Engine Installation and Operation Manual

IO-390-D Series

March 2020

Part No. IOM-IO-390-D Series

IO-390-D Series Engine
Installation and Operation Manual

Lycoming Part Number: IOM-IO-390-D Series

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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-IO-390-D Series

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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. Supplements to a service document contain information relevant to the service document but not yet added to the service document.

The latest revision of all service documents in this list can be downloaded from our website https://www.lycoming.com/contact/knowledge-base/publications.

To narrow the search parameters and limit the number of returns, enter only the numerical portion of the service document number in the **Search** box on the website.

Number	Incorporation Date	Subject
S.B. 369	03/20	Engine Inspection after Overspeed
S.B. 399	03/20	Action to Take If Loss of Oil Pressure
S.B. 480	03/20	I. Oil and Filter Change and Screen Cleaning II. Oil Filter Screen Content Inspection
S.B. 533	03/20	Recommended Action for Sudden Engine Stoppage, Propeller/Rotor Strike or Loss of Propeller/Rotor Blade or Tip
S.I. 1009	03/20	Recommended Time Between Overhaul Periods
S.I. 1014	03/20	Lubricating Oil Recommendations
S.I. 1070	03/20	Specified Fuels
S.I. 1094	03/20	Fuel Mixture Leaning Procedures
S.I. 1098	03/20	Propeller Flange Bushing Location
S.I. 1132	03/20	Magneto Drop-off
S.I. 1143	03/20	Counterweight Bushing Inspection, Replacement, and Special Tooling Upgrades
S.I. 1154	03/20	FAA Approved Starter and Alternators
S.I. 1241	03/20	Pre-oil the Engine Prior to Initial Start
S.I. 1304	03/20	Engine Nameplate Replacement
S.I. 1409	03/20	Lycoming Engines P/N LW-16702, Oil Additive
S.I. 1427	03/20	Lycoming Reciprocating Engine Run-In and Oil Consumption
S.I. 1443	03/20	Approved Slick Magnetos and Lycoming Electronic Ignition System (EIS) on Lycoming Engines
S.I. 1472	03/20	Removal of Preservative Oil from Engine
S.I. 1481	03/20	Factory Engine Preservation

SERVICE DOCUMENT LIST (CONT.)

S.I. 1505	03/20	Cold Weather Starting
S.I. 1528	03/20	Aircraft Engine Starter Recommendations
S.I. 1530	03/20	Engine Inspection in a Particulate Laden Environment (Volcanic Ash, Sand, Dust, Airborne Debris)
S.I. 1532	03/20	Approved Fuel Injectors, Fuel Manifold Assemblies, and Fuel Nozzle Assemblies for Lycoming Engines
S.I. 1566	03/20	Lycoming Engines Approves the Use of Safety Cable
S.I. 1569	03/20	Installation of Lycoming Electronic Ignition System (EIS)
L 114	03/20	Reciprocating Engine and Accessory Maintenance Publications
L180	03/20	Engine Preservation for Active and Stored Aircraft
L193	03/20	Engine Firing Order

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ABBREVIATIONS AND ACRONYMS

A	
Amp	Ampere
B	
BHP	Brake Horsepower
BSFC	Brake Specified Fuel Consumption
BTC	Before Top Center
Btu	British Thermal Unit
C	
C	Celsius
CHT	Cylinder Head Temperature
cm	Centimeter
E	
EIS	Lycoming Electronic Ignition System
EGT	Exhaust Gas Temperature
EIS	Electronic Ignition System
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	
ICAs	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 of the IO-390 engine models. Hyphenated numbers and letters in the suffix (D1A6, D3A6, D1B6, or D3B6) of the engine model number are configuration designations associated with the core engine.

Model Number	Meaning
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 IO-390-D series 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 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 ***IO-390-D Series Engine Maintenance Manual.***

For spare parts information, refer to the ***IO-390-D Series 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 subscribers with 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 without a subscription.

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 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.

List of Publications

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

Instructions for Continued Airworthiness

The ***IO-390-D Series Engine Maintenance Manual***, latest revision of the ***Service Table of Limits - SSP-1776,*** and service documents make up the complete set of Instructions for Continued Airworthiness (ICAs). The ICAs are prepared by Lycoming Engines and are accepted 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 WRITTEN AT A LATER DATE SUPERSEDE PROCEDURES IN THIS MANUAL.

PROCEDURES IN THE MAINTENANCE MANUALS 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 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.

Tables and Checklists

Tables in this manual are used to display detailed information in an organized format. Tables always start as Table 1 in each chapter. Checklists are used to display a list of tasks to be completed as part of a specific procedure. Checklists are not numbered because they are used as a reference tool contained within the procedure.

Copyright

Environmental Compliance

Lycoming Engines recommends that engine owners and 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.

Feedback

To supply comments, suggestions, or corrections to this manual, either email or contact Lycoming Engines Technical Support at the email or phone number in the front of this manual or use the Lycoming.com website.

Manual Revisions

Lycoming Engines constantly examines our manuals to provide our customers the most complete and up-to-date information for operating and maintaining our engines. Revisions to this manual will be published as necessary.

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SYSTEM DESCRIPTION

The Lycoming IO-390-D series engines are direct-drive four-cylinder, horizontally opposed, fuel-injected, air-cooled engines. Each engine has tuned induction and a down exhaust.

There are different IO-390-D engine models. Figures 1A and 1B show the IO-390-D engine models. The main difference between the engine models has to do with the location of the propeller governor. The IO-390-D1A6 and -D3A6 models (Figure 1A) have an optional propeller governor installed on the rear of the engine. Whereas, on the IO-390-D1B6 and -D3B6 engine models (Figure 1B), the propeller governor is installed on the front of the crankcase.

There are different propeller flange bushing configurations for these engine models. Refer to the latest revision of Service Instruction No. SI-1098 for the configuration for your engine model.

NOTICE: Refer to Appendix B for engine performance data.

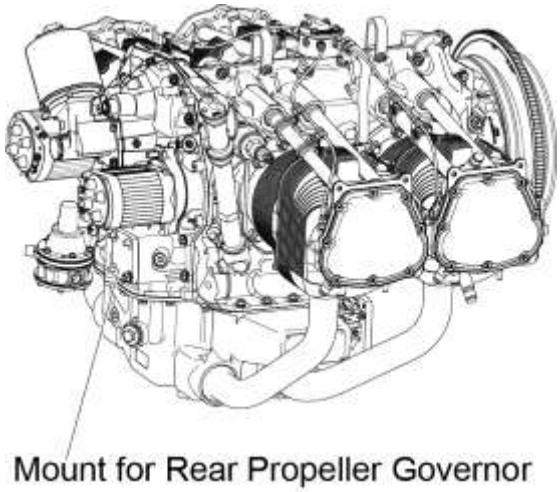

Figure 1A
IO-390-D1A6, -D3A6 Engine

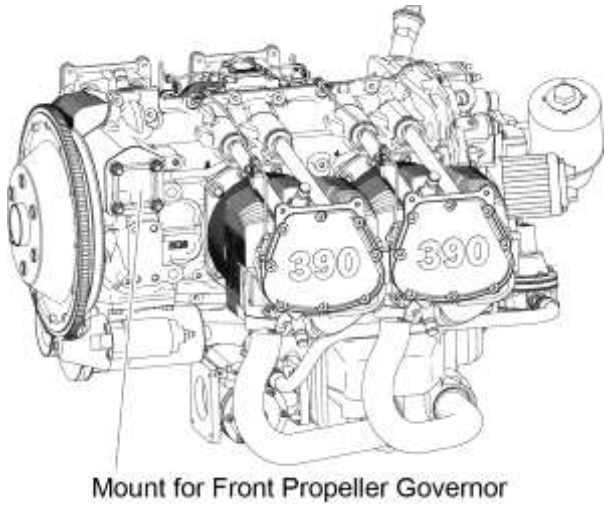

Figure 1B
IO-390-D1B6, -D3B6 Engine

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.

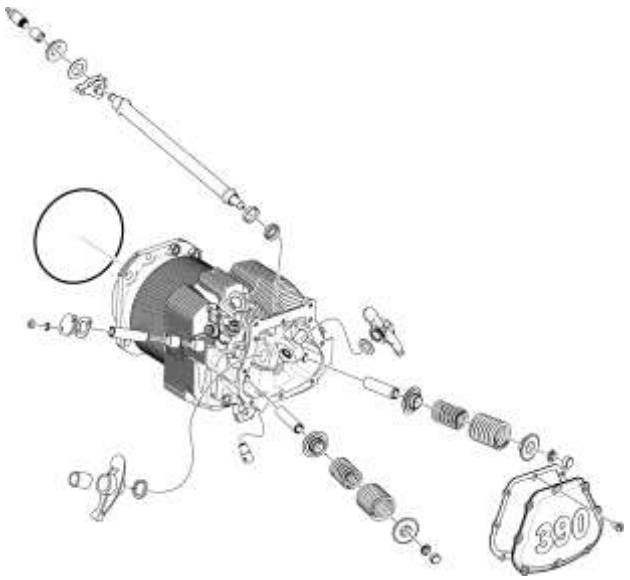

Figure 2
Engine Cylinder

Crankcase

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

The crankcase forms the bearings for the camshaft. The camshaft operates the tappets which control opening and closing of the intake and exhaust valves. For front propeller governor models the camshaft has an integral spur gear that drives the propeller governor output shaft.

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 and counterweights. The counterweights decrease torsional vibrations as the crankshaft turns to operate the propeller.

Oil is supplied through the propeller flange for a single-acting controllable pitch propeller.

