IO-360-A, AB
C, CB
D, DB, ES
G, GB
H, HB
J, JB
K & KB

CONTINENTAL® AIRCRAFT ENGINE

MAINTENANCE AND OPERATOR'S MANUAL

TECHNICAL CONTENT ACCEPTED BY THE FAA

Publication X30617

AUG 2011

Supersedure Notice

This manual revision replaces the front cover and list of effective pages for Publication Part No. X30617, dated January 1994. Previous editions are obsolete upon release of this manual.

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NOTICE

Continental Motors engine operating instructions are generated prior to and independently of the aircraft operating instructions established by the airframe manufacturer. Continental Motors operating instructions are developed using factory controlled parameters that are not necessarily the same as those specifications required to satisfy a specific aircraft I engine installation. Because of this difference the aircraft operator should use the airframe manufacturers operating instructions found in the Pilots Operating Handbook (POH) while operating the aircraft unless otherwise specified by the original airframe manufacturer.

The operator must comply with all the instructions contained in this manual and related publications in order to assure safe and reliable engine performance. Failure to comply will be deemed misuse, thereby relieving the engine manufacturer of responsibility under its warranty.

This manual contains no warranties, either expressed or implied. The information and procedures contained herein provide the operator with technical information and instructions applicable to safe operation.

CHAPTER INDEX

FIGURE INDEX

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CHAPTER 1
INTRODUCTION

Section Index

1-1 SCOPE

Requirements, cautions and warnings regarding operation of this engine are not intended to impose undue restrictions, but are inserted to enable the pilot to obtain maximum performance from the engine commensurate with safety and efficiency. Abuse, misuse, or neglect of any piece of equipment can cause eventual failure. In the case of an aircraft engine it should be obvious that a failure may have disastrous consequences. Failure to observe the instructions contained in this manual constitutes unauthorized operation in areas unexplored during development of the engine, or in areas which experience has proved to be undesirable or detrimental.

Notes, *Cautions* and **Warnings** are included throughout this manual. Application is as follows:

NOTE...Special interest information which may facilitate the operation of equipment.

CAUTION...Information issued to emphasize certain instructions or to prevent possible damage to engine or accessories.

WARNING...Information which, if disregarded, may result in severe damage to or destruction of the engine or endangerment to personnel.

1-2 RELATED PUBLICATIONS

1. Overhaul Manual for IO-360 Series Aircraft Engine. Form X30594A.
2. Illustrated Parts Catalog for IO-360 Series Aircraft Engine. Form X30595A.
3. Teledyne Continental Motors Aircraft Engine Service Bulletins.
4. Fuel Injection Manual. Form X30593A.

The above publications can be ordered through your Teledyne Continental Motors Distributor or ordered directly, from:

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Accessory Manuals:

1.	Magnetos	Service Manual Form X40000
2.	Alternator	Alternator Service Instructions Form X30531-3
3.	Starter	Starter Service Instructions Form X30592

Bulletins:

Bulletins that are issued to Distributors and subscribers from Teledyne Contiental Motors are divided into three separate groups: (1) Customer Information Bulletins; (2) Service Bulletin and (3) Mandatory Service Bulletins.

(1) Customer Information Bulletins are published to help provide the latest information on TCM marketing procedures, polices and product information.

(2) Service Bulletins provide current information related to service, maintenance and technical support of the product.

(3) Mandatory Service Bulletins are issued with required compliance information that may affect safety of flight.

These bulletins are also available to owners, operations or maintenance personnel on an annual subscription basis.

NOTE...Teledyne Continental Bulletins are easily distinguished by their title color:

(1) Customer Informaiton Bulletins — Blue.
(2) Service Bulletins — Black.
(3) Mandatory Service Bulletins — Red.

1-3 ABBREVIATIONS AND GLOSSARY OF TERMS

Abbreviation	Terms
A.B.C.	After Bottom Center
ADMP	Absolute Dry Manifold Pressure
Approx.	Approximately
A.T.C.	After Top Center
Bar.	Barometric
B.B.C.	Before Bottom Center
B.H.P.	Brake Horsepower
BSFC	Brake Specific Fuel Consumption
BSOC	Brake Specific Oil Consumption
B.T.C.	Before Top Center
C.A.R.	Civil Air Regulations
C.G.	Center of Gravity
c.f.m.	Cubic Feet Per Minute
C.H.T.	Cylinder Head Temperature
CW	Clockwise Rotation
CCW	Counterclockwise Rotation
°C	Degrees Celsius
°F	Degrees Fahrenheit
°	Degrees of Angle
Dia.	Diameter
EGT	Exhaust Gas Temperature
FAA	Federal Aviation Administration
Fig.	Figure (Illustration)
Front	Propeller End of Engine
Ft.	Foot or Feet
F.T.	Full Throttle
FT-LBS	Foot Pounds Torque
G.P.M.	Gallons Per Minute
gms	Grams
Hex	Hexagon
H2O	Water
Hg.	Mercury
hr.	Hour
I.D.	Inside Diameter
IN-LBS	Inch Pounds Torque
in. (")	Inches
Left Side	Side on which No's 2, 4 and 6 cylinders are located.
Lbs.	Pounds
Lockwire	Soft steel wire used to safety connections, etc.
Man.	Manifold or Manometer
MAP	Manifold Pressure
Max.	Maximum
Min.	Minimum

N.P.T.	National Pipe Thread (Tapered)
N.R.P.	Normal Rated Power
N.C.	National Course (Thread)
N.F.	National Fine (Thread)
O.A.T.	Outside Air Temperature
O.D.	Outside Diameter
oz.	Ounce
PPH	Pounds Per Hour
Press.	Pressure
p.s.i.	Pounds Per Square Inch
PSIA	Power Per Square Inch Absolute
PSIG	Power Per Square Inch Gauge
Rear	Accessory End of Engine
Right Side	Side on which No's 1, 3 and 5 cylinders are located.
R.P.M.	Revolutions Per Minute
Std.	Standard
TBO	Time Between Overhaul
T.C.D.P.	Turbocharger Deck Pressure
T.D.C.	Top Dead Center
Temp.	Temperature
T.I.T.	Turbine Inlet Temperature
Torque	Force x lever arm (125 ft.-lbs. torque = 125 lbs. Force applied one ft. from bolt center or 62-1/2 lbs. 2 ft. from center)
100LL	100 Octane Low Lead Fuel
1-3-5	Cylinder numbering right side of engine (rear to front)
2-4-6	Cylinder numbering left side of engine (rear to front)
30'	Thirty minutes of angle (60' equal one degree)

Glossary

ADMP — Absolute dry manifold pressure, is used in establishing a baseline standard of engine performance. Manifold pressure is the absolute pressure in the intake manifold; measured in inches of mercury.

Ambient — A term used to denote a condition of surrounding atmosphere at a particular time. For example; Ambient Temperature or Ambient Pressure.

BHP — Brake Horsepower. The power actually delivered to the engine propeller shaft. It is so called because it was formerly measured by applying a brake to the power shaft of an engine. The required effort to brake the engine could be converted to horsepower - hence: "brake horsepower".

BSFC — Brake Specific Fuel Consumption. Fuel consumption stated in pounds per hour per brake horsepower. For example, an engine developing 300 horsepower while burning 150 pounds of fuel per hour, has a BSFC of .5.

$$\frac{\text{Fuel Consumption in PPH}}{\text{Brake Horsepower}} = .5$$

Cavitation — Formation of partial vacuums in a flowing liquid as a result of the separation of its part.

Cold Soaking	Prolonged exposure of an object to cold temperatures so that its temperature throughout approaches that of ambient.
Corrosion	Deterioration of a metal surface usually caused by oxidation of the metal.
Critical Altitude	"Critical Altitude" means the maximum altitude at which, in standard atmosphere, it is possible to maintain, at a specified rotational speed, a specified power or a specified manifold pressure. Unless otherwise stated.
Density Altitude	Altitude as determined by pressure altitude and existing ambient temperature. In Standard Atmosphere (IAS) density and pressure altitudes are equal. For a given pressure altitude, the higher the temperature, the higher the density altitude.
Dynamic Condition	A term referring to properties of a body in motion.
E.G.T.	Exhaust Gas Temperature. Measurement of this gas temperature is sometimes used as an aid to fuel management.
Exhaust Back Pressure	Opposition to the flow of exhaust gas, primarily caused by the size and shape of the exhaust system. Atmospheric pressure also affects back pressure.
Four Cycle	Short for "Four Stroke Cycle." It refers to the four strokes of the piston in completing a cycle of engine operation (Intake, Compression, Power and Exhaust).
Fuel Injection	A process of metering fuel into an engine by means other than a carburetor.
Gallery	A passageway in the engine or subcomponent. Generally one through which oil is flowed.
Galling or Scuffing	Excessive friction between two metal surfaces resulting in particles of the softer metal being torn away and literally welded to the harder metal.
Hg"	Inches of Mercury. A standard for measuring pressure, especially atmospheric pressure or manifold pressure.
Heat Soaked	Prolonged exposure of an object to hot temperature so that its temperature throughout approaches that of ambient.
Humidity	Moisture in the atmosphere. Relative humidity, expressed in percent, is the amount of moisture (water vapor) in the air compared with the maximum amount of moisture the air could contain at a given temperature.
Impulse Coupling	A mechanical device used in some magnetos to retard the ignition timing and provide higher voltage at cranking speeds for staring.
Lean Limit Mixture	The leanest mixture approved for any given power condition. It is not necessarily the leanest mixture at which the engine will continue to operate.
Manifold Pressure	Pressure as measured in the intake manifold down-stream of the air throttle. Usually measured in inches of mercury.
Mixture	Mixture ratio. The proportion of fuel to air used for combustion.

Naturally Aspirated	A term used to describe an engine which obtains induction (Engine)air by drawing it directly from the atmosphere into the cylinder. A non-supercharged engine.
NRP	Normal Rated Power.
O.A.T	Outside Air Temperature.
Octane Number	A rating which describes relative anti-knock (detonation) characteristics of fuel. Fuels with greater detonation resistance than 100 octane are given performance number ratings.
Oil Temperature Control Valve	A thermostatic unit to divert oil through or around the oil cooler, as necessary, to maintain oil temperature within desired limits.
Overboost Valves	A pressure relief valve, set slightly in excess of maximum deck pressure, to prevent damaging overboost in the event of a system malfunction.
Overhead Valves	An engine configuration in which the valves are located in the cylinder head itself.
Overspeed	When an engine has exceeded its rated revolutions per minute.
Performance Number	A rating system used to described the anti-knock (detonation) characteristic as compared with 100 octane fuel. For example, an engine with high compression needs a higher Performance Number fuel than a low compression engine.
Pressure Altitude	Altitude, usually expressed in feet, (using absolute static pressure as a reference) equivalent to altitude above the standard sea level reference plane (29.92" Hg).
Propeller Load Curve	A plot of horsepower, fuel flow, or manifold pressure versus engine speed through the full power range of one engine using a fixed pitch propeller or a constant speed propeller running on the low pitch stops. This curve is established or determined during design and development of the engine.
Propeller Pitch	The angle between the mean chord of the propeller and the plane of rotation.
Ram	Increased air pressure due to forward speed.
Rated Power	The maximum horsepower at which an engine is approved for operation. Rated power may be expressed in horsepower or percent.
Retard Breaker	A device used in magnetos to delay ignition during cranking. It is used to facilitate starting.
Rich Limit	The richest fuel/air ratio permitted for any given power condition. It is not necessarily the richest condition at which the engine will run.
Rocker Arm	A mechanical device used to transfer motion from the pushrod to the valve.

Run Out	Eccentricity or wobble of a rotating part.
Scavenge Pump	A pump (especially an oil pump) to prevent accumulation of liquid in some particular area.
Sonic Venturi	A restriction, especially in cabin pressurization systems, to limit the flow of air through a duct.
Standard Day	By general acceptance, temperature -59°F/15°C, pressure -29.92 In. Hg.
Static Condition	A term referring to properties of a body at rest.
Sump	The lowest part of a system. The main oil sump on a wet sump engine contains the oil supply.
TBO	Time Between Overhauls. Usually expressed in operating hours.
T.D.C.	Top Dead Center. The position in which the piston has reached the top of its travel. A line drawn between crankshaft rotation axis, through the connection rod and axis and the piston pin center would be straight line. Ignition and valve timing are stated in terms of degrees before or after TDC.
Thermal Efficiency	Regarding engines, the percent of total heat generated which is converted into useful power.
T.I.T.	Turbine Inlet Temperature. The measurement of E.G.T. at the turbocharger turbine inlet.
Torque	Twisting moment or leverage, stated in pounds-foot (or pounds-inch).
Turbocharger	A device used to supply increased amounts of air to engine induction system. In operation, a turbine is driven by engine exhaust gas. In turn, the turbine directly drives a compressor which pumps air into the engine intake.
Vapor Lock	A condition in which the proper flow of a liquid through a system is disturbed by the formation of vapor. Any liquid will turn to vapor if heated sufficiently. The amount of heat required for vaporization will depend on the pressure exerted on the liquid.
Variable Absolute Pressure Controller	A device used to control the speed, and thus the output of the turbocharger. It does so by operating the wastegate which diverts, more or less, exhaust gas over the turbine.
Vernatherm Valve	A thermostatic valve used to divert oil through or around the oil cooler, as necessary, to maintain oil temperature within desired limits.
Viscosity	The characteristic of a liquid to resist flowing. Regarding oil, high viscosity refers to thicker or "heavier" oil while low viscosity oil is thinner. Relative viscosity is indicated by the specific "weight" of the oil such as 30 "weight" or 50 "weight". Some oils are specified as multiple-viscosity such as 10W30. In such cases, this oil is more stable and resists the tendency to thin when heated or thicken when it becomes cold.
Volatility	The tendency of a liquid to vaporize.

Volumetric Efficiency	The ability of an engine to fill its cylinders with air compared to their capacity for air under static conditions. A "naturally aspirated" engine will always have a volumetric efficiency of slightly less than 100%, whereas superchargers permit volumetric efficiencies in excess of 100%.
Wastegate Valve	A unit, used on turbocharged engines, to divert exhaust gas through or around the turbine, as necessary to maintain turbine speed. As more air is demanded by the engine, due to throttle operation, the compressor must work harder. In order to maintain compressor and turbine speeds, more exhaust must be flowed through the turbine. The wastegate valve closes and causes gas, which would go directly overboard, to pass through the turbine. The wastegate is usually operated by an actuator which gets signals from the turbocharger controller.
Wastegate Valve (Fixed Orifice)	A ground adjustable by pass located in the turbine exhaust bypass duct. The position of the fixed orifice wastegate valve remains constant throughout all modes of engine operation.

1-4 MANUAL REVISIONS

This manual and Teledyne Continental Motors related manuals are current and correct to the best of Teledyne Continental Motors' knowledge at the time of publication. Any errors, recommended changes, or questions should be submitted in writing to:

Technical Publications Department
Teledyne Continental Motors
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Mobile, Alabama 36601

Manuals will be revised and updated as necessary.

Consult Teledyne Continental Motors' Service Bulletin publications for latest technical information available.

CHAPTER 2
DETAILED ENGINE DESCRIPTION

Section Index

2-1 DESCRIPTION OF ENGINE MODEL CODE

DETAILED ENGINE DESCRIPTION

Prefix

I - Fuel Injected

O - Horizontally Opposed
Cylinder Configuration

Example: IO 360 AB (1) B

Suffix

The Model of Engine

Wooden Container (Section 4-8)

Specification Number
Refer To Current Specification
Listings or Parts Catalog
Form X30595A for information

Displacement
360 Cubic Inch Cylinder
Volume Displacement

2-2 BASIC DESIGN FEATURES

The IO-360 Series engines are air cooled, having six horizontally opposed, inclined overhead valve cylinders. The cylinder displacement of 360 cubic inches is achieved with a 4.44 inch bore and a 3.88 inch stroke. The IO-360 Series engines have an 8.5 to 1 compression ratio. The IO-360 Series engines are fuel injected and naturally aspirated. The crankshaft is equipped with pendulum type vibration absorber that suppress torsional vibrations.

The IO-360 engines have a doweled six bolt hole configuration propeller flange. A mounting pad is provided for a governor which provides control for a hydraulically operated constant speed propeller.

2-3 LUBRICATION SYSTEM

The oil supply is contained in a (Figure 2-1) wet sump attached to the bottom of the crankcase. A conventional dipstick is provided for determining the oil quantity.

When the crankshaft is turning, oil is drawn through a screen and pick up tube which extends from the sump to a port in the crankcase. (Due to the modification to the oil sump and accessory case of some engine model-spec. applications, oil may be picked up from two separate locations depending on engine position and flight attitude. A baffle and flapper valve assembly located in the oil sump retains oil around the pick-up tube during variable attitude flight operations to prevent oil starvation.) Oil then passes to the inlet of the gear-type, engine-driven oil pump and is forced under pressure through the pump outlet. A pressure relief valve prevents excessive oil pressure by allowing excess oil to be returned to the sump. After exiting the pump, the oil (now under pressure), enters a full-flow filter and is passed on to the oil cooler. If the filter element becomes blocked, a bypass relief valve will open to permit unfiltered oil to flow to the engine. As the oil enters the oil cooler, it will flow in one of two directions: (a) When the oil is cold, an oil temperature control unit will open and most of the oil will bypass the cooler. Some oil always flows through the cooler to help prevent congealing in cold weather. (b) As the oil warms, the oil temperature control unit actuates to close off the cooler bypass forcing the oil flow through the cooler core. In operation, the oil temperature control unit modulates to maintain oil temperature in the normal range of approximately 170°F.

After leaving the cooler, the oil enters the crankcase where the various channels and passageways direct it to the bearing surfaces and other areas requiring lubrication and cooling. The propeller governor boosts engine oil pressure for operation of the propeller. It controls oil pressure going to the propeller hub to maintain or change propeller blade angles. This oil flows through the propeller shaft to reach the hub.

Other areas within the engine receiving oil include the valve lifters, inner domes and lower cylinder walls. Oil within the engine drains, by gravity, back into the sump.

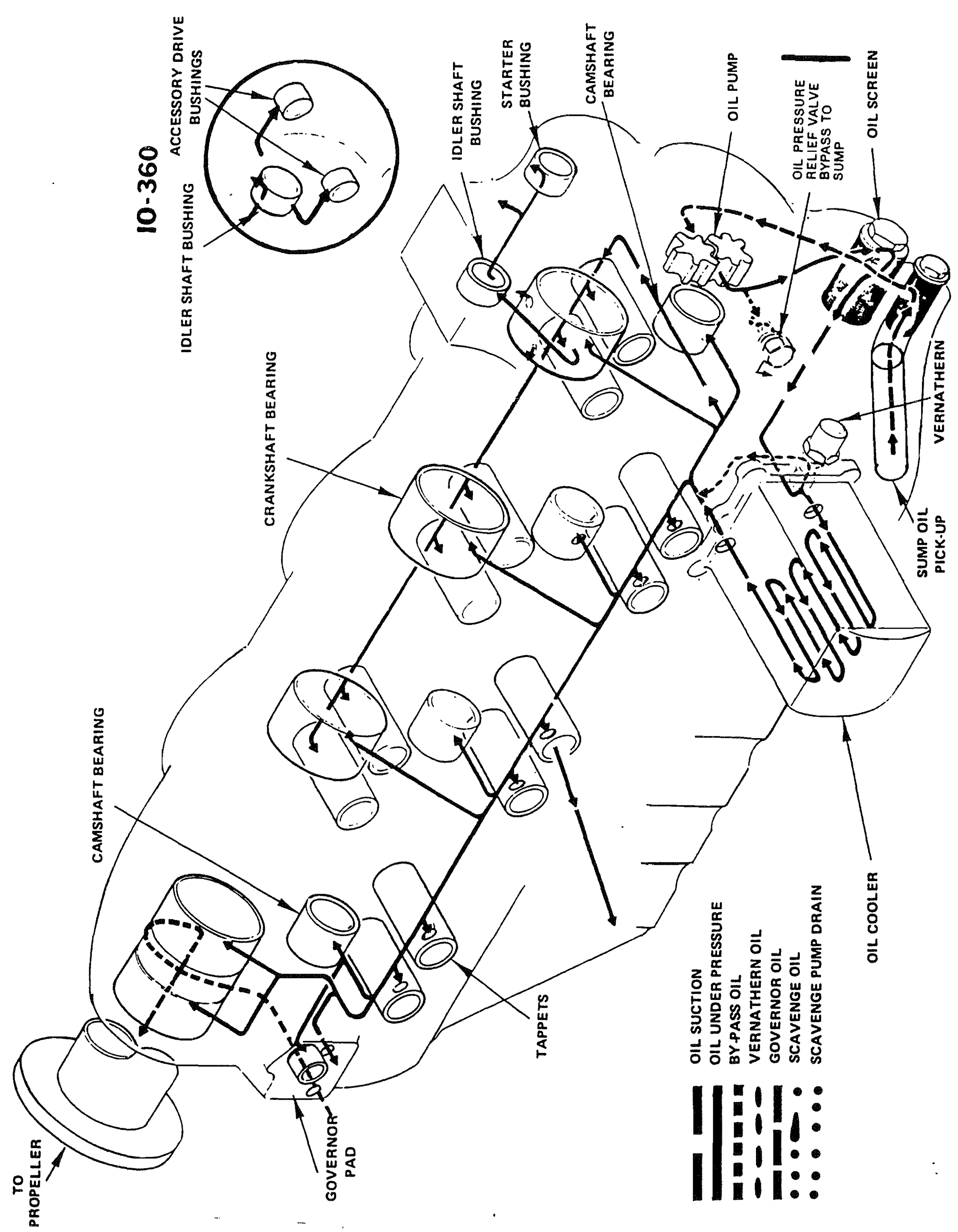

FIGURE 2-1. LUBRICATION DIAGRAM

2-4 INDUCTION SYSTEM

The induction system components include the aircraft filter/alternate air door, throttle, manifold and cylinder intake ports. Air flows through these components in the order they are listed.

Refer to Aircraft Operating Handbook for alternate air door operation.

The intake manifold system is a six-tube, air distribution system mounted atop the engine. It serves to carry induction air to the individual cylinder intake ports.

The cylinder intake ports are cast into the cylinder head assembly. Air from the manifold is carried into the intake ports, mixed with fuel from the injector nozzles, and then enters the cylinder as a combustible mixture when the intake valve opens.

2-5 IGNITION SYSTEM

Engine firing order is 1-6-3-2-5-4. As viewed from the distributor end, the magneto rotor turns counterclockwise, passing in succession the terminals of spark plug cables in engine firing order. Cables are connected to the magnetos so that the right magneto fires the 1-3-5 upper plugs on the right side and 2-4-6 lower plugs on the left. The left magneto fires the 2-4-6 upper plugs on the left and the 1-3-5 lower plugs on the right. The magneto cases, spark plugs, cables and connections are shielded to prevent radio interference.

Torque from the engine crankshaft is transmitted through the camshaft gear to the magneto drive gear. The magneto drive gear incorporates rubber bushings that engage the magneto impulse coupling. As the rubber bushings in the drive gear turns the coupling drive lugs, counterweighted latch pawls, inside the coupling cover, engage a pin on the magneto case and hold back the latch plate until it is forced inward by the coupling cover. When the latch plate is released, the coupling spring spins the magneto shaft through its neutral position and the breaker opens to produce a high voltage surge in the secondary coil. The spring action permits the latch plate, magneto and breaker to be delayed through a lag angle of 30 degrees of drive gear rotation during the engine cranking period. Two stop pins in the case and two lobes on the breaker cam produce two sparks per revolution of the drive shaft. After the engine is started, counterweights hold the latch paws clear of the stop pins and the magnet shaft is driven at full advance.

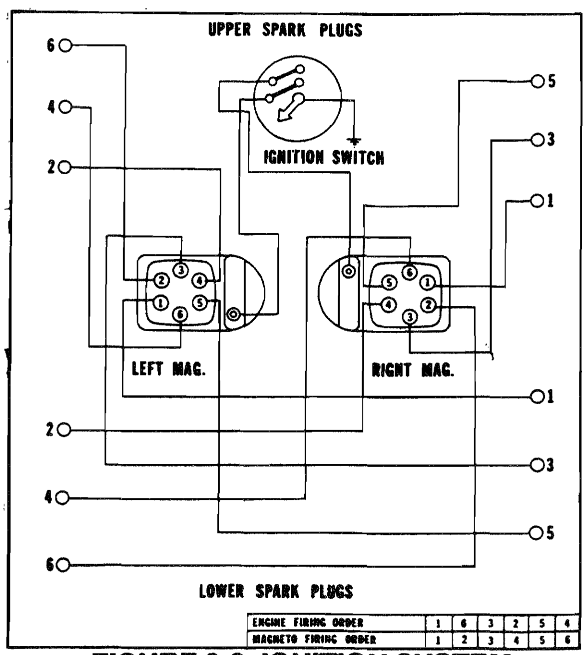

FIGURE 2-2. IGNITION SYSTEM

2-6 FUEL SYSTEM

The fuel injection system is of the multi-nozzle, continuous-flow type which controls fuel flow to match engine air flow. (See Figure 2-3.) Any change in air throttle position, engine speed, or a combination of these cause changes in fuel flow in the correct relation to engine air flow. A manual mixture control is provided for leaning at any combination of altitude and power setting.

