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SECTION 1
GENERAL

SECTION 1

GENERAL

1.1 INTRODUCTION

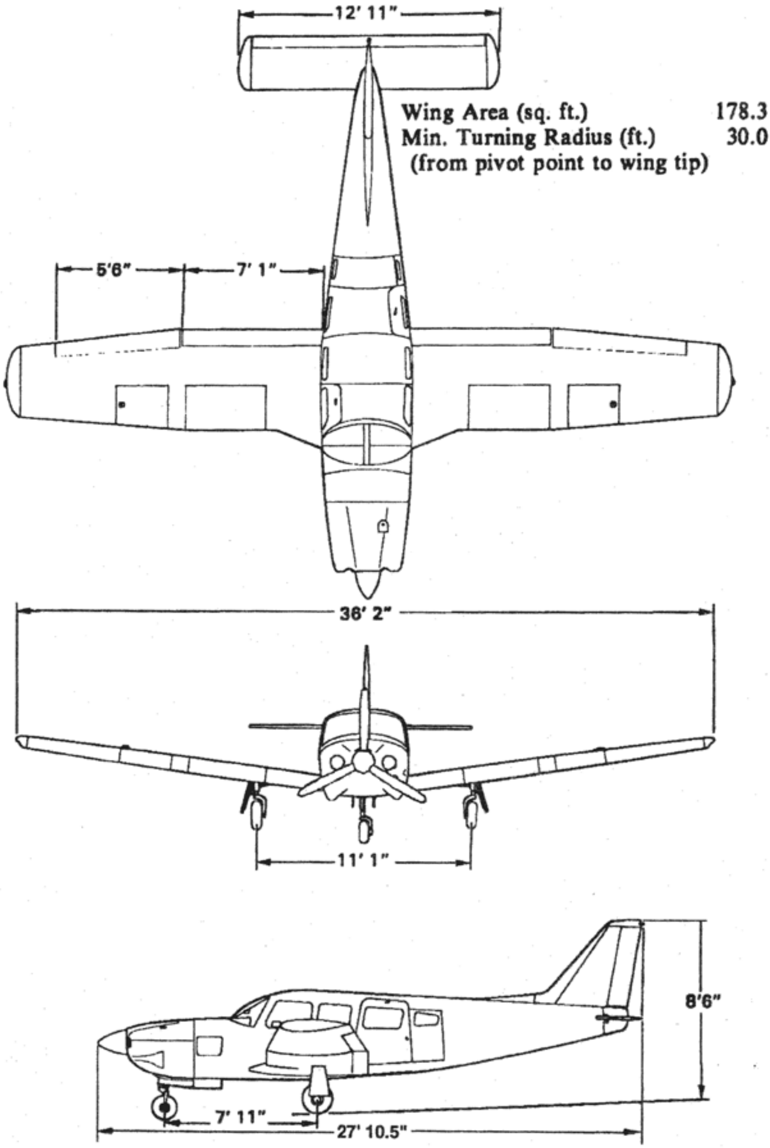
This Pilot's Operating Handbook is designed for maximum utilization as an operating guide for the pilot. It includes the material required to be furnished to the pilot by FAR/CAR. It also contains supplemental data supplied by the airplane manufacturer.

This handbook is not designed as a substitute for adequate and competent flight instruction, knowledge of current airworthiness directives, applicable federal air regulations or advisory circulars. It is not intended to be a guide for basic flight instruction or a training manual and should not be used for operational purposes unless kept in a current status.

Assurance that the airplane is in an airworthy condition is the responsibility of the owner. The pilot in command is responsible for determining that the airplane is safe for flight. The pilot is also responsible for remaining within the operating limitations as outlined by instrument markings, placards, and this handbook.

Although the arrangement of this handbook is intended to increase its in-flight capabilities, it should not be used solely as an occasional operating reference. The pilot should study the entire handbook to familiarize himself with the limitations, performance, procedures and operational handling characteristics of the airplane before flight.

The handbook has been divided into numbered (arabic) sections each provided with a ``finger-tip'' tab divider for quick reference. The limitations and emergency procedures have been placed ahead of the normal procedures, performance and other sections to provide easier access to information that may be required in flight. The "Emergency Procedures" Section has been furnished with a red tab divider to present an instant reference to the section. Provisions for expansion of the handbook have been made by the deliberate omission of certain paragraph numbers, figure numbers, item numbers and pages noted as being intentionally left blank.



