the aircraft manufacturer's maintenance manual.
4. Disconnect the hoist from the lifting eyes.
5. Make sure the airframe ground straps are connected to the engine mounts.

Step 2. Connect the Wiring Harness

1. Connect the aircraft engine wiring harness as necessary. Refer to the aircraft manufacturer's wiring diagram, specifications and drawings.
2. Connect wiring to the starter.

Step 3. Install External Accessories (as necessary)

1. Remove the accessory drive cover plate and gasket.
2. Install the accessory on the supplied pad in accordance with the aircraft manufacturer's instructions. Refer to Table A-3 in Appendix A.

Step 4. Connect the Linkages

Connect the throttle linkage as necessary in accordance with the aircraft manufacturer's specifications and drawings.

Step 5. Install Baffling

Install baffling around the engine compartment per the aircraft manufacturer's instructions.

Step 6. Install the Compressor Belt (as necessary)

Install the compressor belt (which will drive an aircraft-supplied air conditioning unit) in accordance with aircraft and compressor manufacturer's instructions.

Step 7. Connect Fuel Lines

1. Before connection of the main fuel inlet line to the fuel pump, remove all contaminants from aircraft fuel tanks and fuel lines.

   WARNING: REMOVE ANY CONTAMINATION FROM AIRCRAFT FUEL TANKS AND FUEL LINES. FAILURE TO REMOVE ALL CONTAMINATION CAN CAUSE PREMATURE FUEL FILTER REPLACEMENT OR INCORRECT FUEL SYSTEM OPERATION.

2. Remove unwanted material from the aircraft fuel strainer. Let a minimum of 1 gallon (3.8 liters) of fuel flow through the strainer, aircraft fuel filter and fuel supply line.
3. Make sure that the aircraft manufacturer has a fuel filter installed on the aircraft.
4. Remove protective caps from the main fuel inlet.
5. Connect the main fuel inlet line to the fuel pump. Torque the connections per the aircraft manufacturer's instructions.
6. Required guidelines for making fuel line connections:

   A. Before connection of the main fuel inlet line to the fuel pump, remove all contaminants from aircraft fuel tanks and fuel lines.

   NOTICE: Refer to Chapter 73-10 in the ***HIO-390-A1A Engine Maintenance Manual*** for suggested routing and configuration arrangement diagrams for fuel lines on this engine. The fuel line configuration diagram is conceptual and for reference only. Fuel line routing on your engine could have slightly different configurations. Fuel lines must be examined every 100 hours per the ***HIO-390-A1A Engine Maintenance Manual***.

B. Make sure that the fuel lines are held in place with the necessary serviceable cushioned clamps and hardware. Make sure the clamps are tightly attached to prevent fuel line movement due to vibration, friction, or frequencies. Do NOT use plastic tie straps in place of cushioned clamps.

WARNING: DO NOT ROUTE FUEL LINES CLOSE TO HEAT SOURCES. HEAT CAN DAMAGE THE FUEL LINE AND CAUSE A FUEL LEAK WHICH COULD LEAD TO CATASTROPHIC ENGINE FAILURE.

C. Do not let fuel lines touch the engine or aircraft baffle hardware. There must be a minimum clearance of 3/16 in. (4.76 mm) between a fuel line and any engine or aircraft surface.

D. Torque the fuel line union nut (Figure 2) between 35 to 50 in.-lb. (4 to 6 Nm).

E. Torque the fuel line connections/fittings (that had been removed before engine installation) per torque values in the latest revision of the ***Service Table of Limits - SSP-1776.***

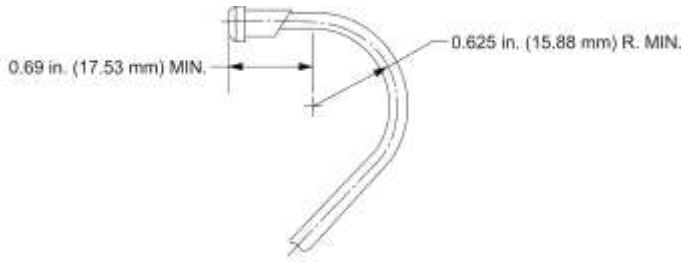

Figure 1
Minimum Acceptable Dimension for a Bend in a Fuel Injector Line

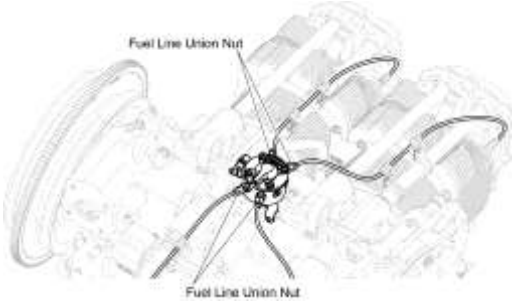

Figure 2
Fuel Line Union Nuts

CAUTION: TO ENSURE CORRECT ENGINE OPERATION AND FLIGHT SAFETY, THERE MUST NOT BE ANY FUEL LEAK AND ALL FUEL LINES MUST BE SECURED WITH CLAMPS. IDENTIFY AND CORRECT THE CAUSE OF ANY FUEL LEAK.

Step 8. Connect Oil Lines

CAUTION: MAKE SURE THERE ARE NO SHARP BENDS OR KINKS IN THE OIL LINE ROUTING TO PREVENT INTERRUPTIONS TO OIL FLOW. DO NOT ROUTE OIL LINES CLOSE TO HEAT SOURCES.

1. Connect the oil lines to the airframe-supplied oil cooler and remote oil filter.
2. Clean each oil line and install it in the respective areas. Make sure the oil line routing is smooth, without sharp bends, kinks or helical twists.
3. When making oil line connections:
   A. Align the oil line with the fitting for best orientation (without kinks or sharp bends).
   B. Torque the fitting to the torque value in the latest revision of the ***Service Table of Limits - SSP-1776***.

Step 9. Install Components (That Had Been Removed Before Engine Installation and Any Additional Ship Loose Components)

1. Install any component that was removed to enable engine installation.
2. Install any remaining components that were shipped loose with the engine.

Step 10. Add Oil

Oil Additives

CAUTION: DO NOT ADD TOP CYLINDER LUBRICANT, DOPES, OR CARBON REMOVERS TO THE ENGINE. THESE PRODUCTS CAN DAMAGE THE ENGINE (PISTONS, ENGINE RINGS, ETC.). IF THESE PRODUCTS ARE ADDED TO THE ENGINE, THE ENGINE WARRANTY IS VOID.

OIL IN SUFFICIENT QUANTITY AND OF THE CORRECT VISCOSITY FOR THE CORRESPONDING AMBIENT TEMPERATURE (APPENDIX A) MUST BE ADDED TO THE ENGINE FOR CORRECT LUBRICATION ESSENTIAL TO ENGINE OPERATION.

NOTICE: On new, rebuilt, or overhauled engines or an engine that had a cylinder and/or piston rings replaced, during the first 50 hours of engine operation, it is recommended that this engine be operated with mineral oil until oil consumption has stabilized. Afterwards, complete an oil change per instructions in Chapter 12-10 of the ***HIO-390-A1A Engine Maintenance Manual***, drain the mineral oil and add new oil.

1. Pull out the oil level gage assembly (dipstick) (Figure 3) from the oil level gage tube.
2. Add either new clean mineral oil (if within the first 50 hours of operation of a new, rebuilt or overhauled engine or an engine that had a cylinder and/or piston rings replaced) or specified oil of the correct quantity and viscosity for the ambient temperature (identified in Appendix A) to the oil sump through the oil level gage tube.

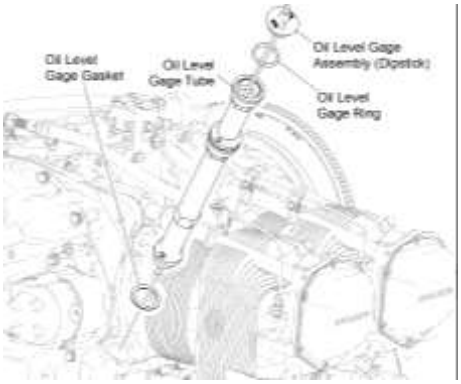

Figure 3
Oil Level Gage Tube
and Oil Level Gage (Dipstick)

3. Measure the oil level per the "Oil Level Check" procedure in Chapter 12-10 of the ***HIO-390-A1A Engine Maintenance Manual***. Add more oil if necessary until the oil level in the engine is sufficient for the flight conditions.
4. Install the oil level gage assembly (dipstick) into the oil level gage tube securely.
5. Record the amount of oil added to calculate oil consumption.

Step 11. Engine Pre-Oil Procedure

WARNING: IF THE PRE-OIL PROCEDURE IS NOT DONE, HIGH-SPEED BEARING FAILURE CAN OCCUR.

NOTICE: The purpose of the engine pre-oil procedure is to internally circulate oil through the engine via a few turns of the crankshaft and ensure that oil pressure is sustained which is an indication that there are no oil leaks.

Complete the engine pre-oil procedure on the engine at the following times:

- Before the initial start of a new, rebuilt, overhauled, or stored engine after engine installation

  or

- After oil cooler replacement or draining

  or

- After any prolonged period of inactivity requiring preservation per the "Engine Preservation and Storage" chapter in this manual

  or

- Whenever the oil lines have been disconnected. Disconnect the oil inlet connection at the oil pump and drain a sufficient amount of oil from the tank to be certain there are no obstructions or air in the inlet line to the oil pump.

To complete the pre-oil procedure:

1. If not already done, fill the oil sump with clean engine oil to the correct level per the "Step 10. Add Oil" procedure in this chapter.
2. Make sure that the Ignition switch, the Auxiliary Fuel Pump switch, and the Fuel Selector are all in the OFF position.
3. Fill the oil cooler with engine oil per the airframe manufacturer's instructions.
4. Per Chapter 74-20 in the ***HIO-390-A1A Engine Maintenance Manual***, disconnect the ignition leads from all spark plugs; remove one spark plug from each cylinder of the engine. Remove and discard the spark plug gasket.
5. Move the throttle control to the FULL OPEN position.