The continuous-flow system permits the use of a typical rotary vane pump with integral relief valve.

Fuel is drawn from the supply tanks by the engine driven pump, where and vapor is separated from liquid fuel by swirling action. Vapor is returned to the fuel tank.

An auxiliary pump is supplied by the airframe manufacturer for use in starting or as an emergency pump to supply fuel in flight if the engine-driven pump fails.

When liquid fuel leaves the pump pressure chamber it is directed to the mixture control valve, which is an integral part of the fuel pump assembly. The mixture control valve shaft is linked to the cockpit mixture control.

From the mixture control valve fuel is directed to the fuel metering valve, which is mounted on the side of the air throttle body. (See Figure 2-4.) The shaft that positions the air throttle body butterfly valve also positions the metering valve. The air throttle body throttle and metering shaft is linked to the cockpit throttle control.

The fuel manifold valve contains a diaphragm chamber and necessary outlet ports which connect to the fuel injector lines. The spring-loaded diaphragm works with a ported plunger which allows fuel, through fuel injector lines, to the fuel injector nozzles, (See Figure 2-5), in the cylinders.

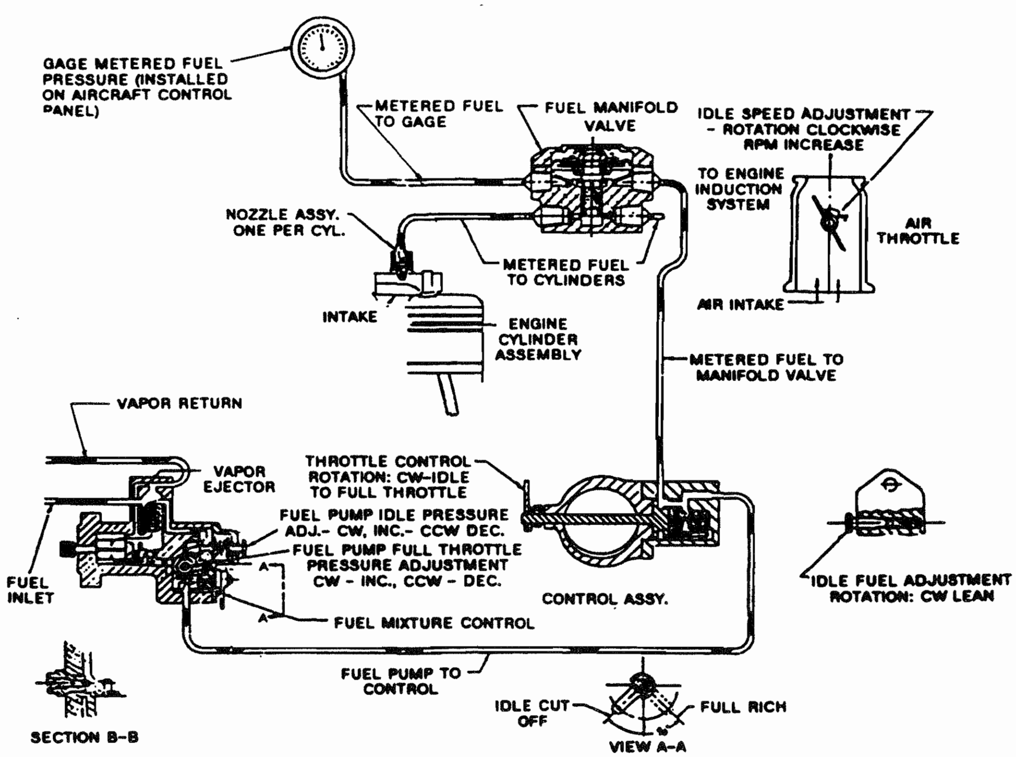

FIGURE 2-3. FUEL SYSTEM SCHEMATIC

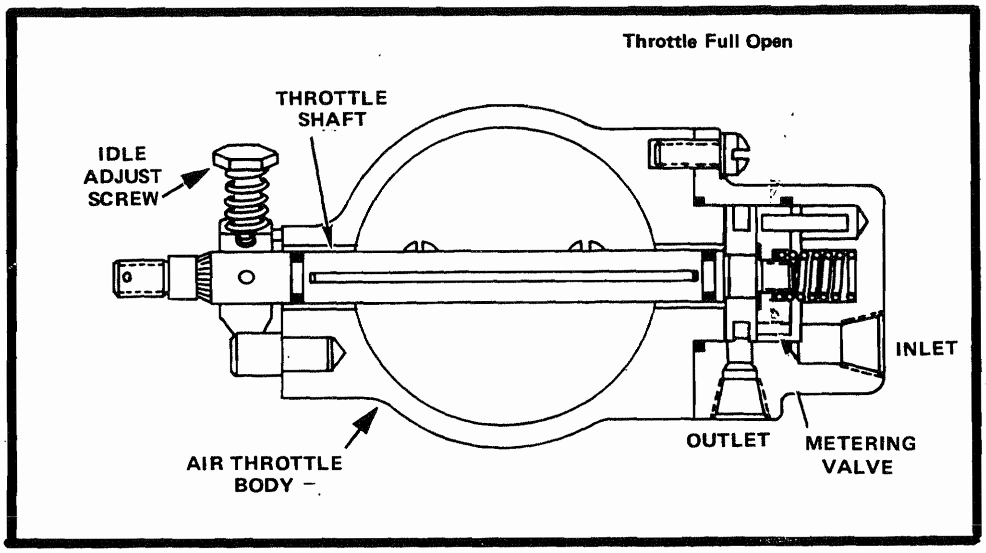

FIGURE 2-4. AIR THROTTLE & METERING UNIT

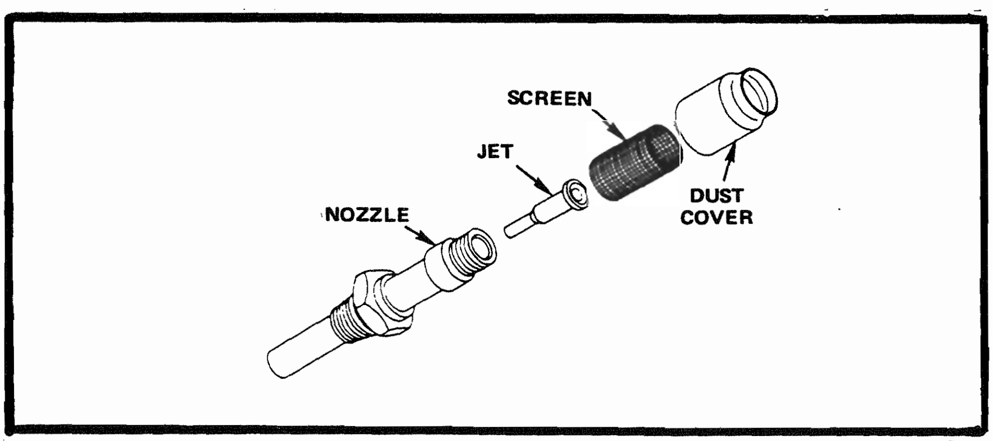

FIGURE 2-5. FUEL INJECTION NOZZLE.

2-7 CYLINDERS

The externally finned aluminum cylinder heads are heated and threaded on to the steel alloy barrels. The valve guides and seats are pressed into the hot cylinder head. When the entire unit has cooled, a permanent cylinder assembly results. Replaceable helical coil inserts are installed in the spark plug ports.

2-8 VALVE TRAIN

Exhaust valves are faced with a special heat and corrosion-resistant material and the valve stems are chromed for wear resistance. Oil fed to the hydraulic valve lifters, under pressure from galleries, lubricates the lifter guide surfaces and fills the reservoirs inside the lifers. Oil from the lifters flows through the pushrods to the rocker arms. Each rocker arm directs a portion of its oil through a drilled orifice toward the respective valve stem. Oil is returned to the crankcase through the pushrod housings, which are sealed to the cylinder head and crankcase with rubber seals. Drain holes in the lifter bores return oil to the sump.

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CHAPTER 3
ENGINE SPECIFICATIONS AND OPERATING LIMITS

Section Index

3-1 GENERAL

The operating limits and specifications listed in this section are applicable to the IO-360 Series aircraft engine. Consult Sections 6 and 7 for additional operating procedures.

3-2 ENGINE SPECIFICATIONS

Manufacturer . . . . Teledyne Continental Motors
Model . . . . IO-360 Series
FAA Type Certificate Number E1CE

Cylinders

Arrangement . . . . Individual cylinders in a horizontally opposed position
Compression Ratio 8.5:1
Firing Order 1-6-3-2-5-4
*Cylinder Head Temperature Maximum Allowable . . . . 460°F
Number of cylinders 6

* Indicates temperature measured by Bayonet Thermocouple, (Aeronautical standard AS234 Element or equivalent), installed in boss in bottom of cylinder head.

Numbering (Accessory end toward propeller):

Right Side cylinders 1-3-5
Left Side cylinders 2-4-6
Bore (Inches) 4.44
Stroke (Inches) 3.88
Piston Displacement (cu. in.) 360

Dimensions (inches)

MODEL	LENGTH	WIDTH	HEIGHT
IO-360A,AB	34.03	31.40	22.43
C,CB	35.34	33.03	22.43
D,DB	34.03	33.04	22.43
ES	36.32	33.05	23.52
G,GB	35.34	33.03	22.43
H,HB	35.34	33.03	22.43
J,JB	35.34	33.03	22.43
K,KB	35.34	33.03	22.43

Complete Engine Includes:
Crankcase assembly, crankshaft assembly, camshaft assembly, valve drive train, cylinder assemblies, piston & connecting rod assemblies, oil sump assembly, (*inter-cylinder baffling), alternator, starter, starter adapter assembly, lubrication system (*includes oil filter), accessory drives, ignition system (includes spark plugs), fuel injection (includes starting primer), induction system, all engine to engine attaching hardware, hoses clamps and fittings.

* On some models; Items are airframe supplied.

TOTAL BASIC ENGINE WEIGHT - DRY (No oil in sump)

(Subject to product variation of ± 2.5%)	IO-360-A,AB,D,BB,H,HB,J,JB,K,KB	327.25
	IO-360-C,CB,G,GB	331.25
	IO-360-ES	350.00

3-3 OPERATING LIMITS

ENGINE MODEL	RATED MAX. CONT. BHP
IO-360-A,AB	195
IO-360-C,CB	210
IO-360-D,DB,ES	210
IO-360-G,GB	210
IO-360-H,HB	210
IO-360-J,JB	195
IO-360-K,KB	195

Crankshaft Speed - RPM

Rated Maximum Continuous . . . . A,AB,C,CB,D,DB,ES,G,GB,H,HB 2800
Rated Maximum Continuous Operation . . . . JB, & KB 2600
Rated Maximum Take-Off . . . . All except K, KB 2800
Rated Maximum Take-Off . . . . K, KB 2600
Recommended Max. for Cruising (75% Power) . . . . All Except A, AB 2600
Recommended Max. for Cruising (75% Power) . . . . A, AB 2500

Intake Manifold Pressure (In. Hg.)

Maximum Take-Off . . . . See Performance Chart (Chapter 12)
Maximum Continuous . . . . See Performance Chart (Charter 12)
Recommended Continuous Max. for Cruising . . . . . . See Performance Chart (Chap. 12)
Fuel Control System . . . . TCM Continuous Flow Fuel Injection
Unmetered Fuel Pressure (P.S.I.G.) . . . . See Performance Chart (Chap. 12)
Fuel (Min. Grade) . . . . Aviation Grade 100 or 100LL

WARNING...The use of lower octane rated fuel can result in destruction of an engine the first time high power is applied. This would most likely occur on takeoff. If the aircraft is inadvertently serviced with the wrong grade of fuel, the fuel tank must be completely drained, properly serviced, and the proper engine inspection completed.

Oil: (First 25 hours of operation) . . . . Mineral (non-detergent) Oil or
. . . . Corrosion Preventive oil Corresponding to MIL-C-6529 Type II
Oil Specification . . . . MHS-24F or MHS-25

Normal Service

All Temperatures . . . . 15W-50 • 20W-50
Below 40°F. Ambient Air (Sea Level) . . . . SAE30 or 10W-30
Above 40° F. Ambient Air (Sea Level) SAE50

Oil Sump Capacity . . . . 10 qts.
Oil Sump Capacity (ES) . . . . 8 qts.
Oil Filter . . . . Full Flow
Max. Oil Consumption lb/hr
ALL MODELS (Except ES)

$$.006 \times \frac{\% \text{ Power}}{100}$$

ES

$$.004 \times \frac{\% \text{ Power}}{100}$$

Oil Pressure

Idle, Minimum, psi 10
Normal Operation, psi . . . . 30 to 60

Oil Temperature Limits

Minimum for Take-Off . . . . 24°C / 75°F
Maximum Allowable (IO-360A,AB) . . . . 107°C / 225°F

Maximum Allowable (All Except A,AB) . . . . 116°C / 240°F
Recommended Cruising . . . . 71° - 82°C / 160°F - 180°F

IGNITION TIMING ° BTC ± 1°	RIGHT	LEFT
All IO360 Models (Except ES)	20°	20°
ES	24°	24°

3-4 ACCESSORIES

The following magnetos equipped with an appropriate harness are eligible on the engines covered by this manual.

Two each TCM S6LN-25 . . . . All Models except ES - No Wt. Change
Two each Slick 6214 . . . . -1.4 lbs. ES

The following spark plugs are approved for use in engines covered in this manual as applicable

ALL IO-360 MODELS

TCM	625350, 365862, 626363, 626364, 636861, 632462, 632463, 635146, 635147, 628325, 646629, 630049, 646630, 642097, 642098, 646091, 646092,
AUBURN	SR83P, SR86, SR93, HSR83P, HSR86, HSR93
AUTOLITE	SH26, SH260, PA26, PH260
CHAMPION	REM38E, REM38S, RHM38E, RHM38S
SMITH	RSE23-3R, RSH23-3R, RSE23-3R1, RSH23-3R1

CHAPTER 4
UNPACKING, INSTALLATION, TESTING AND REMOVAL

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4-1 UNPACKING

Packaging Category "A" (Cardboard Container)

1. Cut steel banding straps securing the container. (Use caution as straps may spring loose when cut.)
2. Remove the staples from the base of the cardboard cover.
3. Lift cardboard cover vertically and remove.
4. Attach a hoist to the engine lifting eye, located at the top of the crankcase backbone. Take up slack on the hoist, then cut the steel banding straps holding the engine to the base.(Use caution as straps may spring loose when cut.) Lift the engine vertically and install on a transportation stand or dolly.

Packaging Category "B" (Wooden Container)

1. Remove the four (4) lag screws attaching the wooden cover to the base.
2. Lift the wooden cover vertically and remove.
3. Open the moisture proof plastic bag.
4. Attach a hoist to the engine lifting eye located at the top of the crankcase backbone.Take up slack on the hoist, prior to loosening the engine mount bolts; then remove the bolts from the shipping shock mounts.Lift the engine vertically and install on a transportation stand or dolly.

4-2 PREPARATION FOR SERVICE

If the engine is not to be installed within five (5) days after unpacking, must be represerved in accordance with procedures listed in Chapter 10.

If the engine is to be installed within five (5) days after unpacking, remove the shipping plugs installed in the lower spark plug holes and turn the crankshaft through at least two complete revolutions in order to remove the cylinder preservation oil from the cylinders. Remove the shipping plugs installed in the upper spark plug holes and inspect the cylinder bores with a borescope for rust or contamination. Contact your Teledyne Continental Motors Distributor if any abnormal condition is noted.

Install the upper spark plugs finger tight and torque the lower spark plugs to 300-360 in. lbs. Do not lubricate spark plug threads prior to installation.

NOTE...Remove exhaust port protective plugs. Service the lubrication system with mineral (non-detergent) oil or Corrosion Preventive oil corresponding to MIL-C-6529 Type II. See Chapter 3 for sump capacity.

Remove the shipping plate from the propeller governor pad forward of number 6 cylinder. Lubricate the governor shaft splines with engine oil; install a new gasket and then install the propeller governor control. Attach with plain washers, new lock washer, and torque the nuts in accordance with governor manufactures specs.

CAUTION...Align spline of governor drive gear and assure that the governor is fully seated to the crankcase prior to installing the attaching hardware. This will eliminate the possibility of misalignment forcing the drive gear off location within the crankcase.

Optional Accessories: Optional accessories such as hydraulic pumps, vacuum pumps, etc., may be installed on the magneto and accessory drive pads located on the upper rear portion of the crankcase. Remove the accessory drive covers and install new gaskets. Install accessories in accordance with the airframe manufacturer's instructions.

Install all airframe manufacturer required cooling baffles, hoses, fittings, brackets and ground straps in accordance with airframe manufacturers installation instructions.

4-3 ENGINE INSTALLATION INSTRUCTIONS

Install per airframe manufacturers instructions and the following generalized instructions. Torque bolt as recommended by the airframe manufacturer. Safety bolt per airframe manufacture's instructions.

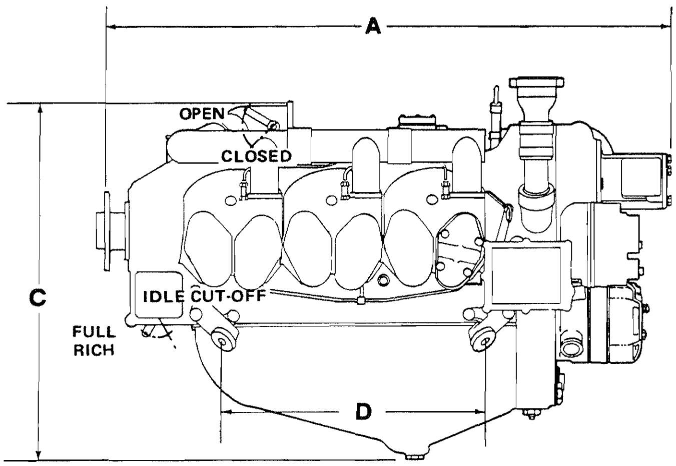
CAUTION...Remove all protective covers, plugs, caps and identification tags as each item is connected or installed.

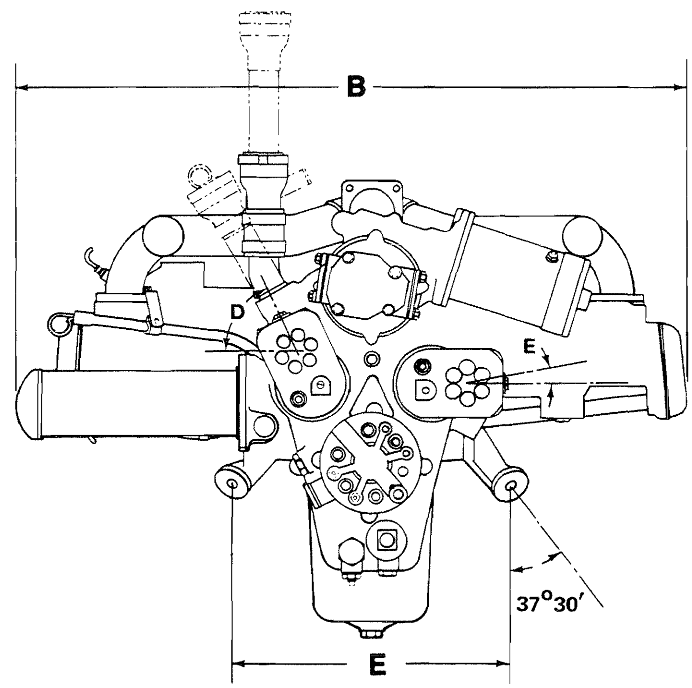
NOTE...See airframe manufacturer's instructions for engine to airframe connections.

CAUTION...The aircraft fuel tanks and lines must be purged to remove all contamination removed prior to installation in the main fuel inlet line to the fuel pump. Failure to comply can cause erratic fuel injection system operation and damage to its components.

CAUTION...Do not install the ignition harness "B" nuts on the spark plugs until the propeller installation is completed. Failure to comply could result in bodily injury when the propeller is rotated during installation.

Install the approved propeller in accordance with the airframe manufacturer's instructions.





DIMENSIONS					
MODEL	A	B	C	D	E
IO360,A,BB	34.03	31.40	22.43	16.33	13.47
C,CB	35.34	33.03	22.43	16.33	13.47
D,DB	34.03	33.03	22.43	16.33	13.47
G,GB	35.34	33.03	22.43	16.33	13.47
H,HB	35.34	33.03	22.43	16.33	13.47
J,JB	35.34	33.03	22.43	16.33	13.47
K,KB	35.34	33.03	22.43	16.33	13.47
ES	36.32	33.05	23.52	16.33	14.12

FIGURE 4-1. INSTALLATION DRAWING IO-360 SERIES

4-4 PREFLIGHT AND RUN-UP

The engine lubrication system must be pre-oiled prior to starting. This can be accomplished using a pressure oiling system installed into a main oil gallery or the oil pump. An acceptable alternate method is to use the engine starter to motor the engine with the spark plugs removed until an oil pressure indication is noted.

NOTE...Recheck the oil level in the sump if the pre-oiling method was used. Do not operate the engine with more or less than the oil sump capacity.

If the magneto attaching nuts were loosened or the magnetos rotated during engine installation, magneto to engine timing must be accomplished prior to starting.

Install and torque the upper spark plugs to 300-360 in. lbs. Install the ignition harness "B" nuts to the spark plugs in the order shown in Figure 2-2. "B" nuts are identified for position, i.e. "1T" for number one top spark plug, etc.

Start the engine in accordance with the Service Bulletin M89-7 R1 or subsequent revisions as applicable or the airframe manufacturer's operator's manual.

Unmetered and metered fuel pressures must be adjusted to specs prior to flight.

The engine has received a test cell run-in prior to leaving the factory, however, short flight test is recommended to assure that the piston rings have seated and that no induction system, exhaust system, oil or fuel system leaks exist prior to releasing the aircraft for normal service.

4-5 FLIGHT TESTING

Ambient air and engine operating temperatures are of major concern during this test flight. Accomplish a normal pre-flight run-up in accordance with the aircraft flight manual. Conduct a normal take-off with full power and monitor the fuel flow, RPM, oil pressure, cylinder head temperatures and oil temperatures. Reduce to climb power in accordance with the flight manual and maintain a shallow climb altitude to gain optimum airspeed and cooling. Rich mixture should be used for all operations except lean for field elevation, (where applicable), and lean to maintain smoothness during climb in accordance with airframe manufacturers operating instructions.

Level flight cruise should be at 75% power with best power or richer mixture for the first hour of operation. The second hour power settings should alternate between 65% and 75% power with the appropriate best power mixture settings.

The descent should be made at low cruise power settings,with careful monitoring of engine pressures and temperatures. Avoid long descents with cruise RPM and manifold pressure below 18" Hg.; if necessary decrease the RPM sufficiently to maintain manifold pressure.

Any abnormal conditions detected during test flight must be corrected and any final adjustments required must be accomplished prior to releasing the aircraft for normal service.

4-6 ENGINE REMOVAL INSTRUCTIONS

Identify each item as the item is disconnected from the engine to aid in reinstallation.

NOTE...If the engine is being removed to be placed in storage, accomplish steps listed in Chapter 10, in the section titled "Indefinite Storage" prior to removal.

1. Turn all cockpit switches and fuel selector valves OFF.
2. Disconnect the battery ground cable.
3. Disconnect the starter cable.
4. Tag and disconnect the engine wiring bundle from the following components.
   a. Magnetos
   b. Alternator
   c. Oil temperature bulb
   d. Cylinder head temperature bulb
   e. Remove all clamps attaching engine wire bundle to engine components and route clear of the engine.

Accomplish the following items:

1. Drain the engine oil from the sump. Replace drain plug and tighten.
2. Remove the propeller in accordance with airframe manufacturer's instruction.
3. Remove engine to airframe connections in accordance with airframe manufacturer's instructions.