THREE VIEW
Figure 1-1

1.3 ENGINE

(a) Number of Engines	1
(b) Engine Manufacturer	Lycoming
(c) Engine Model Number	TIO-540-AH1A
(d) Rated Horsepower	300
(e) Rated Speed (rpm)	2500
(f) Bore (inches)	5.125
(g) Stroke (inches)	4.375
(h) Displacement (cubic inches)	541.5
(i) Compression Ratio	7.3:1
(j) Engine Type	Six Cylinder, Direct Drive, Horizontally Opposed, Air Cooled, Turbocharged, Fuel Injected

1.5 PROPELLER

(a) Number of Propellers	1
(b) Propeller Manufacturer	Hartzell
(c) Blade Model	F-7663DR
(d) Number of Blades	3
(e) Hub Model	HC-I3YR-1RF
(f) Propeller Diameter (inches)	
(1) Minimum	77
(2) Maximum	78
(g) Propeller Type	Constant Speed, Hydraulically Actuated

1.7 FUEL

AVGAS ONLY

(a) Fuel Capacity (U.S. gal.) (total)	107
(b) Usable Fuel (U.S. gal.) (total)	102
(c) Fuel Grade, Aviation	
(1) Minimum Grade	100 - Green or 100LL - Blue Aviation Grade
(2) Alternate Fuels	Refer to latest revision of Lycoming Service Instruction 1070

1.9 OIL

(a) Oil Capacity (U.S. quarts) 12

(b) Oil Specification Refer to latest issue of Lycoming Service Instruction 1014.

(c) Oil Viscosity per Average Ambient Temp. for Starting

	SINGLE	MULTI
(1) Above 80°F	60	60
(2) Above 60°F	50	40 or 50
(3) 30°F to 90°F	40	40
(4) 0°F to 70°F	30	30, 40 or 20W40
(5) 0°F to 90°F	20	20W50 or 15W50
(6) Below 10°F	20	30 or 20W30

1.11 MAXIMUM WEIGHTS

(a) Maximum Takeoff Weight (lbs.)		3600
(b) Maximum Landing Weight (lbs.)		3600
(c) Maximum Ramp Weight (lbs.)		3615
	FORWARD	AFT
Compartments	100	100

1.13 STANDARD AIRPLANE WEIGHTS

Refer to Figure 6-5 for the Standard Empty Weight and the Useful Load.

1.15 BAGGAGE SPACE

	FORWARD	AFT
(a) Compartment Volume (cubic feet)	7.0	17.3
(b) Entry Width (inches)	16.0	48.0
(c) Entry Height (inches)	22.0	26.0

1.17 SPECIFIC LOADING

(a) Wing Loading (lbs. per sq. ft.)	20.2
(b) Power Loading (lbs. per hp)	12.0

1.19 SYMBOLS, ABBREVIATIONS AND TERMINOLOGY

The following definitions are of symbols, abbreviations and terminology used throughout the handbook and those which may be of added operational significance to the pilot.

(a) General Airspeed Terminology and Symbols

CAS	Calibrated Airspeed means the indicated speed of an aircraft, corrected for position and instrument error. Calibrated airspeed is equal to true airspeed in standard atmosphere at sea level.
KCAS	Calibrated Airspeed expressed in "Knots."
GS	Ground Speed is the speed of an airplane relative to the ground.
IAS	Indicated Airpseed is the speed of an aircraft as shown on the airspeed indicator when corrected for instrument error. IAS values published in this handbook assume zero instrument error.
KIAS	Indicated Airspeed expressed in "Knots."
M	Mach number is the ratio of true airspeed to the speed of sound.
TAS	True Airspeed is the airspeed of an airplane relative to undisturbed air which is the CAS corrected for altitude, temperature and compressibility.
V_A	Maneuvering Speed is the maximum speed at which application of full available aerodynamic control will not overstress the airplane.
V_{FE}	Maximum Flap Extended Speed is the highest speed permissible with wing flaps in a prescribed extended position.

