Engine Installation and Operation Manual

TEO-540-C1A Engine

November 2021

Part No. IOM-TEO-540-C1A Rev 4

TEO-540-C1A Engine
Installation and Operation Manual

Lycoming Part Number: IOM-TEO-540-C1A Rev 4

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RECORD OF REVISIONS

Revision	Revision Date	Revision Description
Original		Original Release of Installation and Operation Manual - Part No. IOM-TEO-540-C1A
Rev. 1	April 2019	**Abbreviations and Acronyms** • Added listings for psia, psid, and psig **System Description** • EECS Architecture o Revised the description of the ECU and Power Box connection to the engine due to change in wiring harness configuration o Revised Figure 4 • Revised Figure 5 in the Field Service Tool (FST) section due to change to wiring harness configuration • Revised the description in the Wiring Harness section due to change in the wiring harness configuration • Revised the abbreviation for the Knock Sensor in Table 2 **Theory of Operation** • Added new section for Generated Power Calculation **Engine Reception and Lift** • Revised Step 1,A to include additional shipping methods **Engine Installation** • Revised Step 3 due to change in the wiring harness configuration • Revised Figure 1 due to change in the wiring harness configuration • Revised Step 5 due to change in the wiring harness configuration **Engine Initiation** • Revised the CAUTION after Step 12 in “Step 3. Engine Start” • Revised the RPM range and CHT temperature range for the PFT criteria in “Step 6. Complete the Pre-Flight Test” • Revised the maximum RPM identified in Step 5,D in “Step 6. Complete the Pre-Flight Test” • Revised the maximum CHT identified in Step 5,D in “Step 6. Complete the Pre-Flight Test” **Engine Operation** • Step 2. Engine Start o Revised the CAUTION after Step 11 o Reversed the order of Steps 11 and 12 • Step 4. Pre-Flight Test o Revised the RPM range and CHT temperature range for the PFT criteria o Revised the maximum RPM identified in Step 5,D o Revised the maximum CHT identified in Step 5,D

RECORD OF REVISIONS (CONT.)

Revision	Revision Date	Revision Description
Rev. 1 (Cont.)	April 2019	**Appendix A** • Table A-1 o Changed Spark Plug Advance from 20º BTC to 15º BTC o Changed the critical altitude for Maximum Rated Continuous HP from 12,000 feet to 10,000 feet • Table A-2 o Changed the Maximum Heat Rejection to Oil from 1750 Btu/minute to 2160 Btu/minute o Changed Minimum Fuel Rail Pressure from 33 psid to 43 psid o Revised all Minimum Fuel Consumption values o Changed Maximum Manifold Pressure from 52 in. hg. To 57.9 in. hg. o Changed Critical Altitude (at standard day conditions) from 12,000feet to 10,000 feet • Added new accessories Fuel Pump and Compressor to Table A-3 • Revised Figures A-1, A-2, A-3, A-4, A-5, and A-6
Rev. 2	May 2021	**Global** • Revised the footer on each page to indicate the date of original publication or the date of revision for that page **Pilot Controls and Annunciators** • Revised the Definition and Pilot Action for the NTO in Table 2 • Revised the Definition and Pilot Action for the TLO in Table 2 **Engine Installation** • Added new WARNING at the beginning of Step 1 **Engine Initiation** • Revised Step 2 in the Engine Stop section to base engine shutdown on CHT temperature instead of EGT temperature **Engine Operation** • Revised Step 2 in the Engine Stop section to base engine shutdown on CHT temperature instead of EGT temperature **Engine Conditions** • Revised the Explanation/Corrective Action for "TLO annunciator illuminates during flight" in Table 1 to clarify that hours refers to engine hours **Engine Preservation and Storage** • Deleted "Fuel Injector Preservation" section as it is not applicable for this engine

RECORD OF REVISIONS (CONT.)

Revision	Revision Date	Revision Description
Rev. 2 (Cont.)	May 2021	**Appendix A** • Table A-1 o Revised the RPM required for horsepower ratings to include "± 15 RPM" for Maximum Rated Continuous, Performance Cruise, and Economy Cruise o Added "without starter and alternator" to the Dry Weight row • Table A-2 o Changed "Oil Pressure - Operating" to "Oil Pressure - Operating and Take-off" o Changed "Oil Pressure - Starting, Warm-up, Taxi, and Take-off (Maximum)" to "Oil Pressure - Starting, Warm-up, and Taxi (Maximum)" o Changed "Minimum Oil Temperature (before take-off) read from engine" from 140°F and 60°C to 160°F and 71.1°C o Revised the fuel consumption rates for the three rated power settings • Table A-3 o Added a row for a new optional Alternator Drive Ratio of 3.65:1 **Appendix C** • Revised the WARNING for Ref. ID 2 in Table C-1
Rev. 3	July 2021	**Service Document List** • Revised the Subject for S.I. 1573 • Added new Service Letter No. 287 **List of Figures** • Revised the Description for Figure A-6 • Added a listing for new Figure A-7 **Pilot Controls and Annunciators** • Revised the Definition and Pilot Action for the FFL in Table 2 **Requirements for Engine Installation** • Added (if applicable) to the listing for the FFL annunciator **Appendix A** • Revised the Minimum Fuel Consumption row in Table A-2 • Added new NOTICE for Figure A-6, to determine engine configuration and applicability for performance curves • Added new Figure A-7 • Added new NOTICE for Figures A-7, to determine engine configuration and applicability for performance curves

RECORD OF REVISIONS (CONT.)

Revision	Revision Date	Revision Description
Rev. 4	November 2021	**Engine Initiation** • In step 6 changed 1 minute to 90 seconds in paragraph beginning “The PFT takes approximately…” **Engine Operation** • In step 4 changed 1 minute to 90 seconds in paragraph beginning “The PFT takes approximately…” • In step 5 changed 70 seconds to 90 seconds **Engine Conditions** • In cold weather engine start section, added new step 1, revised steps 2 and 3, changed numbering for subsequent steps **Appendix A** • Table A-2 o Removed “Take-off” from "Oil Pressure - Operating and Take-off" o Changed “Oil Pressure - Starting, Warm-up, and Taxi (Maximum)” to “Oil Pressure - Starting, Warm-up, Taxi, and Take-off (Maximum)” o Changed "Minimum Oil Temperature (before take-off) read from engine" from 160°F and 71.1°C to 140°F and 60°C o Changed “Maximum Exhaust Gas Temperature (EGT)” to “Maximum Turbine Inlet Temperature (TIT) (measured at the exhaust bypass valve transition)”

SERVICE DOCUMENT LIST

NOTICE: The following is a list of service documents referenced in or incorporated into the information in this manual. Always refer to the latest revision of any service document for changes or additional information. Supplements to a service document contain information relevant to the service document but not yet added to the service document.

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

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

Number	Incorporation Date	Subject
S.B. 369	11/18	Engine Inspection after Overspeed
S.B. 480	11/18	I. Oil and Filter Change and Screen Cleaning II. Oil Filter Screen Content Inspection
S.B. 533	11/18	Recommended Action for Sudden Engine Stoppage, Propeller/Rotor Strike or Loss of Propeller/Rotor Blade or Tip
S.I. 1011	11/18	Table of Current Tappet Bodies, Plunger Assemblies and Hydraulic Lifter Assemblies
S.I. 1014	11/18	Lubricating Oil Recommendations
S.I. 1070	11/18	Specified Fuels
S.I. 1241	11/18	Pre-oil the Engine Prior to Initial Start
S.I. 1304	11/18	Engine Nameplate Replacement
S.I. 1409	11/18	Lycoming Engines P/N LW-16702, Oil Additive
S.I. 1427	11/18	Lycoming Reciprocating Engine Run-In and Oil Consumption
S.I. 1472	11/18	Removal of Preservative Oil from Engine
S.I. 1481	11/18	Factory Engine Preservation
S.I. 1505	11/18	Cold Weather Starting
S.I. 1528	11/18	Aircraft Engine Starter Recommendations
S.I. 1530	11/18	Engine Inspection in a Particulate Laden Environment (Volcanic Ash, Sand, Dust, Airborne Debris)
S.I. 1566	11/18	Lycoming Engines Approves the Use of Safety Cable
S.I. 1573	11/18	Lycoming TEO-540 Engine Series Approved Engine Configurations
L 114	11/18	Reciprocating Engine and Accessory Maintenance Publications
L180	11/18	Engine Preservation for Active and Stored Aircraft
L193	11/18	Engine Firing Order
S.L L287	07/21	Increased Fuel Economy and Improved Manifold Pressure Control

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TABLE OF CONTENTS

Section **Page**

LIST OF FIGURES

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LIST OF TABLES

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ABBREVIATIONS AND ACRONYMS

A	
AC	Alternating Current
ACU	Engine Control Unit
ADL	Data Logger
AMP	Ampere
B	
BHP	Brake Horsepower
BIT	Built-In Test
BTC	Before Top Center
C	
C	Celsius
CAM	Camshaft Speed Sensor
CAN	Controller Area Network
CHT	Cylinder Head Temperature
CIP-P	Primary Compressor Inlet Pressure
CIP-S	Secondary Compressor Inlet Pressure
cm	Centimeter
CRANK	Crankshaft Speed Sensor
D	
DC	Direct Current
DECK-P-P	Primary Induction Air Deck Temperature
DECK-P-S	Secondary Induction Air Deck Temperature
DECK-T	Induction Air Deck Temperature
DPS	Delta Pressure Sensor
E	
ECU	Engine Control Unit
EECS	Electronic Engine Control System
EGT	Exhaust Gas Temperature
EOP	Engine Oil Pressure
EOT	Engine Oil Temperature
ESD	Electrostatic Discharge

ABBREVIATIONS AND ACRONYMS (CONT.)

F	
F	Fahrenheit
FAA	Federal Aviation Administration
FAR	Federal Aviation (and Space) Regulation
FFL	Fault Found
FFPD	Fuel Filter Pressure Drop
FOD	Foreign Object Debris
FPP	Fuel Pump Pressure Sensor
FST	Field Service Tool
Ft.-lb.	Foot Pound (torque)
FUEL-P	Fuel Rail Pressure Sensor
FUEL-T	Fuel Temperature Sensor
H	
Hg	Mercury
HIRF	High Intensity Radiated Field
I	
ICA	Instructions for Continued Airworthiness
ICD	Interface Control Document
in.	Inch, inches
in.-lb	Inch Pound (torque)
In-Hg	Inches of Mercury
K	
KNOCK	Knock Sensor
kPa	Kilopascals
L	
lb	Pound
LL	Low Lead (fuel)
M	
MAP	Manifold Air Pressure
MAT-P	Primary Induction Air Manifold Temperature Sensor
MAT-S	Secondary Induction Air Manifold Temperature Sensor
mm	Millimeter
N	
Nm	Newton Meters
NPT	National Pipe Thread
NTO	No Take-Off

ABBREVIATIONS AND ACRONYMS (CONT.)

O	
OIL-P	Oil Pressure Sensor
OIL-T	Oil Temperature Sensor
P	
PFT	Pre-Flight Test
PMA	Permanent Magnet Alternator
P/N	Part Number
POH	Pilot Operating Handbook
psi	Pounds per square inch
psia	Pounds per square inch absolute
psid	Pounds per square inch absolute differential
psig	Pounds per square inch gage
R	
RCA	Radio Corporation of America
RPM	Revolutions per Minute
S	
SAE	Society of Automotive Engineers (oil viscosity)
SB	Service Bulletin
SI	Service Instruction
T	
TIT	Turbine Inlet Temperature Sensor
TLO	Time-Limited Operation
TPS	Throttle Position Sensor
U	
UL	Unleaded (gasoline)
V	
V	Volt, Voltage

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INTRODUCTION

Engine Model Nomenclature

The table below shows the definition of each letter and number for the TEO-540 engine model nomenclature. Numbers and letters in the suffix (C1A) of the engine model number are configuration designations associated with the core engine.

Model Number	Meaning
T	Turbocharged
E	Electronic Engine Control System
O	Horizontally Opposed
540	Displacement in cubic inches

Scope of this Manual

This manual supplies an engine description and instructions for uncrating procedures, acceptance check, engine lift procedure, engine preservation and storage, depreservation, engine installation requirements, engine installation, operation and stop procedures, engine initiation (break-in/flight test), fuels and oil to be used, and operating specifications for TEO-540-C1A Lycoming aircraft engines.

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

For maintenance procedures, such as: oil changes, oil addition, oil filter replacement, routine time-interval inspections, routine service, spark plug replacement/inspection procedures, cylinder inspection, fuel system inspection, scheduled servicing procedures, airworthiness limitations, fault isolation guidelines and procedures to replace components and to disassemble and assemble the engine, refer to the ***TEO-540-C1A Engine Maintenance Manual.***

For spare parts information, refer to the ***TEO-540-C1A Illustrated Parts Catalog***.

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

Service Bulletins, Service Instructions, and Service Letters

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

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

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

Reminder: Unless otherwise specified, Lycoming Engines' service documents (which are dated after this manual's release date) that pertain to the engine model in this manual supersede procedures in this manual.

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

List of Publications

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

Compliance Requirements

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

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

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

Warning, Cautions, and Notices

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

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

Instructions for Continued Airworthiness

The ***TEO-540-C1A Engine Maintenance Manual***, ***TEO-540-C1A Engine Overhaul Manual,*** the latest revision of the ***Service Table of Limits - SSP-1776***, and service documents applicable to this engine model make up the complete set of Instructions for Continued Airworthiness (ICAs). The ICAs are prepared by Lycoming Engines and are accepted by the Federal Aviation Administration (FAA).

Simplified Technical English

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

Figures

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

Tables and Checklists

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

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Environmental Compliance

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

Feedback

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

Manual Revisions

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

Patents

The following patents apply to the engine and control systems:

- 7,658,184
- 7,875,989
- 7,827,965
- 8,131,406
- 7,828,509

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SYSTEM DESCRIPTION

The Lycoming TEO-540-C1A Engine (Figure 1) is a direct-drive six-cylinder, horizontally opposed, turbocharged, electronically-controlled engine. It has electronic fuel injection, electronic ignition, and down exhaust. As standard equipment, this engine has an automotive type starter, an alternator, and two standard AN type accessory drives.

The engine has an Electronic Engine Control System (EECS) which is a microprocessor. The EECS continuously monitors and automatically adjusts operating conditions such as ignition timing, fuel injection timing, and fuel mixture. The EECS eliminates the need for magnetos and manual fuel/air mixture control.

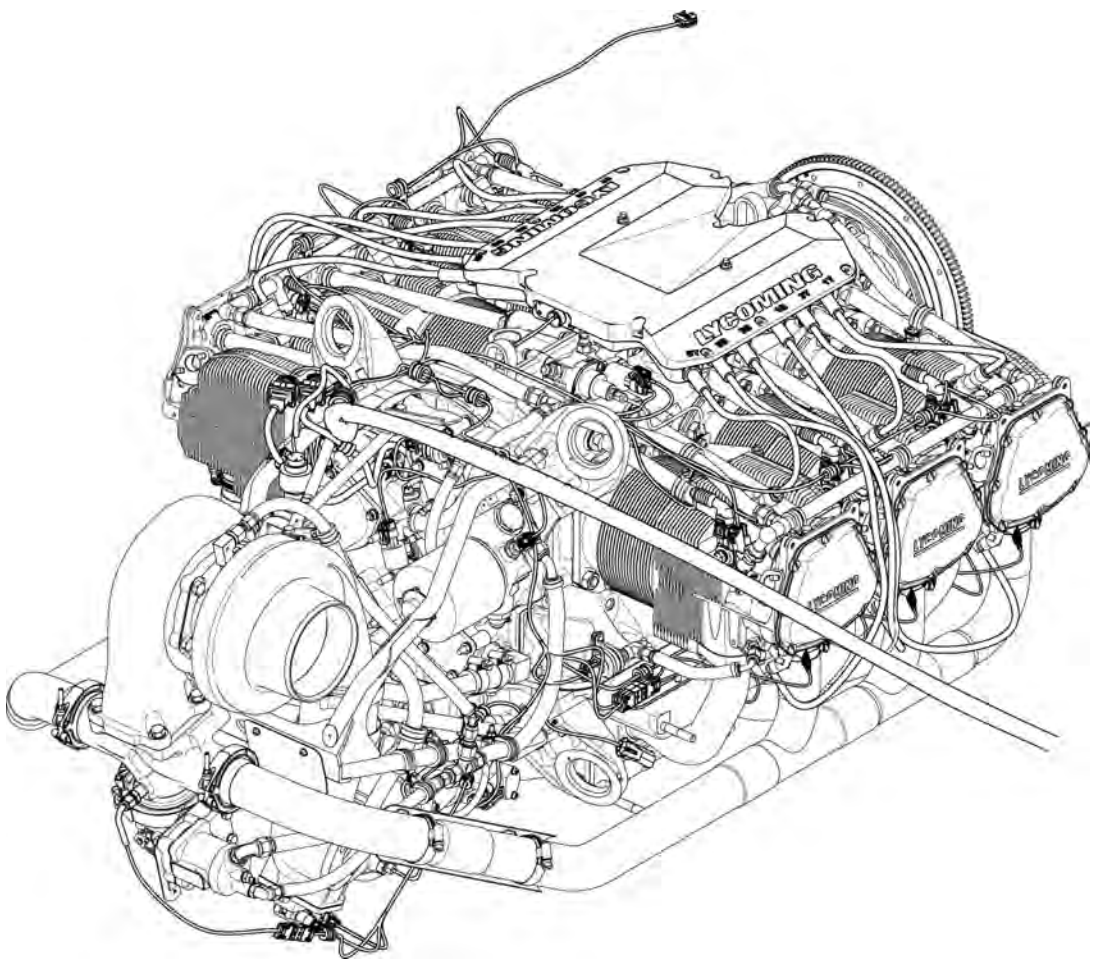

Figure 1
TEO-540-C1A Engine

Electronic Engine Control System (EECS)

The EECS is an electronic, microprocessor controlled system that continuously monitors and adjusts ignition timing, fuel injection timing, and fuel mixture based on operating conditions. The EECS eliminates the need for magnetos and manual fuel/air mixture. Figure 2 shows the EECS integrated controls.

The EECS connects engine hardware with electronic controls to replace mechanical control systems and enables single lever engine control.

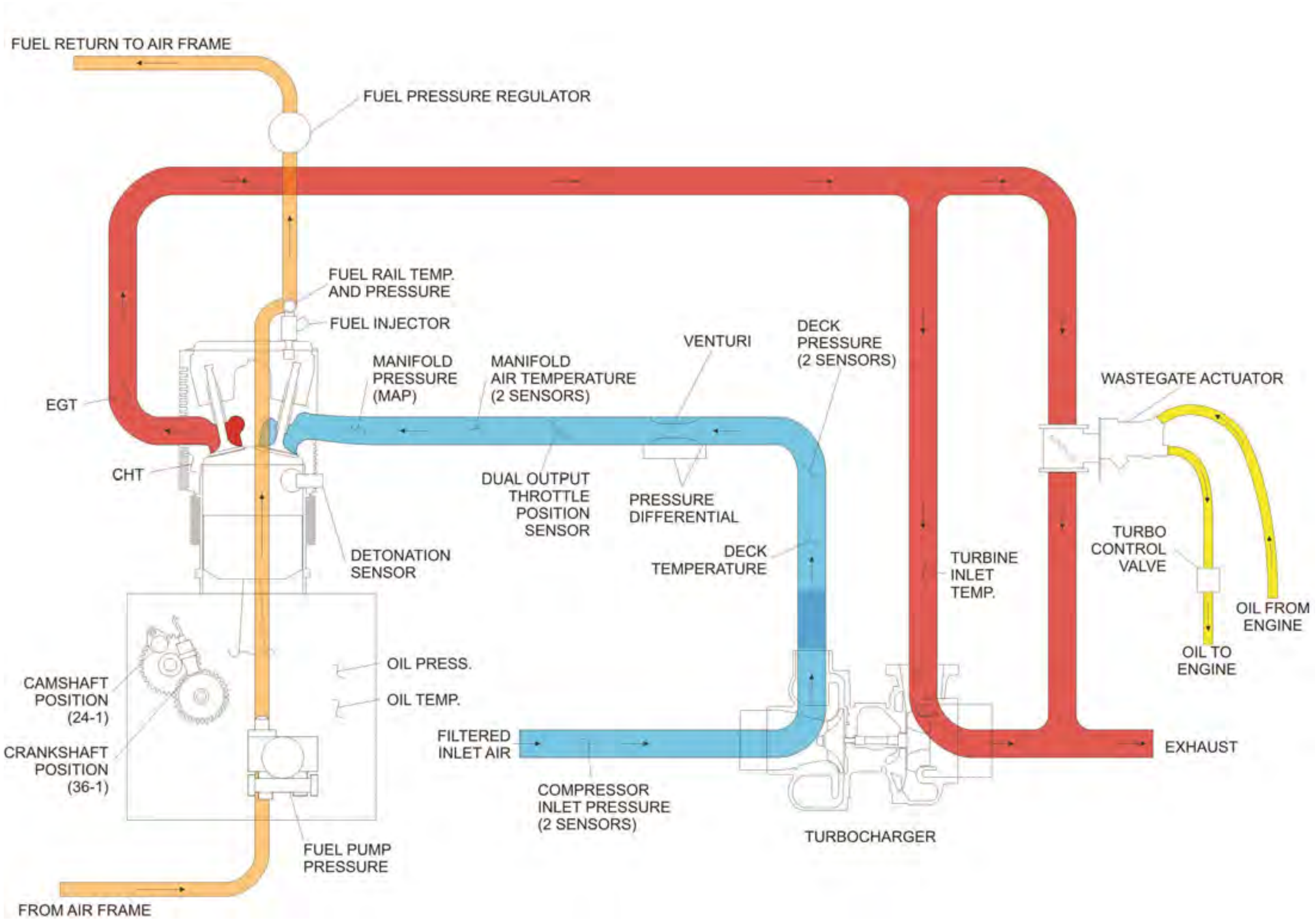

Figure 2
EECS Integrated Controls

EECS Architecture

The EECS architecture consists of:

- Primary components (Figure 3):
  - Engine Control Unit (ECU) (also identified as ACU) - is a dual channel unit which contains system processors, input signal conditioning, output actuator drive stages, and aircraft communication interfaces. The ACU Controller Area Network (CAN) bus communications linked to a host personal computer can be used to monitor the system and upload logged data.
  - Power Box - a dual channel unit which supplies regulated primary and secondary 14V power over to the EECS. Airframe power at start-up or when engine speed is below 1000 RPM supplies power to the power box regulators. When engine RPM is above 1000 RPM, a dedicated Permanent Magnet Alternator (PMA) (mounted on the engine accessory drive) supplies power to the power box.
  - Data Logger (ADL) - a single channel unit that records data received from the ACU via the CAN bus communication.
- Secondary components:
  - Engine harness
  - Sensors
  - Actuators.

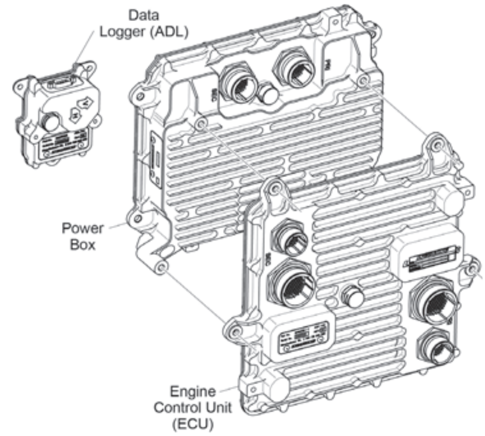

Figure 3
EECS Primary Components

The ECU and Power Box are connected by a wiring harness (Figure 4) to the engine. Two channels on the ECU communicate with each other through a CAN bus (CAN1). Each channel has input processing, a microprocessor and output processing which control the engine independently of each other. Sensors connected to the engine harness send inputs to the ECU to control the engine through output to the actuators. The actuators also are connected to the ECU by the same wiring harness. Refer to Figure 5 for a general EECS overview.