Attach a hoist to the engine lifting eye and relieve the weight from the engine mounts.

CAUTION...Place a suitable stand under the aircraft tail cone before removing the engine. The loss of weight may cause the tail to drop.

Remove the engine mounts and engine as follows:

1. Hoist engine vertically out of the nacelle and clear of the aircraft.

   NOTE...Hoist engine slowly and make sure that all wires, lines and hoses have been disconnected.

2. Install engine on a transportation stand, dolly or on the engine shipping container base.

4-7 GROUND HANDLING

After engine is removed from aircraft or container (attached to hoist) proceed with care. Do not let engine front, rear, sides or bottom come in contact with any obstructions as the extreme weight may cause damage to the engine or components. If contact has occurred inspect for obvious or consequential damage.

4-8 CRATING AND SHIPPING

Preserve the engine in accordance with Chapter 10.

Category "A" (cardboard container). Lower engine onto container base and attach with metal banding straps. Install and attach container cover.

Category "B" (wooden container). Lower engine onto container base. Attach engine using shock mounts and bolts cover engine with plastic bag. Install and attach container cover to base.

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CHAPTER 5
NORMAL OPERATING PROCEDURES

Section Index

Section **Page**

5-1 GENERAL

CAUTION...This section pertains to operation under standard environmental conditions. The pilot should thoroughly familiarize himself with Chapter 7, Abnormal Environmental Conditions. Whenever such abnormal conditions are encountered or anticipated, the procedures and techniques for normal operation should be tailored accordingly.

WARNING...Some model specs. are available with provisions for use with an airframe manufacturer furnished inverted flight oil system. Installation and qualification of the inverted flight oil system is the responsibility of the airframe manufacturer.

The engine received a run-in operation before leaving the factory. Therefore, no break-in schedule is required. Straight mineral oil or corrosion preventive oil MIL-C-6529 Type II per paragraph 3-3 should be used for the first oil change period (25 hours).The life of your engine is determined by the care it receives. Follow the instructions contained in this manual carefully.

The minimum grade aviation fuel for this engine is 100LL (Blue) or 100 (Green). If the minimum grade required is not available, use a higher rating. Never use a lower rated fuel.

WARNING...The use of a lower octane rated fuel can cause pre-ignition and/or detonation which can damage an engine the first time high power is applied, possibly causing engine failure. This could most likely occur on takeoff. If the aircraft is inadvertently serviced with the wrong grade of fuel, then the fuel must be completely drained and the tank properly serviced, prior to engine operation.

5-2 PRESTARTING

Before each flight the engine and propeller must be examined for damage, oil or fuel leaks, security and proper servicing.

1. Assure that fuel tanks contain proper type and quantity of fuel. (100LL-Blue, or 100 Green)
2. Drain all sumps and strainers in accordance with airframe manufacturers recommendations. If water or foreign matter is noted, continue draining until only clean fuel appears.
3. Check proper oil level in sump.

5-3 STARTING

Start engine in accordance with manufacturers instructions.

1. Fuel Selector - On proper tank.
2. Mixture - Full Rich.
3. Throttle - ¼ Open
4. Prop Control - Full Forward.
5. Master Switch - On.
6. Turn ignition switch to “BOTH”.

WARNING...Overpriming can cause hydro static lock and subsequent engine failure.

7. Set auxiliary pump switch "ON" (or as instructed by aircraft manufacturer).

   CAUTION...If engine is hot, press starter button first, then turn auxiliary fuel pump switch "ON" (or as instructed by aircraft manufacturer).

8. When fuel pressure gage shows normal idle pressure (2 to 2.5 psi), engage starter.

   CAUTION...Release starter switch as soon as engine fires. never engage the starter while the propeller is still turning. If the starter has been engaged for 30 seconds, and the engine has not been started, release the starter switch and allow the starter motor to cool 3 to 5 minutes before another starting attempt is made.

9. After engine is running smoothly, turn auxiliary pump off (or as instructed by aircraft manufacturer).

10. Check oil pressure frequently. Oil pressure indication should be noted within 30 seconds in normal weather. If no pressure is noted within the specified time, stop the engine and investigate the cause.

5-4 COLD STARTS

Use the same procedure as for normal start, except that more prime will normally be necessary. After the engine begins running, it may be necessary to operate the primer intermittently for a few seconds in order to prevent the engine from stopping.

5-5 FLOODED ENGINE

1. Mixture Control - IDLE CUT-OFF.
2. Throttle - FULL OPEN.
3. Allow fuel to drain from intake tubes.
4. Magneto/Start Switch - START.
5. When engine starts, return the Magneto/Start switch to BOTH. Retard the throttle and slowly advance the mixture control to FULL RICH position.

5-6 HOT STARTS

Use the same procedure as for normal start.

5-7 GROUND WARM-UP

Teledyne Continental Motors aircraft engines are air cooled and are dependent on the forward speed of the aircraft for cooling. To prevent overheating, it is important that the following rules be observed.

1. Head the aircraft into the wind.
2. Operate the engine on the ground with the propeller in "Full Increase" RPM position.
3. Avoid prolonged idling at low RPM. Fouled spark plugs can result from this practice.
4. Leave mixture in "Full Rich". (See "Ground Operation at High Altitude Airports", Chapter 7 for exceptions.)
5. Warm-up 900-1000 RPM.

5-8 PRE-TAKEOFF CHECK

1. Maintain engine speed at approximately 900 to 1000 RPM for at least one minute in warm weather, and as required during cold weather, to prevent cavitation in the oil pump and to assure adequate lubrication.

2. Advance throttle slowly until tachometer indicates an engine speed of approximately 1200 RPM. Allow additional warm-up time at this speed depending on ambient temperature. This time may be used for taxiing to takeoff position. The minimum allowable oil temperature for run-up is 75°F.

   CAUTION...Do not operate the engine at run-up speed unless oil temperature is 75°F. minimum and oil pressure is within specified limits of 30-60 PSI.

   CAUTION...Operation of the engine at too high a speed before reaching minimum oil temperature may cause loss of oil pressure and engine damage.

3. Perform all ground operations with cowling flaps (if installed), full open, with mixture control in "FULL RICH" position, dependent on field elevation, and propeller control set for maximum RPM (except for brief testing of propeller governor).

4. Restrict ground operations to the time necessary for warm-up and testing.

5. Increase engine speed to 1700 RPM only long enough to perform the following checks:

   a. Check magnetos: Move the ignition switch first to "R" position and note engine RPM, then move switch back to "BOTH" position to clear the other set of spark plugs. Then move the switch to "L" position and note RPM. The difference between the two magnetos operated individually should not differ more than 50 RPM with a maximum drop for either magneto of 150 RPM. Observe engine for roughness during this check.

      WARNING...Absence of RPM drop when checking magnetos may indicate a malfunction in the ignition circuit. Should the propeller be moved by hand (as during preflight) the engine may start and cause injury to personnel. This type of malfunction must be corrected prior to continued operation of the engine.

      CAUTION...Do not underestimate the importance of pre-takeoff magneto check. When operating on single ignition, some RPM drop should be noted. Normal indications are 25-75 RPM drop and slight engine roughness as each magneto is switched off. An RPM drop in excess of 150 RPM may indicate a faulty magneto or fouled spark plugs.

      Minor spark plug fouling can usually be cleared as follows:

      (1) Magnetos - Both On.

      (2) Throttle - 2200 RPM

      (3) Mixture - Move toward idle cutoff until RPM peaks and hold for ten seconds. Return mixture to full rich.

      (4) Magnetos - Recheck.

      If the engine is not operating within specified limits, it must be inspected and repaired prior to continued operational service.

      Avoid prolonged single magneto operation to preclude fouling of the spark plugs.

b. Check throttle and propeller operation.

Move propeller governor control toward low RPM position and observe tachometer. Engine speed should decrease to minimum governing speed (200-300 RPM drop). Return governor control to high speed position. Repeat this procedure two or three times to circulate warm oil into the propeller hub.

Where applicable move propeller control to "feather" position. Observe for 300 RPM drop below minimum governing RPM, then return control to "full increase" RPM position.

CAUTION...Do not operate the engine at a speed in excess of 2000 RPM longer than necessary to test operation and observe engine instruments. Proper engine cooling depends upon forward speed of the aircraft. Discontinue testing if temperature or pressure limits are approached.

6. Instrument Indications.

WARNING...If any discrepancies are noted in instrument indications, identification of cause and correction of problem is required before takeoff.

a. Oil Pressure: The oil pressure relief valve will maintain pressure within the specified limits if the oil temperature is within the specified limits and if the engine is not excessively worn or dirty. Fluctuating or low pressure may be due to dirt in the oil pressure relief valve or congealed oil in the system.

b. Oil Temperatures: The oil cooler and oil temperature control valve will maintain oil temperature within the specified range unless the cooler oil passages or air channels are obstructed. Oil temperature above the prescribed limit may cause a drop in oil pressure, leading to rapid wear of moving parts in the engine.

c. Cylinder Head Temperature: Any temperature in excess of the specified limit may cause cylinder or piston damage. Proper cooling of cylinders depends on cylinder baffles being properly positioned on the cylinder heads and barrels, and other joints in the pressure compartment being tight so as to force air between the cylinder fins. Fuel and air mixture ratio will affect cylinder temperature. Excessively lean mixture causes overheating even when the cooling system is in good condition. High power and low air speed, or any slow speed flight operation, may cause overheating by reducing the cooling air flow. The engine depends on the ram air flow developed by the forward motion of the aircraft for proper cooling.

d. Battery Charging: The ammeter should indicate a positive charging rate until the power used for starting has been replaced by the battery charging circuit, unless the electrical load on the generator is heavy enough to require its full output, in which event the ammeter reading should return to the positive side as soon as the load is reduced. A low charging rate is normal after the initial recharging of the battery. A zero reading or negative reading with no battery load indicates a malfunction in the generator or regulator system.

5-9 POWER CONTROL

When increasing power, first increase the RPM with the propeller control and then increase manifold pressure with throttle. When decreasing power, throttle back to desired manifold pressure and then adjust to the desired RPM. Readjust manifold pressure after final RPM setting.

5-10 TAKEOFF

1. Set mixture to "FULL RICH" setting. Where installed, cowl flaps must be in the full open position.

The "ES" engine is equipped with an altitude compensating fuel pump which automatically provides the proper full rich mixture at any given altitude.

NOTE...For operation from fields at high altitudes, operation must be conducted with the mixture control leaned for maximum performance as defined by charts in the aircraft manual. The leaner mixture is required to eliminate engine roughness. Engines with an altitude compensating fuel pump (ES Model) are automatically leaned for this condition. The mixture control should be in the full rich position for these engines.

2. Advance the throttle to the maximum take-off manifold pressure (red-line on manifold pressure gage). The recommended power setting (RPM and manifold pressure) should never be exceeded. Monitor all engine instrumentation. The A,AB, J and JB model engines have a special take-off rating limited to five minutes at maximum take-off power; then power must be reduced to maximum cruise.

3. Set auxiliary pump switch as instructed by aircraft manufacturer.

   NOTE...With high temperature at ground level, a very low fluctuation in metered fuel pressure may appear in the early flight stages, which is caused by excess vapor.

   CAUTION...Cylinder head and oil temperatures must never be allowed to exceed the limitations specified. Near-maximum temperatures should occur only when operating under adverse conditions, such as high power settings, low airspeed, extreme ambient temperature, etc. If excessive temperatures are noted, and cannot reasonably be explained, or if abnormal cowl flap and/or mixture settings are required to maintain temperatures, then an inspection should be performed to determine the cause. Possible causes of high temperatures may include broken or missing baffles, inoperative cowl flaps, sticking oil temperature control unit, or restricted fuel nozzles jets (resulting in lean-running cylinders). Faulty instruments or thermocouples may cause erroneous high (or low) temperature indications. Refer to Chapter 9 of this manual and/or the aircraft overhaul manual for troubleshooting procedures.

5-11 CLIMB (In Accordance with Aircraft Manufactures Recommendations)

1. All high power climbs must be performed at "FULL RICH" mixture setting with cowl flaps, if provided, in the full open position.

2. During climb (immediately after takeoff), observe manifold pressure and retard throttle to stay below the 28.0 inch (29.5 inch for ES) maximum manifold pressure setting (red line).

3. At reduction from take-off power for climb, follow aircraft manufacturer's recommendation for fuel pressure at power setting.

5-12 CRUISE

1. Set manifold pressure and RPM for cruise power selected. Reset mixture control for "Best Power Setting" in accordance with the applicable fuel pressure or Fuel Flow vs Brake Horsepower curve.

2. After engine temperatures have stabilized at cruise condition (usually within 5 minutes), the mixture may be reset for a "Normal Lean".

   NOTE...An excessively lean mixture can lead to high cylinder temperatures and detonation which will result in burned pistons, glazed or scored cylinders and broken or stuck piston rings.

3. When an economy setting (step 2 above) is in use and a change in power setting is to be made, it is recommended that the mixture control be returned to approximately "Best Power Setting" before changing the throttle or propeller setting.

4. If it is necessary to retard the throttles at altitudes above approximately 10,000 ft., leaning of the fuel mixture may also be necessary to maintain satisfactory engine operation. The mixture must be returned to the richer setting before the throttle is returned to the high power position.

NOTE...If an exhaust gas temperature gage is used to monitor cruise mixture setting at 75% power and below, consult Service Bulletin M89-18 or current revision as applicable.

5-13 DESCENT

1. Set mixture control at "Best Power Setting" or richer, "Full Rich" for "ES" before reducing power for descent.
2. The mixture control must be set in "FULL RICH" position before entering the airport traffic pattern.
3. Operate the auxiliary pump as instructed by aircraft manufacturer.
4. Adjust power as desired and monitor all engine instrumentation.

WARNING...Rapid descents at high RPM and idle manifold pressure or long descents below 18" hg. or manifold pressure may cause intermittent oil consumption through the induction system, excessive piston ring land wear, or unsatisfactory acceleration due to spark plug fouling or extreme cooling.

If power must be reduced for long periods, adjust propeller to minimum governing RPM and set manifold pressure no lower than necessary to obtain desired performance. Outside air temperature is a factor which affects cylinder and oil temperatures, and in those cases of very cold temperatures it may be necessary to lean the mixture and/or add drag to the aircraft, according to the airframe manufacturer's recommendations, in order to maintain engine power without gaining excess airspeed so as not to let cylinder head and oil temperatures go below operational limits listed in detailed specifications in Section 1.

Do not permit cylinder temperature to drop below 300°F. for periods exceeding five (5) minutes.

5-14 LANDING

1. In anticipation of a go around and need for high power settings, the mixture control must be set in "FULL RICH" or "BEST POWER" position, depending on field elevation, before landing.

   NOTE...Advance mixture slowly toward 'FULL RICH". If engine roughness occurs, as may happen at very low throttle settings and high RPM, it may be desirable to leave the mixture control leaner than full rich until the throttle is advanced above 15 inches of manifold pressure.

2. Operate the auxiliary pump as instructed by the aircraft manufacturer.

5-15 ENGINE SHUTDOWN

1. If auxiliary pump has been on in landing, turn "OFF".
2. Place mixture control in "IDLE CUT-OFF".
3. Turn magneto "OFF".

WARNING...Do not turn the propeller while the ignition switch is in the "BOTH", "LEFT" or "RIGHT" position, because this could start the engine and cause injury. Do not turn the propeller on a hot engine, even though the ignition switch is in the "OFF" position, because the engine could "KICK" as a result of auto-ignition of a small amount of fuel remaining in the cylinders.

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CHAPTER 6
EMERGENCY PROCEDURES

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6-1 ENGINE FIRE DURING START

If flames are observed in the induction or exhaust system during engine starting, proceed as follows:

1. Mixture Control - Move to the idle cut-off position.
2. Throttle Control - Move to the full open position.
3. Starter Switch - Hold in the cranking position until fire is extinguished.
4. Evacuate aircraft if fire is not quickly contained.

6-2 GENERAL IN-FLIGHT INFORMATION

If a malfunction should occur in flight, certain remedial actions may eliminate or reduce the problem. Some malfunctions which might conceivably occur are listed in this section. Recommended corrective action is also included: however, it should be recognized that no single procedure will necessarily be applicable to every situation.

A thorough knowledge of the aircraft and engine systems will be an invaluable asset to the pilot in assessing a given situation and dealing with it accordingly.

6-3 ENGINE ROUGHNESS

Observe engine for visible damage or evidence of smoke or flame. Extreme roughness may be indicative of a propeller blade problem. If any of these characteristics are noted, follow aircraft manufacturer's instructions.

1. Mixture - Adjust as appropriate to power setting being used. Do not arbitrarily go to Full Rich as the roughness may be caused by an over rich mixture.
2. Magnetos - Check - on both.

If engine roughness does not disappear after the above, the following steps should be taken to evaluate the ignition system.

1. Throttle - Reduce power until roughness becomes minimal.
2. Magnetos - Turn Off, one magneto at a time. If engine smoothes out while running on single ignition, adjust power as necessary and continue. Do not operate the engine in this manner any longer than absolutely necessary. The airplane should be landed as soon as practical for engine repairs.

If no improvement in engine operation is noted while operating on either magneto alone, return all magneto switches to On.

CAUTION...The engine may quit completely when one magneto is switched off, if the other magneto is faulty. If this happens, close throttle to idle and move mixture to idle cutoff before turning magnetos on. This will prevent a severe backfire. When magnetos have been turned back on, advance mixture and throttle to previous setting.

WARNING...If roughness is severe or if the cause cannot be determined, engine failure may be imminent. In this case, it is recommended that the aircraft manufacturer's emergency procedure be employed. In any event, further damage may be minimized by operating at a reduced power setting.

6-4 HIGH CYLINDER HEAD TEMPERATURE

1. Mixture - Adjust to proper fuel flow for power being used.

2. Cowl Flaps - Open.

3. Airspeed - Increase.

It temperature cannot be maintained within limits, reduce power, land as soon as practical and have the malfunction evaluated and repaired before further flight.

6-5 HIGH OIL TEMPERATURE

NOTE...Prolonged high oil temperature indications will usually be accompanied by a drop in oil pressure. If oil pressure remains normal, a high temperature indication may be caused by a faulty gage or thermocouple. If the oil pressure drops as temperature increases, proceed as follows:

1. Cowl Flaps - Open.

2. Airspeed - Increase.

3. Power - Reduce if steps 1 and 2 do not lower oil temperature.

CAUTION...If these steps do not restore oil temperature to normal, an engine failure or severe damage can result. In this case it is recommended that the aircraft manufacturer's emergency instructions be followed.

6-6 LOW OIL PRESSURE

If the oil pressure drops without apparent reason from normal indication of 30 to 60 psi, monitor temperature and pressure closely. If oil pressure drops below 30 psi, an engine failure should be anticipated and the aircraft manufacturer's instructions should be followed.

6-7 IN-FLIGHT RESTARTING

WARNING...Actual shutdown of an engine for practice or training purposes should be minimized. Whenever engine failure is to be simulated, it should be done by reducing power.

The following procedure is recommended for in-flight restarting.

1. Mixture - Advance to 3/4 FULL RICH.

2. Fuel Selector Valve - On Proper Tank.

3. Fuel Boost Pump - Off.

4. Magneto Switches - ON BOTH.

5. Throttle - NORMAL START POSITION (Open 1").

6. Propeller - Low Pitch High RPM.

6-8 ENGINE FIRE IN-FLIGHT

1. Fuel Selector - Turn to the Off Position.
2. Mixture Control - Place in the Idle Cut-Off Position.
3. Throttle Control - Place in the Closed Position.
4. Propeller Control
   a. Non-Feathering Type Propeller - Full Decrease RPM Position.
   b. Feathering Type - Feather position position.
5. Magnetos - Place Both in the "OFF" position.
6. Follow air frame manufacturer's instructions for emergency/forced landing.

CHAPTER 7
ABNORMAL ENVIRONMENTAL CONDITIONS

Section Index

7-1 GENERAL

Three areas of operation require special attention, (a) extreme cold weather, (b) extreme hot weather and (c) high density altitude ground operation.

7-2 COLD WEATHER OPERATION (Ambient Temperature Below Freezing)

NOTE...Prior to operation and/or storage in cold weather assure engine oil viscosity is SAE 30, 10W30, 15W50 or 20W50.In the event of temporary cold weather operation,not justifying an oil change to SAE 30, consideration should be given to hangaring the aircraft between flights.

Engine starting during extreme cold weather is generally more difficult than during normal temperature conditions. Cold soaking causes the oil to become thicker (more viscous), making it more difficult for the starter to crank the engine. This results in a slow cranking speed and an abnormal drain on the battery capacity. At low temperatures, gasoline does not vaporize readily, further complicating the starting procedure.

False starting (failure to continue running after starting) often results in the formation of moisture on spark plugs due to condensation. This moisture can freeze and must be eliminated either by applying heat to the engine or removing and cleaning the spark plugs.

7-3 PREHEATING

The use of preheat and auxiliary power unit (APU) will facilitate starting during cold weather and is required when the engine has been cold soaked at temperatures of 25°F, and below in excess of 2 hours.

The following procedures are recommended for preheating, starting, warm-up, run-up and takeoff.

1. Select a high volume hot air heater. Small electric heaters which are inserted into the cowling opening do not appreciably warm the oil and may result in superficial preheating.

WARNING...Superficial application of preheat to a cold-soaked engine can cause damage to the engine.

A minimum of preheat application may warm the engine enough to permit starting but will not de-congeal oil in the sump, lines, cooler, filter, etc.

Congealed oil in such lines may require considerable preheat. The engine may start and apparently run satisfactorily, but can be damaged from lack of lubrication due to congealed oil in various parts of the system. The amount of damage will vary and may not become evident for many hours. On the other hand, the engine may be severely damaged and could fail shortly following application of high power.

Proper procedures require thorough application of preheat to all parts of the engine. Hot air should be applied directly to the oil sump and external oil lines as well as the cylinders, air intake and oil cooler. Excessively hot air can damage non-metallic components such as seals, hoses and drive belts, so do not attempt to hasten the preheat process.

2. Hot air should be applied primarily to the oil sump and filter area. The oil drain plug door or panel may provide access to these areas. Continue to apply heat for 15 to 30 minutes and turn the propeller, by hand, through 6 or 8 revolutions at 5 or 10 minute intervals.

3. Periodically feel the top of the engine and when some warmth is noted apply heat directly to the upper portion of the engine for approximately five minutes. This will provide sufficient heating of the cylinders and fuel lines to promote better vaporization for starting. If enough heater hoses are available, continue heating the sump area. Otherwise, it will suffice to transfer the source of heat from the sump to the upper part of the engine.

4. Start the engine immediately after completion of the preheating process. Before starting is attempted, turn the engine by hand or starter (mixture at idle cut off) until it rotates freely. After starting, observe carefully for high or low oil pressure and continue the warm-up until the engine operates smoothly and all controls can be moved freely. Operate cowl flaps as per airframe manufacturer's instructions.

   NOTE...Since the oil in the oil pressure gage line may be congealed, as much as 60 seconds may elapse before oil pressure is indicated. If oil pressure is not indicated within one minute, shut the engine down and determine the cause.

5. Operate the engine at 1000 RPM until some oil temperature is indicated. Monitor oil pressure closely during this time and be alert for a sudden increase or decrease. Retard throttle, if necessary to maintain oil pressure below 100 psi. If oil pressure drops suddenly to less than 30 psi, shut down the engine and inspect the lubrication system. If no damage or leaks are noted, preheat the engine for an additional 10 to 15 minutes before restarting. (Refer to Section 5-8 "Pre-Takeoff Check".)

6. Before takeoff, run up the engine to 1700 RPM. If necessary approach this RPM in increments to prevent oil pressure from exceeding 100 psi.

   At 1700 RPM, adjust the propeller control to Full Decrease RPM until minimum governing RPM is observed, then return the control to Full Increase RPM. Repeat this procedure three or four times to circulate warm oil into the propeller dome.

   NOTE...Continually monitor oil pressure during run up.

7. Check magnetos in the normal manner.

8. When the oil temperature has reached 100°F and oil pressure does not exceed 70 psi at 2500 RPM, the engine has been warmed sufficiently to accept full rated power.

   NOTE...Fuel flow will probably be on the high limit; however, this is normal and desirable since the engine will be developing more horsepower at substandard ambient temperatures.

Observe oil pressure for indication and warm-up engine at 1000 RPM. Ground operation and run up require no special techniques other than warming the engine sufficiently to maintain oil temperature and oil pressure within limits when full RPM is applied.

