AEIO-390-A Series Engine Installation and Operation Manual

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AEIO-390-A Series Engine Installation and Operation Manual

Lycoming Part Number: 60297-42

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TRANSMITTAL LETTER

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Current Revision: _____
Current Revision Date: _____
Original Issue Date: _____

To: Recipients of AEIO-390-A Series Engine Installation and Operation Manual

Subject: Release of the current manual revision

This page section transmits the initial edition of the AEIO-390-A Series Engine Installation and Operation Manual. Please replace any previous revisions of this manual with this current edition. See Record of Revisions for a complete list of dates and numbers of all released revisions of this manual.

The following Table of Revision Highlights is a compilation of all Revisions incorporated, plus any more currently approved information. The table will identify the pages that have been removed and/or replaced, a concise description of changes, and a list of the supporting documentation (Service Bulletins, etc.).

HIGHLIGHTS

Page(s) Removed	Page(s) Added	Description of Change	Reference Docs	Doc Date

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RECORD OF REVISIONS

Rev. No	Issue Date	Initials	Insertion Date

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SERVICE DOCUMENT LIST

NOTICE: The "Incorporation Date" column indicates the latest revision date of this manual, due to a Service Document, or Service Document revision. The words "No Effect" indicate that the Service Document caused no changes within this manual.

Number	Revision Number	Incorporation Date	Subject
S.I. 1241	C	02/12	Pre-oil the Engine Prior to Initial Start
S.I. 1014	M	02/12	Lubricating Oil Recommendations
S.I. 1528		02/12	Aircraft Engine Starter Recommendations
S.I. 1472		02/12	Removal of Preservative Oil from Engine
S.I. 1505		02/12	Cold Weather Starting
S.I. 1481	B	02/12	Factory Engine Preservation
S.L. L180	B	02/12	Engine Preservation for Active and Stored Aircraft
S.I. 1132	B	02/12	Magneto Drop-Off

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LIST OF EFFECTIVE PAGES

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ABBREVIATIONS AND ACRONYMS

A	
AD	Airworthiness Directive
AFM	Aircraft Flight Manual
AMP	Ampere
B	
BHP	Brake Horsepower
BSFC	Brake Specific Fuel Consumption
C	
C	Celsius
CHT	Cylinder Head Temperature
E	
EGT	Exhaust Gas Temperature
EPA	Environmental Protection Agency
F	
F	Fahrenheit
FAA	Federal Aviation Administration
FAR	Federal Aviation (and Space) Regulation
FFL	Fault Found Lamp
FOD	Foreign Object Debris
Ft.-lb.	Foot Pound (torque)
G	
GPH	Gallons per Hour
GPM	Gallons per Minute
H	
Hg	Mercury
HIRF	High Intensity Radiated Field
I	
ICA	Instructions for Continued Airworthiness
in.-lb	Inch Pound (torque)
in.	Inch, inches
In-Hg	Inches of Mercury
L	
lb	Pound
LL	Low Lead (fuel)

M	
MAP	Manifold Air Pressure
MSB	Mandatory Service Bulletin
P	
P/N	Part Number
ppm	Particles per Million
PSI	Pounds per square inch
R	
RCA	Radio Corporation of America
RPM	Revolutions per Minute
S	
SAE	Society of Automotive Engineers (oil viscosity)
SB	Service Bulletin
SI	Service Instruction
SL	Service Letter
STC	Supplemental Type Certificate
T	
TBO	Time Between Overhaul
TC	Type Certificate, Type Certification
TLO	Time-Limited Operation
TR	Temporary Revision
U	
UL	Unleaded (gasoline)
V	
V	Volt, Voltage
vol.	Volume

INTRODUCTION

Scope of this Manual

This manual supplies instructions (in compliance with FAR 33.5) for engine preparation, airframer installation requirements, installation and operation of the AEIO-390-A Series Lycoming aircraft engines. For maintenance and overhaul refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual. For spare parts information refer to the AEIO-390-A Series Engine Illustrated Parts Catalog.

Service Bulletins, Service Instructions, and Service Letters

As advancements in technological applications on this engine continue, Lycoming will make future revisions to this manual. However, if more timely distribution is necessary, Lycoming supplies subscribers with up-to-date Service Bulletins (SBs), Service Instructions (SIs) and Service Letters (SLs). These service documents can be found on the company's website with a paid access subscription.

For subscription information, look on Lycoming's website or speak to Lycoming by telephone: 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.

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

Change Update Distribution

Lycoming Engines supplies changes in the form of revised pages or manuals (depending upon the extent of the changes) to customer subscribers.

Instructions for Continued Airworthiness

This manual, together with the Maintenance Manual, Overhaul Manual, Service Bulletins and related publications make up the complete set of Instructions for Continued Airworthiness (ICAs). The ICAs are prepared by Lycoming Engines and are approved by the Federal Aviation Administration (FAA).

Compliance Requirements

WARNING: FOR CORRECT ENGINE INSTALLATION AND OPERATION, YOU MUST OBEY THE PROCEDURES IN THIS MANUAL AND APPLICABLE SERVICE DOCUMENTS. YOU ALSO MUST DO THE REQUISITE MAINTENANCE AND OVERHAUL PROCEDURES IDENTIFIED IN THE RESPECTIVE MAINTENANCE AND OVERHAUL MANUALS.

Warning, Cautions, and Notices

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

The table below defines the four types of safety advisory message used in this manual as per the American National Standard and ANSI 2535-6-2006.

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 may also be used without the safety alert symbol as an alternative to **"NOTICE."**
NOTICE:	The preferred signal word to address practices not related to personal injury.

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

Simplified Technical English

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

Figures

Figures in this manual are for illustration purposes only.

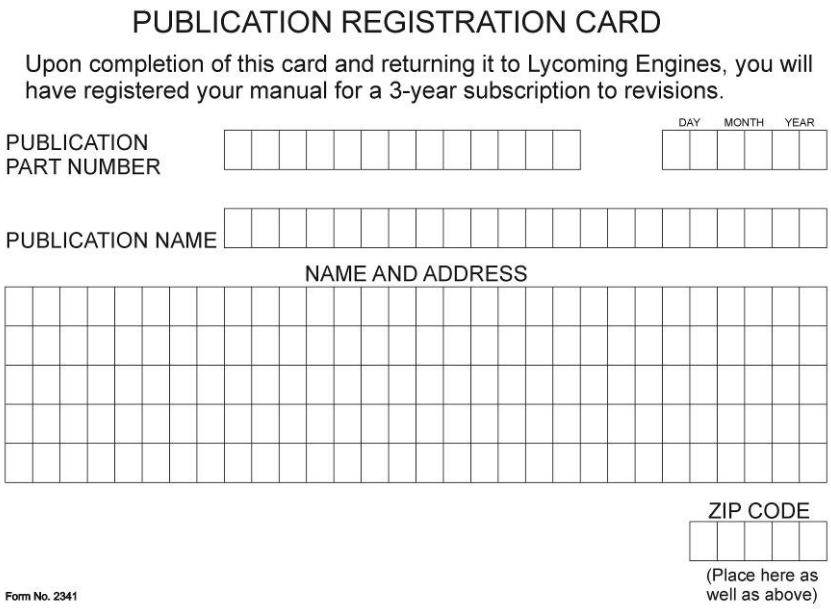
Copyright

Environmental Compliance

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

Supplemental Service Information

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


PUBLICATION REGISTRATION CARD

Upon completion of this card and returning it to Lycoming Engines, you will have registered your manual for a 3-year subscription to revisions.

PUBLICATION PART NUMBER

DAY MONTH YEAR

PUBLICATION NAME

NAME AND ADDRESS

ZIP CODE

(Place here as well as above)

Form No. 2341

Sample Registration Card
Figure 1

Feedback

To supply comments, suggestions, or corrections to this manual, either make a call to customer service or use the Lycoming website.

Customer Service

Additionally, Lycoming has a Customer Service Hot Line to supply information and assistance to owners, operators, and maintenance personnel servicing Lycoming engines.

Call (570) 323-6181

8:00 A.M. – 5:00 P/M. EST (-5 GMT)
Monday – Friday

Change of Address Notification

The owner of the manual is responsible for supply of a change of address.

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AIRWORTHINESS LIMITATIONS

1. General

   The Airworthiness Limitations chapter sets forth each mandatory replacement time, inspection interval, and related procedure required for type certification. The Airworthiness Limitations chapter is FAA Approved and specifies maintenance required under §§ 43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA Approved.

2. Mandatory Replacement

   At every 500 hours of operation, replace both magnetos with serviceable parts. Refer to the "Requirements for Engine Installation" chapter in this manual.

3. Mandatory Inspection - Exhaust Valve and Guide

   At every 1000 hours of operation, examine the Exhaust Valve and Guide conditions.

Approved by: _____

Timothy Hadsall
Acting Manager, New York Aircraft Certification Office
Federal Aviation Administration

Date: 4/5/2012

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SYSTEM DESCRIPTION

The Lycoming AEIO-390-A Series aerobatic engine is a direct-drive four-cylinder, horizontally opposed, fuel-injected, air-cooled engine. It has tuned induction, down exhaust, and an inverted oil system for aerobatic maneuvers. As standard equipment, this engine has an automotive type starter, two alternator drives for AN type accessories, and an AN propeller mounting flange. A propeller governor is optional. Refer to Figure 1.

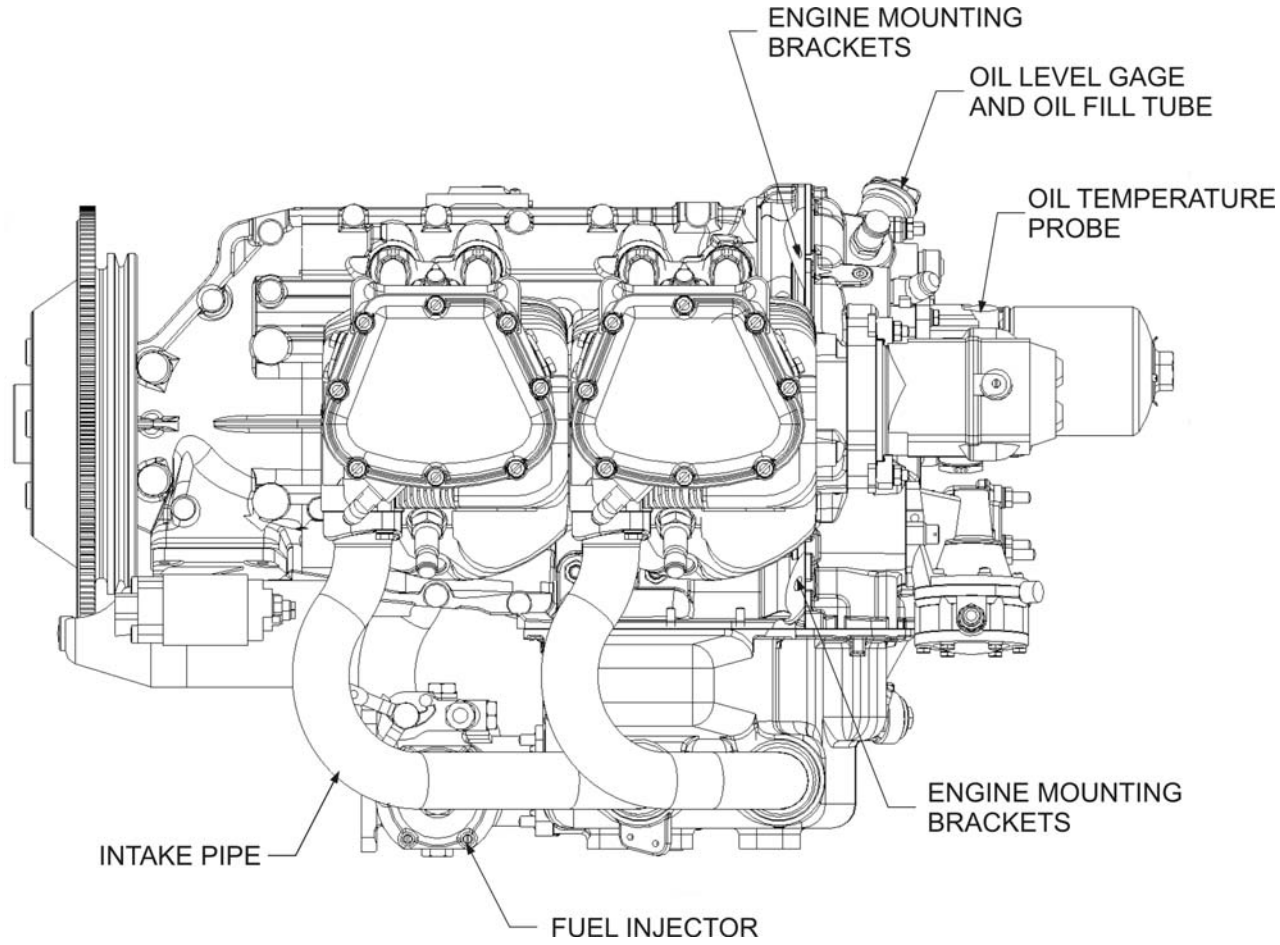

Figure 1 - AEIO-390-A Series Engine

Cylinders

Each of the four nitrided engine cylinders (identified by blue paint) between the shroud tubes has rings, pistons, push rods, valves, valve springs, and hydraulic roller tappets.

