LYCOMING™

Engine Installation and Operation Manual

IO-360-N1A Engine

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IO-360-N1A Engine
Installation and Operation Manual

Lycoming Part Number: IOM-IO-360-N1A

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RECORD OF REVISIONS

Revision	Revision Date	Revised By	Revision Description
Original			Original Release of Installation and Operation Manual - Part No. IOM-IO-360-N1A

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SERVICE DOCUMENT LIST

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

Number	Incorporation Date	Subject
S.B. 369	02/16	Engine Inspection after Overspeed
S.B. 480	02/16	I. Oil and Filter Change and Screen Cleaning II. Oil Filter Screen Content Inspection
S.B. 533	02/16	Recommended Action for Sudden Engine Stoppage, Propeller/Rotor Strike or Loss of Propeller/Rotor Blade or Tip
S.I. 1009	02/16	Recommended Time Between Overhaul Periods
S.I. 1014	02/16	Lubricating Oil Recommendations
S.I. 1070	02/16	Specified Fuels
S.I. 1098	02/16	Propeller Flange Bushing Location
S.I. 1132	02/16	Magneto Drop-off
S.I. 1154	02/16	FAA Approved Starter and Alternators
S.I. 1241	02/16	Pre-oil the Engine Prior to Initial Start
S.I. 1409	02/16	Lycoming Engines P/N LW-16702, Oil Additive
S.I. 1427	02/16	Lycoming Reciprocating Engine Run-In and Oil Consumption
S.I. 1443	02/16	Approved Slick Magnetos on Lycoming Engines
S.I. 1472	02/16	Removal of Preservative Oil from Engine
S.I. 1481	02/16	Factory Engine Preservation
S.I. 1505	02/16	Cold Weather Starting
S.I. 1528	02/16	Aircraft Engine Starter Recommendations
S.I. 1530	02/16	Engine Inspection in a Particulate Laden Environment (Volcanic Ash, Sand, Dust, Airborne Debris)
L 114	02/16	Reciprocating Engine and Accessory Maintenance Publications
L180	02/16	Engine Preservation for Active and Stored Aircraft

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ABBREVIATIONS AND ACRONYMS

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

ABBREVIATIONS AND ACRONYMS (CONT.)

M	
mm	Millimeter
MSB	Mandatory Service Bulletin
N	
Nm	Newton Meter
P	
P/N	Part Number
POH	Pilot's Operating Handbook
ppm	Particles per Million
psi	Pounds per Square Inch
R	
rpm	Revolutions per Minute
S	
SAE	Society of Automotive Engineers (oil viscosity)
SB	Service Bulletin
SI	Service Instruction
STC	Supplemental Type Certificate
T	
TCM	Teledyne Continental Motors
TR	Temporary Revision
V	
V	Volt, Voltage

INTRODUCTION

Engine Model Nomenclature

The tables below show the definition of each letter and number for IO-360-N1A engines.

Model Number	Meaning
I	Fuel Injected
O	Horizontally Opposed
360	Displacement in cubic inches

Scope of this Manual

This manual supplies instructions (in compliance with FAR 33.5 and 21.50) for engine preparation, installation, and operation of the IO-360-N1A Lycoming aircraft engines. The installation instructions in this manual are basic guidelines. When installing the engine in the airframe, follow the airframe manufacturer's installation instructions.

Refer to the ***IO-360-N1A Engine Service Manual*** for required maintenance (service information) such as: oil changes, oil addition, oil filter replacement, routine time-interval inspections, routine service, spark plug replacement/inspection procedures, cylinder inspection, fuel system inspection, and scheduled servicing procedures.

For airworthiness limitations, guidelines to isolate faults and for procedures to replace components, disassemble and assemble the engine, refer to the ***IO-360-N1A Engine Maintenance Manual.***

For spare parts information, refer to the ***IO-360-N1A Illustrated Parts Catalog***.

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

Service Bulletins, Service Instructions, and Service Letters

As advancements in technological applications on this engine continue, Lycoming 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 (which are abbreviated with a capital "L" followed by the number, example L180). Special Advisories (SAs) are supplied as necessary without a subscription.

For subscription information, look on Lycoming's website or speak to Lycoming by telephone: U.S. and Canada toll free: 1-800-258-3279; International Customers: 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.

Instructions for Continued Airworthiness

The ***IO-360-N1A Engine Service Manual, IO-360-N1A Engine Maintenance Manual***, latest revision of the ***Service Table of Limits - SSP-1776,*** service documents, and related publications make up the complete set of Instructions for Continued Airworthiness (ICAs). The ICAs are prepared by Lycoming Engines and are approved by the Federal Aviation Administration (FAA).

Compliance Requirements

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

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

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

Warning, Cautions, and Notices

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

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

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

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

Simplified Technical English

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

Figures

Figures in this manual are for conceptual illustrative purposes only.

Copyright

Environmental Compliance

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

Supplemental Service Information

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

Feedback

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

Customer Service

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

Phone:

Factory:	U.S. and Canada toll free - +1 (800) 258-3279
	International Customers - +1 (570) 323-6181
Sales Department:	+1 (570) 327-7278
Fax:	+1 (570) 327-7101

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

Change of Address Notification

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

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SYSTEM DESCRIPTION

The Lycoming IO-360-N1A engine (Figure 1) is a direct-drive four-cylinder, horizontally opposed, fuel-injected, air-cooled engine. It has tuned induction, and a down exhaust.

NOTICE: Refer to Appendix C for engine performance data.

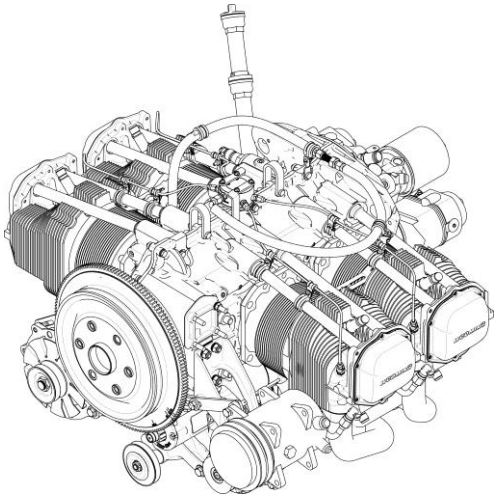

Figure 1
IO-360-N1A

Cylinders

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

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

The engine has intercylinder cooling baffles.

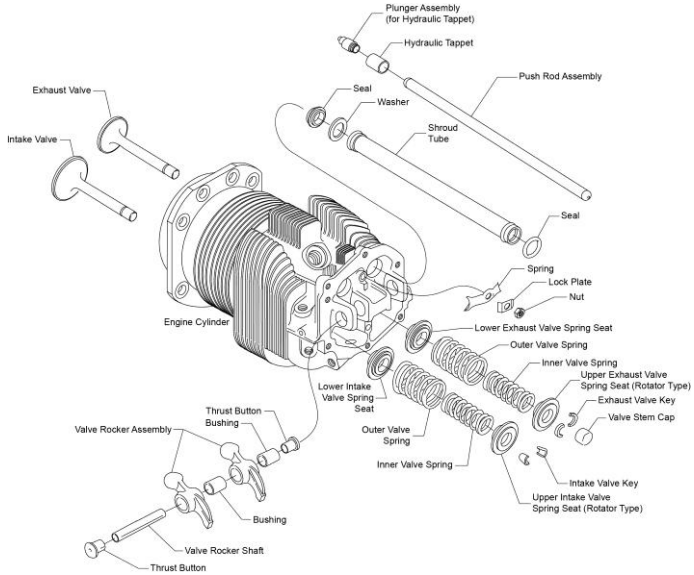

Figure 2
Engine Cylinder

Crankcase

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

The crankcase forms the bearings for the camshaft. The camshaft operates the 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 (Figure 4) is within the crankcase. The crankshaft has journals to attach connecting rods and pistons.

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

Four oil nozzles supply oil for internal piston cooling

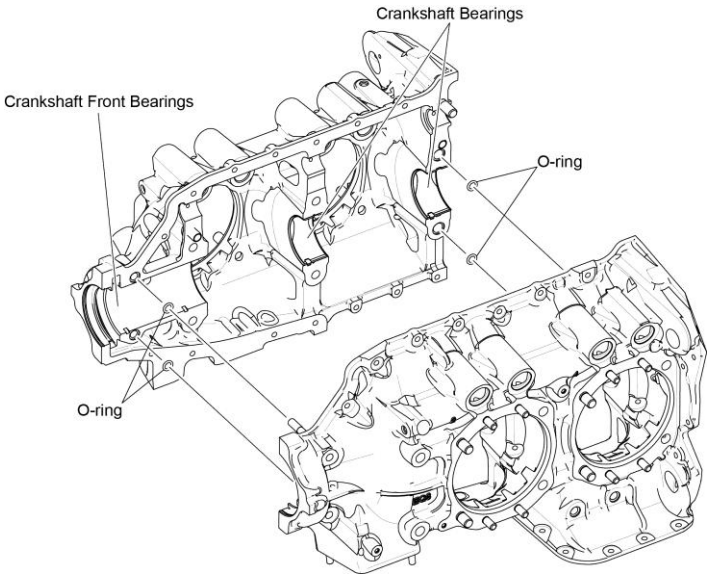

Figure 3
Crankcase

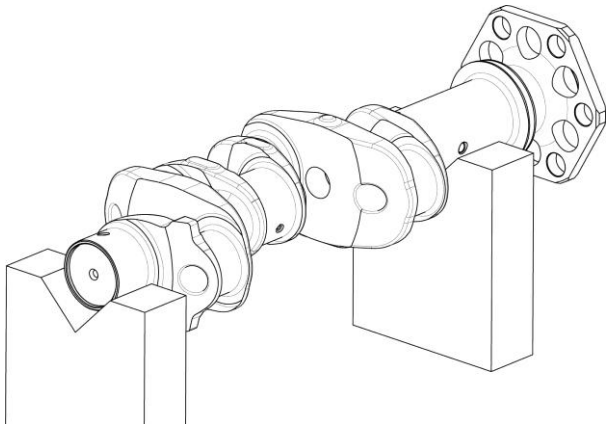

Figure 4
Crankshaft

Ignition System

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

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

One magneto can have one retard breaker magneto and one plain magneto. The plain magneto must be grounded during the start cycle. The shafts in both magnetos rotate clockwise (when facing the drive pad).