NOTE...Before applying power for takeoff, assure that oil pressure, oil temperature and cylinder head temperature are well within the normal operating range. When full power is applied for takeoff, assure that oil pressure is within limits and steady.

Any of the following engine conditions should be cause for concern, and are justification to discontinue the takeoff.

1. Low, high or surging RPM.

2. Fuel flow excessively high or low.

3. Any oil pressure indication other than steady within limits.

4. Engine roughness.

7-4 HOT WEATHER OPERATION (Ambient Temperature in Excess of 90°F)

CAUTION...When operating in hot weather areas, be alert for higher than normal levels of dust, dirt, or sand in the air. Inspect air filters frequently and be prepared to clean or replace them if necessary. Weather conditions can lift damaging levels of dust and sand high above the ground. If the aircraft is flown through such conditions, an oil change is recommended as soon as possible. Do not intentionally operate the engine in dust and/or sand storms. The use of dust covers on the cowling will afford additional protection for a parked aircraft.

Flight operation during hot weather usually presents no problem since ambient temperatures at flight altitudes are seldom high enough to overcome the cooling system used in modern aircraft design. There are, however, three areas of hot weather operation which will require special attention on the part of the operator. These are: (1)Starting a hot engine (2)Ground operation under high ambient temperature conditions and (3)Takeoff and initial climbout.

1. Starting a Hot Engine. After an engine is shutdown, the temperature of its various components will begin to stabilize;that is, the hotter parts such as cylinders and oil will cool, while other parts will begin to heat up due to lack of air flow,heat conduction, and heat radiation from those parts of the engine which are cooling. At some time period following engine shutdown the entire unit will stabilize near the ambient temperature. This time period will be determined by temperature and wind conditions and may be as much as several hours. This heat soaking is generally at the extreme from 30 minutes to one hour following shutdown. During this time, the fuel system will heat up causing the fuel in the pump and lines to "boil" or vaporize.During subsequent starting attempts the fuel pump will initially be pumping some combination of fuel and fuel vapor.At the same time,the injection nozzle lines will be filled with varying amounts of fuel and vapor.Until the entire fuel system becomes filled with liquid fuel,difficult starting and unstable engine operation can normally be expected.

   Another variable affecting the fuel vapor conditions is the state of the fuel itself.Fresh fuel contains a concentration of volatile ingredients.The higher this concentration the more readily the fuel will vaporize and the more severe will be the problems associated with vapor in the fuel system.Time, heat or exposure to altitude will "age" aviation gasoline;that is, these volatile ingredients tend to dissipate.This reduces the tendency of fuel to vaporize. Starting problems may occur if the volitity is not sufficient for adequate fuel vaporization.

The operator, by being cognizant of these conditions, can take certain steps to cope with problems associated with hot weather/hot engine starting. The primary objective should be that of permitting the system to cool. Lower power settings during the landing approach when practical will allow some cooling prior to the next start attempt. Reducing ground operation to a minimum is desired to keep engine temperatures down. Cowl flaps should be opened fully while taxiing. The aircraft should be parked so as to face into the wind to take advantage of the cooling effect. Restarting attempts will be the most difficult from 30 minutes to one hour after shutdown. Following that interval fuel vapor will be less pronounced and normally will present less of a restart problem.

The starting procedure for a hot engine is the same as the normal starting procedure except that the throttle should be opened more while cranking.

If the procedure does not effect a start, proceed as follows:

a. Ignition switch off.

b. Throttle open.

c. Mixture control IN Idle Cut-Off

d. Fuel Pump on high 15 seconds

e. Normal start procedure

2. Ground Operation in High Ambient Temperature Conditions. Oil and cylinder temperatures should be monitored closely during taxiing and engine run up. Operate with cowl flaps full open. Do not operate the engine at high RPM except for necessary operational checks. If takeoff is not to be made immediately following engine run up, the aircraft should be faced into the wind with the engine idling at 900-1000 RPM. It may be desirable to operate the fuel boost pumps to assist in suppressing fuel vaporization and provide more stable fuel pressure during taxiing and engine run up.

3. Take-off Initial Climbout. Do not operate at maximum power any longer than necessary to establish the climb configuration recommended by the aircraft manufacturer. Temperatures should be closely monitored and sufficient airspeed maintained to provide cooling of the engine.

If higher than desired temperatures are experienced during the climb phase, the pilot may elect to establish a lower angle of attack or higher climb speed, consistent with safety and thereby provide increased cooling for the engine.

CAUTION...Reduced engine power will result from higher density altitude associated with high temperature.

7-5 GROUND OPERATION AT HIGH ALTITUDE AIRPORTS

Idle fuel mixture may be rich at high altitudes. Under extreme conditions, it may be necessary to manually lean the mixture in order to sustain engine operation at low RPM. When practical, operate the engines at higher idling speed.

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CHAPTER 8
SERVICING AND UNSCHEDULED MAINTENANCE

Section Index

Section **Page**

8-1 SERVICING

The owner or operator is responsible for maintaining the engine in an airworthy condition, including compliance with all applicable Airworthiness Directives as specified in Part 39 of the Federal Aviation Regulations and "Airworthiness Limitation" of this manual per FAR A33.4. It is further the responsibility of the owner or operator to ensure that the engine is inspected in conformity with the requirements of Parts 43 and 91 of the Federal Aviation Regulations. Teledyne Continental Motors has prepared this inspection guide to assist the owner or operator in meeting the foregoing responsibilities. This inspection guide is not intended to be all-inclusive, for no such guide can replace the good judgment of a certified airframe and power plant mechanic in the performance of his duties. As the one primarily responsible for the airworthiness of the airplane, the owner or operator should select only qualified personnel to maintain the airplane.

Fuel (Min. Grade) . . . . Aviation Grade 100 or 100 LL

WARNING...The use of a lower octane rated fuel can result in destruction of an engine the first time high power is applied. This would most likely occur on takeoff. If the aircraft is inadvertently serviced with the wrong grade of fuel, then the fuel must be completely drained and the tank properly serviced.

Oil: (First 25 hrs. operation) Mineral (non-Detergent) oil or Corrosion Preventive oil Corresponding to MIL-C-6529 Type II

Normal Service

All Temperatures	15W-50 20W-50
Below 40°F Ambient Air (Sea Level)	SAE30 or 10W-30
Above 40°F Ambient Air (Sea Level)	SAE 50
Oil Sump Capacity	10 U.S. Quarts (8 U.S. Quarts ES)
Oil Change Interval:	With Integral Screen 25 Hrs. Small Full Flow Filter 50 Hrs. Large Full Flow Filter 100 Hrs.

CAUTION...Use only oils conforming to Teledyne Continental Motors Specification MHS24 or MHS-25 after break-in period.

8-2 APPROVED PRODUCTS

The marketers of the aviation lubricating oils listed below have supplied data to Teledyne Continental Motors indicating their products conform to all requirements of TCM Specification MHS-24, Lubricating Oil, Ashless Dispersant, or MHS-25, Synthetic Lubrication Oil.

In listing the product names, TCM makes no claim or verification of marketer's statements or claims. Listing is made in alphabetical order and is provided only for the convenience of the users.

APPROVED PRODUCTS

Supplier	Brand
BP Oil Corporation	BP Aero Oil
Castrol Limited (Australia)	Castrolaero AD Oil
Chevron U.S.A Inc.	Chevron Aero Oil
Continental Oil	Conco Aero S
Delta Petroleum Company	Delta Avoil Oil
Exxon Company, U.S.A.	Exxon Aviation Oil EE
Mobil Oil Company	Mobil Aero Oil
Mobil Oil Corporation	Mobil AV-1
NYCO S.A.	Turbonycoil 3570
Pennzoil Company	Pennzoil Aircraft Engine Oil
Phillips 66 Company	Aviation Oil Type A
Phillips 66 Company	X/C Multiviscosity SAE 20W-50
Phillips 66 Company	X/C Multiviscosity SAE 25W-60
Quaker State Oil & Refining Co.	Quaker State AD Aviation Engine Oil
Red Ram Limited (Canada)	Red Ram Aviation Oil 20W-50
Shell Australia	Aeroshell (R) W
Shell Canada Limited	Aeroshell Oil W, Aeroshell Oil W 15W-50 Anti-Wear Formulation Aeroshell Oil W 15W50
Shell Oil Company	Aeroshell Oil W, Aeroshell Oil W 15W-50 Anti-Wear Formulation Aeroshell Oil W 15W50
Sinclair Oil Company	Sinclair Avoil
Texaco Inc.	Texaco Aircraft Engine Oil - Premium AD
Total France	Total Aero DW 15W50
Union Oil Company of California	Union Aircraft Engine Oil HD

NOTE...The following procedures and schedules are recommended for engines which are subjected to normal operation. If the aircraft is exposed to severe conditions, such as training, extreme weather, or infrequent operation, inspections should be more comprehensive and the hourly intervals should be decreased.

8-3 PREFLIGHT INSPECTION

Before each flight, the engine and propeller should be examined for damage, oil leaks, proper servicing and security. Refer to the aircraft manual "Preflight Check List".

WARNING...Any descrepencies detremintal to flight safety, will be cause for grounding aircraft unitl descrepencies are corrected.

8-4 50 HOUR INSPECTION

Detailed information regarding adjustments, repair and replacement of components may be found in the appropriate Overhaul Manual. The following items should be checked during normal inspections:

1. Engine Conditions: (Refer to Chapter 5)

a.	Magneto RPM drop:	Check
b.	Full Power RPM:	Check
c.	Full Power Manifold Pressure:	Check
d.	Full Power Fuel Flow:	Check
e.	Idle RPM:	Check

Record any values not conforming to engine specifications so that necessary repair or adjustment can be accomplished before further flight.

2. Oil Filter: Replace filter, inspect cartridge.
3. Oil: Change oil, if integral screen or small filter is used.
4. Air Filter: Inspect and clean or replace as necessary.
5. High Tension Leads: Inspect for chafing and deterioration.
6. Magnetos: Check and adjust only if non-conformities were noted in Step 1.
7. Visual: Check hoses, lines, wiring, fittings, baffles, etc. for general condition.
8. Exhaust System: Inspect for condition and leaks.
9. Adjustments & Repairs: Perform service as required on any items that are not within specifications.
10. Engine Condition: Run up and check as necessary. Check engine for oil and fuel leaks before returning to service.

8-5 100 HOUR INSPECTION

Detailed information regarding adjustments, repair and replacement of components may be found in the appropriate Overhaul Manual. The following items should be checked during normal inspections:

1. Engine Conditions: (Refer to Chapter 5)

a.	Magneto RPM drop:	Check
b.	Full Power RPM:	Check
c.	Full Power Manifold Pressure:	Check
d.	Full Power Fuel Flow:	Check
e.	Idle RPM:	Check

Record any values not conforming to engine specifications so that necessary repair or adjustment can be accomplished before further flight.

2. Oil Filter: Replace, inspect cartridge.
3. Oil: Drain while engine is warm. Refill sump.
4. Valves/Cylinders: Check compression (Refer to Service Bulletin M84-1 or subsequent revisions as applicable).

5.	Cylinders,Fins, Baffles	Inspect.
6.	Spark Plugs:	Inspect, clean, regap (if necessary), reinstall. Rotate plugs from upper to lower positions and vice versa to lengthen plug life.
7.	High Tension Leads:	Inspect for chafing and deterioration.
8.	Magnetos:	Check. Adjust points and timing if necessary.

NOTE...Minor changes in magneto timing can be expected during normal engine service. The time and effort required to check and adjust the magnetos to specifications is slight and the operator will be rewarded with longer contact point and spark plug life, smoother engine operation and less corrective maintenance between routine inspections.

WARNING...At each 500 hours, the magnetos are required to be disassembled and inspected according to Magneto Service Manual.

9.	Air Filter:	Inspect and clean or replace as necessary.
10.	Alternate Air Door:	Check operation.
11.	Throttle Shaft and Linkage:	Inspect for wear and lubricate.
12.	Fuel Nozzles:	Inspect nozzles and vent manifold for leaks or damage.
13.	Fuel & Oil Hoses & Lines:	Inspect for deterioration, leaks, chafing.
14.	High & Low Fuel Pump Outlet Pressure	Check. Adjust if necessary. (Refer to TCM Bulletin M89-10 or current revision as applicable for Procedure)
15.	Control Connections:	Inspect and lubricate.
16.	Oil Pressure Relief Valve:	Inspect and clean.
17.	Oil Temp. Control Unit:	Inspect and clean.
18.	Exhaust:	Check all joints for condition and leaks.
19.	Adjustment & Repairs:	Perform service as required on any items that are not within specifications.
20.	Engine Condition:	Perform complete run up. Check engine for fuel or oil leaks before returning to service.

Fuel Injection Service and Maintenance: When attempting to determine whether a problem exists in the engine fuel injection system it is advisable to confirm that other engine systems, (particularly the aircraft fuel system and the ignition system) are functioning correctly before concluding that the trouble lies in the fuel injection system. Any trouble in the fuel injection system will likely be associated with dirt or foreign matter. For this reason, the filter screens at the fuel manifold valve and the main filter in the aircraft supply line must be kept clean and unrestricted.

Adjustments: The idle speed adjustment is a conventional spring loaded screw, located in the air throttle lever. (See Figure 8-1.) Set idling speed for 600 RPM. the idler mixture adjustments is a screw on the metering valve directly above the lead seal. (See Figure 8-1.) Tightening the screw will provide a leaner mixture. A richer mixture is obtained by backing off the screw. Tap fuel control unit slightly when enrichening to stabilize fuel control cam. Adjust to obtain a slight and momentary gain in idle speed as the mixture control is slowly moved toward "IDLE CUT-OFF". (If set too lean, idle speed will drop under the same conditions.) See service Bulletin M89-10 or subsequent revisions as applicable.

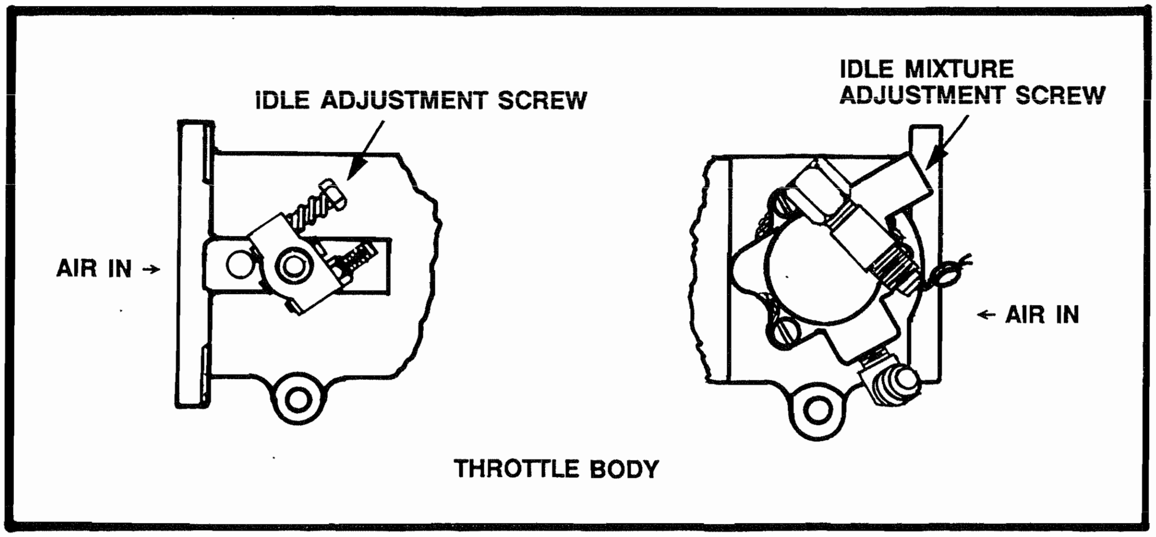


FIGURE 8-1. IDLE ADJUSTMENT POINTS

8-6 UNSCHEDULED MAINTENANCE

Detailed information required for component part replacement, system adjustments, accessory replacement/repair, top overhaul etc., can be found in the "Related Publications" listed in Chapter 1.

No unscheduled maintenance of the categories listed above should be attempted without consulting the applicable related publications.

The Time Between Overhaul (TBO) for the IO-360 Series is 1500 hours, (2000 for KB). Those accessories supplied with this engine by TCM are considered to have the same TBO as the engine with the criteria for service and longevity as outlined in the most current TCM TBO service bulletin M89-13 or subsequent revision as applicable.

8-7 CYLINDER COMPRESSION (Leakage) CHECK

The differential pressure test is an accepted method of determining cylinder condition by measuring air pressure loss past the pistons, rings and valves. The operation of the equipment is based on the principle that, for any given airflow through a fixed orifice, a constant pressure drop across that orifice will result. On many engines it is now a regular part of the 100 hour or annual inspection.

We have received reports of incorrect cylinder leakage check results caused by improper use of test equipment and/or by the use of faulty test equipment.

To help you accurately accomplish a leakage check, we submit the following information on leakage and use of the Master Orifice Tool (Ref. Figure 8-2) to calibrate the leakage checking equipment used on Teledyne Continental engines.

LEAKAGE CHECKS

Cylinder leakage is broken down into two areas of concern, the "Static Seal" and the "Dynamic Seal".

Static Seal

The static seal consists of the valve to valve seat seals, spark plug to spark plug port seals and cylinder head to barrel seal (Ref. Figure 8-3). No leakage of the static seal is permissible.

Dynamic Seal

The dynamic seal consists of the piston rings to the cylinder wall seal (Ref. Figure 8-3). This seal leakage can vary from engine to engine by the cylinder displacement, cylinder choke, ring end gap and piston design.

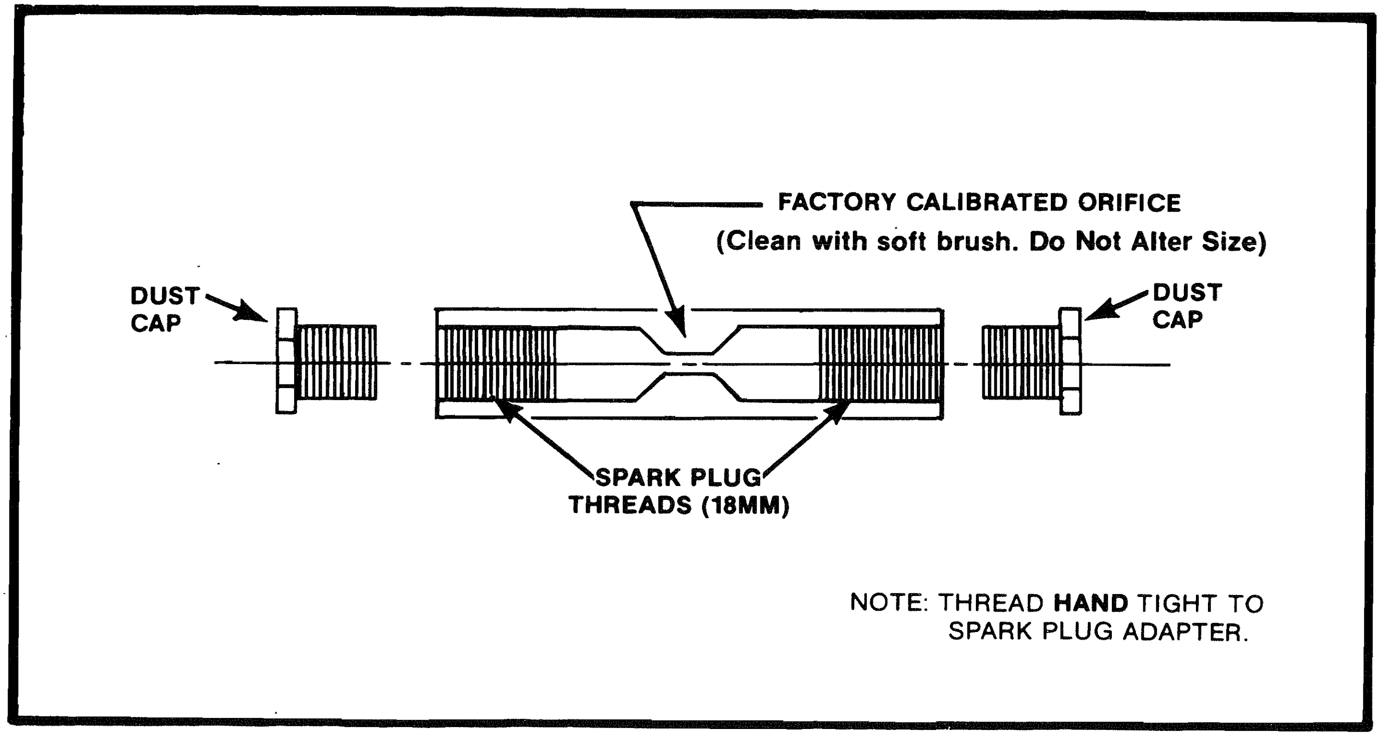
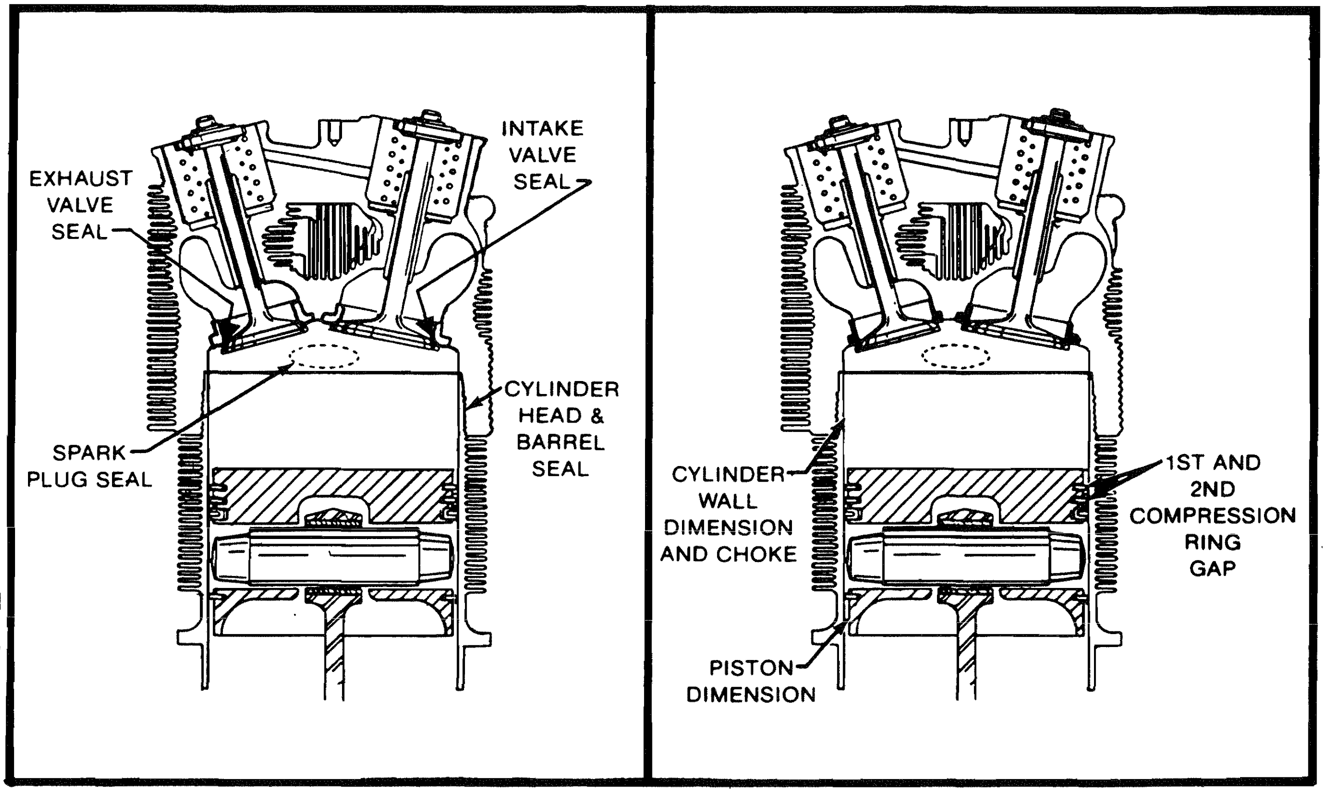


FIGURE 8-2. MASTER ORIFICE ASSEMBLY TOOL BORROUGHS P/N 646953.

Borroughs Tool & Equipment Co.
2429 N. Burdick St.
Kalamazoo, MI 49007
Tel. 616/345-2700



STATIC SEAL **DYNAMIC SEAL**

FIGURE 8-3.