The valve-operating mechanism uses a conventional camshaft located above and parallel to the crankshaft. The camshaft operates the hydraulic roller tappets. These tappets adjust for expansion or contraction that occurs in the valve train. The roller tappets use push rods and valve rockers to operate the valves.

A bayonet-type thermocouple can be installed on the cylinder head.

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

The connecting rods have replaceable bearing inserts in the crankshaft ends. Two bolts/nuts attach the bearing caps to the crankshaft end of each rod.

The engine has intercylinder cooling baffles.

Crankcase

The crankcase is made up of two reinforced castings divided at the centerline of the engine. The castings are attached by a series of through-studs, bolts and nuts. The mating surfaces of the two castings are joined without a gasket.

The crankcase forms the bearings for the camshaft. The camshaft operates the hydraulic roller tappets which control opening and closing of the intake and exhaust valves. 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 is within the crankcase. The crankshaft has journals and counterweights. The counterweights decrease torsional vibrations as the crankshaft turns to operate the propeller.

The crankshaft has one 6.3 order and one 8^{th} order pendulum-type counterweights.

There are four oil nozzles, one at each piston.

Ignition System

The ignition system includes:

- 12V, 70amp. Self-rectifying alternator (24V, 70amp. Alternator optional)
- 12V starter (24V starter optional)
- One magneto with a retard breaker
- One plain magneto (without a retard breaker)
- Eight radio-shielded spark plugs, two for each cylinder
- Weather-shielded, braid-on wire ignition harness.

Fuel and Induction System

The engine fuel system includes a fuel pump and the RSA-5AD1 servo regulator for fuel injection to control metered fuel flow to the nozzles at each individual cylinder intake port. The fuel flow rate is in proportion to induction air flow.

The servo regulator measures air flow against fuel flow. The regulator controls the fuel pressure differential applied across the fuel metering section to make fuel flow proportional to air flow.

The fuel-air mixture occurs through the center zone induction system. Fuel vaporization occurs at the intake ports.

Propeller Drive Shaft

The propeller drive shaft is part of the crankshaft in accordance with specification AS127, Type 2. Oil can flow through the propeller drive shaft for a single, controllable pitch propeller.

Inverted Lubrication System

The inverted oil system supplies engine lubrication, with minimal oil loss, during inverted flight and aerobatic maneuvers.

The inverted oil system includes: a wet oil sump, oil pump, oil valve, oil separator, sump fitting, breather tee, oil sump strainer fitting, oil return sump fitting, oil hoses/lines, oil suction screen, oil suction sump fitting and sump plug. The oil pump collects scavenged oil in both the normal and inverted aircraft during acrobatic maneuvers. Oil pressure during inverted flight can be 5 to 10 psi less than in normal flight. Oil pressure can be interrupted momentarily in certain aircraft attitudes or during certain combinations of maneuvers.

Cylinder Number Designations

- The propeller is at the front of the engine and the accessories are at the rear of the engine.
- When you view the engine from the top, the left side cylinders are 2-4. Cylinder 2 is at the front of the engine. Refer to Figure 2.
- When you view the engine from the top, the cylinders on the right are 1-3. Cylinder 1 is at the front of the engine. Refer to Figure 2.
- The firing order of the cylinders is 1-3-2-4.

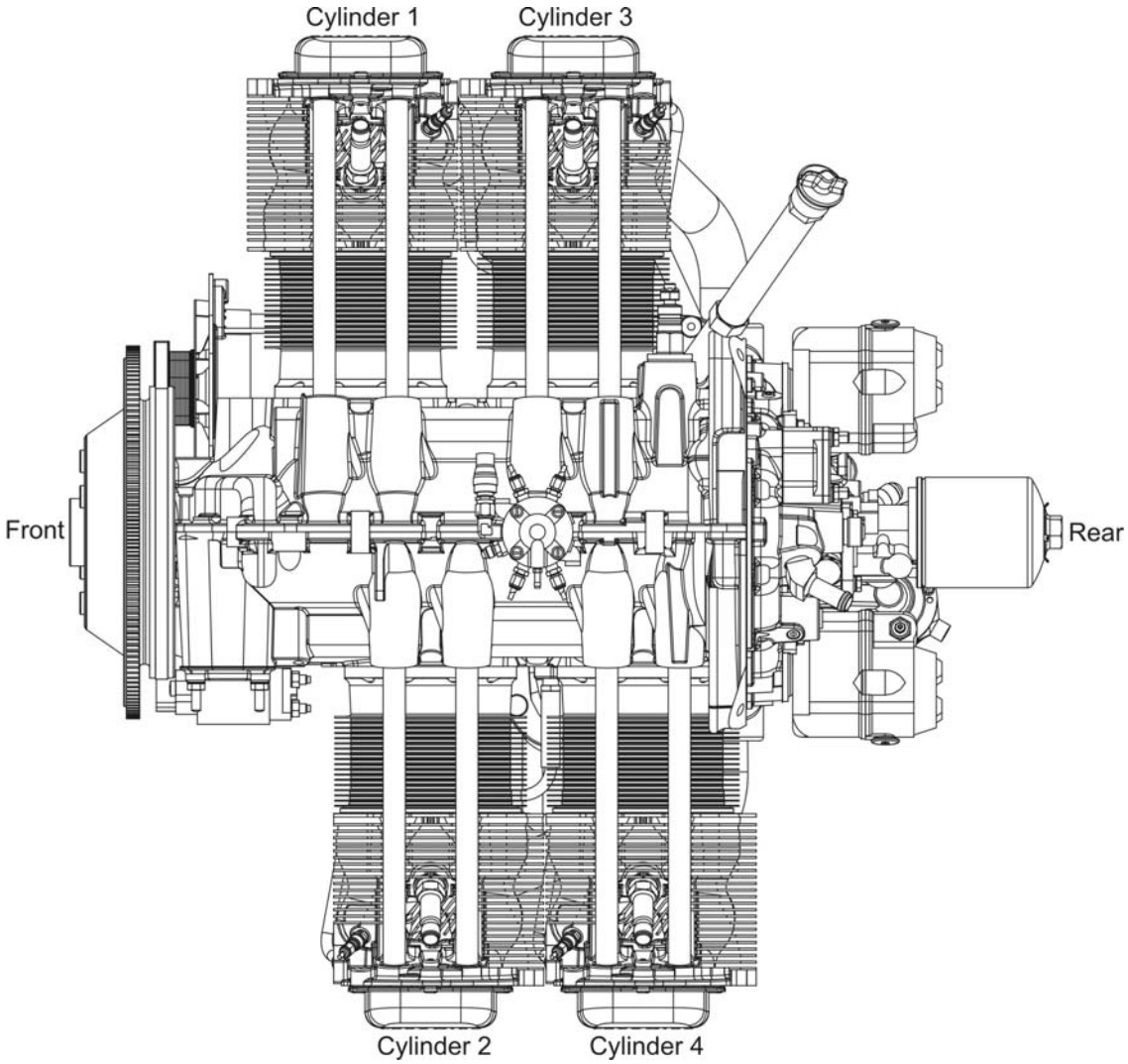

Figure 2 - Cylinder Number Designation

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THEORY OF OPERATION

Inverted Oil System

During normal flight, the weighted ball valve at the top of the oil separator is open, allowing blow by gases from the engine crankcase to be vented from the breather port, through the breather tee, to the top of the oil separator, and out through the overboard breather line. The top ball valve of the oil valve is closed, and the bottom ball valve is open, allowing oil to flow from the sump out through the strainer fitting, to the oil valve, back through the sump fitting to the oil pump and out to engine lubrication points.

When the aircraft is inverted, engine oil falls to the top of the crankcase. The weighted ball valve in the oil separator closes, preventing overboard loss of oil through the top of the oil separator and out through the overboard breather line. The top ball valve of the oil valve is open, and the bottom ball valve is closed, allowing oil to flow out from the breather port, through the breather tee, to the oil valve, through the sump fitting and the sump screen, to the oil pump and out to engine lubrication points.

Any oil in lines which fails to return to the sump during the transition between normal and inverted flight drains into the oil separator. This oil then returns to the sump from the bottom of the oil separator during periods of normal flight.

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ENGINE RECEPTION AND LIFT

Uncrate Procedure for a New or Rebuilt Engine

NOTICE: If the engine is to be stowed, refer to the chapter "Engine Preservation and Storage" in this manual.

1. When the engine is received, make sure that the crating is not damaged. If the engine crate is damaged, speak to Lycoming's Service Department and the freight shipper. If the crate is acceptable, remove the engine from the crate.
   A. These engines are usually sent in a box where the engine is in a crate within the box. The engine can be in a plastic bag or wrapped and it could have a top foam pillow.

⚠ WARNING: URETHANE FOAM IS FLAMMABLE! DO NOT PUT URETHANE FOAM NEAR OPEN FLAMES OR ANY OTHER DIRECT OR INDIRECT HIGH TEMPERATURE SOURCE OF IGNITION SUCH AS WELDING, BURNING CIGARETTES, SPACE HEATERS, OR HOT LIGHTS.

URETHANE FOAM WILL BURN RAPIDLY AND RELEASE A LOT OF HEAT. IN AN ENCLOSED SPACE, THE DEFICIENCY OF OXYGEN WILL CAUSE A DANGER OF SUFFOCATION TO THE OCCUPANTS. IF HUMANS BREATHE HAZARDOUS GASES SUCH AS CARBON MONOXIDE AND CARBON DIOXIDE RELEASED BY THE BURNING FOAM, THE NOXIOUS FUMES CAN BE HARMFUL OR FATAL.

2. To uncrate the engine:
   A. Cut the bands on the box.
   B. If there are staples at the bottom perimeter around the box, remove the staples and lift away the box. If there are no staples on the bottom perimeter of the box, cut the tape at the top of the box with a knife and open the box.
   C. Remove a few top slats of the crate and then remove the top pillow.
   D. Look for any fluid (oil or fuel) on the skid or below the engine. If fluid is found, identify the source.
   E. If the leaked fluid is preservative oil, EXAMINE each engine cylinder as per the "60 to 180-Day Engine Preservation" section in the "Engine Preservation and Storage" chapter in this manual

Acceptance Check

1. Make sure that the engine serial number and model number on the engine identification plate are the same as specified in the engine logbook and on the packing slip.
2. 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's Service Department and the Freight Shipper.