⚠ CAUTION: DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 TO 15 SECONDS. LET THE STARTER COOL FOR 30 SECONDS AFTER EACH ENERGIZATION. IF THE STARTER FAILS TO ENERGIZE AFTER TWO ATTEMPTS, IDENTIFY AND CORRECT THE CAUSE PER THE AIRFRAME MANUFACTURER'S MAINTENANCE MANUAL.

6. Pre-oil start cycle: Energize the starter for 10 to 15 seconds and look for evidence of oil pressure of at least 20 psi (138 kPa) within 10 to 15 seconds.

   If there is no oil pressure within 10 to 15 seconds, stop energizing the starter. Wait at least 30 seconds and repeat the pre-oil start cycle.

   Up to six consecutive pre-oil start cycles can be done. Afterwards let the starter cool for 30 minutes. If stable oil pressure is not achieved, stop pre-oiling and contact Lycoming Engines.

NOTICE: Unstable oil pressure or oil pressure less than 20 psi (138 kPa) could be an indication of obstructed or interrupted oil flow or air in the oil lines.

7. If oil pressure of at least 20 psi (138 kPa) was sustained in the previous step, repeat the pre-oil start cycle to make sure oil pressure holds stable and that there is no sudden drop in oil pressure. If oil pressure is not stable or drops suddenly, stop pre-oiling, and contact Lycoming Engines.

NOTICE: A new spark plug gasket must be installed whether a new or acceptable re-used spark plug is to be installed.

8. Once the minimum oil pressure of 20 psi (138 kPa) is shown on the oil pressure gauge, re-install the spark plugs each with a new gasket, and connect the ignition leads to all spark plugs per instructions in Chapter 74-20 of the ***HIO-390-A1A Engine Maintenance Manual.***
9. Within 3 hours of completing the pre-oil procedure, complete the remaining steps in this chapter, then start and operate the engine for 3 minutes at idle speed.

Step 12. Add Fuel

WARNING: DETONATION CAN OCCUR IF THE INCORRECT FUEL IS USED. DETONATION CAN INCREASE ENGINE CYLINDER TEMPERATURE AND PRESSURE AND CAUSE DAMAGE TO THE ENGINE.

Add the correct fuel. Refer to Appendix A or the latest revision of Service Instruction No. SI-1070 for approved fuels for this engine.

Step 13. Final Installation Inspection

Complete the Engine Installation Checklist at the end of this chapter.

Step 14. Close the Engine Compartment

1. Make sure that there are no tools or unwanted materials in the engine or engine nacelle or compartment.
2. Install all cowling and nacelle access panels to close the engine compartment securely. Refer to the airframe manufacturer's instructions and specified torque values.

Engine Installation Checklist

Engine Installation Checklist

Requirement	Done	Comment
Make sure that the engine mounts are aligned and not bent or deformed. Ensure that the engine is securely installed on the engine mounts and that the hardware that attaches the engine mounts to the engine is torqued per the airframe manufacturer's specified torque values. Make sure the airframe ground straps are connected to the engine mounts.		
Make sure the aircraft engine wiring harness is connected and that the starter is connected to the applicable wiring.		
Make sure the accessories and alternator(s) are installed.*		
Make sure the throttle and mixture linkage are connected.*		
Make sure baffling around the engine compartment has been installed.*		
Make sure the compressor belt (if applicable) has been installed per aircraft and compressor manufacturer's instructions.		
Make sure fuel lines and oil lines are connected and that there are no leaks. Make sure clamps are securely installed on the fuel lines.**		
Make sure all components removed for engine installation and all shipped loose parts have been installed.		
Make sure oil has been added to engine and the oil quantity added is recorded to calculate oil consumption.		
Make sure the engine pre-oil procedure has been completed.		
Make sure fuel has been added to aircraft fuel tanks.		
WARNING: TO PREVENT CATASTROPHIC FAILURE FROM FOREIGN OBJECT DEBRIS (FOD), MAKE SURE THAT THERE ARE NO TOOLS IN THE ENGINE NACELLE AND COMPARTMENT.		
Remove any tools or unwanted materials from the engine compartment.		
Close the engine compartment.		
* In accordance with the aircraft manufacturer's instructions, specifications and drawings ** Refer to Chapter 73-10 in the ***HIO-390-A1A Engine Maintenance Manual*** for suggested routing and configuration arrangement diagrams for fuel lines on this engine. The fuel line configuration diagram is conceptual and for reference only. Fuel line routing on your engine could have slightly different configurations.		

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FIELD RUN-IN

Either a ***field run-in*** or a factory ***run-in*** procedure is done to ensure that the engine meets all specifications and is operating correctly. Since a ***run-in*** is done on new, rebuilt or overhauled engines shipped from Lycoming Engines, the field run-in is not necessary. However, this ***field run-in*** procedure herein is done only on engines in the field after any of the following:

- A field-overhauled engine is installed
- Field disassembly and reassembly of the engine for any repair, component replacement, or inspection that requires separation of the crankcase halves

NOTICE: Refer to the latest revision of Service Instruction No. SI-1427 for any additional details on the field run-in.

Field Run-In Procedure

Field run-in of horizontally installed engines on rotary wing aircraft is done by following a sequence of steps ranging from engine service of the engine on the ground to progressively increasing its power output during operation. In addition to these instructions, refer to the Pilots Operating Handbook (POH) for a particular helicopter model.

Because helicopters always operate at a fixed or rated engine speed, any decrease of engine RPM necessary during field run-in must be done with the helicopter on the ground and with the rotor engaged. During flight, make all power reductions by manifold pressure alone.

Because of the difference in helicopter models, refer to the helicopter POH for methods of operation for a specific helicopter regarding rotor engagement, manifold pressure ratings, the method of rotor engagement, and centrifugal clutch or manually-operated belt drive.

1. **Preparation for Ground Operational Test with Engine Installed in Aircraft**

NOTICE: "Step 11. Complete the Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual must be already completed before the ground operational test can be done.

A. Ensure that all engine instrumentation is calibrated to ensure accuracy.

⚠ **CAUTION:** MAKE SURE THAT ALL VENT AND BREATHER LINES ARE INSTALLED CORRECTLY AND ARE SECURELY IN PLACE IN ACCORDANCE WITH THE AIRFRAME MAINTENANCE MANUAL.

B. Install engine intercylinder baffles, airframe baffles/seals, and cowling. All baffles and seals must be in new or good condition to ensure sufficient cooling airflow differential across the engine.

C. Before the start of the ground operational test, examine the lubrication system for metal contamination. These parts must be clean and free of contamination before the ground operational test can begin.

D. If the engine had failed before overhaul, the oil filter must be replaced and the oil cooler and all oil hoses must be replaced or cleaned and examined by an approved repair facility.

2. **Ground Operational Test**

NOTICE: Before the ground operational test, the oil cooler system must not have any air locks.

A. Put the helicopter in a position facing the wind to take advantage of prevailing wind to keep the engine cool.

B. Make sure the throttle and mixture control, if applicable, are at the FULL-OFF position.

C. Refer to the helicopter POH for the correct start-up procedures. Start the engine. If either you do not see oil pressure (greater than 0) indication within 10 seconds after engine start or oil pressure does **not** continue to increase above the published minimum pressure in the next 20 seconds, stop the engine. Identify and correct the problem before another engine start.

D. Operate the engine for 5 minutes at idle RPM (1200-1500 RPM).

E. Adjust the idle mixture (if applicable) and oil pressure as necessary.

F. Complete a magneto drop-off check as follows:

NOTICE: Recommendations herein are general. Refer to the POH for instructions specific to the aircraft.

(1) Raise the collective pitch stick to obtain 15 inches manifold pressure at 2000 RPM.

⚠ **CAUTION:** DO NOT OPERATE ON A SINGLE MAGNETO FOR TOO LONG A PERIOD; A FEW SECONDS IS USUALLY SUFFICIENT TO CHECK DROP-OFF AND TO MINIMIZE PLUG FOULING.

(2) Switch from both magnetos to one and note the drop-off; return to BOTH until the engine regains speed and switch to the other magneto and note the drop-off. Drop-off must not exceed 175 RPM. The difference between the drop-off values for both magnetos must not exceed 50 RPM. A smooth drop-off past normal is usually a sign of a too lean or too rich mixture.

G. Shut down the engine.

H. Examine the engine for oil and fuel leaks. Identify and correct the cause of any leaks.

I. Start the engine and operate for 5 minutes at idle speed (1200-1500 RPM).

J. Engage the rotor, if necessary, and increase the engine RPM to 50% to 60% of rated engine speed for 5 minutes with rotor blades at flat pitch (collective full down).

K. If the oil pressure is at the correct operating pressure and the oil temperature is between 180°F and 200°F (82°C and 93°C per Appendix A), with the cylinder head temperatures between 350°F and 400°F (177°C and 204°C), increase the engine RPM to 80% of rated engine speed for 5 minutes, followed by 100% airframe manufacturer's rated engine speed for another 5 minutes.

NOTICE: For correct field run-in, do not let the cylinder head temperature go above 420°F (216°C).

L. After operating the engine for the last 5-minute segment, let the engine cool as recommended in the POH and then stop the engine.

M. Per Chapter 12-10 in the ***HIO-390-A1A Engine Maintenance Manual:***

(1) Complete an oil change and replace the oil filter.

(2) Remove, clean, and install the oil suction screen.

(3) Add the correct grade and quantity of oil to the engine per the latest revision of Service Instruction No. SI-1014 and Appendix A of this manual.

(4) Make any necessary oil pressure adjustments per Chapter 72-50 in the ***HIO-390-A1A Engine Maintenance Manual.***

(5) Start the engine and let it operate at 1500 RPM idle.

(6) Engage the rotor, if necessary, and increase the engine RPM to 2000 RPM.

(7) Warm the engine to do a ground operational check per the helicopter's POH.