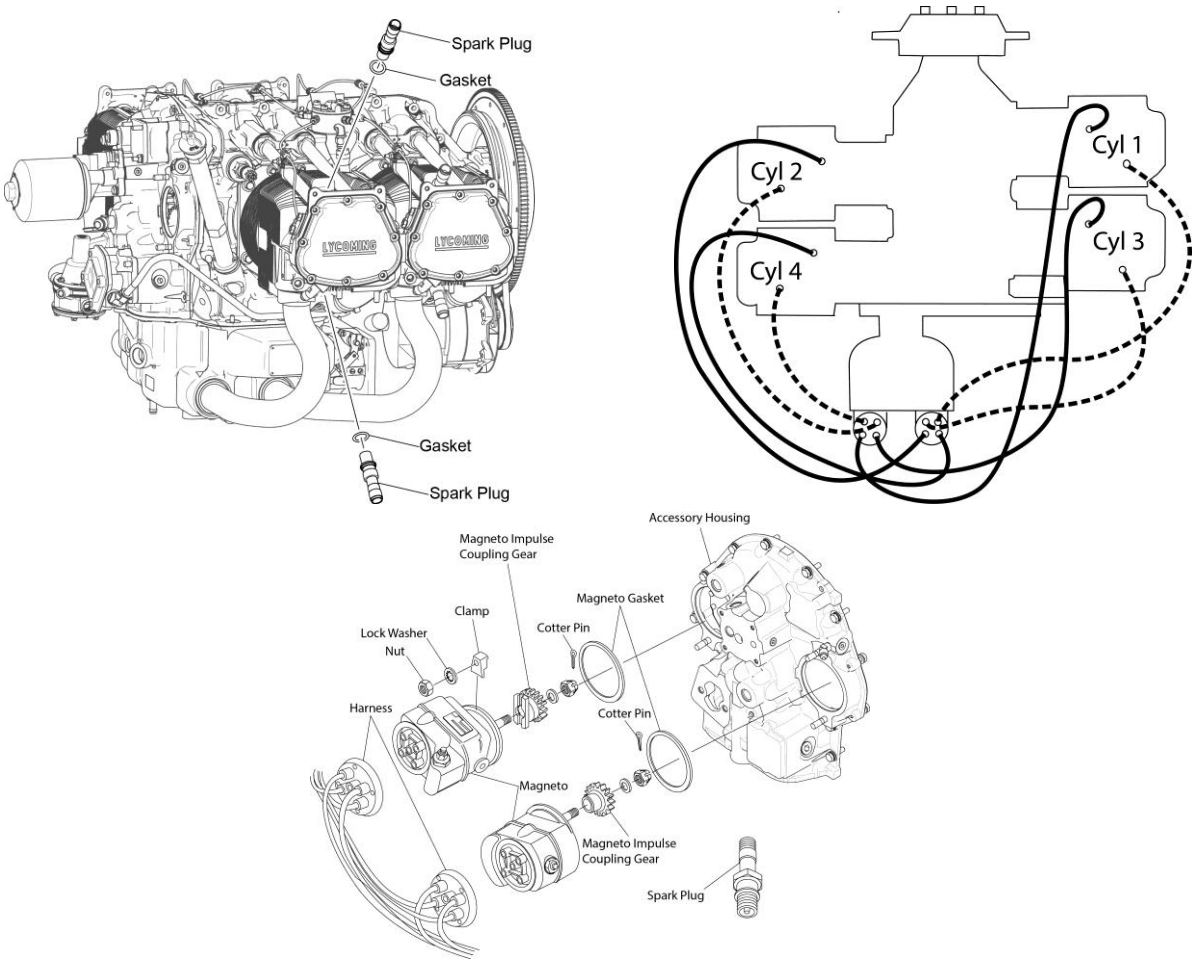

Figure 5
Ignition System

Starter

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

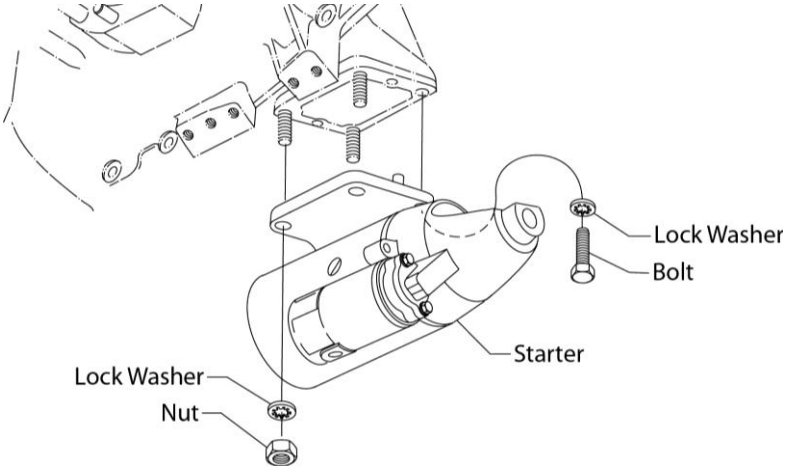

Figure 6
Starter

Fuel Injection System

The fuel injection system (Figure 7) includes: a fuel manifold and fuel injector, four injection nozzles (one per cylinder), a diaphragm-type fuel pump, and fuel lines which connect the fuel injectors to the fuel manifold. Refer to the fuel flow and consumption curves in Appendix C.

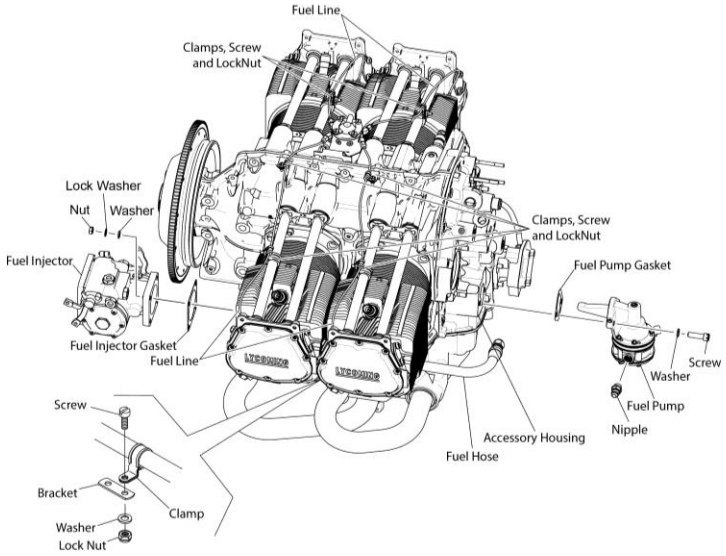

Figure 7
Fuel Injection System

Lubrication System

The lubrication system (Figure 8) includes a wet sump, oil pump, oil fill/dipstick, oil suction screen, full flow oil filter, and oil lines. Two filler extensions are available.

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

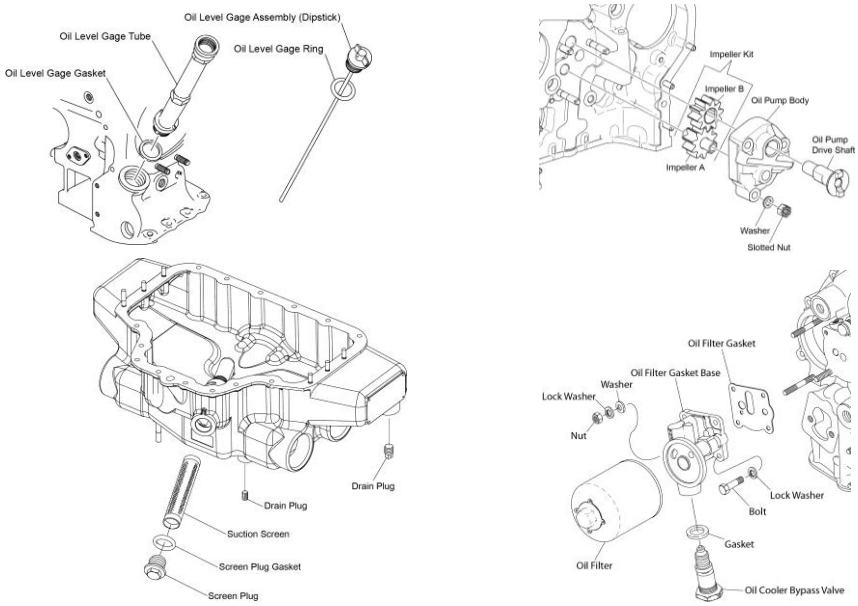

Figure 8
Lubrication System

Cylinder Number Designations

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

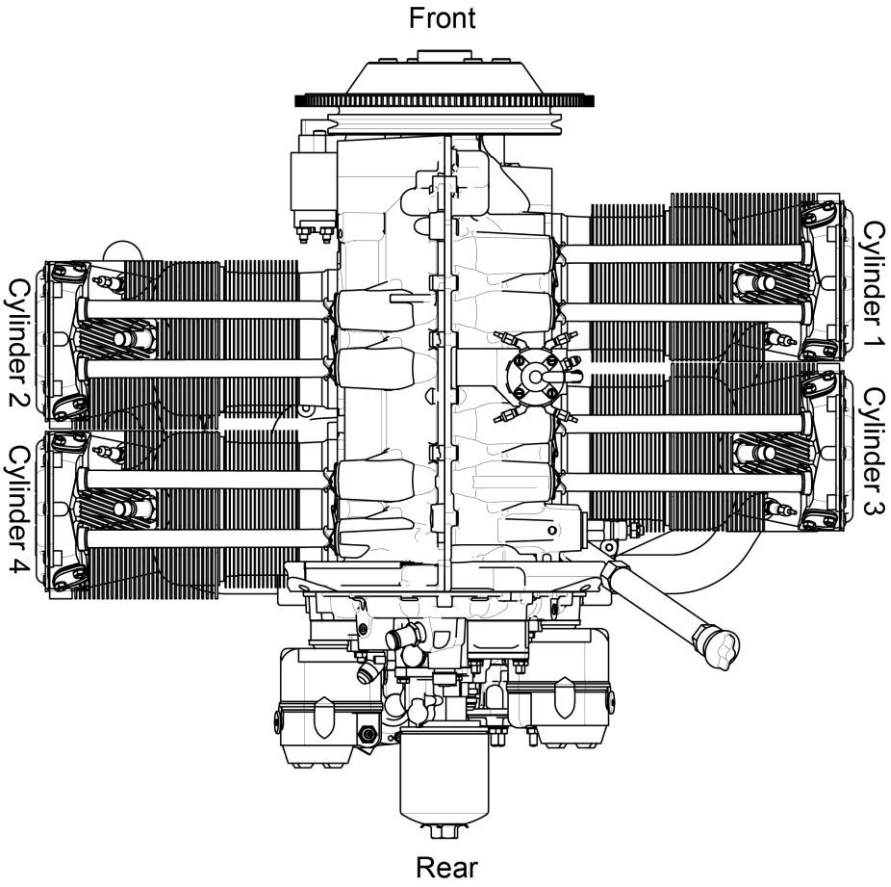

Figure 9
Cylinder Number Designation

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ENGINE RECEPTION AND LIFT

Uncrate Procedure for a New, Rebuilt, or Overhauled 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 shipping container or box is not damaged. If the engine crate is damaged, speak to Lycoming's Service Department and the freight shipper.
   A. These engines are usually sent in a box where the engine is attached to a pallet within the box. The engine can be in a plastic bag or wrapped and it could have a top foam pillow.