⚠ CAUTION: DO NOT LIFT, INSTALL OR STORE A DAMAGED OR CORRODED ENGINE (PRIOR TO RECEIVING INSTRUCTIONS FROM LYCOMING ENGINES OR THE FREIGHT SHIPPER).

3. 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.

4. Refer to the section “Lift the Engine” in this chapter and lift the engine.

Engine Deinhibition

The engine is sent with preservative oil in the cylinder and preservative oil in the crankcase. Refer to the “Prepare a New or Rebuilt Engine for Installation” section in the “Requirements for Engine Installation” chapter in this manual.

Lift the Engine

⚠ **CAUTION:** THE HOIST MUST HAVE A CAPACITY TO LIFT A MINIMUM OF 750 LBS.

⚠ **CAUTION:** BEFORE SHIPMENT, THE ENGINE CYLINDERS AND CRANKCASE HAVE BEEN FILLED WITH PRESERVATIVE OIL. WHEN LIFTING THE ENGINE, USE CARE TO PREVENT THE PRESERVATIVE OIL FROM SPLASHING ON OTHER ENGINE PARTS.

1. Connect the hoist and chains to the lifting lug on the engine as shown in Figure 1.

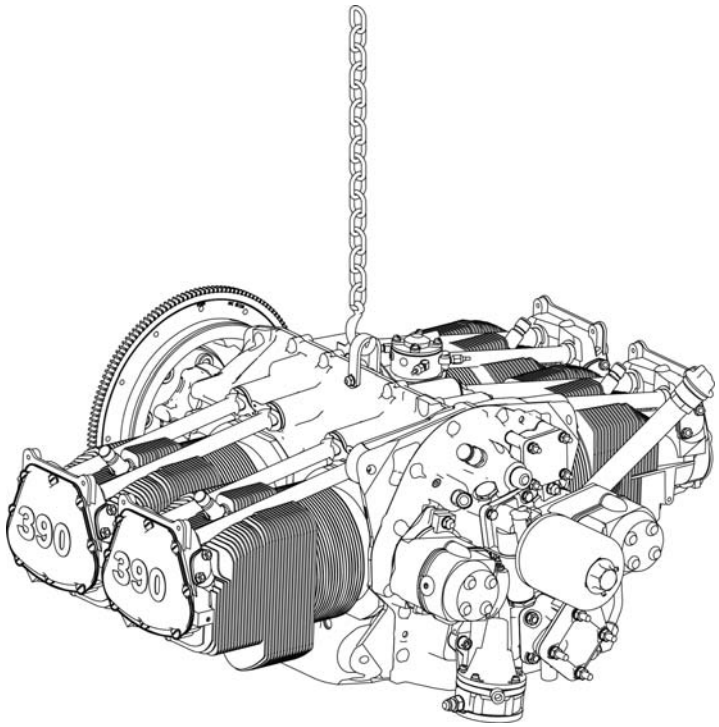

Figure 1 - Engine Lift

⚠ **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 HITANY OBJECTS TO PREVENT DAMAGE TO THE ENGINE OR ITS COMPONENTS.

2. Lift the engine slowly and vertically.
3. When the engine has preservative oil, do the deinhibition procedure now while the engine is lifted. Refer to the section “Prepare a New or Rebuilt 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.

Table 1 identifies the necessary steps that must be done before the engine can be installed.

TABLE 1. PREREQUISITES FOR ENGINE INSTALLATION

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

Step 1. Prepare the Engine

To prepare a new or rebuilt engine	Refer to the section “Prepare a New or Rebuilt 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 or Rebuilt Engine for Installation

If the engine has been stored in temperatures below 50°F (10°C), 24 hours before the engine is to be installed and operated, move the engine to an environment where the temperature is at least 70°F (21°C). If the engine cannot be moved to a warmer environment, apply heat to the cylinders with heat lamps before draining the preservative oil from the engine. Refer to the section “Apply Heat to a Cold Engine” in the “Unusual Conditions” chapter in this manual.

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

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

NOTICE: The engine is sent from the factory with preservative oil in the cylinders and in the crankcase. If an intake valve was open, the preservative oil can get into the induction system of the engine. This preservative oil must be removed as per this procedure.

1. Lift the engine. Refer to the section “Lift the Engine” in the “Engine Reception and Lift” chapter in this manual.
2. Do the deinhibition procedure as follows:

A. If any of the dehydrator plugs (which contain crystals of silica gel) break and the crystals fall into the engine, do the following.

— Disassemble the affected portion of the engine (per the AEIO-390-A Series Engine Maintenance and Overhaul Manual).

— Clean the engine (per the AEIO-390-A Series Engine Maintenance and Overhaul Manual).

B. Remove desiccant bags.

C. Remove the shipping plugs installed in the lower spark plug holes.

D. Remove the desiccant plugs from the upper spark plugs holes.

E. Put a container under the engine to collect the cylinder preservative oil.

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. Rotate 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. Rotate 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 AEIO-390-A Series Maintenance and Overhaul Manual.

4. If any corrosion or unusual conditions are found, speak to Lycoming Engine's Service Department.

5. Drain oil from the oil sump:

A. Put a container under the oil sump.

B. Remove the oil sump drain plug.

C. 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. The oil must be drained while hot to remove any remaining preservative oil.

D. Install the drain plug with a new crush washer.

E. Torque and safety the drain plug. Refer to the latest revision of the Table of Limits, SSP-1776 for torque values.

6. Drain the fuel pump:

A. Put a collection container underneath the fuel pump.

B. Remove the shipping cap installed on the inlet fitting of the fuel pump.

C. Disconnect the outlet hose from the outlet fitting on the fuel pump.

D. Let the preservative fluid drain from the fuel pump and outlet hose into a collection container.

E. Connect the outlet hose to the outlet fitting on the fuel pump.

F. Install the shipping cap.

7. Examine the spark plugs. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual for the spark plug inspection procedure.
8. If spark plugs are acceptable, install them. If the spark plugs are dirty, clean them. If the spark plugs are not acceptable, install new spark plugs.
9. Make sure that the induction riser is clean and dry.
   A. If you find more than 1/2 quart of preservative oil is in the induction riser:
      (1) Remove the intake pipes.
      (2) Clean the induction riser.
      (3) Examine it again.
      (4) Install the intake pipes.
10. Use the correct disposal procedure for collected oil in accordance with local regulations and Environmental Protection Agency policy.

Prepare a Stored Engine for Installation

This procedure is for an engine that has been in storage. An engine in storage has preservative oil.

If the engine has been stored in temperatures below 50°F (10°C), move the engine to an environment of at least 70°F (21°C) for 24 hours before preservative oil is drained from the cylinders. If the engine cannot be moved to a warmer environment, apply heat to the cylinders with heat lamps before draining the preservative oil from the engine. Refer to the section “Apply Heat to a Cold Engine” in the “Unusual Conditions” chapter of this manual.

Within 2 hours of engine installation, prepare the stored engine for installation into the airframe as follows:

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 ROTATE THE CRANKSHAFT OF AN ENGINE WITH PRESERVATIVE OIL BEFORE REMOVAL OF THE BOTTOM SPARK PLUGS. ENGINE DAMAGE DUE TO HYDRAULC LOCK CAN OCCUR.

3. If an engine has been in long-term storage or preservation, remove the seals, tape, dehydrator plugs, and desiccant bags. (Use solvent to remove tape residue).
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 bottom spark plug holes.
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.

8. Do the deinhibition procedure as follows:

A. If any of the dehydrator plugs (which contain crystals of silica gel) break and the crystals fall into the engine, do the following.
   — Disassemble the affected portion of the engine (as per the AEIO-390-A Series Engine Maintenance and Overhaul Manual).
   — Clean the engine (per the AEIO-390-A Series Engine Maintenance and Overhaul Manual).
B. Put a container under the engine to collect the cylinder preservative oil.
C. Turn the crankshaft through three or four revolutions to remove the cylinder preservative oil from the cylinders.
D. Collect the cylinder preservative oil as it drains out of the lower spark plug holes.
E. Tilt the engine to one side, until the spark plug holes on that side are vertical.
F. Rotate the crankshaft two revolutions and let the oil drain out through the spark plug holes.
G. Tilt the engine to the other side until the spark plug holes on that side are vertical.
H. Rotate 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.
10. If any corrosion or unusual conditions are found, speak to Lycoming Engine's Service Department.
11. Drain oil from the oil sump:
    A. Put a container under the oil sump.
    B. Remove the oil sump drain plug, crush washer and safety wire. Discard the crush washer and safety wire.
    C. Drain the preservative oil from the oil sump into the container.
    D. Remove the oil screen and clean it with a hydrocarbon-based solvent such as Varsol or equivalent.
    E. Install the screen.

       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. The oil must be drained while hot to be sure to remove any remainder of preservative oil.

    F. Install the drain plug with a new crush washer.
    G. Torque and safety wire the drain plug. Refer to the latest revision of Table of Limits, SSP-1776.
12. Remove the oil filter and install a new oil filter. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual.
13. If you use a constant speed propeller:
    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.

14. Examine the spark plugs. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual for the spark plug inspection procedure.
    A. If spark plugs are acceptable, install them. If the spark plugs are dirty, clean them in petroleum solvent. If the spark plugs are not acceptable, install new spark plugs.
    B. Remove the protectors on the ignition lead ends.
    C. Connect the ignition lead ends.
15. Use the correct procedure for disposal of drained oil in accordance with local, state, federal, and Environmental Protection Agency regulations.

Step 2. Supply Interface Items

For engine installation, the airframe manufacturer must supply the following items:

- Correctly-sized hose for the fuel pump supply and return vent line back to the airframe
- Fuel selector switch with an ON/OFF/AUTO position
- Independent Fuel Shut-Off Valve (to meet engine shutdown requirements).
- Magneto switch (dual pole single throw) switches
- 150-micron fuel filter with a bypass
- Air cleaner
- Fuel pump independently controlled by a circuit breaker with access by the flight crew for fire and emergency procedures
- Auxiliary fuel pump output wired to a three-position switch to drive a relay that controls the airframe boost pump
- Full flow oil cooler (with capacity for oil flow of 7.5 gallons/minute and heat rejection not to exceed 820 Btu per minute). The oil cooler must be able to withstand continuous pressure of 150 psi and be designed to a minimum proof pressure of 400 psi. A pressure relief valve limits pressure drop through the cooler connection to 35 psi. A thermostatic bypass and pressure relief valve is available as optional equipment. It closes at 185ºF routing all engine oil flow through the cooler. If pressure drop across the oil cooler system exceeds 75 ± 15 psi the pressure relief valve opens bypassing the cooler.
- Connector interface to the airframe engine wiring harness
- Aircraft battery
- Starter wiring and controls
- Airframe engine mount ground straps
- A connection point to attach the wiring harness to the airframe
- A propeller
- Four bayonet thermocouples for cylinder heads
- Thermometer bulb in accessory housing to measure oil temperature (refer to installation drawing - Appendix B)
- Oil pressure gauge with a restricted fitting (filler cap, oil level gauge and connection are installed on the engine)
- (Optional) Crankcase breather
- (Optional) Exhaust collector

Step 3. Measure Engine Dimensions

Figures 1 and 2 show the approximate physical dimensions of the engine.

1. Measure the length, width, and height of the engine.
2. Measure the length, width, and depth of the engine compartment.