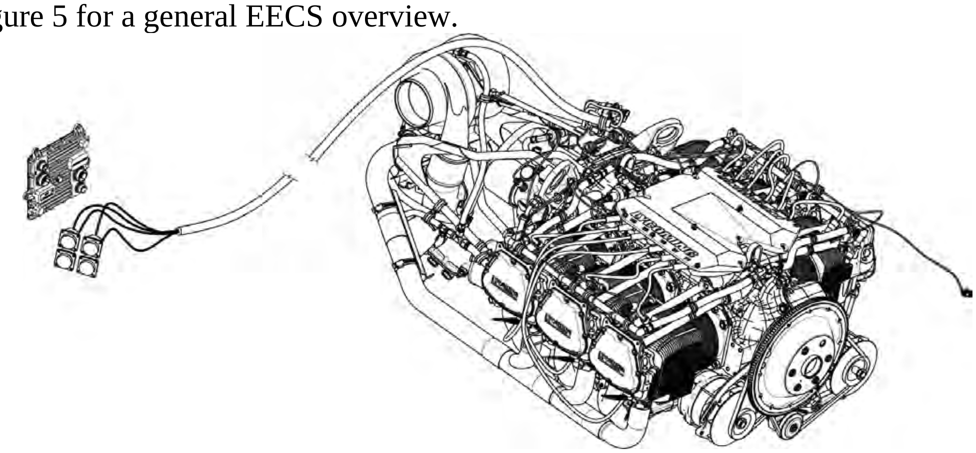

Figure 4
Wiring Harness

NOTICE: The ECU software is unique to each engine and is not to be installed on any other engine unless it has been re-configured.

Field Service Tool (FST)

The Field Service Tool (FST) is diagnostic software that identifies fault codes (Appendix C in the ***TEO-540-C1A Engine Maintenance Manual***) and engine operation information to be used by ground-based support personnel to:

- View fault codes from the ECU
- Upload fault codes from the ECU
- Monitor ECU operation
- Upload data from the data logger (if needed)

The EECS collects internal fault log data and external fault log data. Maintenance personnel use this data for diagnostic and continuous airworthiness.

Access to this tool is through a laptop where the software is installed and through an established link with the EECS for the engine using the iE^2 Service Cable (ST-528) and the iE^2 Field Service Tool CAN Interface (ST-530) connected to an RCA jack on the airframe engine wiring harness.

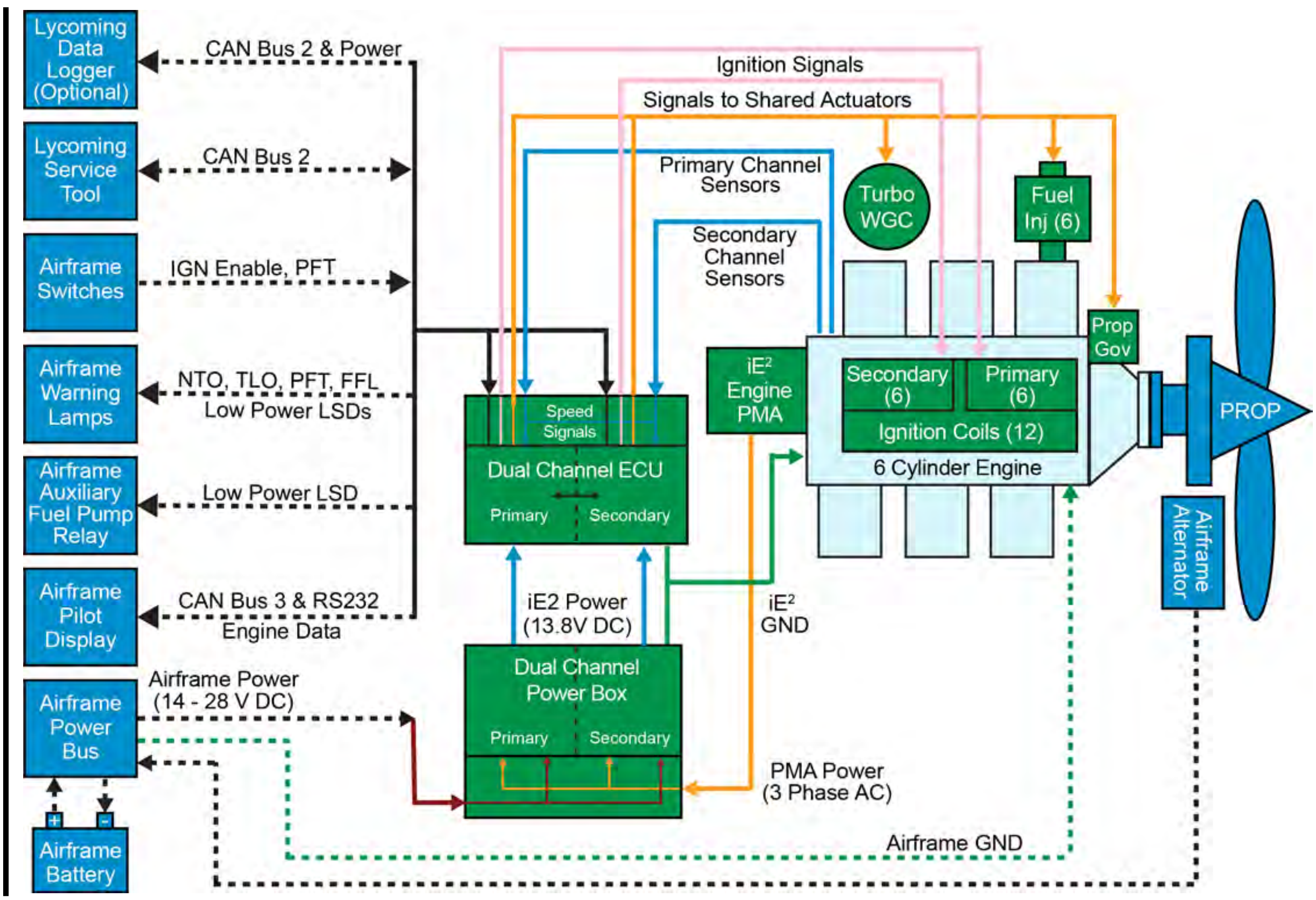

Figure 5
EECS Overview

EECS Operation

The EECS does not have redundant actuators. It has only one fuel injector per cylinder, one exhaust bypass valve, and one propeller governor. Both channels (microprocessors) are capable of controlling the actuators but only one channel within the ECU can control the actuators at a given time - with the exception of the ignition coils, which are redundant with two per cylinder. Each channel can control six of the 12 coils, one for each cylinder. The primary and secondary channels must work simultaneously to control and activate all 12 spark plugs. The channel in control sends output to the fuel injectors, exhaust bypass valve, propeller governor, and its six ignition coils. The other channel sends output to its six ignition coils. These outputs control fuel flow, induction manifold pressure, engine speed, and ignition timing.

The ECU transmits output data through two CAN buses (CAN2 and CAN3) and one RS232 bus (Figure 6). The CAN2 is used to connect the FST. An RCA female receptacle is required as a connector for the FST thru CAN2. The FST has a cable with an RCA male jack that mates with this receptacle.

The CAN3 and RS232 buses transmit engine parameters and EECS operational status information to the aircraft display. The airframe manufacturer can use either the CAN3 bus or RS232 bus to supply information necessary for the airframe third party display units.

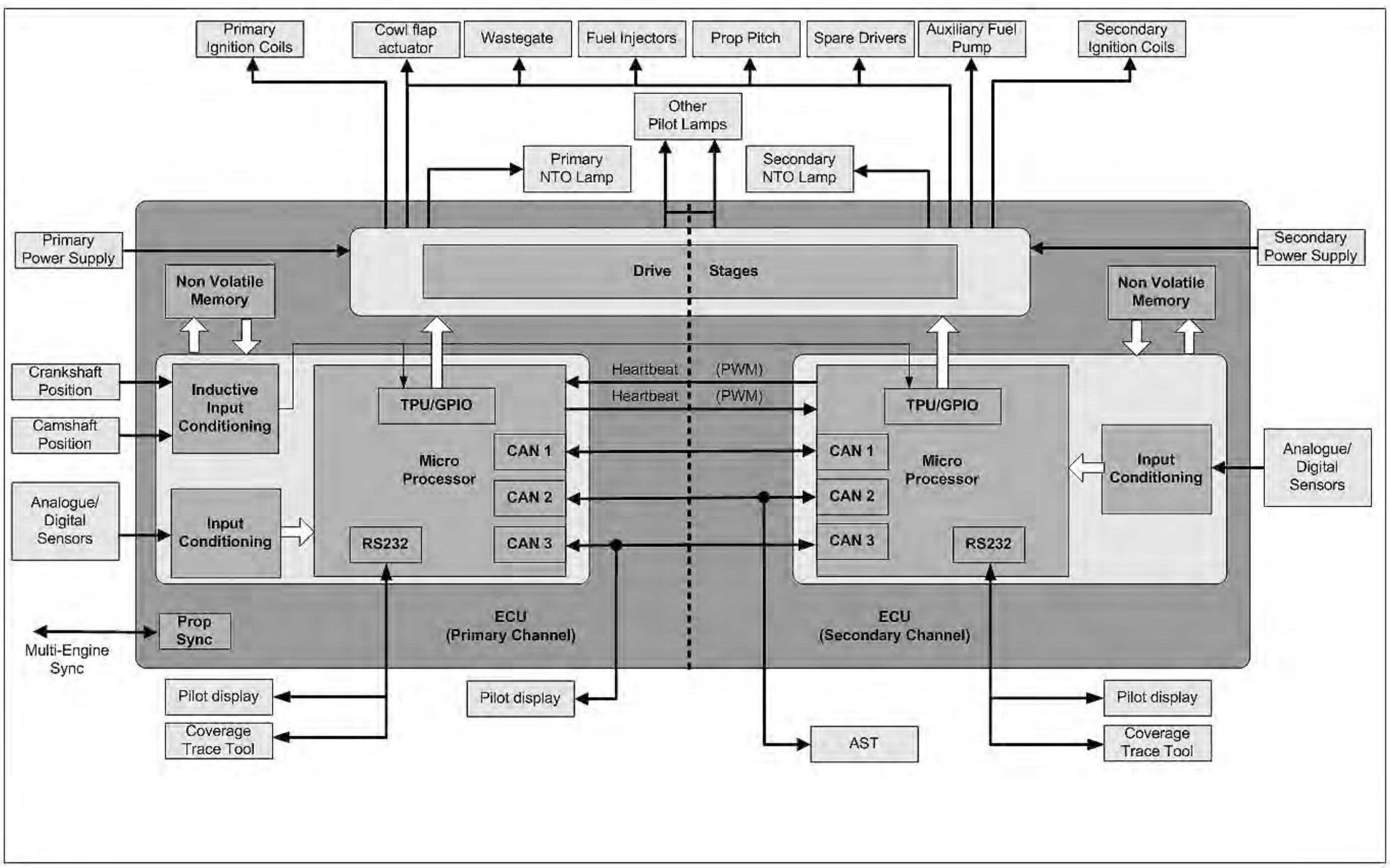

Figure 6
Engine Control

The Power Box supplies regulated, conditioned 13.8 VDC power through primary and secondary channels to the ECU, ignition coils, and warning annunciators. Each Power Box channel is identical and independent of the other and corresponds to the primary and secondary channels of the ECU. Each Power Box channel can provide sufficient power to operate the EECS through its corresponding ECU channel if one Power Box channel fails.

Each channel of the Power Box can get power from either the airframe-supplied 28 VDC or the engine-driven Permanent Magnet Alternator (PMA) which supplies three-phase AC power. The PMA is driven from the engine's accessory housing and is the dedicated source of primary power for the Power Box. The Power Box selects the applicable power source for the EECS either from airframe power or the PMA. The Power Box can only use power from one source at a time and cannot get power from both sources simultaneously.

Airframe power only is used under the following conditions:

- During engine start
- When the engine speed is below approximately 1000 RPM
- When the PMA has failed.

Each Power Box Channel has a dedicated ground connected to a common airframe ground.

Electrical Interface

Table 1 identifies elements of the electrical interface for the engine.

Table 1
Engine Electrical Interface

Element	Description
EECS electrical input power requirements	Must have a supply voltage of between 12 and 28 VDC. The EECS must have airframe electric power for start-up and as a redundant back-up to engine power from the EECS-dedicated PMA. **NOTICE:** The minimum usable voltage for the system is 10.5 VDC.
Interface	The airframe power is supplied to the EECS through a four-pin plug on the wiring harness.

Wiring Harnesses

The wiring harness connects the ECU directly to the sensors, connectors, and components on the engine.

Sensors

Sensors, identified in Table 2, are connected to the wiring harnesses.

The sensors measure engine parameters and supply input to the ECU. The ECU uses this data to control operation of the engine through actuators.

Table 2
Sensors

Sensor Name	Abbr.	Qty.	Description
Throttle Position Sensor	TPS	2	Both sensors are contained in one housing and have a single output connector. They redundantly measure the throttle angle.
Delta Pressure Sensor	DPS	1	Measures the pressure drop across the venturi.
Crankshaft Speed Sensor	CRANK	1	Measures the speed and position of the crankshaft.
Camshaft Speed Sensor	CAM	1	Measures the speed and position of the camshaft.
Oil Temperature Sensor	OIL-T	1	Monitors oil temperature immediately after the oil filter downstream of the oil cooler return.
Induction Air Deck Temperature	DECK-T	1	Measures the temperature of air before the throttle.
Primary Induction Air Manifold Temperature Sensor	MAT-P	1	Redundantly measures the MAT.
Secondary Induction Air Manifold Temperature Sensor	MAT-S	1	Redundantly measures the MAT.
Fuel Temperature Sensor	FUEL-T	1	Measures the temperature of the fuel in the fuel rail.
Cylinder Head Temperature Sensor	CHT 1-6	6	Measures the Cylinder Head Temperature (CHT).
Exhaust Gas Temperature Sensor	EGT 1-6	6	Measures the Exhaust Gas Temperature (EGT) of each respective cylinder.
Turbine Inlet Temperature Sensor	TIT	1	Measures the average temperature of the exhaust gas entering the turbocharger turbine.
Oil Pressure Sensor	OIL-P	1	Monitors oil pressure immediately after the oil filter and before the pressure regulator.
Fuel Pump Pressure Sensor	FPP	1	Measures fuel pump outlet pressure for the EECS to calculate the pressure drop across the engine fuel filter.
Fuel Rail Pressure Sensor	FUEL-P	1	Measures fuel rail pressure.
Primary Induction Air Deck Pressure Sensor	DECK-P-P	1	Redundantly measures the induction air deck pressure.
Secondary Induction Air Deck Pressure Sensor	DECK-P-S	1	Redundantly measures the induction air deck pressure.

Table 2 (Cont.)
Sensors

Sensor Name	Abbr.	Qty.	Description
Induction Manifold Air Pressure Sensor	MAP	1	Measures induction air manifold pressure.
Primary Compressor Inlet Pressure Sensor	CIP-P	1	Redundantly measures the pressure of the induction air entering the turbochargers.
Secondary Compressor Inlet Pressure Sensor	CIP-S	1	Redundantly measures the pressure of the induction air entering the turbochargers.
Knock Sensor	KNOCK 1-6	6	Used to detect detonation in each respective engine cylinder.

Cylinders

Each of the six engine cylinders has rings, pistons, push rods, valves, valve springs, and hydraulic roller tappets.

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

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

Each cylinder is air-cooled by integral cooling fins. Cylinder baffles push air through the cylinder fins. Refer to Appendix A for the cylinder cooling airflow and pressure differential curve.

Crankcase

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

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

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

The crankshaft is within the crankcase. The crankshaft has journals and counterweights. The counterweights decrease torsional vibrations as the crankshaft turns to operate the propeller. The crankshaft has one 5^{th} order and one 6^{th} order pendulum-type counterweights.

Pressurized oil flows through oiling passages in the crankcase and bearings to lubricate the crankshaft journals and to supply the propeller governor oil circuit and the hydraulic propeller pitch control circuit. The crankcase has a breather for ventilation to the atmosphere to prevent excess pressure in the crankcase. The crankcase breather connection is on the accessory housing.

The filler cap and oil level gage are installed in the crankcase. An optional filler extension is available.

Propeller Drive

The flange-type propeller shaft, an integral part of the crankshaft, conforms to SAE Specification AS127, Type 2. This direct drive propeller is attached to the crankshaft with six bolts. Oil is supplied through the propeller shaft for a single acting controllable pitch propeller. The engine must be approved by Lycoming for use with an FAR 23.1305 certified propeller system which is independent of the engine installation.

The propeller governor drive is on the left front half of the crankcase.

Fuel System

The fuel system (Figure 7) can support continued engine operation throughout its flow and pressure range.

The engine fuel system is made up of a three-position engine-driven fuel pump, in-line fuel filter, fuel hoses, fuel rails, six electronic fuel injectors, fuel manifold, and fuel pressure regulator.

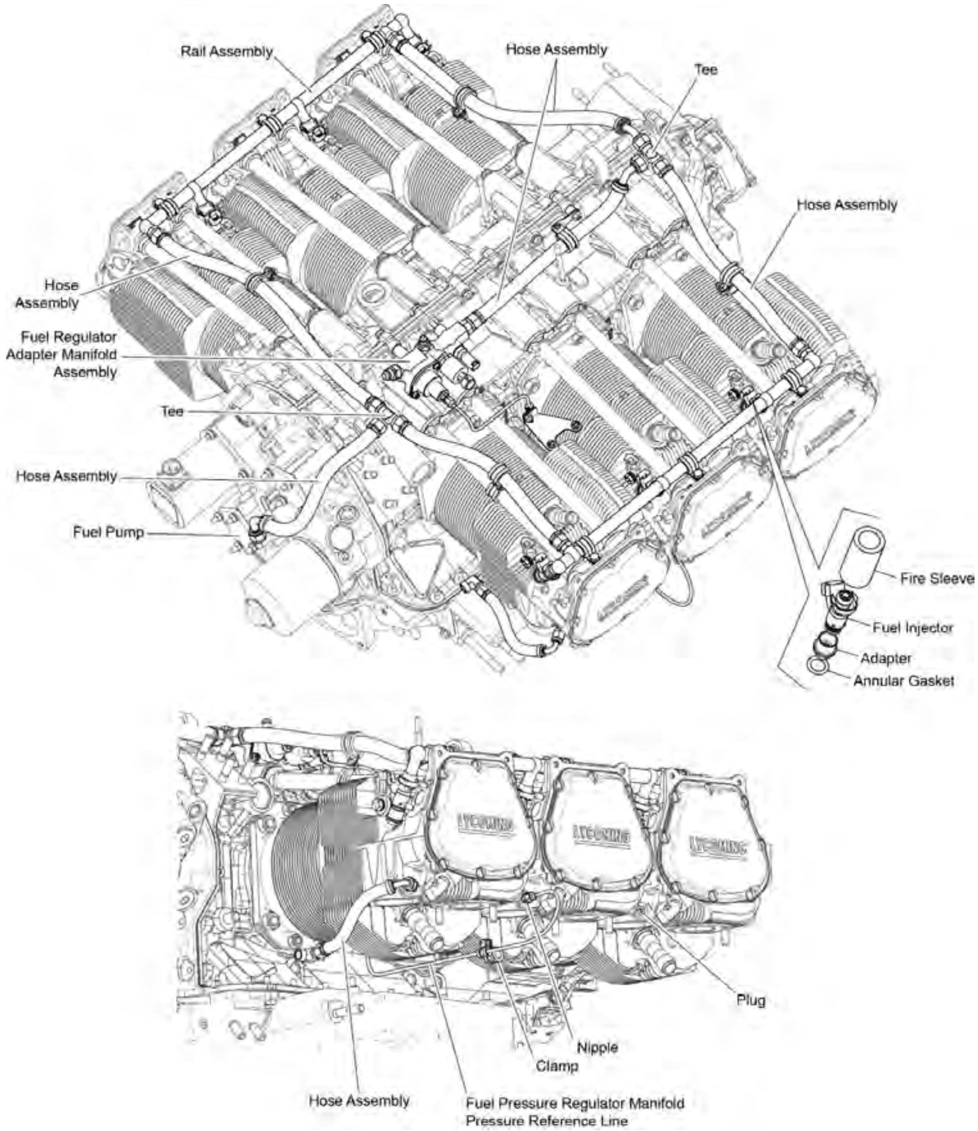

Figure 7
TEO-540-C1A Engine Fuel System

The crankshaft operates the fuel pump. The fuel pump is attached to a machined pad on the accessory housing. The fuel pump supplies fuel through fuel hoses connected to an electronic fuel injector on the intake port of each engine cylinder. The 10-micron back-up fuel filter on the engine is upstream of the fuel injectors. The airframe fuel filter is the primary filter for removal of dirt and contamination from fuel before it enters the engine.

The fuel system has a removable 10-micron filter and sediment trap to collect debris from fuel.

The engine fuel pump supplies the correct amount of fuel (through all operating ranges under all flight and atmospheric conditions) to the six fuel injectors. The ECU controls fuel injection. The ECU times and sets fuel injection sequentially and proportionally with the induction airflow. A fuel pressure regulator controls fuel pressure in the fuel rails connected to the fuel injectors. Only the correct amount of fuel (calculated from sensor input) is injected into the engine at a time identified by the ECU.

The ECU calculates the air/fuel ratio necessary for engine operation, given the operating conditions. The ECU controls the amount of fuel flow through each fuel injector based on the measured airflow rate. The fuel injectors supply atomized fuel into the intake port of each cylinder sequentially.

The electronic fuel system supplies priming fuel for engine start.

Electronic Ignition System

The Electronic Ignition System (Figure 8) has an all-weather shielded, braided wire-type ignition harness and coil box with 12 electronic ignition coils connected to 12 radio-shielded spark plugs. The long-reach spark plugs are the all-weather type. There are two spark plugs for each of the six cylinders.

The ignition system is a redundant inductive discharge system for start-up and continued in-flight operation. This system has separate sources of power sent through two electrical circuits.

The main source of power for the EECS is the gear-driven PMA on the accessory housing. The aircraft battery is used to start the engine.

The EECS controls ignition and spark plug operation. The ECU is connected to 12 ignition coils, six coils for each ECU channel.

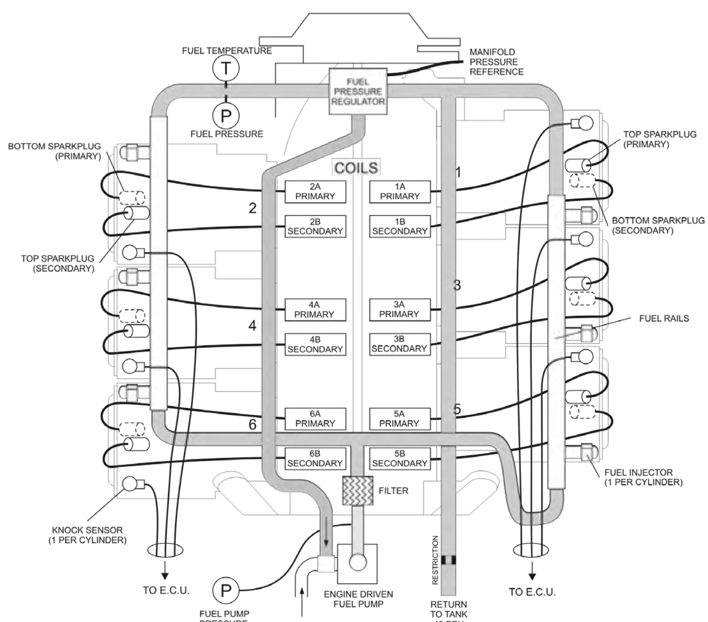

Figure 8
Electronic Ignition System

Air Induction System

The Air Induction System is integral with the oil sump, with individual induction pipes going to each cylinder. Each passage in the induction system, where fuel and air mix, self-drain to prevent liquid lock in the cylinder.

Induction air coolers are installed between each compressor outlet and throttle body inlet. Refer to the curve in Appendix A for cooling airflow vs. pressure drop for each induction air cooler. Minimum requirements are 4 in. of water cooling.