3. Proceed to the "Engine Initiation" chapter for the remaining procedures to put the engine into service.

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ENGINE INITIATION

Engine Initiation

Engine initiation includes the procedures in Table 1 which are to be done in the field on any of the following newly installed Lycoming engines:

- Any new, overhauled, or rebuilt engine from the factory and field-overhauled engines
- Engine taken out of storage (if not run-in when put in storage)
- An engine which has been disassembled/re-assembled

NOTICE: All of the procedures in Table 1 are mandatory and must be done prior to the first flight with the engine.

Table 1
Engine Initiation Procedures for All Lycoming Engines

Step	Section References in This Chapter
1	Pre-Flight Inspection for Engine Initiation
2	Engine Start
3	Engine Run-Up
4	Engine Stop
5	Break-In/Flight Test/50-Hour Operation
6	Required Inspections During Break-In

Warranty Requirement

WARNING: AS ONE OF THE CONDITIONS FOR THE ENGINE WARRANTY, YOU MUST OPERATE THIS ENGINE IN ACCORDANCE WITH SPECIFICATIONS IN THIS MANUAL. YOU ALSO MUST COMPLETE THE RECOMMENDED SERVICE AND MAINTENANCE PROCEDURES IN ACCORDANCE WITH THE HIO-390-A1A ENGINE MAINTENANCE MANUAL FOR THIS ENGINE.

Step 1. Pre-Flight Inspection for Engine Initiation

Copy and complete the Pre-Flight Inspection Checklist for Engine Initiation.

Pre-Flight Inspection Checklist for Engine Initiation for HIO-390-A1A Engines

Engine Serial Number:_____ Engine Time:_____

Date Inspection Done:_____ Inspection done by:_____

Requirement	Comments	Done
Make sure that all switches are OFF.		
Make sure the magneto P-leads are connected.		
NOTICE: During the first 50 hours of engine operation of a new, rebuilt, or overhauled engine, it is recommended that this engine be operated with mineral oil until oil consumption has stabilized. The oil sump capacity and the minimum quantity for flight are identified in Appendix A.		
Per the "Oil Level Check" procedure in Chapter 12-10*, measure the engine oil level before every flight to make sure there is sufficient oil in the engine. If the oil level is unexpectedly too low, look for any oil leaks. Identify and correct the cause of any oil leak. There must not be any oil leaks. Add the correct specified grade of oil as necessary per the "Add Oil to the Engine" procedure in Chapter 12-10.*		
Make sure that the engine crankcase breather is attached tightly and that there are no blockages to the breather air flow.	Remove any blockage to the air flow. Identify and correct the cause of any blockage.	
If the engine is newly installed or is to be put back into service after long-term storage, make sure that the pre-oil procedure was done.	Refer to Section "Step 11. Complete the Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual.	
Make sure that the induction air filter is clean and securely in place.		
Examine the engine, engine compartment, and cowl for indication of fuel and engine oil leaks.	Identify and correct the cause of any leaks.	
Look in the engine compartment and cowling for any FOD such as: unwanted material, tools, loose, missing fittings, clamps and connections. Examine for restrictions to cooling airflow. Remove any FOD.	Tighten any loose hardware or connections per torque values supplied by the aircraft manufacturer.	
* Refer to the ***HIO-390-A1A Engine Maintenance Manual.***		

Pre-Flight Inspection Checklist for Engine Initiation for HIO-390-A1A Engines (Cont.)

Requirement	Comments	Done
WARNING: DO NOT ROUTE FUEL OR OIL LINES CLOSE TO HEAT SOURCES. HEAT CAN DAMAGE THE FUEL AND OIL LINES AND CAUSE A LEAK WHICH COULD LEAD TO CATASTROPHIC ENGINE FAILURE.		
Examine fuel lines: A. Make sure that each fuel and oil line is intact, not bent or damaged, and does not have any kinks or dents. B. Make sure that the fuel and oil lines are securely connected. C. Make sure the clamps are tightly attached to support the fuel and oil lines and to prevent movement from vibration or motion frequencies. Do NOT use plastic tie straps in place of cushioned clamps. D. Do not let fuel or oil lines touch the engine or aircraft baffle hardware. There must be a minimum of clearance of 3/16 in. (4.76 mm) between a fuel and oil line and any engine or aircraft surface.	Refer to Chapters 72-50 and 73-10 in the ***HIO-390-A1A Engine Maintenance Manual.***	
NOTICE: Record any problems found and corrective action taken in the engine logbook. Record the magnitude and duration of a problem and any out-of-tolerance values.		
Correct all problems before engine start. Refer to the "Engine Conditions" chapter in this manual.		

Step 2. Engine Start

NOTICE: If the engine is to be started in an environment at temperatures less than +10°F (-12°C), refer to the section “Apply Heat to a Cold Engine” in the “Engine Conditions” chapter in this manual. If the engine is to be operated at temperatures over 90°F (32°C), refer to the section “Engine Operation in Hot Weather” in the “Engine Conditions” chapter in this manual.

The following is Lycoming Engine’s recommended procedure for engine starts. If there is any variation between the start procedure in the aircraft manufacturer’s Pilot’s Operating Handbook (POH) and Lycoming Engine’s recommended start procedure, follow the aircraft manufacturer’s procedure.

1. If the engine is newly installed or is to be put back into service after long-term storage, make sure the pre-oil procedure was done. Refer to the section "Step 11. Complete the Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual.
2. Put the helicopter in a position facing the wind to take advantage of prevailing wind to keep the engine cool.
3. Make sure the throttle and mixture control, if applicable, are at the FULL-OFF position.

4. Refer to the helicopter POH for the correct start-up procedures. Start the engine. If either you do not see oil pressure (greater than 0) indication within 10 seconds after engine start or oil pressure does **not** continue to increase above the published minimum pressure in the next 20 seconds, stop the engine. Identify and correct the problem before another engine start.
5. Operate the engine for 5 minutes at idle RPM (1200-1500 RPM).
6. Adjust the idle mixture (if applicable) and oil pressure as necessary.
7. Complete a magneto drop-off check as follows:

NOTICE: Recommendations herein are general. Refer to the POH for instructions specific to the aircraft.

A. Raise the collective pitch stick to obtain 15 inches manifold pressure at 2000 RPM.

⚠ **CAUTION:** DO NOT OPERATE ON A SINGLE MAGNETO FOR TOO LONG A PERIOD; A FEW SECONDS IS USUALLY SUFFICIENT TO CHECK DROP-OFF AND TO MINIMIZE PLUG FOULING.

B. Switch from both magnetos to one and note the drop-off; return to BOTH until the engine regains speed and switch to the other magneto and note the drop-off. Drop-off must not exceed 175 RPM. The difference between the drop-off values for both magnetos must not exceed 50 RPM. A smooth drop-off past normal is usually a sign of a too lean or too rich mixture.

8. Shut down the engine.
9. Examine the engine for oil and fuel leaks. Identify and correct the cause of any leaks.

Step 3. Engine Run-Up

⚠ **WARNING:** IF DURING ENGINE RUN-UP OR ENGINE IDLE, ANY OPERATIONAL PROBLEMS OCCUR, DO NOT TAKE-OFF. IDENTIFY AND CORRECT THE CAUSE OF THE PROBLEM AND COMPLETE THE GROUND OPERATIONAL TEST IN THE "FIELD RUN-IN" CHAPTER.

Complete the engine run-up as follows:

1. Start the engine and operate for 5 minutes at idle speed (1200-1500 RPM).
2. Engage the rotor, if necessary, and increase the engine RPM to 50% to 60% of rated engine speed for 5 minutes with rotor blades at flat pitch (collective full down).
3. If the oil pressure is at the correct operating pressure and the oil temperature is between 180°F and 200°F (82°C and 93°C), with the cylinder head temperatures between 350°F and 400°F (177°C and 204°C), increase the engine RPM to 80% of rated engine speed for 5 minutes, followed by 100% airframe manufacturer's rated engine speed for another 5 minutes.
4. Warm the engine to complete a ground operational check per the helicopter's POH.

Step 4. Engine Stop

1. Disengage the rotor per the airframe manufacturer's POH.
2. Keep the engine speed at idle, until the operating temperatures are stable and Exhaust Gas Temperature (EGT) (if applicable) is approximately 1100ºF (593ºC).
3. Move the mixture control to IDLE CUT-OFF.

4. After the engine stops, set the ignition switch to the OFF position.
5. Turn the fuel valve OFF in accordance with the aircraft POH.

WARNING: DO NOT MANUALLY TURN THE CRANKSHAFT ON A HOT ENGINE EVEN THOUGH THE IGNITION SWITCH IS IN THE **OFF** POSITION. THE ENGINE COULD KICK BACK AS A RESULT OF AUTO-IGNITION CAUSED BY A SMALL AMOUNT OF FUEL REMAINING IN THE CYLINDERS. AUTO-IGNITION COULD RESTART THE ENGINE AND CAUSE SERIOUS BODILY INJURY OR DEATH.

6. Refer to the aircraft manufacturer's POH for additional information.

Step 5. Break-In/Flight Test/50-Hour Operation

NOTICE: The "Break-In/Fight Test/50-Hour Operation" procedure and the "Required Inspections During Break-In (50-Hour Operation)" must be completed any time new piston rings are installed or ay time one or more cylinders are replaced per procedures in Chapter 72-30 in the ***HIO-390-A1A Engine Maintenance Manual.***

Engine ***break-in*** is done to seat the piston rings and stabilize oil consumption. Break-in includes two progressive procedures:

- A flight test (done first)
- 50 hours of continued flight at power settings of 70% to 75% per the applicable POH

NOTICE: Refer to the latest revision of Service Instruction No. SI-1427 for any additional details.

An operational test and a pre-flight ground run-up must be done before approval by an authorized inspector for a flight test. This flight test, which is part of the required engine break-in field procedure, is necessary to make sure that the engine and aircraft are in compliance with all of the manufacturer's performance and operational specifications before release of the aircraft for service.

CAUTION: DO NOT TAKE-OFF IF ANY OF THE FOLLOWING CONDITIONS ARE FOUND:

Engine roughness	High or low fuel flow
Low, high, or surging rpm or fluctuations	High manifold pressure
High, low, or fluctuating oil pressure	Low battery charge.