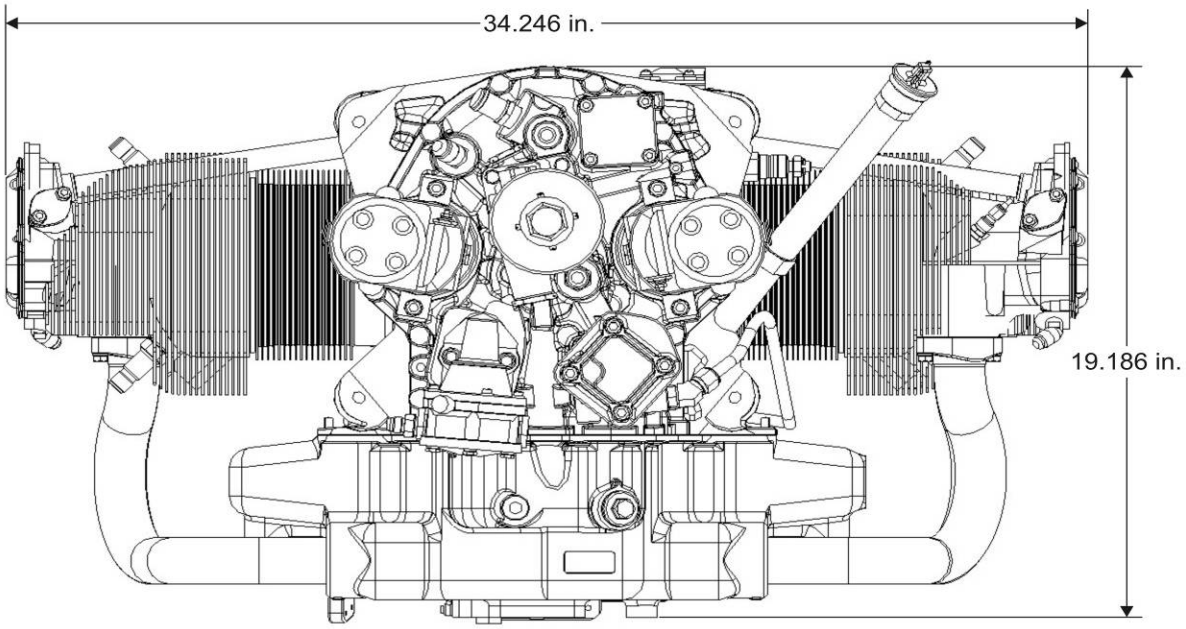

Figure 1. Physical Dimensions of the Engine (Front)

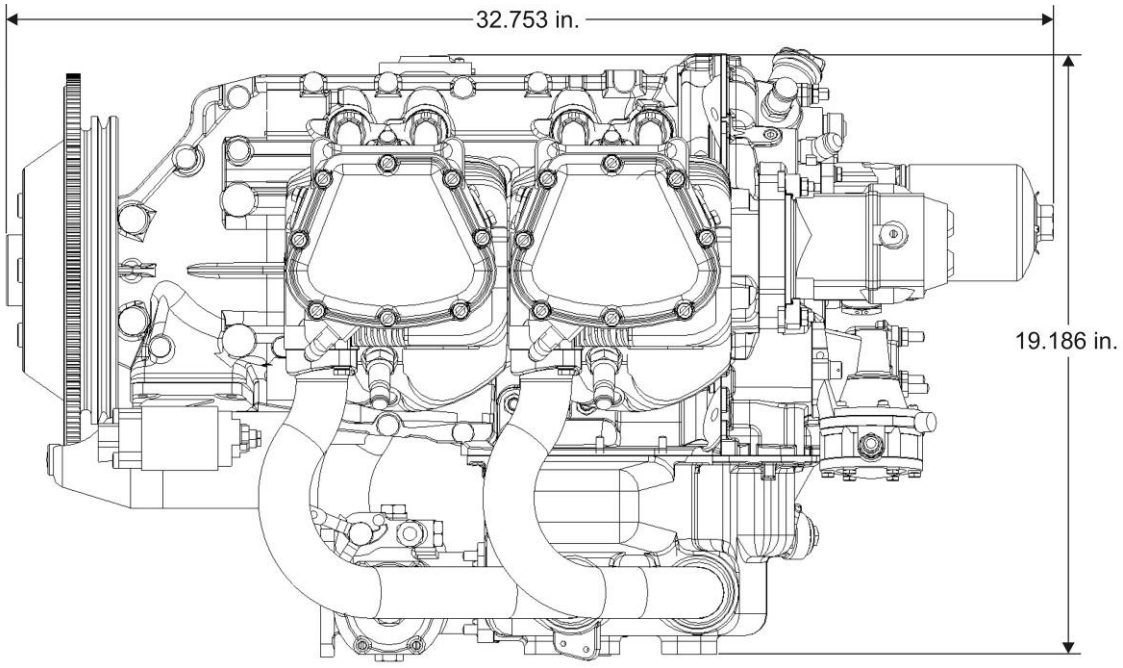

Figure 2. Physical Dimensions of the Engine (Side)

Step 4. Remove Components

It could be necessary to temporarily remove a component, such as an exhaust pipe, to install the engine in its compartment on the aircraft.

Remove only the components necessary to enable engine installation.

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

Step 5. Install Aircraft-Supplied Engine Mounts

The airframer is to supply bonded rubber mounts and bolts for attachment to the Type 1 Dynafocal engine mounts. There are four mounting bosses integral to the crankcase. Refer to the Installation Drawing in Appendix B.

Maximum Allowable Load for the Mounting Attachment and Structure

The Type 1 Dynafocal mounts can withstand a 10g load per FAA FAR requirements.

Step 6. Make the Aircraft Engine Harness

A wiring diagram will be supplied to the airframer which identifies the necessary wires and configurations that must be used to make the aircraft engine harness. This harness is not to be confused with the wiring harness that is already attached to the engine.

All wires must be in compliance with aviation standards wiring. Appendix B in this manual contains wiring diagrams.

Step 7. Make Electrical Interface Connections

The electrical interface includes wiring, lighting indication, and switches.

Grounding Requirements

Install three low-impedance grounding jumpers of 16 mm^2 minimum conductive area from the engine case to the engine mounting frame. The grounding jumpers must be less than 30 cm long. (The engine mount must also be grounded to the airframe with a similarly low impendence).

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ENGINE INSTALLATION

Engine Installation Overview

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

NOTICE: This engine can be installed in aircraft in Table 1.

TABLE 1. AIRCRAFT WHERE AEIO-390-A ENGINES CAN BE INSTALLED

FAR Part 23 commuter or aerobatic category aircraft
FAR Part 23 normal and utility category aircraft up to Class III
Experimental airworthy certificated aircraft

NOTICE: This engine cannot be installed in aircraft in Table 2.

TABLE 2. AIRCRAFT WHERE AEIO-390-A ENGINES CANNOT BE INSTALLED

Any FAR part 25 aircraft
Any FAR Part 27 rotorcraft
Any FAR Part 29 rotorcraft

Refer to the engine installation drawing in Appendix B.

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

TABLE 3. ENGINE INSTALLATION STEPS AND REFERENCES

Step	Section References in This Chapter
1	Install the Engine on Mounts
2	Connect the Wiring Harness
3	Connect the Power Control Linkage
4	Install External Accessories (as necessary)
5	Install the Compressor Belt (as necessary)
6	Install the Propeller
7	Connect Fuel Lines
8	Connect Oil Lines
9	Install Components That Had Been Removed Before Engine Installation
10	Make Remaining Engine Connections
11	Install Baffling
12	Add Oil
13	Engine Pre-Oil Procedure
14	Add Fuel (to aircraft as necessary)
15	Final Installation Inspection
16	Close 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 as per the airframe manufacturer’s maintenance manual.

Disconnect the hoist from the lifting eyes.

Step 2. Connect the Wiring Harnesses

1. Connect the airframe engine wiring harness to avionics and ignition sources. Refer to the airframe manufacturer’s wiring diagram.
2. Connect wiring to the starter.

Step 3. Connect the Power Control Linkage

Connect the cable to the power control linkage for the engine.

Step 4. 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 airframe manufacturer’s instructions.
3. If necessary, install the propeller governor; use the manufacturer’s supplied gasket and hardware.

Step 5. Install the Compressor Belt (as necessary)

Install the compressor belt in accordance with airframe and compressor manufacturer’s instructions.

Step 6. Install the Propeller

Install the propeller in accordance with the propeller and airframe manufacturer’s instructions.

Step 7. Connect Fuel Lines

1. Remove unwanted material from the aircraft fuel strainer. Let a minimum of 1 gallon (3.8 liters) of fuel to flow through the strainer, aircraft fuel filter and fuel supply line.

⚠ **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. Before connection of the main fuel inlet line to the fuel pump, remove all contaminants from aircraft fuel tanks and fuel lines.
3. Make sure that the airframe manufacturer has a fuel filter installed on the airframe.
4. Remove protective caps from the main fuel inlet.

5. Connect the main fuel inlet line to the fuel pump. Torque the connection as per the airframe manufacturer's instructions.

Step 8. Connect Oil Lines

Connect the oil line from the oil sump to the wastegate.

Step 9. Install Components That Had Been Removed Before Engine Installation

Install any component that was removed to enable the engine to be installed.

Step 10. Make Remaining Engine Connections

1. Make engine connections to accessories.
2. Make engine connections to wires and cables.
3. Make engine connections to ducts and cowling.
4. Make engine connections to breather, hoses and pipes.
5. In accordance with the airframe manufacturer’s instructions, install all cowling and nacelle access panels.

Step 11. Install Baffling

Install baffling around the engine compartment.

Step 12. Add Oil

Add oil to the engine. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual for the procedure to add oil.

Step 13. Engine Pre-Oil Procedure

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

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

- After oil lines have been connected
- Before the initial start of a new, overhauled, rebuilt or stored engine
- After oil cooler replacement-draining
- After oil replacement
- After any prolonged period of inactivity.

To do the pre-oil procedure:

1. Make sure that the Enable switch is in the OFF position.
2. Make sure the fuel selector and fuel pump switches are in the OFF position.
3. Disconnect the inlet lines at the turbocharger and the front lines to the exhaust valve guide oiler.
4. Disconnect the engine air duct from the compressor housing inlet.
5. Connect the air duct.
6. Fill the oil cooler with oil.
7. Remove one spark plug from each cylinder of the engine.
8. Move the power control to the FULL OPEN position.

9. Turn the engine with the starter (or external power source) until oil is seen at the end of the oil lines.
10. Connect the inlet lines at the turbocharger.
11. Connect the front lines to the exhaust valve guide oiler.

⚠ **CAUTION:** DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 TO 15 SECONDS. LET THE STARTER COOL AFTER EACH ENERGIZATION.

12. Start the engine until a minimum oil pressure of 20 PSI is shown. If there is no oil pressure after 10 to 15 seconds, allow the starter to cool. Energize the starter for two or more 10 to 15 second periods.
13. Install the spark plugs and immediately start the engine. Refer to the “Engine Start and Operation” chapter.

Step 14. Add Fuel

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

Add the correct fuel to the aircraft. Refer to Appendix A or the latest revision of Service Instruction No. 1070 for fuel specifications.

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

Step 15. Final Installation Inspection

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

Step 16. Close Engine Compartment

1. Make sure that there are no tools or unwanted materials in the engine, in the engine nacelle or compartment.
2. Install all cowling and nacelle access panels to close the engine compartment securely. Refer to the airframe manufacturers 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 manufacturers specified torque values.	Yes	No	
Make sure the airframe ground straps are connected to the engine mounts.	Yes	No	
Make sure all spark plugs are installed.	Yes	No	
Make sure all harness and wiring connections have been made.	Yes	No	
Make sure the wiring harness is attached to the engine.	Yes	No	
Make sure baffles have been installed.	Yes	No	
Make sure oil has been added to engine.	Yes	No	
Make sure the engine pre-oil procedure has been completed.	Yes	No	
Make sure fuel has been added to aircraft fuel tanks.	Yes	No	
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.	Yes	No	
Close the engine compartment.	Yes	No	

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ENGINE START AND OPERATION

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 DO THE RECOMMENDED MAINTENANCE AND OVERHAUL PROCEDURES IN ACCORDANCE WITH THE AEIO-390-A SERIES ENGINE MAINTENANCE AND OVERHAUL MANUAL FOR THIS ENGINE.