⚠ 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, ETC.

2. If the crate is acceptable, remove the engine from the crate. 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 per the "Engine Preservation - 61 to 180 Days" 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 data plate (Figure 1) 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.

Figure 1
Engine Data Plate

NOTICE: 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 Preservative Oil Removal

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

Lift the Engine

⚠ **CAUTION:** THE HOIST MUST HAVE A CAPACITY TO LIFT A MINIMUM OF 750 LB (340 KG).

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 2.

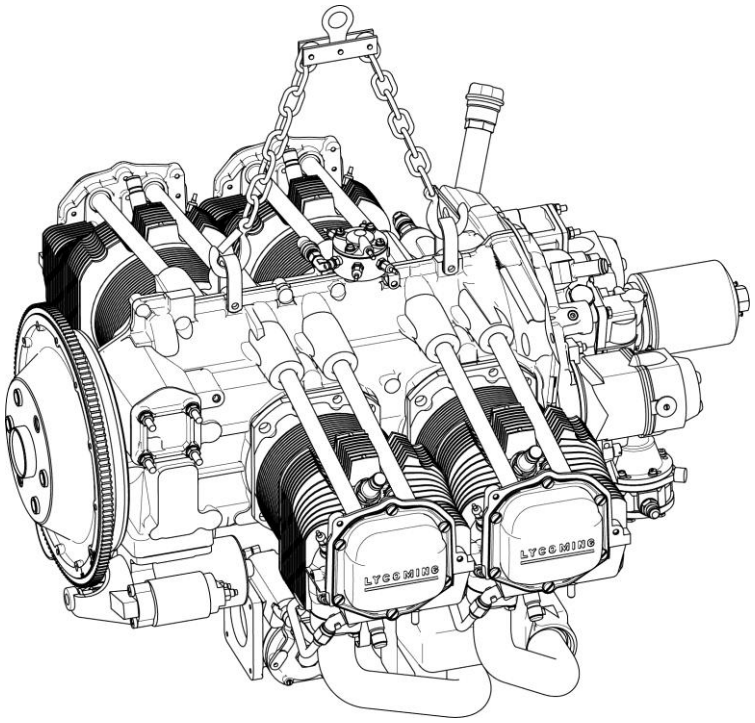

Figure 2
Engine Lift

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

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

REQUIREMENTS FOR ENGINE INSTALLATION

Overview

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

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

Table 1
Prerequisites for Engine Installation

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

Step 1. Prepare the Engine

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

Prepare a New, Rebuilt, or Overhauled Engine for Installation

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

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

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

1. Lift the engine. Refer to the section "Lift the Engine" in the "Engine Reception and Lift" chapter in this manual.
2. Complete the preservative oil removal procedure as follows:
   A. If any of the dehydrator plugs (which contain crystals of silica gel) break and the crystals fall into the engine, complete the following per the ***IO-360-N1A Engine Maintenance Manual.***
      - Disassemble the affected portion of the engine.
      - Clean the engine.

B. Remove desiccant bags.

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

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

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

F. Turn the crankshaft through three or four complete revolutions to remove the cylinder preservative oil from the cylinders.

G. Collect the cylinder preservative oil as it drains out of the lower spark plug holes.

H. Tilt the engine to one side until the spark plug holes on that side are vertical.

I. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.

J. Tilt the engine to the other side until the spark plug holes on that side are vertical.

K. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.

3. Examine the cylinder bores with a borescope for rust and contamination. Refer to the ***IO-360-N1A Engine Service Manual***.

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

5. Drain preservative oil from the oil sump:

   A. Put a 15-quart (14-liter) capacity container under the oil sump.

   B. Remove the safety wire from both oil sump drain plugs. Discard the safety wire.

   C. Remove the oil sump drain plugs.

   D. Drain the remaining preservative oil from the oil sump into the container.

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

   E. Remove, examine, clean, and reinstall the oil suction screen per the "Oil Suction Screen Removal/Inspection/Cleaning/Installation" section in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual.***

   F. Apply one to two drops of Loctite® 564™ to the threads of each oil sump drain plug and install the oil sump drain plugs in the oil sump. Torque the drain plugs in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

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

   G. Safety wire the two oil sump drain plugs and oil suction screen plug in accordance with the standard practices per the latest revision of AC43.13-1B.

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. Make sure that the induction riser is clean and dry.
8. Remove and examine the spark plugs. If spark plugs are acceptable, install them. Refer to the spark plug procedures in Chapter 74-20 of the ***IO360-N1A Engine Service Manual.***
9. If a constant speed propeller is used:
   A. Use a pointed punch tool to make a 1/8 in. (3.18 mm) to 3/16 in. (4.76 mm) hole in the center of the front expansion plug on the crankshaft.
   B. Remove and discard the expansion plug from the crankshaft.
   C. Look for and remove any foreign object contamination (sometimes a little piece of expansion plug falls off).
10. Remove the fuel inlet strainer and clean it with a hydrocarbon-based solvent such as mineral spirits or equivalent.
11. Examine the fuel supply lines, fuel manifold, and throttle body, to make sure they are clean and dry.

NOTICE: During the first 50 hours of engine operation of new, rebuilt, or overhauled engines, it is recommended that this engine by operated with mineral oil until oil consumption has stabilized.

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

Promptly, 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 TURN THE CRANKSHAFT OF AN ENGINE WITH PRESERVATIVE OIL BEFORE REMOVAL OF THE BOTTOM SPARK PLUGS. ENGINE DAMAGE CAUSED BY HYDRAULIC 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).

NOTICE: If any of these plugs break and the crystals fall into the engine, complete the following procedure per the ***IO-360-N1A Engine Maintenance Manual.***

- Disassemble the engine.
- Clean the engine.

4. Examine the engine for any damage.
5. If the engine is not damaged, go to the next step. If damage is found, identify and correct or repair the problem. Record findings and corrective action in the engine logbook.
6. Remove the spark plugs or protective plugs from the bottom spark plug holes per instructions in Chapter 74-20 in the ***IO-360-N1A Engine Service Manual.***
7. Remove any other moisture-prevention seals and covers from the engine.

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

NOTICE: To touch-up paint, refer to Chapter 72-10 in the ***IO-360-N1A Engine Maintenance Manual.***

8. Complete the preservative oil removal procedure as follows:
   A. If any of the dehydrator plugs (which contain crystals of silica gel) break and the crystals fall into the engine, complete the following procedure per the ***IO-360-N1A Engine Maintenance Manual.***
      - Disassemble the engine.
      - Clean the engine.
   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. Turn 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. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.
9. Examine the cylinder bores with a borescope for rust and contamination. Refer to the ***IO-360-N1A Engine Service Manual.***
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 safety wire and oil sump drain plugs. Discard the safety wire.
    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.

D. Remove, examine, clean, and reinstall the oil suction screen per the "Oil Suction Screen Removal/Inspection/Cleaning/Installation" section in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual.***

E. Apply one to two drops of Loctite® 564™ to the threads of each oil sump drain plug and install the oil sump drain plugs in the oil sump. Torque the drain plugs in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

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

F. Safety wire the two oil sump drain plugs in accordance with the standard practices per the latest revision of AC43.13-1B.

12. Remove the oil filter and install a new oil filter. Refer to the ***IO-360-N1A Engine Service Manual.***
13. If a constant speed propeller is to be used:
    A. Use a pointed punch tool to make a 1/8 in. (3.18 mm) to 3/16 in. (4.76 mm) hole in the center of the front crankshaft plug.
    B. Remove and discard the expansion plug from the crankshaft.
    C. Look for and remove any foreign object contamination (sometimes a little piece of expansion plug falls off).
14. Refer to Chapter 74-20 in the ***IO-360-N1A Engine Service Manual*** to:
    A. Examine the spark plugs.
    B. If spark plugs are acceptable, install them. If the spark plugs are dirty, clean them in petroleum solvent. If the spark plugs are not acceptable, install new spark plugs.
    C. Remove the protectors on the ignition lead ends.
    D. Connect the ignition lead ends.
15. Remove the fuel inlet strainer and clean it with a hydrocarbon-based solvent such as mineral spirits or equivalent.
16. Examine the fuel supply lines, fuel manifold, and throttle body to make sure they are clean and dry.

NOTICE: During the first 50 hours of engine operation of new, rebuilt, or overhauled engines, it is recommended that this engine by operated with mineral oil until oil consumption has stabilized.

17. Add mineral oil to a new, rebuilt, or overhauled engine, otherwise add specified oil in Appendix A. Refer to the ***IO-360-N1A Engine Service Manual.***
18. Use the correct procedure for disposal of drained oil and fuel in accordance with local, state, federal, and environmental protection regulations.

Step 2. Supply Interface Items

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

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

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

Step 3. Remove Components

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

Remove only the components necessary to enable engine installation.

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

Step 4. Install Aircraft-Supplied Engine Mounts

The airframer is to supply bonded rubber mounts and bolts for attachment to the Type 1 Dynafocal engine mounts. There are four mounting bosses integral to the crankcase. Refer to the respective Installation Drawing identified in Appendix B for the IO-360-N1A engine.

Maximum Allowable Load for the Mounting Attachment and Structure

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

Step 5. Prepare the Aircraft Engine Harness

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

Step 6. Make Electrical Interface Connections

Make electrical interface connections.

Grounding Requirements

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

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ENGINE INSTALLATION

Engine Installation Overview

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

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

This engine can be installed in aircraft in Table 1.

Table 1
Aircraft Where IO-360-N1A Engines Can Be Installed

FAR Part 23 normal and utility category aircraft up to Class III

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

Table 2
Aircraft Where IO-360-N1A Engines Cannot Be Installed

Any FAR Part 25 aircraft
Any FAR Part 29 rotorcraft

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

To install the engine, refer to the section reference in this chapter for each step in Table 3.