EQUIPMENT

Testing equipment must be kept clean and checked periodically for accuracy as follows: Using a line pressure of 100 to 120 p.s.i., close the cylinder pressure valve, then set the regulator pressure valve to 80 p.s.i.. The pressure in both gages should stabilize with no leakage.

The restrictor orifice dimension in the differential pressure tester (Fig. 8-4) for Teledyne Continental aircraft engines must be 0.040 inch orifice diameter, 0.250 inch long with 60° approach angle, and must flow 120 ± 5 cubic feet per hour at 30 p.s.i. differential pressure.

Master Orifice Tool

For conformity in tester equipment, a Master Orifice Tool has been developed to calibrate equipment and determine the low indicated leakage limit prior to the engine leakage check. Connect compressed air at 100-120 p.s.i. to the tester with cylinder pressure valve closed. Turn the regulator pressure valve on, adjusting pressure to indicate 80 p.s.i.. Remove the dust caps from both ends of the Master Orifice Tool and install onto your cylinder spark plug adapter. Turn the cylinder pressure valve on and readjust regulator pressure gage to read 80 p.s.i.. At this time the cylinder pressure gage indication will be the low allowable limit for cylinder leak checks. The low allowable limit is referred to as the master orifice calibrated pressure reading. After the master orifice calibrated pressure reading has been recorded, close regulator pressure valve and remove Master Orifice Tool from your cylinder adapter.

A schematic diagram of a typical differential pressure tester is shown in Figure 8-4.

Performing The Check

The following procedures are listed to outline the principles involved, and are intended to supplement the manufacturer's instructions for the particular tester being utilized.

CAUTION...Magnetos and fuel must be shut off prior to test to make certain that the engine combustion cannot accidently occur.

1. Perform the test as soon as possible after the engine is shut down to ensure that the piston rings, cylinder walls, and other engine parts are well lubricated and at running tolerance.

2. Remove the most accessible spark plug from each cylinder.

3. Turn the crankshaft by hand in the direction of rotation until the piston (in the cylinder being checked) is coming up on its compression stroke.

4. Install an adapter in the spark plug hole and connect the differential pressure tester to the adapter (NOTE: Cylinder pressure valve is in the Closed position). Slowly open the cylinder pressure valve and pressurize the cylinder not to exceed 20 p.s.i. Continue rotating the engine against this pressure until the piston reaches top dead center (TDC). Reaching TDC is indicated by a flat spot or sudden decrease in force required to turn the crankshaft. If the crankshaft is rotated too far, back up at least one-half revolution and start over again to eliminate the effect of backlash in the valve operating mechanism and to keep the piston rings seated on the lower ring lands. This is critical because the slightest movement breaks this piston ring sealing and allows the pressure to drop.

   CAUTION ... Care must be exercised in opening the cylinder pressure valve, since sufficient air pressure will be built up in the cylinder to cause it to rotate the crankshaft if the piston is not at TDC. It is recommended that someone hold the propeller during check to prevent possible rotation.

5. Open the cylinder pressure valve completely. Check the regulator pressure gage and adjust, if necessary to 80 p.s.i..

6. Observe the pressure indication on the cylinder pressure gage. The difference between this pressure and the pressure shown by the regulator pressure gage is the amount of leakage through the cylinder. If the cylinder pressure gage reading is higher than the previously determined master orifice calibrated pressure reading, proceed to the next cylinder leak check. If the cylinder pressure gage reading is lower, proceed with the following.

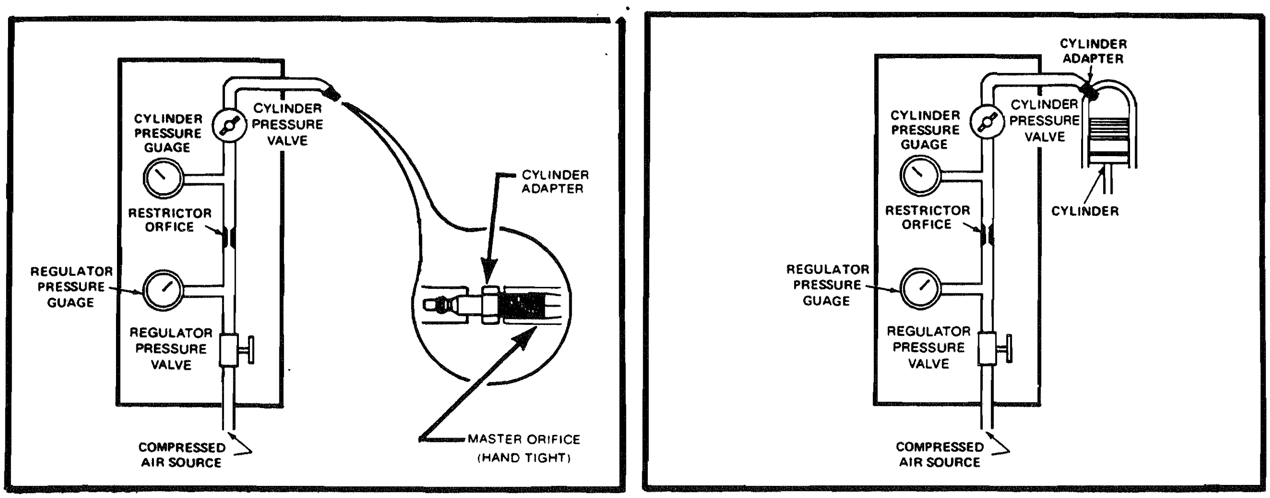


FIGURE 8-4. DIFFERENTIAL PRESSURE TESTER

Static Seal Check (Table 1)

7. The source of air leakage should first be checked for the static seal. Positive identification of static seal leakage is possible by listening for air flow sound at the exhaust or induction system cylinder port. When checking for cylinder head to barrel leakage, use a soapy solution between the fins and watch for bubbles. Use a soapy solution also around both spark plug seals for leakage. NO LEAKAGE IS ALLOWED IN STATIC SEALS.

8. If leakage is occurring in the intake or exhaust valve areas, it may be possible to correct a low reading by staking the valves. This is accomplished by placing a fiber drift on the rocker arm directly over the valve stem and tapping the drift several times with a hammer to dislodge any foreign material that may be between the valve face and seat.

   NOTE...Striking rotocoil may dislodge valve keepers.

   CAUTION...When correcting a low reading in this manner, rotate the propeller so the piston will not be at TDC. This is necessary to prevent the valve from striking the top of the piston in some engines. Rotate the propeller again before rechecking leakage to reset the valves in the normal manner.

   NOTE...When the rocker cover is removed, inspect valve springs, valve retainers and valve stem for wear. This may have contributed to the valve leakage.

9. If leakage is noted between the cylinder head and barrel, REPLACE THE CYLINDER. If leakage cannot be corrected at the valves by "staking", the cylinder must be removed and repaired before a Dynamic Seal Check.

   NOTE... When the cylinder is removed, with the spark plugs installed, inspection can be accomplished by filling the inverted cylinder bore with nonflammable solvent and then inspected for leaks at the static seal areas.

10. If the cylinderr was removed for static leakage, replacement or repair, inspect piston ring gap and cylinder wall for tolerance (Ref. Dynamic Seal, Figure 8-3). Once the piston and the cylinder have been cleaned, inspected, and ring gap tolerances have been met, reassemble to the engine.

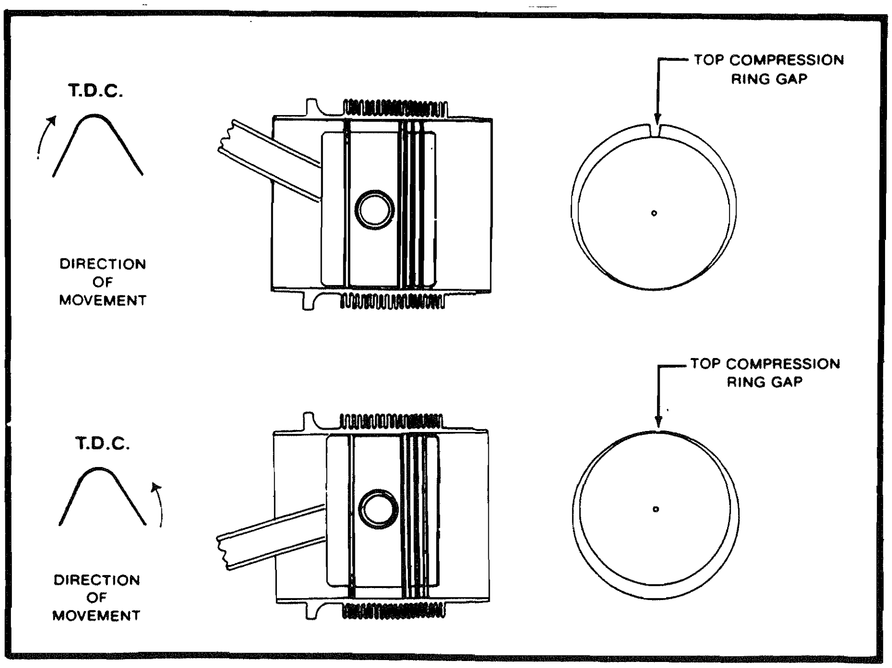


FIGURE 8-5.

Dynamic Seal Check (Table 1)

11. To check the dynamic seal of a cylinder, proceed with the leakage test and observe the pressure indication of the cylinder pressure gage. The difference between this pressure and the pressure shown by the regulator gage is the amount of leakage at the dynamic seal.

12. If the leakage is below the previously determined low cylinder gage reading, loss past the dynamic seal may be due to piston ring end gap alignment or by the piston and piston rings' angular direction in the cylinder bore (Figure 8-5). First assure that the piston and piston rings are centered. This may be accomplished by reducing regulator pressure to 20 p.s.i. and working piston through TDC several times, bringing the piston to TDC in the normal direction of engine rotation. Adjust regulated pressure to 80 p.s.i. and determine amount of loss. If the gage reading is higher than the previously determined master orifice calibrated reading, proceed to next cylinder to be tested.

    NOTE...Piston ring rotation within the ring land is a normal design characteristic. As illustrated in Figure 8-5, the compression ring location may have a direct bearing on the dynamic seal pressure check. Therefore, we suggest you complete the test in the opposite direction if readings are below prescribed limits.

13. If recheck of cylinder pressure gage reading indication remains below allowable loss, engine may be run-up to operating temperature and rechecked prior to cylinder being removed and repaired. Rework of cylinders should be accomplished as outlined in the engine overhaul manual and service bulletins.

FIRST CHECK	CHECK FOR	METHOD	1. DISCREPANCY	2. CORRECTIVE ACTION	3. CORRECTIVE ACTION
STATIC SEAL (NO LEAKAGE PERMISSIBLE)	Intake Valve to Seat Seal	Listen for Air Flow in Intake Port	Carbon	Stake Valve	
			(Cracked Cylinder)	Replace Cylinder	
			Seat Worn or Burned	Grind or Replace	Reinspect
			Valve Worn or Burned	Grind or Replace	
	Exhaust Valve to Seat Seal	Listen for Air Flow in Exhaust Port	Carbon	Stake Valve	
			(Cracked Cylinder)	Replace Cylinder	
			Seat Worn or Burned	Grind or Replace	Reinspect
			Valve Worn or Burned	Replace	
	Spark Plug (2) to Port Seal	Apply Soapy Solution Around Spark Plug	Loose Heli-coil	Replace Heli-coil	Reinspect
			Cracked Cylinder	Replace Cylinder	
	Cylinder Head to Barrel Seal	Apply Soapy Solution Between Head and Barrel	Bubbles	Replace Cylinder	
	Cylinder Head Cracks	Apply Soapy Solution Around Fins	Bubbles	Replace Cylinder	

SECOND CHECK	CHECK FOR	METHOD	1. DISCREPANCY	2. CORRECTIVE ACTION	3. CORRECTIVE ACTION
DYNAMIC SEAL	Leakage by Piston Rings	Test Gauge below Tolerance	Piston cracked or out of limits	Replace Piston	
			Worn Rings	Replace Rings	
			Cylinder wall dimentions out of limits	Replace Cylinder	
		Test Gauge above Tolerance	None	None	

TABLE 1
SEAL CHECK

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CHAPTER 9

TROUBLESHOOTING

Section Index

9-1 GENERAL INFORMATION

The troubleshooting chart which follows, discusses symptoms which can be diagnosed and interprets the results in terms of probable causes and the appropriate corrective action to be taken.

For additional information on more specific troubleshooting procedures, refer to Overhaul Manual and Service Bulletins.

All engine maintenance should be performed by a qualified mechanic. Any attempt by unqualified personnel to adjust, repair, or replace any parts, may result in damage to the engine.

WARNING...Operation of a defective engine without a preliminary examination can cause further damage to a disabled component and possible injury to personnel. By careful inspection and troubleshooting such damage an injury can be avoided.

9-2 ENGINE TROUBLESHOOTING

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTIONS
Engine Will Not Start	Fuel tank empty.	Fill with correct grade of fuel.
	Improper starting procedure.	Refer to Pilot's Checklist for starting procedures and check for performance of each item.
	Cylinder overprimed. Engine flooded.	Place mixture levers in IDLE CUT-OFF position. Open throttle wide allow fuel to drain.
	Induction system leak.	Tighten or replace loose or damaged hose connections.
	Excessive starter slippage.	Replace starter adapter.
	Fuel system malfunction.	Isolate cause and correct (See Troubleshooting the Fuel Injection System.)
	Ignition system malfunction.	Isolate cause and correct. (See Troubleshooting the Ignition System.)
	Manifold valve vent.	Repair or replace manifold valve obstruction.
Engine Will Not Run At Idle Speed	Propeller levers set in high pitch. (DECREASE RPM.)	Use low pitch (Increase RPM) position for all ground operations.
	Fuel injection system improperly adjusted.	See Troubleshooting the Fuel Injection System.
	Air leak in intake manifold.	Tightening loose connection or replace damaged part.

TROUBLE	PROBABLE CAUSE	CORRECTIONS
Rough Idling	Fuel injection system improperly adjusted.	See Troubleshooting the Fuel Injection System.
	Mixture levers set for improper mixture.	Use FULL RICH position for all ground operation, except high altitude airports.
	Fouled spark plugs.	Remove and clean. Adjust gaps.
	Hydraulic lifters fouled.	Remove and clean lifters. Inspect and clean oil filter at more frequent intervals.
	Burned or warped exhaust valves, worn seat, scored valve guides	Repair cylinder.
Engine Runs Too Lean At Cruising Power	Improper manual leaning procedure. Gage incorrect.	Refer to Section 12 for proper fuel flow settings. Recalibrate.
	Fuel flow reading too low.	Check fuel strainer for clogging. Clean screen.
	Fuel injection malfunction.	See Troubleshooting the Fuel Injection System.
Engine Runs Too Rich At Cruising Power	Restrictions in air intake passages. Gage incorrect.	Check passages and remove restrictions. Recalibrate.
Engine Runs Too Lean Or Too Rich At Throttle Setting Other Than Cruise	Fuel injection malfunction. Gage incorrect.	See Troubleshooting the Fuel Injection System. Recalibrate.
Continuous Fouling Of Spark Plugs	Piston rings excessively worn or broken.	Replace rings. Replace cylinder if damaged.
	Piston rings are not seated.	Hone cylinder walls, replace rings.
Engine Runs Rough At High Speeds	Loose mounting bolts or damaged mount pads.	Tighten mounting bolts. Replace mount pads.
	Plugged fuel nozzle jet.	Clean.
	Propeller out of balance.	Remove and repair.
	Ignition system malfunction.	See Troubleshooting the Ignition System.
Continuous Missing At High Speed	Broken valve spring.	Replace.
	Plugged fuel nozzle jet.	Clean.
	Burned or warped valve.	Repair cylinder.
	Hydraulic tappet dirty or worn.	Remove and clean or replace.
	Ignition system malfunction.	See Troubleshooting the Ignition System.
Sluggish Operation And Low Power	Throttle not opening wide.	Check and adjust linkage (See Rigging of Mixture and Throttle Controls).
	Restrictions in air intake passages.	Check.
	Ignition system malfunction.	See Troubleshooting the Ignition System.
	Fuel injection malfunction.	See Troubleshooting the Fuel Injection System.

9-2 ENGINE TROUBLESHOOTING (cont'd)

TROUBLE	PROBABLE CAUSE	CORRECTIONS
Sluggish Operation And Low Power (cont'd)	Valve seats worn and leaking. Piston rings worn or stuck in grooves.	Borescope cylinders and check compression.
High Cylinder Head Temperature	Low octane fuel. Incorrect gage.	Drain tanks and replace with correct grade of fuel. Recalibrate.
	Lean fuel/air mixture due to improper manual leaning procedure. Insufficient Airflow	See "CORRECTION" under 'Engine run too lean at cruising power".
	Cylinder baffles loose or bent.	Check and correct.
	Dirt between cylinder fins.	Clean thoroughly.
	Excessive carbon deposits in cylinder head and on pistons.	Check ignition and fuel injection system.
	Magnetos out of time.	Re-time, internally and externally.
	Magneto distributor block contamination.	Disassemble and repair as required or replace magneto.
	Exhaust system gas leakage.	Locate and correct.
	Exhaust valve leaking.	Repair cylinder.
Oil Leaks	At front of engine; damaged crankshaft oil seal.	Replace
	Around propeller mounting flange: damaged hub o-ring seal.	Replace.
	Around plugs, fittings, and gaskets due to looseness or damage.	Tighten or replace.
Low Compression	Piston rings excessively worn.	Repair cylinder.
	Valve faces and seats worn.	Repair cylinder.
	Excessively worn cylinder walls.	Replace cylinder & piston rings.
Slow Engine Acceleration On A Hot Day	Mixture too rich.	Momentarily pull mixture control back until engine acceleration picks up, then set proper mixture.
Rough Idle At Airfields With Elevation Of 3500 Feet Or Higher	Mixture too rich	Pull mixture control back to where the engine operates the smoothest at IDLE RPM.
Slow Engine Acceleration At Airfields With A Ground Elevation Of 3500 Feet Or higher	Mixture too rich.	Adjust mixture per Chapter 12. Calibrate fuel flow gage.
Engine Will Not Stop At Idle Cut-Off.	Fuel manifold valve not seating tightly.	Replace manifold valve.

9-2 ENGINE TROUBLESHOOTING (cont'd)

TROUBLE	PROBABLE CAUSE	CORRECTIONS
High Engine Idle Pressure Impossible to Obtain	Fuel manifold valve sticking closed.	Replace manifold valve.
	Fuel manifold valve vent obstruction.	Replace manifold valve.
Erratic Engine Operation	Fuel manifold valve sticking, or not free.	Repair or replace manifold valve.
Climbing to Altitudes 12,000 Feet, engine Power Fluctuates When Power Reduced	Fuel vaporization.	Operate fuel boost pump according to aircraft manufacturer's instructions. See fuel flow per Chapter 12.
Low Fuel Pressure	Restricted flow to fuel metering valve.	Check mixture control for full travel. Check for restrictions in fuel filter and lines, adjust control and clean filter. Replace damaged parts.
	Fuel control lever interference.	Check operation of throttle control and for possible contract with cooling shroud. Adjust as required to obtain correct operation.
	Incorrect fuel pump adjustment and operation.	Check and adjust using appropriate equipment. Replace malfunctioning pumps.
	Malfunctioning fuel pump relief valve.	Replace pump.
High Fuel Pressure	Restricted flow beyond fuel control assembly.	Check for restricted fuel nozzles jet or fuel manifold valve. Clean or replace nozzles. Replace malfunctioning fuel manifold valve.
	Malfunctioning relief valve operation in fuel pump.	Replace pump.
	Restricted re-circulation passage in fuel injector pump.	Replace pump.
Fluctuating Fuel Pressure	Vapor in fuel system, excessive fuel temperature.	Normally, operating the auxiliary pump will clear system. Operate auxiliary pump and purge system.
	Fuel gage line leak or air in gage line.	Drain gage line and tighten connections.
	Restrictions in vapor separator vent.	Check for restriction in ejector jet of vapor separator cover. Clean jet with solvent (only). Do Not Use Wire as Probe. Replace malfunctioning parts.

9-2 ENGINE TROUBLESHOOTING (cont'd)

TROUBLE	PROBABLE CAUSE	CORRECTIONS
Low Oil Pressure On Engine Gage	Insufficient oil in oil sump, oil dilution or using improper grade oil from prevailing ambient temperature.	Add oil, or change oil to proper viscosity.
	Gage incorrect	Recalibrate
	High oil temperature.	Malfunctioning vernatherm valve in oil cooler; oil cooler restriction. Replace valve or clean oil cooler.
	Leaking, damaged or loose oil line connections - Restricted screen or filter.	Check for restricted lines and loose connections, and for partially plugged oil filter or screens. Clean parts, tighten connections and replace malfunctioning parts.
Engine Runs Rough At Speeds Above Idle	Improper fuel-air mixture	Check manifold connections for leaks. Tighten loose connections. Check fuel filters and linkage for setting and adjustment. Check for proper pump pressure, and replace pump if malfunctioning.
	Restricted fuel nozzle jet.	Remove and clean all nozzles
	Ignition system and spark plugs malfunctioning.	Clean and regap spark plugs. check ignition cables for defects. Replace malfunctioning components.
Engine Lacks Power, Reduction In Maximum Power	Incorrectly adjusted throttle control, "sticky" linkage or dirty air cleaner.	Check movement of linkage by moving control from idle to full throttle. Make proper adjustments and replace worn components. Service air cleaner.
	Malfunctioning ignition system.	Inspect spark plugs for fouled electrodes, heavy carbon deposits, erosion of electrodes, improperly adjusted electrode gaps, and cracked porcelains. Test plugs for regular firing under pressure. Replace damaged or misfiring plugs. Spark plug gap to be 0.015 to 0.019 inch.
Engine Lacks Power, Reduction in Maximum Manifold Pressure	Loose or damaged intake manifolds.	Inspect entire manifold system for possible leakage at connections. Replace damaged components tighten all connections and clamps.
	Restriced air cleaner.	Clean or replace.
	Fuel nozzles malfunctioning.	Check for restricted nozzles and lines and clean or replace as necessary.
Engine Has Poor Acceleration	Idle mixture too lean.	Readjust idle mixture.
	Incorrect fuel-air mixture, worn control linkage, or restricted air cleaner.	Tighten loose connections, replace worn elements of linkage service air cleaner.
	Malfunctioning ignition system.	Check accessible cables and connections. Replace malfunctioning spark plugs.

9-3 IGNITION TROUBLESHOOTING

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTIONS
Engine Fails To Start Due To Ignition Trouble	Ignition switch OFF or grounded switch wires.	Turn switch On. Check for grounded wires.
	Magneto malfuction.	Refer to service manual.
	Spark plugs fouled, improperly gaped, or loose.	Remove and clean. Adjust to proper gap. Tighten to specified torque.
	Magnetos improperly timed to engine.	Refer to Installation of Magnetos and Ignition Timing for timing procedures.
	Shorted condenser.	Replace condenser.
	Magneto internal timing incorrect or timed for opposite rotation.	Install correctly timed magneto.
Rough Idling	Spark plugs fouled or improperly gaped.	Clean spark plugs. Adjust spark plug gap.
	Weak condenser.	Replace condenser.
	Loose or improperly gaped spark plug.	tighten to specified torque. Adjust to proper gap.
	High tension leak in ignition harness.	Check for faulty harness, replaced as required.
	Weak or burned out condenser as evidenced by burned or pitted breaker points.	Replace points and condenser.
Sluggish Operation And/Or Excessive RPM Drop	Fouled or faulty spark plugs.	Clean spark plugs. Replace faulty spark plugs.
	Improperly gaped spark plugs.	Adjust to proper gap.
	Magnetos timing incorrect.	Refer to Installation of Magnetos and Ignition Timing for proper timing procedure.
	Damaged magneto breaker points or condenser.	Replace points and condenser.

9-4 OIL SYSTEM TROUBLESHOOTING CHART

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTIONS
High Oil Temperature Indication	Thermostat damaged or held open by solid matter.	Remove, clean valve and seat. If still inoperative, replace.
	Oil viscosity too high.	Drain and refill with correct seasonal oil grade. (See Sect.8-1)
	Prolonged ground operation.	Limit ground operation to a minimum.
	Malfunctioning gage or bulb unit.	Check wiring. Check bulb unit. Check gage. Replace malfunctioning parts.
	High power, low airspeed.	Adjust power - flgiht altitude.
	Low oil supply.	Replenish.
	Cooler air passages clogged.	Clean thoroughly.
	Cooler core plugged.	Remove cooler and flush thoroughly.
Low Oil Pressure Indication	Low oil supply.	Replenish.
	Oil viscosity too low.	Drain and refill with correct seasonal oil grade. (See Sect. 8-1)
	Foam in the oil due to presence of alkaline solids in system.	Drain and refill with fresh oil. (It may be necessary to flush cooler core if presence of alkaline solids is due to previous cleaning with alkaline materials.)
	Pump producing low pressure.	Replace pump.
	Malfunctioning pressure gage.	Check gage. Clean plumbing. Replace if required.
	Weak or broken oil pressure relief valve spring.	Replace spring. Adjust pressure to 30-60 p.s.i. with oil at normal operating temperature.