V_{LE}	Maximum Landing Gear Extended Speed is the maximum speed at which an aircraft can be safely flown with the landing gear extended.
V_{LO}	Maximum Landing Gear Operating Speed is the maximum speed at which the landing gear can be safely extended or retracted.
V_{NE}/M_{NE}	Never Exceed Speed or Mach Number is the speed limit that may not be exceeded at any time.
V_{NO}	Maximum Structural Cruising Speed is the speed that should not be exceeded except in smooth air and then only with caution.
V_S	Stalling Speed or the minimum steady flight speed at which the airplane is controllable.
V_{SO}	Stalling Speed or the minimum steady flight speed at which the airplane is controllable in the landing configuration.
V_X	Best Angle-of-Climb Speed is the airspeed which delivers the greatest gain of altitude in the shortest possible horizontal distance.
V_Y	Best Rate-of-Climb Speed is the airspeed which delivers the greatest gain in altitude in the shortest possible time.

(b) Meteorological Terminology

ISA	International Standard Atmosphere in which: The air is a dry perfect gas; the temperature at sea level is 15° Celsius (59° Fahrenheit); The pressure at sea level is 29.92 inches Hg (1013.2 mb); the temperature gradient from sea level to the altitude at which the temperature is -56.5° C (-69.7°F) is -0.00198°C (-0.003564°F) per foot and zero above that altitude.
OAT	Outside Air Temperature is the free air static temperature, obtained either from inflight temperature indications or ground meteorological sources, adjusted for instrument error and compressibility effects.
Indicated Pressure Altitude	The number actually read from an altimeter when the barometric subscale has been set to 29.92 inches of mercury (1013.2 millibars).
Pressure Altitude	Altitude measured from standard sea-level pressure (29.92 in Hg) by a pressure or barometric altimeter. It is the indicated pressure altitude corrected for position and instrument error. In this handbook, altimeter instrument errors are assumed to be zero.
Station Pressure	Actual atmospheric pressure at field elevation.
Wind	The wind velocities recorded as variables on the charts of this handbook are to be understood as the headwind or tailwind components of the reported winds.

(c) Power Terminology

Takeoff Power	Maximum power permissible for takeoff.
Maximum Continuous Power	Maximum power permissible continuously during flight.
Maximum Climb Power	Maximum power permissible during climb.
Maximum Cruise Power	Maximum power permissible during cruise.

(d) Engine Instruments

TIT Gauge	Turbine Inlet Temperature Gauge

(e) Airplane Performance and Flight Planning Terminology

Climb Gradient	The demonstrated ratio of the change in height during a portion of a climb, to the horizontal distance traversed in the same time interval.
Demonstrated Crosswind Velocity	The demonstrated crosswind velocity is the velocity of the crosswind component for which adequate control of the airplane during takeoff and landing was actually demonstrated during certification tests.
Accelerate-Stop Distance	The distance required to accelerate an airplane to a specified speed and, assuming failure of an engine at the instant that speed is attained, to bring the airplane to a stop.
Route Segment	A part of a route. Each end of that part is identified by: (1) a geographical location; or (2) a point at which a definite radio fix can be established.

(f) Weight and Balance Terminology

Reference Datum	An imaginary vertical plane from which all horizontal distances are measured for balance purposes.
Station	A location along the airplane fuselage usually given in terms of distance from the reference datum.
Arm	The horizontal distance from the reference datum to the center of gravity (C.G.) of an item.
Moment	The product of the weight of an item multiplied by its arm. (Moment divided by a constant is used to simplify balance calculations by reducing the number of digits.)
Center of Gravity (C.G.)	The point at which an airplane would balance if suspended. Its distance from the reference datum is found by dividing the total moment by the total weight of the airplane.
C.G. Arm	The arm obtained by adding the airplane's individual moments and dividing the sum by the total weight.
C.G. Limits	The extreme center of gravity locations within which the airplane must be operated at a given weight.
Usable Fuel	Fuel available for flight planning.
Unusable Fuel	Fuel remaining after a runout test has been completed in accordance with governmental regulations.
Standard Empty Weight	Weight of a standard airplane including unusable fuel, full operating fluids and full oil.

Basic Empty Weight	Standard empty weight plus optional equipment.
Payload	Weight of occupants, cargo and baggage.
Useful Load	Difference between takeoff weight, or ramp weight if applicable, and basic empty weight.
Maximum Ramp Weight	Maximum weight approved for ground maneuver. (It includes weight of start, taxi and run up fuel.)
Maximum Takeoff Weight	Maximum Weight approved for the start of the takeoff run.
Maximum Landing Weight	Maximum weight approved for the landing touchdown.
Maximum Zero Fuel Weight	Maximum weight exclusive of usable fuel.

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SECTION 2

LIMITATIONS

SECTION 2

LIMITATIONS

2.1 GENERAL

This section provides the "FAA Approved'' operating limitations, instrument markings, color coding and basic placards necessary for operation of the airplane and its systems.