Before Engine Start

Before a newly installed/rebuilt/repaired/overhauled or stored engine can be used for flight, all of the steps shown in Table 1 must be done in the sequence shown. Otherwise, just do steps 2, 3, 5 and 6 in Table 1. Refer to sections in this chapter.

WARNING: THE SEQUENCE OF STEPS IN TABLE 1 MUST BE COMPLETED IN THE ORDER SHOWN ON AN ENGINE THAT HAS BEEN NEWLY INSTALLED AND/OR ROUTINELY INSPECTED, REBUILT, REPAIRED, OR OVERHAULED BEFORE THE AIRCRAFT IS PUT BACK INTO SERVICE.

TABLE 1. PREREQUISITE REQUIREMENTS FOR ENGINE OPERATION

Step	Section References in This Chapter
1	Prepare the Engine for Operation
2	Daily Pre-Flight Inspection
3	Start the Engine
4	Do the Operational Test
5	Do the Engine Run-Up
6	Operate the Engine
7	Stop the Engine

Step 1. Prepare the Engine for Operation (Part of Pre-Flight Inspection)

1. After any of the following actions, do a complete pre-flight inspection (which includes this procedure) of the engine, propeller, cowl, and aircraft to make sure that the engine is operating correctly:
   - Engine installation
   - Fault isolation
   - Maintenance or Overhaul
2. Make sure that all switches are **OFF.**
3. Make sure that the power control and alternate air controls are free to move in the full range of travel.
4. Make sure the aircraft battery has a full charge, especially in sub-freezing temperatures.
5. Examine the propeller and propeller hub for cracks, oil leaks, and security. Tighten if loose. Remove and replace if cracks are found. Identify and correct the cause of oil leak(s).

6. As necessary, add fuel specified (in Appendix A) to the aircraft in accordance with the airframe manufacturer's instructions.
7. Measure the engine oil level (quantity in Appendix A) to make sure there is sufficient oil in the engine. If the oil level is too low, add the correct specified grade of oil as necessary. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual.
8. 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.
9. 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 the section "Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual.
10. Make sure that the induction air filter is clean and securely in place.
11. Make sure the alternate air supply operates correctly.
12. Examine the engine, propeller hub area, and cowl for indication of fuel and engine oil leaks. Identify and correct the cause of any leaks.
13. Look in the engine and cowling for unwanted material, loose, missing fittings, clamps and connections. Examine for restrictions to cooling airflow. Remove any unwanted material. Tighten any loose connections per torque values supplied by the airframer.
14. Make sure that the fuel and lubrication lines are securely connected (to prevent line movement during flight) with the necessary clamps and hardware. Fuel lines must be held in place securely with clamps in position approximately 8 in. (20 cm) apart.
15. Make sure that all baffles and baffle seals are installed in the correct position and are serviceable.

    NOTICE: Record any maintenance-significant events and corrective action taken in the engine logbook. Record the magnitude and duration of a problem and any out-of-tolerance values.

16. Correct all problems before engine start. Refer to the "Unusual Conditions" chapter in this manual.

Step 2. Daily Pre-Flight Inspection

1. Be sure all switches are in the OFF position.
2. Make sure the magneto ground wires are connected.
3. Measure the engine oil level to make sure there is enough oil in the engine before flight.
4. Before each flight, always examine the fuel hoses, fittings, and oil line connections for leakage. Identify and correct the cause of any leaks before the aircraft is flown.
5. Make sure the fuel tanks are full.
6. Open the fuel drain to remove any accumulation of water and sediment.
7. Make sure all shields and cowling are in place and secure. If any are missing or damaged, repair or replace before the aircraft is flown.
8. Examine controls for general condition, correct travel and correct freedom of operation.
9. Examine the induction system air filter and complete service in accordance with the airframe manufacturer's recommendations.

10. Look for any leaks in the Induction System and Exhaust Systems.
11. Identify and correct the cause of any leaks before flight. Make sure there are no leaks before flight.

Step 3. Start the Engine

WARNING: MAKE SURE THAT THE AREA IN THE ROTATIONAL ARC RADIUS OF THE PROPELLER IS CLEAR OF PERSONNEL OR ANY OBSTRUCTION BEFORE STARTING THE ENGINE.

CAUTION: DO NOT ATTEMPT IN-FLIGHT ENGINE RESTARTS ABOVE 25,000 FEET.

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 “Unusual 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 “Unusual Conditions” chapter in this manual.

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

WARNING: EXAMINE THE ENGINE FOR HYDRAULIC LOCK; REFER TO THE AEIO-390-A SERIES ENGINE MAINTENANCE AND OVERHAUL 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.

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

2. Refer to the aircraft POH for the engine start settings and start procedure.
3. Set the propeller governor to FULL RPM.
4. Set the Master Power selector switch to the ON position and move the mixture control to FULL RICH until there is indication of steady fuel flow.
5. Turn the Fuel Selector to the ON position.
6. Put the power control to the IDLE position.
7. Set the magneto select switch as per the aircraft manufacturer’s instructions.

   NOTICE: For switch information, refer to the airframe manufacturer’s handbook.

8. Set the throttle to 1/4 travel.
9. Move the mixture control to FULL RICH.
10. Turn the boost pump ON.
11. For a cold engine, if the engine has a priming system, do a prime of the cold engine with one to three strokes of the priming pump. If there is no priming system, move the throttle to FULL OPEN and back to the IDLE position two to three times.

12. Turn on the starter to start the engine – engage the starter for no more than 10 seconds. If the engine does not start and there are no warning lamps illuminated, wait at least 10 seconds and engage the starter again. You can make up to five engine start attempts within a 2 minute period. If the engine does not start, refer to the “Unusual Condition” chapter in this manual.

    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 "Unusual Conditions" chapter.

⚠ **CAUTION:** DO NOT TRY MORE THAN FIVE ENGINE STARTS WITHIN A 2-MINUTE PERIOD. WAIT 10 SECONDS BETWEEN EACH START ATTEMPT TO LET THE STARTER COOL AND PREVENT OVERHEATING.

    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 "Unusual Conditions" chapter.

13. When the engine starts, put the magneto switch in the BOTH position.

14. Do a magneto drop-off check as follows for all three cycles ON/OFF/BOTH.

    NOTICE: For both fixed and rotor wing installations, do not operate on a single magneto for too long a period; a few seconds is usually sufficient to check drop-off and to minimize plug fouling.

    A. Move the propeller control through its complete range as a check for operation and return to the full low pitch position. Full feathering check (twin engine) on the ground is not recommended but the feathering action can be checked by operating the engine between 1000-1500 RPM, then momentarily pulling the propeller control into the feathering position. Do not allow the RPM to drop more than 500 RPM.

    B. With the propeller in minimum pitch angle, set the engine to produce 50-65% power as per the manifold pressure gage unless otherwise specified in the aircraft manufacturer’s manual. At these settings, the ignition system and spark plugs must work harder because of the greater pressure within the cylinders. Under these conditions, ignition problems can occur. Magneto checks at low power settings will only indicate fuel/air distribution quality.

    C. 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 175RPM and must not exceed 50 RPM between magnetos.

    D. If the RPM drop exceeds 175 RPM, slowly lean the mixture until the RPM peaks. Then retard the throttle to the RPM specified in step 14a. 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.

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

15. Move the mixture control slowly and smoothly to FULL RICH.

16. Move the power control slowly and smoothly to the IDLE RPM.

    NOTICE: During flight do not fully close the power control because it can cause extremely low manifold air pressure.

⚠ **CAUTION:** DO NOT EXCEED THE IDLE RPM (SET BY THE AIRFRAME MANUFACTURER) UNTIL THE OIL PRESSURE IS STABLE ABOVE THE MINIMUM IDLING RANGE. IF THE OIL PRESSURE DOES NOT INCREASE TO THE MINIMUM PRESSURE WITHIN 30 SECONDS, STOP THE ENGINE. IDENTIFY AND CORRECT THE CAUSE. REFER TO THE "UNUSUAL CONDITIONS" CHAPTER IN THIS MANUAL.

⚠ **CAUTION:** DO NOT OPERATE THE ENGINE AT SPEEDS ABOVE 2500 RPM UNLESS THE OIL TEMPERATURE IS AT A MINMUM OF 100°F (38°C) AND THE OIL PRESSURE IS AT 115 PSI FOR INITIAL START AND WARM-UP. ENGINE DAMAGE CAN OCCUR IF THE OIL TEMPERATURE OR OIL PRESSURE IS NOT AT THE SPECIFIED MINIMUM LEVELS.

17. Look at the oil pressure gage for indicated pressure. If it does not indicate oil pressure within 30 seconds, stop the engine. Identify and correct the problems.

NOTICE: 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 the smoke continues for more than 1 minute, stop the engine. Drain the oil. Add new lubricating oil (Appendix A)- not preservative oil. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual

NOTICE: Full power is available within 4 seconds for a cold engine and 6 seconds for a hot engine after an in-flight engine restart as long as no other faults are present.

18. After any of the following, do the operational test (as per Step 4. "Do the Operational Test" in this chapter.):
    - Engine installation
    - Engine put back into service after storage, maintenance, overhaul/repair, or fault isolation
    - 50-Hour, 100-Hour/Annual, and 500-Hour Inspection.

Step 4. Do the Operational Test

Do this operational test while the engine is operating.

⚠ **WARNING:** IF THE ENGINE IS OPERATED AT LOW OR NO OIL PRESSURE, THE ENGINE CAN MALFUNCTION OR STOP.

1. Operate the engine at 750 RPM for 1 minute; slowly increase the speed to 1000 RPM in 3 minutes.
2. Let the engine operate at 1000 RPM for approximately 3 minutes.
3. Look for any illuminated caution or warning lights in the cockpit.
4. Stop the engine and allow it to cool until the CHT temperature is 100ºF (38ºC).

Operating Tips for Aerobatic Engines

NOTE: Pressure fluctuations that last 1 second can normally occur between 10 to 30 PSI when the aircraft is in maneuvers or in transition from upright to inverted flight. If the fluctuation in oil pressure is more than 5 seconds, have maintenance examine the oil system for abnormal restrictions to oil flow.

1. Monitor the oil pressure and oil temperature. If low or no oil pressure is found, stop the engine and identify the cause.
2. In certain maneuvers, such as steep dives, zero-g periods, and knife edge flight, an oil pressure loss will occur. During these transient conditions, do not let oil pressure fall more than 20 PSI below normal oil pressure. Certain uncommon aerobatic maneuvers, if done for an extended period of time or in rapid repetitive sequences, could cause abnormal oil losses. For example, if after a series of vertical roll-type maneuvers in rapid succession, from inverted flight entry to inverted recovery, oil accumulates in the oil separator and cannot return to the engine sump. As a result, the oil eventually flows overboard through the breather line. The oil loss can be eliminated by returning the aircraft to the normal upright attitude occasionally to allow oil accumulated in the oil separator to return to the engine sump.
3. Do not fly for more than 10 seconds in the following attitudes (because in these attitudes the oil system cannot scavenge oil and engine damage could occur):
   - Vertical flight, steep dive
   - Inverted flight, steep dive
   - Zero-g periods
   - Wing-down or knife-edge flights.

⚠WARNING: IF DURING AN OPERATIONAL TEST OR ENGINE IDLE, ANY OPERATIONAL PROBLEMS OCCUR, DO NOT TAKE-OFF. IDENTIFY AND CORRECT THE CAUSE OF THE PROBLEM AND DO THE OPERATIONAL TEST AGAIN.

NOTICE: After 25 hours of operation, change the oil. Examine the oil filter and screen. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual.

- 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.

Step 5. Do the Engine Run-Up

Do the engine run-up as follows:

1. Start the engine.
2. Turn the Fuel Selector to FULLEST or BOTH.
3. Make sure the oil temperature is above the specified minimum.

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

4. Make sure the oil pressure and oil temperatures are within operating range.
5. Increase the power control to 1000 to 1200 RPM.