Four oil nozzles supply oil for internal piston cooling

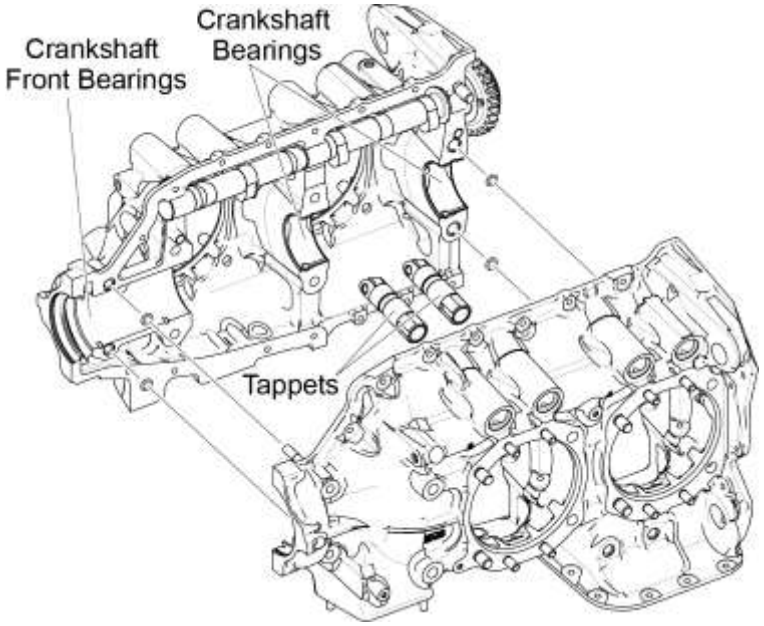

Figure 3
Crankcase

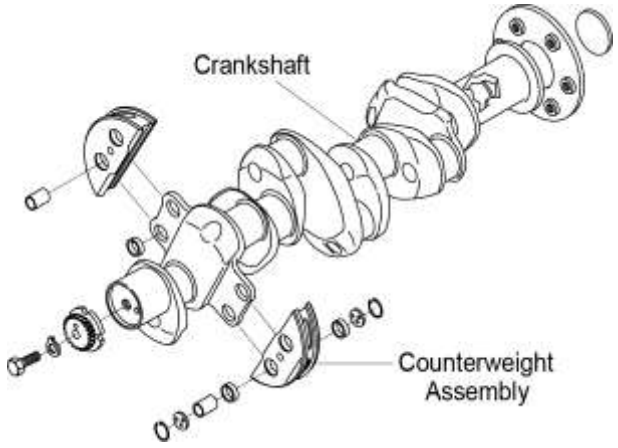

Figure 4
Crankshaft

Ignition System

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

- Eight spark plugs (two per cylinder)
- Ignition harness
- Ignition system consisting of two Lycoming Electronic Ignition System units or as an option the engine can be equipped with two magnetos (identified in Appendix A).

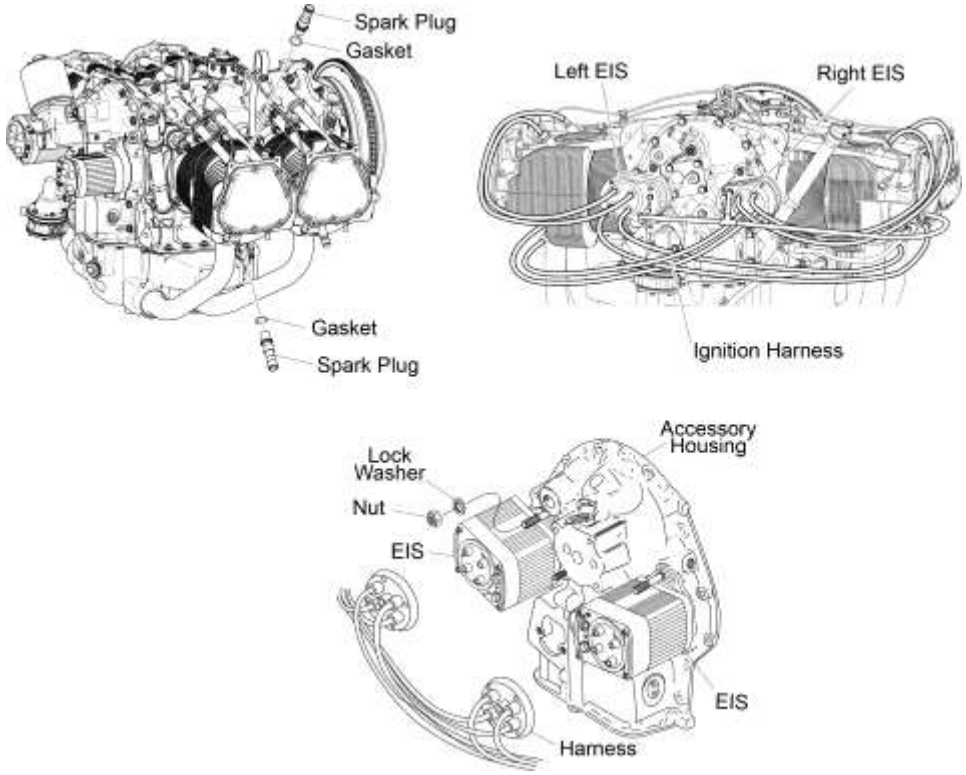

Figure 5
Ignition System

Starter

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

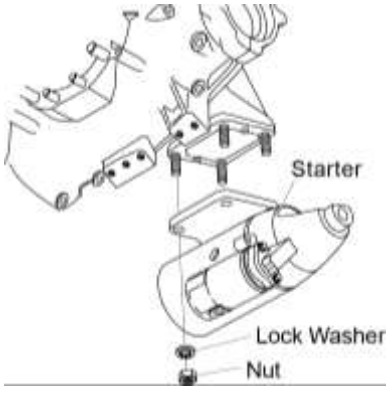

Figure 6
Starter

Fuel Injection System

The fuel injection system (Figure 7) includes: a fuel manifold, fuel injector, four injection nozzles (one per cylinder), a diaphragm-type fuel pump, and fuel lines which connect the:

- Fuel pump to the fuel injector
- Fuel injector to the fuel manifold
- Fuel manifold to the four injection nozzles

Refer to the fuel flow and consumption curves in Appendix B.

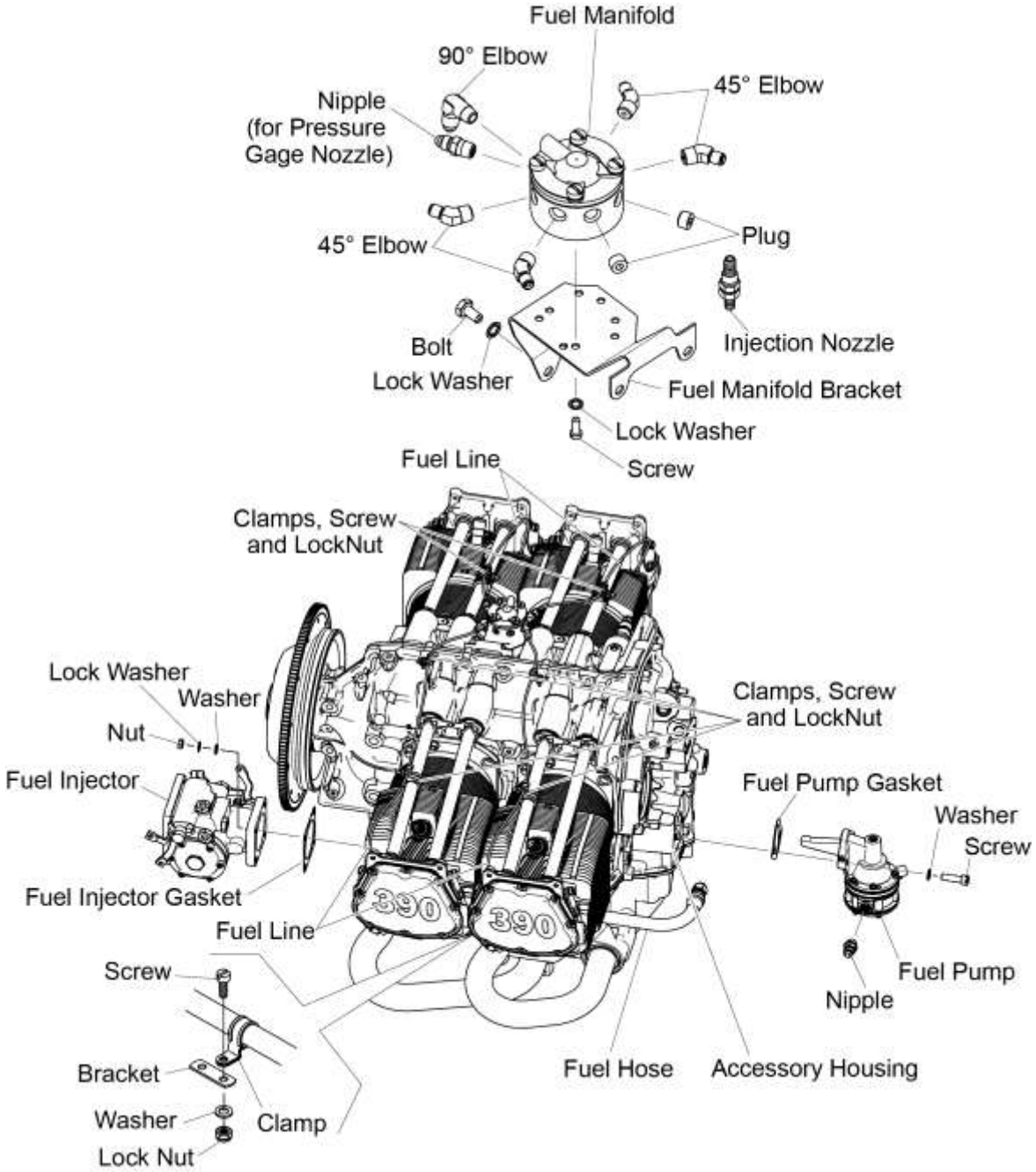

Figure 7
Fuel Injection System

Lubrication System

The lubrication system (Figure 8) includes a wet sump, oil pump, oil fill/dipstick, oil suction screen, full flow oil filter or pressure screen, and oil lines.

There is a drain plug on the oil sump. Another plug on the oil sump is for removal of the oil suction screen.

NOTICE: IO-390-D Series engines can be equipped with aluminum or magnesium oil sump or accessory housing. Be aware of the type of components installed on your engine before cleaning, completing maintenance, or replacing parts.