1. **Flight Test**
   A. Start the engine and operate it at 1500 RPM.
   B. Engage the rotor, if necessary, and increase the engine speed to 75% RPM.
   C. With the engine warm, complete a ground operational check in accordance with the helicopter manufacturer's POH (including a magneto check).

   NOTICE: Use two crew members to control and monitor the engine instruments, including the aircraft and engine operating temperatures and pressures. If any parameters are out of tolerance with the helicopter POH or engine operating manual limitations, stop the flight test. Identify and correct the cause.

   D. Put the helicopter into a hover mode for 10 minutes while monitoring the manifold pressure, fuel pressure, oil temperature, oil pressure and cylinder head temperature, etc.

E. If engine instruments are satisfactory, go to cruise altitude.

F. Operate the engine at cruise power at 70% to 75% of rated power for 30 minutes to keep a constant safe altitude.

G. At the end of the 30-minute flight at 70% to 75% power, record the manifold pressure and engine temperature.

H. Increase engine RPM and manifold pressure to maximum specified limits in the helicopter manufacturer's POH. Hold this power setting for 45 minutes at a constant safe altitude.

I. At the end of 45 minutes, again record the manifold pressure and engine temperature.

J. After the flight test and before engine shutdown, operate the aircraft either in a hover mode for 10 minutes or for the time recommended in the helicopter POH.

K. Record the manifold pressure and engine temperatures.

L. After landing, refer to the POH for cool-down and shutdown procedures.

M. Examine the engine for oil and fuel leaks. Identify and correct the cause of any leaks.

N. Calculate oil consumption and compare the limits given in Appendix A.

$$0.006 \times BHP \times 4 \div 7.4 = Qt./Hr.$$

O. If the oil consumption value is above the limits in Appendix A, identify and correct the cause. Complete this flight test again, up to and including this step before releasing the aircraft for service.

P. Per Chapter 12-10 in the ***HIO-390-A1A Engine Maintenance Manual:***

(1) Complete an oil change and replace the oil filter. (Add new mineral oil up to the specified oil sump capacity in Appendix A. Mineral oil is used since it is within the first 50 hours of engine operation of a new, rebuilt, or overhauled engine.)

(2) Remove, clean, and install the oil suction screen.

(3) Add the correct grade and quantity of oil to the engine per the latest revision of Service Instruction No. SI-1014 and Appendix A of this manual.

Q. Complete the inspections identified in the "Step 6. Required Inspections During Break-In" section in this chapter.

R. Correct any problems before releasing the engine back into service.

2. Continue to operate the engine on straight mineral oil at cruise power settings above 65% for 50 hours or until oil consumption stabilizes.

3. Monitor all engine operating temperatures and pressures and maintain within limits.

Step 6. Required Inspections During Break-In (50-Hour Operation)

During the next 50 hours of flight, complete the following inspections per Chapter 05-20 in the ***HIO-390-A1A Engine Maintenance Manual***:

- Visual Inspection
- 10-Hour Initial Engine Inspection Checklist
- 25-Hour Engine Inspection Checklist
- 50-Hour Engine Inspection Checklist

ENGINE OPERATION

The procedures in this chapter are for routine engine operation. The steps in Table 1 must be completed in the order shown for engine operation during routine service

Table 1
Prerequisite Requirements for Engine Operation

Step	Section References in This Chapter
1	Pre-Flight Check
2	Engine Start
3	Engine Run-Up
4	Engine Operation
5	Engine Stop

Step 1. Pre-Flight Check

Refer to the Pilot's Operating Handbook (POH) and complete a Pre-Flight Check before starting the engine.

NOTICE: Examine the air filters every other flight for dirt and be prepared to clean or replace them if necessary.

If the aircraft is flown in dusty conditions, more frequent oil changes and air filter replacements are recommended. Install dust covers over openings in the cowling for additional protection. Refer to the section "Volcanic Ash" in the "Engine Conditions" chapter in this manual.

Step 2. Engine Start

WARNING: MAKE SURE THAT THE AREA AROUND THE AIRCRAFT IS CLEAR OF PERSONNEL OR ANY OBSTRUCTION BEFORE STARTING THE ENGINE. IF THE ROTOR HITS AN OBJECT, DO NOT PROCEED WITH FLIGHT. REFER TO THE LATEST REVISION OF SERVICE BULLETIN NO. SB-533.

NOTICE: If the engine is to be started in an environment at temperatures less than +10°F (-12°C), refer to the section "Apply Heat to a Cold Engine" in the "Engine Conditions" chapter in this manual. If the engine is to be operated at temperatures over 90°F (32°C), refer to the section "Engine Operation in Hot Weather" in the "Engine Conditions" chapter in this manual.

The following is Lycoming Engine's recommended procedure for engine starts. If there is any variation between the start procedure in the aircraft manufacturer's Pilot's Operating Handbook (POH) and Lycoming Engine's recommended start procedure, follow the aircraft manufacturer's procedure.

Because helicopters always operate at a fixed or rated engine speed, any decrease of engine RPM necessary must be done with the helicopter on the ground and with the rotor engaged. During flight, make all power reductions by manifold pressure alone.

Because of the difference in helicopter models, refer to the helicopter POH for methods of operation for a specific helicopter regarding rotor engagement, manifold pressure ratings, the method of rotor engagement, and centrifugal clutch or manually-operated belt drive.

1. Examine the engine for hydraulic lock which is a condition where fluid accumulates in the induction system or the cylinder assembly. Refer to Chapter 05-50 of the ***HIO-390-A1A Engine Maintenance Manual*** for details.

WARNING: DO NOT OPERATE THE ENGINE IF HYDRAULIC LOCK IS POSSIBLE. HYDRAULIC LOCK CAN CAUSE ENGINE DAMAGE. DO NOT CONTINUE TO OPERATE A MALFUNCTIONING ENGINE TO PREVENT ADDITIONAL DAMAGE TO THE ENGINE, POSSIBLE BODILY INJURY OR DEATH.

2. Put the helicopter in a position facing the wind to take advantage of prevailing wind to keep the engine cool.
3. Make sure the throttle and mixture control, if applicable, are at the FULL-OFF position.
4. Refer to the helicopter POH for the correct start-up procedures. Start the engine. If either you do not see oil pressure (greater than 0) indication within 10 seconds after engine start or oil pressure does **not** continue to increase above the published minimum pressure in the next 20 seconds, stop the engine. Identify and correct the problem before another engine start.
5. Operate the engine for 5 minutes at idle RPM (1200-1500 RPM).
6. Adjust the idle mixture (if applicable) and oil pressure as necessary.

Step 3. Engine Run-Up

WARNING: IF DURING ENGINE RUN-UP OR ENGINE IDLE, ANY OPERATIONAL PROBLEMS OCCUR, DO NOT TAKE-OFF. IDENTIFY AND CORRECT THE CAUSE OF THE PROBLEM AND COMPLETE THE "GROUND OPERATIONAL TEST" IN THE "FIELD RUN-IN" CHAPTER.

Complete the engine run-up as follows:

1. Make sure the oil pressure is within the specified limits (Appendix A).
2. Complete a magneto drop-off check as follows:

NOTICE: Recommendations herein are general. Refer to the POH for instructions specific to the aircraft.

A. Raise the collective pitch stick to obtain 15 inches manifold pressure at 2000 RPM.

CAUTION: DO NOT OPERATE ON A SINGLE MAGNETO FOR TOO LONG A PERIOD; A FEW SECONDS IS USUALLY SUFFICIENT TO CHECK DROP-OFF AND TO MINIMIZE PLUG FOULING.

B. Switch from both magnetos to one and note the drop-off; return to BOTH until the engine regains speed and switch to the other magneto and note the drop-off. Drop-off must not exceed 175 RPM. The difference between the drop-off values for both magnetos must not exceed 50 RPM. A smooth drop-off past normal is usually a sign of a too lean or too rich mixture.

WARNING: IF THE ENGINE IS OPERATED AT LOW OIL PRESSURE OR LOW OIL LEVEL, THE ENGINE CAN MALFUNCTION OR STOP.

3. Make sure the oil pressure and oil temperatures are within the specified operating range in Appendix A.

⚠ **CAUTION:** AVOID PROLONGED IDLING. DO NOT EXCEED 2200 RPM DURING WARM-UP. THE ENGINE IS WARM ENOUGH FOR TAKE-OFF WHEN THE THROTTLE CAN BE OPENED WITHOUT THE ENGINE FALTERING.

4. Move the throttle slowly and smoothly to the IDLE rpm.

Step 4. Engine Operation

⚠ **CAUTION:** DO NOT TAKE-OFF IF ANY OF THE FOLLOWING CONDITIONS ARE FOUND:

Engine roughness	High or low fuel flow
Low, high, or surging rpm or fluctuations	High manifold pressure
High, low, or fluctuating oil pressure	Low battery charge.

1. Before take-off, monitor the oil pressure, oil temperature, and cylinder head temperature to make sure all are within their operating ranges (as specified in Appendix A).
2. Keep the mixture control at FULL RICH.
3. Make sure that when full throttle is applied smoothly, oil pressure, fuel flow, manifold pressure, and rpm remain stable.

NOTICE: After 25 hours of operation, change the oil. Examine the oil filter and screen. Refer to Chapter 12-10 in the ***HIO-390-A1A Engine Maintenance Manual.***

4. Examine the air filters every other flight for dirt and be prepared to clean or replace them if necessary.
5. If the aircraft is flown in dusty conditions, more frequent oil changes and air filter replacements are recommended. Install dust covers over openings in the cowling for additional protection. Refer to the section “Volcanic Ash” in the “Engine Conditions” chapter in this manual.

Operation in Flight

1. See the aircraft manufacturer's instructions for recommended power settings.
2. Until oil consumption has stabilized after the first 50 hours of flight, cruising is to be done at not less than 65% power to ensure correct seating of the rings.