The Air Induction System must have an aircraft-supplied air cleaner that operates with a pressure drop not to exceed 6 in. of water. Additional air cleaner capacity is necessary to operate under dusty conditions. The Compressor Inlet Pressure (CIP) sensors must be installed in a common intake plenum after the aircraft induction filter.

Turbocharger System

This engine has one turbocharger, mounted on a support structure on the rear of the engine. The EECS controls the induction manifold air pressure (boost) using power control (throttle) position and regulation of the amount of exhaust gases supplied to the turbine wheel.

The EECS monitors induction manifold air pressure and transmits the control signal to the electronic two-way solenoid valve. The electronic two-way solenoid valve controls oil pressure to the exhaust bypass valve’s hydraulic actuator. The exhaust bypass valve controls exhaust gas flow to the turbine wheels.

Accessory Housing/Accessory Drive Pads

The accessory housing is a machined aluminum alloy casting attached to the rear of the crankcase on top of the oil sump.

There are two accessory drive pads on this engine. Refer to Appendix A for technical details.

Lubrication System

The wet sump pressurized Lubrication System (Figure 9) has the following:

- Oil pump
- Oil sump
- Oil cooler (supplied by airframe manufacturer)
- Oil filter
- Oil pressure relief valve
- Oil cooler bypass valve
- Electronic oil temperature sensor (OIL-T) (on accessory housing)
- Electronic oil pressure sensor (OIL-P) (on accessory housing)

The oil pump is integrated into the accessory housing.

The wet sump-type Lubrication System supplies oil to the oil galleys in the crankcase and to the engine in all altitudes and atmospheric conditions. There are two drain plugs in the bottom of the oil sump, one on each side. A threaded oil plug is on the left side of the oil sump for removal of the suction screen.

Six oil nozzles, one at each piston, supply positive internal piston cooling. An airframe-supplied oil cooler is necessary. Oil is supplied to and returned from the oil cooler by ports in the accessory housing. A oil cooler bypass valve in the accessory housing controls oil flow to the cooler. The airframe-supplied oil cooler keeps the oil at the correct temperature to prevent overheating.

Oil circulation in the engine is as follows:

1. The oil pump pulls oil from the oil sump through a suction screen.
2. Oil from the oil pump flows through the accessory housing and out through a threaded port on the housing to the external oil cooler.
3. An oil cooler bypass valve in the accessory housing provides a route for the oil to bypass the oil cooler directly to the oil filter inlet. The oil cooler bypass valve is fully closed when the oil temperature reaches a set limit (identified in Appendix A), forcing all oil flow through the external oil cooler.
4. From the oil cooler, pressurized oil flows back to the engine to a threaded port on the right side of the accessory housing.
5. The oil flows through a spin-on oil filter attached to the accessory housing and back into the accessory housing (where the oil temperature and pressure are measured by sensors).
6. The filtered oil flows into the main oil passage in the crankcase. An oil pressure relief valve on the upper right side of the crankcase (forward of the accessory housing) bleeds excess oil to maintain oil below a set maximum pressure.

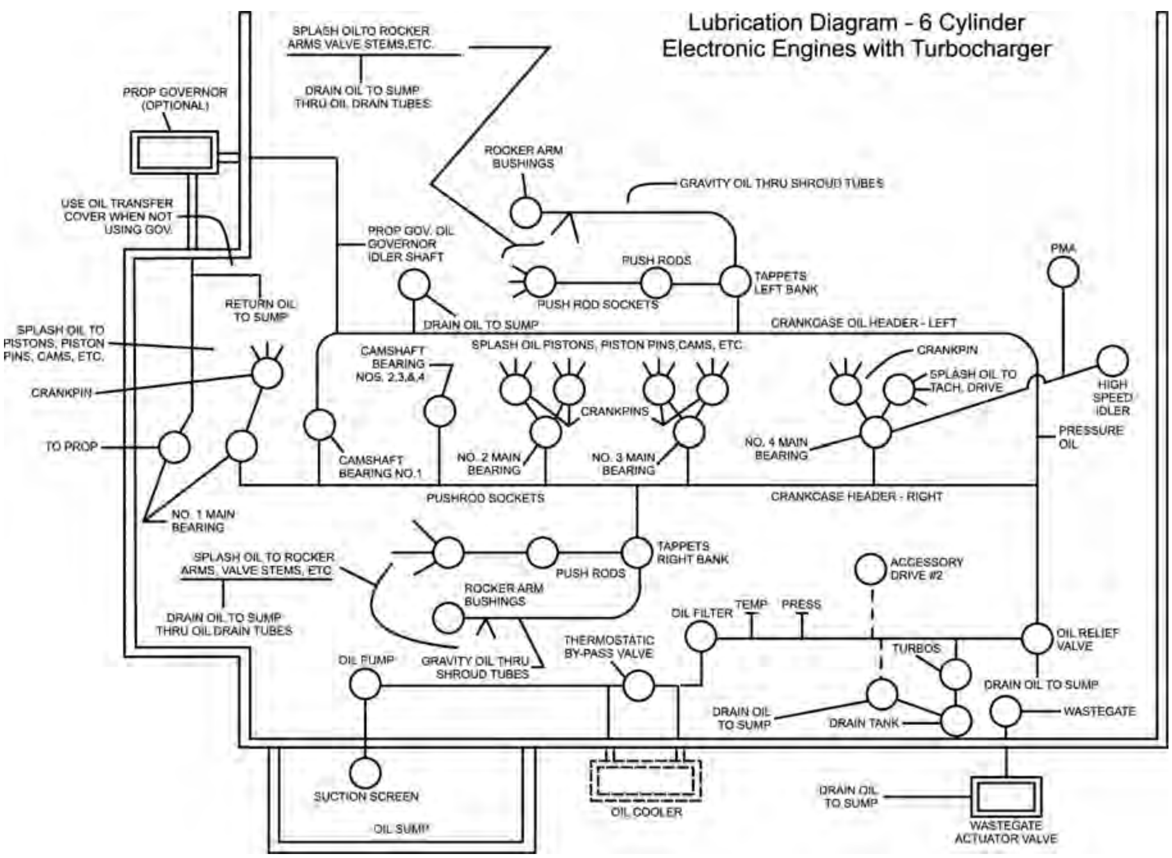

Figure 9
Oil System Schematic

7. The filtered pressurized oil flows to the cam and valve gear openings of the main oil galley.
8. Oil flows through branch openings to the tappets and camshaft bearings.
9. Oil flows into the tappet through indexing holes and through the hollow push rods to the valve mechanism. The oil lubricates the valve rocker bearings and valve stems.
10. Oil continues to flow through isolated drilled openings to the main bearings of the crankshaft. Angular holes go through the main bearings to the rod journals.
11. Oil flows through the accessory housing to supply oil to all accessory housing-mounted components.
12. Oil also flows out of a threaded port in the accessory housing through an external line to the turbocharger. Oil drains out of the turbocharger into the accessory housing.
13. Passages from the rear main bearings supply pressurized oil to both crankcase idler gears.
14. Gravity drains oil from the bearings, accessory drives, and rocker boxes to the oil sump.
15. The relief valve also sends oil back to the oil sump.
16. The electronic oil temperature sensor sends temperature readings to the aircraft through the communication bus.
17. An electronic oil pressure sensor sends the oil pressure reading to the aircraft through the communication bus.

Engine Mounting

Four brackets are supplied for rear Dynafocal mounting. Vibration isolators are not supplied. Refer to the airframe manufacturer's maintenance manual for details.

Cylinder Number Designations

- The propeller is at the front of the engine and the turbocharger and accessory drives are at the rear of the engine.
- In a top view of the engine, the cylinders on the right are 1-3-5. Cylinder 1 is at the front of the engine. Refer to Figure 10.
- In a top view of the engine, the left side cylinders are 2-4-6. Cylinder 2 is at the front of the engine. Refer to Figure 10.
- The firing order of the cylinders is 1-4-5-2-3-6.

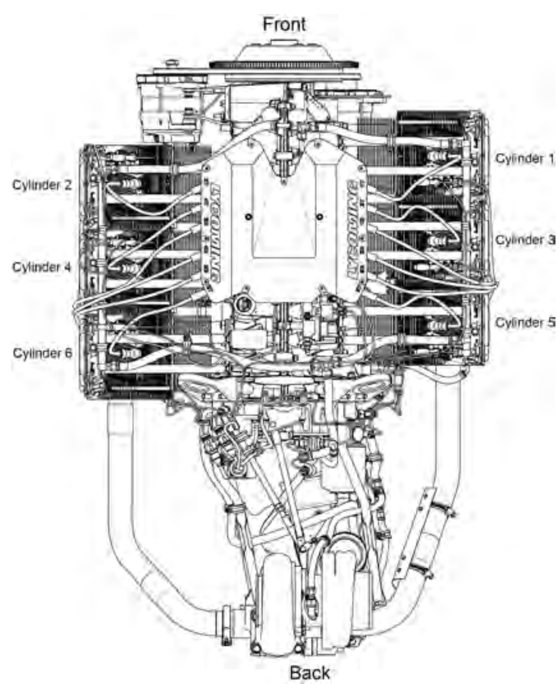

Figure 10
Cylinder Number Designation

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THEORY OF OPERATION

EECS Operation

The EECS:

- Controls engine operation in accordance with Lycoming's established engine operating specifications
- Increases engine performance for:
  - More balanced distribution of power across each cylinder (balanced air-fuel mixture)
  - More efficient operation at each engine power
  - More consistent engine starts under all operating conditions, especially hot and cold soak conditions
- Makes engine shutdown easier
- Automatically adjusts fuel mixture based on operation setpoints and engine conditions to:
  - Independently control each engine cylinder to prevent high CHTs
  - Enhanced fuel efficiency - Enables the engine to run at best power or best economy depending on the engine operation setpoint
- Prevents overspeed and overpressure conditions to reduce pilot intervention
- Enables more stable engine operation through automatic adjustments with changing environmental conditions such as changes in altitude, temperature, or changes in engine load
- Supplies more detailed feedback about engine operating conditions and history
- Automatically does engine pre-flight tests
- Automatically uses redundant features when necessary
- Supplies integrated functionality such as propeller control
- The EECS isolates engine faults by detection of the following:
  - Short and open circuit detection of specified sensors and actuators
  - Out-of-range hardware failures of sensors and actuators
  - In-range failures of specified sensors
  - Conditions outside specified operation range (low oil pressure, and high oil temperature).
- The EECS records the following engine information:
  - Fault information sent to pilots
  - Fault information to service personnel
  - General engine lifetime usage and performance information (histogram at various operating points, maximum values over life, etc.)

NOTICE: Software and programmed calibration data within the ECU control how the EECS adjusts actuators based on sensor inputs.**Engine Control Sequence**

NOTICE: The ignition switch is wired directly to both channels of the ACU. When the ignition switch is set to the ON position (open circuit) the ACU is enabled to supply fuel and spark to the engine. This switch is the primary means of turning the engine OFF.

If the EECS has power:

1. The Enable switches are identified in the ON position.
2. The system identifies the engine rotation.
3. As a result, the system supplies fuel and spark to operate the engine. In some cases, this function can be disabled by the following:
   - Fuel flow manually turned off or not available
   - Cylinder disabled for overspeed
   - Cylinder disabled for overboost
   - Cylinder disabled for dead-cylinder detection.

Engine Synchronization

"Engine synchronization" refers to the speed and position of the engine crankshaft. The EECS uses the crankshaft and camshaft speed sensors to calculate engine speed and position. Although the engine can operate with full functionality with either sensor, position data from the camshaft sensor is necessary for full sequential fuel injection.

Fuel Control

The fuel system supplies a mixture of fuel and air to the cylinders under all conditions of operation.

The fuel system will keep the correct fuel pressure during all conditions of normal operation.

The EECS electronically activates fuel injection and adjusts fuel for each cylinder to control the air/fuel ratio by engine speed and engine load.

Ignition Control

The EECS controls ignition events electronically. The EECS calculates ignition timing based on engine speed and engine load.

When only one spark plug is operational on a particular cylinder, the EECS adjusts the spark timing on the remaining spark plug of that particular cylinder to keep power loss to a minimum.

Load Sensing

The EECS calculates airflow by the following redundant methods:

- Venturi-delta-pressure
- Speed density
- Speed throttle.

The EECS compares the different sources of engine airflow to identify sensor failures.

Generated Power Calculation

The EECS calculates an estimate of the power that is generated by the engine based on the current operating conditions. This estimated power calculation is transmitted through the instrumentation communication channel as a reference value that the pilot may use to set the desired aircraft performance. The EECS does not compensate for sensor accuracy or all operating condition specific modifications and thus should not be used as a direct horsepower measurement.

Inoperative Cylinder Detection

The EECS can identify a cylinder that is not in operation. As a result, the EECS disables all spark and fuel events for a cylinder that is non-operational.

Cylinder Head Temperature Control

The EECS monitors Cylinder Head Temperature (CHT) and corrects any cylinder temperature that has gone above the maximum temperature limit (shown in Appendix A). The EECS keeps the CHT below the maximum temperature limit up to the correction limit. The maximum temperature limit is set as per the engine speed and engine load. The maximum temperature limit applies to all cylinders.

The EECS only adjusts fuel within a set range to control CHTs. The range limit prevents excessively rich or lean operation. The EECS adjusts fuels to control the CHT with air/fuel mixtures rich of stoichiometric. If a cylinder is currently operated as lean of stoichiometric and is hot, rather than lean to decrease temperature, the system adjusts back to the rich side.

Turbocharger Turbine Inlet Temperature Control

The EECS only adjusts fuel within a set range to control the turbocharger turbine inlet temperature. The range limit prevents excessively rich or lean operation. The EECS keeps the turbine inlet temperature below a set maximum temperature up to the correction limit. The maximum turbine inlet temperature is set in the calibration configuration.

Turbocharger Control

The EECS controls the exhaust bypass valve during engine operation. Although each channel of the ECU can control the exhaust bypass valve actuator, only the ECU channel currently in control of the fuel has control of the exhaust bypass valve actuator.

The EECS prevents the pressure ratio across the turbocharger compressor from going above a maximum value set in the software.

The EECS controls the induction air manifold to a set pressure or density based on power control position, engine speed, pressure, or density setpoint. The pressure or density setpoint is a function of the pilot’s requested power. The EECS controls the exhaust bypass valve position to the set manifold conditions.

The EECS keeps deck pressure to a set minimum value independent of the power control position when the turbocharger compressor bleed air is used for aircraft pressurization.

Engine Overhaul vs. Engine Rebuild

Engine overhaul is different from engine rebuild as follows:

1. Engine overhaul – The engine is completely disassembled and assembled with parts and components that have been inspected to be within serviceable limits. After an engine overhaul, the engine is returned to service and the engine operating hours continue without interruption as recorded in the engine logbook.
2. Engine rebuild - The engine is completely disassembled and assembled with parts and components that have been inspected to new limits. An engine rebuild is only completed at the Lycoming Engines’ factory. After an engine rebuild, the engine is issued a zero-time logbook.

Timekeeping

The EECS records the amount of time the controller has power (as "EECS Hours").

NOTICE: The total recorded hours cannot be reset. This time is just a continuous counter until the unit is out of service and is reset during a factory engine recap.

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PILOT CONTROLS AND ANNUNCIATORS

Pilot Controls

Table 1 identifies pilot controls for the TEO-540-C1A engine. Figure 1 shows typical cockpit controls.

Table 1
Pilot Controls

EECS aircraft breaker set to ON	Airframe power is supplied to EECS
Ignition switch ON	EECS enables fuel and spark to the engine
Ignition switch OFF	EECS disables fuel and spark to the engine
Ignition switch START	Enables power to the starter
Pre-Flight Test (PFT) switch	Starts the pre-flight test sequence or sends an acknowledgement and stops the pre-flight test
Fuel Pump Switch - ON	Turns the aircraft fuel boost pump ON continuously
Fuel Pump Switch - AUTO	Enables control of the aircraft fuel boost pump by the EECS
Fuel Pump Switch - OFF	Turns the aircraft fuel boost-pump OFF
Power Control Lever	Controls engine power

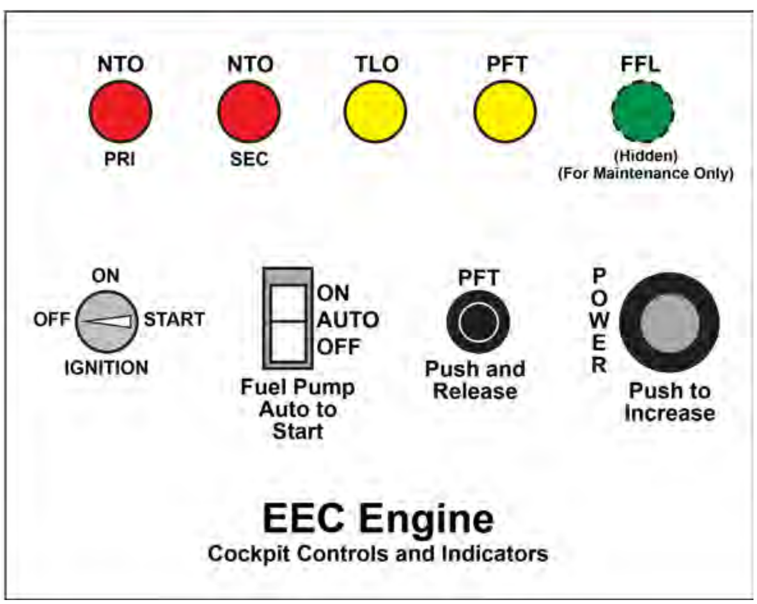

Figure 1
EECS Cockpit Controls and Indicators

Warning Indication Annunciators

The EECS has a simple set of hardwired warning annunciators (shown in Figure 1 and identified in Table 2 along with pilot action), to supply critical system status data to the pilot. These annunciators are connected directly to the ECU. The annunciators will still operate if airframe power is lost.

NOTICE: During routine maintenance, such as a scheduled oil change, the service technician can display the ECU fault codes (Appendix D in the ***TEO-540-C1A Engine Maintenance Manual***) using the FST on an attached laptop or other digital device. If any fault is present, the service technician must take action to correct the fault.

Table 2
Indicator Annunciators

Annunciator Acronym	Annunciator Name	Definition and Pilot Action
NTO Pri NTO Sec	No Take-Off	If the NTO annunciator is constantly illuminated before, during, or after completing the Pre-Flight Test, while the aircraft is on the ground, **do not take-off.** Identify the fault(s) using the FST, correct the condition(s), and clear the fault(s). If the NTO annunciator illuminates during flight and stays illuminated for more than 10 seconds, make minimum power control changes, land as soon as safely possible. Although, the engine will continue to operate, operation will be in a degraded mode which requires a prompt, safe landing. Identify the fault(s) using the FST, correct the condition(s), and clear the fault(s) before further flight.
TLO	Time-Limited Operation	If the TLO annunciator illuminates, it is still safe for flight if flight is necessary. However, it is recommended the fault(s) is identified using the FST, the condition(s) corrected, and the fault(s) cleared. If service is not done within 20 hours of engine operation, the NTO annunciator will illuminate.
FFL	Fault Found	An illuminated FFL annunciator, if applicable, indicates a minor fault, which does not have an effect on engine operation has occurred. No pilot action is necessary. However, this fault must be corrected at the next service interval.
PFT	Pre-Flight Test	If this annunciator is illuminated, the pre-flight test is in progress. Do not move the power control until the annunciator has turned off. If the pre-flight test sequence is stopped before it is completed, the PFT annunciator will flash. Momentarily press the PFT button. Complete another pre-flight test per instructions in this chapter.

ENGINE RECEPTION AND LIFT

Uncrate Procedure for a New, Rebuilt, or Overhauled Engine

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

NOTICE: Box crating can vary at times. Figure 1 shows a typical example.

These engines are usually sent in a box where the engine is attached to a pallet within the box. The engine can be in a plastic bag or wrapped and it could have a top foam pillow or be completely encased in foam, depending on the shipping destination and customer requested packing material.

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

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

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

Figure 1
Example of Engine Box/Crate

Acceptance Check

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

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

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

Figure 2
Engine Data Plate

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

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

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

Engine Preservative Oil Removal

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

Lift the Engine

⚠ **CAUTION** USE CAUTION AROUND THE ECU, POWER BOX, WIRING HARNESS, SENSORS, AND ACTUATORS. IF ANY OF THESE ITEMS ARE DAMAGED, THEY MUST BE REPLACED, (EVEN IF ONLY ONE WIRE BREAKS ON THE HARNESS) AS PER INSTRUCTIONS IN THE TEO-540-C1A SERIES ENGINE MAINTENANCE MANUAL.

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

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

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

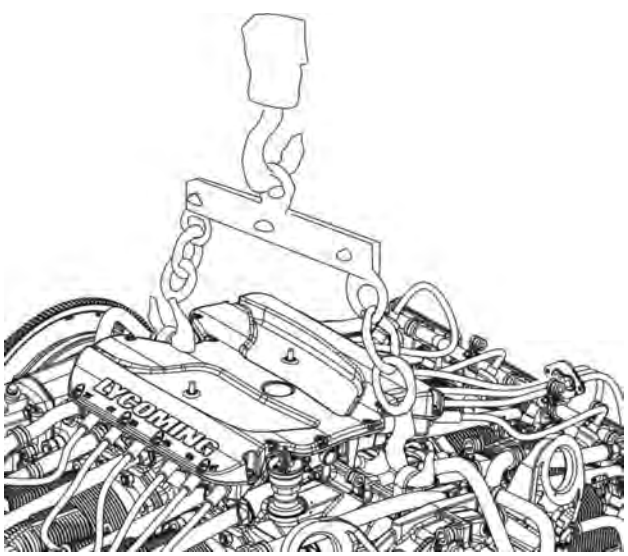

Figure 3
Engine Lift

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

2. Remove the bolts that attach the shipping brackets to the front and rear of the engine.
3. Lift the engine slowly and vertically.
4. When the engine has preservative oil, complete the preservative oil removal procedure now while the engine is lifted. Refer to the section “Prepare for Installation of a New, Rebuilt, or Overhauled Engine” section or “Prepare a Stored Engine for Installation” in the “Requirements for Engine Installation” chapter in this manual.

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REQUIREMENTS FOR ENGINE INSTALLATION

Overview

NOTICE: If a problem or leak is found on the engine, refer to the ***TEO-540-C1A Engine Maintenance Manual*** for corrective action. If the problem or leak continues, contact Lycoming Engines.

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

Refer to the separate, standalone Interface Control Document (ICD) which identifies the format for data transmission and reception required by each subsystem within the software/hardware interface between the airframe controller and the ECU. The ICD is available upon request.

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 Engine Mounting Brackets

Step 1. Prepare the Engine

To prepare a new, rebuilt, or overhauled engine	Refer to the section “Prepare for Installation of a New, Rebuilt, or Overhauled Engine” 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 for Installation of a New, Rebuilt, or Overhauled Engine

⚠ **CAUTION** THE ENGINE IS SENT WITH THE WIRING HARNESS AND SENSORS ATTACHED ON THE ENGINE. THE ECU, POWER BOX, WIRING HARNESS, AND SENSORS CANNOT BE REPAIRED. IF ANY OF THESE ITEMS ARE DAMAGED, THEY MUST BE REPLACED. REFER TO THE TEO-540-C1A ENGINE MAINTENANCE MANUAL.

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 depreservation 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 PLUGS FROM THE BOTTOM SPARK PLUG HOLES. 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 depreservative procedure as follows:
   A. Remove desiccant bags.
   B. During the procedure, 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 ***TEO-540-C1A Engine Maintenance Manual:***
      - Disassemble the affected portion of the engine.
      - Clean the engine.
   C. Put a container under the engine to collect the cylinder preservative oil.
   D. Remove the shipping plugs installed in the lower spark plug holes.
   E. Remove the desiccant plugs from the upper spark plugs holes.
   F. Turn the crankshaft completely 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 ***TEO-540-C1A Engine Maintenance Manual***.
4. If any corrosion or unusual conditions are found, speak to Lycoming Engine’s Service Department.
5. Drain preservative oil from the oil sump:
   A. Put a 15-quart (14-liter) capacity container under the oil sump.
   B. Remove the safety wire/cable from the oil sump drain plugs. Discard the safety wire/cable.
   C. Remove the two oil sump drain plugs (Figure 1).
   D. Drain the remaining preservative oil from the oil sump into the container.