Step 6. Operate the Engine

Operation in Flight

1. Subject engines are equipped with a dynamic counterweight system and must be operated accordingly. Use a smooth, steady movement (avoid rapid opening and closing) of the throttle.
2. See airframe manufacturer's instructions for recommended power settings.

Fuel Mixture Leaning

1. For maximum service life, Cylinder Head Temperatures (CHT) must be maintained below 435ºF (224ºC) during high performance cruise operation and below 400ºF (205ºC) for economy cruise powers.
2. Manual leaning can be monitored by exhaust gas temperature indication, fuel flow indication, and by observation of engine speed and/or airspeed.

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

3. On engines with manual control, maintain mixture control in FULL RICH position for rated take-off, climb and maximum cruise powers (above approximately 75%). However, during take-off from high elevation airport or during climb, roughness or loss of power may result from over-richness. In such a case adjust mixture control only enough to obtain smooth operation - not for economy. Observe 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.
4. Always return the mixture to FULL RICH before increasing power settings.
5. 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 Pilot's Operating Handbook (POH).
6. During let-down flight operations it may be necessary to manually lean carbureted or fuel injected engines to obtain smooth operation.
   A. Leaning to EGT (Normally aspirated engines with fuel injectors or carburetors).
      (1) Maximum Power Cruise (approximately 75% power) - Never lean beyond 150ºF on rich side of peak EGT unless aircraft operator's manual shows otherwise. Monitor cylinder head temperatures.
      (2) Best Economy Cruise (approximately 75% power and below) - Operate at peak EGT.
   B. Leaning to Flowmeter.
      (1) Lean to applicable fuel-flow tables or lean to indicator marked for correct fuel-flow for each power setting.

Step 7. Stop the Engine

1. Keep the engine speed between 1000 to 1200 RPM, until the operating temperatures are stable and Exhaust Gas Temperature (EGT) is approximately 1100°F (593°C).

1. After temperatures are stable, set the Enable switch to the OFF position to stop the engine.

⚠WARNING: DO NOT MANUALLY TURN THE PROPELLER ON A HOT ENGINE EVEN THOUGH THE ENABLE 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.

2. When the propeller stops rotating, turn the Fuel Selector to the OFF position.

   NOTICE: An independent fuel shut-off valve is supplied by the airframe manufacturer in compliance with engine shut-down integrity requirements.

3. Refer to the airframe manufacturer's Pilot's Operating Handbook for additional information.

UNUSUAL CONDITIONS

Corrective Action for Unusual Engine Conditions

Table 1 identifies corrective action for unusual engine conditions.

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. UNUSUAL ENGINE CONDITIONS

Unusual Condition	Explanation/Corrective Action
Engine Operation	
Engine roughness	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.
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.
Operation in climates above 100°F	Decrease climb angles to keep the engine cool. Refer to the section “Engine Operation in Hot Weather” in this chapter.
Dead airframe battery on the ground	Use a battery charger or jumper cart to start the engine.
Stalled engine	Look at the Fuel Selector setting. Look at the Auxiliary Fuel Pump setting. Turn the Enable switch OFF then back to ON. If the engine does not operate, look at the starter and see if it is engaged.
Engine oscillation (either RPM or manifold pressure)	Slowly decrease the power control RPM until the oscillations STOP. Then slowly increase RPM back to the desired operational RPM.
Engine stops during flight	Refer to the section “In-Flight Engine Restart Procedure” in this chapter.
Rapid decrease in cylinder head temperature	To prevent shock cooling, do not decrease cylinder head temperature at a climate rate more than 50°F (10°C) per minute.
Oil pressure falls below the minimum level	Do a safe landing. Refer to the section “Low Oil Pressure During Flight” in this chapter.

TABLE 1. UNUSUAL ENGINE CONDITIONS (CONT.)

Unusual Condition	Explanation/Corrective Action
Engine Operation (Cont.)	
Oil pressure interruption or loss of 50 to 10 psi during inverted flight	Return to normal attitude and look at oil pressure.
Overheating	The temperature of the system components is greater than the maximum design operating temperature for the components.
Overspeed	Refer to the section “Overspeed” in this chapter.
Conditions	
Fire	Make a safe landing as soon as possible and get help to put out the fire.
Low oil pressure (below minimum specified in Appendix A)/oil starvation	Do a safe landing as soon as possible. Refer to the section “Low Oil Pressure During Flight” in this chapter.
Volcanic ash	Refer to the latest revision of Service Instruction No. 1530.
Engine soaked in water	Examine the engine. Moisture and unwanted materials can cause damage to all systems on the engine. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual for corrective action.

Apply Heat to a Cold Engine

1. 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: Do not use small electric heaters which install in the cowling opening because they do not apply sufficient heat.

   NOTICE: If the aircraft is not in a hangar, use a blanket to keep hot air around the engine.

2. Use a high volume air heater to apply heat.
3. Apply hot air to all parts of a cold-soaked engine.

   Pre-heat application will make the engine start during cold weather and is necessary when the engine has been in sub-freezing temperatures +10F° (12°C).

   Make sure the engine oil is in compliance with the recommended grades in Appendix A.

   NOTICE: 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.

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

4. Apply hot air directly 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. Refer to the section “Start the Engine” in the “Engine Start and Operation” chapter of this manual. Also, refer to additional engine start information in the section “Cold Weather Start” in this chapter.

Cold Weather Start

NOTICE: If the battery is cold, its charge can be drained quickly. An auxiliary power source is recommended as a back-up.

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 30 seconds, stop the engine. Identify and correct the cause. If no leaks or damage are found, do 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.
3. Do a ground check in accordance with the airframe manufacturer’s Pilot's Operating Handbook.
4. Complete a cycle of the propeller control position in accordance with the airframe 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 FOUND:

1. ENGINE ROUGHNESS
2. LOW, HIGH OR SURGING RPM OR FLUCTUATIONS
3. HIGH, LOW, OR FLUCTUATING OIL PRESSURE
4. HIGH OR LOW FUEL FLOW
5. HIGH MANIFOLD PRESSURE
6. IDENTIFY AND CORRECT THE CAUSE.

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

1. During engine operation in hot weather:
   A. Monitor oil and cylinder temperatures during taxiing and engine run up.
   B. Operate 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.
2. Monitor temperature closely.
   A. Operate at sustained sufficient airspeed to cool off the engine.
   B. Keep cowl flaps fully open during the climb.

In-Flight Engine Restart Procedure

If the engine stops during flight:

1. Decrease the power control up to 10% of the current RPM (do not go over 10% of the RPM). This setting is to adjust the propeller to a fine pitch for maximum wind milling.
2. Turn the Enable switch OFF then ON.

Volcanic Ash

1. 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.
2. Ash on the ground and runways can cause contamination in the engine compartment and subsequent engine damage during aircraft landing or take-off.
3. 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.
4. In the event that flight through volcanic ash clouds or with ash on the ground and subsequent contamination occurs, Lycoming recommends the following standard actions listed below.

⚠ **CAUTION:** DO NOT USE WATER INITIALLY TO REMOVE THE ASH. WHEN VOLCANIC ASH COMES INTO CONTACT WITH WATER IT CAN FORM A HARDENED, CORROSIVE COMPOUND.

A. 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).

B. 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.

C. Additional measures could be necessary under specific operating conditions. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual for corrective action.

Overspeed

1. In *engine overspeed,* the engine operates above its rated speed (RPM)). Operation of an engine above its rated RPM 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 3 seconds or less. If the duration and amount of overspeed is in compliance with the limitations identified as *momentary,* no maintenance actions are necessary.

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

2. Refer to the latest revision of Service Bulletin No. 369 for corrective action for engine overspeed.
3. Record all incidents of engine overspeed in the engine logbook, along with the inspection and any specified corrective action taken as per the AEIO-390-A Series Engine Maintenance and Overhaul 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, the most conservative action is to remove the engine, disassemble, and completely examine all engine components.

NOTE: 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 do a safe landing of the aircraft as soon as possible. Identify the root cause according to the protocol per the following progressive steps:

1. Do a check of the oil level in the oil sump. Drain the oil, if necessary, to determine the oil quantity. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual.
2. If the oil level is sufficient, do a check of the accuracy of the oil pressure indication system. If the oil pressure gage is not operating correctly, replace it.
3. Examine oil line connections for leaks. Tighten any loose connections and look for leaks. Replace leaking oil lines.

4. Examine the oil suction screen at the oil sump and the pressure screen/oil filter for blockage or metal deposits. If metal or blockage is found, remove the material and identify the origin of material. Correct the root cause.
5. Examine the oil pump for malfunction. Replace the oil pump if it is not operating correctly.
6. If the oil pressure indication system is operating correctly and oil pressure loss/oil starvation has occurred, remove and disassemble the engine and perform a complete inspection.

   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.

FLIGHT TEST

As shown in the "Engine Start and Operation" chapter of this manual, 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 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 normal service.

Although new and rebuilt engines sent by Lycoming Engines receive a test cell run-in before shipment, this flight test is done to make sure that the engine is in compliance with all operational parameters before release for service. Refer to Appendix A in this manual for operating specifications.

NOTICE: During the flight test, record all data in the engine logbook.

To do this flight test:

1. Start the engine and do a pre-flight run-up in accordance with the chapter "Engine Start and Operation."
2. Do a full power take-off in accordance with the POH.
3. During take-off, monitor the following gages:
   - — Engine RPM
   - — Fuel flow
   - — Oil pressure
   - — Oil temperature
   - — Cylinder head temperature.
4. As soon as possible, decrease the engine speed to climb power in accordance with the airframe manufacturer's POH.
5. Do a shallow climb angle to a suitable cruise altitude.
6. At cruise altitude, decrease power to approximately 75% and continue flight for 2 hours. For the second hour, do power settings alternating 65% and 75% power as per the applicable POH
7. If the engine and aircraft are operating to correct specifications (Appendix A), increase engine power to the maximum airframer recommendations 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.

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

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

9. After landing and shutdown, look for leaks at fuel and oil fittings. Identify and correct the cause of any leaks.
10. Calculate fuel and oil consumption and compare the limits given in Appendix A. If the oil consumption value is above the limits in Appendix A, identify and correct the cause. If there were problems that were corrected, do the flight test again, up to and including this step, before releasing the aircraft for service.
11. Record results of the flight test in the engine logbook.

ENGINE PRESERVATION AND STORAGE

Engine Corrosion and Prevention

The life expectancy of engines in aircraft that are not in flight frequently (flown for 1 hour within 30 days) can decrease because of engine corrosion. Engine corrosion occurs when moisture from the air and products of combustion stick to 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. Whereas in less humid environments, cylinder walls on engines that have 50 hours or more time in service within weeks, can have a varnish coating that will protect them from corrosive action. Such engines under these atmospheric conditions can be inactive for several weeks without evidence of damage by corrosion. Engines that are in flight only occasionally (less than one time per week) are more at risk for corrosion.

NOTICE: **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 1 continuous hour 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.

NOTICE: The Lycoming warranty does not include corrosion unless otherwise identified on the notice tag for new, rebuilt, or overhauled engines sent from Lycoming Engines.

Because climate conditions are different in various geographic areas, Lycoming can only 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
- Salt spray from the ocean
- Frequency of flight
- 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
- Complete oil and oil filter changes as per the recommended intervals in the latest revision of Service Bulletin No. 480
- Do a monthly inspection of engines stored in humid conditions and/or in flight less than once and week.

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.

NOTICE: Lycoming recommends frequent inspection of engines that are stored in humid conditions and/or in flight less than once a week. The Lycoming warranty does not include corrosion.

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 APPLY LUBRICATION TO THE ENGINE CYLINDERS. LUBRICATION IS INEFFICIENT WITH MANUAL OPERATION AND CAN CAUSE PREMATURE WEAR OF ENGINE PARTS FROM SCUFFING AND SPALLING.

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.

Engine Preservation

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 add preservative oil to the cylinder and oil sump in accordance with this procedure.