Fuel Mixture Leaning

- For maximum service life, the Cylinder Head Temperature (CHT) must be maintained below 435ºF (224ºC) during performance cruise operation and below 400ºF (205ºC) for economy cruise powers.
- Manual leaning can be monitored by exhaust gas temperature indication (if equipped with an Exhaust Gas Temperature (EGT) gage), fuel flow indication, and by observation of engine speed and/or airspeed.

⚠ **CAUTION:** NEVER EXCEED THE MAXIMUM RED LINE CHT LIMIT.

- On engines with manual control, maintain mixture control in the FULL RICH position for rated take-off, climb and maximum cruise powers (above approximately 75%). However, during take-off from a high elevation airport or during climb, roughness or loss of power can occur from over-richness. In such a case, adjust the mixture control only enough for smooth operation - not for economy. Monitor instruments for temperature rise. Rough operation due to over-rich fuel/air mixture is most likely to be encountered at altitudes above 5,000 feet (1524 meters).

- Always return the mixture to FULL RICH before increasing power settings.
- Operate the engine at maximum power mixture for performance cruise powers and at best economy mixture for economy cruise power; unless otherwise specified in the POH. Refer to Appendix A.
- Fuel Mixture Leaning Options

NOTICE: Because helicopters always operate at a fixed or rated engine speed, refer to the helicopter POH for fuel mixture leaning options. The following are general recommendations for fuel mixture leaning.

1. Leaning to EGT (Normally aspirated engines with fuel injectors or carburetors).
   A. Maximum Power Cruise (approximately 75% power) - Never lean beyond 150ºF (66°C) on rich side of peak EGT unless the aircraft operator's manual shows otherwise. Monitor cylinder head temperatures.
   B. Best Economy Cruise (approximately 75% power and below) - Operate at peak EGT.
2. Leaning to Flowmeter.

   Lean to applicable fuel-flow tables or lean to indicator marked for correct fuel-flow for each power setting.
3. Leaning with Manual Mixture (without flowmeter or EGT gage).
   A. Maximum Power Cruise (approximately 75% power) - Lean to maximum rpm or airspeed.
   B. Best Economy Cruise (approximately 75% power and below).
      (1) Slowly lean the mixture until engine operation becomes rough or a rapid decrease in RPM or airspeed occurs.
      (2) Slowly enrich the mixture until engine operation becomes smooth or most of the RPM or airspeed is restored.

Step 5. Engine Stop

1. After landing, disengage the rotor per the airframe manufacturer’s POH and keep the engine speed to idle rpm, until the operating temperatures are stable and EGT (if applicable) is approximately 1100ºF (593ºC).
2. Move the mixture control to IDLE CUT-OFF.
3. After the engine stops, set the ignition switch to the OFF position.
4. Turn the fuel valve OFF in accordance with the aircraft POH.

⚠ WARNING: DO NOT MANUALLY TURN THE CRANKSHAFT ON A HOT ENGINE EVEN THOUGH THE IGNITION SWITCH IS IN THE **OFF** POSITION. THE ENGINE COULD KICK BACK AS A RESULT OF AUTO-IGNITION CAUSED BY A SMALL AMOUNT OF FUEL REMAINING IN THE CYLINDERS. AUTO-IGNITION COULD RESTART THE ENGINE AND CAUSE SERIOUS BODILY INJURY OR DEATH.

5. Refer to the aircraft manufacturer's POH for additional information.

ENGINE CONDITIONS

Action for Engine Conditions

Table 1 identifies action for engine conditions. Detailed fault isolation is included Chapter 12-30 of in the ***HIO-390-A1A Engine Maintenance Manual.***

NOTICE: Record any problems and maintenance-significant events in the engine logbook. Record the magnitude and duration, and any out-of-tolerance values.

Table 1
Action for Engine Conditions

Condition	Action
Engine roughness	Make a safe landing and speak to Maintenance.
Engine hesitates, misses	Make a safe landing and speak to Maintenance.
Low, high or surging rpm	Make a safe landing and speak to Maintenance.
Low or fluctuating oil pressure	Make a safe landing and speak to Maintenance. Refer to the section "Low Oil Pressure During Flight" in this chapter.
High oil pressure	Before increasing the throttle, allow the oil temperature to increase.
High oil temperature	Make a safe landing and speak to Maintenance.
Low or high fuel flow	Make a safe landing and speak to Maintenance.
Excessive manifold pressure	Make a safe landing and speak to Maintenance.
Engine Indication not available	Make a safe landing and speak to Maintenance.
Engines in an environment at temperatures less than 10°F (-12°C) for more than 2 hours	Refer to the section "Apply Heat to a Cold Engine" in this chapter.
Operation in climates above 100°F	Refer to the aircraft manufacturer's Pilot's Operating Handbook (POH) for instructions.
Stalled engine	Refer to the aircraft manufacturer's POH for instructions.
Engine oscillation (either rpm or manifold pressure)	Slowly decrease the throttle rpm until the oscillations STOP. Then slowly increase rpm back to the desired operational rpm. Complete a safe landing. Identify and correct the cause.
Rotor strike, sudden stoppage and lightning strikes	Make a safe landing. Refer to Chapter 05-50 the ***HIO-390-A1A Engine Maintenance Manual*** for corrective action.
Engine does not hold rpm during cruise, climb, or descent	Make a safe landing and speak to Maintenance.
Rapid decrease in cylinder head temperature	To prevent shock cooling, do not decrease cylinder head temperature at a rate more than 50°F (10°C) per minute.
Overheating (The temperature of the system components is greater than the maximum design operating temperature for the components.)	Make a safe landing as soon as possible, and identify and correct the cause. Refer to the ***HIO-390-A1A Engine Maintenance Manual***

Table 1 (Cont.)
Action for Engine Conditions

Condition	Action
Overspeed	Refer to the section "Overspeed" in this chapter.
Volcanic ash/dust-sand particulate	Refer to the section "Volcanic Ash" in this chapter.
Engine soaked in water	Refer to Chapter 05-50 in the ***HIO-390-A1A Engine Maintenance Manual*** for corrective action.

Apply Heat to a Cold Engine

If an engine is in cold weather longer than 2 hours (at temperatures less than 10°F (-12°C)) it can become "cold soaked." At these low temperatures, oil can become thicker, battery capacity decreased, and the starter could be operated above capacity. Incorrect cold weather starting can cause unusual engine wear, decreased performance, shortened time between overhauls, or engine malfunctions. In the "cold soaked" condition, fuel can vaporize too slowly which could make engine start difficult.

NOTICE: Pre-heat application will help the engine start during cold weather and is necessary when the engine has been in sub-freezing temperature + 10º F (12ºC). Refer to the latest revision of Service Instruction No. SI-1505.

Do not use a heated dipstick to apply heat because heat will be concentrated and not applied throughout the engine. Concentrated heat can cause damage to non-metal engine parts. The oil must be warmed to flow to all parts of the engine.

If the engine is not equipped with a commercially available engine pre-heating system:

1. Ensure that the lubricating oil being used is acceptable with specifications in Appendix A.
2. If cowl flaps are installed, open the cowl flaps to prevent heat buildup.
3. Use a high-volume air heater to uniformly (5-minute intervals for a minimum of 30 minutes) apply heat to the following components:

- Oil sump
- Oil cooler
- Cylinder assemblies
- External oil lines
- Oil filter
- Air intake

4. Between intervals, ensure the engine stays warm and keeps the heat, and that heat buildup is not concentrated and there is no damage from heat buildup.
5. During the last 5 minutes of the pre-heating process, apply the heat to the top of the engine.
6. Close cowl flaps (if required by airframe manufacturer) and proceed with the engine starting process.

⚠ WARNING: IF HEAT HAS NOT BEEN APPLIED TO ALL PARTS OF THE ENGINE, THE ENGINE CAN START AND RUN BUT LATER FAIL AFTER APPLICATION OF HIGH POWER BECAUSE THE OIL WILL NOT FLOW FULLY THROUGH THE ENGINE. DAMAGE CAN OCCUR AND NOT BE KNOWN UNTIL AFTER SEVERAL HOURS OF OPERATION.

7. To ensure uniform heat application, apply hot air directly to the following parts in 5-minute intervals for a minimum of 30 minutes:

⚠ **CAUTION:** APPLY THE HOT AIR UNIFORMLY AND NOT CONCENTRATED IN ONE SPOT TO PREVENT HEAT DAMAGE TO NON-METAL PARTS. HEAT BUILD-UP CAN CAUSE DAMAGE TO WIRING, HOSES, ETC.

8. Between intervals, make sure the engine stays warm and keeps the heat. Make sure there is no damage from heat build-up.
9. During the last 5 minutes of the heat process, apply heat to the top of the engine.
10. Start the engine immediately after the hot air application. Refer to the section "Start the Engine" in the "Engine Operation" chapter of this manual. Also, refer to additional engine start information in the section "Cold Weather Start" in this chapter.

Cold Weather Engine Start

NOTICE: Before an attempt to start an engine in cold weather, complete the "Apply Heat to a Cold Engine" procedure in this chapter. The following is Lycoming Engine's recommended procedure for cold weather engine starts. Refer to the aircraft manufacturer's Pilot's Operating Handbook (POH) for in-flight recommendations during cold weather. Refer to the latest revision of Service Instruction No. SI-1505.

NOTICE: Since the battery could be cold and subject to rapid discharge, use an auxiliary power source.

1. Start the engine and monitor the oil pressure indication.
2. If either you do not see oil pressure (greater than 0) indication within 10 seconds after engine start or oil pressure does **not** continue to increase above the published minimum pressure in the next 20 seconds, stop the engine. Identify and correct the problem before another engine start.
3. After a cold start, do not rapidly increase rpm or exceed the idle rpm.
4. Allow up to 1 minute for oil pressure to become stable above the minimum idling range, since oil lines to the gage can stay cold.
5. Let the engine warm up at idle speed until oil pressure and temperature are stabilized in accordance with the POH.
6. Once oil pressure is stabilized, let the engine warm up 1000 to 1200 rpm until full rpm is reached without exceeding maximum oil pressure. Continue at this rpm while completing pre-flight checks and during taxiing.
7. Before take-off, oil is acceptably warm when full power RPM can applied without exceeding maximum oil pressure.
8. Ensure that when take-off power is applied smoothly, oil pressure, fuel flow, manifold pressure, and rpm remain stable. Surges or fluctuations can be an indication that the engine is not sufficiently warm enough for take-off.