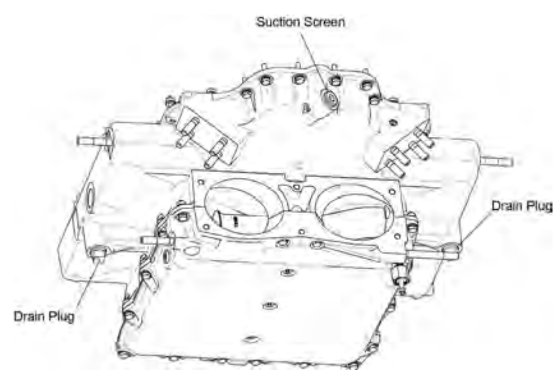

Figure 1
Oil Sump Drain Plugs and Oil Suction Screen

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

E. Remove, examine, clean, and reinstall the oil suction screen (Figure 1) per the "Oil Suction Screen Removal/Inspection/Cleaning/Installation" section in Chapter 12-10 of the ***TEO-540-C1A Engine Maintenance Manual.***

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

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

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

6. Drain the fuel pump:

A. Put a collection container underneath the fuel pump.

B. Remove the shipping caps installed on the fuel pump.

C. Let any preservative fluid drain from the fuel pump into a collection container.

D. Remove the collection container.

E. Reinstall the shipping cap on the main fuel inlet on the fuel pump.

F. Install all shipped loose components of the fuel system.

G. Connect the fuel lines to all fuel system components. Refer to Chapter 73-10 in the ***TEO-540-C1A Engine Maintenance Manual.***

7. Remove the plug in the induction system (Figure 2).

8. Drain any preservative oil from the induction system.

9. Install the fuel drain valve adapter assembly (shipped with the engine as a "Ship Loose Part") in the induction system (Figure 3). Refer to Chapter 72-80 in the ***TEO-540-C1A Series Engine Maintenance Manual*** for installation instructions.

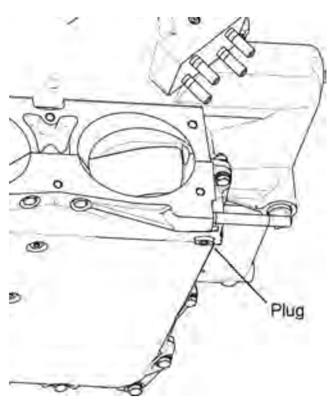

Figure 2
Plug in the Induction System

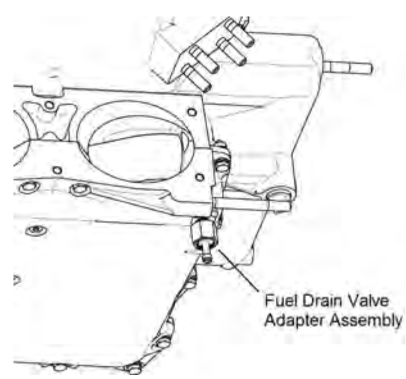

Figure 3
Fuel Drain Valve Adapter Assembly Installed in the Induction System

10. Examine the spark plugs. If spark plugs are acceptable, install them with a new gasket and connect the ignition leads. If the spark plugs are dirty, clean them per the procedure in Chapter 05-30 of the ***TEO-540-C1A Engine Maintenance Manual***. If the spark plugs are not acceptable, install new spark plugs with a new gasket. Refer to Chapter 74-20 in the ***TEO-540-C1A Engine Maintenance Manual*** for the spark plug removal, inspection, and installation procedures.
    A. Remove the protectors on the ignition lead ends.
    B. Connect the ignition lead ends.
11. If a constant speed propeller is used, remove the expansion plug per instructions in Chapter 72-20 in the ***TEO-540-C1A Engine Maintenance Manual.***
12. Remove the fuel inlet strainer from the throttle body, clean it with a hydrocarbon-based solvent such as mineral spirits or equivalent, and re-install the strainer in the throttle body.
13. Examine the fuel supply lines, fuel manifold, and throttle body, to make sure they are clean and dry.

NOTICE: It is recommended that turbocharged engines be operated with ashless dispersant oil during and after break-in (the first 50 hours of engine operation or until oil consumption has stabilized.)

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

Prepare a Stored Engine for Installation

This procedure is for an engine that has been in storage. An engine in storage has preservative oil which must be removed just prior to engine installation.

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 DUE TO HYDRAULC LOCK CAN OCCUR.

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

NOTICE: If any of these plugs break and the crystals fall into the engine, complete the following procedure per the ***TEO-540-C1A Engine Maintenance Manual.***

- Disassemble the engine as necessary to remove all of the crystals that fell into 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 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 ***TEO-540-C1A Engine Maintenance Manual.***
7. Remove any other moisture-prevention seals and covers from the engine.

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

NOTICE: To touch-up paint, refer to Chapter 72-10 in the ***TEO-540-C1A Engine Maintenance Manual.***

8. Complete the preservative oil removal procedure as follows:
   A. Put a container under the engine to collect the cylinder preservative oil.
   B. Turn the crankshaft completely three or four revolutions to remove the cylinder preservative oil from the cylinders.
   C. Collect the cylinder preservative oil as it drains out of the lower spark plug holes.
   D. Tilt the engine to one side, until the spark plug holes on that side are vertical.
   E. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.
   F. Tilt the engine to the other side until the spark plug holes on that side are vertical.
   G. Turn the crankshaft two revolutions and let the oil drain out through the spark plug holes.
9. Examine the cylinder bores with a borescope for rust and contamination. Refer to Chapter 72-30 in the ***TEO-540-C1A Engine Maintenance Manual***.
10. If any corrosion or unusual conditions are found, speak to Lycoming Engines Service Department.
11. Drain preservative oil from the oil sump:
    A. Put a container under the oil sump.
    B. Remove the safety wire or safety cable and oil sump drain plugs (Figure 1). Discard the safety wire/cable.
    C. Remove the oil sump drain plugs.
    D. Drain the remaining preservative oil from the oil sump into the container.

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

E. Remove, examine, clean, and reinstall the oil suction screen (Figure 1) per the “Oil Suction Screen Removal/Inspection/Cleaning/Installation” section in Chapter 12-10 of the ***TEO-540-C1A Engine Maintenance Manual.***

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

⚠ **CAUTION** MAKE SURE THAT THE OIL SUMP DRAIN PLUGS AND THE OIL SUCTION SCREEN PLUG ARE INSTALLED TIGHTLY. IF THE OIL DRAIN PLUGS AND OIL SUCTION SCREEN PLUG ARE NOT TIGHTLY INSTALLED, OIL CAN LEAK, WHICH EVENTUALLY OVER TIME CAUSE ENGINE FAILURE.

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

12. Remove the oil filter and install a new oil filter. Refer to Chapter 12-10 in the ***TEO-540-C1A Engine Maintenance Manual.***
13. If the front expansion plug is installed and a constant speed propeller is to be used, remove the expansion plug per instructions in the “Crankshaft Disassembly” section of Chapter 72-20 in the ***TEO-540-C1A Engine Maintenance Manual.***
14. Refer to Chapter 74-20 in the ***TEO-540-C1A Engine Maintenance Manual*** to:

    A. Examine the spark plugs.

    B. If spark plugs are acceptable, install them with a new gasket. If the spark plugs are dirty, clean them per the procedure in Chapter 05-30 of the ***TEO-540-C1A Engine Maintenance Manual.*** If the spark *plugs* are not acceptable, install new spark plugs with a new gasket.

    C. Remove the protectors on the ignition lead ends.

    D. Connect the ignition lead ends.

15. Remove the fuel inlet strainer 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.
17. Add ashless dispersant oil to a new, rebuilt, or overhauled engine. Record the amount of oil added. Refer to Appendix A for the oil capacity. Refer to the “Add Oil” procedure in the “Engine Installation” chapter in this manual.
18. Use the correct procedure for disposal of drained oil and fuel in accordance with local, state, federal, and environmental protection regulations.

Step 2. Supply Interface Items

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

Required for initial engine installation:

- Correctly-sized hose for the fuel pump supply and fuel pump vent line
- Correctly-sized fuel return line (from fuel pressure regulator)
- Airframe fuel pump (fuel pump independently controlled by a circuit breaker with access by the flight crew for fire and emergency procedures)
- Auxiliary fuel pump output wired to a three-position switch to drive a relay that controls the airframe boost pump
- Airframe fuel pump switch with ON/OFF/AUTO positions
- Independent Fuel Shut-Off Valve (to meet engine shutdown requirements)
- 10-micron fuel filter (with a bypass)
- Air cleaner
- Oil cooler and appropriate oil hoses
- Bonded rubber mounts
- Hardwired lights to display warnings and cautions from the system
    - No Take-Off (NTO) Primary annunciator
    - NTO Secondary annunciator
    - Time-Limited Operation (TLO) annunciator
    - Fault Found (FFL) annunciator (if applicable)
- Pre-Flight Test (PFT) pushbutton (pushbutton with illumination capability or pushbutton with separate illumination)
- Ignition (dual pole single throw) switches
- Aircraft battery used as an EECS backup
- Starter wiring and controls
- Two ground straps from the ground lugs for the ECU - refer to “Step 11. Attach Ground Straps” in the Engine Installation chapter
- Two ground straps for the Power Box
- Airframe engine mount ground straps
- Three low impedance ground straps from the engine case to the engine mounting frame

NOTICE: Mounting the ECU to the Power Box requires four 1/4-20 bolts with a maximum length of 1/2 inch.

- A physical location for the mount of the Power Box and the ECU
- A connection point to attach the wiring harness to the airframe
- Airframe mate to the four-pin plug on the wiring harness can be a wall mount, cable connection, box mount, or jam nut receptacle
- 37-pin connector interface to the airframe engine wiring harness
- Communications interface to receive EECS instrumentation data
- A propeller.

Step 3. Remove Components

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

Remove only the components necessary to enable engine installation.

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

Step 4. Install Engine Mounting Brackets

If not already done, install the four engine mounting brackets on the engine. If the engine mounting brackets were removed from a previously installed engine, examine the brackets per the “Engine Mount Inspection” section in Chapter 72-00 of the ***TEO-540-C1A Engine Maintenance Manual.***

The engine is installed in the aircraft using the rear top and bottom engine mounts. There are no mounts in the front of the engine.

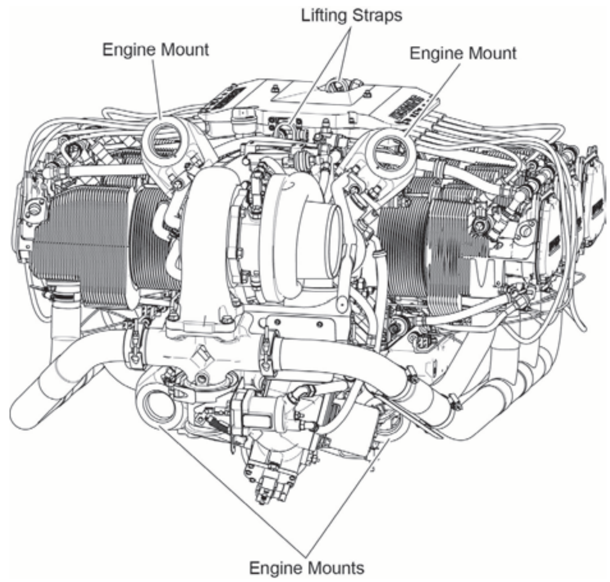

Figure 4
Engine Mounts

ENGINE INSTALLATION

Engine Installation Overview

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

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

Table 1
Engine Installation Steps and References

Step	Section References in This Chapter
1	Install the ECU
2	Install the Power Box
3	Install the Engine on Mounts
4	Connect the Wiring Harnesses
5	Connect the Power Control Linkage
6	Install External Accessories
7	Install the Alternator
8	Install the Propeller
9	Connect Fuel Hoses
10	Connect Oil Hoses
11	Attach Ground Straps
12	Install Components That Had Been Removed Before Engine Installation and Any Additional Ship Loose Components
13	Make Remaining Engine Connections
14	Install Baffling
15	Add Oil
16	Engine Pre-Oil Procedure
17	Add Fuel (to aircraft as necessary)
18	Make RPM Measurements
19	Final Installation Inspection
20	Close Engine Compartment

Step 1. Install the ECU

WARNING ENSURE CORRECT FUEL INJECTORS ARE INSTALLED. REFER TO THE LATEST REVISION OF SERVICE INSTRUCTION NO.1573 FOR PROPER CONFIGURATION. FAILURE TO COMPLY WILL RESULT IN IMPROPER ENGINE OPERATION AND LOSS OF POWER.

CAUTION THE ENGINE CONTROL UNIT (ECU) HAS A SPECIFIC CONFIGURATION FOR EACH ENGINE AND AIRFRAME. THE ECU AND ENGINE HAVE FACTORY-DESIGNATED SERIAL NUMBERS THAT GO TOGETHER. MAKE SURE THE SERIAL NUMBERS ON THE ECU AND THE ENGINE AGREE WITH SERIAL NUMBERS IDENTIFIED IN THE DOCUMENTATION SENT WITH THE ENGINE. IF THE SERIAL NUMBERS DO NOT AGREE, DO NOT INSTALL THE ECU. CONTACT LYCOMING ENGINES IMMEDIATELY.

Install the ECU with the correct serial number on the airframe in its designated location in accordance with the wiring diagram. Also refer to Appendix B in the ***TEO-540-C1A Engine Maintenance Manual*** for additional details.

CAUTION THERE MUST NOT BE EXCESSIVE CONVECTIVE OR RADIANT HEAT IMPINGEMENT ON THE ECU AS A RESULT OF THE INSTALLATION.

NOTICE: Torque the ECU fasteners in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

Step 2. Install the Power Box

1. Install the Power Box with the correct serial number on the airframe in its designated location in accordance with the wiring diagram. Refer to Appendix B in the ***TEO-540-C1A Engine Maintenance Manual*** for additional details.

NOTICE: Mounting the ECU to the Power Box requires four 1/4-20 bolts with a maximum length of 1/2 inch.

2. The Power Box can be installed in a stacked configuration.

CAUTION THERE MUST NOT BE ANY EXCESSIVE THERMAL CONVECTIVE OR RADIANT HEAT IMPINGEMENT ON THE POWER BOX AS A RESULT OF THE INSTALLATION.

NOTICE: Torque the Power Box fasteners in accordance with the latest revision of the ***Service Table of Limits - SSP-1776***.

Step 3. 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 FORCE WHICH CAN CAUSE MALFUNCTION.

USE CAUTION AROUND THE ECU, POWER BOX, WIRING HARNESS, SENSORS, AND ACTUATORS. IF ANY OF THESE ITEMS ARE DAMAGED, THEY MUST BE REPLACED, (EVEN IF ONLY ONE WIRE BREAKS ON THE HARNESS) AS PER INSTRUCTIONS IN THE TEO-540-C1A SERIES ENGINE MAINTENANCE MANUAL.

NOTICE: The engine is sent from the factory with the wiring harness sensors and spark plugs installed (Figure 1).

1. Attach the hoist, lift the engine, and put it into the airframe. Refer to the "Lift the Engine" section in the "Engine Reception and Lift" chapter in this manual.
2. Install hardware to securely attach the engine to the airframe and isolation mounts.
3. Torque the mounting hardware as per airframe manufacturer's specifications.
4. Disconnect the hoist from the lifting eyes.
5. Examine the engine wiring harness (Figure 1), sensors, and actuators for damage. If damage is found, replace the damaged items. Refer to the ***TEO-540-C1A Engine Maintenance Manual.***

Step 4. Connect the Wiring Harnesses

1. Examine the airframe receptacles for the airframe interface and airframe power. Look closely at the pins and sockets. If a receptacle is damaged, repair or replace the receptacle as per the airframe manufacturer's instructions.
2. Appendix B of the ***TEO-540-C1A Engine Maintenance Manual*** identifies harness leads and plugs on the wiring harness. Examine the plugs on the engine wiring harness for damage. Look closely at the sockets. If a connector is damaged, the wiring harness must be replaced as per instructions in the ***TEO-540-C1A Engine Maintenance Manual.***

NOTICE: Make sure there is sufficient slack (or dip loop) just before the firewall connection.

3. Connect the wiring harness to the ECU (Figure 1) and secure the wiring harness per the airframe manufacturer's instructions.

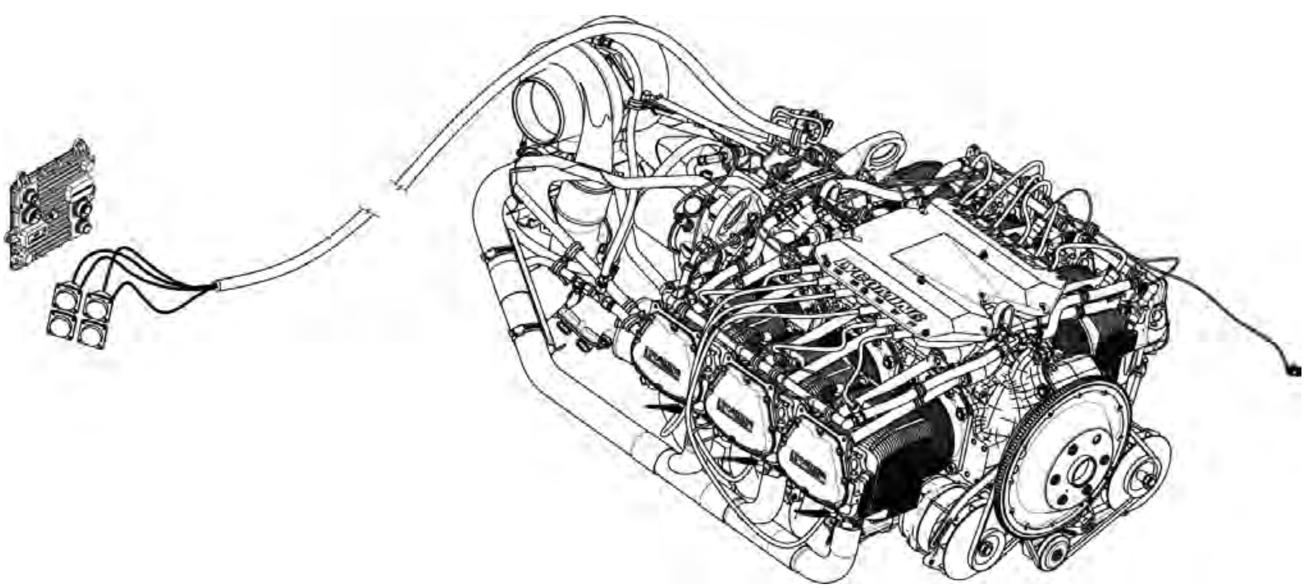

Figure 1
Wiring Harness Installed on TEO-540-C1A Engine

NOTICE: The collar on the threaded plugs should only be tightened by hand. Do not use pliers, adjustable pliers, or any other tool to tighten the collar on the threaded plugs.

4. Tighten the collar on the threaded plugs. The plugs must be tightened, by hand, until the red colored band on the receptacle (Figure 2) cannot be seen from the side of the connection (Figure 3).

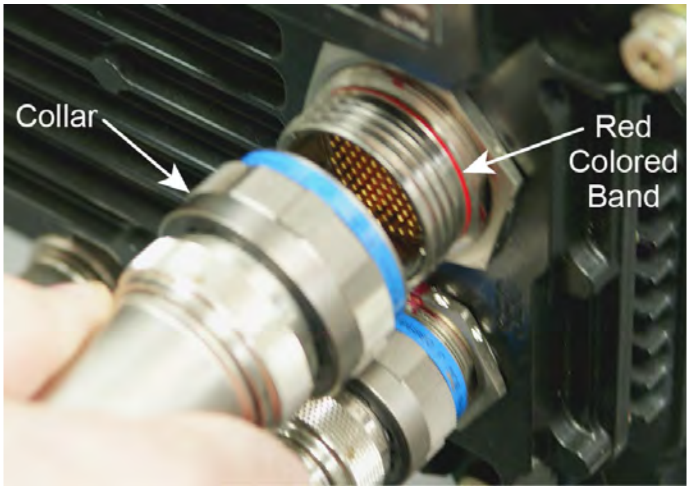

Figure 2
Red Colored Band on the Receptacle

Figure 3
Correctly Installed Threaded Plug

5. Ensure all other necessary connections are made to the wiring harness per the airframe manufacturer's wiring diagram.

6. Connect the wiring to the starter and PMA per the airframe manufacturer's instructions.

⚠ **CAUTION** NO EECS PARTS OR HARNESS CAN BE INTERCHANGED BETWEEN ENGINES UNLESS AGREED UPON BY LYCOMING ENGINES.

NOTICE: All the plugs on the wiring harness are uniquely keyed and must be in the correct orientation for the plug to install correctly in the receptacle.

7. Connect the two harness plugs, primary and secondary, identified as CIP-P and CAP-S to the compressor inlet pressure sensors installed in the induction system between the airframe induction air filter and the turbocharger compressor inlet. Install the connector CIP-P to the sensor for the turbocharger inlet on the left side (exhaust bypass valve side) of the engine.

8. After the engine and airframe engine harnesses are installed, examine the connectors on both wire harnesses for damage. Look closely at the connector contacts (pins and sockets), connector body, and back shell. If any part of a connector is damaged on the engine harness, replace the harness per instructions in the latest revision of the ***TEO-540-C1A Engine Maintenance Manual.*** If a connector is damaged on the engine airframe wiring harness, replace the harness per instructions in the latest revision of the ***Aircraft Maintenance Manual.***

Step 5. Connect the Power Control Linkage

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

Step 6. Install External Accessories

NOTICE: Accessory Drive Pads Nos. 1, 2, and 3 and AND 20000 are spline compatible accessories with mounting flanges.

1. Remove the cover plate and gasket.
2. Install the accessory on the supplied pad in accordance with the airframe manufacturer’s instructions.

NOTICE: A propeller governor drive pad is on the upper left front of the crankcase.

3. If necessary, install the propeller governor; use the manufacturer’s supplied gasket and hardware. Refer to the ***TEO-540-C1A Engine Maintenance Manual.***

Step 7. Install the Alternator

1. The alternator is supplied in a kit.
2. In accordance with Chapter 72-70 in the ***TEO-540-C1A Engine Maintenance Manual***:
   A. Install the alternator.
   B. Install the alternator belt.
   C. Complete an alternator belt tension check and adjust the alternator belt as needed.

Step 8. Install the Propeller

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

Step 9. Connect the Fuel Hoses

1. 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.

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

2. Before connection of the main fuel inlet line to the fuel pump, remove all contaminants from aircraft fuel tanks and fuel hoses.
3. Make sure that the airframe manufacturer has a fuel filter installed on the airframe. (The engine has a small back-up fuel filter - which is not to be used as the primary fuel filter.)
4. Remove protective caps from the main fuel inlet.
5. Connect the main fuel inlet line to the fuel pump. Torque the connection as per the airframe manufacturer's instructions.
6. Follow these required guidelines for making fuel hose connections.
   A. Make sure that each fuel hose is intact, not bent or damaged, and does not have any kinks or dents.

NOTICE: Refer to Chapter 73-10 in the ***TEO-540-C1A Engine Maintenance Manual*** for suggested routing and configuration arrangement diagrams for fuel hoses and fuel injector lines on this engine. The fuel hose and fuel injector line configuration diagram is for reference only. If specific fuel hose and fuel injector line routing information is in airframe documentation, follow the airframe instruction. Fuel hoses and fuel injector lines must be examined during every visual inspection as per the ***TEO-540-C1A Engine Maintenance Manual.***

B. Make sure cushioned clamps securely attach fuel hoses and fuel injector lines (to dampen vibration during flight). Do NOT use plastic tie straps in place of cushioned clamps.