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 Linkages
4	Install External Accessories (as necessary)
5	Install Baffling
6	Install the Compressor Belt (as necessary)
7	Install the Propeller
8	Connect Fuel Lines
9	Connect Oil Lines
10	Install Components That Had Been Removed Before Engine Installation
11	Add Oil
12	Add Fuel (to aircraft as necessary)
13	Engine Pre-Oil Procedure

Step 1. Install the Engine on Mounts

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

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

Step 2. Connect the Wiring Harness

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

Step 3. Connect the Linkages

Connect the throttle linkage, and propeller (if constant speed) as necessary in accordance with the aircraft manufacturer's specifications and drawings.

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 aircraft manufacturer's instructions. Refer to Table A-3 in Appendix A.
3. If necessary, install the propeller governor; use the manufacturer's supplied gasket and hardware. Refer to Table A-3 in Appendix A.

Step 5. Install Baffling

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

Step 6. Install the Compressor Belt (as necessary)

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

Step 7. Install the Propeller

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

Install the propeller in accordance with the propeller and aircraft manufacturer's instructions. Make sure the correct propeller flange bushings are installed in the correct location. Refer to the latest revision of Service Instruction SI-1098 and any supplements.

Step 8. Connect Fuel Lines

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

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

2. Remove unwanted material from the aircraft fuel strainer. Let a minimum of 1 gallon (3.8 liters) of fuel flow through the strainer, aircraft fuel filter and fuel supply line.
3. Make sure that the aircraft manufacturer has a fuel filter installed on the aircraft.
4. Remove protective caps from the main fuel inlet.
5. Connect the main fuel inlet line to the fuel pump. Torque the connections per the aircraft manufacturer's instructions.
6. Required guidelines for making fuel line connections:
   A. Make sure that each fuel line is intact. Not bent or damaged, and does not have any kinks or dents. The fuel line must be intact.

   NOTICE: Refer to Chapter 73-10 in the ***IO-360-N1A Engine Maintenance Manual*** for suggested routing and configuration arrangement diagrams for fuel lines on this engine. The fuel line configuration diagram is conceptual and for reference only. Fuel line routing on you engine could have slightly different configurations. Fuel lines must be examined every 100 hours per the ***IO-360-N1A Engine Service Manual***.

   B. Make sure that the fuel lines are securely connected (to dampen vibration during flight) with the necessary cushioned clamps and hardware.
   C. Fuel lines must be held in place securely using clamps with cushions. Make sure the clamps are tightly attached to support the fuel line and to prevent movement from vibration or motion frequencies. Do NOT use plastic tie straps in place of cushioned clamps.

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

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

Step 9. Connect Oil Lines

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

1. Connect the oil line to the airframe-supplied oil cooler.
2. Clean each oil line and install it in the respective areas. Make sure the oil line routing is smooth, without sharp bends, kinks or helical twists.

3. When making oil line connections:
   A. Align the oil line with the fitting for best orientation (without kinks or sharp bends).
   B. Torque the fitting to the torque value in the latest revision of the ***Service Table of Limits - SSP-1776***.

Step 10. Install Components That Had Been Removed Before Engine Installation

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

Step 11. Add Oil

Oil Additives

Anti-scuffing agent oil additive (P/N LW-16702) to decrease engine wear can be added to the oil sump during an oil change except for installations that use a friction-type clutch and common engine oil system for the transmission and clutch assembly. Prior to adding to the oil, contact the aircraft manufacturer for approval. Refer to the latest revision of Service Instruction No. SI-1409 for quantity and instructions to add the oil additive.

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

NOTICE: On new, rebuilt, or overhauled engines, during the first 50 hours of engine operation, it is recommended that this engine be operated with mineral oil until oil consumption has stabilized. Afterwards, complete an oil change, drain the mineral oil and add new oil identified in Appendix A.

⚠ **CAUTION:** OIL MUST BE FLOWING TO ALL ENGINE PARTS THAT REQUIRE LUBRICATION AT ALL TIMES AND IN ALL ATTITUDES FOR CORRECT ENGINE OPERATION.

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

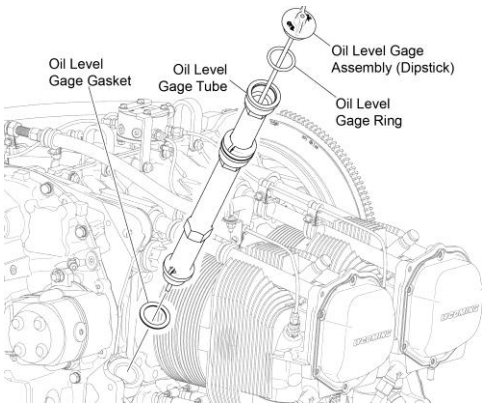

Figure 1
Oil Fill Tube and Oil Level Gage (Dipstick)

3. Measure the oil level per the "Oil Level Check" procedure in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual***. Add more oil if necessary until the oil level in the engine is sufficient for the flight conditions.
4. Install the oil level gage assembly (dipstick) into the oil level gage tube securely.

Step 12. Add Fuel

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

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

Step 13. Engine Pre-Oil Procedure

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

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

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

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

  or

- After oil cooler replacement-draining

  or

- After any prolonged period of inactivity

  or

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

To complete the pre-oil procedure:

1. Remove one spark plug from each cylinder of the engine per instructions in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual.***
2. Remove and discard the spark plug gasket.
3. Make sure that the mixture control lever is in the IDLE CUT-OFF position.
4. Make sure the ignition switch is OFF and magneto P leads are grounded.
5. Make sure the fuel selector and fuel pump switches are in the OFF position.
6. Disconnect the fuel inlet lines.
7. Enable power to the engine.

CAUTION: DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 SECONDS. LET THE STARTER COOL FOR 30 SECONDS AFTER EACH ENERGIZATION. IF THE STARTER FAILS TO ENERGIZE AFTER TWO ATTEMPTS, IDENTIFY AND CORRECT THE CAUSE.

8. Pre-oil start cycle: Energize the starter for 10 seconds and look for evidence of oil pressure of at least 25 psi (172 kPa) within 10 seconds.

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

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

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

9. If oil pressure of at least 25 psi (172 kPa) was sustained in the previous step, repeat the pre-oil start cycle to make sure oil pressure holds stable and that there is no sudden drop in oil pressure. If oil pressure is not stable or drops suddenly, stop pre-oiling, identify and correct the cause.

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

10. Once the minimum oil pressure of 25 psi (172 kPa) is shown on the oil pressure gauge, re-install the spark plug each with a new gasket as per instructions in Chapter 74-20 of the ***IO-360-N1A Engine Service Manual.***
11. Connect the fuel inlet lines.
12. Within the next 3 hours, start and operate the engine for 3 minutes at approximately 1000 rpm.

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 COMPLETE THE RECOMMENDED SERVICE PROCEDURES IN ACCORDANCE WITH THE IO-360-N1A ENGINE SERVICE 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, 4, and 5 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 an Engine for First-Time Operation
2	Start the Engine
3	Complete the Engine Run-Up
4	Operate the Engine
5	Stop the Engine

Engine Run-In / Engine Break-In

Engine run-in is the initial operational check usually done on a new, rebuilt, or overhauled engine in a test cell at the factory or authorized repair facility (where operating conditions can be closely monitored). The purpose of this procedure is to ensure that the engine is operating correctly according to engine specifications. **A *run-in*** is already done on all new, rebuilt, or overhauled engines shipped from the factory. Therefore an additional run-in procedure in the field is not necessary for these engines. Only the engine break-in procedure will need to be done on engines that have been shipped from the factory.

Engine break-in (which must be done after engine run-in) is done in the field with the two progressive flight runs.

- A flight test, refer to the "Flight Test" chapter in this manual
- 50 hours of continued flight at power settings alternating between 65% to 75% per the applicable Pilot Operating Handbook (POH)

NOTICE: Engine break-in must be done on all engines regardless of whether they are new, rebuilt, and overhauled and shipped from the factory or whether they were overhauled in the field or had one or more cylinders replaced or piston rings replaced.

Step 1. Prepare an Engine for First-Time Operation

1. After any of the following actions on a newly installed/rebuilt/repaired/overhauled or stored engine, complete the Pre-Flight Inspection for First-Time Operation Checklist to make sure that the engine is operating correctly after:
   - Engine installation
   - Fault isolation
   - Maintenance or Overhaul

Pre-Flight Inspection for First-Time Operation Checklist

Engine Model Number_____ Engine Serial Number:_____

Engine Time:_____ Date Inspection Done:_____

Inspection done by:_____

Requirement	Comments	Done
Make sure that all switches are OFF.		
Make sure the magneto ground wires are connected.		
NOTICE: Refer to Appendix A for minimum quantity of oil in flight.		
Measure the engine oil level before every flight to make sure there is sufficient oil in the engine. If the oil level is too low, look for any oil leaks. Identify and correct the cause of any oil leak. There must not be any oil leaks.	Refer to Appendix A in this manual. Add the correct specified grade of oil as necessary. Refer to the ***IO-360-N1A Engine Service Manual***.	
NOTICE: During the first 50 hours of engine operation of a new, rebuilt, or overhauled engine, it is recommended that this engine be operated with mineral oil until oil consumption has stabilized. The oil sump capacity and the minimum quantity for flight and on the ground are identified in Appendix A.		
Make sure that the engine crankcase breather is attached tightly and that there are no blockages to the breather air flow.	Remove any blockage to the air flow. Identify and correct the cause of any blockage.	
If the engine is newly installed or is to be put back into service after long-term storage, make sure that the pre-oil procedure was done.	Refer to Section "Step 13. Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual.	

Pre-Flight Inspection for First-Time Operation Checklist (Cont.)

Requirement	Comments	Done
Make sure that the induction air filter is clean and securely in place.		
Examine the engine, propeller hub area, and cowl for indication of fuel and engine oil leaks.	Identify and correct the cause of any leaks.	
Look in the engine compartment and cowling for 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 aircraft manufacturer.	
⚠ WARNING: DO NOT ROUTE FUEL OR OIL LINES CLOSE TO HEAT SOURCES. HEAT CAN DAMAGE THE FUEL AND OIL LINES AND CAUSE A LEAK WHICH COULD LEAD TO CATASTROPHIC ENGINE FAILURE.		
Examine fuel lines: A. Make sure that each fuel and lubrication line is intact, not bent or damaged, and does not have any kinks or dents. B. Make sure that the fuel and lubrication lines are securely connected. C. Make sure the clamps are tightly attached to support the fuel and lubrication line and to prevent movement from vibration or motion frequencies. Do NOT use plastic tie straps in place of cushioned clamps. D. Do not let fuel or lubrication lines touch the engine or aircraft baffle hardware. There must be a minimum of clearance of 3/16 in. (4.76 mm) between a fuel and lubrication line and any engine or aircraft surface.		
NOTICE: Record any problems found and corrective action taken in the engine logbook. Record the magnitude and duration of a problem and any out-of-tolerance values.		
Correct all problems before engine start. Refer to the "Engine Conditions" chapter in this manual.		
Complete a flight test per the “Flight Test” chapter in this manual.		