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

The following items from industrial suppliers are necessary for the preservation procedure:

- preservative oil mixture with one part by volume MIL-C-6529C Type I concentrated preservation compound added to three parts by volume of MIL-L-6082C (SAE J1966), Grade 1100, mineral aircraft engine oil conforming to MIL-C-6529C Type II. Refer to the latest revision of Service Letter No. L180 for any new information.
- A means to heat the oil mixture
- An airless spray gun (Spraying Systems Co. "Gunjet" Model 24A-8395 or equivalent). If an airless spray gun is not available, install a moisture trap in the air line of a conventional spray gun.
- Clay dessicant bags.

NOTICE: Make sure that the preservative oil mixture is hot at the spray nozzle before application to the cylinder in the following procedure.

Complete the engine preservation procedure in a hangar or shelter.

Do the following for engine preservation procedure with the engine installed in the aircraft or on a test stand for the engine to be operated at the start of this procedure:

1. Drain the lubricating oil from the sump or system.
2. Wash and brush finger screen with mineral spirits.
3. Clean the finger screen plug.
4. Apply food grade AA anti-seize compound to the screen plug and install the finger screen, gasket and plug. Tighten until sealing surfaces are in contact then rotate an additional 135º.
5. Apply Loctite 564 to oil drain plug.

6. Install and torque the oil drain plug in accordance with the latest revision of the Table of Limits SSP-1776.

   NOTICE: AEIO engine models finger screen plugs are to be finger-tight only; no safety wire is necessary.

7. Fill the spray gun with the preservative oil mixture.
8. Fill the oil sump with the specified preservative oil mixture.
9. 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.
10. Stop the engine.
11. While the engine is still hot, immediately remove sufficient cowling to get access to the spark plugs.

    NOTICE: Make sure the oil is hot at the nozzle before spray application to the cylinders.

13. Remove both spark plugs from each cylinder.
14. Put the spray device in either of the spark plug holes. Apply the preservative oil mixture to each cylinder, one at a time.
15. Use the spray device 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 YOU SPRAY THE CYLINDERS WITH PRESERVATIVE OIL.

16. After spray application is complete, remove the spray device from the spark plug hole.
17. Install either the spark plugs (or 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).
18. While the engine is still warm:
    A. Install bags of clay desiccant in the exhaust and intake ports.
    B. Attach red cloth streamers as a reminder for the material to be removed when the engine is made ready for flight.
    C. With moisture-proof material and pressure sensitive tape, seal these openings.
       — Exhaust ports
       — Intake ports
       — Breather
       — Vacant accessory pad
       — All openings that connect the inside of the engine to the outside atmosphere.
    D. Apply seals and tape to areas of the engine exposed to the air.
    E. Put a note on the propeller that reads: "Engine preserved - DO NOT TURN THE PROPELLER."
    F. At 15 day intervals, examine the cylinder dehydrator plugs and desiccant. When the color of the desiccant plug and desiccant bag have turned from blue to pink, remove the used desiccant bags and plugs. Install new desiccant bags and plugs.

60 to 180-Day Engine Preservation

New, rebuilt, and overhauled engines from Lycoming Engines have preservation oil for 60 days. The tag on the outside of the engine box is for indication that the engine contains preservative oil

The date of preservation is shown on the sticker on the outside corner of the engine box with the gross weight or the date written on the top of the box following a “Preservation Date” stamp.

NOTICE: Corrosion is warrantable only during the specified preservation period.

If at the end of the specified preservation period, the engine is to stay in storage, do the following inspection, (although this inspection does not extend the corrosion warranty).

1. After the first 60 days, and every 60 days thereafter up to 180 days, examine each engine cylinder one at a time as follows:
   A. Remove the top and bottom spark plugs from each cylinder, one cylinder at a time.
   B. Rotate the crankshaft until the piston is at the bottom dead center.

      NOTICE: Do not rotate the crankshaft any further during the borescope evaluation

   C. Use a 4x borescope with a 70 degree angle of view, or similar equivalent internal examining device, examine each cylinder for evidence of corrosion. The diameter of the borescope must be smaller than the diameter of the spark plug hole.
   D. Install the top and bottom spark plugs in the cylinder
   E. Remove the rocker box covers and look for any evidence of corrosion.
   F. After the inspection is complete, install the rocker box covers.
   G. Remove the accessories. Examine the drives and shafts for moisture or corrosion.
2. When the inspection is complete, install the accessories.
3. At the first sign of corrosion speak to a Lycoming authorized distributor or a Lycoming Technical Service at 877-839-7878 (877-TEX-SUPT).

180-Day or More Engine Preservation

If the engine is to be stored for 180 days or longer, after the first 180 days, and every 60 days thereafter, do the following:

1. If the engine is still in the box, keep the engine in the box and wrapped in plastic. Otherwise, wrap the engine in clean, dry plastic without any rips, tears or openings.

   NOTICE: If available and clean, the urethane top foam pillow can be used again.
2. Examine the moisture indicator on the side of the engine. If there is moisture, the indicator will be pink. If there is no moisture the indicator will be blue.
3. If the moisture indicator is pink:
   A. Remove the wrapping from the engine.
   B. Examine each engine cylinder.
   C. Look for rips or tears in the plastic.
   D. Look for damage to the box, the engine, and the cylinder.
   E. Complete a borescope inspection on each engine cylinder as per the “60 to 180 Day Engine Preservation” section in this chapter.

F. Repair any damage and add preservative oil as necessary as per the “Engine Preservation” section in this chapter.

G. Replace the pink moisture indicator with a fresh blue moisture indicator.

H. Record and report all findings to the shipping agent.

4. At the end of the 180 days, if the moisture indicator is still blue, and the engine must stay in storage, as long as the plastic is not ripped or torn, continue storage with 60-day interval checks, for up to 1 year.

   NOTICE: Completion of the previous steps for storage extension will not extend the warranty.

5. After 1 year of storage, either put the engine into service or repeat the previous steps in this procedure.

Cold Weather Storage

In cold weather, if possible, store the aircraft in a heated hangar between flights. Add oil to the engine as required with the specified oil grade. Refer to the AEIO-390-A Series Engine Maintenance and Overhaul Manual.

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APPENDIX A

TABLE 1. AEIO-390-A SERIES ENGINE SPECIFICATIONS

Number of Cylinders		4	
Cylinder Arrangement - Firing Order		1-3-2-4	
Spark Plugs		8	
Maximum Continuous Horsepower		210 HP @ 2700 RPM 0.50 BSFC	
Performance Cruise (75% Rated)		158 @ 2450 RPM	
Economy Cruise (60% Rated)		137 @ 2350 RPM	
Fuel Consumption, Cruise	75% rated power 65% rated power	12.5 gph 9.1 gph	
Fuel Injector		RSA-5AD1	
Fuel Injector Fuel Filter		75 micron	
Propeller Drive Ratio		1:1	
Propeller Shaft Rotation		Clockwise	
Compressor Bore		5.319 in.	13.510 cm
Compressor Stroke		4.375 in.	11.1 cm
Piston Displacement		389 $in.^3$	6374 cm^3
Compression Ratio		8.9:1	
Weight (lb)		315 lb	143 kg
Dimensions		Height 19.35 in.	49.15cm
		Width 34.25 in.	61.60cm
		Length 30.70 in.	77.98 cm
Oil Sump Capacity		8 quarts	7.6 liters
Minimum Non-Aerobatic Capacity		4 quarts	3.5 liters
Oil Grade Specification		MIL-L-6082 or SAE J1966 SAE Grades	MIL-L-22851 or Ashless Dispersant
Oil Grade at All Temperatures		------	15W-50, or 20W-50
Oil Grade at Temperatures above 80°F (27°C)		60	60
Oil Grade at Temperatures above 60°F (16°C)		50	40 or 50
Oil Grade at Temperatures between 30°F to 90°F (-1°C to 32°C)		40	40
Oil Grade at Temperatures between 0°F to 70°F (-18°C to 21°C)		30	30, 40 or 20W-40

TABLE 1. AEIO-390-A SERIES ENGINE SPECIFICATIONS (CONT.)

Oil Grade Specification (Cont.)	MIL-L-6082 or SAE J1966 SAE Grades	MIL-L-22851 or Ashless Dispersant
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 you are going to fly an aircraft into an area that is much warmer or colder than the aircraft is usually operated in, then you must consider using 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 make the temperatures lower.		
Fuel (minimum octane)	100 or 100LL (Aviation Grade)	
Starter	12 Volt ─ Standard 24 Volt – Optional	
Starter Drive, Ratio to Crankshaft and Rotation At Bendix and Rotation	16.556:1 - Counterclockwise	
Alternator Drive, Ratio to Crankshaft and Rotation	3.20:1 - Clockwise	
Alternator	12 Volt, 70 Amp Optional 24 Volt, 70 Amp Optional	
Tachometer Drive, Ratio to Crankshaft and Rotation	0.5:1 - Clockwise	
Accessory Drive, AND2000:	Optional	
Accessory Drive Ratio, Crankshaft and Rotation	1.3:1 - Counterclockwise	
Magneto Drive, Ratio to Crankshaft and Rotation	1.000:1 - Clockwise	
Magnetos (2) Slick or Teledyne Continental Motors (TCM)	4345 (Left) 4370 (Right) S4LN-200 (Left) S4LN-204 (Right)	
Propeller Governor Drive, AND20010, Type XX	Optional	
Fuel Pump	Diaphragm-Type	

NOTICE: The A3A6 engine is the same as the A1A6 engine except for the propeller flange bushings.

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

NOTICE: For optional starters and alternators, refer to the latest revision of Lycoming Service Instruction No. 1154.

TABLE 2. TABLE OF OPERATING LIMITS FOR ENGINE

Oil Pressure - Minimum Idling	27 PSI	186 kPa
Oil Pressure - Operating	55 to 95 PSI	379 to 655 kPa
Oil Pressure - Starting, Warm-up, Taxi, and Take-off (Maximum)	115 PSI	792 kPa
Minimum Oil Temperature (before take-off)	140ºF	60ºC
Minimum Oil Temperature (during cruise)	170ºF	77ºC
Maximum Oil Temperature	235°F	113°C
Maximum Oil Consumption	0.006 lb/BHP/Hr.	
Fuel Pressure Above Ambient Air Pressure (at the fuel pump)	Maximum 35 PSI Minimum -2 PSI	241 kPa 14 kPa
Zero Fuel Pump (Parallel Boost)	45 PSI	310 kpa
Zero Fuel Pump (Maximum Series Boost)	35 PSI	241 kpa
Maximum Fuel Flow (Parallel Boost)	14 PSI	97 kpa
Maximum Fuel Flow (Series Boost)	14 PSI	97 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) - Below 75% power in level flight	435°F	224°C
Maximum Exhaust Back Pressure at Any Cylinder	2 in. Hg.	5 cm Hg.
Alternator Stator Slot Temperature	360ºF	182ºC
Alternator Stator End Turns Temperature	360ºF	182ºC
Alternator Drive End Bearing Temperature	248ºF	120ºC
Alternator Positive Heat Sink Temperature	305ºF	152ºC

TABLE 3. ACCESSORY DRIVES

Accessory Drive	Type of Drive	Direction of Rotation	Drive Ratio	Maximum Torque		Maximum Overhang Moment (in.-lb)
				Continuous (in.-lb)	Static (in.-lb)	
Starter	SAE	Counter-clockwise	13.556:1	------	450	150
Alternator	SAE	Clockwise	3.20:1	60	120	175
Accessory Drive	AND20000*	Counter-clockwise	1.300:1	70	450	25
Tachometer	SAE	Counter-clockwise	0.500:1	7	50	5
Propeller Governor on A1A6 and A3A6 Engines	AND20010+	Clockwise	0.866:1	125	1200	45
Propeller Governor on A1B6 and A3B6 Engines	AND20010+	Clockwise	0.895:1	125	1200	40

* Except for torque limitation and rotation

\+ Except for torque limitations

APPENDIX B

INSTALLATION AND WIRING DIAGRAMS

NOTICE: Installation drawings are available for purchase from Lycoming Engines. Contact the Publications clerk at Lycoming Engines at 570-327-7274.