Limitations associated with those optional systems and equipment which require handbook supplements can be found in Section 9 (Supplements).

2.3 AIRSPEED LIMITATIONS

SPEED	KIAS	KCAS
Never Exceed Speed (VNE) - Do not exceed this speed in any operation.	191	189
Maximum Structural Cruising Speed (VNO) - Do not exceed this speed except in smooth air and then only with caution.	167	165
Design Maneuvering Speed (VA) - Do not make full or abrupt control movements above this speed.		
At 3600 LBS. G.W.	134	132
At 2230 LBS. G.W.	105	104

CAUTION

Maneuvering speed decreases at lighter weight as the effects of aerodynamic forces become more pronounced. Linear interpolation may be used for intermediate gross weights. Maneuvering speed should not be exceeded while operating in rough air.

SPEED	KIAS	KCAS
Maximum Flaps Extended Speed (VFE) - Do not exceed this speed with the flaps extended.	110	109
Maximum Landing Gear Extension Speed (VLO) - Do not exceed this speed when extending the landing gear.	132	130
Maximum Landing Gear Retraction Speed (VLO) - Do not exceed this speed when retracting the landing gear.	110	109
Maximum Landing Gear Extended Speed (VLE) Do not exceed this speed with the landing gear extended.	132	130

2.5 AIRSPEED INDICATOR MARKINGS

MARKING	IAS
Red Radial Line (Never Exceed)	191 KTS
Yellow Arc (Caution Range - Smooth Air Only)	167 KTS to 191 KTS
Green Arc (Normal Operating Range)	67 KTS to 167 KTS
White Arc (Flap Down)	63 KTS to 110 KTS

2.7 POWER PLANT LIMITATIONS

(a) Number of Engines	1
(b) Engine Manufacturer	Lycoming
(c) Engine Model No.	TIO-540-AH1A
(d) Engine Operating Limits	
(1) Maximum Horse Power	300
(2) Maximum Rotation Speed (RPM)	2500
(3) Maximum Oil Temperature (°F)	245
(e) Oil Pressure	
Minimum (red line)	25 PSI
Maximum (red line)	115 PSI
(f) Fuel Grade (minimum grade)	100 - Green or 100LL - Blue Aviation Grade
(g) Number of Propellers	1
(h) Propeller Manufacturer	Hartzell
(i) Propeller Hub and Blade Model	HC-I3YR-1RF F-7663DR
(j) Propeller Diameter (inches)	
Minimum	77
Maximum	78
(k) Blade Angle Limits	
Low Pitch Stop	14.1° ± 0.1°
High Pitch Stop	34.0° ± 0.5°
(l) Maximum Cylinder Head Temperature	500°F
(m) Maximum Turbine Inlet Temperature	1650°F
(n) Maximum Manifold Pressure (inches of mercury)	
To 14,000 feet	38
14,000 to 20,000 feet	38 - 1.1 per 1000 foot increase

2.9 POWER PLANT INSTRUMENT MARKINGS

(a) Tachometer	
Green Arc (Normal Operating Range)	600 to 2500 RPM
Red Line (Maximum)	2500 RPM
(b) Manifold Pressure	
Green Arc (Normal Operating Range)	10 to 38 in. hg.
Red Line (Maximum)	38 in. hg.
(c) Oil Temperature	
Green Arc (Normal Operating Range)	100° to 245°F
Red Line (Maximum)	245°F
(d) Oil Pressure	
Green Arc (Normal Operating Range)	55 PSI to 95 PSI
Yellow Arc (Caution Range) (Idle)	25 PSI to 55 PSI
Yellow Arc (Caution Range) (Start and Warm Up)	95 PSI to 115 PSI
Red Line (Minimum)	25 PSI
Red Line (Maximum)	115 PSI
(e) Cylinder Head Temperature	
Green Arc (Normal Operating Range)	200° to 500°F
Red Radial Line (Maximum)	500°F
(f) Turbine Inlet Temperature	
Green Arc (Normal Operating Range)	1200° to 1650° F
Red Line (Maximum)	1650° F
(g) Fuel Flow	0 gal/hr. to 35 gal/hr.
(h) Vacuum Pressure	
Green arc (normal operating range)	4.8 to 5.2 in. Hg.
Red Line (minimum)	4.8 in. Hg.
Red Line (maximum)	5.2 in. Hg.
-or-	
Green arc (normal operating range)	4.5 to 5.2 in. Hg.
Red Line (minimum)	4.5 in. Hg.
Red Line (maximum)	5.2 in. Hg.