Step 2. Start the Engine

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

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

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

1. If the engine is newly installed or is to be put back into service after long-term storage, make sure the pre-oil procedure was done. Refer to section "Step 13. Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual.
2. Complete specified steps for engine start recommended by the aircraft Pilot Operating Handbook (POH), aircraft manufacturer, or Supplemental Type Certificate (STC) holder's instructions.

⚠WARNING: EXAMINE THE ENGINE FOR HYDRAULIC LOCK. REFER TO THE IO-360-N1A ENGINE MAINTENANCE MANUAL. DO NOT OPERATE THE ENGINE IF HYDRAULIC LOCK IS POSSIBLE. HYDRAULIC LOCK IS A CONDITION WHERE FLUID ACCUMULATES IN THE INDUCTION SYSTEM OR THE CYLINDER ASSEMBLY. HYDRAULIC LOCK CAN CAUSE ENGINE DAMAGE.

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

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

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

⚠ **CAUTION:** DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 SECONDS. LET THE STARTER COOL FOR 30 SECONDS AFTER EACH ENERGIZATION. IF THE STARTER FAILS TO ENERGIZE AFTER TWO ATTEMPTS, IDENTIFY AND CORRECT THE CAUSE. DO NOT TRY MORE THAN FIVE ENGINE STARTS WITHIN A 2-MINUTE PERIOD.

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

11. Energize the starter (not to exceed 10 seconds) until the engine starts.

12. Put the magneto switch in the BOTH position.

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

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

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

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

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

⚠ **CAUTION:** DO NOT OPERATE THE ENGINE AT SPEEDS ABOVE 2500 RPM UNLESS THE OIL TEMPERATURE AND THE OIL PRESSURE ARE AT LEAST THE MINIMUM SPECIFIED IN APPENDIX A FOR INITIAL START. ENGINE DAMAGE CAN OCCUR IF THE OIL TEMPERATURE OR OIL PRESSURE IS NOT AT THE SPECIFIED MINIMUM LEVELS.

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 oil pressure is normal and the engine operates smoothly, continue to operate the engine until the smoke clears. Otherwise, stop the engine and identify the cause.

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

NOTICE: Aircraft with fixed pitch propellers, or those that do not have a manifold pressure gage, can complete magneto drop-off with engine operating at approximately 2100 to 2200 RPM.

16. Complete a magneto drop-off check as follows for all three cycles RIGHT/LEFT/BOTH.
    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 a check of the feathering action can be done by operating the engine between 1000 to 1500 rpm, then momentarily pulling the propeller control into the feathering position. Do not allow the rpm to drop more than 500 rpm.
    B. With the propeller in minimum pitch angle, set the engine to produce 50 to 65% power 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.

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

    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 175 rpm 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 specified rpm, for the magneto drop-off check and repeat the check. If the drop-off does not exceed 175 rpm and the difference between the drop-off values for both magnetos does not exceed 50 rpm, and the engine is running smoothly, the ignition system is operating properly.
    E. Smooth operation of the engine with a drop-off that exceeds the specification of 175 rpm is usually an indication of a propeller load condition at a rich mixture.
17. Look for any illuminated caution or warning lights in the cockpit.

Step 3. Complete the Engine Run-Up

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

Complete the engine run-up as follows:

1. With the engine running, turn the Fuel Selector to FULLEST or BOTH.
2. Make sure the oil temperature is above the specified minimum (Appendix A).
3. Operate the engine on the ground (with the propeller at minimum blade angle setting).

⚠ **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 the specified operating range in Appendix A.

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

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

Step 4. Operate the Engine

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

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

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

NOTICE: After 25 hours of operation, change the oil. Examine the oil filter and screen. Refer to Chapter 12-10 in the ***IO-360-N1A Engine Service Manual.***

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

Operation in Flight

1. See the aircraft manufacturer's instructions for recommended power settings.
2. Until oil consumption has stabilized after the first 50 hours of flight, cruising is to be done at 65% to 75% power to ensure correct seating of the rings.

Fuel Mixture Leaning

1. For maximum service life, the 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 the FULL RICH position for rated take-off, climb and maximum cruise powers (above approximately 75%). However, during take-off from a high elevation airport or during climb, roughness or loss of power can occur from over-richness. In such a case, adjust the mixture control only enough for smooth operation - not for economy. Monitor instruments for temperature rise. Rough operation due to over-rich fuel/air mixture is most likely to be encountered at altitudes above 5,000 feet.
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 POH. Refer to Appendix A.
6. During let-down flight operations, it could be necessary to manually lean fuel-injected engines for 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 the 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.

      Lean to applicable fuel-flow tables or lean to indicator marked for correct fuel-flow for each power setting.
   C. Leaning with Manual Mixture (economy cruise, 75% power or less without flowmeter or EGT gage).
      (1) Slowly move the mixture control from FULL RICH to LEAN.
      (2) Continue leaning until a slight loss of power occurs (engine roughness could occur).
      (3) Enrich until the engine operates smoothly and power is restored.

Step 5. Stop the Engine

1. With the aircraft on the ground, set the propeller at minimum blade angle.
2. Keep the engine speed between 1000 to 1200 rpm, until the operating temperatures are stable and EGT is approximately 1100ºF (593ºC).
3. Move the mixture control to IDLE CUT-OFF.
4. After temperatures are stable and the engine stops, set the ignition switch to the OFF position.
5. Turn the Fuel Selector to the OFF position.

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

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

ENGINE CONDITIONS

Action for Engine Conditions

Table 1 identifies action for engine conditions. Detailed fault isolation is included in the ***IO-360-N1A Engine Maintenance Manual.***

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

Table 1
Action for Engine Conditions

Condition	Action
Engine roughness	Make a safe landing and speak to Maintenance.
Engine hesitates, misses	Make a safe landing and speak to Maintenance.
Low, high or surging rpm	Make a safe landing and speak to Maintenance.
Low, high or fluctuating oil pressure	Make a safe landing and speak to Maintenance.
Excessive oil pressure	Make a safe landing and speak to Maintenance.
High oil temperature	Make a safe landing and speak to Maintenance.
Low or high fuel flow	Make a safe landing and speak to Maintenance.
Excessive manifold pressure	Make a safe landing and speak to Maintenance.
Engine Indication not available	Make a safe landing and speak to Maintenance.
Engines in an environment at temperatures less than 10°F (-12°C) for more than 2 hours	Refer to the section "Apply Heat to a Cold Engine" in this chapter.
Operation in climates above 100°F	Decrease climb angles to keep the engine cool. Refer to the section "Engine Operation in Hot Weather" in this chapter.
Stalled engine	• Make sure the fuel selector is set to the correct fuel tank. • Make sure that the auxiliary fuel pump is **ON**. • Set the mixture to rich. • Make sure that the ignition switch is set to **BOTH**. • If the propeller has stopped turning, engage the starter. **If the engine restart procedure during flight is not successful, complete a safe landing. Refer to the Aircraft POH for complete procedures on in-flight loss of power.**
Engine oscillation (either rpm or manifold pressure)	Slowly decrease the throttle rpm until the oscillations STOP. Then slowly increase rpm back to the desired operational rpm. Complete a safe landing. Identify and correct the cause.
Propeller strike, sudden stoppage and lightning strikes	Make a safe landing. Refer to the ***IO-360-N1A Engine Maintenance Manual*** for corrective action.
Sluggish propeller operation	Make a safe landing and speak to Maintenance.

Table 1 (Cont.)
Action for Engine Conditions

Condition	Action
Engine does not hold rpm during cruise, climb, or descent	Make a safe landing and speak to Maintenance.
Rapid decrease in cylinder head temperature	To prevent shock cooling, do not decrease cylinder head temperature at a rate more than 50°F (10°C) per minute.
Overheating (The temperature of the system components is greater than the maximum design operating temperature for the components.)	Make a safe landing as soon as possible, and identify and correct the cause. Refer to the ***IO-360-N1A Engine Maintenance Manual***
Overspeed	Refer to the section "Overspeed" in this chapter.
Low oil pressure (below minimum specified in Appendix A)/oil starvation	Complete a safe landing as soon as possible. Refer to the section "Low Oil Pressure During Flight" in this chapter.
Volcanic ash/dust-sand particulate	Make a safe landing as soon as possible. Refer to the latest revision of Service Instruction No. SI-1530. Refer to the ***IO-360-N1A Engine Maintenance Manual.***
Engine soaked in water	Examine the engine. Moisture and unwanted materials can cause damage to all systems on the engine. Refer to the ***IO-360-N1A Engine Maintenance Manual*** for corrective action.

Apply Heat to a Cold Engine

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

NOTICE: Pre-heat application will help the engine start during cold weather and is necessary when the engine has been in sub-freezing temperature + 10º F (12ºC). Do not use small electric heaters (which install in the cowling opening) to warm up an engine because they do not apply sufficient heat.

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

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

1. Use a high volume air heater to apply heat.

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

⚠ WARNING: IF HEAT HAS NOT BEEN APPLIED TO ALL PARTS OF THE ENGINE, THE ENGINE CAN START AND 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: The following is Lycoming Engine's recommended procedure for cold weather engine starts. Refer to the aircraft manufacturer's Pilot's Operating Handbook (POH) for in-flight recommendations during cold weather.

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

5. Before take-off, monitor the oil pressure, oil temperature, and cylinder head temperature to make sure all are within their operating ranges (as specified in Appendix A).

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

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

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

Engine Operation in Hot Weather

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.
   D. Enrich fuel mixture as necessary.
   E. Operate at sustained sufficient airspeed to cool off the engine.
   F. Continue to closely monitor temperatures.

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. Refer to the latest revision of Service Instruction No. SI-1530 for any new details.
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. However, if during flight, the engine is in a particulate-laden atmosphere, do the following:
   (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 the engine to overheat.)

(b) If the engine is not operating smoothly in flight, make a safe landing as soon as possible. Identify and correct the cause of rough operation.

⚠ **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.