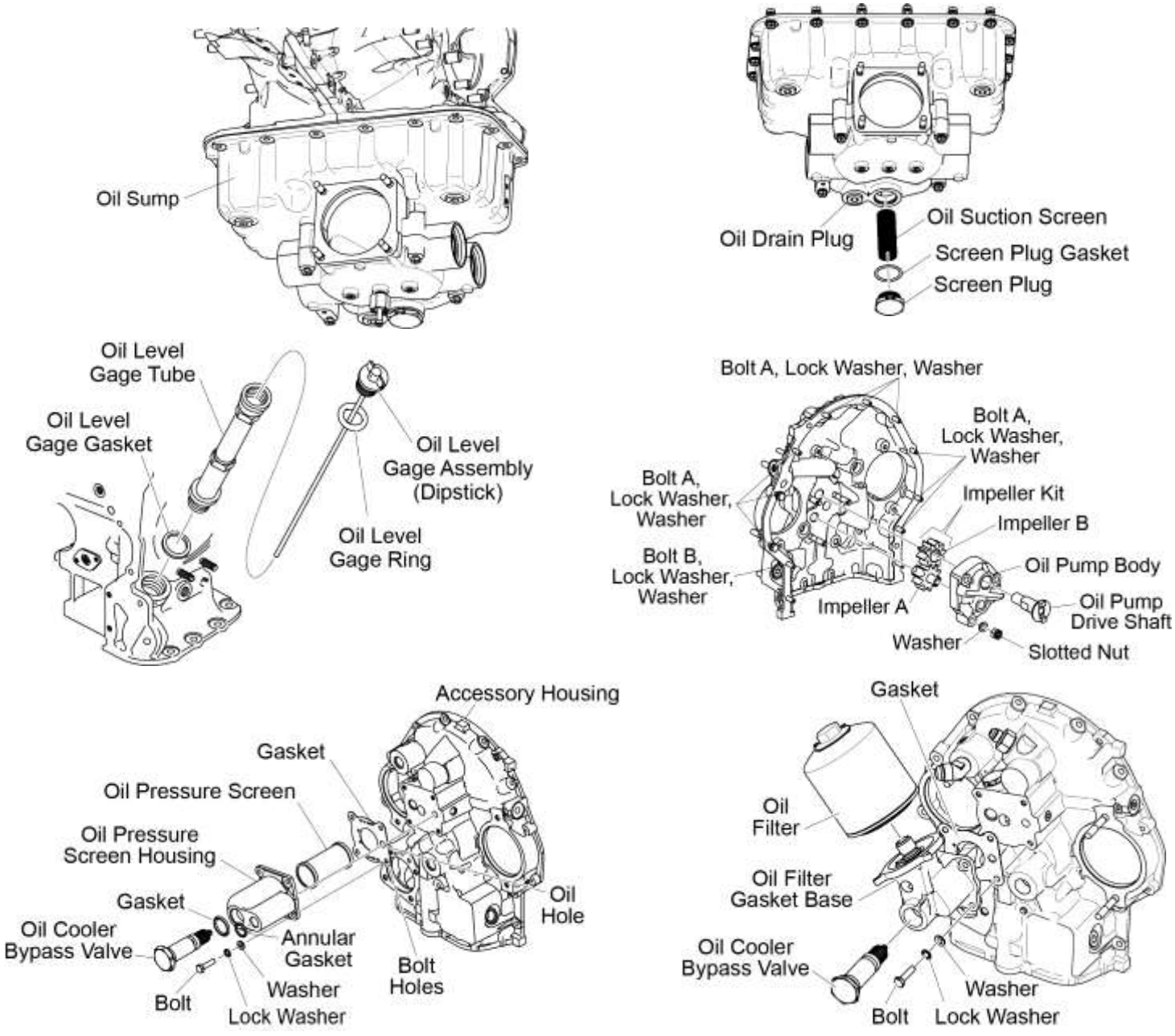

Figure 8
Lubrication System for IO-390-D Series Engines

Cylinder Number Designations

- The propeller 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.

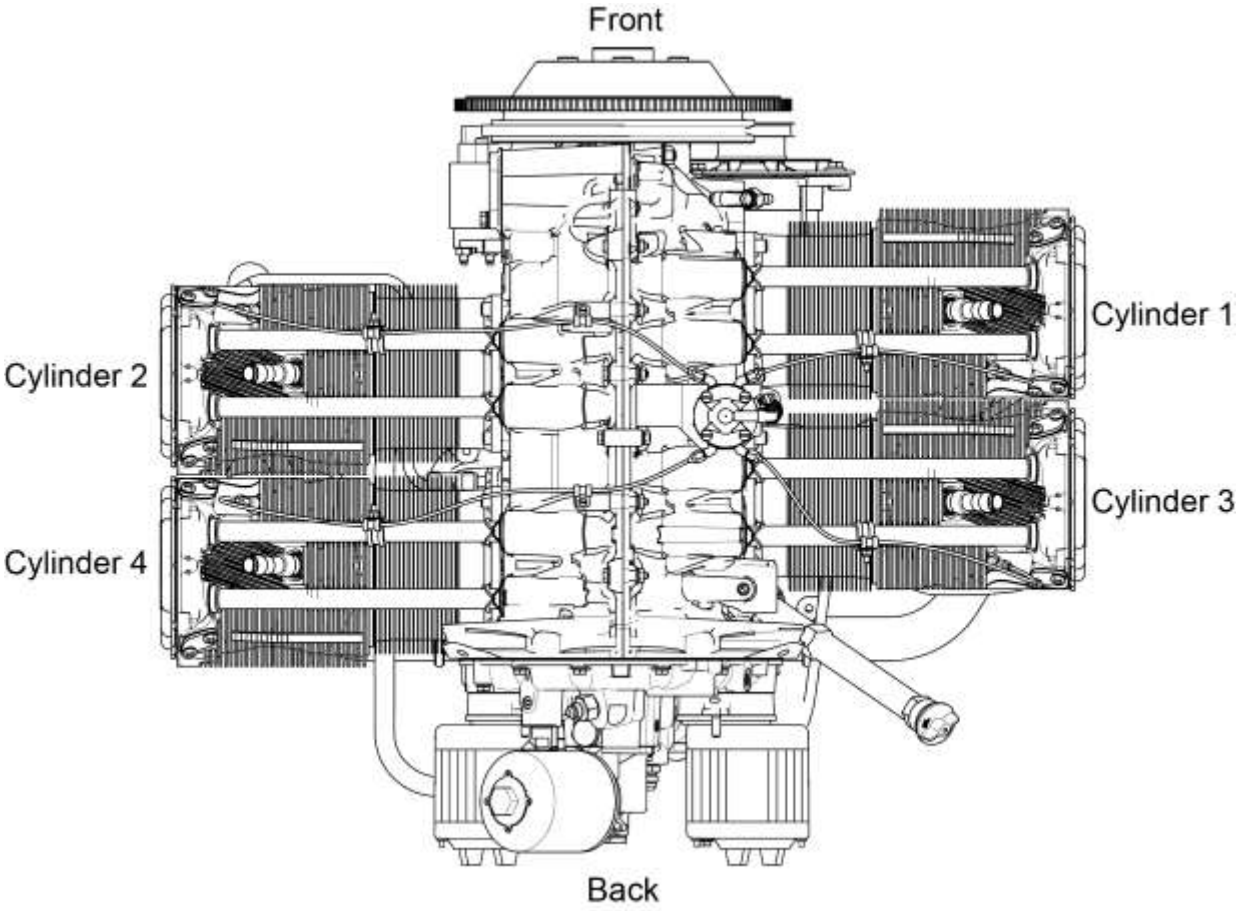

Figure 9
Cylinder Number Designation

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.

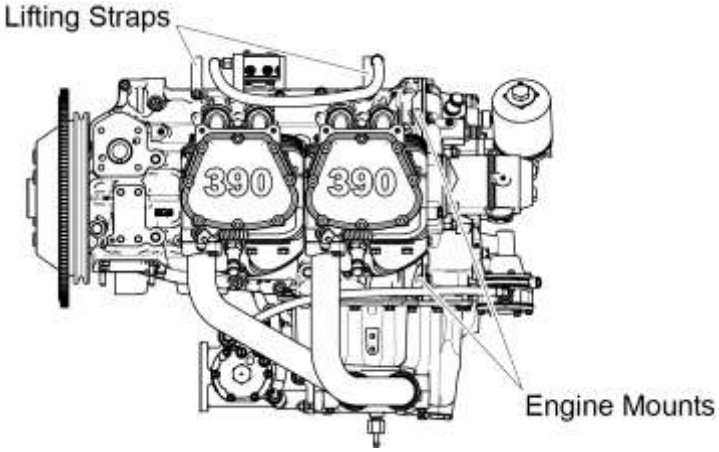

Figure 2
Engine Lift

⚠ **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. Remove the bolts that attach the shipping brackets to the front and rear of the engine.
3. Lift the engine slowly and vertically.
4. 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 or stored engine to be placed into service.

As an overview, Table 1 identifies the necessary steps with references to sections in this chapter, 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 and 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.

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

⚠ **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.

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 ***IO-390-D Series Engine Maintenance Manual.***

2. Complete the preservative oil removal procedure as follows:
   A. If any of the dehydrator plugs (which contain crystals of silica gel) break and the crystals fall into the engine, complete the following per the ***IO-390-D Series Engine Maintenance Manual.***
      - Disassemble the affected portion of the engine.
      - Clean the engine.
   B. Remove desiccant bags.
   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 ***IO-390-D Series 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 both oil sump drain plugs. Discard the safety wire/cable.
   C. Remove the oil sump drain plugs.
   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 ***IO-390-D Series Engine Maintenance Manual.***
   F. Apply one to two drops of Loctite® 564™ to the threads of each oil sump drain plug and install the oil sump drain plugs in the oil sump. Torque the drain plugs in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

   ⚠ **CAUTION** MAKE SURE THAT BOTH OIL SUMP DRAIN PLUGS AND THE SUCTION SCREEN PLUG ARE INSTALLED TIGHTLY. IF THE DRAIN PLUGS AND OIL SUCTION SCREEN PLUG ARE NOT TIGHTLY INSTALLED AND LEAK, ENGINE FAILURE CAN OCCUR.

   G. Safety wire/cable the two 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.

6. Drain the fuel pump:
   A. Put a collection container underneath the fuel pump.
   B. Remove the shipping caps installed 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 ***IO-390-D Series Engine Maintenance Manual***.
7. Remove the plug in the induction system (Figure 1).
8. Drain any preservative oil from the induction system.
9. Install the fuel drain valve adapter assembly (shipped with the engine as a "Ship Loose Part") in the induction system (Figure 2). Refer to Chapter 72-80 in the ***IO-390-D Series Engine Maintenance Manual*** for installation instructions.

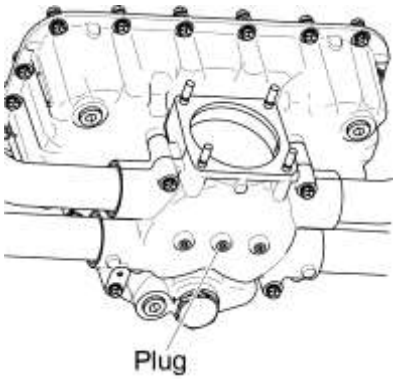

Figure 1
Plug in the Induction System

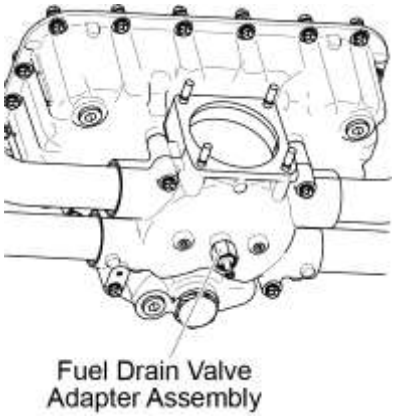

Figure 2
Fuel Drain Valve Adapter Assembly Installed in the Induction System

10. Refer to Chapter 74-20 in the ***IO-390-D Series 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 ***IO-390-D Series 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.
11. If a constant speed propeller is used:
    A. Use a pointed punch tool to make a 1/8 in. to 3/16 in. hole in the center of the front expansion plug on the crankshaft.
    B. Remove and discard the expansion plug from the crankshaft.
    C. Since it is possible a little piece of expansion plug can fall off, look for and remove any foreign object contamination.
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, it is recommended that this engine be operated with mineral oil until oil consumption has stabilized.