9-5 FUEL INJECTION SYSTEM TROUBLESHOOTING CHART

This troubleshooting chart is provided as a guide. Review all probable causes given, check other listings of troubles with similar symptoms. Items are presented in sequence of the approximate ease of checking, not necessarily in order of probability.

TROUBLE	PROBABLE CAUSE	CORRECTIONS
Engine Will Not Start And No Fuel Flow Gage Indication	No fuel to engine.	Check tank fuel level.
	Mixture control improperly adjusted.	Check mixture control for proper adjustment.
	Engine not primed.	Place auxiliary pump switch in PRIME position.
	Selector valve in wrong position.	Position selector valve to MAIN TANK position.
Engine Will Not Start With Fuel Flow Gage Indication	Engine flooded.	Open throttle, allow fuel to drain.
	No fuel to engine.	Loosen one line at nozzle. If no fuel is presents with fuel pressure on gage, replace fuel manifold valve.
Rough Idle	Nozzle restricted.	Remove nozzles and clean.
	Improper idle mixture.	Adjust metering unit in accordance with adjustment procedures.
Poor Acceleration	Idle mixture incorrect.	Adjust metering unit in accordance with adjustment procedures.
	Unmetered fuel pressure too high.	Lower unmetered fuel pressure.
	Worn linkage.	Replace worn elements of linkage.
Engines Runs Rough	Restricted nozzle jet.	Remove and clean all nozzles jet.
	Improper mixture.	Improper pump pressure, replace pump.
Low Fuel Flow Gage Indication	Restricted flow to metering unit.	Check mixture control for full travel. Check for clogged fuel filters.
	Inadequate flow from fuel pump.	Adjust engine-driven fuel pump.
High Fuel Flow Gage Indication	Restricted flow beyond metering unit.	Check for restricted nozzles jet or fuel manifold valve. Clean or replace as required.
	Restricted recirculation passage in fuel pump.	Replace engine-driven fuel pump.
Fluctuating or Erroneous Fuel Flow Indications	Vapor in system, excess fuel temperature.	If not cleared with auxiliary pump, check for clogged ejector jet in vapor separator cover. Clean only with solvent, no wires.
	Air in fuel flow gage line. Leak at gage connection.	Repair leak and purge line.
Poor Idle Cut-Off	Engine getting fuel.	Check mixture control is in full idle cut-off. Check auxiliary pump is OFF. If neither, replace manifold valve.

9-5 FUEL INJECTION SYSTEM TROUBLESHOOTING CHART (cont'd)

TROUBLE	PROBABLE CAUSE	CORRECTIONS
Unmetered Fuel Pressure Drop	Relief valve stuck open.	Repair or replace fuel pump.
Very High Idle and Full Throttle Fuel Pressure Present	Relief valve stuck closed.	Repair or replace fuel pump.
No Fuel Pressure	Check valve stuck open.	Repair or replace fuel pump.

CHAPTER 10
ENGINE PRESERVATION AND STORAGE

Section Index

10-1 ENGINE PRESERVATION AFTER OVERHAUL

Engines in aircraft that are flown only occasionally tend to exhibit cylinder wall corrosion more than engines in aircraft that are flown frequently.

Of particular concern are new engines with new or freshly honed cylinders after a top or major overhaul. In areas of high humidity, there have been instances where corrosion has been found in such cylinders after an inactive period of only a few days. When cylinders have been operated for approximately 50 hours, the varnish deposited on the cylinder walls offers some protection against corrosion. Hence a two step program for Flyable Storage category is recommended.

Obviously, proper steps must be taken on engines used infrequently to lessen the possibility of corrosion. This is especially true if the aircraft is based near the sea coast or in areas of high humidity and flown less than once a week.

In all geographical areas the best method of preventing corrosion of the cylinders and other internal parts of the engine, is to fly the aircraft at least once a week, long enough to reach normal operating temperatures, which will vaporize moisture and other by-products of combustion. In consideration of the circumstances mentioned, TCM has listed three reasonable minimum preservation procedures, that if implemented, will minimize the detriments of rust and corrosion. It is the owners responsibility to choose a program that is viable to the particular aircrafts mission.

Aircraft engine storage recommendations are classified by the following categories:

A. FLYABLE STORAGE (Program I or II)

B. TEMPORARY STORAGE (up to 90 days)

C. INDEFINITE STORAGE

10-2 FLYABLE STORAGE (Program I or II)

Program I- Engines or cylinders with less than 50 operating hours:

a. Operate engine every 5 days; and

b. Fly every 15 days as per paragraph.

Program II- Engines or cylinders with more than 50 operating hours to TBO if not flown weekly:

a. Operate engine every 7 days; and

b. Fly every 30 days as per paragraph.

1. Service aircraft per normal airframe manufacturer's instructions.

WARNING...For maximum safety, accomplish engine rotation as follows:

a. Verify magneto switches are "OFF"

b. Throttle position "CLOSED"

c. Mixture control "IDLE CUT-OFF"

d. Set brakes and block aircraft wheels

e. Leave aircraft tie-downs installed and verify that the cabin door latch is open.

f. Do not stand within the arc of the propeller blades while turning the propeller.

3. The aircraft should be flown for thirty (30) minutes, reaching, but not exceeding, normal oil and cylinder temperatures. If the aircraft cannot be flown it should be represerved in accordance with "B" (Temporary Storage) or "C" (Indefinite Storage). Ground running is not an acceptable substitute for flying.

It is necessary that for future reference, that the engine run and flight time be recorded and verified in the engine maintenance record/log with the date, time and signature.

10-3 TEMPORARY STORAGE (up to 90 days)

1. Preparation for Storage

a. Remove the top spark plug and spray preservative oil (Lubrication Oil - Contact and Volatile Corrosion - Inhibited, MIL-L-46002, Grade 1) at room temperature, through upper spark plug hole of each cylinder with the piston in approximately the bottom dead center position. Rotate crankshaft as each pair of opposite cylinders are sprayed. Stop crankshaft with no piston at top dead center. A pressure pot or pump-up type garden pressure sprayer may be used. The spray head should have ports around the circumference to allow complete coverage of the cylinder walls.

NOTE...Shown below is an approved preservative oil recommended for use in Teledyne Continental engines for temporary and indefinite storage:

MIL-L-46002, Grade 1 Oils:

NOX RUST VCI-105 Daubert Chemical Company
May be purchased through:
Rock Island Lubricant & Chemical Company
P.O. Box 5015
1320 1st Street
Rock Island, Illinois 61204
1-800-522-1150

b. Re-spray each cylinder without rotating crank. To thoroughly cover all surfaces of the cylinder interior, move the nozzle or spray gun from the top to the bottom of the cylinder.

c. Re-install spark plugs.

d. Apply preservative to engine interior by spraying the above specified oil (approximately two ounces) through the oil filler tube.

e. Seal all engine openings exposed to the atmosphere using suitable plugs, or moisture resistant tape, and attach red streamers at each point.

f. Engines, with propellers installed that are preserved for storage in accordance with this section should have a tag affixed to the propeller in a conspicuous place with the following notation on the tag: "DO NOT TURN PROPELLER - ENGINE PRESERVED" PRESERVATION DATE__________.

NOTE ...If the engine is not returned to flyable status at the expiration of the Temporary Storage (90 Day), it must be preserved in accordance with the Indefinite Storage procedures.

2. Preparation for Service

a. Remove seals, tape, paper and streamers from all openings.

b. With bottom spark plugs removed from the cylinders, hand turn propeller several revolutions to clear excess preservative oil and re-install spark plugs.

c. Conduct normal run-up procedure and inspect for leaks.

d. Clean aircraft throughly and conduct a visualy inspection and test flight per airframe manufactures instructions.

10-4 INDEFINITE STORAGE

1. Preparation for Storage

a. Drain the engine oil and refill with MIL-C-6529 Type II (Aeroshell Fluid 2F). The aircraft should be flown for thirty (30) minutes, reaching, but not exceeding normal oil and cylinder temperatures. Allow engine to cool to ambient temperature. Accomplish steps "1.a." and "1.b" of Temporary Storage.

NOTE...MIL-C-6529 Type II may be formulated by thoroughly mixing one part compound MIL-C-6529 Type I (Esso Rust-Ban 628, Cosmoline No. 1223 or equivalent) with three parts new lubricating oil of the grade recommended for service (all at room temperature). Single grade oil is recommended.

b. Apply preservative to engine interior by spraying MIL-L-46002, Grade I oil (approximately two ounces) through the oil filler tube.

c. Install dehydrator plugs MS27215-1 or -2, in each of the top spark plug holes, making sure that each plug is blue in color when installed. Protect and support the spark plug leads with AN-4060 protectors.

d. The TCM fuel injection system does not require any special preservation preparation.

e. Place a bag of desiccant in the exhaust pipes and seal the openings with moisture resistant tape.

f. Seal the cold air inlet to the heater muff with moisture resistant tape to exclude moisture and foreign objects.

g. Seal the engine breather by inserting a dehydrator MS27215-2 plug in the breather hose and clamping in place.

h. Attach a red streamer to each place on the engine where bags of desiccant are placed. Either attach red streamers outside of the sealed area with tape or to the inside of the sealed area with safety wire to prevent wicking of moisture into the sealed area.

i. Engines with propellers installed that are preserved for storage in accordance with this section should have each propeller tagged in a conspicuous place with the following notation on the tag: "DO NOT TURN PROPELLER - ENGINE PRESERVED", - PRESERVATION DATE____________

10-5 PROCEDURES NECESSARY FOR RETURNING AN AIRCRAFT TO SERVICE ARE AS FOLLOWS:

1. Remove the cylinder dehydrator plugs and all paper, tape, desiccant bags and streamers used to preserve the engine.
2. Drain the corrosion preventive mixture and re-service with recommended lubricating oil.

   WARNING ...When returning the aircraft to service do not use the corrosion preventive oil referenced in, 10-4, (1a) for more than 25 hours.

3. With bottom plugs removed, rotate propeller to clear excess preservative oil from cylinders.
4. Re-install the spark plugs and rotate the propeller by hand through the compression strokes of all the cylinders to check for possible liquid lock. Start the engine in the normal manner.
5. Clean aircraft thoroughly and conduct a visual inspection and test flight per airframe manufacturer's instructions.

10-6 AIRCRAFT STORED IN ACCORDANCE WITH THE INDEFINITE STORAGE PROCEDURES SHOULD BE INSPECTED PER THE FOLLOWING INSTRUCTIONS:

1. Aircraft prepared for Indefinite Storage should have the cylinder dehydrator plugs visually inspected every 15 days. The plugs should be changed as soon as their color indicates unsafe conditions of storage. If the dehydrator plugs have changed color in one-half or more of the cylinders, all desiccant material on the engine should be replaced.
2. The cylinder bores of all engines prepared for Indefinite Storage should be re-sprayed with corrosion preventive mixture every six months, or more frequently if bore inspection indicates corrosion has started earlier than six months. Replace all desiccant and dehydrator plugs. Before spraying, the engine should be inspected for corrosion as follows: Inspect the interior of at least one cylinder through the spark plug hole. If cylinder shows start of rust, spray cylinder corrosion preventive oil and turn prop over six times, then re-spray all cylinders. Remove at least one rocker box cover and inspect the valve mechanism.

The above procedures are a general specifications for rust and corrosion prevention. Since local conditions are different and Teledyne Continental Motors has no control over the application, more stringent procedures may be required. Rust and corrosion prevention are the owner's responsibility.

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CHAPTER 11
AIRWORTHINESS LIMITATIONS

The Airworthiness Limitations Section is FAA Approved and specifies maintenance required under §21.31 of the Federal Aviation Regulations unless an alternative program has been FAA approved. This section is part of the type design of the IO-360 Series pursuant to §21.31 of the Federal Aviation Regulations.

1. Mandatory Inspection Intervals

   50 hour, 100 hour and 500 hour inspections as described in the IO 360 Maintenance and Operator's Manual subject to additional information contained in FAA Approved Mandatory Service Bulletins issued after date of certifications, and inspections mandated by the FAA and under Parts 43 and 91 of the Federal Aviations Regulations.

2. Other Related Procedures

   Unless subsequently noted in FAA approved Mandatory Service Bulletins, the IO360 Series Engine does not have any inspections related or replacement time-related procedures required for type certifications.

3. Distribution of Changes to Airworthiness Limitations

   Changes to Airworthiness Limitations section constitute changes to the type design of the IO-360 Series engine and require FAA approval pursuant to Federal Aviation Regulations §21.95, 21.97 or 21.99. Such changes will be published in FAA Approved Mandatory Service Bulletins, which are furnished to subscribers to TCM Service Bulletins and can be obtained by writing Teledyne Continental Motors, P.O. Box 90, Mobile, Alabama 36601.

CHAPTER 12
ENGINE PERFORMANCE AND CRUISE CONTROL

Section Index

12-1 CRUISE CONTROL BY PERFORMANCE CURVE

1. Set manifold pressure and RPM at cruise power selected.

2. To determine actual horsepower, employ the following procedure:

   a. Correct horsepower for inlet air temperature as follows:
      (TS = Standard Altitude Temperature)
      (1)Add 1% for each 10°F below TS.
      (2)Subtract 1% for each 10°F above TS

3a. Adjust the mixture to the value specified in the aircraft operators manual, using he above corrected horsepower.

3b. The ES engine is equipped with altitude compensating fuel pump which automatically provides the proper full rich mixture at any given altitude. Adjust mixture to lean out fuel flow for cruise settings according to applicable fuel flow vs. brake horsepower curve.

CAUTION... When increasing power, enrich mixture, advance RPM and adjust throttle in that order. When reducing power, retard throttle, then adjust RPM and mixture.

NOTE...It may be necessary to make minor readjustments to fuel flow (mixture) after changing RPM.

12-2 CRUISE CONTROL BY E.G.T.

If an exhaust gas temperature gage is used as an aid to leaning, proceed as follows:

1. Adjust manifold pressure and RPM for desired cruise setting.

2. Slowly move mixture control toward "lean" while observing E.G.T. gage. Note position on the instrument were the needle "peaks" or starts to drop as mixture is leaned further.

3. Advance mixture control toward "rich" until EGT is 50°F. rich of peak.

4. Operation at peak EGT is permitted ONLY at powers and speeds lower than 65% NRP. See Service Bulletin M89-18 or subsequent revision as applicable.

CAUTION...Do not attempt to adjust mixture by use of EGT at settings above 75% of rated power. Also, remember that engine power will change with ambient conditions. Changes in altitude or outside air temperature will require adjustments in manifold pressure and fuel flow.

Gage fuel flow should fall between the maximum and minimum values on the curve. If not, the fuel injection system or instrumentation (including tachometer, manifold pressure, fuel flow gage or EGT system) should be checked for maladjustment or calibration error.

12-3 PERFORMANCE CHARTS

The curves in this section represent uninstalled performance and are provided as a reference in establishing power conditions for takeoff, climb and cruise operation. Refer to aircraft manufacturer's flight manual for tabular climb and cruise data.