⚠ **CAUTION:** DO NOT TAKE-OFF IF ANY OF THE FOLLOWING CONDITIONS ARE OBSERVED:

- Engine roughness
- Low, high or surging rpm or fluctuations
- High, low, or fluctuating oil pressure
- High or low fuel flow
- High or low manifold pressure
- Low battery charge.

Engine Operation in Hot Weather

During engine operation in hot weather (temperatures above 90°F (32°C)):

1. Monitor oil and cylinder temperatures as per Appendix A.
2. Enrich fuel mixture as necessary.
3. Operate at sustained sufficient airspeed to cool off the engine.
4. Continue to closely monitor temperatures.

Volcanic Ash

⚠ **CAUTION:** DO NOT TOUCH THE VOLCANIC ASH WITH BARE HANDS. DO NOT USE WATER TO REMOVE THE VOLCANIC ASH.

- Given the dynamic conditions of volcanic ash, Lycoming's recommendation is NOT to operate the engine in areas where volcanic ash is present - in the air or on the ground. Refer to the latest revision of Service Instruction No. SI-1530 for any new details.
- Ash on the ground and runways can cause contamination in the engine compartment and subsequent engine damage during aircraft landing or take-off.
- Piston engines can be damaged by inlet air contaminated with volcanic ash. Solid deposits from any number of sources can collect on engine baffles or other engine surfaces and prevent engine cooling. Accumulation of deposits on the induction air filter can restrict or block air flow to the engine and significantly decrease engine power. Contamination of engine oil can cause engine malfunction and/or failure from abrasive wear.
- In the event that flight through volcanic ash clouds or with ash on the ground and subsequent contamination occurs, Lycoming Engines recommends the following standard actions:
    1. Monitor the engine temperature during flight (damaged or blocked cooling baffles or heavy deposits on engine cooling surfaces can decrease cooling efficiency and cause engine overheating).
    2. If the engine is not operating smoothly in flight, make a safe landing of the aircraft as soon as possible and isolate faults on the engine.
    3. Additional measures could be necessary under specific operating conditions. Refer to Chapter 05-50 in the ***HIO-390-A1A Engine Maintenance Manual*** for corrective action.

Overspeed

1. In *engine overspeed*, the engine operates above its rated speed (rpm). Operation of an engine above its rated rpm (specified in Appendix A) can cause accelerated wear on already stressed components. *Momentary overspeed* can occur when the rotor is disengaged from the engine. In rotary wing aircraft, no momentary overspeed is allowed and inspection and maintenance must be done as per the latest revision of Service Bulletin No. SB-369.

   ⚠ **CAUTION:** DO NOT OPERATE AN ENGINE CONTINUOUSLY AT AN OVERSPEED RATE BECAUSE IT CAN WEAR OUT ENGINE PARTS AND EVENTUALLY CAUSE ENGINE FAILURE.

2. Refer to the latest revision of Service Bulletin No. SB-369 for corrective action for engine overspeed.
3. Record all incidents of engine overspeed in the engine logbook, along with the inspection and any specified corrective action taken per Chapter 05-30 in the ***HIO-390-A1A Engine Maintenance Manual.***

Low Oil Pressure During Flight

Circumstances which cause loss of oil pressure are many and varied. Therefore, it is difficult to make a prediction of the extent of damage to the engine or its future reliability. In case of oil pressure loss or engine operation with oil below the recommended minimum operating level (identified in Table A-1 in Appendix A),, the most conservative action is to remove the engine, disassemble, and completely examine all engine components per instructions in the ***HIO-390-A1A Engine Maintenance Manual.***

NOTICE: Very often a sudden loss of oil pressure also shows a sudden increase in oil temperature.

Any time oil pressure falls below the minimum level, complete a safe landing of the aircraft as soon as possible. Identify the root cause according to the protocol per Chapters 05-50 and 12-10 in the ***HIO-390-A1A Engine Maintenance Manual.***

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ENGINE PRESERVATION AND STORAGE

Engine Corrosion and Prevention

Engines in aircraft that are not flown for at least 1 continuous hour within 30 days could be prone to corrosion. Engine corrosion occurs when moisture from the air and products of combustion mix to cause corrosion on cylinder walls and bearing surfaces when the aircraft is not used.

Corrosion rates can increase because of variable factors such as environmental conditions (humidity, salt air in ocean areas), seasonal changes, and engine usage.

Since conditions can change, the corrosion rate can change. Aircraft operated close to oceans, lakes, and rivers and in humid regions have a greater need for engine preservation than engines operated in arid regions. In regions of high humidity, corrosion can be found on cylinder walls of new inoperative engines in as little as 2 days.

The best way to decrease the risk of engine corrosion is for the aircraft to be in flight at least every 30 days for at least 1 continuous hour at oil temperatures between 180°F to 200°F (80°C to 93°C), depending on location and storage conditions. This continuous 1 hour of operation does not include taxi, take-off and landing time. If the engine cannot be operated at the recommended oil temperatures, speak with the aircraft manufacturer about the use of oil cooler winterization plates.

Because climate conditions are different in various geographic areas, Lycoming Engines only can give general recommendations for corrosion prevention. The owner and operator must take into account the following factors for setting a rust and corrosion prevention maintenance schedule for the engine:

- Environmental conditions, especially humidity
- Frequency of flight
- Salt spray from the ocean
- Duration of flights
- Size of the oil cooler system for the engine and airframe installation. (If the oil cooler system is not the correct size, it can cause the engine to overheat or operate below the minimum temperatures.) Low temperature operation can cause a build-up of water and acids

For operation at the correct temperature:

- Make sure the aircraft temperature gages are correct.
- Examine the condition of cooling air baffles. There must not be any blockage.
- Make sure the baffles are the correct fit for maximum cooling air flow.
- Complete the "Oil Change Procedure" at the recommended intervals per Chapter 12-10 in the ***HIO-390-A1A Engine Maintenance Manual***
- Examine the cylinders for corrosion in engines that are stored in humid conditions and/or in flight less than once a week.

Lycoming Engines' recommends compliance with the engine preservation guidelines herein. Active aircraft are flown at least 1 continuous hour at least once within 30 days. Stored aircraft are not in flight for 31 to 60 days.

Engine Preservation Guidelines - 31 to 60 Days

The main emphasis in engine preservation is to decrease the risk of corrosion of engine parts which can decrease engine service life. The engine cylinders, piston rings, valves, valve guides, camshaft, and lifters are of primary concern with regards to corrosion prevention. Corrosion prevention uses rust inhibitive compounds applied to vulnerable surfaces to prevent corrosion.

⚠ **CAUTION:** DO NOT MANUALLY (HAND) OPERATE THE CRANKSHAFT TO LUBRICATE THE ENGINE CYLINDERS. LUBRICATION IS INEFFICIENT WITH MANUAL OPERATION AND CAN CAUSE PREMATURE WEAR OF ENGINE PARTS FROM SCUFFING AND SPALLING.

Engine preservation is necessary, especially for engines that are not operated at least for 1 continuous hour every 30 consecutive days. If you know that an aircraft will not be operated for a minimum of 30 days, then you must follow this procedure.

NOTICE: Ground operation of the engine for brief periods of time is not a substitute for hour-long continuous engine flight. Short ground operation can make corrosive conditions worse.

The engine preservation procedure includes a spray application of preservative oil to the walls of each engine cylinder.

You will need the following items from industrial suppliers to complete this procedure:

- Engine preservation oil mixture made up of 24% MIL-C-6529, 71% SAE J1966 Grade 1065 or MIL-PRF-21260 Grade 30, 5% Cortec M-529)
- Airless spray gun or garden sprayer
- Clay desiccant bags

NOTICE: Start this preservation procedure at the end of the last flight (while the engine is still warm) before putting the engine into storage.

To preserve an engine

1. Operate the engine until it is at the specified operating temperature in Appendix A. If temperatures are below freezing, the oil temperature must be at least 165ºF (74ºC) before the engine is stopped in the next step.
2. Stop the engine.
3. Refer to Chapter 12-10 in the ***HIO-390-A1A Engine Maintenance Manual*** to complete the following steps:
   A. Drain the lubricating oil from the sump or system.
   B. Remove, clean, and install the oil suction screen plug.
4. Fill the sprayer with the preservative oil mixture.
5. Fill the oil sump with the specified preservative oil mixture up to the quantity of oil sump capacity in Table A-1 in Appendix A.
6. Operate the engine until it is at the specified operating temperature. If temperatures are below freezing, the oil temperature must be at least 165ºF (74ºC) before the engine is stopped in the next step.
7. Stop the engine.

8. While the engine is still hot, immediately remove sufficient cowling to access the spark plugs.
9. Remove either the top or bottom spark plug from each cylinder (per the "Spark Plug Removal" procedure in Chapter 74-20 in the ***HIO-390-A1A Engine Maintenance Manual***).
10. Put the sprayer nozzle in the open spark plug hole on each cylinder.
11. Use the sprayer to apply a coat of approximately 2 oz. (60 ml) of the preservative oil mixture through the spark plug hole on the interior wall of each cylinder.

⚠ **CAUTION:** DO NOT TURN THE CRANKSHAFT AFTER SPRAYING THE CYLINDERS WITH PRESERVATIVE OIL.

12. After spray application is complete, remove the sprayer from the spark plug hole.
13. Install the cylinder dehydrator plugs MA-27512-2 (or equivalent) if the aircraft is kept in a region that has high humidity or near a sea coast.

NOTICE: Cylinder dehydrator plugs are recommended to be installed in place of spark plugs because the dehydrator plugs provide moisture indication.