(c) Additional measures could be necessary under specific operating conditions. Refer to the ***IO-360-N1A Engine Maintenance Manual*** for corrective action.

Overspeed

1. In *engine overspeed,* the engine operates above its rated speed (rpm). Operation of an engine above its rated rpm (specified in Appendix A) can cause accelerated wear on already stressed components. *Momentary overspeed* can occur 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.

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

2. Refer to the latest revision of Service Bulletin No. SB-369 for corrective action for engine overspeed.
3. Record all incidents of engine overspeed in the engine logbook, along with the inspection and any specified corrective action taken per the ***IO-360-N1A Engine Maintenance Manual.***

Low Oil Pressure During Flight

Circumstances which cause loss of oil pressure are many and varied. Therefore, it is difficult to make a prediction of the extent of damage to the engine or its future reliability. In case of oil pressure loss or engine operation with oil below the recommended minimum operating level, the most conservative action is to remove the engine, disassemble, and completely examine all engine components per instructions in the ***IO-360-N1A Engine Maintenance Manual.***

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

Any time oil pressure falls below the minimum level, complete a safe landing of the aircraft as soon as possible. Identify the root cause according to the protocol per the following progressive steps:

1. Complete a check of the oil level in the oil sump. Drain the oil, if necessary, to measure the oil quantity. Refer to Chapter 12-10 in the ***IO-360-N1A Engine Service Manual.***
2. If the oil level is sufficient, complete 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 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. Refer to Chapter 12-10 in the ***IO-360-N1A Engine Service Manual.***
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 do a complete inspection per the ***IO-360-N1A Engine Maintenance Manual.***

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

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, which is part of the required engine break-in field procedure, is necessary to make sure that the engine and aircraft are in compliance with all of the manufacturer's performance and operational specifications before release of the aircraft for usual service.

1. Flight Test

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

A. Start the engine and complete a preflight run-up in accordance with the applicable manufacturer's Pilot's Operating Handbook (POH).

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

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

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

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

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

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

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

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

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

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

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

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

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

NOTICE: Use the following formula to calculate the maximum allowable oil consumption limits for all Lycoming aircraft engines:

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

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

M. Drain the oil per the "Oil Change Procedure" in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual***.

N. Remove the oil suction screen and the oil pressure screen or oil filter to look for any blockage or contamination. If blockage or contamination is found, remove the blockage and contamination and change the oil.

O. Clean the oil suction screen and, if necessary, replace the oil filter.

P. Install the suction screen and oil pressure screen (or new oil filter) per instructions in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual***.

Q. Add oil per Chapter 12-10 of the ***IO-360-N1A Engine Service Manual***.

R. Record the results of the flight test in the engine logbook.

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

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

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 mix to cause corrosion on cylinder walls and bearing surfaces when the aircraft is not used.

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

Since conditions can change, the corrosion rate can change. Aircraft operated close to oceans, lakes, and rivers and in humid regions have a greater need for engine preservation than engines operated in arid regions. In regions of high humidity, corrosion can be found on cylinder walls of new inoperative engines in as little as 2 days. 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 from 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 continuous 1 hour of operation does not include taxi, take-off and landing time. If the engine cannot be operated at the recommended oil temperatures, speak with the aircraft manufacturer about the use of oil cooler winterization plates.

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 Engines only can give general recommendations for corrosion prevention. The owner and operator must take into account the following factors for setting a rust and corrosion prevention maintenance schedule for the engine:

- Environmental conditions, especially humidity
- 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.

For operation at the correct temperature:

- Make sure the aircraft temperature gages are correct.
- Examine the condition of cooling air baffles. There must not be any blockage.
- Make sure the baffles are the correct fit for maximum cooling air flow.
- Complete oil and oil filter changes per the recommended intervals in Chapter 12-10 of the ***IO-360-N1A Engine Service Manual.***
- Complete a monthly inspection of engines stored in humid conditions and/or in flight less than once a week.

Engine Preservation - 30 to 60 Days

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

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

Engine preservation is necessary, especially for engines that are not operated at least for 1 continuous hour every 30 consecutive days. If you know that an aircraft will not be operated for a minimum of 30 days, then you must add preservative oil to the cylinder and oil sump in accordance with this procedure.

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

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

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 desiccant bags.

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

Complete the following engine preservation procedure in a hangar or shelter 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. Operate the engine until it is at the specified operating temperature in Appendix A. If temperatures are below freezing, the oil temperature must be at least 165ºF (74ºC) before the engine is stopped in the next step.
2. Stop the engine.
3. Drain the lubricating oil from the sump or system per Chapter 12-10 in the ***IO-360-N1A Engine Service Manual.***
4. Wash and brush the oil suction screen with Low VOC mineral spirits.
5. Clean the oil suction screen plug.

6. Apply Food Grade AA Anti-Seize compound to the oil suction screen plug and install the oil suction screen, and plug with a new gasket. Tighten until sealing surfaces are in contact then turn an additional 135º.
7. Apply one to two drops of Loctite® 564 to the threads of the oil sump drain plug.
8. Install, torque, and safety wire the oil sump drain plug in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.
9. Fill the spray gun with the preservative oil mixture.
10. Fill the oil sump with the specified preservative oil mixture.
11. 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.
12. Stop the engine.
13. 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.

14. Remove both spark plugs from each cylinder. Refer to Chapter 74-20 in the ***IO-360-N1A Engine Service Manual.***
15. Put the spray gun in either of the spark plug holes. Apply the preservative oil mixture to each cylinder, one at a time.
16. Use the spray gun 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.

17. After spray application is complete, remove the spray gun from the spark plug hole.
18. Install the spark plugs per Chapter 74-20 in the ***IO-360-N1A Engine Service Manual*** (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).

NOTICE: In the next several steps, refer to the ***IO-360-N1A Engine Maintenance Manual*** for component removal and installation instructions.

19. While the engine is still warm:
    A. Remove the exhaust system and intake pipes.
    B. Install bags of clay desiccant in the exhaust and intake ports.
    C. Install the exhaust system and intake pipes.
    D. Attach red cloth streamers to the desiccant as a reminder for the material to be removed when the engine is made ready for flight.
    E. 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

F. Apply seals and tape to areas of the engine exposed to the air.

G. Put a note on the propeller that reads: "Engine preserved - DO NOT TURN THE PROPELLER."

H. At 15-day intervals, examine the desiccant in the desiccant bags and the cylinder dehydrator plugs (if installed). When the color of the desiccant has changed from blue to pink, remove the used desiccant bags and plugs. Install new desiccant bags and cylinder dehydrator plugs (if used). Record the date (for future reference) when the desiccant bags and/or plugs were installed.

Fuel Injector Preservation

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

Engine Preservation - 61 to 180 Days

New, rebuilt, and overhauled engines from Lycoming Engines have preservation oil for 60 days per the tag on the outside of the engine box. 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, complete 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, complete a borescope inspection of 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. Refer to Chapter 74-20 in the ***IO-360-N1A Engine Service Manual***.

   B. Turn the crankshaft until the piston is at the bottom dead center.

   NOTICE: Do not turn the crankshaft any further during the borescope evaluation.

   C. Use a 4x borescope with a 70 degree angle of view, or equivalent internal examining device to examine each cylinder for evidence of corrosion. The diameter of the borescope must be smaller than the diameter of the spark plug hole. If corrosion is found, refer to Chapter 72-30 in the ***IO-360-N1A Engine Maintenance Manual.***

   D. Install the top and bottom spark plugs in the cylinder each with a new gasket per Chapter 74-20 in the ***IO-360-N1A Engine Service Manual***.

   E. Remove the rocker box covers per Chapter 72-30 in the ***IO-360-N1A Engine Service Manual*** and look for any evidence of corrosion.

   F. After the inspection is complete, install the rocker box covers. Refer to Chapter 72-30 in the ***IO-360-N1A Engine Service Manual***.

   G. Remove the accessories. Examine the drives and shafts for moisture or corrosion. Refer to the ***IO-360-N1A Engine Maintenance Manual***.

   H. When the inspection is complete, install the accessories.

2. Repeat the previous inspection steps for each cylinder on the engine

Engine Preservation - 181 Days or More

If the engine is to be stored for 180 days or longer, after the first 180 days, and every 60 days thereafter, complete 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 (original packing for the engine when shipped from the factory) 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. If the plastic is ripped or torn, replace with plastic that does not have any rips or tears.
   D. Look for damage to the box and the engine. If the box is damaged, replace it with a new undamaged box.
   E. Complete a borescope inspection on each engine cylinder per the procedure "Engine Preservation - 61 to 180 Days" in this chapter.
   F. Add preservative oil as necessary per the procedure "Engine Preservation - 30 to 60 Days" in this chapter.
   G. Replace the pink moisture indicator with a fresh blue moisture indicator.
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. Otherwise, replace the plastic and continue with storage.
5. Record the results of each 60-day check.

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

6. 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 (Appendix A). Refer to the ***IO-360-N1A Engine Service Manual.***

Long-Term Storage of Engines that Use Automotive Fuel

If automotive fuel is used to operate this engine per the latest revision of Service Instruction No. SI-1070, Lycoming Engines recommends the following:

1. Either operate the engine or drain the aircraft fuel system per the aircraft manufacturer's instruction until the fuel tank contains less than 50% of automotive fuel.
2. Add the specified aviation fuel, as per Appendix A or the latest revision of Service Instruction No. SI-1070, until the aircraft fuel tanks are full.

NOTICE: Aviation fuel can be mixed with the automotive fuel. The goal is to have more than 50% aviation fuel in the fuel tanks during storage to prevent possible formation of undesirable deposits.

3. Operate the engine for a minimum of 45 minutes with the oil temperature at 180ºF (80ºC) to work the aviation and automotive fuel mixture through the engine and fuel lines.

⚠ WARNING: IF THE 45 MINUTE ENGINE OPERATION IS DONE ON THE GROUND, DO NOT OPERATE THE ENGINE AT FULL-STATIC FOR MORE THAN 10 SECONDS.