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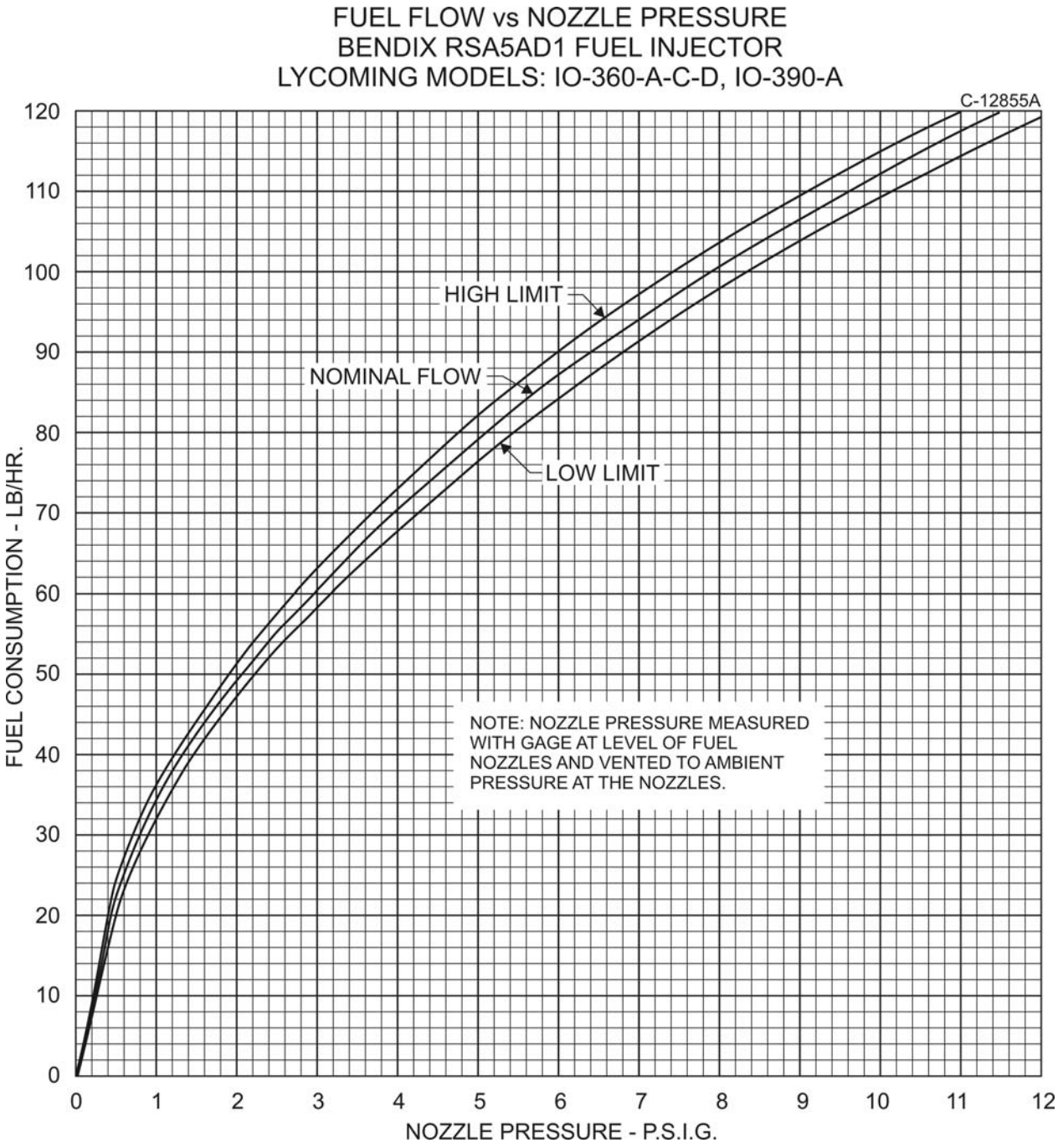
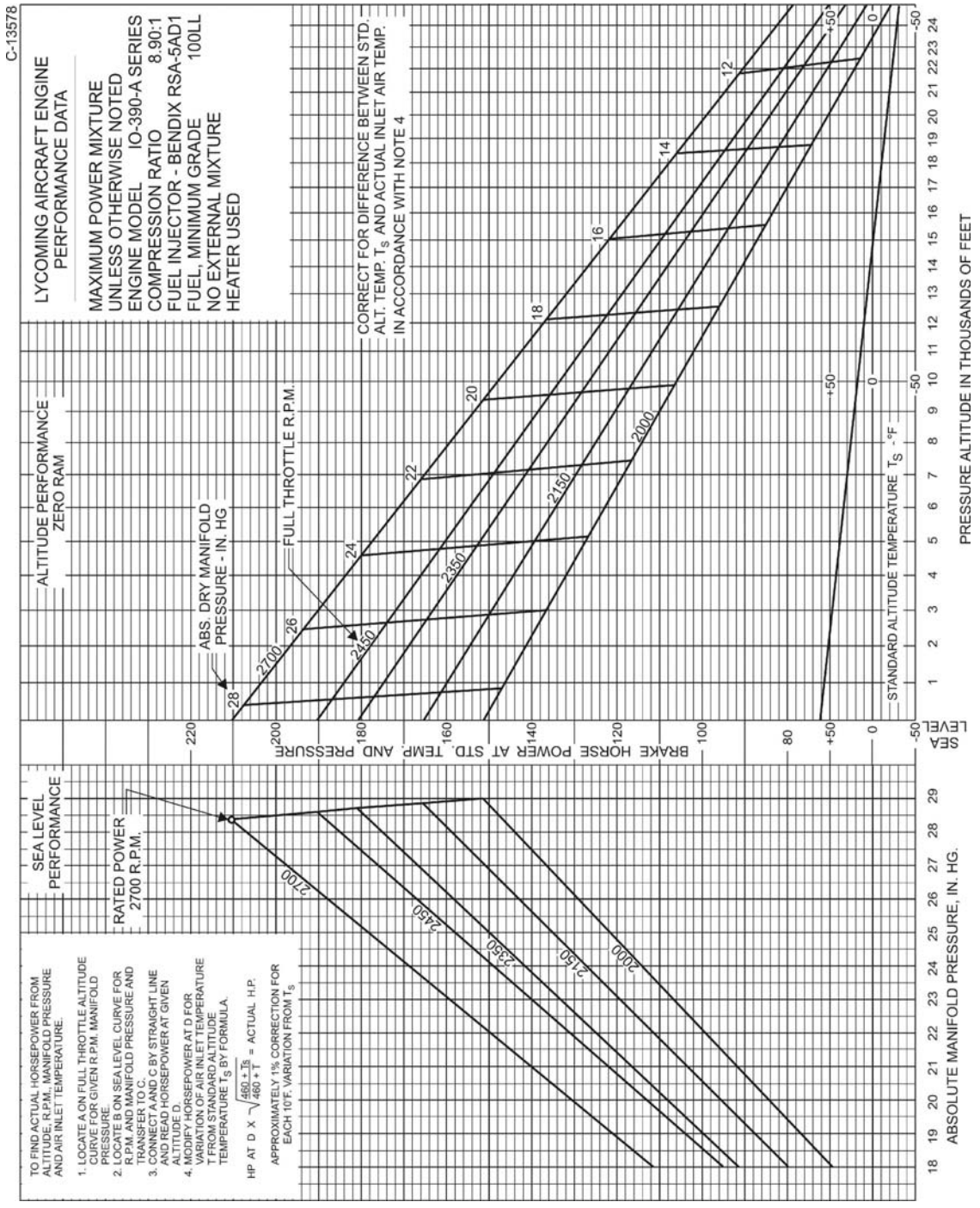
APPENDIX C

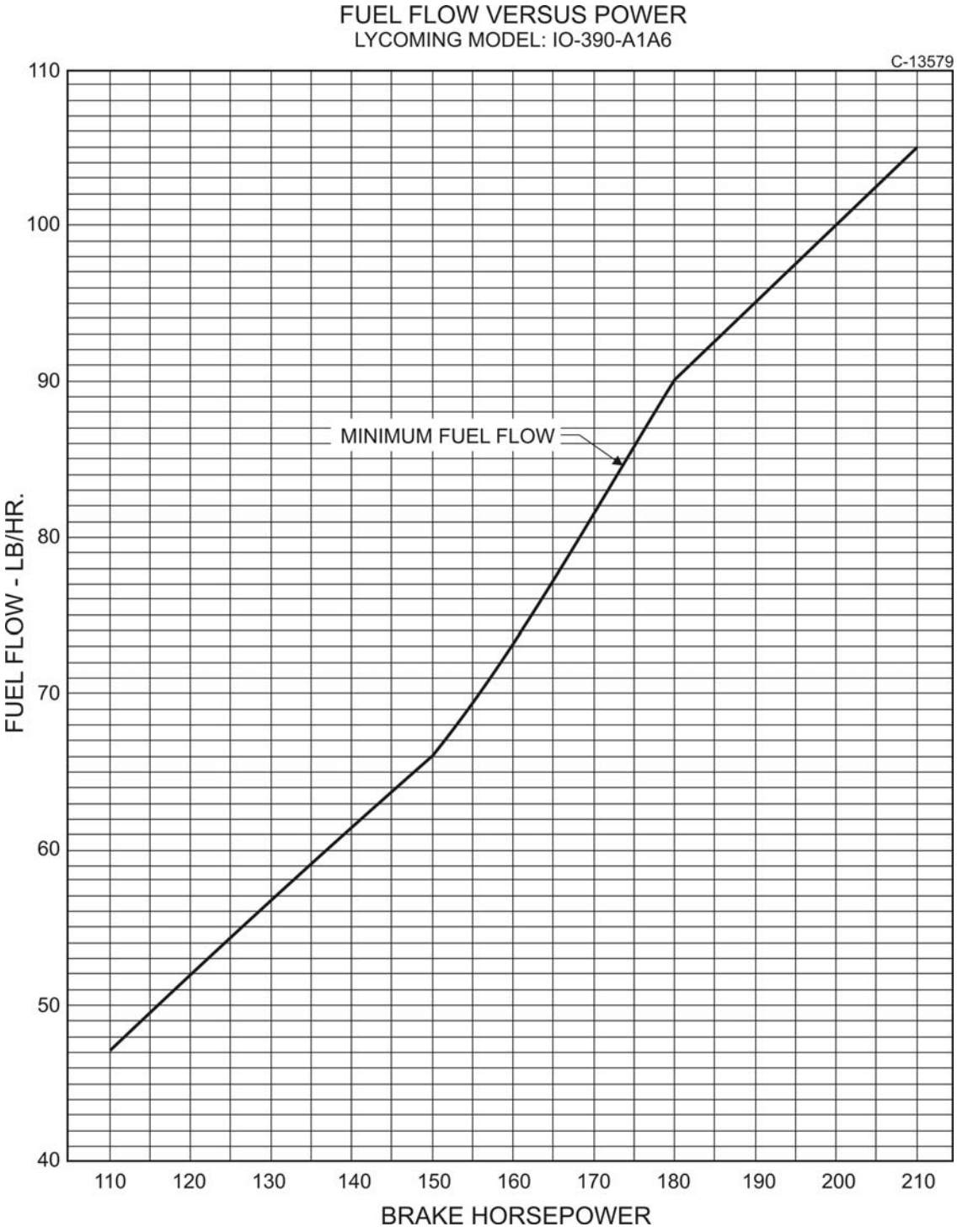
PERFORMANCE DATA



Part Throttle Fuel Consumption
Figure 1



Sea Level and Altitude Performance Curve
Figure 2



Minimum Fuel-Flow vs. Power
Figure 3