14. While the engine is still warm:
    A. Remove the intake pipes per instructions in Chapter 72-80 in the ***HIO-390-A1A Engine Maintenance Manual***; remove the exhaust system per the airframe manufacturer's manual.
    B. Install bags of clay desiccant in the exhaust and intake ports.
    C. Install the intake pipes per instructions in Chapter 72-80 in the ***HIO-390-A1A Engine Maintenance Manual***; install the exhaust system per the airframe manufacturer's manual.
    D. Attach red cloth streamers to the desiccant as a reminder for the material to be removed when the engine is ready for flight.
    E. Use moisture-proof material and pressure sensitive tape to seal these openings:
    - Exhaust ports
    - Intake ports
    - Breather
    - Vacant accessory pads
    - All openings that connect the inside of the engine to the outside atmosphere

    F. Put a note on the crankshaft flange that reads: "Engine preserved - DO NOT TURN THE CRANKSHAFT."
    G. At 15-day intervals, examine the clay desiccant in the desiccant bags and the cylinder dehydrator plugs (if installed). When the color of the desiccant has changed from blue to pink, remove the used clay desiccant bags and plugs. Install new clay desiccant bags and cylinder dehydrator plugs. Record the date (for future reference) when the desiccant bags and/or plugs were installed.
    H. To return the engine to service after preservation, refer to the "Prepare a Stored Engine for Installation" section in the "Requirements for Engine Installation" chapter of this manual.

Extended Engine Preservation for 61 Days or More

Refer to the latest revision of Service Instruction No. SI-1481.

Fuel Injector Preservation

Refer to the fuel injector manufacturer's instructions for preservation of fuel injectors.

APPENDIX A
ENGINE SPECIFICATIONS AND OPERATING LIMITS

Table A-1
HIO-390-A1A Engine Specifications

Number of Cylinders	4	
Cylinder Arrangement - Firing Order	1-3-2-4	
Spark Plugs	8	
Spark plug advance	20º BTC	
Maximum Continuous Horsepower & Brake Specified Fuel Consumption (BSFC)	210 HP @ 2700 rpm & 0.50	
Take-off Rating Horsepower @ rpm and Manifold Pressure	210 HP @ 2800 rpm & 28.5 in. Hg	
Performance Cruise (75% Rated)	158 @ 2700 rpm	
Economy Cruise (65% Rated)	137 @ 2700 rpm	
Fuel Consumption, Cruise 75% rated power 65% rated power	14 gph 12 gph	
Crankshaft Drive Ratio	1:1	
Crankshaft Rotation	Clockwise	
Cylinder Bore	5.319 in.	13.510 cm
Piston Stroke	4.375 in.	11.1 cm
Cylinder Displacement	389 $in.^3$	6 374.6 cm^3
Compression Ratio	8.9:1	
Weight (lb)	296 lb	134 kg
Dimensions	Height 20.00 in.	50.80 cm
	Width 34.50 in.	87.63 cm
	Length 32.00 in.	81.28 cm
Oil Sump Capacity	8 quarts	7.6 liters
Minimum quantity of oil in flight	2 quarts	1.9 liters
Maximum Oil Consumption	0.006 lb./BHP-Hr.	
Oil Grade Specification **NOTICE:** During the first 50 hours of engine operation of a new, rebuilt, or overhauled engine, it is recommended that this engine be operated with mineral oil until oil consumption has stabilized.	MIL-L-6082 or SAE Grades	MIL-L-22851 or SAE Grades

Table A-1 (Cont.)
HIO-390-A1A Engine Specifications

Oil Grade at All Temperatures	------	15W-50, or 20W-50
Oil Grade at Temperatures above 80°F (27°C)	60	60
Oil Grade at Temperatures above 60°F (16°C)	50	40 or 50
Oil Grade at Temperatures between 30°F to 90°F (-1°C to 32°C)	40	40
Oil Grade at Temperatures between 0°F to 70°F (-18°C to 21°C)	30	30, 40 or 20W-40
Oil Grade at Temperatures below 10ºF (-12ºC)	20	30 or 20W-30
The correct grade of oil to be used is based on environmental conditions. If the aircraft is going to be flown into an area that is much warmer or colder than the aircraft is usually operated in, use a different viscosity of oil. During operation, if the oil inlet temperatures are near the maximum permitted temperatures, then a higher viscosity oil can help to decrease the temperatures.		
Fuel minimum octane (refer to the latest revision of Service Instruction No. 1070 for any new approved fuels)	100 or 100LL (Aviation Grade)	
Fuel Injector (Rear-mounted AVStar servo regulator)	RSA-10ED1	
Fuel Pump	Diaphragm Type	
Starter - Hartzell (formerly Kelly Aerospace) or equivalent Starter - Sky-Tec or equivalent	12 Volt - Geared (Optional) 24 Volt Geared (Optional) 12 Volt - Geared (Optional) 24 Volt - Geared -(Optional)	
Alternator - Hartzell (formerly Kelly Aerospace) or equivalent	12 Volt, 70 Amp (Optional) 24 Volt, 70 Amp (Optional)	
Magnetos (2) Slick or equivalent or Magnetos (2) TCM or equivalent	4345 (Left) (Retard Breaker) 4370 (Right) (Plain) S4LN-200 (Left) (Retard Breaker) S4LN-204 (Right) (Plain)	
Magneto Drive, Ratio to Crankshaft and Rotation	1.000:1 - Clockwise	

NOTICE: All locations and rotations are as viewed from the anti-crankshaft flange end of the engine unless specified differently.

For any possible additional optional starters and alternators, refer to the latest revision of Lycoming Service Instruction No. 1154.

Table A-2
Table of Operating Limits for HIO-390-A1A Engine

Oil Pressure - Minimum Idling		25 psi	172 kPa
Oil Pressure - Operating (rear of engine)		55 to 95 psi	379 to 655 kPa
Oil Pressure - Starting, Warm-up, Taxi, and Take-off (Maximum)		115 psi	792 kPa
Optimum Oil Temperature (for maximum engine life)		165ºF to 200 ºF	74ºC to 93 ºC
Minimum Oil Temperature (before take-off) read from engine		140ºF	60ºC
Minimum Oil Temperature (during cruise) read from engine		170ºF	77ºC
Maximum Oil Temperature		245°F	118°C
Boost Pump Outlet Pressure Limits to Fuel Injector Inlet	Parallel Boost	14 to 45 psi	97 to 310 kPa
	Series Boost	14 to 35 psi	97 to 241kPa
Fuel Pressure at inlet to the Fuel Pump		-2 to +35 psi	-14 to 241 kPa
Maximum Cylinder Head Temperature (measured at thermocouple)		465°F	241°C
Cylinder Head Temperature (for maximum engine life) - Above 75% power (in level flight cruise conditions)		450°F	232°C
Cylinder Head Temperature (for maximum engine life) - At 75% power and below (in level flight cruise conditions)		435°F	224°C
Alternator Stator Slot Temperature		360ºF	182ºC
Alternator Stator End Turns Temperature		360ºF	182ºC
Alternator Drive End Bearing Temperature		248ºF	120ºC
Alternator Positive Heat Sink Temperature		305ºF	152ºC
Maximum Magneto Temperature (measured in the pole laminations)		225ºF	107ºC

Table A-3
Accessory Drives for HIO-390-A1A Engines

Accessory Drive	Type of Drive	Direction of Rotation	Drive Ratio	Maximum Torque				Maximum Overhang Moment	
				Continuous		Static			
				in.-lb	Nm	in.-lb	Nm	in.-lb	Nm
Starter	SAE	Counter-clockwise	16.556:1	---	---	450	52	150	17
Alternator	SAE	Clockwise	3.25:1	60	7	120	14	175	20
Tachometer	SAE	Clockwise	0.5:1	7	0.8	50	6	5	0.6
Accessory Drive No. 1	AND20000*	Counter-clockwise	1.3:1	70	8	450	51	25	2.9
Accessory Drive No. 2	AND20000	Clockwise	1.3:1	100	11	800	90	40	4.5
* Except for torque limitation and rotation									

For any possible additional optional starters and alternators, refer to the latest revision of Lycoming Service Instruction No. 1154.

APPENDIX B

INSTALLATION AND WIRING DIAGRAMS

NOTICE: Installation drawing (O4C63627) is available from Lycoming Engines for the HIO-390-A1A engine.