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

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

Step 10. Connect Oil Hoses

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

1. Connect the oil hose from the oil sump to the wastegate.
2. Connect the oil hoses from the airframe-supplied oil cooler.
3. Clean each oil hose section and install it in the respective areas. Make sure the oil hose routing is smooth, without sharp bends, kinks or helical twists.
4. When making the following oil hose connections:

   A. Align the oil hose 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 11. Attach Ground Straps

NOTICE: Ground straps are necessary to make sure that the EECS operates correctly, and that the sensors and actuators have the necessary ground for correct operation. The ground straps are a primary line of defense in the event of a lightning strike to the aircraft.

1. Connect two ground straps (with at least 0.012 in^2 (8 mm^2) of cross sectional area - approximately equivalent to AWG 8) from the dedicated grounding lugs (the non-colored pads) on the ECU to the dedicated airframe ground bus.
2. Connect two ground straps (with at least 0.012 in^2 (8 mm^2) of cross sectional area - approximately equivalent to AWG 8) from the dedicated grounding lugs (the non-colored pads) on the Power Box to the dedicated airframe ground bus.

3. In accordance with FAA guidelines on HIRF and Lightning, install three low impedance grounding jumpers of 0.025 in^2 (16 mm^2) minimum conductive areas from the engine case to the engine mounting frame. The grounding jumpers must be less than 12 in. (30 cm) long.

4. Connect low impendence grounding jumpers between the engine mount and airframe, if necessary, to ensure a conductive path from engine to airframe equivalent to the three low impedance grounding jumpers specified in the previous step.

Step 12. Install Components That Had Been Removed Before Engine Installation and Any Additional Ship Loose Components

1. Install any component that was removed to enable engine installation.

2. Install any remaining components that were shipped loose with the engine.

Step 13. Make Remaining Engine Connections

1. Connect EECS wiring harness to airframe adapter interface wiring harness.

2. Make engine connections to accessories.

3. Make engine connections to wires and cables.

4. Make engine connections to ducts and cowling.

5. Make engine connections to breather, hoses and pipes.

6. Connect alternator blast tubes to a source of cooling air sufficient to prevent the alternator temperature from increasing above maximum limits set by the alternator manufacturer.

Step 14. Install Baffling

Install baffling around the engine compartment.

Step 15 Add Oil

⚠ **CAUTION** OIL IN THE CORRECT QUANTITY AND OF THE CORRECT VISCOSITY FOR THE CORRESPONDING AMBIENT TEMPERATURE MUST BE ADDED TO THE ENGINE FOR CORRECT LUBRICATION ESSENTIAL TO ENGINE OPERATION. REFER TO APPENDIX A FOR OIL TYPES AND OIL SUMP CAPACITY TO HAVE THE CORRECT QUANTITY AND TYPE OF OIL TO ADD TO THE ENGINE.

Add ashless dispersant oil to turbocharged engines, as specified in Appendix A. Refer to Chapter 12-10 in the ***TEO-540-C1A Engine Maintenance Manual*** for the procedure to add oil.

NOTICE: To accurately calculate oil consumption, every time oil is added, record the quantity of oil added in the engine logbook.

Step 16. 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 manual turns of the crankshaft and ensure that oil pressure is sustained and 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, overhauled, rebuilt, or stored engine

  or

- After oil cooler replacement or draining

  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.

  or

- After any prolonged period of inactivity requiring the “Engine Preservation and Storage” procedure in this manual

To complete the pre-oil procedure:

1. Make sure that the Ignition switch, the Auxiliary Fuel Pump switch, and the Fuel Selector are all in the OFF position.
2. Disconnect the oil supply hose from the top of the turbocharger.
3. Disconnect the engine air duct from the compressor housing inlet.
4. Fill the turbocharger oil inlet port with clean ashless dispersant engine oil and manually turn the compressor wheel several revolutions in both directions to apply a coat of oil to all journal and bearing surfaces.
5. Reconnect the engine air duct to the compressor housing inlet.
6. Fill the oil cooler with oil per the airframe manufacturer’s instructions.
7. Remove one spark plug from each cylinder of the engine. Remove and discard the spark plug gasket per instructions in Chapter 74-20 in the ***TEO-540-C1A Engine Maintenance Manual***.
8. Move the power control to the FULL OPEN position.

   ⚠ **CAUTION** DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 SECONDS. LET THE STARTER COOL AFTER EACH ENERGIZATION. IF THE STARTER FAILS TO ENERGIZE AFTER TWO ATTEMPTS, CONTACT LYCOMING ENGINES.

9. Energize the starter until oil is visible and/or flows from the end of the disconnected turbocharger oil supply hose.
10. Reconnect the turbocharger oil supply hose to the turbocharger.

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

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

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

NOTICE: Unstable oil pressure or oil pressure less than 20 psi (138 kPa) could be an indication of obstructed or interrupted oil flow or air in the oil lines. Lack of pressure build-up or rapid drop-off of pressure is an indication of the presence of air in the line and the engine is not getting oil. To correct this problem, disconnect the inlet lines at the turbocharger and exhaust valve guide oil. Turn the starter again until oil pressure is shown.

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

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

13. Once the minimum oil pressure of 20 psi (138 kPa) is shown on the oil pressure gauge, re-install the spark plugs each with a new gasket, and connect the ignition leads to all spark plugs per instructions in Chapter 74-20 of the ***TEO-540-C1A Engine Maintenance Manual***.
14. Within 3 hours of completing the pre-oil procedure, complete the remaining steps in this chapter, then start and operate the engine for 3 minutes at approximately 1000 RPM.

Step 17. Add Fuel

⚠ **WARNING** DO NOT USE A LOWER OCTANE OR INCORRECT GRADE OR TYPE OF FUEL (DIFFERENT FROM FUEL IDENTIFIED IN APPENDIX A). USE OF INCORRECT FUEL CAN LEAD TO DETONATION, POWER LOSS, AND ENGINE DAMAGE.

Add the fuel identified in Appendix A to the aircraft.

Step 18. Make RPM Measurements

1. There is no provision for a mechanical tachometer drive.
2. The airframe manufacturer must calibrate the engine speed (RPM) measurement.

Step 19. Final Installation Inspection

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

Step 20. Close Engine Compartment

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

Engine Installation Checklist

Engine Installation Checklist

Requirement	Done	Comment
Make sure the engine is securely installed on the engine mounts. Make sure that the hardware that attaches the engine to the engine mounts is torqued as per the airframe manufacturer's specified torque values.		
Make sure the power control linkage is connected.		
Make sure all ground straps are connected to the engine mounts.		
Make sure the accessories and alternator are installed.		
Make sure all spark plugs are installed.		
Make sure all wiring harnesses and wiring connections have been made.		
Make sure the wiring harness and sensors are attached to the engine.		
Make sure the ECU and Power Box are installed.		
Make sure baffles have been installed.		
Make sure fuel hoses and oil hoses are connected and that there are no leaks. Make sure clamps are securely installed on the fuel hoses.		
Make sure oil has been added to engine and the oil quantity added is recorded to calculate oil consumption.		
Make sure the engine pre-oil procedure has been completed.		
Make sure fuel has been added to aircraft fuel tanks.		
Make sure the RPM measurements have been made.		
WARNING TO PREVENT CATASTROPHIC FAILURE FROM FOREIGN OBJECT DEBRIS (FOD), MAKE SURE THAT THERE ARE NO TOOLS IN THE ENGINE NACELLE AND COMPARTMENT.		
Remove any tools or unwanted materials from the engine compartment.		
Close the engine compartment.		

FIELD RUN-IN

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

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

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

Field Run-In Procedure

Field run-in of fixed wing aircraft includes two procedures, "Preparation for Ground Operational Test with Engine Installed in Aircraft" and "Ground Operational Test."

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

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

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

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

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

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

2. **Ground Operational Test**

Complete this test while the engine is operating.

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

⚠ **CAUTION** ON TURBOCHARGED ENGINES, OPERATE THE ENGINE AT LOW SPEED UNTIL THE OIL PRESSURE IS STABLE. OVERBOOST CAN OCCUR IF THE TURBOCHARGER CONTROL SYSTEM EXPERIENCES UNUSUAL OIL PRESSURES DUE TO AN OIL TEMPERATURE BELOW THE MINIMUM OPERATION TEMPERATURE OF 140ºF (60ºC).

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

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

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

C. Start the engine. If either you do not see oil pressure (greater than 0) indication within 10 seconds after engine start or oil pressure does **not** continue to increase above the published minimum pressure (per Appendix A, Table A-2) in the next 20 seconds, stop the engine. Identify and correct the problem before another engine start.

D. Monitor the oil pressure and oil temperature. If low or no oil pressure is noted, stop the engine and identify the cause.

E. Operate the engine at 750 RPM for 1 minute; slowly increase the speed to 1000 RPM in 3 minutes.

F. Let the engine operate at 1000 RPM for approximately 3 minutes.

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

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

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

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

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

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

K. If the engine is equipped with a mechanical propeller governor, complete a cycle of the propeller blade pitch positions as applicable per the airframe manufacturer's recommendations.

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

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

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

N. Shut down the engine per "Step 4. Engine Stop" procedure in the "Engine Initiation" chapter of this manual.

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

P. Per Chapter 12-10 in the ***TEO-540-C1A Engine Maintenance Manual:***

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

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

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

WARNING IF DURING AN OPERATIONAL TEST OR ENGINE IDLE ANNUNCIATORS ILLUMINATE OR ANY OPERATIONAL PROBLEMS OCCUR, IDENTIFY THE FAULT(S) USING THE FST, CORRECT THE CONDITION(S), AND CLEAR THE FAULT(S) OR CONTACT LYCOMING ENGINES.

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

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ENGINE INITIATION

Engine Initiation

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

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

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

Table 1
Engine Initiation Procedures for All Lycoming Engines

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

Warranty Requirement

⚠ **WARNING** AS ONE OF THE CONDITIONS FOR THE ENGINE WARRANTY, YOU MUST OPERATE THIS ENGINE IN ACCORDANCE WITH SPECIFICATIONS IN THIS MANUAL. YOU ALSO MUST COMPLETE THE RECOMMENDED SERVICE AND MAINTENANCE PROCEDURES IN ACCORDANCE WITH THE TEO-540-C1A ENGINE MAINTENANCE MANUAL FOR THIS ENGINE.

Step 1. Pre-Flight Inspection for Engine Initiation

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

NOTICE: Refer to the "Pilot Controls and Annunciators" chapter in this manual for dashboard controls.

Pre-Flight Inspection Checklist for Engine Initiation

Engine Model Number TEO-540-C1A **Engine Serial Number:**____________________

Engine Time:_________________________ **Date Inspection Done:**_________________________

Inspection done by:____________________________

Requirement	Comments	Done
Make sure that all switches are OFF or NORM.		
Make sure the NTO light or any other EECS light are not illuminated, which are an indication not to take-off.		
Make sure that the power control and alternate air controls are free to move in the full range of travel.		
Make sure the alternate air supply operates correctly.		
Make sure the aircraft battery has a full charge, especially in sub-freezing temperatures.		
NOTICE: The oil sump capacity and the minimum quantity for flight and on the ground are identified in Appendix A.		
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 (after adding oil), look for any oil leaks. Identify and correct the cause of any oil leak.	Complete an oil level check per Chapter 12-10 in the ***TEO-540-C1A Engine Maintenance Manual***.	
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 17. Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual.	
Make sure that the induction air filter is clean and securely in place.		
Examine the propeller and propeller hub for cracks, oil leaks, and security. If cracks are found, refer to the propeller manufacturer's instructions. Flight is not allowed with cracks in the propeller or propeller hub. If oil leaks are found, contact the propeller manufacturer.		

Pre-Flight Inspection Checklist for Engine Initiation (Cont.)

<table>
<tr><td>Examine the engine and cowl for indication of fuel and engine oil leaks.</td><td>Identify and correct the cause of any leaks.</td><td></td></tr>
<tr><td>Make sure that all baffles and baffle seals are installed in the correct position and are serviceable.</td><td></td><td></td></tr>
<tr><td>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.</td><td>Tighten any loose connections per torque values supplied by the aircraft manufacturer.</td><td></td></tr>
<tr><td>As necessary, add fuel specified (in Appendix A) to the aircraft in accordance with the airframe manufacturer’s instructions.</td><td></td><td></td></tr>
<tr><td colspan="3">⚠ WARNING DO NOT ROUTE FUEL HOSES OR OIL HOSES CLOSE TO HEAT SOURCES. HEAT CAN DAMAGE THE FUEL AND OIL HOSES AND CAUSE A LEAK WHICH COULD LEAD TO CATASTROPHIC ENGINE FAILURE.</td></tr>
<tr><td>Examine fuel and lubrication lines:
A. Make sure that each fuel hose and oil hose is intact, not bent or damaged, and does not have any kinks or dents.
B. Make sure that the fuel hoses and oil hoses are securely connected.
C. Make sure the clamps are tightly attached to support the fuel and oil hoses and to prevent movement from vibration. Do NOT use plastic tie straps in place of cushioned clamps.
D. Do not let fuel and oil hoses touch the engine or aircraft baffle hardware. There must be a minimum of clearance of 3/16 in. (4.76 mm) between fuel and oil hoses and any engine or aircraft surface.</td><td></td><td></td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>Correct all problems before engine start. Refer to the "Engine Conditions" chapter in this manual.</td><td></td><td></td></tr>
<tr><td>Complete a flight test per the section “Step 8. Break-In/Flight Test/50-Hour Operation” in this chapter.</td><td></td><td></td></tr>
</table>

Step 2. Pre-Start Inspection

Refer to the Pilot's Operating Handbook (POH) for the Pre-Start inspection.

Step 3. Engine Start

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

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. This engine has a fuel vapor return. The fuel rail operates at high pressure which makes the engine easier to start in hot weather. If the engine is to be operated in an environment at temperatures above 100°F (38°C), refer to the section "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 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 17. Engine Pre-Oil Procedure" in the "Engine Installation" chapter in this manual.

2. Complete specified steps and settings for engine start recommended by the aircraft POH or aircraft manufacturer.

3. Examine the engine for hydraulic lock which is a condition where fluid accumulates in the induction system or the cylinder assembly. Refer to Chapter 05-50 of the ***TEO-540-C1A Engine Maintenance Manual*** for details.

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

4. Set the Master Power selector switch to the ON position.

5. Propeller - check clear.

6. Turn the Fuel Selector ON.

7. If installed, turn the boost pump to the ON or AUTO position

8. Put the power control to the IDLE position.

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

9. Set the Ignition switch to ON.

NOTICE: A low battery, engine speed less than 250 RPM, or sub-zero temperatures can prevent engine start. Refer to the section "Apply Heat to a Cold Engine" in the "Engine Conditions" chapter.

10. Wait until the NTO PRI and NTO SEC annunciators go out.

⚠ **CAUTION** DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 SECONDS. LET THE STARTER COOL FOR 30 SECONDS AFTER EACH ENERGIZATION. DO NOT TRY MORE THAN FIVE ENGINE STARTS WITHIN A 2-MINUTE PERIOD.

IF THE STARTER FAILS TO ENERGIZE AFTER TWO ATTEMPTS, IDENTIFY AND CORRECT THE CAUSE.

11. Energize the starter (not to exceed 10 seconds) until the engine starts.
12. After the engine starts, move the power control slowly and smoothly to the IDLE RPM.

⚠ **CAUTION** DO NOT EXCEED THE IDLE RPM (SET BY THE AIRFRAME MANUFACTURER) UNTIL THE OIL PRESSURE IS STABLE ABOVE THE MINIMUM IDLING RANGE. IF THE OIL PRESSURE DOES NOT INCREASE TO THE MINIMUM PRESSURE WITHIN 10 SECONDS, TURN OFF THE ENGINE. CONTACT LYCOMING ENGINES.

DO NOT OPERATE THE ENGINE AT SPEEDS ABOVE 2500 RPM UNLESS THE OIL TEMPERATURE IS AT A MINIMUM OF 140°F (60°C) AND THE OIL PRESSURE IS BELOW THE MAXIMUM OF 115 PSI (793 KPA) FOR INITIAL START AND WARM-UP. ENGINE DAMAGE CAN OCCUR IF THE OIL TEMPERATURE IS NOT AT THE SPECIFIED MINIMUM OR THE OIL PRESSURE EXCEEDS THE SPECIFIED MAXIMUM.

13. Monitor engine instrumentation for indicated oil pressure. If there is no oil pressure indication within 10 seconds, stop the engine. Contact Lycoming Engines.

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 hose. In this case, stop, and have a technician look at the oil hoses.

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, contact Lycoming Engines.

14. After any of the following, complete the operational test (as per "Step 4. Complete the Operational Test" in this chapter.):
    - Engine installation
    - Engine put back into service after storage, maintenance, repair, fault isolation, overhaul, or rebuild

Step 4. Operational Test

Complete this test while the engine is operating.

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

⚠ **CAUTION** ON TURBOCHARGED ENGINES, OPERATE THE ENGINE AT LOW SPEED UNTIL THE OIL PRESSURE IS STABLE. OVERBOOST CAN OCCUR IF THE TURBOCHARGER CONTROL SYSTEM EXPERIENCES UNUSUAL OIL PRESSURES DUE TO AN OIL TEMPERATURE BELOW THE MINIMUM OPERATION TEMPERATURE OF 140ºF (60ºC).

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

1. Before the start of the ground operational test, examine the oil cooler, propeller, and governor for metal contamination. These parts must be clean and free of contamination before the ground operational test can begin. If the engine had failed before overhaul, the oil cooler, propeller, and governor must be replaced or cleaned and examined by an approved repair facility.
2. Put the aircraft in a position facing the wind.
3. Start the engine. If either you do not see oil pressure (greater than 0) indication within 10 seconds after engine start or oil pressure does **not** continue to increase above the published minimum pressure (per Appendix A, Table A-2) in the next 20 seconds, stop the engine. Identify and correct the problem before another engine start.
4. Monitor the oil pressure and oil temperature. If low or no oil pressure is noted, stop the engine and identify the cause.
5. Operate the engine at 750 RPM for 1 minute; slowly increase the speed to 1000 RPM in 3 minutes.
6. Let the engine operate at 1000 RPM for approximately 3 minutes.
7. Look for any illuminated caution or warning lights in the cockpit.
8. If oil pressure is sufficient, operate the engine at 1000 RPM until the oil temperature is stable or is at 140°F (60°C). After warm-up, the oil pressure is not to be less than the minimum specified pressure per Appendix A.
9. Increase the engine speed to 1500 RPM and operate the engine at that speed for 15 minutes.
10. Make sure the cylinder head temperature, oil temperature, and oil pressure are within the specified limits in Appendix A of this manual.

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

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

11. Propeller Governor Check
    - If the engine is equipped with a mechanical propeller governor, complete a cycle of the propeller blade pitch positions as applicable per the airframe manufacturer’s recommendations.
    - If the engine is equipped with an electronic propeller governor, the propeller will cycle through blade pitch positions during “Step 6. Complete the Pre-Flight Test”.
12. Operate the engine to full-static aircraft recommended power (in Appendix A) for up to 10 seconds.

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

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

14. Shut down the engine per “Step 4. Engine Stop” procedure in the “Engine Initiation” chapter of this manual.
15. After shutdown, examine the engine for oil and fuel leaks. Identify and correct the cause of any leaks.
16. Per Chapter 12-10 in the ***TEO-540-C1A Engine Maintenance Manual:***
    A. Complete an oil change and replace the oil filter.
    B. Remove, clean, and install the oil suction screen.
    C. Add the correct grade and quantity of oil to the engine per the latest revision of Service Instruction No. SI-1014 and Appendix A of this manual.

⚠ **WARNING** IF DURING AN OPERATIONAL TEST OR ENGINE IDLE ANNUNCIATORS ILLUMINATE OR ANY OPERATIONAL PROBLEMS OCCUR, IDENTIFY THE FAULT(S) USING THE FST, CORRECT THE CONDITION(S), AND CLEAR THE FAULT(S) OR CONTACT LYCOMING ENGINES.

NOTICE: After the first 25 hours of operation, change the oil. Examine the oil filter and oil suction screen. Refer to Chapter 12-10 in the ***TEO-540-C1A Engine Maintenance Manual.***

- Examine the air filters every other flight for dirt and be prepared to clean or replace them if necessary.
- If the aircraft is flown in dusty conditions, more frequent oil changes are recommended. Install dust covers over openings in the cowling for additional protection.

Step 5. 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 REPEAT THIS RUN-UP.

Complete the engine run-up as follows:

1. Start the engine.
2. Make sure the oil temperature is above the specified minimum.

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

3. Make sure the oil pressure and oil temperatures are within operating range (Appendix A).
4. Increase the power control to 1200 RPM and let it stabilize.
5. Pull the EEC/ECU circuit breaker.
6. As the engine continues to operate, increase the power control from 1200 to 1400 RPM over 2 minutes. Allow the engine to stabilize and continue to operate.

7. Decrease the power control back to 1200 RPM over 2 minutes. Allow the engine to stabilize and continue to operate.
8. Reset the EEC/ECU circuit breaker. Decrease the power control to IDLE and allow the engine to stabilize.
9. Continue to “Step 6. Complete the Pre-Flight Test” section in this chapter.

Step 6. Complete the Pre-Flight Test

The Pre-Flight Test (PFT) is done during engine run-up before flight to make sure that:

- The engine is operating correctly
- Both ECU channels are operating correctly to control the engine
- There are no latent failures on the secondary channel of the ECU before each flight.

The PFT takes approximately 90 seconds and allows the secondary channel to control each actuator. The EECS ensures the ignition, fuel, and turbocharger controls on each of the two channels are operating correctly. During this test, the EECS identifies any faults.

Before this test, the following enable criteria must be met to complete the PFT:

- The RPM must be set to 1800 (the range is 1000 to 2000 RPM)
- Average CHT between 140ºF and 428ºF (60ºC and 220ºC)

Before the PFT, the EECS activates Built-In-Tests (BITs). The BITs are sequences that are pre-programmed in the EECS software to look for unacceptable conditions in the engine. After all BITs are acceptable, the EECS enables the PFT.

NOTICE: Complete the pre-flight test when the aircraft is still on the ground.

To start the pre-flight test:

1. Point the aircraft into the wind.
2. Make sure the alternator reading is correct.
3. Set the power control between 1800 and 1900 RPM.

⚠ **CAUTION** DO NOT MOVE THE POWER CONTROL DURING THE NEXT STEP.

4. All of the following criteria must be met to enable the pre-flight test to start when the PFT button is pressed in the next step:
   - Engine speed is within 1800 RPM ± 25 RPM
   - Oil pressure in green
   - Oil temperature in green.

NOTICE: If the PFT button is pressed and held down, the pre-flight test will not begin because the EEC system will assume the PFT button is stuck.

5. Momentarily press and release the PFT button. (Do not press the PFT button again - the pre-flight test will stop.) The PFT annunciator will illuminate. The automatic pre-flight sequence will take approximately 70 seconds. The RPM, manifold pressure, and other engine parameters could change during the pre-flight test.

A. The pre-flight test operates in the following sequence (with a calibrated delay between each test in the pre-flight test):

(1) Exhaust bypass valve controls the manifold pressure

(2) Propeller pitch will change if the electronic governor is installed.

(3) Transition from the current fueling setpoint to a calibrated lean setting (i.e. Fuel Sweep)

(4) Engine transition from the calibrated lean setting to the calibrated rich setting

(5) Transition from the calibrated rich setting back to the usual fueling setpoint

(6) EECS fuel control transitions from one control channel to the alternate channel and back to the original control channel

(7) All cylinders operate correctly when only the primary sparks are enabled and the fueling is set to a specified air-fuel ratio

(8) All cylinders operate correctly when only the secondary spark is enabled and the fueling is set to a specified air-fuel ratio

B. The EECS enables and disables each pre-flight test in sequence through calibration. The EECS continues the pre-flight test to completion even if the expected system response does not occur.

NOTICE: Allow sufficient time for the pre-flight test to complete (as shown by the PFT annunciator) before making any power control changes. Otherwise the pre-flight test could be inadvertently cancelled with no other indication that the test is incomplete.

C. If the PFT annunciator:

(1) Never came on, the pre-flight test did not run.