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 SPARK PLUGS. 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 clay desiccant bags for the intake and exhaust ports.

NOTICE: If any of these plugs break and the crystals fall into the engine, complete the following procedure per the ***IO-390-D Series 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 ***IO-390-D Series 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 ***IO-390-D Series Engine Maintenance Manual.***

8. Complete the preservative oil removal 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 ***IO-390-D Series 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 ***IO-390-D Series Engine Maintenance Manual.***
   F. Apply one to two drops of Loctite® 564™ 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 THE SUCTION SCREEN PLUG ARE INSTALLED TIGHTLY. IF THE DRAIN PLUG AND SCREEN PLUG ARE NOT TIGHTLY INSTALLED AND LEAK, ENGINE FAILURE CAN OCCUR.

   G. Safety wire/cable the oil sump drain 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.
12. Remove the oil filter and install a new oil filter. Refer to Chapter 12-10 in the ***IO-390-D Series Engine Maintenance Manual.***

13. If the front expansion plug is installed and a constant speed propeller is to be used:
    A. Use a pointed punch tool to make a 1/8 in. to 3/16 in. hole in the center of the front crankshaft plug.
    B. Remove and discard the expansion plug from the crankshaft.
    C. Since it is possible a little piece of expansion plug can fall off, look for and remove any foreign object contamination.
14. Refer to Chapter 74-20 in the ***IO-390-D Series 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 ***IO-390-D Series 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.
15. Remove the fuel inlet strainer from the throttle body and clean it with a hydrocarbon-based solvent such as mineral spirits or equivalent and re-install the strainer on the throttle body.
16. Examine the fuel supply lines, fuel manifold, and throttle body to make sure they are clean and dry.
17. Add specified oil per Appendix A. Refer to the "Add Oil" procedure in the "Engine Installation" chapter in this manual.
18. 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

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
Electronic Ignition System (EIS)	Refer to the "Lycoming Electronic Ignition System (EIS)" section in the ***IO-390-D Series Engine Maintenance Manual.***
Magnetos (Optional)	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 AN5541 fittings for installation on each cylinder head.

Table 2 (Cont.)
Optional Equipment, Recommendations,
and Requirements to Prepare the Engine for Installation

Issue	Recommendation/Requirement
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 970 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 provided as standard equipment. 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.
Oil pressure gage	There is a provision for installation by the aircraft manufacturer for installation of an oil pressure gage connection.
Fuel supply hose	Correctly-sized hose for the fuel pump supply and return vent line back to the airframe.
Propeller Shaft	Conforms to specification AS127, Type 2.
Mounting	Four mounting brackets for rear-type conical mounting, maximum load 5500 lb. (2495 kg). The front pads on the crankcase are also machined to allow for bed-mounting of the engine.
Air cleaner	Air cleaner at rated power is 1500 lb of air per hour; pressure drop not to exceed 6 in. of water.
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.
External fuel filter	150 microns

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 rubber mounts and bolts for attachment to the conical engine mounts. There are four mounting bosses integral to the crankcase.

Maximum Allowable Load for the Mounting Attachment and Structure

The conical mounts can withstand a 10 G load per FAA FAR requirements.

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).

Dual EIS Installations

Refer to the airframe manufacturers specifications to ensure the second EIS is connected to a backup power source independent from the aircraft's electrical system.

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.

Table 1 identifies steps and section references in this chapter for engine installation.

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	Install the Propeller
8	Connect Fuel Lines
9	Connect Oil Lines
10	Install Components That Had Been Removed Before Engine Installation and Any Additional Ship Loose Components
11	Add Oil
12	Engine Pre-Oil Procedure
13	Add Fuel
14	Final Installation Inspection
15	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 or A-4 in Appendix A.
3. If necessary, install the propeller governor; use the manufacturer's supplied gasket and hardware. Refer to Table A-3 or A-4 in Appendix A.
4. Install the alternator per airframe manufacturer's instructions.

Step 4. Connect the Linkages

Connect the throttle, mixture, and propeller linkages 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. Install the Propeller

⚠ **CAUTION** IF THE CORRECT PROPELLER BUSHING IS NOT INSTALLED IN THE SPECIFIED LOCATION, THE PROPELLER WILL NOT BE INDEXED CORRECTLY AND EXCESSIVE PROPELLER BLADE STRESSES CAN OCCUR.

Install the propeller in accordance with the propeller and aircraft manufacturer's instructions. Make sure the propeller flange bushings of the correct part number are installed in the correct indexed location. Refer to the latest revision of Service Instruction No. SI-1098 and any supplements.

Step 8. 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 fuel supply line to the fuel pump inlet. Torque the connections per the aircraft manufacturer's instructions.
6. Required guidelines for making fuel line connections:
   A. Make sure the fuel line is not crimped or kinked, there are no cracks at solder joints, and the fuel line is in compliance with Figure 1 for the minimum acceptable dimension for a bend in the fuel line.

   NOTICE: Refer to Chapter 73-10 in the ***IO-390-D Series 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 ***IO-390-D Series Engine Maintenance Manual.***

   B. Make sure that the fuel lines are held in place with the necessary cushioned clamps and hardware. Make sure the clamps are tightly attached to support the fuel line and to prevent movement from vibration or motion 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.

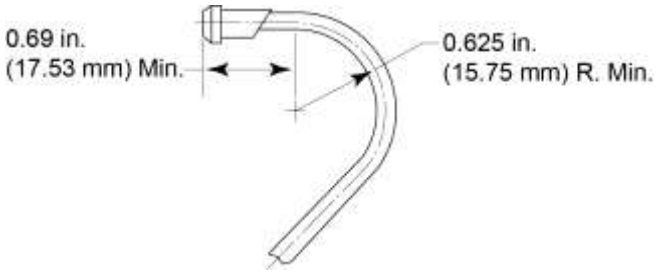

Figure 1
Minimum Acceptable Dimension for a Bend in a Fuel Line

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

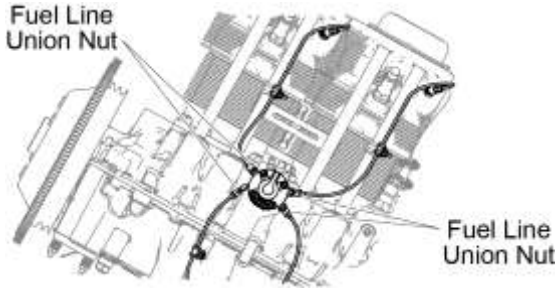

Figure 2
Fuel Line Union Nuts

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 9. 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 airframe supplied oil lines to the engine per airfare manufacturer's instructions. Refer to the installation drawing for correct engine oil line connections.
2. 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 10. 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 11. 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, 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, drain the mineral oil and add new oil identified in Appendix A.

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.

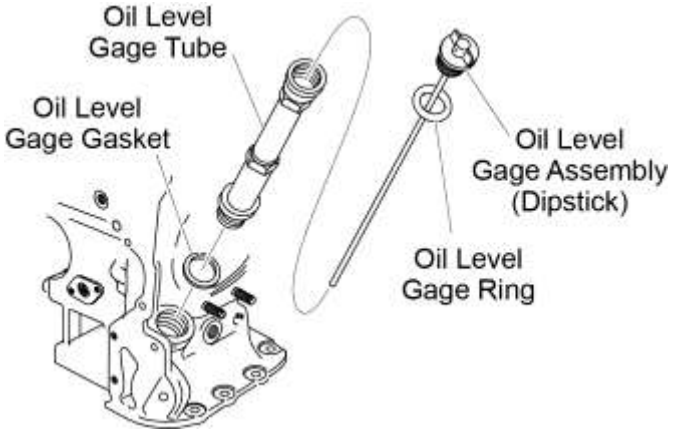

Figure 3
Oil Level Gage Tube and Oil Level Gage (Dipstick)

3. Measure the oil level per the "Oil Level Check" procedure in Chapter 12-10 of the ***IO-390-D Series 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 12. Engine Pre-Oil Procedure

WARNING IF THE PRE-OIL PROCEDURE IS NOT DONE, 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 engine propeller or 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

  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 11. Add Oil to the Engine" 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 (as applicable to the aircraft configuration).
3. Fill the oil cooler with engine oil per the airframe manufacturer's instructions.
4. Per the "Spark Plug Removal" procedure in Chapter 74-20 of the ***IO-390-D Series Engine Maintenance Manual***, remove one spark plug from each cylinder of the engine. Remove and discard the spark plug gasket.

   NOTICE: Ensure that both Lycoming Electronic Ignition System units or both magnetos are grounded during the pre-oil procedure.

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 in each cylinder as per instruction in Chapter 74-20 of the ***IO-390-D Series 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 approximately 1000 rpm.

Step 13. Add Fuel

WARNING DETONATION CAN OCCUR IF THE INCORRECT FUEL IS USED. DETONATION CAN INCREASE ENGINE CYLINDER TEMPERAURE 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 14. Final Installation Inspection

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

Step 15. Close 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 the engine is securely installed on the engine mounts. Make sure that the hardware that attaches the engine to the engine mounts is torqued as per the airframe manufacturer's specified torque values.		
Make sure all wiring harnesses and wiring connections have been made.		
Make sure the throttle, mixture, and propeller linkage are connected.*		
Make sure the accessories and alternators are installed.		
Make sure baffles have been installed.		
Make sure the compressor belt has been installed per aircraft and compressor manufacturer's instructions.		
Make sure the propeller is installed per propeller and aircraft 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 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 ***IO-390-D Series 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, a ***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 fixed wing aircraft includes two procedures, "Preparation for Ground Operational Test with Engine Installed in Aircraft" and "Ground Operational Test."

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

NOTICE: 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. For optimum cooling during the ground operational test, use a test club propeller. If a test club is unavailable, a regular flight propeller can be used as long as cylinder head temperatures are monitored closely.

2. **Ground Operational Test**

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

A. Before the start of the ground operational test, examine the oil cooler, propeller, and governor for metal contamination. These parts must be clean and free of contamination before the ground operational test can begin. If the engine had failed before overhaul, the oil cooler, propeller, and governor must be replaced or cleaned and examined by an approved repair facility.

B. Put the aircraft in a position facing the wind.

C. Start the engine and look at the oil pressure gage. If sufficient oil pressure indication (per Appendix A, Table A-2) is not shown within 30 seconds, stop the engine. Identify and correct the cause.

D. If oil pressure is sufficient, operate the engine at 1000 RPM until the oil temperature is stable or is at 140°F (60°C). After warm-up, the oil pressure is not to be less than the minimum specified pressure per Appendix A.

E. Increase the engine speed to 1500 RPM and operate the engine at that speed for 15 minutes.

F. Make sure the cylinder head temperature, oil temperature, and oil pressure are within the specified limits in Appendix A of this manual.

NOTICE: Extended ground operation can cause excessively high cylinder head and/or oil temperatures.