2.11 WEIGHT LIMITS

(a) Maximum Takeoff Weight	3600 LBS.
(b) Maximum Ramp Weight	3615 LBS.
(c) Maximum Baggage (100 lbs. each compartment)	200 LBS.

NOTE

Refer to Section 5 (Performance) for maximum weight as limited by performance.

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2.13 CENTER OF GRAVITY LIMITS

Weight Pounds	Forward Limit Inches Aft of Datum	Rearward Limit Inches Aft of Datum
3600	91.4	95.0
3200	83.5	95.0
2400 (and less)	78.0	95.0

NOTES

Straight line variation between points given.

The datum used is 78.4 inches ahead of the wing leading edge at the intersection of the untapered and inboard tapered section.

It is the responsibility of the airplane owner and the pilot to insure that the airplane is properly loaded. See Section 6 (Weight and Balance) for proper loading instructions.

2.15 MANEUVER LIMITS

No acrobatic maneuvers including spins approved.

2.17 FLIGHT LOAD FACTORS

(a) Positive Load Factor (Maximum)	3.8 G
(b) Negative Load Factor (Maximum)	No inverted maneuvers approved
(c) Positive Load Factor - Flaps Down (Maximum)	2.0 G
(d) Negative Load Factor - Flaps Down (Maximum)	No inverted maneuvers approved

2.19 TYPES OF OPERATIONS

The airplane is approved for the following operations when equipped in accordance with FAR 91 or FAR 135.

(a)Day V.F.R.
(b)Night V.F.R.
(c)Day I.F.R.
(d)Night I.F.R.
(e)Non Icing

2.21 FUEL LIMITATIONS

(a) Total Capacity..107 U.S. GAL.
(b) Unusable Fuel..5 U.S. GAL.
The unusable fuel for this airplane has been determined as 2.5 gallons in each wing in critical flight attitudes (2.5 gallons is the total per side, each side having two interconnected tanks).
(c) Usable Fuel..102 U.S. GAL.
The usable fuel in this airplane has been determined as 51 gallons in each wing (51 gallons is the total per side, each side having two interconnected tanks).

2.25 PLACARDS

In full view of the pilot:

THIS AIRPLANE MUST BE OPERATED AS A NORMAL CATEGORY AIRPLANE IN COMPLIANCE WITH THE OPERATING LIMITATIONS STATED IN THE FORM OF PLACARDS, MARKINGS AND MANUALS. NO ACROBATIC MANEUVERS INCLUDING SPINS, APPROVED.

THIS AIRCRAFT APPROVED FOR V.F.R., I.F.R., DAY AND NIGHT NON-ICING FLIGHT WHEN EQUIPPED IN ACCORDANCE WITH FAR 91 OR FAR 135.

WARNING

TURN OFF STROBE LIGHTS WHEN IN CLOSE PROXIMITY TO GROUND, OR DURING FLIGHT THROUGH CLOUD, FOG OR HAZE.

On the instrument panel in full view of the pilot:

VA 134 KIAS at 3600 LBS.
(See A.F.M.)

On the instrument panel in full view of the pilot:

DEMO X-WIND 17 KTS

In full view of the pilot:

V_{LO} 132 KIAS DN, 110 KIAS UP
V_{LE} 132 KIAS MAX

Near gear selector switch:

GEAR UP	**110 KIAS MAX**
DOWN	**132 KIAS MAX**

In full view of the pilot:

DO NOT EXCEED 26 INCHES OF MANIFOLD PRESSURE BELOW 2100 RPM.

In full view of the pilot:

WARNING

TURN OFF STROBE LIGHTS WHEN IN CLOSE PROXIMITY TO GROUND OR DURING FLIGHT THROUGH CLOUD, FOG OR HAZE.

In full view of the pilot, in the area of the air conditioner controls when the air conditioner is installed:

WARNING AIR CONDITIONER MUST BE OFF TO INSURE NORMAL TAKEOFF CLIMB PERFORMANCE.

On the inside of the forward baggage compartment:

MAXIMUM BAGGAGE THIS COMPARTMENT 100 LBS. SEE THE LIMITATIONS SECTION OF THE AIRPLANE FLIGHT MANUAL.