(2) Blinks, the pre-flight test was aborted. Press the PFT button momentarily to acknowledge that the test was not completed. After an aborted start PFT, wait 5 seconds after re-establishing correct engine speed and ensure average CHT is within limits before pressing the PFT button again.

D. Once the pre-flight test starts, it will abort if any of the following occur:

- Power control changes more than ± 5% from where it was at the start of the sequence
- Engine speed goes below 1000 RPM
- Engine speed goes above 2000 RPM
- Engine load goes below 15%
- Average CHT goes below 140º (60ºC)
- Average CHT goes above 428ºF (220ºC)
- If the PFT button is pressed while the pre-flight test is running.

6. During pre-flight test monitor the following:
   - **Ignition Check** - engine speed will dip twice as each half of the redundant ignition system is disabled and then re-enabled, deactivating half of the spark plugs during each check
   - **Primary Fuel Injector Test** - engine speed will decrease slightly and then recover
   - **Primary Turbocharger Test -** manifold pressure will briefly increase slightly.
   - **Primary Propeller Control Cycle -** (if the engine is equipped with an electronic propeller governor) the propeller will briefly operate in a cycle to coarse pitch and decrease the RPM, then go back to fine pitch.
   - **Secondary Fuel Injector Test** - engine speed will decrease slightly and then recover
   - **Secondary Turbocharger Test** - manifold pressure will briefly increase slightly
   - **Secondary Propeller Control Cycle -** (if the engine is equipped with an electronic propeller governor) the propeller will briefly operate in a cycle to coarse pitch and decrease the RPM, then go back to fine pitch.

NOTICE: If a fault is found during the pre-flight test, the EECS identifies the fault and illuminates the NTO PRI and/or NTO SEC annunciators, identify the fault(s) using the FST, correct the condition(s), and clear the fault(s).

7. Once the pre-flight test is completed, the PFT annunciator goes out. If either the NTO PRI or NTO SEC annunciator remains illuminated, there is a condition that prevents flight and must be corrected. Such conditions can be a fault that exceeds set limits or the system does not have sufficient resources to operate the engine. If a fault is found, refer to the “Engine Conditions” chapter in this manual.
8. If the TLO annunciator is illuminated after the pre-flight test is completed, check with maintenance as soon as possible to correct the fault.

NOTICE: Do not take-off if any of the following occur:

- Low, high or surging RPM
- Low, high or fluctuating oil pressure
- Low or high fuel flow
- Excessive manifold pressure
- NTO annunciator illuminated.

NOTICE: If problems are found that go beyond field maintenance, contact Lycoming Engines.

9. The engine is ready for take-off when the oil temperature is greater than 140°F (60°C) and there are no faults or items that need corrective action.
10. Use smooth transitions of the power control (FULL CLOSED to FULL OPEN in no less than 2 seconds during power control shift) for the desired RPM.

NOTICE: Ground operation of the engine is not an acceptable substitute for an in-flight test. Ground operation does not supply sufficient cooling for the cylinders and can cause contamination in the Lubrication System (with water and acid) which can cause substantial damage over time to cylinders and other engine components such as camshafts and lifters.

Do not turn the propeller by hand as a short cut to lubricate the engine since this manual rotation removes residual oil.

11. Monitor the oil temperature, CHT, EGT, and the climb angles. Keep the airframe speed at a sufficient air speed to keep the CHT within the specified range in Appendix A.

NOTICE: During engine operation, the data logger (if installed) will automatically record all engine operating data. This data can be accessed after flight on the FST.

12. After 10 hours of engine operation for a new, rebuilt, or overhauled engine, complete the 10-hour inspection. Refer to the ***TEO-540-C1A Engine Maintenance Manual.***

Step 7. Engine Stop

1. Before engine shutdown, operate the engine between 1000 and 1200 RPM for at least 5 minutes to allow turbocharger cool down.
2. When operating temperatures are stable and the CHT drops below 320°F (160°C), increase engine speed to 1800 RPM for 15 to 20 seconds. Then decrease engine speed to between 1000 and 1200 RPM before engine shutdown.
3. After the temperatures are stable, set the Ignition switch to the OFF position to stop the engine.
4. When the propeller stops rotating, turn the Fuel Selector to the OFF position.

WARNING DO NOT 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.

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

5. During engine shutdowns, the EECS:
   - Stops fuel injection with the next scheduled fuel event
   - Schedules ignition events for a calibrated period of time or until the propeller has stopped rotating, whichever occurs first.
6. When the engine stops, turn off the airframe power.
7. Refer to the airframe manufacturer's POH for additional information.

Step 8. Break-In/Flight Test/50-Hour Operation

NOTICE: The "Break-In/Fight Test/50-Hour Operation" procedure and the "Required Inspections During Break-In (50-Hour Operation)" must be completed any time new piston rings are installed or any time one or more cylinders are replaced per procedures in Chapter 72-30 in the ***TEO-540-C1A Engine Maintenance Manual.***

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

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

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

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

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

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

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

1. Start the engine and complete a pre-flight run-up in accordance with the applicable manufacturer's POH.
2. Complete a full power take-off in accordance with the POH.
3. Monitor the engine RPM, fuel flow, oil pressure, oil temperature and cylinder head temperature during take-off.
4. As soon as possible, decrease to climb power in accordance with the POH.
5. Complete a shallow climb angle to a suitable cruise altitude.

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

6. 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.
7. If the engine and aircraft are operating to specifications in Appendix A, increase engine power to the maximum airframe recommended power and hold for 30 minutes.

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

DO NOT MAKE CLOSED THROTTLE DESCENTS WHICH CAN CAUSE RING FLUTTER AND DAMAGE TO THE CYLINDERS AND PISTON RINGS.

8. Decrease altitude at low cruise power and closely monitor the engine instruments. Do not make long descents at low manifold pressure. Do not decrease altitude too rapidly. The engine temperature could decrease too quickly.
9. After landing and shutdown, examine the engine for oil and fuel leaks. Identify and correct the cause of any leak.
10. Calculate oil consumption and compare the limits given in Appendix A.

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

11. 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.
12. Refer to the Chapter 12-10 of the ***TEO-540-C1A Series Engines Maintenance Manual*** to complete the “Oil Change Procedure” – drain the ashless dispersant oil and add new ashless dispersant oil up to the specified oil sump capacity in Appendix A. (Ashless dispersant oil is used during and after break-in for turbocharged engines.)
13. Complete the inspections identified in the “Step 9. Required Inspections During Break-In (50-Hour Operation)” section in this chapter.
14. Correct any problems before releasing the engine back into service.
15. Continue to operate the engine at cruise power settings of 65% to 75% for 50 hours or until oil consumption stabilizes.

Step 9. Required Inspections During Break-In (50-Hour Operation)

During the next 50 hours of flight, complete the following inspections per Chapter 05-20 in the ***TEO-540-C1A Series Engines Maintenance Manual***:

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

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ENGINE OPERATION

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

Table 1
Prerequisite Requirements for Engine Operation

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

Step 1. Pre-Start Check

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

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

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

NOTICE: Refer to the "Pilot Controls and Annunciators" chapter in this manual for dashboard controls.

Step 2. Engine Start

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

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. This engine has a fuel vapor return. The fuel rail operates at high pressure which makes the engine easier to start in hot weather. If the engine is to be operated in an environment at temperatures above 100°F (38°C), refer to the section "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 POH and Lycoming Engine's recommended start procedure, follow the aircraft manufacturer's procedure.

1. Complete specified steps and settings for engine start recommended by the aircraft POH or aircraft manufacturer.
2. Examine the engine for hydraulic lock which is a condition where fluid accumulates in the induction system or the cylinder assembly. Refer to Chapter 05-50 of the ***TEO-540-C1A Engine Maintenance Manual*** for details.

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

3. Set the Master Power selector switch to the ON position.
4. Propeller - check clear.
5. Turn the Fuel Selector ON.
6. If installed, turn the boost pump to the ON or AUTO position
7. Put the power control to the IDLE position.

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

8. Set the Ignition switch to ON.

NOTICE: A low battery, engine speed less than 250 RPM, or sub-zero temperatures can prevent engine start. Refer to the section "Apply Heat to a Cold Engine" in the "Engine Conditions" chapter.

9. Wait until the NTO PRI and NTO SEC annunciators go out.

⚠ **CAUTION** DO NOT ENERGIZE THE STARTER FOR PERIODS OVER 10 SECONDS. LET THE STARTER COOL FOR 30 SECONDS AFTER EACH ENERGIZATION. DO NOT TRY MORE THAN FIVE ENGINE STARTS WITHIN A 2-MINUTE PERIOD.

IF THE STARTER FAILS TO ENERGIZE AFTER TWO ATTEMPTS, IDENTIFY AND CORRECT THE CAUSE.

10. Energize the starter (not to exceed 10 seconds) until the engine starts.
11. Monitor engine instrumentation for indicated oil pressure. If there is no oil pressure indication within 10 seconds, stop the engine. Contact Lycoming Engines.

⚠ **CAUTION** DO NOT EXCEED THE IDLE RPM (SET BY THE AIRFRAME MANUFACTURER) UNTIL THE OIL PRESSURE IS STABLE ABOVE THE MINIMUM IDLING RANGE. IF THE OIL PRESSURE DOES NOT INCREASE TO THE MINIMUM PRESSURE WITHIN 10 SECONDS, TURN OFF THE ENGINE. CONTACT LYCOMING ENGINES.

DO NOT OPERATE THE ENGINE AT SPEEDS ABOVE 2500 RPM UNLESS THE OIL TEMPERATURE IS AT A MINIMUM OF 140°F (60°C) AND THE OIL PRESSURE IS BELOW THE MAXIMUM OF 115 PSI (793 KPA) FOR INITIAL START AND WARM-UP. ENGINE DAMAGE CAN OCCUR IF THE OIL TEMPERATURE IS NOT AT THE SPECIFIED MINIMUM OR THE OIL PRESSURE EXCEEDS THE SPECIFIED MAXIMUM.

12. If an electronic governor is installed, increase RPM to 1800. Do not exceed oil pressure of 115 psi (793 kPa).

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 hose. In this case, stop, and have a technician look at the oil hoses.

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, contact Lycoming Engines.

13. After the engine is put back into service after storage, maintenance, repair, fault isolation, rebuild, or overhaul, complete the operational test (as per "Step 4. Complete the Operational Test" in this chapter.).

Step 3. Engine Run-Up

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

Complete the engine run-up as follows:

1. Start the engine.
2. Make sure the oil temperature is above the specified minimum.

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

3. Make sure the oil pressure and oil temperatures are within operating range (Appendix A).
4. Increase the power control to 1200 RPM and let it stabilize.
5. Pull the EEC/ECU circuit breaker.
6. As the engine continues to operate, increase the power control from 1200 to 1400 RPM over 2 minutes. Allow the engine to stabilize and continue to operate.
7. Decrease the power control back to 1200 RPM over 2 minutes. Allow the engine to stabilize and continue to operate.
8. Reset the EEC/ECU circuit breaker. Decrease the power control to IDLE and allow the engine to stabilize.

NOTICE: Do not use the Field Service Tool (FST) during flight.

9. Continue to "Step 4. Complete the Pre-Flight Test" section in this chapter.

Step 4. Pre-Flight Test

The Pre-flight check (PFT) is done during engine run-up before flight to make sure that:

- The engine is operating correctly
- Both ECU channels are operating correctly to control the engine
- There are no latent failures on the secondary channel of the ECU before each flight.

The PFT takes approximately 90 seconds and allows the secondary channel to control each actuator. The EECS ensures the ignition, fuel, and turbocharger controls on each of the two channels are operating correctly. During this test, the EECS identifies any faults.

Before this test, the following enable criteria must be met to complete the PFT:

- The RPM must be set to 1800 (the range is 1000 to 2000 RPM)
- Average CHT between 140ºF and 428ºF (60ºC and 220ºC)

Before the PFT, the EECS activates Built-In-Tests (BITs). The BITs are sequences that are pre-programmed in the EECS software to look for unacceptable conditions in the engine. After all BITs are acceptable, the EECS enables the PFT.

NOTICE: Complete the pre-flight test when the aircraft is still on the ground.

To start the pre-flight test:

1. Point the aircraft into the wind.
2. Make sure the alternator reading is correct.
3. Set the power control to 1800 RPM.

⚠ **CAUTION** DO NOT MOVE THE POWER CONTROL DURING THE NEXT STEP.

4. All of the following criteria must be met to enable the pre-flight test to start when the PFT button is pressed in the next step:
   - Engine speed is 1800 RPM
   - Oil pressure in green
   - Oil temperature in green.

NOTICE: If the PFT button is pressed and held down, the pre-flight test will not begin because the EEC system will assume the PFT button is stuck.

5. Momentarily press and release the PFT button. (Do not press the PFT button again - the pre-flight test will stop.) The PFT annunciator will illuminate. The automatic pre-flight sequence will take approximately 90 seconds. The RPM, manifold pressure, and other engine parameters could change during the pre-flight test.
   A. The pre-flight test operates in the following sequence (with a calibrated delay between each test in the pre-flight test):
      (1) Exhaust bypass valve controls the manifold pressure
      (2) Propeller pitch will change if an electronic governor is installed.
      (3) Transition from the current fueling setpoint to a calibrated lean setting (i.e. Fuel Sweep)
      (4) Engine transition from the calibrated lean setting to the calibrated rich setting
      (5) Transition from the calibrated rich setting back to the usual fueling setpoint
      (6) EECS fuel control transitions from one control channel to the alternate channel and back to the original control channel

(7) All cylinders operate correctly when only the primary sparks are enabled and the fueling is set to a specified air-fuel ratio

(8) All cylinders operate correctly when only the secondary spark is enabled and the fueling is set to a specified air-fuel ratio

B. The EECS enables and disables each pre-flight test in sequence through calibration. The EECS continues the pre-flight test to completion even if the expected system response does not occur.

NOTICE: Allow sufficient time for the pre-flight test to complete (as shown by the PFT annunciator) before making any power control changes. Otherwise the pre-flight test could be inadvertently cancelled with no other indication that the test is incomplete.

C. If the PFT annunciator:

(1) Never came on, the pre-flight test did not run.

(2) Blinks, the pre-flight test was aborted. Press the PFT button momentarily to acknowledge that the test was not completed. After an aborted start PFT, wait 5 seconds after re-establishing correct engine speed and ensure average CHT is within limits before pressing the PFT button again.

D. Once the pre-flight test starts, it will abort if any of the following occur:

- Power control changes more than ± 5% from where it was at the start of the sequence
- Engine speed goes below 1000 RPM
- Engine speed goes above 2000 RPM
- Engine load goes below 15%
- Average CHT goes below 140º (60ºC)
- Average CHT goes above 428ºF (220ºC)
- If the PFT button is pressed while the pre-flight test is running.

6. During pre-flight test monitor the following:

- **Ignition Check** - engine speed will dip twice as each half of the redundant ignition system is disabled and then re-enabled, deactivating half of the spark plugs during each check
- **Primary Fuel Injector Test** - engine speed will decrease slightly and then recover
- **Primary Turbocharger Test** - manifold pressure will briefly increase slightly
- **Primary Propeller Control Cycle** - (if the engine is equipped with an electronic propeller governor) the propeller will briefly operate in a cycle to coarse pitch and decrease the RPM, then go back to fine pitch
- **Secondary Fuel Injector Test** - engine speed will decrease slightly and then recover
- **Secondary Turbocharger Test** - manifold pressure will briefly increase slightly
- **Secondary Propeller Control Cycle** - (if the engine is equipped with an electronic propeller governor) the propeller will briefly operate in a cycle to coarse pitch and decrease the RPM, then go back to fine pitch.

NOTICE: If a fault is found during the pre-flight test, the EECS identifies the fault and illuminates the NTO PRI and/or NTO SEC annunciators, identify the fault(s) using the FST, correct the condition(s), and clear the fault(s).

7. Once the pre-flight test is completed, the PFT annunciator goes out. If either the NTO PRI or NTO SEC annunciator remains illuminated, there is a condition that prevents flight and must be corrected. Such conditions can be a fault that exceeds set limits or the system does not have sufficient resources to operate the engine. If a fault is found, refer to the "Engine Conditions" chapter in this manual.
8. If the TLO annunciator is illuminated after the pre-flight test is completed, check with maintenance as soon as possible to correct the fault.

⚠ **CAUTION** IF THE AIRCRAFT DOES NOT CONTINUE FORWARD MOVEMENT, THE AIR PRESSURE CANNOT SUFFICIENTLY KEEP THE ENGINE COOL.

NOTICE: Do not take-off if any of the following occur:

- Low, high or surging RPM
- Low, high or fluctuating oil pressure
- Low or high fuel flow
- Excessive manifold pressure
- NTO annunciator illuminated.

NOTICE: If problems are found that go beyond field maintenance, contact Lycoming Engines' Technical Support.

9. The engine is ready for take-off when the oil temperature is greater than 140°F (60°C) and there are no faults or items that need corrective action.
10. Use smooth transitions of the power control (FULL CLOSED to FULL OPEN in no less than 2 seconds during power control shift) for the desired RPM.

NOTICE: Ground operation of the engine is not an acceptable substitute for an in-flight test. Ground operation does not supply sufficient cooling for the cylinders and can cause contamination in the Lubrication System (with water and acid) which can cause substantial damage over time to cylinders and other engine components such as camshafts and lifters.

Do not turn the propeller by hand as a short cut to lubricate the engine since this manual rotation removes residual oil.

11. Monitor the oil temperature, CHT, EGT, and the climb angles. Keep the airframe speed at a sufficient air speed to keep the CHT within the specified range in Appendix A.

NOTICE: During engine operation, the data logger (if installed) will automatically record all engine operating data. This data can be accessed after flight on the FST.

12. After 10 hours of engine operation for a new, rebuilt, or overhauled engine, complete the 10-hour inspection. Refer to the ***TEO-540-C1A Engine Maintenance Manual.***

Step 5. Engine Operation

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

Engine roughness	High manifold pressure
Low, high, or surging RPM or fluctuations	Low battery charge.
High, low, or fluctuating oil pressure	NTO annunciator is illuminated
High or low fuel flow	

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. 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 ***TEO-540-C1A Engine Maintenance Manual.***

3. Operation in Flight

NOTICE: Although the EECS continuously monitors and adjusts ignition timing, fuel injection timing, and fuel mixture, and propeller governor setting based on operating conditions, continue to monitor engine functions during engine operation.

A. See the aircraft manufacturer's instructions for recommended power settings.

B. Until oil consumption has stabilized after the first 50 hours of flight, cruising is to be done at not less than 65% power to ensure correct seating of the rings.

4. Recommendations to Prevent Spark Plug Fouling

Lead deposits can collect on the spark plug electrodes when the engine operates at lower-than-specified temperatures with fuel-rich mixtures (fuel-rich mixtures do not enable vaporization of lead in aviation gas). These deposits can cause misfiring.

When operating the engine, the following steps can be taken to prevent spark plug fouling and misfiring:

- Operate the engine between 1000 and 1200 RPM after engine start and during warm-up. (At these speeds the spark plug core temperatures are sufficiently hot to activate the lead scavenging agents to prevent lead deposits on the spark plugs and exhaust valve stems.)
- Operate the engine at the specified operating temperature to prevent low temperature operation.
- Avoid rapid power reduction in flight to prevent sudden engine cooling.
- Do not stop the engine immediately after landing to prevent rapid engine cooling.
- Before engine shutdown, operate the engine between 1000 and 1200 RPM until operating temperatures are stable and EGTs drop below 1100°F (593°C). Then increase engine speed to 1800 RPM for 15 to 20 seconds. Then decrease engine speed to between 1000 and 1200 RPM before engine shutdown.

Step 6. Engine Stop

1. Before engine shutdown, operate the engine between 1000 and 1200 RPM for at least 5 minutes to allow turbocharger cool down.
2. When operating temperatures are stable and the CHT drops below 320°F (160°C), increase engine speed to 1800 RPM for 15 to 20 seconds. Then decrease engine speed to between 1000 and 1200 RPM before engine shutdown.
3. After the temperatures are stable, set the Ignition switch to the OFF position to stop the engine.
4. When the propeller stops rotating, turn the Fuel Selector to the OFF position.

WARNING DO NOT 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.

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

5. During engine shutdowns, the EECS:
   - Stops fuel injection with the next scheduled fuel event
   - Schedules ignition events for a calibrated period of time or until the propeller has stopped rotating, whichever occurs first.
6. When the engine stops, turn off the airframe power.
7. Refer to the airframe manufacturer's POH for additional information.

ENGINE CONDITIONS

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

Fault Isolation - Use of Field Service Tools

NOTICE: Do not use the Field Service Tool (FST) during flight.

Refer to the Appendix C of the ***TEO-540-C1A Engine Maintenance Manual*** or the latest revision of ***SSP-118*** for instructions to use the FST.

No diagnostic devices other than the Field Service Tool are to be used at any time on this engine.

Faults

The EECS collects fault code data. Operator and maintenance personnel use this data for diagnostic and continuous airworthiness. Refer to Appendix D in the ***TEO-540-C1A Engine Maintenance Manual*** for a list of fault codes and corrective action.

Due to the built-in redundancy, the EECS can continue engine operation in a safe condition even if there is a single fault failure or malfunction or combination of electrical failures or electronic components failure.

Required Action for Engine Conditions

Table 1 identifies corrective action for engine conditions prior to and during flight. Detailed fault isolation is included in the ***TEO-540-C1A Engine Maintenance Manual.***

Table 1
Action for Engine Conditions

Engine Condition	Explanation/Corrective Action
Displays	
Engine-indicating data not available	Do not take-off until Maintenance identifies and corrects the cause.
Incorrect engine-indicating data	Do not take-off until Maintenance identifies and corrects the cause.
Annunciators	
NTO PRI or NTO SEC annunciators stay illuminated after Pre-Flight Test ends	There is a fault out of tolerance of set limits or the EECS does not have sufficient resources to operate the engine. Do not take-off. Identify the fault(s) using the FST, correct the condition(s), and clear the fault(s).
NTO PRI and/or NTO SEC annunciators stay illuminated for more than 10 seconds during flight	Make minimum power control changes and land as soon as safely possible. Identify the fault(s) using the FST, correct the condition(s), and clear the fault(s). **NOTICE:** An illuminated NTO annunciator does not indicate an emergency. The illuminated annunciator(s) indicate(s) that a component has failed and has put the EECS in a mode with decreased redundancy.

Table 1 (Cont.)
Action for Engine Conditions

Engine Condition	Explanation/Corrective Action
Annunciators (Cont.)	
The NTO or TLO annunciator is illuminated but can still make rated power (Indicates a component has failed and has put the engine in a back-up mode - any additional failure can cause loss of power)	Complete a safe landing and speak to Maintenance to isolate faults.
TLO annunciator illuminates during flight	The current flight can continue for up to 20 engine hours as long as no other annunciators are illuminated and there are no other engine problems. After landing, speak to Maintenance to isolate faults.
Annunciator fails	Have Maintenance replace the annunciator as soon as is practical.
All annunciators fail	Have Maintenance examine all annunciators and wiring as soon as possible.
“PFT in Progress” indication is cleared while the PFT is in progress	The PFT annunciator will flash as an indication that the pre-flight test was not completed. The pilot must push and then let go of the PFT button to clear this condition and then re-start the pre-flight test.
Engine Operation	
Engine roughness	Complete a safe landing and speak to Maintenance.
Engine hesitates, misses	Complete a safe landing and speak to Maintenance.
Low, high or surging RPM	Complete a safe landing and speak to Maintenance.
Low or fluctuating oil pressure	Complete a safe landing and speak to Maintenance, refer to the section “Low Oil Pressure During Flight” in this chapter.
Oil pressure falls below the minimum level	Complete a safe landing. Refer to the section “Low Oil Pressure During Flight” in this chapter.
High oil temperature	Complete a safe landing and speak to Maintenance.
High oil pressure	Before increasing the power control, allow the oil temperature to increase.
Low or high fuel flow	Complete a safe landing and speak to Maintenance
Excessive manifold pressure	Complete a safe landing and speak to Maintenance.