If any malfunction occurs, stop the engine and let it cool. Identify and correct the cause before continuation of the ground operational test.

a) Start the engine again and monitor oil pressure.

b) Increase engine speed to 1500 RPM for 5 minutes.

G. Complete a magneto drop-off check during engine start per the "Engine Initiation" chapter in this manual.

H. Complete a cycle of the propeller pitch and a feathering check as applicable per the airframe manufacturer's recommendations.

I. Operate the engine to full-static aircraft recommended power (in Appendix A) for up to 10 seconds.

J. After engine operation at full power, slowly decrease the RPM to idle and let the engine stabilize.

NOTICE: As needed, set fuel controls on new, rebuilt, or overhauled engine to 50 to 100 rpm higher than usual idle speed (600 to 700 rpm) for the first 25 hours of operation - then adjust to the usual setting after the first 25 hours of operation.

K. Complete a check of the idle mixture adjustment per the "Idle Speed and Mixture Adjustment" procedure in Chapter 72-00 of the ***IO-390-D Series Engine Maintenance Manual.***

L. Shut down the engine per the "Engine Stop" procedure in the "Engine Initiation" chapter of this manual.

M. After shutdown, examine the engine for oil and fuel leaks. Identify and correct the cause of any leaks.

N. Per Chapter 12-10 in the ***IO-390-D Series 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.

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

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
(Except Engine Overhauled in the Field)

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
* The break-in procedure must be done on any engine that has had one or more cylinders or piston rings replaced per procedures in Chapter 72-30 of the ***IO-390-D Series Engine Maintenance Manual***.	

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 IO-390-D SERIES ENGINE MAINTENANCE MANUAL FOR THIS ENGINE.

NOTICE: In this chapter the term "magneto" can refer to either the Lycoming Electronic Ignition System (EIS) or optional, traditional magnetos, depending on the type of system installed on the 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

Engine Model Number_____ Engine Serial Number:_____

Engine Time:_____ Date Inspection Done:_____

Inspection done by:_____

Requirement	Comments	Done
Make sure that all switches are OFF.		
Make sure the Lycoming EIS or 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 12. 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, propeller hub area, 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 ***IO-390-D Series Engine Maintenance Manual.***

Pre-Flight Inspection Checklist for Engine Initiation (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 line 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 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 ***IO-390-D Series 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

WARNING MAKE SURE THAT THE AREA AROUND THE PROPELLER IS CLEAR OF PERSONNEL OR ANY OBSTRUCTION BEFORE STARTING THE ENGINE. IF THE PROPELLER 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 start procedure. 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 12. Complete the Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual.

2. Complete specified steps for engine start recommended by the aircraft Pilot's Operating Handbook (POH), aircraft manufacturer, or Supplemental Type Certificate (STC) holder's instructions.

WARNING EXAMINE THE ENGINE FOR HYDRAULIC LOCK. REFER TO THE IO-390-D SERIES ENGINE MAINTENANCE MANUAL. DO NOT OPERATE THE ENGINE IF HYDRAULIC LOCK IS POSSIBLE. HYDRAULIC LOCK IS A CONDITION WHERE FLUID ACCUMULATES IN THE INDUCTION SYSTEM OR THE CYLINDER ASSEMBLY. HYDRAULIC LOCK CAN CAUSE ENGINE DAMAGE.

DO NOT CONTINUE TO OPERATE A MALFUNCTIONING ENGINE. OPERATION OF A MALFUNCTIONING ENGINE CAN RESULT IN ADDITIONAL DAMAGE TO THE ENGINE, POSSIBLE BODILY INJURY OR DEATH.

3. Refer to the aircraft POH for the engine start settings and start procedure.
4. Set the alternate air control to the OFF position.
5. Set the propeller governor to FULL RPM.
6. Turn the fuel valve ON in accordance with the aircraft POH.
7. Open the throttle approximately to 1/4 travel.
8. Turn the boost pump ON.
9. Move the mixture control to FULL RICH until a slight but steady flow is indicated (approximately 3 to 5 seconds) and return the mixture control to IDLE CUT-OFF.
10. Set the magneto select switch per the aircraft manufacturer's instructions.

NOTICE: For switch information, refer to the aircraft manufacturer's handbook

CAUTION DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 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. DO NOT TRY MORE THAN FIVE ENGINE STARTS WITHIN A 2-MINUTE PERIOD.

NOTICE: A low battery, engine speed less than 50 rpm, or sub-zero temperatures can prevent engine start. Refer to the section "Apply Heat to a Cold Engine" in the "Engine Conditions" chapter.

11. Energize the starter (not to exceed 10 seconds) until the engine starts.
12. Put the magneto switch in the BOTH position.
13. Move the mixture control slowly and smoothly to FULL RICH.

CAUTION DO NOT EXCEED THE IDLE RPM (SET BY THE AIRCRAFT MANUFACTURER) UNTIL THE OIL PRESSURE IS STABLE ABOVE THE MINIMUM IDLING RANGE. IF THE OIL PRESSURE DOES NOT INCREASE TO THE MINIMUM PRESSURE WITHIN 10 SECONDS, STOP THE ENGINE. IDENTIFY AND CORRECT THE CAUSE. REFER TO THE "ENGINE CONDITIONS" CHAPTER IN THIS MANUAL.

CAUTION COMPLETE SMOOTH AND STEADY FULL RANGE THROTTLE MOVEMENTS IN 2 TO 3 SECONDS. FULL RANGE THROTTLE MOVEMENT IN LESS THAN 2 SECONDS IS TOO RAPID AND CAN CAUSE SUBSEQUENT ENGINE DAMAGE.

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

WARNING DO NOT OPERATE THE ENGINE IF THE OIL PRESSURE IS LOW. IF THE ENGINE IS OPERATED AT LOW OR NO OIL PRESSURE, THE ENGINE CAN MALFUNCTION OR STOP.

15. Look at the oil pressure gage for indicated pressure. If there is no oil pressure indication within 10 seconds, stop the engine. Identify and correct the problems.

NOTICE: Unstable oil pressure or oil pressure less than 25 psi (172 kPa) could be an indication of obstructed or interrupted oil flow or air in the oil lines. In this case, stop, identify and correct the cause.

NOTICE: The engine is warm enough for take-off when the throttle can be opened without the engine faltering.

Upon engine start, if smoke comes from a newly installed engine, after the first start, there could have been some preservative oil in the cylinders, induction system, and/or fuel nozzles/lines. If oil pressure is normal and the engine operates smoothly, continue to operate the engine until the smoke clears. Otherwise, stop the engine and identify the cause.

16. Let the engine operate at 1000 rpm for approximately 3 minutes.

17. Complete a magneto drop-off check as follows for all three cycles RIGHT/LEFT/BOTH.

    A. Operate the engine at approximately 2100 to 2200 RPM.

    NOTICE: To prevent spark plug fouling, do not operate on a single magneto for too long a period. A few seconds is usually sufficient for the magneto drop-off check.

    B. Switch from BOTH magnetos to one magneto and note the drop-off; return to BOTH until the engine regains speed and switch to the other magneto and note the drop-off, then return to BOTH. Drop-off must not exceed 175 rpm and must not exceed 50 rpm between magnetos.

    C. If the rpm drop exceeds 175 rpm, slowly lean the mixture until the rpm peaks. Then retard the throttle to the specified rpm, for the magneto drop-off check and repeat the check. If the drop-off does not exceed 175 rpm and the difference between the drop-off values for both magnetos does not exceed 50 rpm, and the engine is running smoothly, the ignition system is operating properly.

    D. Smooth operation of the engine with a drop-off that exceeds the specification of 175 rpm is usually an indication of a propeller load condition at a rich mixture.

18. Look for any illuminated caution or warning lights in the cockpit.

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 OPERATIONAL TEST AGAIN.

Complete the engine run-up as follows:

1. With the engine running, turn the Fuel Selector to FULLEST or BOTH.

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

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

CAUTION AVOID PROLONGED IDLING AND DO NOT EXCEED 2200 RPM ON THE GROUND. THE ENGINE IS WARM ENOUGH FOR TAKE-OFF WHEN THE THROTTLE CAN BE OPENED WITHOUT THE ENGINE FALTERING.

4. With the mixture control at FULL RICH, increase the throttle to 1800 rpm.

Step 4. Engine Stop

1. Set the propeller at minimum blade angle.
2. Keep the engine speed between 1000 to 1200 rpm, until the operating temperatures are stable and EGT 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 PROPELLER 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

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)
- Operating at specified cruise powers (per Appendix A) for 50 hours or until oil consumption stabilizes.

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 usual service.

WARNING REPLACE ENGINE TEST CLUBS WITH APPROVED FLIGHT PROPELLERS BEFORE THE FLIGHT TEST.

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.

A. Start the engine and complete a pre-flight run-up in accordance with the applicable manufacturer's POH.

B. Complete a full power take-off in accordance with the POH.

C. Monitor the engine rpm, fuel flow, oil pressure, oil temperature and cylinder head temperature during take-off.

D. As soon as possible, decrease to climb power in accordance with the POH.

E. Complete a shallow climb angle to a suitable cruise altitude.

F. Adjust the fuel/air mixture per the POH.

WARNING DURING BREAK-IN, MAKE SURE THE ENGINE IS OPERATED AT 65% OR MORE CRUISE POWER AS MUCH AS PRACTICAL TO ENSURE CORRECT PISTON RING SEATING. ENGINE OPERATION BELOW 65% CRUISE POWER AT ANY TIME CAN CAUSE POOR ENGINE PERFORMANCE.

NOTICE: For a normally aspirated (non-turbocharged) engine, operate the engine at cruise power at the lower altitudes. Density altitude in excess of 8,000 feet (2438 m) will prevent the engine from reaching sufficient cruise power for an acceptable break-in; an altitude of 5,000 feet (1524 m) is recommended.

G. At cruise altitude, decrease power to approximately 75% and continue flight for 2 hours. For the second hour, operate the engine at power settings alternating between 65% and 75% power as per the applicable POH.

H. If the engine and aircraft are operating to specifications in Appendix A, increase engine power to the maximum airframe recommended power and hold for 30 minutes.

CAUTION FOR ENGINES THAT HAVE DYNAMIC COUNTERWEIGHT ASSEMBLIES, DO NOT OPERATE AT LOW MANIFOLD PRESSURE DURING HIGH ENGINE SPEEDS UNDER 15 IN. HG AND RAPID CHANGES IN ENGINE SPEEDS. THESE CONDITIONS CAN CAUSE DAMAGE TO THE COUNTERWEIGHTS, ROLLERS OR BUSHINGS, AND CAUSE DETUNING.

⚠ **CAUTION** DO NOT DO CLOSED THROTTLE DESCENTS. CLOSED THROTTLE OPERATION DURING DESCENTS WILL CAUSE RING FLUTTER WHICH CAN CAUSE DAMAGE TO THE CYLINDERS AND PISTON RINGS.