4. Add more aviation fuel to make sure that the aircraft fuel tanks are full.

APPENDIX A
ENGINE SPECIFICATIONS AND OPERATING LIMITS

Table A-1
IO-360-N1A Engine Specifications

Number of Cylinders	4	
Cylinder Arrangement - Firing Order	1-3-2-4	
Spark Plugs	8	
Spark plug advance	25º BTC	
Maximum Continuous Horsepower & Brake Specified Fuel Consumption (BSFC)	180 HP @ 2700 rpm Alternate rating: 160 HP @ 2400 rpm	
Performance Cruise (75% Rated)	135 @ 2450 rpm	
Economy Cruise (65% Rated)	117 @ 2350 rpm	
Fuel Consumption, Cruise 75% rated power 65% rated power	11 gph 8.5 gph	
Propeller Drive Ratio	1:1	
Propeller Shaft Rotation	Clockwise	
Counterweight Order	This engine has no counterweights	
Compressor Bore	5.125 in.	13.018 cm
Compressor Stroke	4.375 in.	11.1 cm
Piston Displacement	361 $in.^3$	5916 cm^3
Compression Ratio	8.5:1	
Weight (lb)	271.5 lb	123.2 kg
Dimensions	Height 20.26 in.	51.46 cm
	Width 33.38 in.	84.79 cm
	Length 32.75 in.	83.19 cm
Oil Sump Capacity	8 quarts	7.6 liters
Minimum quantity of oil in flight	4 quarts	3.8 liters
Oil Grade Specification **NOTICE:** During the first 50 hours of engine operation of a new, rebuilt, or overhauled engine, it is recommended that this engine be operated with mineral oil until oil consumption has stabilized.	MIL-L-6082B or SAE J1966 SAE Grades	MIL-L-22851 or SAE J1899 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

Table A-1 (Cont.)
IO-360-N1A Engine Specifications

Oil Grade at Temperatures between 30°F to 90°F (-1°C to 32°C)	40	40
Oil Grade at Temperatures between 0°F to 70°F (-18°C to 21°C)	30	30, 40 or 20W-40
Oil Grade at Temperatures below 10ºF (-12ºC)	20	30 or 20W-30
The correct grade of oil to be used is based on environmental conditions. If the aircraft is going to be flown into an area that is much warmer or colder than the aircraft is usually operated in, use a different viscosity of oil. During operation, if the oil inlet temperatures are near the maximum permitted temperatures, then a higher viscosity oil can help to decrease the temperatures.		
Fuel minimum octane (refer to the latest revision of Service Instruction No. SI-1070 for any new approved fuels)	91/96 or 100LL (Aviation Grade)	
Fuel Injector (Precision)	RSA-5AD1	
Fuel Pump	Diaphragm	
Starter Drive, Ratio to Crankshaft at Bendix and Rotation	16.556:1 Counterclockwise	
Starter - Sky-Tec or equivalent	12 Volt - Geared (Optional) 24 Volt - Geared -(Optional)	
Alternator Drive Rotation	Clockwise	
Alternator - Hartzell (formerly Kelly Aerospace) or equivalent	12 Volt, 70 Amp (Optional) 24 Volt, 70 Amp (Optional)	
Magnetos (2) Slick	4347 (Left) 4370 (Right)	
Magneto Drive, Ratio to Crankshaft and Rotation	1.000:1 Clockwise	
Tachometer Drive, Ratio to Crankshaft and Rotation (Optional)	0.5:1 Clockwise	
Freon Compressor Drive	Optional	

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

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

Table A-2
Table of Operating Limits for IO-360-N1A Engine

Oil Pressure - Minimum Idling		25 psi	172 kPa
Oil Pressure - Operating (rear of engine)		55 to 95 psi	379 to 655 kPa
Oil Pressure - Starting, Warm-up, Taxi, and Take-off (Maximum)		115 psi	792 kPa
Optimum Oil Temperature		180ºF	82ºC
Maximum Oil Temperature		245°F	118°C
Maximum Oil Consumption		0.006 lb/BPH/Hr.	
Boost Pump Outlet Pressure Limits to Fuel Injector Inlet	Parallel Boost	14 to 45 psi	97 to 310 kPa
	Series Boost	14 to 35 psi	97 to 241kPa
Fuel Pressure at inlet to the Fuel Pump		-2 to +35 psi	-14 to 241 kPa
Maximum Cylinder Head Temperature (measured at thermocouple)		500°F	260ºC
Cylinder Head Temperature (for maximum engine life) - Above 75% power		475°F	246ºC
Cylinder Head Temperature (for maximum engine life) - At 75% power and below		435°F	224°C
Alternator Stator Slot Temperature		360ºF	182ºC
Alternator Stator End Turns Temperature		360ºF	182ºC
Alternator Drive End Bearing Temperature		248ºF	120ºC
Alternator Positive Heat Sink Temperature		305ºF	151ºC
Maximum Magneto Temperature (measured in the pole laminations)		225ºF	107ºC

Table A-3
Accessory Drives for IO-360-N1A Engines

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	16.556:1	--	450	150
Alternator	SAE	Clockwise	3.20:1	60	120	175
Dual Alternators Optional	SAE	Clockwise	3.80:1	60	120	175
Accessory Drive #1	AND20000*	Counter-clockwise	1.3:1	70	450	25
Accessory Drive #2	AND20000	Clockwise	1.3:1	100	800	40
Tachometer - Optional	SAE	Counter-clockwise	0.5:1	7	50	5
Propeller Governor	AND20010**	Clockwise	0.895:1	125	1200	40
Freon Compressor	SAR	Clockwise	1.462:1***	Limited by belt		--

* Except for torque limitation and rotation
** Except for torque limitation
*** With compressor pulley diameter of 6.00 inches

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

APPENDIX B

INSTALLATION AND WIRING DIAGRAMS

NOTICE: Installation drawing (04C63626) is available for purchase from Lycoming Engines for the IO-360-N1A engine. Contact the Publications Clerk at Lycoming Engines at 570-327-7274.