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APPENDIX C

PERFORMANCE DATA

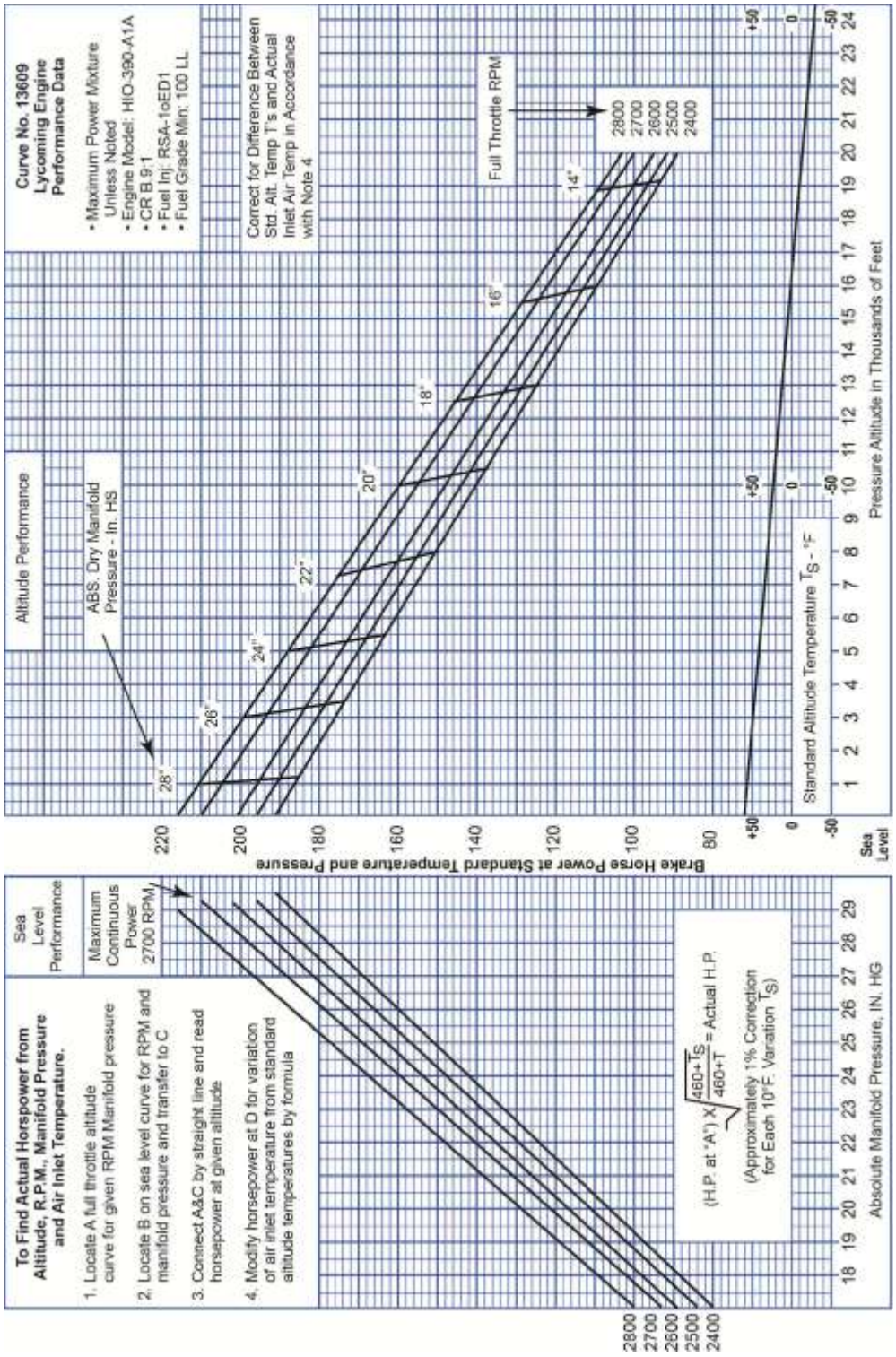

Figure C-1
Sea Level and Altitude Performance

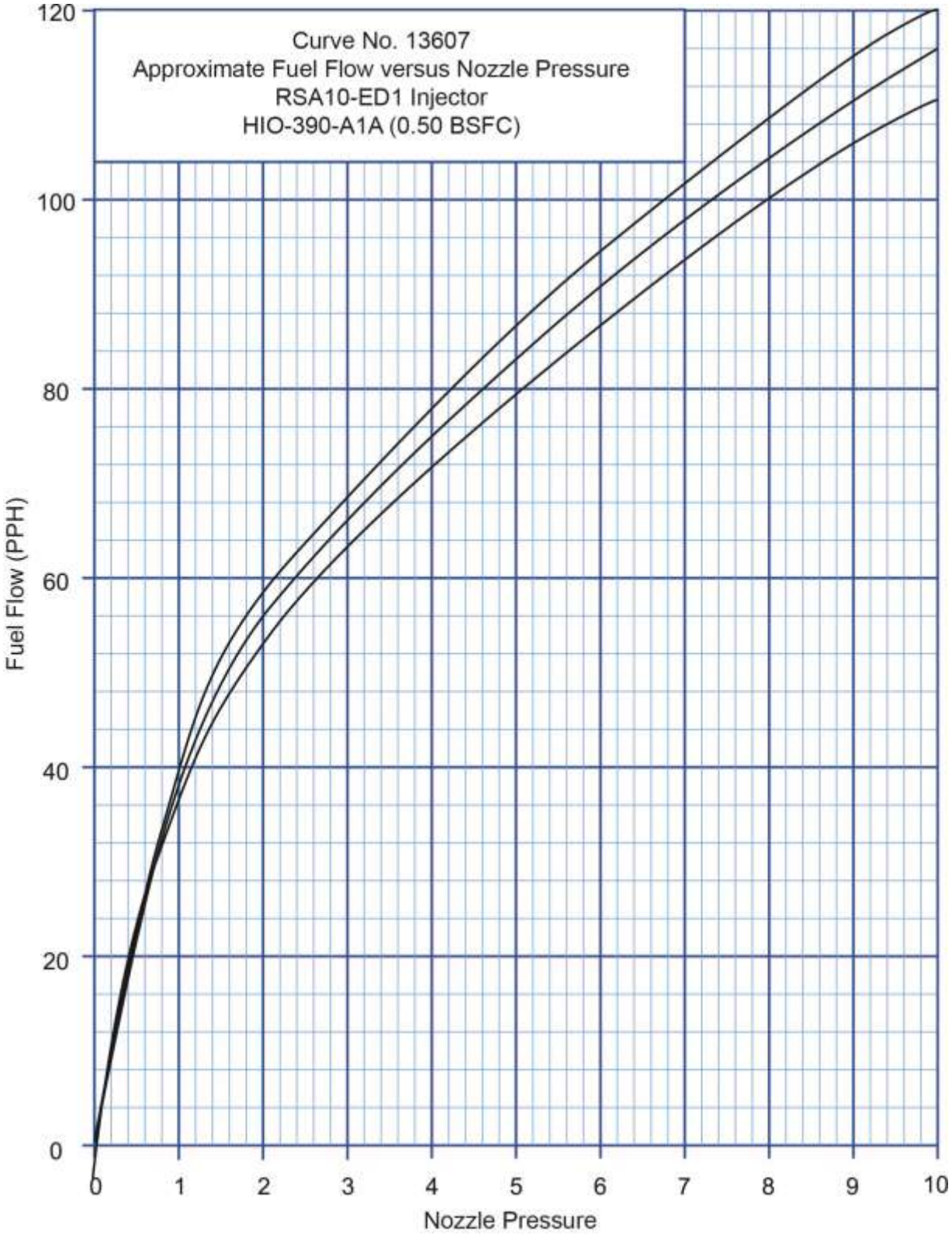

Figure C-2
Minimum Fuel Flow vs. Nozzle Pressure

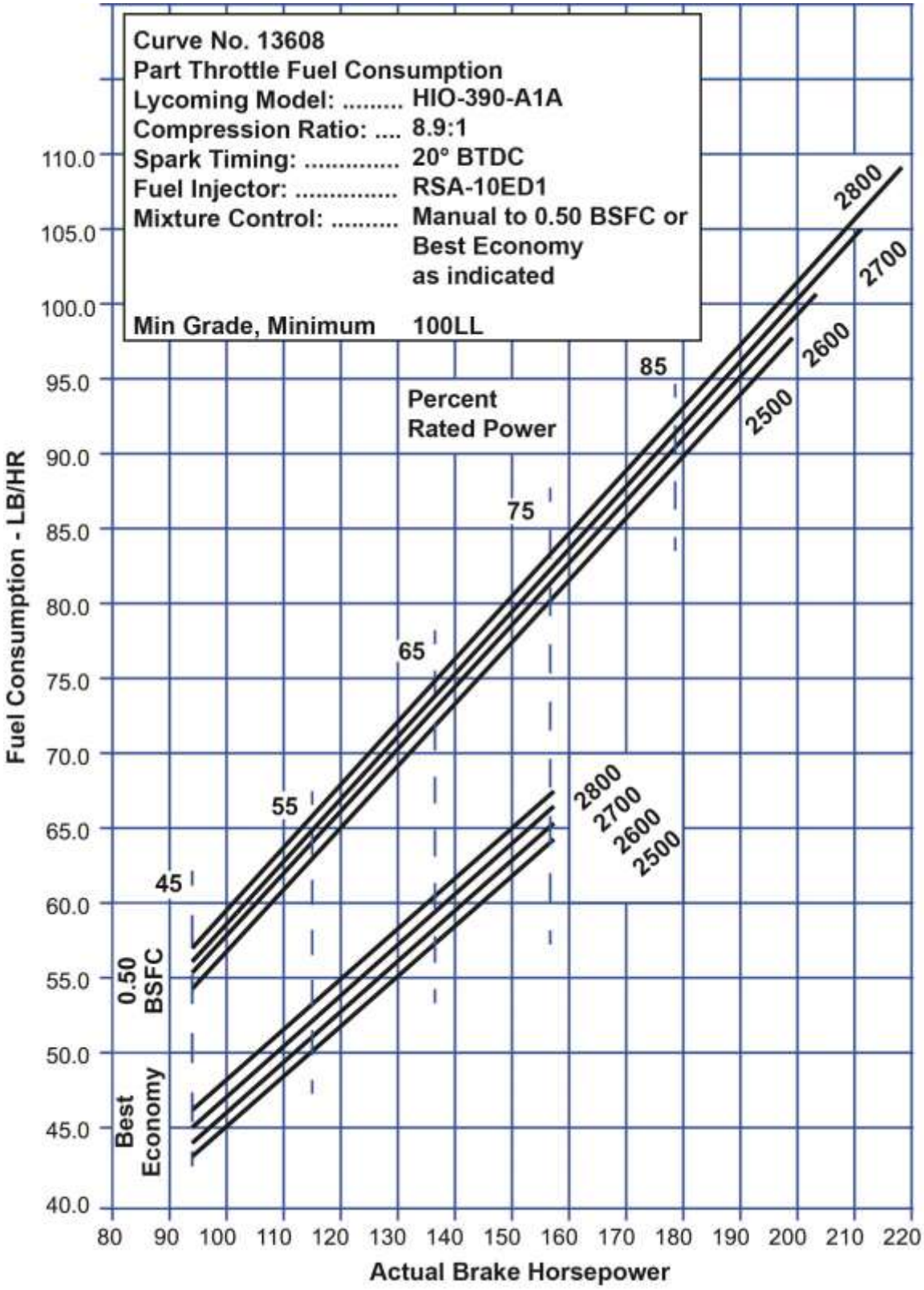

Figure C-3
Part Throttle Fuel Consumption

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