I. Decrease altitude at low cruise power and closely monitor the engine instruments. Do not do long descents at low manifold pressure. Do not decrease altitude too rapidly. The engine temperature could decrease too quickly.

J. After landing and shutdown, examine the engine for oil and fuel leaks. Identify and correct the cause of any leaks.

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

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

L. 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.

M. Complete the inspections identified in the "Required Inspections" section in this chapter.

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

O. Continue to operate the engine at cruise power settings of 65% to 75% for 50 hours or until oil consumption stabilizes.

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 ***IO-390-D Series Engines 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

NOTICE: In this chapter the term "magneto" can refer to either the Lycoming Electronic Ignition System (EIS) or optional, traditional magnetos, depending on the type of system installed on the engine.

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 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 PROPELLER IS CLEAR OF PERSONNEL OR ANY OBSTRUCTION BEFORE STARTING THE ENGINE. IF THE PROPELLER 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 "Engine Operation in Hot Weather" in the "Engine Conditions" chapter in this manual.

The following is Lycoming Engine's recommended start procedure. If there is any variation between the start procedure in the aircraft manufacturer's POH and Lycoming Engine's recommended start procedure, follow the aircraft manufacturer's POH procedure.

1. Complete specified steps for engine start recommended by the aircraft POH, aircraft manufacturer, or Supplemental Type Certificate (STC) holder's instructions.

2. 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 ***IO-390-D Series Engine Maintenance Manual*** for details.

⚠ **CAUTION** 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.

3. Refer to the aircraft POH for the engine start settings and start procedure.
4. Set the alternate air control to the OFF position.
5. Set the propeller governor to FULL RPM.
6. Turn the fuel valve ON in accordance with the aircraft POH.
7. Open the throttle approximately to 1/4 travel.
8. Turn the boost pump ON.
9. Move the mixture control to FULL RICH until a slight but steady flow is indicated (approximately 3 to 5 seconds) and return the mixture control to IDLE CUT-OFF.
10. Set the magneto select switch per the aircraft manufacturer's instructions.

NOTICE: For switch information, refer to the aircraft manufacturer's handbook.

⚠ **CAUTION** DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 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. DO NOT TRY MORE THAN FIVE ENGINE STARTS WITHIN A 2-MINUTE PERIOD.

NOTICE: A low battery, engine speed less than 50 rpm, or sub-zero temperatures can prevent engine start. Refer to the section "Apply Heat to a Cold Engine" in the "Engine Conditions" chapter.

11. Energize the starter (not to exceed 10 seconds) until the engine starts.
12. Look at the oil pressure gage. 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.
13. Put the magneto switch in the BOTH position.
14. Move the mixture control slowly and smoothly to FULL RICH.

⚠ **CAUTION** DO NOT EXCEED THE IDLE RPM (SET BY THE AIRCRAFT MANUFACTURER) UNTIL THE OIL PRESSURE IS STABLE ABOVE THE MINIMUM IDLING RANGE. IF THERE IS NO INDICATION OF OIL PRESSURE WITHIN 10 SECONDS, STOP THE ENGINE. IDENTIFY AND CORRECT THE CAUSE. REFER TO CHAPTER 12-30 IN THE IO-390-D SERIES ENGINE MAINTENANCE MANUAL.

COMPLETE SMOOTH AND STEADY THROTTLE MOVEMENTS. FULL RANGE THROTTLE MOVEMENT IN LESS THAN 2 SECONDS IS TOO RAPID AND CAN CAUSE SUBSEQUENT ENGINE DAMAGE.

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

CAUTION DO NOT OPERATE THE ENGINE IF THE OIL PRESSURE IS LOW. IF THE ENGINE IS OPERATED AT LOW OR NO OIL PRESSURE, THE ENGINE CAN MALFUNCTION OR STOP.

NOTICE: Unstable oil pressure or oil pressure less than 25 psi (172 kPa) could be an indication of obstructed or interrupted oil flow or air in the oil lines. In this case, stop, identify and correct the cause.

The engine is warm enough for take-off when the throttle can be opened without the engine faltering.

Upon engine start, if smoke comes from a newly installed engine, after the first start, there could have been some preservative oil in the cylinders, induction system, and/or fuel nozzles/lines. If oil pressure is normal and the engine operates smoothly, continue to operate the engine until the smoke clears. Otherwise, stop the engine, identify and correct the cause.

16. Let the engine operate at 1000 rpm for approximately 3 minutes.
17. Look for any illuminated caution or warning lights in the cockpit.

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 OPERATIONAL TEST IN THE "FIELD RUN-IN" CHAPTER AGAIN.

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 for all three cycles RIGHT/LEFT/BOTH.
   A. Operate the engine at approximately 2100 to 2200 RPM.

   NOTICE: To prevent spark plug fouling, do not operate on a single magneto for too long a period. A few seconds is usually sufficient for the magneto drop-off check.

   B. Switch from BOTH magnetos to left magneto and record the drop-off; return to BOTH until the engine regains speed and switch to the right magneto and record the drop-off, then return to BOTH. Drop-off must not exceed 175 rpm and must not exceed 50 rpm between magnetos.
   C. If the rpm drop exceeds 175 rpm, slowly lean the mixture until the rpm peaks. Then retard the throttle to the specified rpm, for the magneto drop-off check and repeat the check. If the drop-off does not exceed 175 rpm and the difference between the drop-off values for both magnetos does not exceed 50 rpm, and the engine is running smoothly, the ignition system is operating properly.
   D. Smooth operation of the engine with a drop-off that exceeds the specification of 175 rpm is usually an indication of a propeller load condition at a 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.

NOTICE: Full feathering check (twin engine) on the ground is not recommended but a check of the feathering action can be done by operating the engine between 1000 to 1500 rpm, then momentarily pulling the propeller control into the feathering position. Do not allow the rpm to drop more than 500 rpm.

4. For engines with a variable pitch propeller, increase the engine speed to approximately 2100 to 2200 RPM and cycle through the propeller pitch setting three times to ensure correct propeller operation.
5. 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 take-off power 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 ***IO-390-D Series 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.

NOTICE: During descent, it could be necessary to manually lean fuel-injected engines for smooth operation.

Fuel Mixture Leaning Options

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, set the propeller at minimum blade angle.
2. Keep the engine speed between 1000 to 1200 rpm, until the operating temperatures are stable and 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 PROPELLER 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.

ENGINE CONDITIONS

Action for Engine Conditions

Table 1 identifies action for engine conditions during engine start or operation. Detailed fault isolation is included in the ***IO-390-D Series 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, high or fluctuating oil pressure	Make a safe landing and speak to Maintenance.
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.
Engine 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.
Stalled engine	• Make sure the fuel selector is set to the correct fuel tank. • Make sure that the auxiliary fuel pump is **ON**. • Set the mixture to rich. • Make sure that the ignition switch is set to **BOTH**. • If the propeller has stopped turning, engage the starter. **If the engine restart procedure during flight is not successful, complete a safe landing. Refer to the Aircraft POH for complete procedures on in-flight loss of power.**
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.
Propeller strike, sudden stoppage and lightning strikes	Make a safe landing. Refer to the ***IO-390-D Series 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.

Table 1 (Cont.)
Action for Engine Conditions

Condition	Action
Sluggish propeller operation	Make a safe landing and speak to Maintenance.
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 ***IO-390-D Series Engine Maintenance Manual***
Overspeed	Refer to the section "Overspeed" in this chapter.
Volcanic ash	Refer to the section "Volcanic Ash" in this chapter.
Engine soaked in water	Refer to Chapter 05-50 in the ***IO-390-D Series Engine Maintenance Manual.***

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 extremely 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). Do not use small electric heaters (which install in the cowling opening) to warm up an engine because they do not apply sufficient heat.

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. Use a high volume air heater to apply heat.
2. Apply hot air to all parts of a cold-soaked engine.
3. Make sure the engine oil is in compliance with the recommended grades in Appendix A.

⚠ 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.

4. To ensure uniform heat application, apply hot air to the following parts in 5-minute intervals for a minimum of 30 minutes:
   - Oil sump
   - Oil filter
   - External oil lines
   - Oil cooler
   - Cylinder assemblies
   - Air intake.

⚠ **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.

5. If cowl flaps are installed, open the cowl flaps to prevent heat build-up.
6. Between intervals, make sure the engine stays warm and keeps the heat. Make sure there is no damage from heat build-up.
7. During the last 5 minutes of the heat process, apply heat to the top of the engine.
8. Start the engine immediately after the hot air application. Also, refer to additional engine start information in the section "Cold Weather Start" in this chapter.

Cold Weather Engine Start

NOTICE: 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.

1. After a cold start, do not rapidly increase acceleration or exceed the idle rpm. Allow up to 1 minute for oil pressure to become stable above 1000 rpm, since oil lines to the gage can stay cold. If oil pressure indication is not shown within 10 seconds, stop the engine. Identify and correct the cause. If no leaks or damage are found, complete the pre-heat application again before engine start.
2. Let the engine warm up at 1000 rpm until oil pressure and temperature are stable within operating limits, identified in Appendix A.
3. Complete a ground check in accordance with the aircraft manufacturer's POH.
4. Complete a cycle of the propeller control position in accordance with the aircraft and propeller manufacturer's instructions to make sure warm oil is in the propeller dome.
5. 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).

⚠ **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 manifold pressure
- Low battery charge.

6. Make sure that when take-off power is applied smoothly, oil pressure, fuel flow, manifold pressure, and rpm remain stable.

Engine Operation in Hot Weather

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

A. Monitor oil and cylinder temperatures as per Appendix A.
B. Operate the engine with cowl flaps fully open.
C. Do not operate the engine at maximum power any longer than necessary to make the climb configuration recommended by the aircraft manufacturer.
D. Operate at sustained sufficient airspeed to cool off the engine.

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.
- Ash on the ground and runways can cause contamination of the engine compartment and subsequent engine damage during aircraft landing or take-off.
- 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.

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

    3. Additional measures could be necessary under specific operating conditions. Refer to the ***IO-390-D Series Engine Maintenance Manual*** for corrective action.

Overspeed

- In *engine overspeed*, the engine operates above its rated rpm speed (Appendix A). Operation of an engine above its rated rpm can cause accelerated wear on already stressed components. *Momentary overspeed* can occur during a landing attempt, when the propeller governor is in a lag as the throttle is suddenly opened for a go-around. In fixed wing aircraft, momentary overspeed is an increase of no more than 10% of rated engine rpm for a period not exceeding 3 seconds.