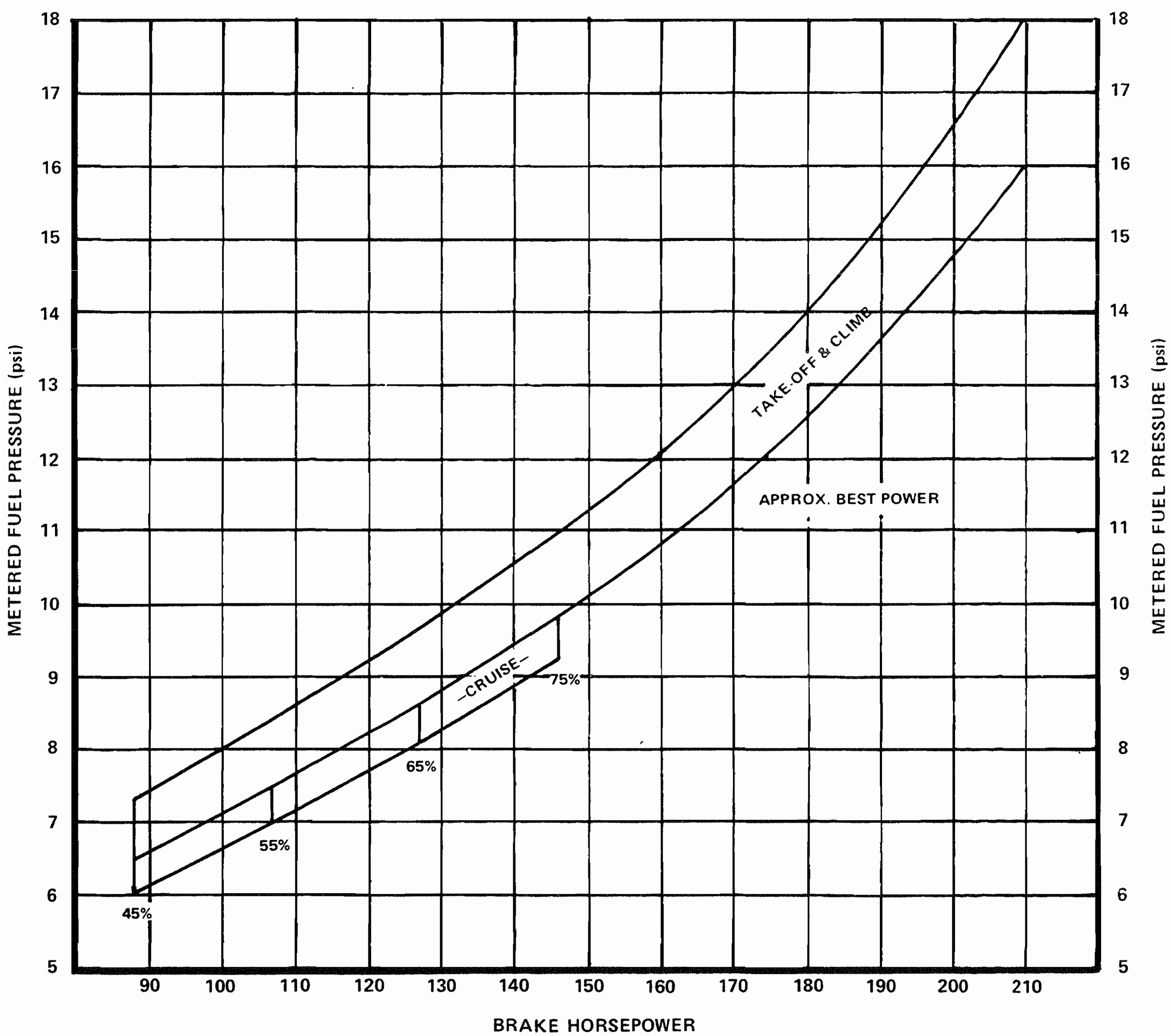

FIGURE 12-1. FUEL PRESSURE VS. BRAKE HORSEPOWER IO-360-A,AB

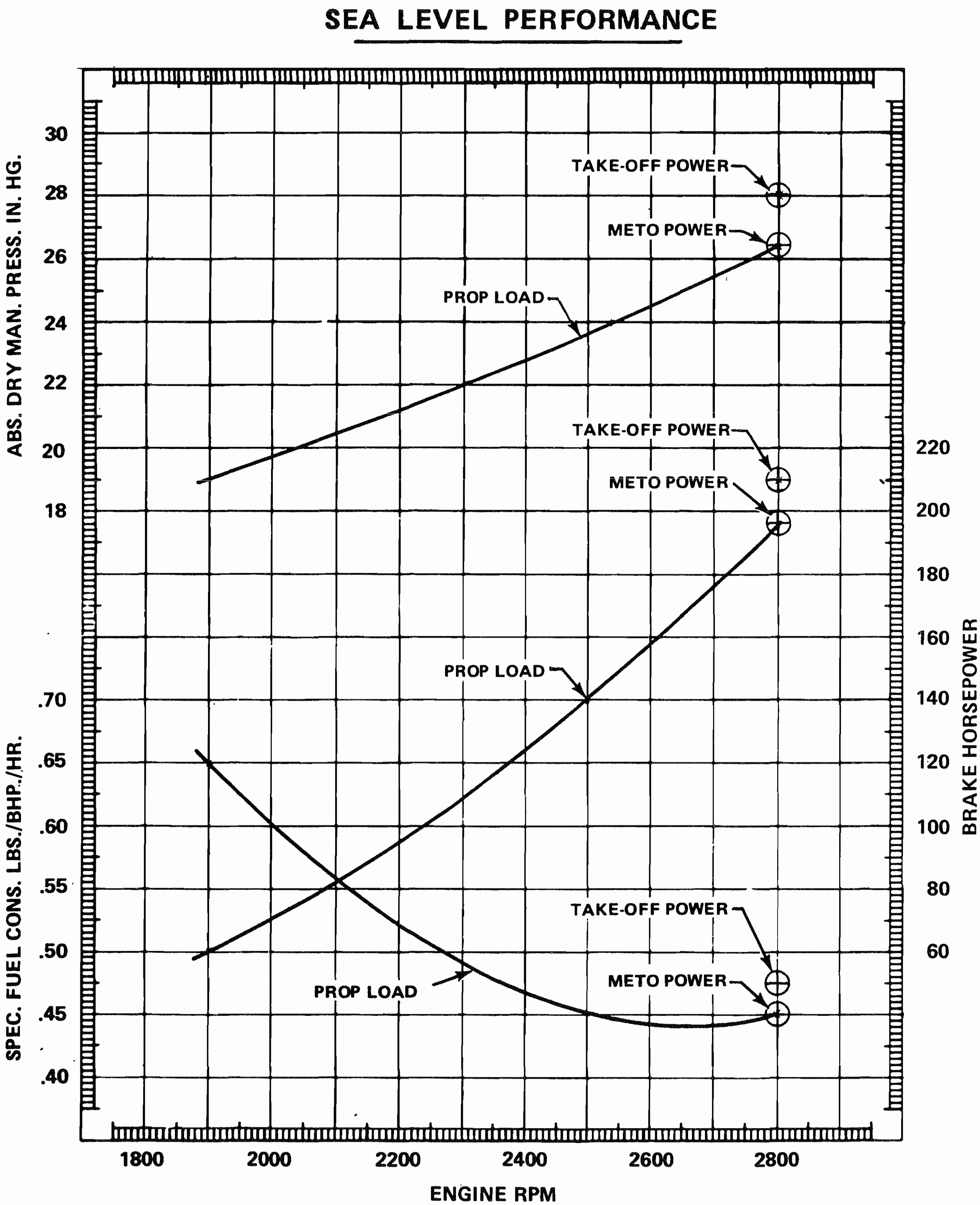

FIGURE 12-2. SEA LEVEL PERFORMANCE,
IO-360-A,AB

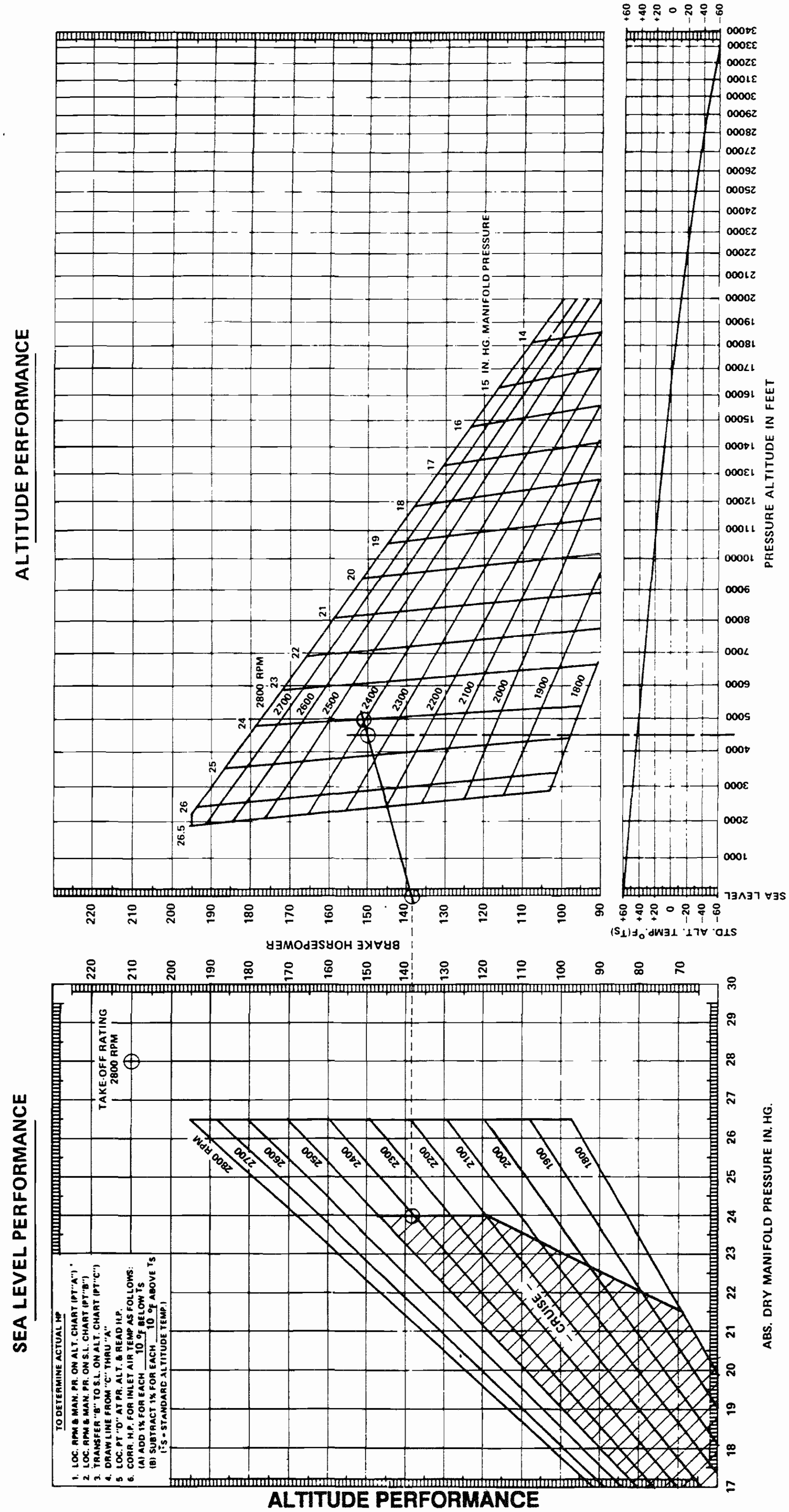

FIGURE 12-3. ALTITUDE PERFORMANCE
IO-360-A,AB

SEA LEVEL PERFORMANCE

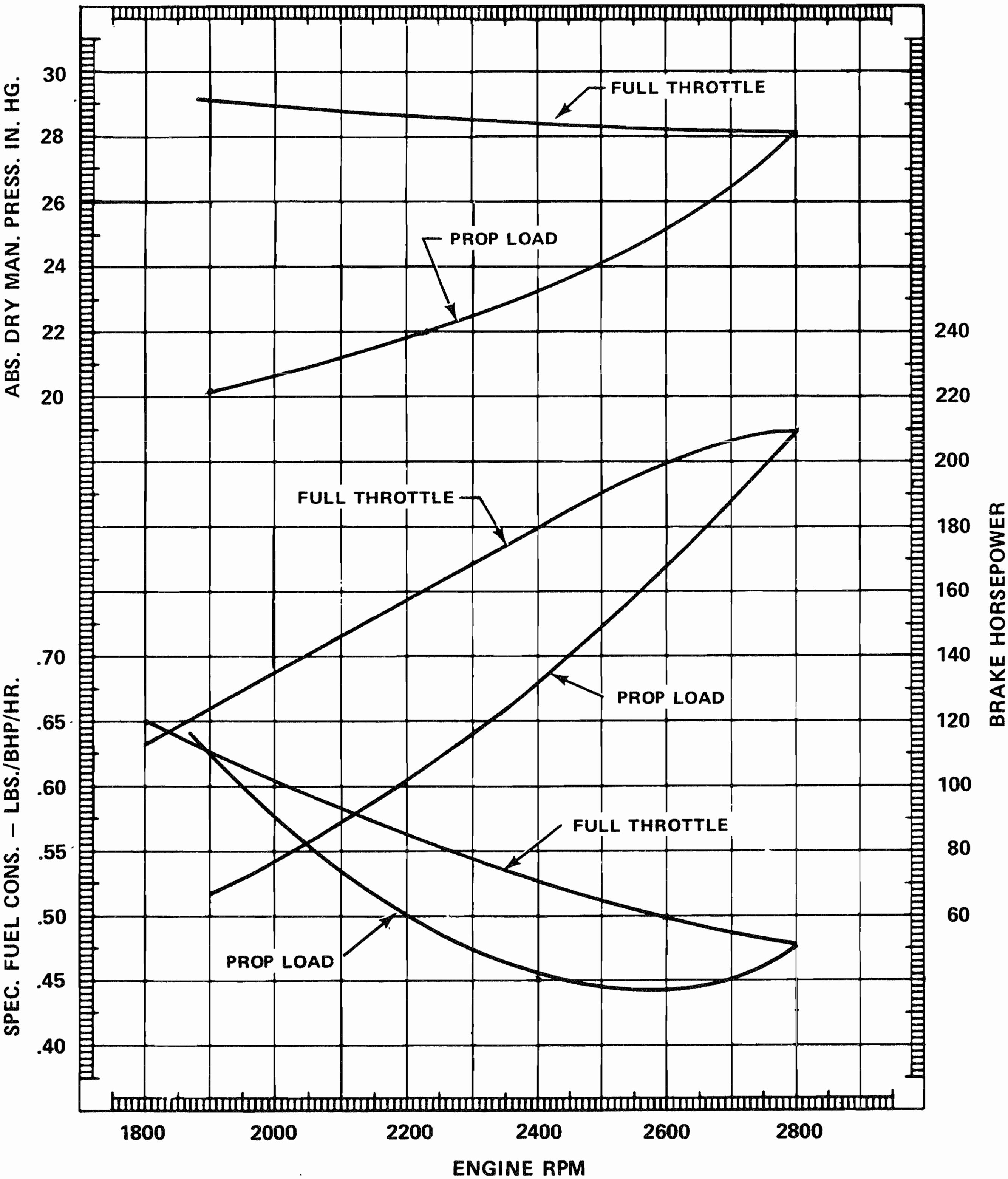

FIGURE 12-4. SEA LEVEL PERFORMANCE
IO-360-C,CB,D,DB,G,GB,H,HB

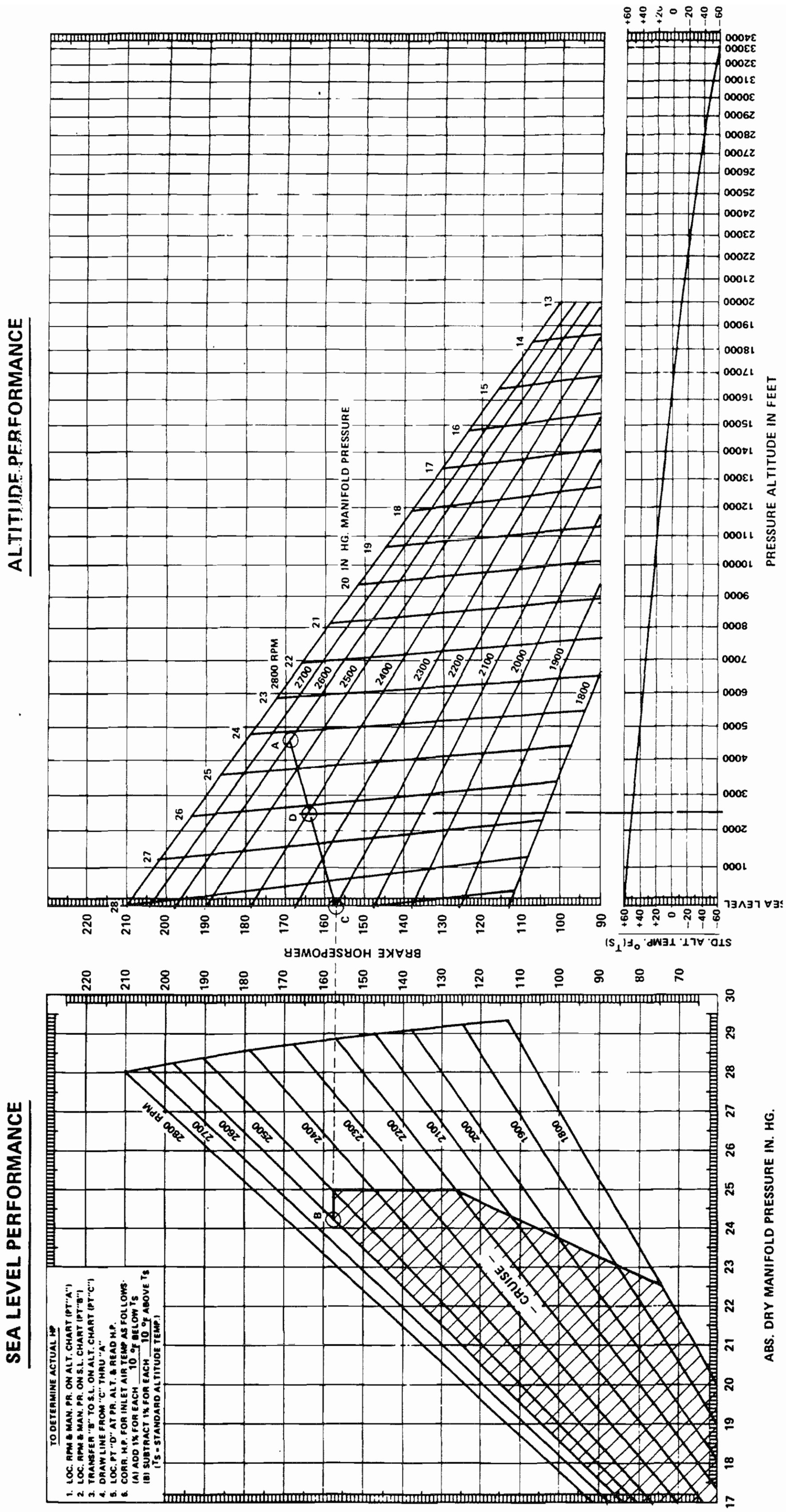

FIGURE 12-5. ALTITUDE PERFORMANCE CURVES IO-360-C,CB,D,DB,G,GB,H,HB

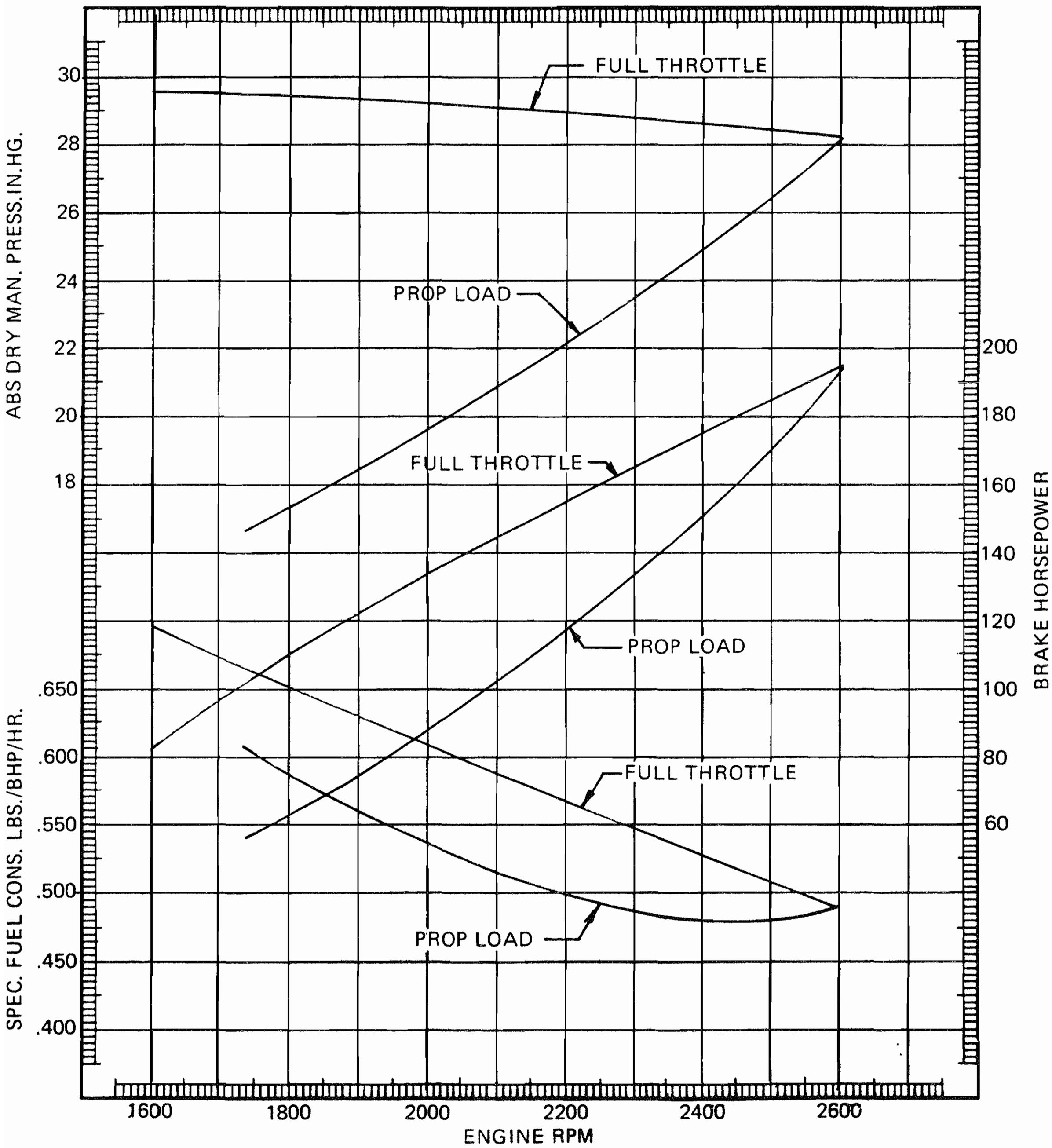

FIGURE 12-6. SEA LEVEL PERFORMANCE IO-360-K,KB

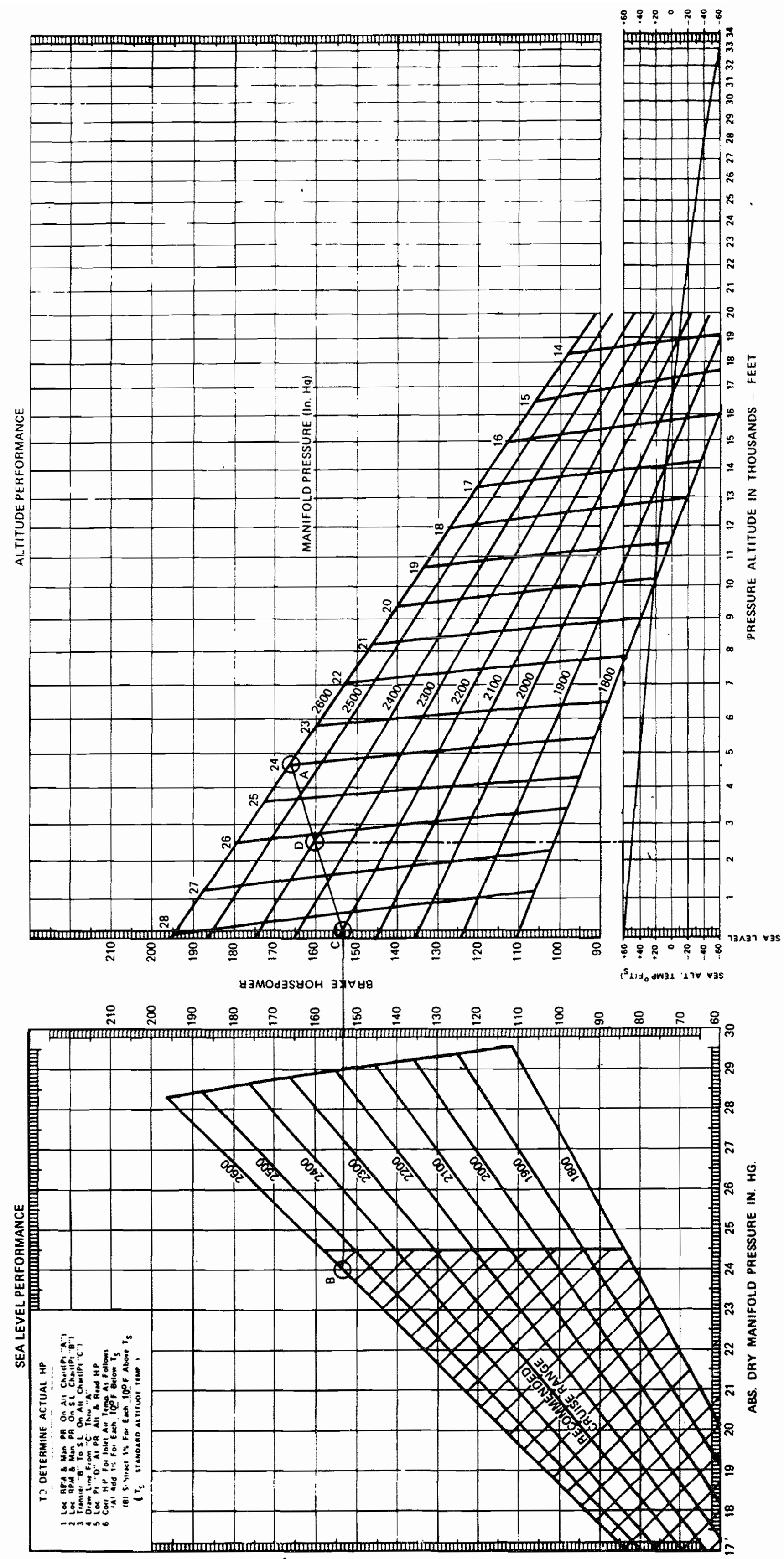

FIGURE 12-7. ALTITUDE PERFORMANCE
IO-360-K,KB

SEA LEVEL PERFORMANCE

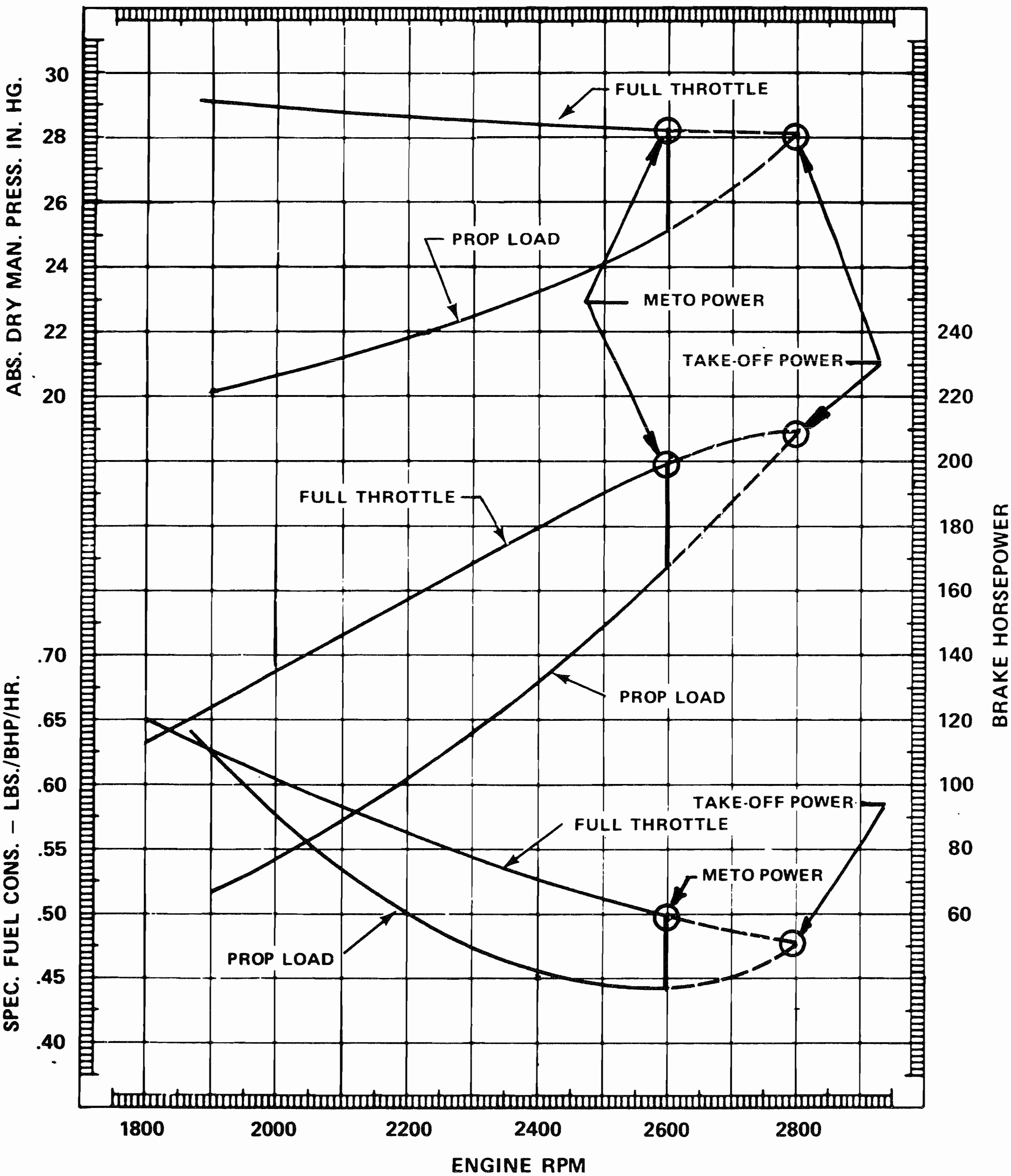