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APPENDIX C

PERFORMANCE DATA

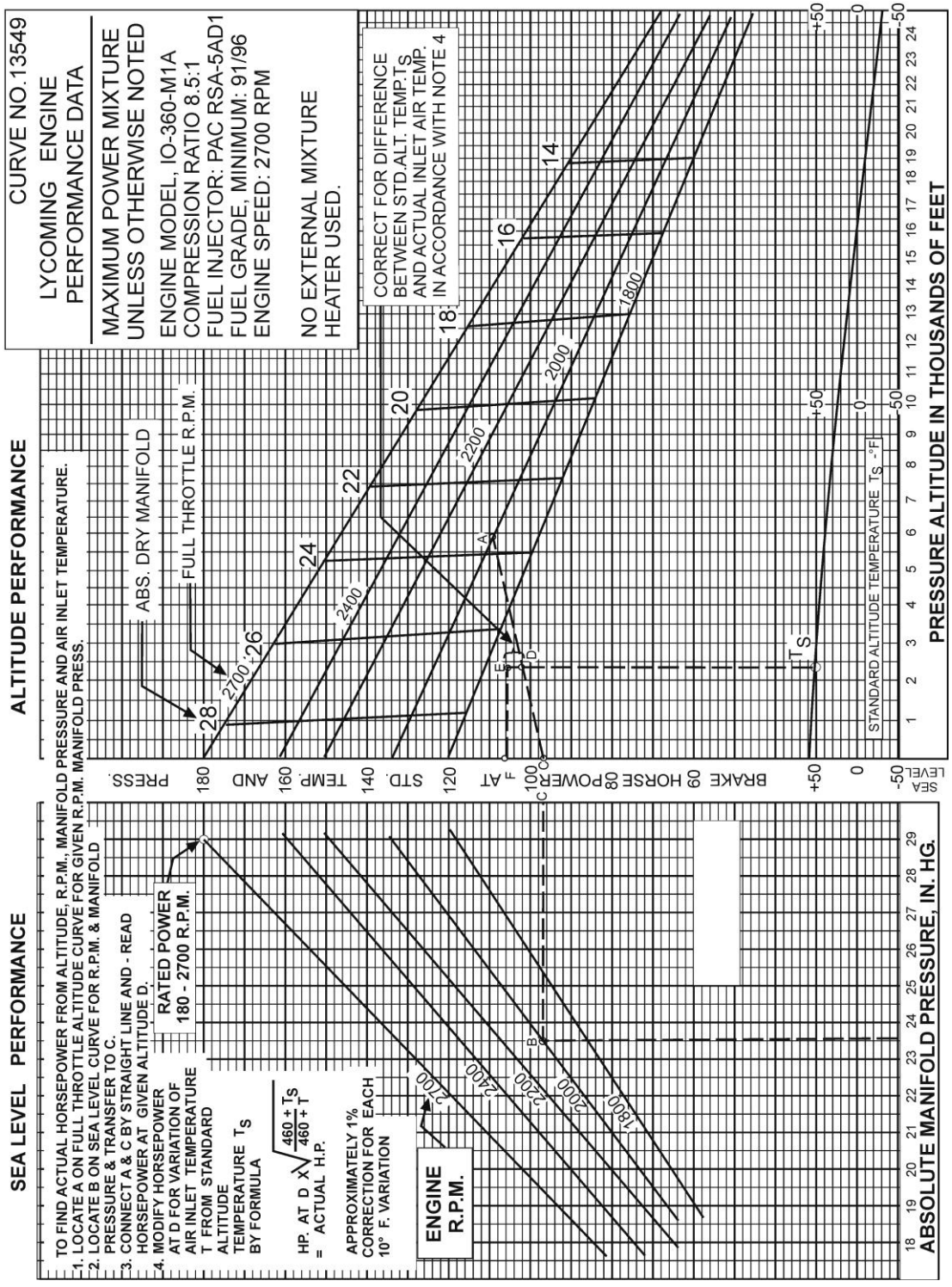

Figure C-1
Sea Level and Altitude Performance

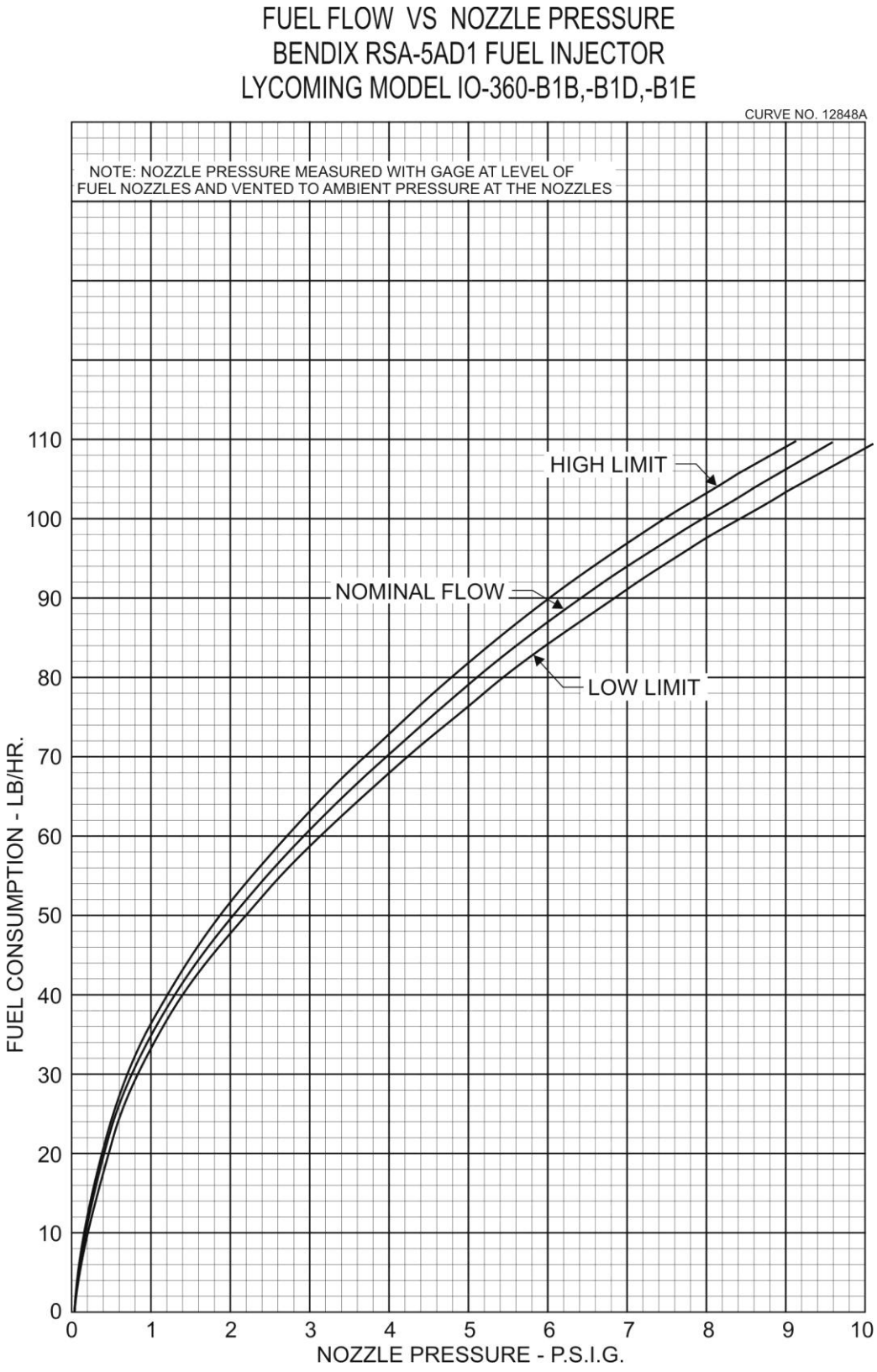

Figure C-2
Minimum Fuel Flow vs. Nozzle Pressure

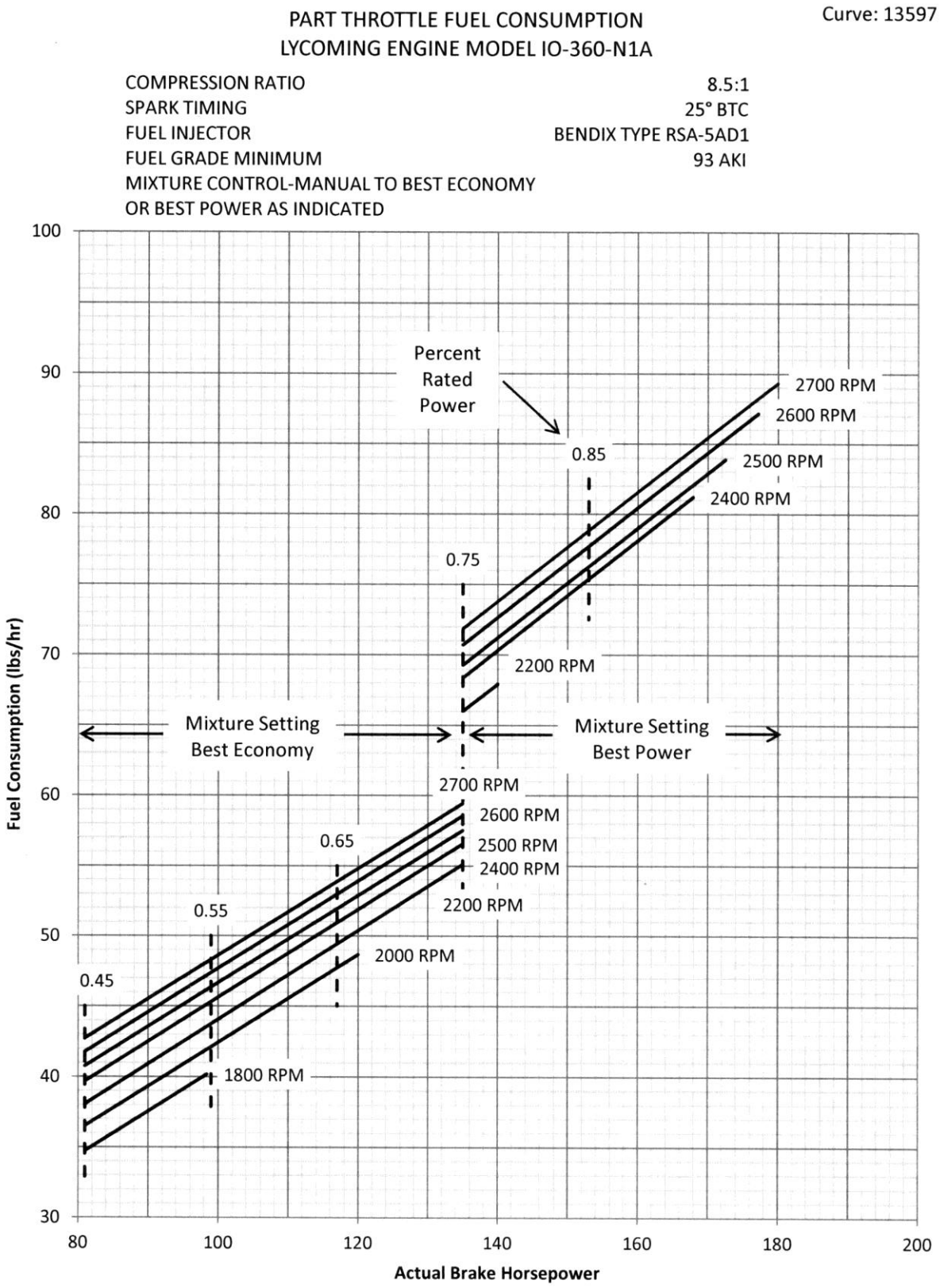

Figure C-3
Fuel Consumption vs. Actual Brake Horsepower

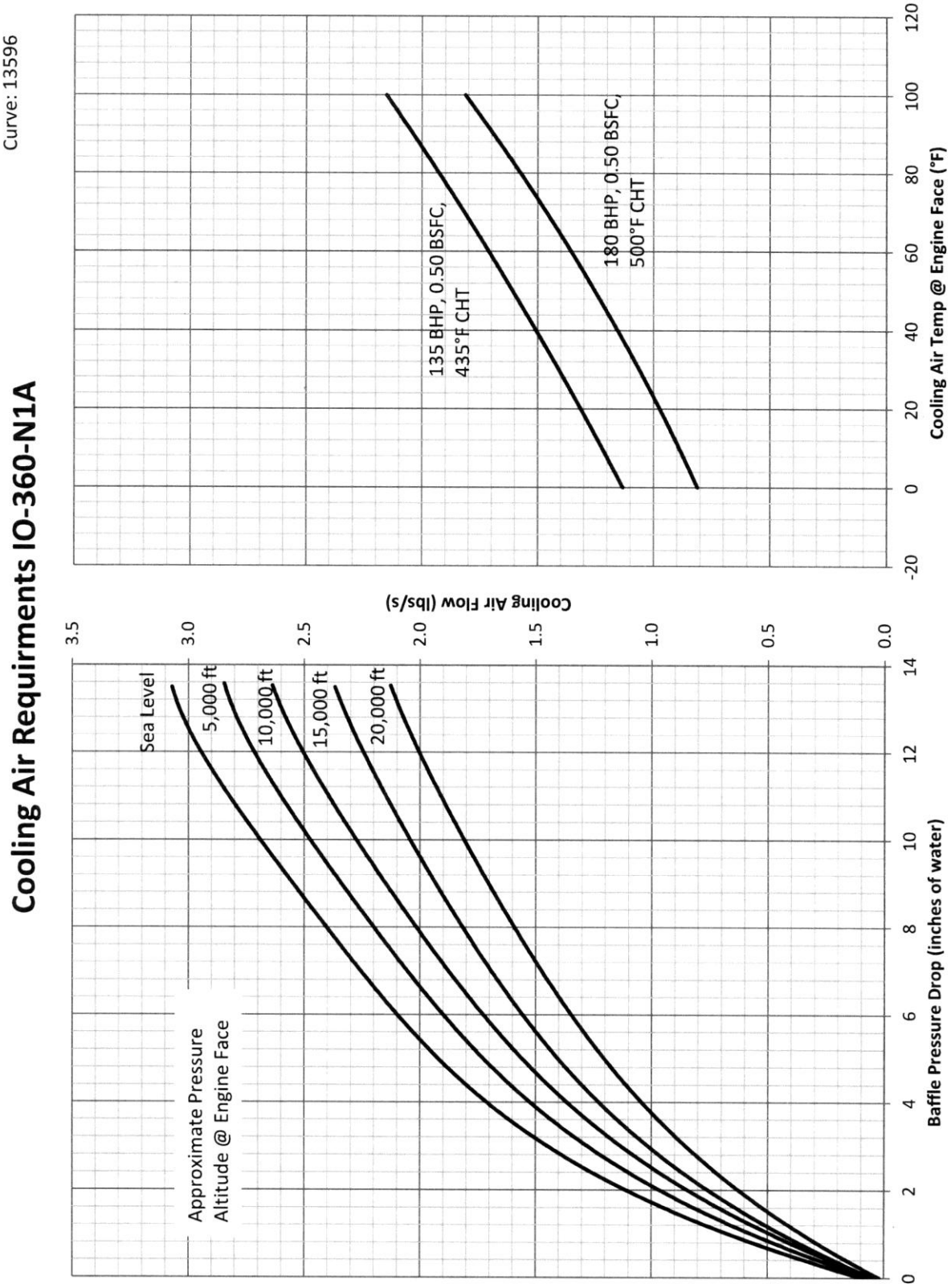

Figure C-4
Cooling Air Requirements