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

- Refer to the latest revision of Service Bulletin No. SB-369 for corrective action for engine overspeed.
- Record all incidents of engine overspeed in the engine logbook, along with the inspection and any specified corrective action taken per Chapter 05-50 in the ***IO-390-D Series 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 and disassemble the engine and completely examine all engine components per instructions in the ***IO-390-D Series 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 of sudden loss of oil pressure according to the progressive steps identified in Chapters 05-50 and 12-30 of the ***IO-390-D Series Engine Maintenance Manual.***

NOTICE: Any decision to operate an engine that had a loss of oil pressure without an inspection must be the responsibility of the agency who is putting the aircraft back into service.

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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 oil and oil filter changes per the recommended intervals per Chapter 12-10 in the ***IO-390-D Series 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 PROPELLER 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 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: Recommend starting this preservation procedure at the end of the last flight before putting the engine into storage.

For engines installed in aircraft stored for 31 to 60 days:

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 ***IO-390-D Series 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 ***IO-390-D Series 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 ***IO-390-D Series 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 ***IO-390-D Series 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 propeller that reads: "Engine preserved - DO NOT TURN THE PROPELLER."
    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
IO-390-D Series Engine Specifications

Number of Cylinders		4	
Cylinder Arrangement - Firing Order		1-3-2-4	
Spark Plugs		8	
Ignition timing advance		20º BTC - Variable	
Maximum Continuous Horsepower		215 HP @ 2700 rpm & 0.47	
Performance Cruise (75% Rated)		161 @ 2450 rpm	
Economy Cruise (65% Rated)		140 @ 2350 rpm	
Fuel Consumption, Cruise	75% rated power 65% rated power	13.1 gph 10.0 gph	
Propeller Drive Ratio		1:1	
Propeller Shaft Rotation		Clockwise	
Counterweight Order		One 6.3 order and one 8th order pendulum-type counterweight	
Bore		5.319 in.	13.510 cm
Stroke		4.375 in.	11.1 cm
Piston Displacement		389 $in.^3$	6 374.6 cm^3
Compression Ratio		8.9:1	
Weight (lb)	D1A6 and D3A6	288 lb.	130.6 kg
	D1B6 and D3B6	285 lb.	129.3 kg
Dimensions	D1A6 and D3A6	Height 20.96 in.	53.24 cm
		Width 34.37 in.	87.30 cm
		Length 32.56 in.	82.70 cm
Dimensions	D1B6 and D3B6	Height 22.52 in.	57.20 cm
		Width 34.37 in.	87.30 cm
		Length 29.08 in.	73.86 cm
Oil Sump Capacity		7 quarts	6.6 liters
Minimum quantity of oil in flight		3.5 quarts	3.3 liters
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.		SAE J1966 or MIL-L-6082B SAE Grades	SAE J1899 or MIL-L-22851 Ashless Dispersant SAE Grades
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

Table A-1 (Cont.)
IO-390-D Series Engine Specifications

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. SI-1070 for any new approved fuels.)	100 or 100LL (Aviation Grade)	
Fuel Injector	LFR-NNSM10	
Fuel Pump	Diaphragm	
Starter Drive, Ratio to Crankshaft and Rotation	16.556:1 Counterclockwise	
Starter - Hartzell Engine Technologies (formerly Kelly Aerospace) or equivalent	12 Volt - (Optional) 24 Volt - (Optional)	
Starter	Refer to the latest revision of Service Instruction No. 1154 or the applicable parts catalog for approved starters.	
Alternator Drive, Ratio to Crankshaft and Rotation	3.20:1 – Clockwise 3.70:1 – Clockwise (Optional)	
Alternator	Refer to the latest revision of Service Instruction No. 1154 or the applicable parts catalog for approved alternators.	
Alternators, Dual	Optional	
Lycoming Electronic Ignition System	66K4A3SN-04 (Left) 66K4A3SN-04 (Right)	
Magneto Drive, Ratio to Crankshaft and Rotation	1.000:1 Clockwise	
Tachometer Drive, Ratio to Crankshaft and Rotation (Optional)	0.5:1 Clockwise	

NOTICE: All locations and rotations are as viewed from the anti-propeller 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. SI-1154.

Table A-2
Table of Operating Limits for IO-390-D Series Engine

Oil Pressure - Pre-Oil Procedure		20 psi	138 kPa
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
Oil Temperature (for maximum engine life)		180ºF	82ºC
Maximum Oil Temperature		235°F	113°C
Maximum Oil Consumption		0.006 lb/BHP/Hr.	
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		450°F	232°C
Cylinder Head Temperature (for maximum engine life) - At 75% power and below		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	151ºC
Maximum EIS/Magneto Temperature (measured in the pole laminations)		225ºF	107ºC

Table A-3
Accessory Drives for IO-390-D1A6 & D3A6 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	3.20:1†	60	7	120	14	175	20
Alternators (2)	SAE	Clockwise	3.70:1♦	60	7	120	14	175	20
Accessory Drive*	AND20000**	Counter-clockwise	1.3:1	70	8	450	51	25	2.9
Tachometer*	SAE	Clockwise	0.5:1	7	0.8	50	6	5	0.6
Propeller Governor	AND20010***	Clockwise	0.866:1	125	14	1200	136	40	4.5

* Requires an accessory housing with drive provisions.
** Except for rotation and torque limitations.
*** Except for torque limitations.
† With alternator pulley diameter of 3.10 in.
♦ With alternator pulley diameter of 2.70 in.

Table A-4
Accessory Drives for IO-390-D1B6 & -D3B6 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	3.20:1†	60	7	120	14	175	20
Alternators (2)	SAE	Clockwise	3.70:1♦	60	7	120	14	175	20
Accessory Drive #1*	AND20000**	Counter-clockwise	1.3:1	70	8	450	51	25	2.9
Accessory Drive #2*	AND20000	Clockwise	1.3:1	100	11	800	90	40	4.5
Tachometer*	SAE	Clockwise	0.5:1	7	0.8	50	6	5	0.6
Propeller Governor	AND20010***	Clockwise	0.895:1	125	14	1200	136	40	4.5

* Requires an accessory housing with drive provisions.
** Except for rotation and torque limitations.
*** Except for torque limitations.
† With alternator pulley diameter of 3.10 in.
♦ With alternator pulley diameter of 2.70 in.