FIGURE 12-8. SEA LEVEL PERFORMANCE IO-360-J,JB

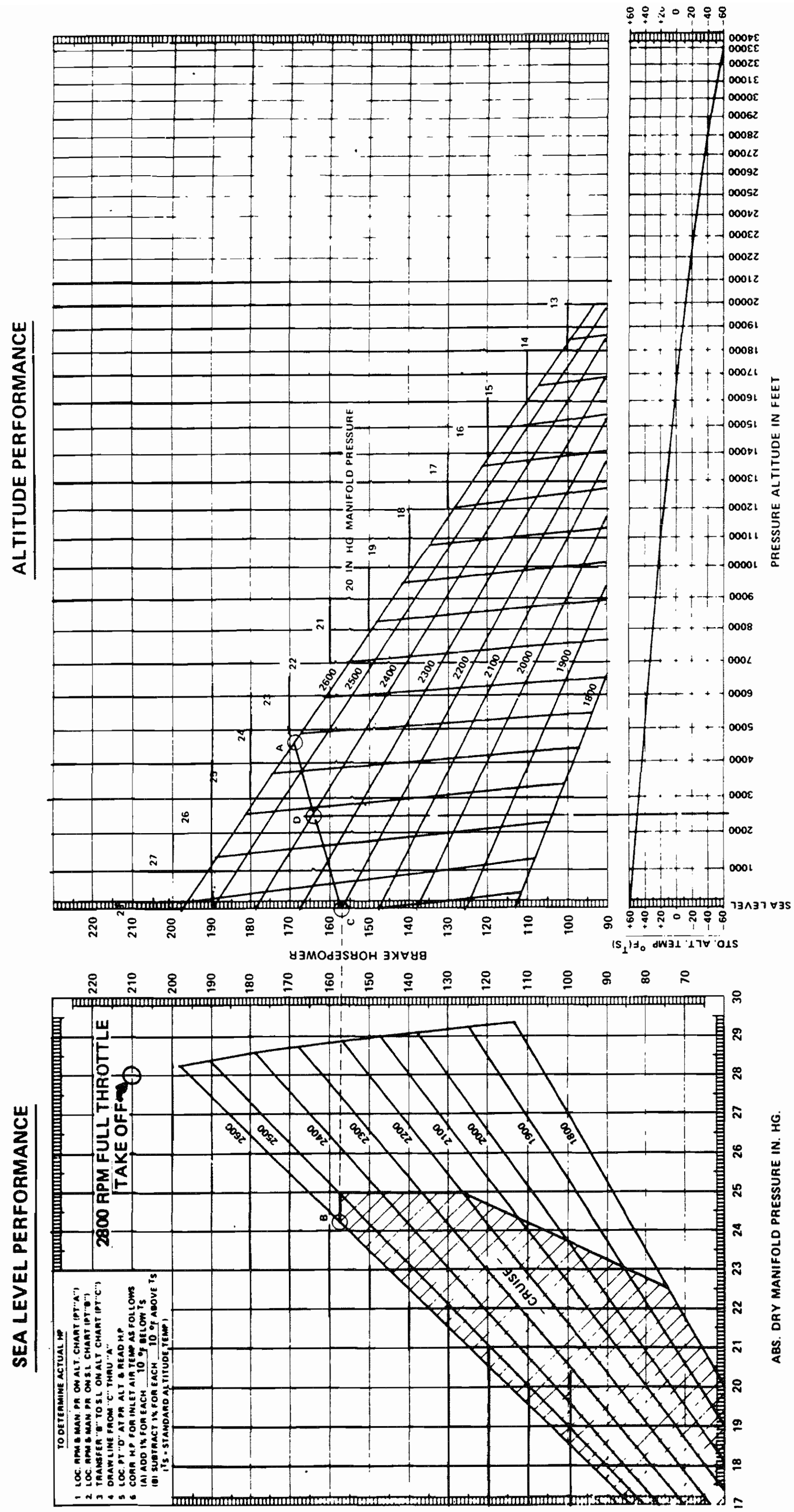

FIGURE 12-9. ALTITUDE PERFORMANCE IO-360-J,JB

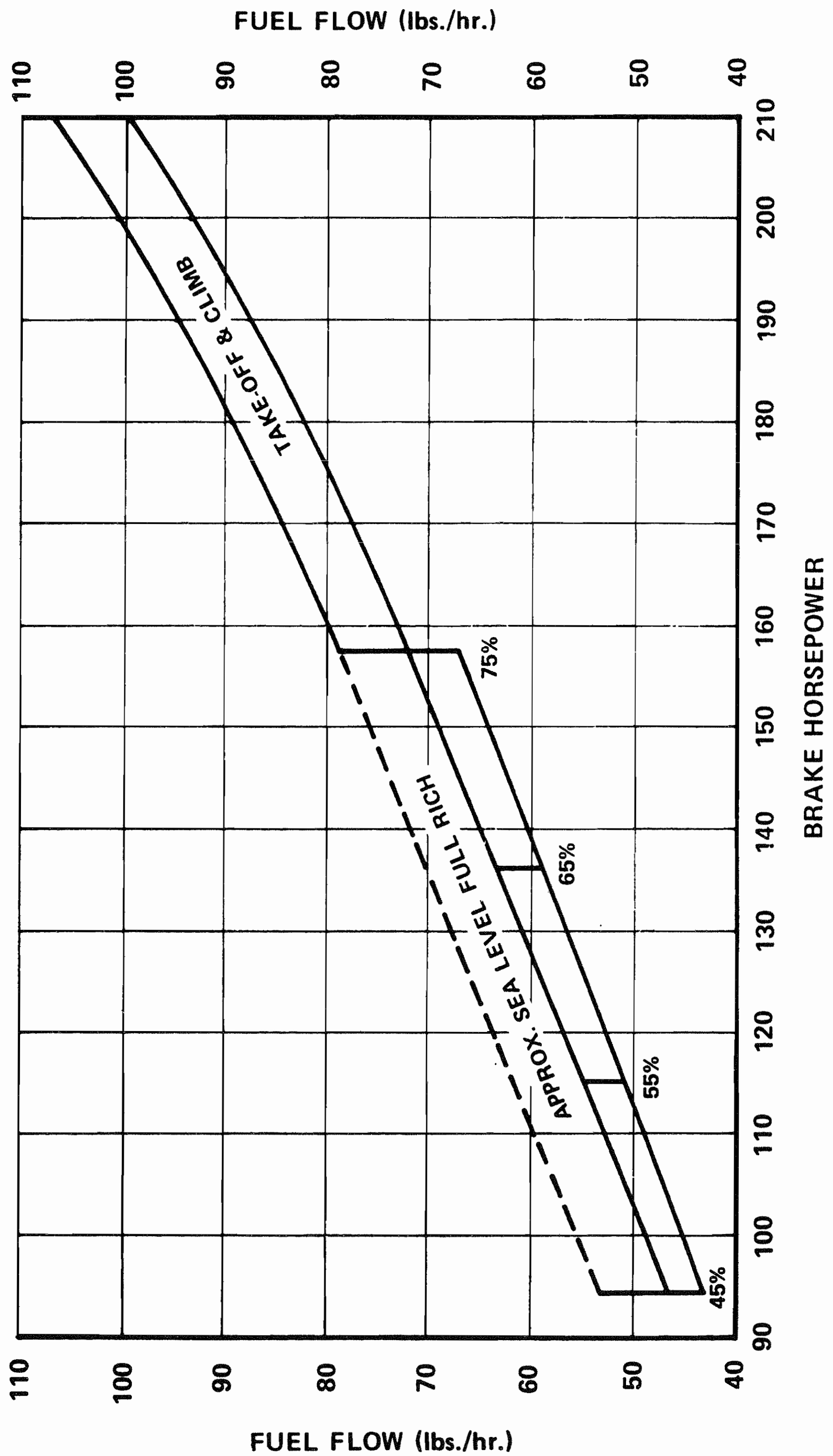

FIGURE 12-10. FUEL FLOW VS. BRAKE HORSEPOWER, IO-360-C,CB,D,DB,G,GB,H,HB,J,JB

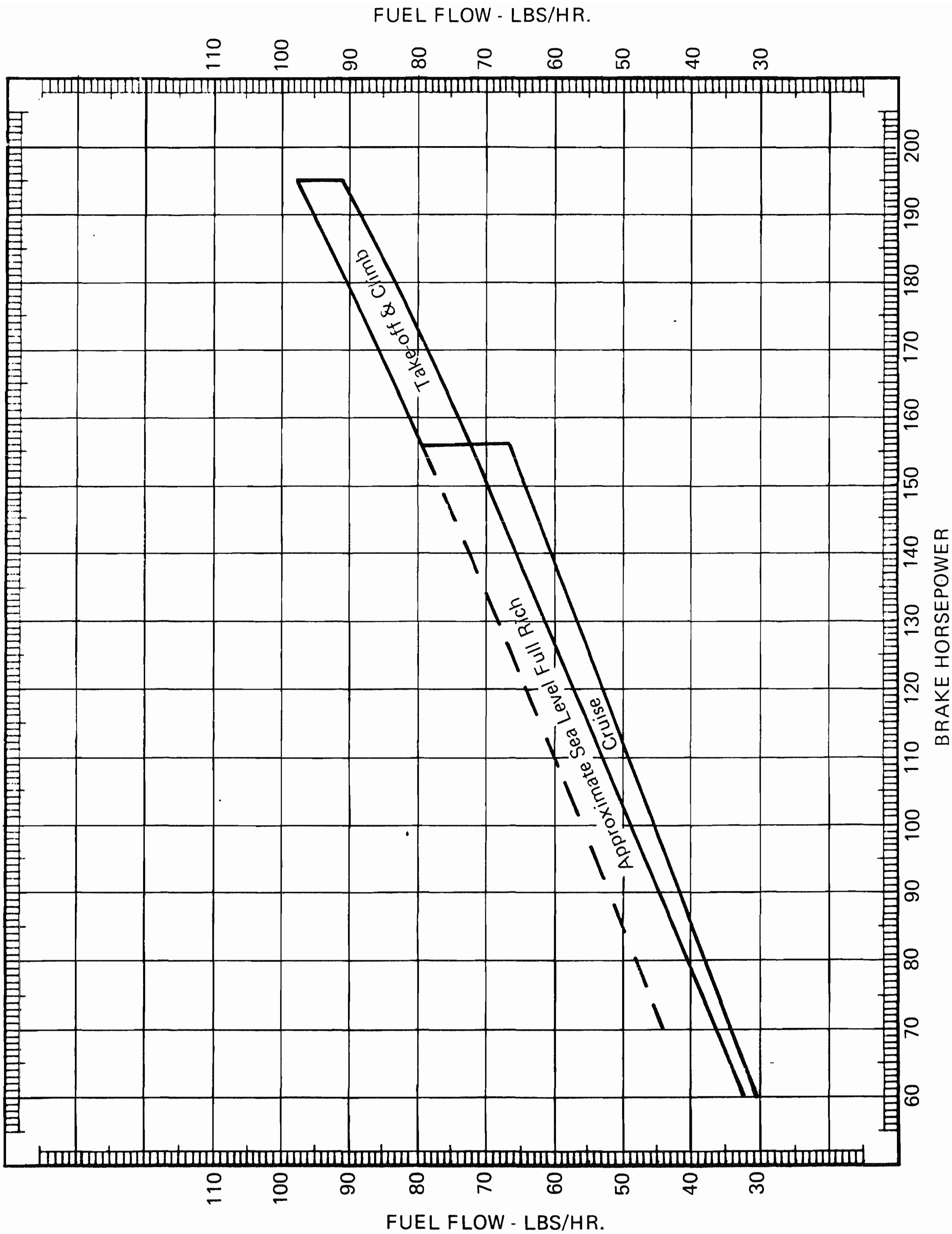

FIGURE 12-11. FUEL FLOW VS. BRAKE HORSEPOWER IO-360-K,KB

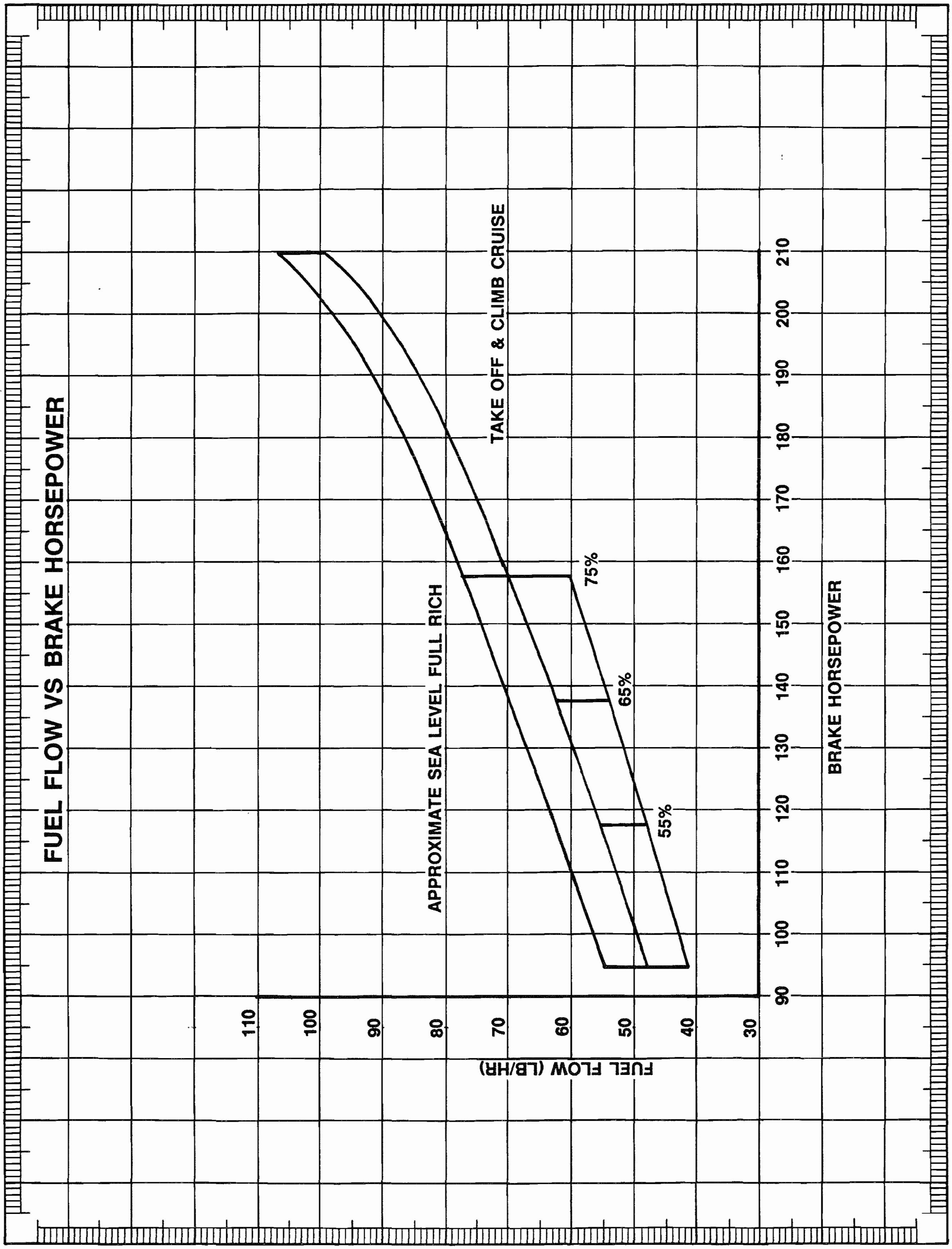

FIGURE 12-12. FUEL FLOW VS. BRAKE HORSEPOWER
ES

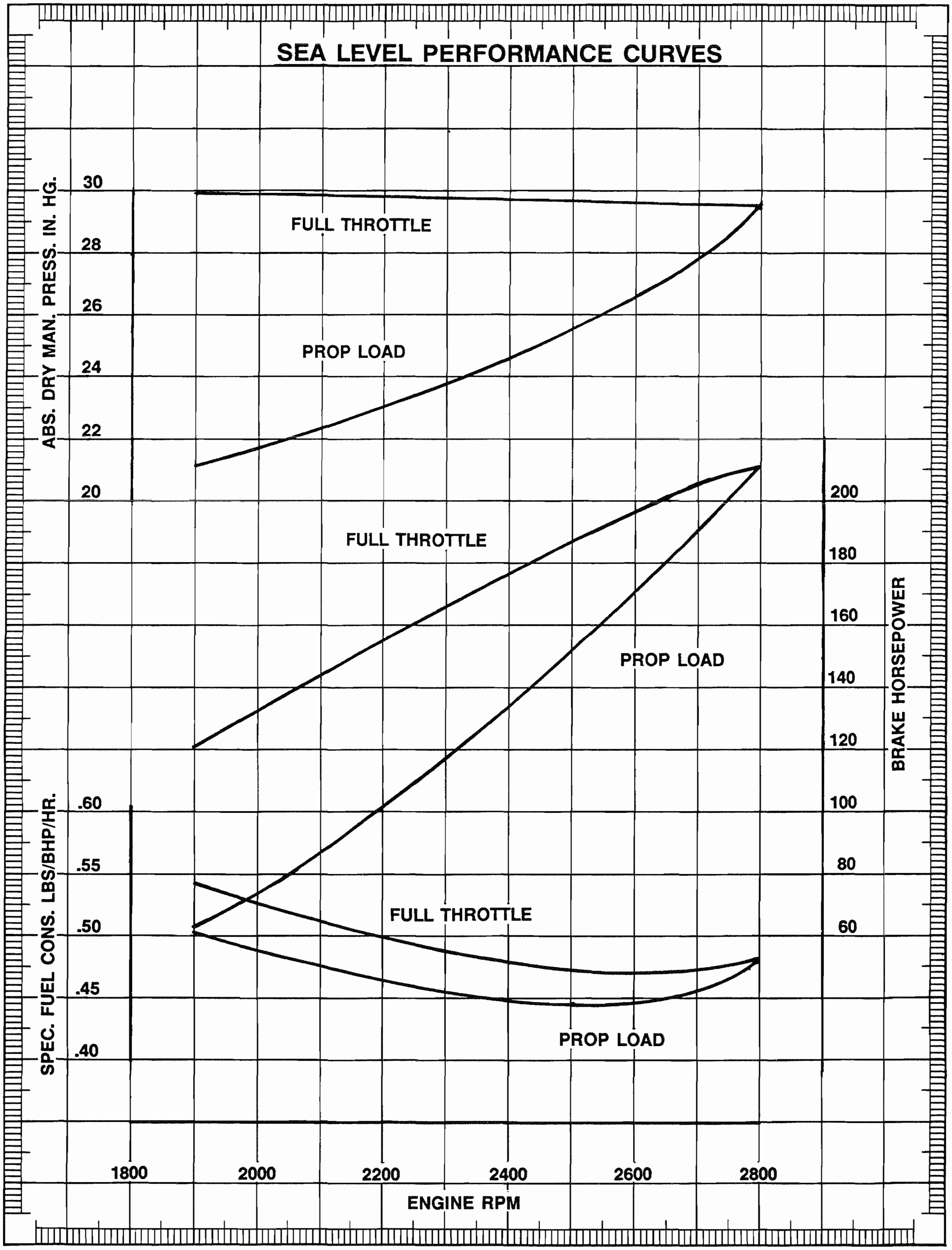

FIGURE 12-13. SEA LEVEL PERFORMANCE CURVES
ES

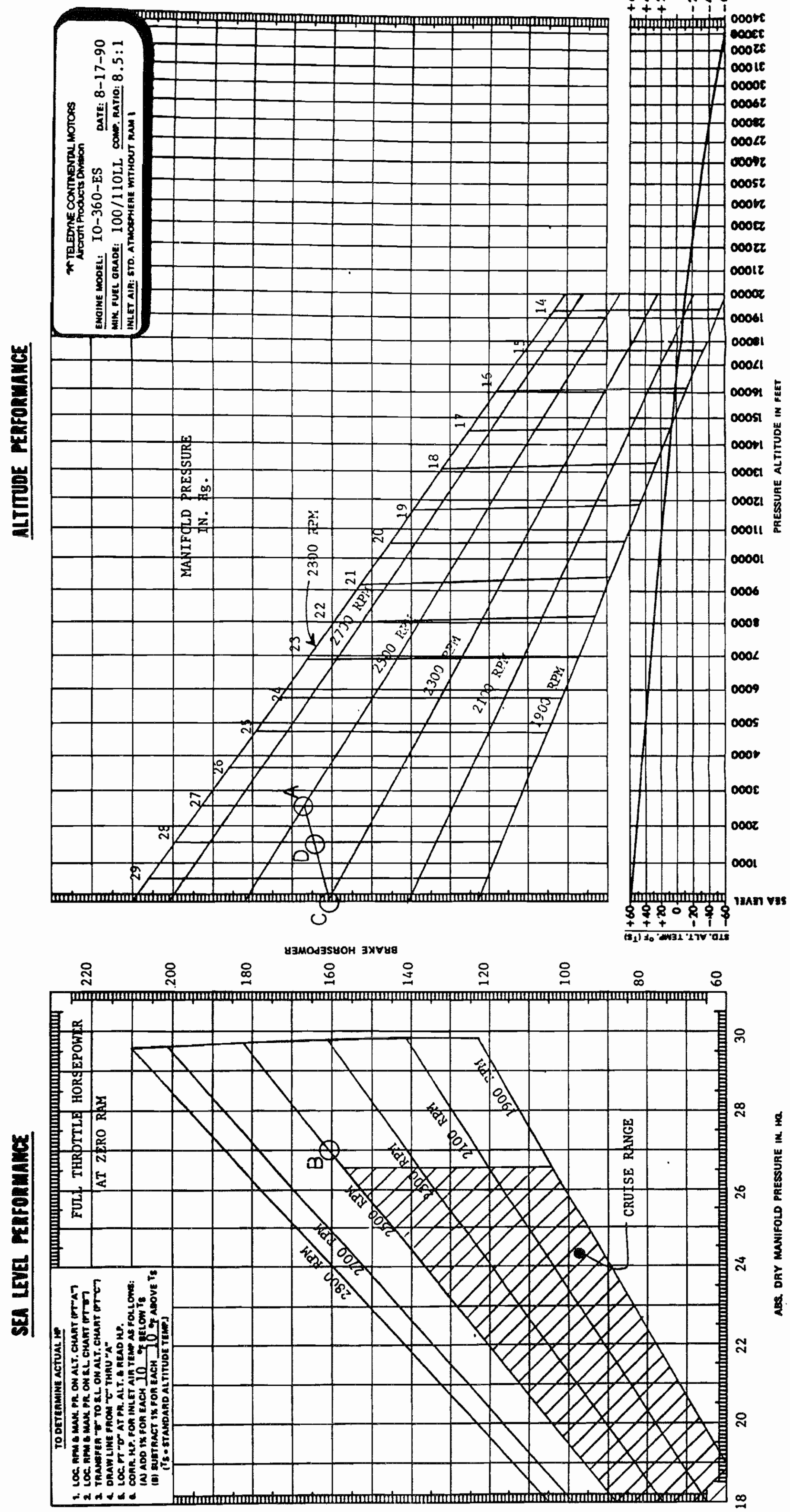

FIGURE 12-14. ALTITUDE PERFORMANCE ES

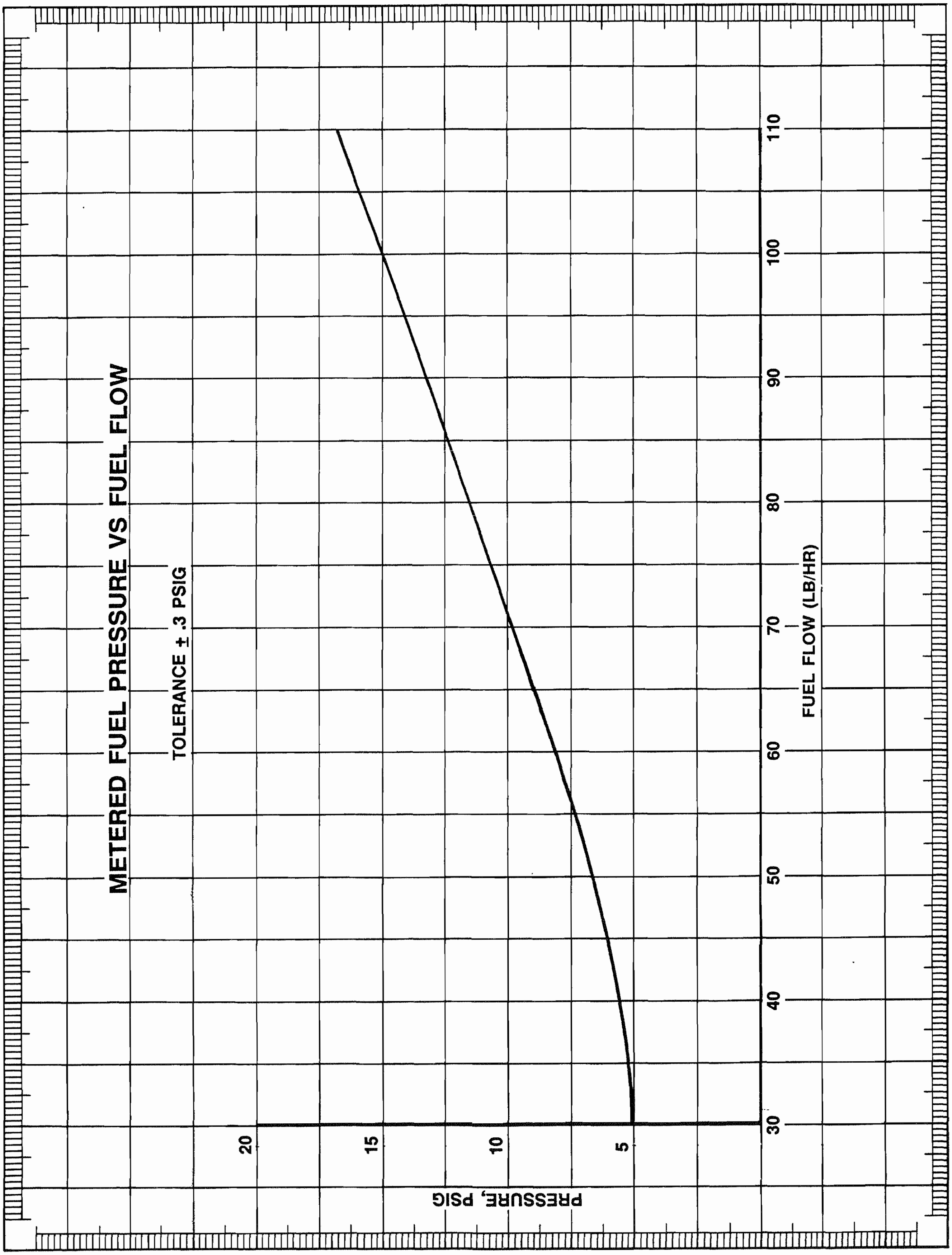

FIGURE 12-15. METERED FUEL PRESSURE VS. FUEL FLOW ES

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