Table 1 (Cont.)
Action for Engine Conditions

Engine Condition	Explanation/Corrective Action
Engine Operation (Cont.)	
Engine indication not available	Complete a safe landing and speak to Maintenance.
Engine in an environment at temperatures less than 10°F (-12°C) for more than 2 hours	Refer to the section “Apply Heat to a Cold Engine” in this chapter.
Operation in climates above 100°F (38°C)	Decrease climb angles to keep the engine cool. Refer to the section “Engine Operation in Hot Weather” in this chapter.
Fuel consumption fluctuation	The EECS controls fuel flow to the engine based on the actual airflow through the engine. The engine will consume more air on a cold day than on a hot day for the same RPM and manifold pressure. The EECS controls fuel flow to maintain the desired fuel-to-air ratio.
Fuel flow rate and lean of peak operation	The optimum fuel flow for a given combination of air intake and engine speed conditions has been pre-calculated. This optimal fuel flow will enable both economy and safe reliable operation. There could be some select points where “Lean of Peak” operation is advantageous.
Ascent to target altitude, leveled off - fuel flow increased with power control input	On hot days, during steep climbs, or in other situations in which the engine could operate at high temperatures, the EECS automatically prevents overheating. Higher fuel flow can be observed as the EECS uses more fuel to prevent detonation or exceeding the CHT or TIT limits.
Alternator or electrical system fails in flight	The engine will continue to operate even if the alternator or electrical system fails. The engine has a dedicated electrical generator that is separate from airframe power to ensure the engine continues to operate if external power is not available. This power source will supply power to the dedicated warning annunciators. In flight, the engine can restart even without airframe power as long as the engine is wind milling at least 1000 RPM.
Dead airframe battery on the ground	Use a battery charger or jumper cart to start the engine.
Cannot operate low or high manifold pressures at a specific RPM	The EECS automatically uses a manifold pressure and RPM combination depending on the throttle position. This setting was calculated by the airframe manufacturer and Lycoming for the most consistent operating points for take-off, climb, and cruise.

Table 1 (Cont.)
Action for Engine Conditions

Engine Condition	Explanation/Corrective Action
Engine Operation (Cont.)	
Manifold pressure decreases during climb without moving the power control	The EECS automatically prevents the turbocharger from overspeed at high altitude by a set limit on the pressure ratio. Above critical altitude, the EECS continues to supply the maximum boost possible without exceeding system limits and without moving the power control.
Loss of boost	Some fault conditions cause a turbocharged engine to operate as a naturally-aspirated engine. The NTO annunciators will illuminate if fault conditions occur. If the fault is transient, boost could continue at a later time without power control movement. For this reason, do not decrease the speed more than 50% if the turbocharger goes back to usual operation.
Engine fuel pump stops	Activate the boost pump to keep the fuel flowing to the engine for continued operation.
Engine stall	• Make sure the Fuel Selector is set to the correct fuel tank. • Make sure that the auxiliary fuel pump is **ON**. • Cycle the ignition switch to **OFF** then **ON**. • Set the power control to maintain a manifold pressure of 8 in-Hg (3.9 psi) or more. • Make sure that the Ignition switch is set to **ON**. • 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 POH for complete procedures on in-flight loss of power.**
Engine oscillation (either RPM or manifold pressure)	Slowly decrease the engine speed or power control until the oscillations stop. Then slowly return back to the desired operating point.
Rapid decrease in cylinder head temperature	To prevent shock cooling, do not operate the engine that causes the CHT to decrease at a rate greater than 50°F (10°C) per minute.
Overheating	Decrease power request and/or pitch down to increase airspeed (and cooling airflow) if possible. If overheating continues, complete a safe landing as soon as possible.
Overspeed	Refer to the section “Overspeed” in this chapter.
Propeller strike, sudden stoppage and lightning strikes	Contact Lycoming Engines Technical Support.
Sluggish propeller operation	Complete a safe landing and speak to Maintenance.

Table 1 (Cont.)
Action for Engine Conditions

Engine does not hold RPM during cruise, climb, or descent	Complete a safe landing and speak to Maintenance.
Fire	Manually turn off engine fuel supply and complete a safe landing as quickly as possible. The engine fuel components have fire shielding and are fire resistant.
Volcanic ash	Refer to the section "Volcanic Ash" in this chapter.
Engine soaked in water	Contact Lycoming Engines Technical Support.

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 overhaul or engine malfunctions. In the "cold soaked" condition, fuel can vaporize too slowly which could make engine start difficult.

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

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

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

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

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

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

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

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

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

Cold Weather Engine Start

NOTICE: The following is Lycoming Engine’s recommended procedure for cold weather engine starts. Refer to the aircraft manufacturer’s POH for in-flight recommendations during cold weather.

1. Move throttle 1/4 inch from its end stop before starting the engine
2. After a cold start, ensure engine speed is at most 1000 RPM. Do not rapidly increase acceleration or exceed 1200 RPM. If oil pressure indication is not shown within 10 seconds, stop the engine. Identify and correct the cause. Allow up to 1 minute for oil pressure to become stable, since oil lines to the gage can stay cold. If no leaks or damage are found, complete the pre-heat application again before engine start.
3. Let the engine warm up until oil pressure and temperature are stable within operating limits identified in Appendix A.
4. Complete a ground check in accordance with the aircraft manufacturer’s POH.
5. 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.
6. Before take-off, monitor the oil pressure, oil temperature, and cylinder head temperature to make sure all are within their operating ranges (as specified in Appendix A).

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

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

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

Engine Operation in Hot Weather

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

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

Volcanic Ash

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

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

  3. Additional measures could be necessary under specific operating conditions. Refer to the ***TEO-540-C1A Engine Maintenance Manual*** for corrective action.

Overspeed

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

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

- The EECS will attempt to limit overspeed events by cutting ignition and fuel to cylinders until engine speed is brought within rated operating limits. As this automatic corrective action occurs, the engine can operate roughly with unusual engine/airframe vibration. This vibration is temporary and is not an indication of engine malfunction.
- If the engine overspeed event continues uncorrected by the EECS for more than 1 minute, complete a safe landing of the aircraft as soon as possible.
- Although the EECS limits instances of engine overspeed, overspeed still can occur in a "dive" or steep descent.

- Refer to the latest revision of Service Bulletin No. SB-369 for corrective action for engine overspeed.
- Record all incidents of engine overspeed in the engine logbook, along with the inspection and any specified corrective action taken per Chapter 05-50 in the ***TEO-540-C1A Engine Maintenance Manual.***

<u>Low Oil Pressure During Flight</u>

Circumstances which cause loss of oil pressure are many and varied. Therefore, it is difficult to make a prediction of the extent of damage to the engine or its future reliability. In case of oil pressure loss or engine operation with oil below the recommended minimum operating level (identified in Table A-1 in Appendix A), the most conservative action is to remove the engine and send the engine to Lycoming Engines for evaluation and corrective action.

<u>NOTICE:</u> 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 following protocol progressive steps identified in Chapters 05-50 and 12-30 of the ***TEO-540-C1A Engine Maintenance Manual.***

<u>NOTICE:</u> 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.

ENGINE PRESERVATION AND STORAGE

Engine Corrosion and Prevention

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

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

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

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

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

- Environmental conditions, especially humidity
- 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 the "Oil Change Procedure" at the recommended intervals per Chapter 12-10 in the ***TEO-540-C1A Engine Maintenance Manual***
- Examine the cylinders for corrosion in engines that are stored in humid conditions and/or in flight less than once a week.

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

Engine Preservation Guidelines - 31 to 60 Days

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

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

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

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

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

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

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

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

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

1. Operate the engine until it is at the specified operating temperature in Appendix A. If temperatures are below freezing, the oil temperature must be at least 165ºF (74ºC) before the engine is stopped in the next step.
2. Stop the engine.
3. Refer to Chapter 12-10 in the ***TEO-540-C1A Engine Maintenance Manual*** to complete the following steps:
   A. Drain the lubricating oil from the sump or system.
   B. Remove, clean, and install the oil suction screen plug.
4. Fill the sprayer with the preservative oil mixture.
5. Fill the oil sump with the specified preservative oil mixture up to the quantity of oil sump capacity in Table A-1 in Appendix A.
6. Operate the engine until it is at the specified normal operating temperature. If temperatures are below freezing, the oil temperature must be at least 165ºF (74ºC) before the engine is stopped in the next step.
7. Stop the engine.
8. While the engine is still hot, immediately remove sufficient cowling to access the spark plugs.

9. Remove either the top or bottom spark plug from each cylinder (per the "Spark Plug Removal" procedure in Chapter 74-20 in the ***TEO-540-C1A Engine Maintenance Manual***).
10. Put the sprayer nozzle in the open spark plug hole on each cylinder.
11. Use the sprayer to apply a coat of approximately 2 oz. (60 ml) of the preservative oil mixture through the spark plug hole on the interior wall of each cylinder.

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

12. After spray application is complete, remove the sprayer from the spark plug hole.
13. Install the cylinder dehydrator plugs MS-27215-2 (or equivalent) if the aircraft is kept in a region that has high humidity or near a sea coast.

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

14. While the engine is still warm:
    A. Remove the intake pipes per instructions in Chapter 72-80 in the ***TEO-540-C1A Engine Maintenance Manual***; remove the exhaust system per the airframe manufacturer's manual.
    B. Install bags of clay desiccant in the exhaust and intake ports.
    C. Install the intake pipes per instructions in Chapter 72-80 in the ***TEO-540-C1A Engine Maintenance Manual***; install the exhaust system per the airframe manufacturer's manual.
    D. Attach red cloth streamers to the desiccant as a reminder for the material to be removed when the engine is ready for flight.
    E. Use moisture-proof material and pressure sensitive tape to seal these openings:
        - Exhaust ports
        - Intake ports
        - Breather
        - Vacant accessory pads
        - All openings that connect the inside of the engine to the outside atmosphere
    F. Put a note on the propeller that reads: "Engine preserved - DO NOT TURN THE PROPELLER."
    G. At 15-day intervals, examine the clay desiccant in the desiccant bags and the cylinder dehydrator plugs (if installed). When the color of the desiccant has changed from blue to pink, remove the used clay desiccant bags and plugs. Install new clay desiccant bags and cylinder dehydrator plugs. Record the date (for future reference) when the desiccant bags and/or plugs were installed.
    H. To return the engine to service after preservation, refer to the "Prepare a Stored Engine for Installation" section in the "Requirements for Engine Installation" Chapter of this manual.

Extended Engine Preservation for 61 Days or More

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

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APPENDIX A

Table A-1 contains engine specifications, Table A-2 identifies operating limits, and Table A-3 shows accessory drives for the TEO-540-C1A Series Engine. This appendix includes the following charts:

- Cooling Air Requirements (Figure A-1)
- Propeller Governor Oil Transfer Leakage Rate (Figure A-2)
- 2575 RPM Sea Level and Altitude Performance (Figure A-3)
- 2400 RPM Sea Level and Altitude Performance (Figure A-4)
- 2200 RPM Sea Level and Altitude Performance (Figure A-5)
- Fuel Flow versus Percent of Rated Power (Figures A-6 and A-7)

Table A-1
TEO-540-C1A Engine Specifications

Number of Cylinders		6	
Cylinder Arrangement - Firing Order		1-4-5-2-3-6	
Spark Plugs		12	
Spark Plug Advance		15º BTC	
Maximum Rated Continuous (at 10,000 ft. / 3,048 Meters)		375 HP @ 2575 RPM ± 15 RPM	
Performance Cruise (75% Rated)		281 HP @ 2400 RPM ± 15 RPM	
Economy Cruise (60% Rated)		225 HP @ 2200 RPM ± 15 RPM	
Fuel Injection		Electronic	
Fuel Injectors		6 (one for each cylinder)	
Engine Back-up Fuel Filter		10 micron	
Fuel Pump, AN Type		Standard	
Fuel Pump Ratio to Crankshaft and Rotation		1:1 - Clockwise	
Propeller Drive Ratio to Crankshaft and Rotation		1:1 – Clockwise	
Counterweight Order		One 5th order and one 6th order pendulum-type counterweight	
Cylinder Bore		5.125 in.	13.0 cm
Cylinder Stroke		4.375 in.	11.1 cm
Piston Displacement		541.5 $in.^3$	8,873 cm^3
Compression Ratio		7.3:1	
Dry Weight (lb) without starter and alternator		553.5 lbs.	251.1 kg
Dimensions:	Height	22.42 in.	56.95 cm
	Width	34.31 in.	87.15 cm
	Length	51.32 in.	130.35 cm

Table A-1 (Cont.)
TEO-540-C1A Engine Specifications

Oil Sump Capacity	12 quarts	11 liters
Minimum Safe Oil Level	2.75 quarts	2.6 liters
Ashless Dispersant Oil Grade Specification	SAEJ1899 or MIL-L-22851	
Recommended seasonal aviation oil grades	Refer to the latest revision of Service Instruction No. 1014	
Fuel* (minimum octane)	100 or 100LL (Aviation Grade)	
Starter**	24 Volt – Geared (Optional)	
Ignition	Electronic - Variable	
Tachometer reported by ECU		
Starter Drive Ratio to Crankshaft at Bendix and Rotation	16.556:1 – Counterclockwise	
Turbocharger	TH08A60	
Alternator**	24 Volt, 140 Amp (Optional)	
Alternator** Direction of Crankshaft Rotation	Clockwise	

***** For possible alternative fuels, contact Technical Support at the phone numbers in the front of this manual.

****** For optional starters and alternators, refer to the ***TEO-540-C1A Illustrated Parts Catalog*** or contact Lycoming Engines.

NOTICE: All locations and rotations are as viewed from the accessory housing end (back) of the engine unless specified differently.

Table A-2
Table of Operating Limits for Engine

Oil Pressure - Minimum Idling	25 psi	172 kPa
Oil Pressure – Operating	55 to 95 psi	379 to 655 kPa
Oil Pressure - Starting, Warm-up, Taxi, and Take-off (Maximum)	115 psi	792 kPa
Minimum Oil Temperature (before take-off) read from engine	140°F	60°C
Maximum Oil Temperature	245°F	118°C
Maximum Oil Temperature above 20,000 feet	225°F	107°C
Optimum Oil Temperature, in level flight (for maximum engine life)	165°F to 180°F	74°C to 82°C
Maximum Oil Consumption	0.006 x BHP x 4 ÷ 7.4 = Qt./Hr.	
Oil Flow Rate Through Oil Cooler	10.0 gallons/minute	

Maximum Heat Rejection to Oil	2160 Btu/minute

Table A-2 (Cont.)
Table of Operating Limits for Engine

Fuel Pressure to Engine Drive Pump (relative to ambient air pressure)	Maximum 65 psig Minimum -2 psig	448 kPa -14 kPa
Fuel Rail Pressure (relative to manifold pressure)	Minimum 43 psid	296 kPa
Minimum Fuel Consumption	Fuel consumption is dependent on engine configuration, refer to Figure A-6 and A-7 in this appendix.	
Maximum Throttle Body Air Inlet Temperature (measured at the deck temperature sensor)	400°F	121°C
Maximum Turbine Inlet Temperature (TIT) (measured at the exhaust bypass valve transition)	1650ºF	889°C
Maximum Manifold Pressure	57.9 in. hg.	196 kPa
Maximum Cylinder Head Temperature	500°F	260°C
Cylinder Head Temperature (for maximum service life) - Above 85% power	475°F	246.1°C
Cylinder Head Temperature (for maximum service life) - 85% power and below, in level flight	435°F	224°C
Maximum Alternator Temperature - Stator Slot and Stator End Turns	356°F	180°C
Maximum Alternator Temperature - Drive End Bearing and Slip Ring End Bearing	240°F	116°C
Maximum Alternator Rectifier Temperature - Bridge	305°F	152°C
Critical Altitude (at standard day conditions)	10,000 ft.	3,048 Meters
Operational Limits for the EECS		
ECU Operating Low Temperature	-49°F	-45°C
ECU Operating High Temperature	158°F	+70°C
Short-Term ECU Operating Low Temperature	-49°F	-45°C
Short-Term ECU Operating High Temperature	230°F	+110°C
Ground Survivable ECU Low Temperature	-67°F	-55°C
Ground Survivable ECU High Temperature	257°F	+125°C

Table A-3
Accessory Drives

Accessory	Type of Drive	Direction of Rotation	Drive Ratio	Maximum Torque				Maximum Overhang Moment	
				Continuous		Static			
				in.-lb	Nm	in.-lb	Nm	in.-lb	Nm
Starter	SAE	Counter-clockwise	16.556:1	--	--	450	51	150	17
Alternator	SAE	Clockwise	3.10:1	60	7	120	14	175	20
Alternator (Optional)	SAE	Clockwise	3.65:1	60	7	120	14	175	20
Accessory Pad 1	AND20000*	Counter-clockwise	1.3:1	70	8	800	90	25	3
Accessory Pad 2	AND20000**	Clockwise	1.385:1	100	11	800	90	40	5
Prop. Gov. Pad	AND20010***	Clockwise (Viewing Pad)	0.947:1	125	14	2200	249	25	3
Fuel Pump	AND20003	Clockwise	1.0:1	25	3	450	51	25	3
Compressor	SAE	Clockwise	1.462:1****	Limited by belt					

* Except for rotation and torque limitations
** Except no provision for oil to accessory
*** Except for torque limitation
**** With compressor pulley diameter of 6.00 inches