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

APPENDIX B

PERFORMANCE DATA

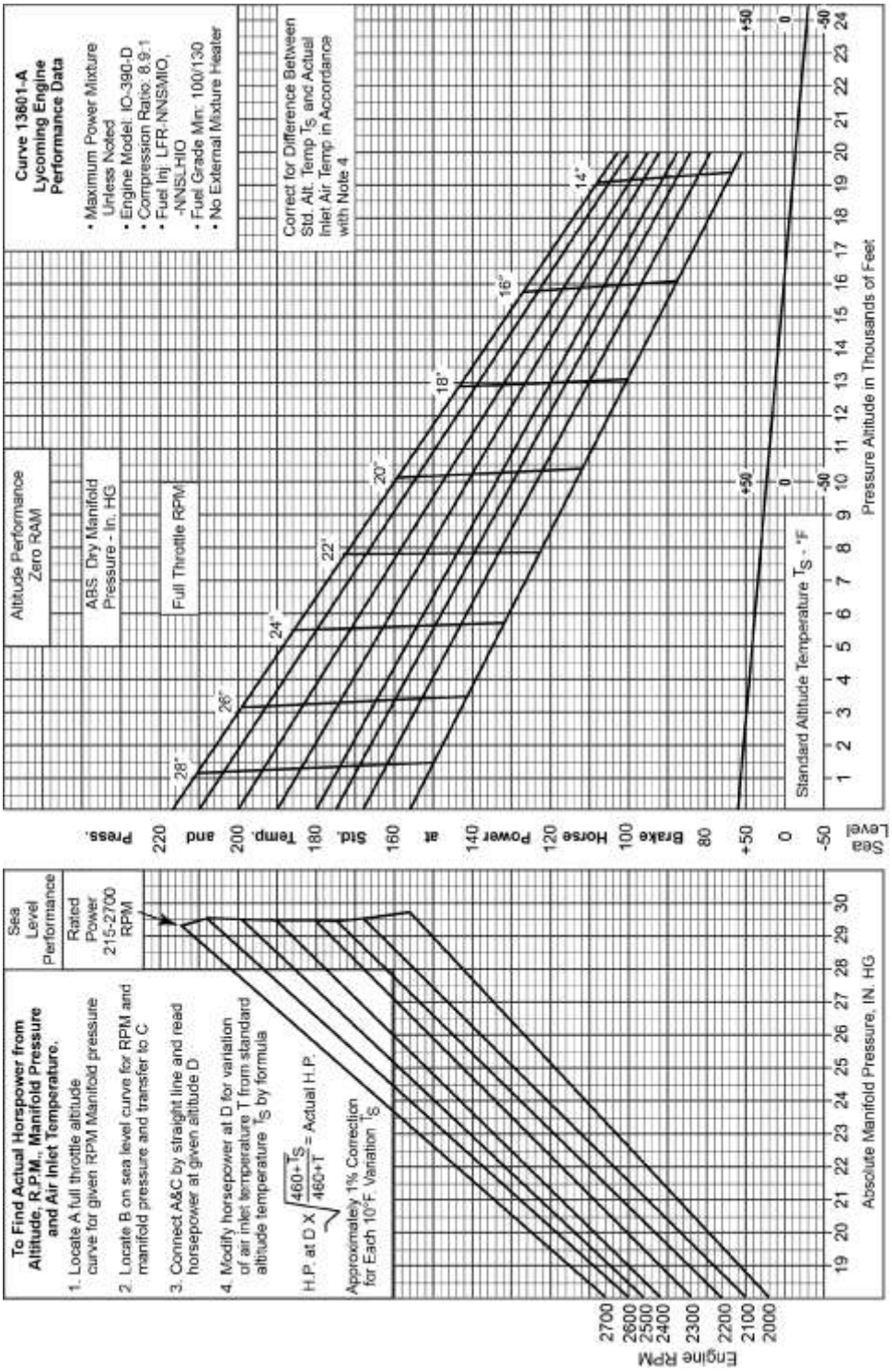

Figure B-1
Sea Level and Altitude Performance

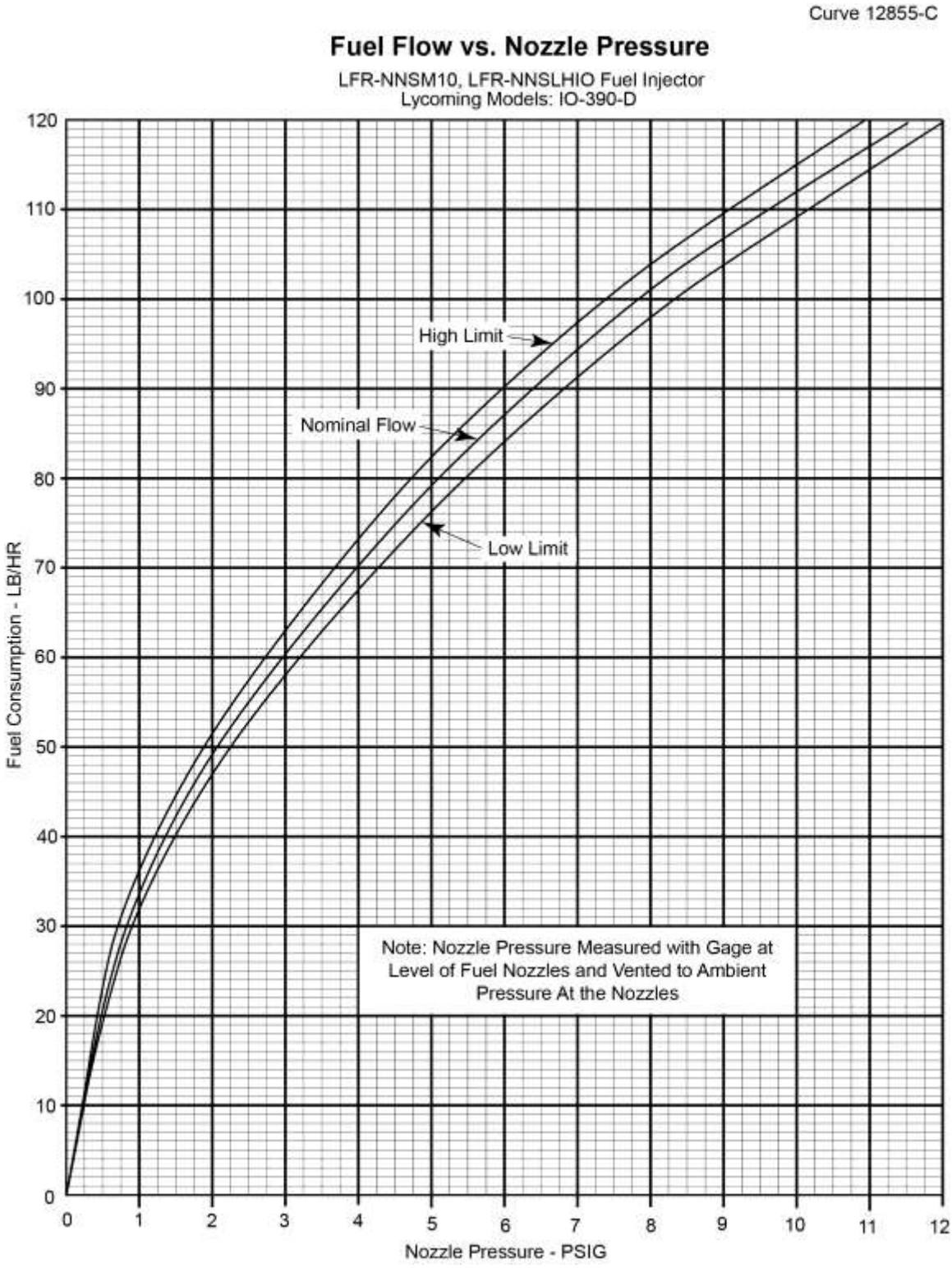

Figure B-2
Fuel Flow vs. Nozzle Pressure

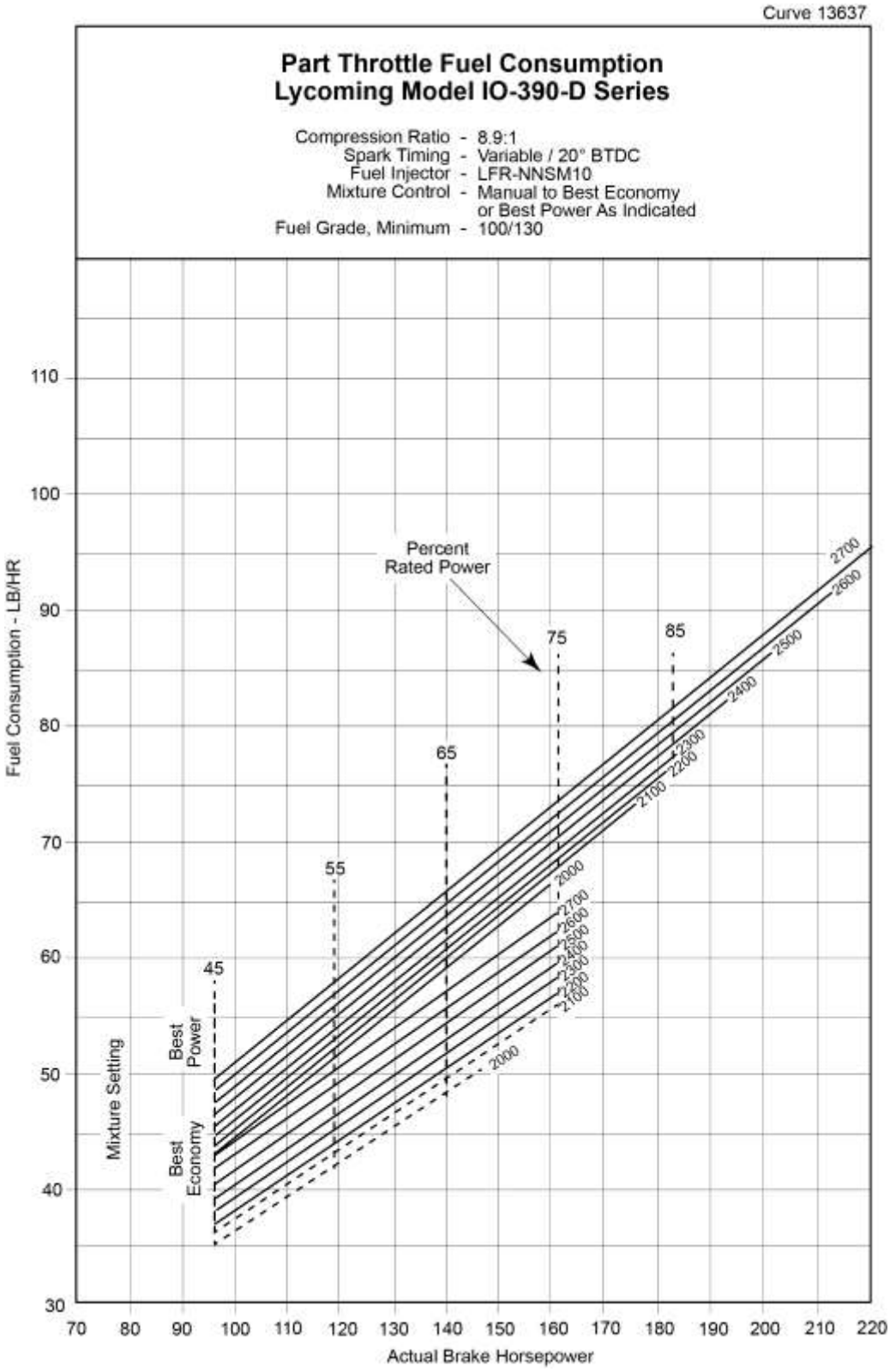

Figure B-3
Fuel Flow vs. Percent Rated Power

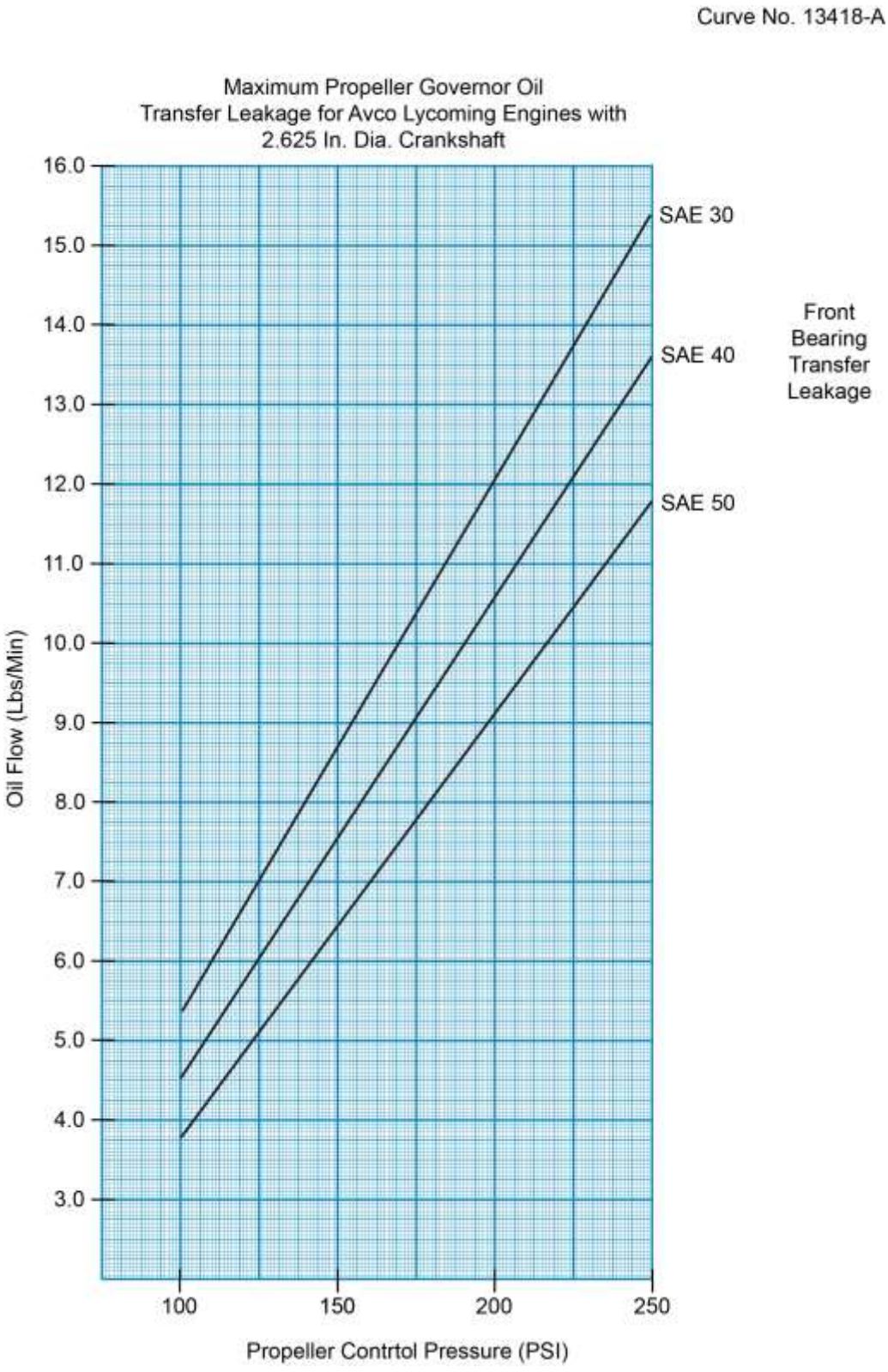

Figure B-4
Propeller Governor Oil Transfer Leakage