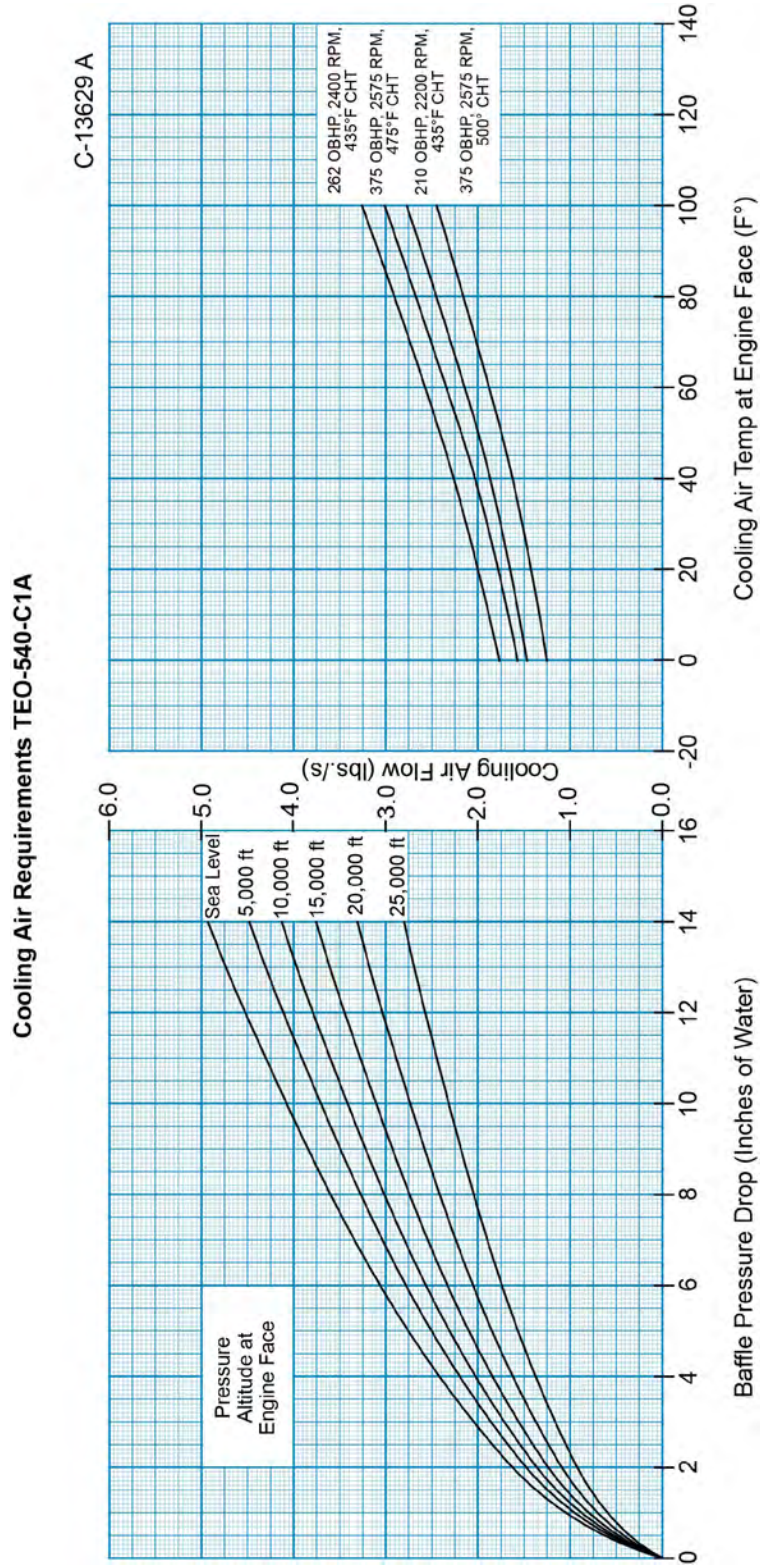

Figure A-1
Cooling Air Requirements

Curve No. 13418-A

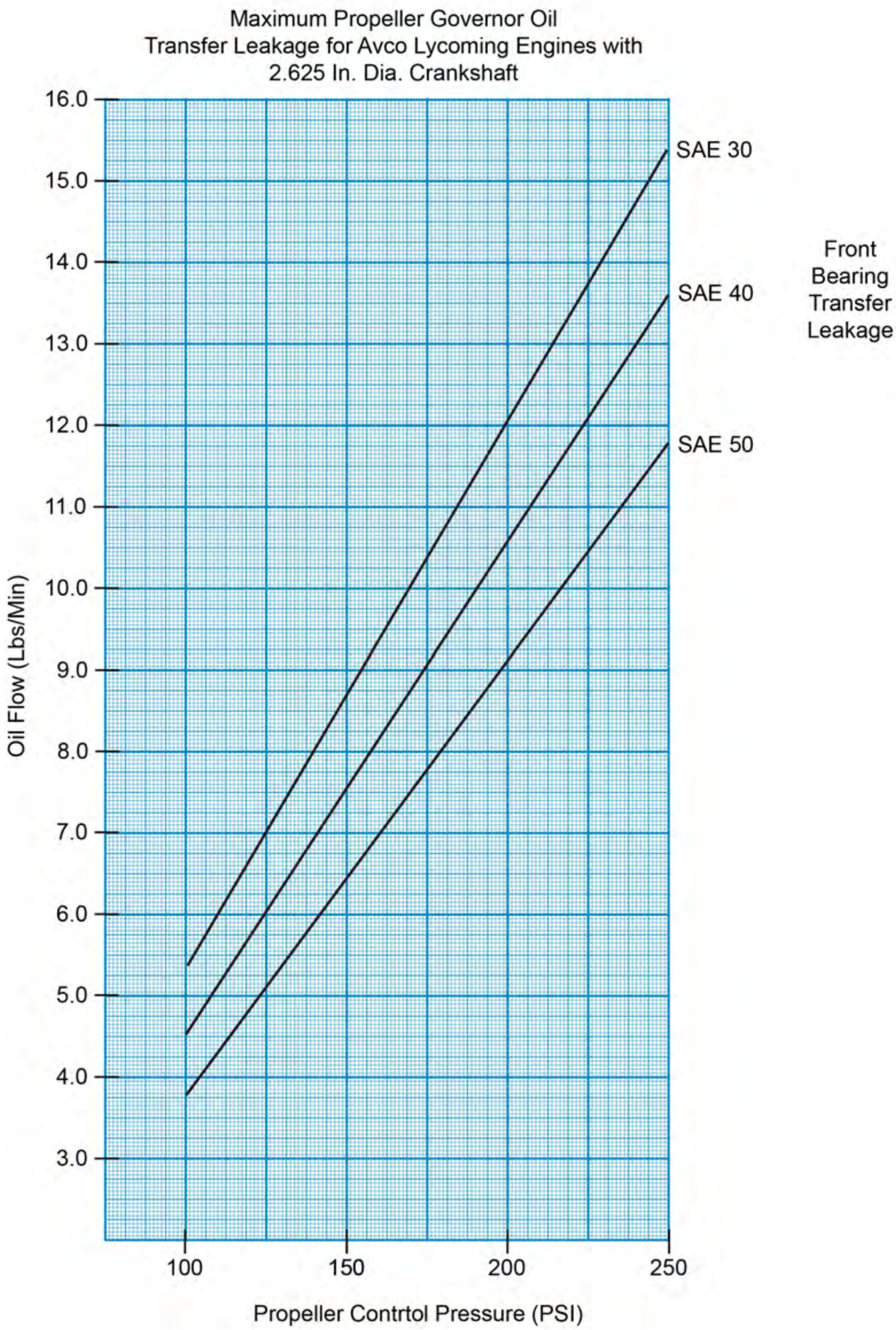

Figure A-2
Propeller Governor Oil Transfer Leakage Rate

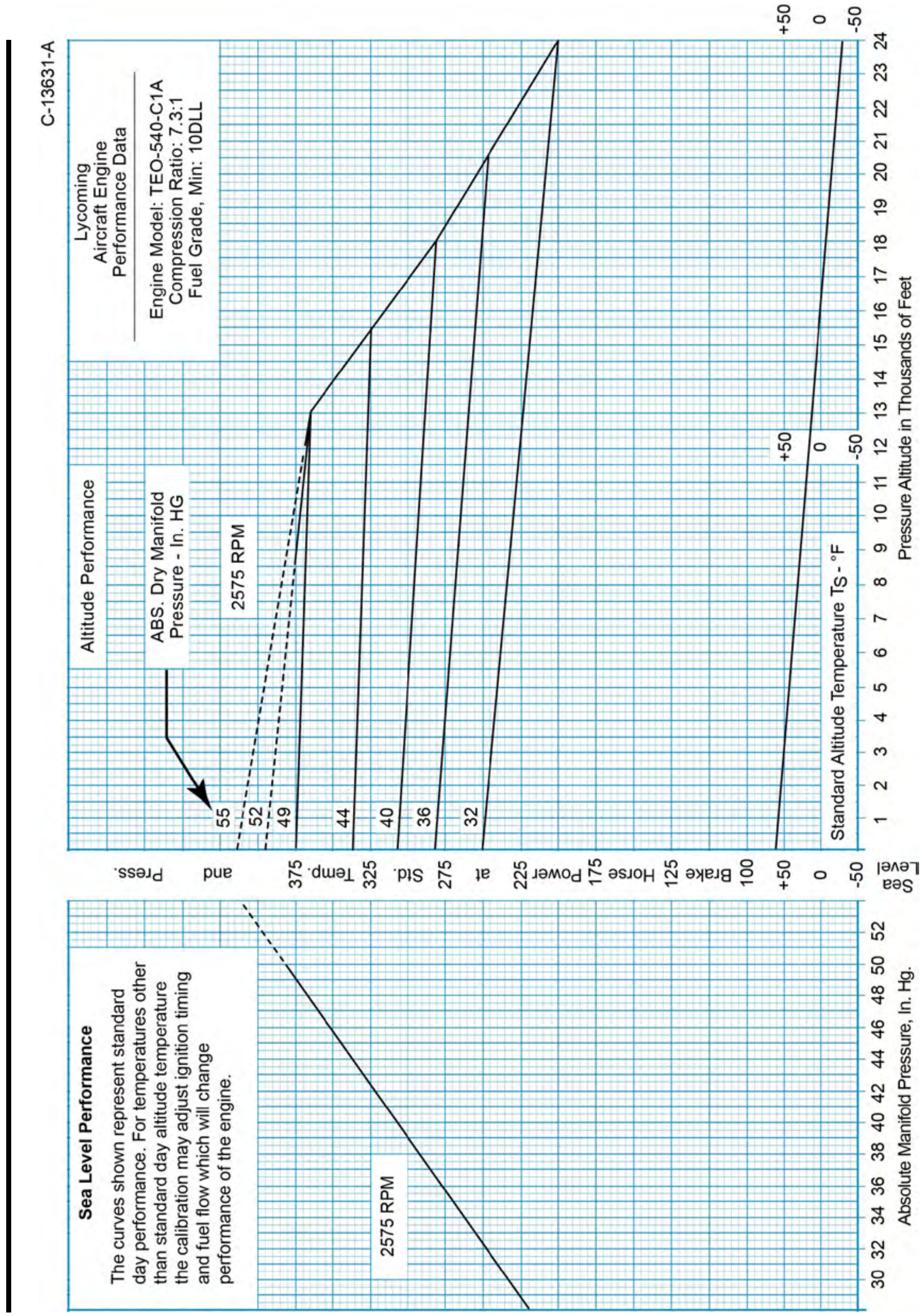

Figure A-3
2575 RPM Sea Level and Altitude Performance

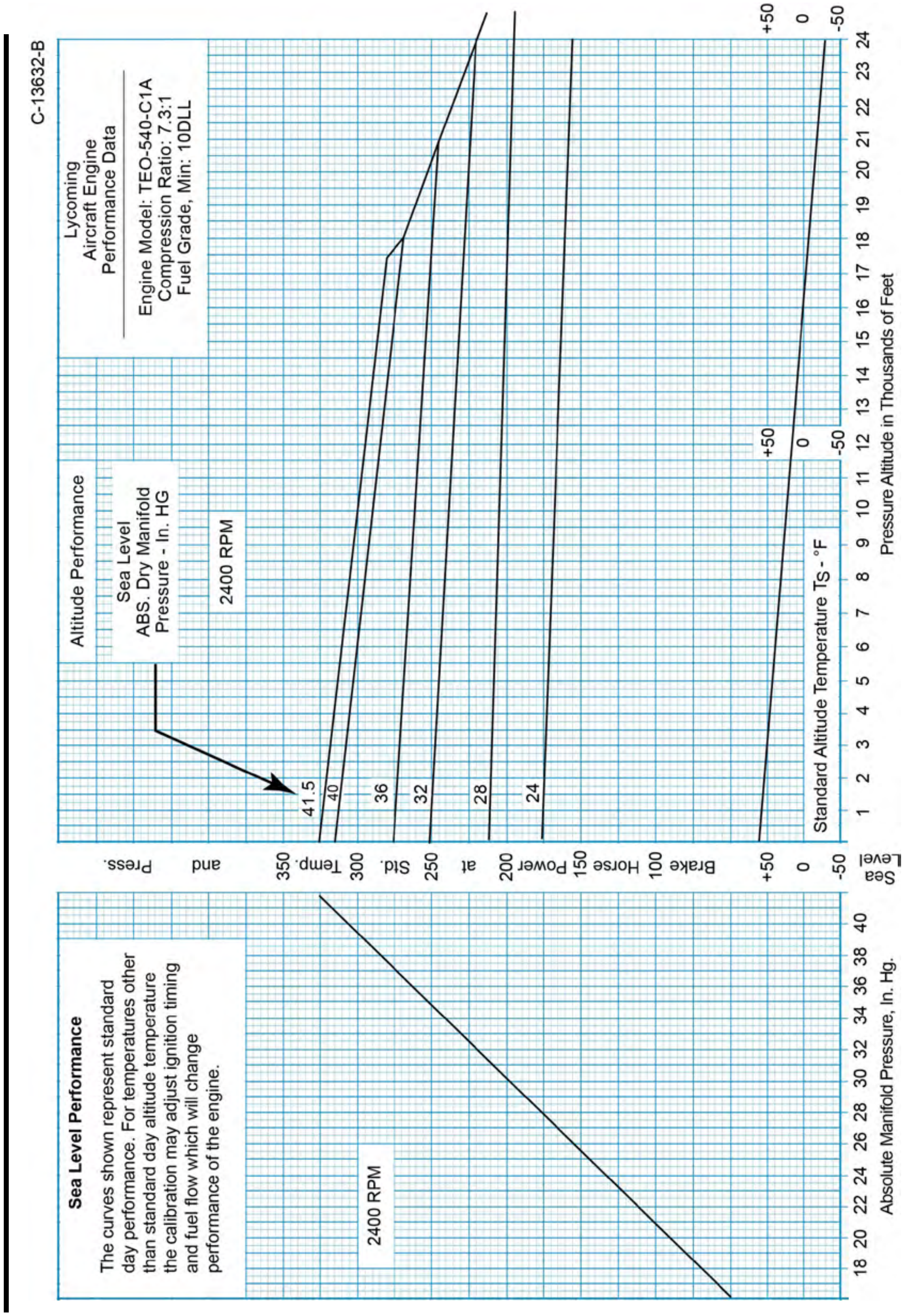

Figure A-4
2400 RPM Sea Level and Altitude Performance

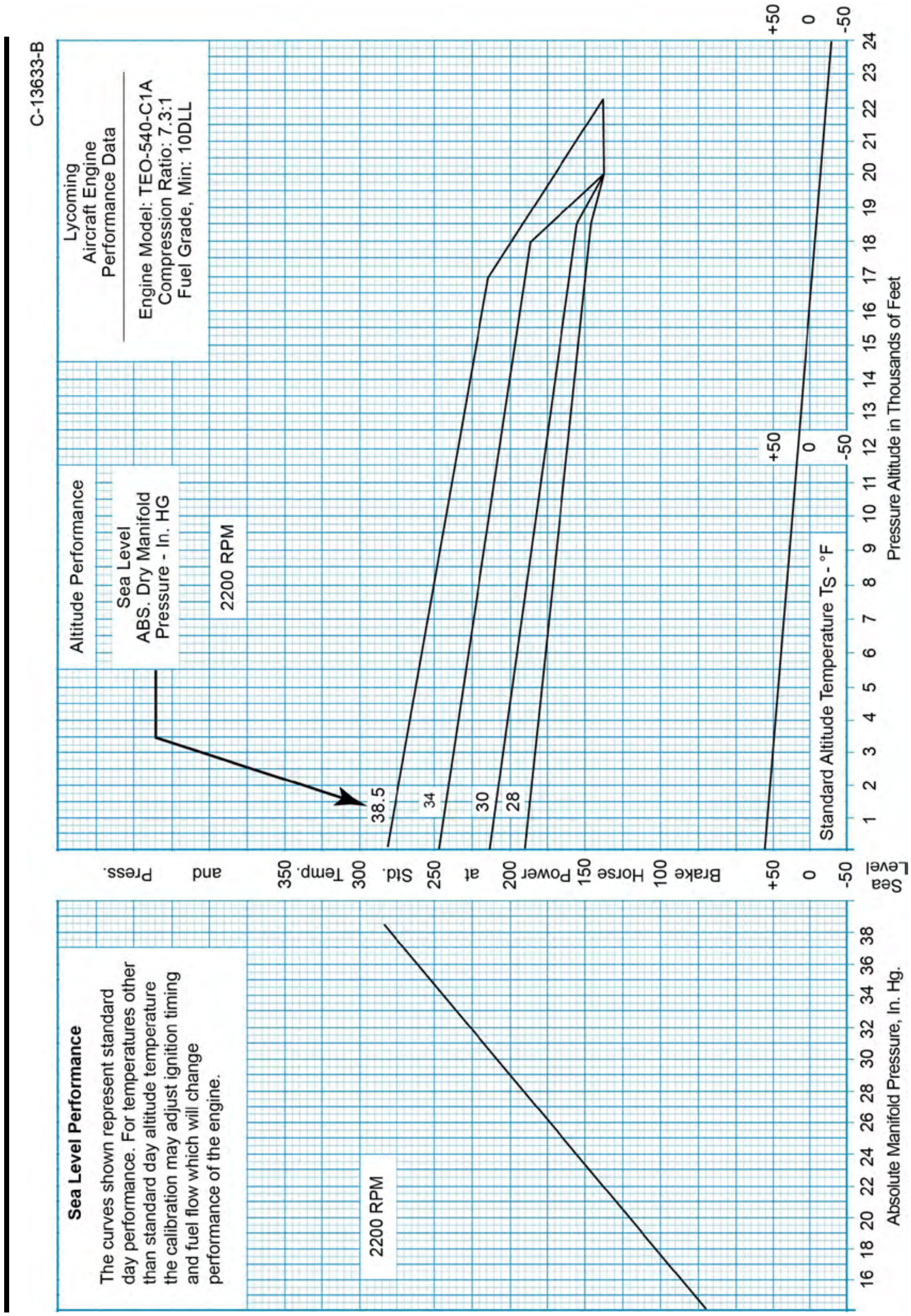

Figure A-5
2200 RPM Sea Level and Altitude Performance

NOTICE: Refer to the latest revision of Service Instruction No. 1573 to determine engine configuration and applicability of Fuel Flow versus Percent of Rated Power curve.

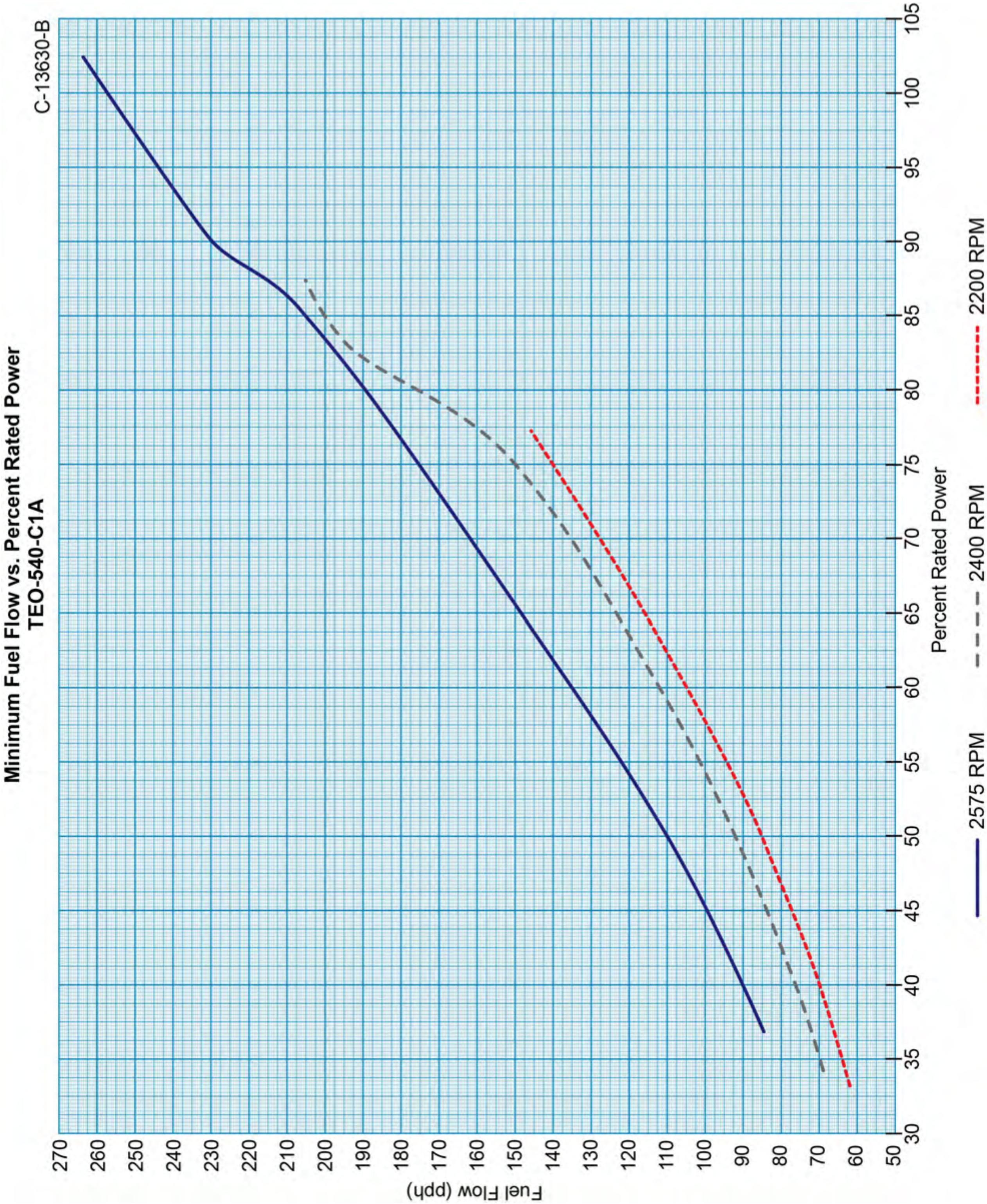

Figure A-6
Fuel Flow versus Percent of Rated Power

NOTICE: Refer to the latest revision of Service Instruction No. 1573 to determine engine configuration and applicability of Fuel Flow versus Percent of Rated Power curve.

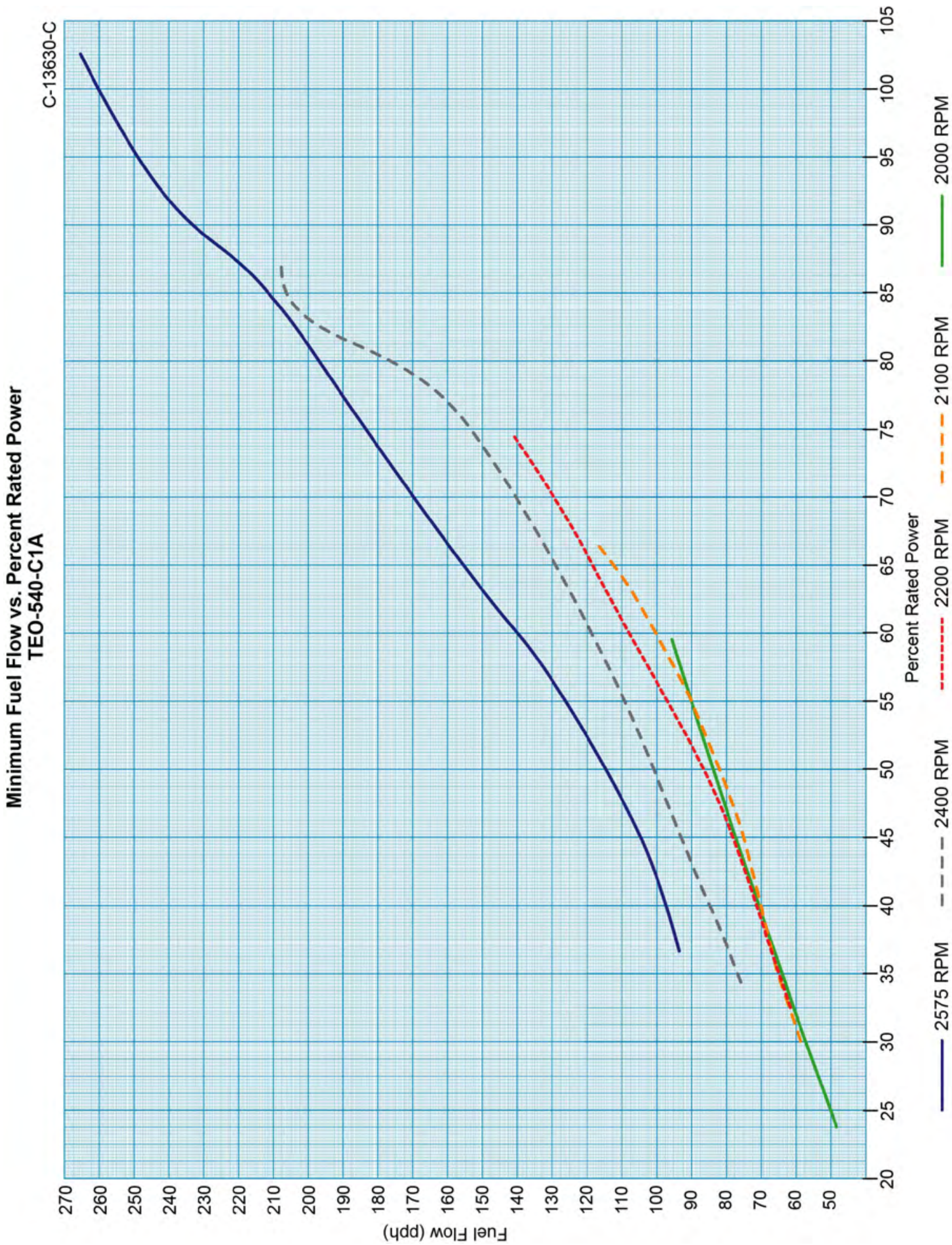

Figure A-7
Fuel Flow versus Percent of Rated Power
(For engines configured with wastegate solenoid P/N 02L29677)

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APPENDIX B

OPERATING LIMITATIONS

Functional Limitation Requirements

Limitations of the EECS

EEC Physical Environmental Limits

The EECS components (ECU, Power Box, and DLU) have the physical environmental limits shown in Table B-1.

Table B-1
Physical Environmental Limits

DO-160 Task No.	Item	Physical Environment Limit (DO-160F Levels)	
		EECS Sensor and Actuators	ECU and Power Box
4	Temperature and Altitude	B3	B3
5	Temperature Variation	A	A
6	Humidity	C	C
8	Vibration	Engine Durability	R Curve I
9	Explosive Atmosphere	IIE	IIE
10	Waterproofness	S	S
11	Fluid Susceptibility	F	F
12	Sand and Dust	D	D
13	Fungus Resistance	F	F
14	Salt Fog	S	S
15	Magnetic Effect	N/A	N/A
16	Power Input	Z	Z
17	Voltage Spike	A	A
18	Audio Frequency Conducted Susceptibility - Power Inputs	Z	Z
19	Induced Signal Susceptibility	ZC	ZC
20	Radio Frequency Susceptibility (Radiated and Conducted)	W/D	W/D
21	Emissions of Radio Frequency Energy	B	B
22	Lightning Induced Transient Susceptibility	A3G33	A3G33
25	Electrostatic Discharge (ESD)	N/A	A

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APPENDIX C

SAFETY

Table C-1 shows the safety alert messages.

Table C-1.
Safety Alert Messages

Ref. ID	Title	
1	⚠ **WARNING**	Connection of equipment or devices other than the Lycoming "Field Service Tool" to CAN 2 Bus may compromise safe EECS operation. Connection of non-Lycoming approved equipment or devices to the CAN 2 bus interface is prohibited. The Field Service Tool must not be used in flight.
2	⚠ **WARNING**	In the event of an NTO indication in flight, illuminated for more than 10 seconds, the operator should make minimum power control changes and land as soon as safely possible to reduce operability anomalies.
3	⚠ **WARNING**	After a software installation, the maintainer shall confirm proper and correct software loading via the Lycoming Field Service Tool.
4	⚠ **WARNING**	An ECU reset (re-initialization) shall only be conducted as a last chance recovery attempt from an EECS anomaly as determined necessary by the operator. It is possible that an ECU reset may not be recoverable. The operator must take this into consideration when deciding to command a reset.
5	⚠ **WARNING**	The NTO indication provides an indication that the ECU along with limited conventional engine hardware is acceptably safe for flight once a proper PFT is conducted. The operator must still interrogate conventional engine indications to determine that the conventional engine is also acceptable safe for flight.
6	⚠ **WARNING**	The operator must properly conduct a PFT prior to flight.
7	⚠ **WARNING**	The operator must allow sufficient time for the PFT to be completely executed (as indicated by the PFT active annunciator) prior to making any throttle changes otherwise the PFT may be inadvertently canceled with no other indication that the PFT is incomplete.
8	⚠ **CAUTION**	The PFT is not to be commanded during flight. If the PFT is commanded during flight, throttle movement will cancel the PFT.
9	⚠ **CAUTION**	To ensure proper EECS operation, the Lycoming Field Service Tool shall not be used during flight.
10	⚠ **CAUTION**	Selection of the IGNITION ON-OFF switch to OFF during ground operations is a single interlock. To ensure that the engine is not inadvertently started or the ignition system is not inadvertently actuated during maintenance, electrical power should be removed from the ECU during maintenance as a secondary interlock to prevent injury.

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APPENDIX D

WIRING DIAGRAMS

NOTICE: For Wiring Harness Leads and Connection Location, Airframe Wiring Interface, Communications Buses, Volt Power System Connection, System Wiring Diagrams, and Communications Bus Data refer to Appendix B in the ***TEO-540-C1A Engine Maintenance Manual.***

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