On aft baggage closeout:

MAXIMUM BAGGAGE THIS COMPARTMENT 100 LBS. NO HEAVY OBJECTS ON HAT SHELF.

On storm window:

DO NOT OPEN ABOVE 129 KIAS.

In full view of the pilot and passengers:

NO SMOKING

In full view of the pilot and on each winterization plate:

IT IS RECOMMENDED THAT THE OIL COOLER WINTERIZATION PLATES BE INSTALLED WHEN GROUND OR IN-FLIGHT TEMPERATURES ARE EXPECTED TO BE BELOW +15°F.

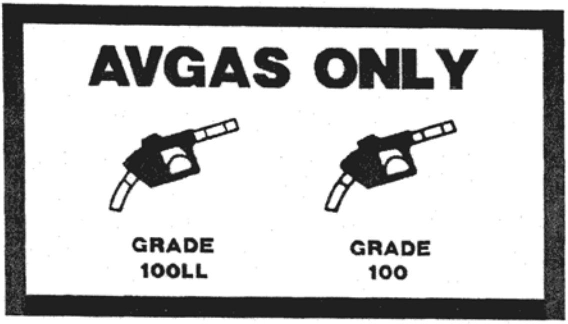
NOTE: THE USE OF THE OIL COOLER WINTERIZATION PLATES IN AMBIENT TEMPERATURES BELOW +15°F WILL PRECLUDE THE OCCURRENCE OF IN-FLIGHT OIL CONGELATION AND IS APPROVED FOR USAGE IN AMBIENT TEMPERATURES UP TO +62° F.

Adjacent to front door latch:

CAUTION

DO NOT ATTEMPT TO CLOSE DOOR WITH HANDLE IN LATCHED POSITION.

Adjacent to fuel tank filler caps:



In full view of the pilot:

SECURE ARMRESTS FOR
TAKEOFF AND LANDING

If required, on the aft close out panel:

REAR PASSENGER/BAGGAGE AREAS

MAXIMUM ALLOWABLE WEIGHT

MAXIMUM ALLOWABLE COMBINED WEIGHT IN AFT SEATS IS

_______________ POUNDS

LOAD IN ACCORDANCE WITH
WEIGHT AND BALANCE DATA

On right hand side of console top:

MONITOR, ALL LOOSE ITEMS, AND CONSOLE TOP ARE TO BE IN THE STOWED POSITION FOR TAKEOFF AND LANDING

On right hand side of console top:

MAXIMUM, WEIGHT ALLOWABLE ON THE CONSOLE TOP IN THE EXTENDED POSITION IS 10 LBS.

On windshield bow above compass:

CAUTION

COMPASS CAL. MAY BE IN ERROR WITH ELECT. EQUIPMENT OTHER THAN AVIONICS ON.

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SECTION 3

EMERGENCY PROCEDURES

SECTION 3

EMERGENCY PROCEDURES

3.1 GENERAL

The recommended procedures for coping with various types of emergencies and critical situations are provided by this section. All of the required (FAA regulations) emergency procedures and those necessary for operation of the airplane as determined by the operating and design features of the airplane are presented.

Emergency procedures associated with those optional systems and equipment which require handbook supplements are provided in Section 9 (Supplements).

The first portion of this section consists of an abbreviated emergency checklist which supplies an action sequence for critical situations with little emphasis on the operation of systems.

The remainder of the section is devoted to amplified emergency procedures containing additional information to provide the pilot with a more complete understanding of the procedures.

These procedures are suggested as a course of action for coping with the particular condition described, but are not a substitute for sound judgment and common sense. Pilots should familiarize themselves with the procedures given in this section and be prepared to take appropriate action should an emergency arise.

Most basic emergency procedures, such as a power off landings, are a normal part of pilot training. Although these emergencies are discussed here, this information is not intended to replace such training, but only to provide a source of reference and review, and to provide information on procedures which are not the same for all aircraft. It is suggested that the pilot review standard emergency procedures periodically to remain proficient in them.

3.3 AIRSPEEDS FOR SAFE OPERATION

Stall Speeds
- 3600 lbs (Gear Up, 0° Flap) .... 67 KIAS
- 3600 lbs (Gear Down, 40° Flap) .... 63 KIAS

Maneuvering Speeds
- 3600 lbs .... 134 KIAS
- 2230 lbs .... 105 KIAS

Never Exceed Speed .... 191 KIAS

Power Off Glide Speed
- 3600 lbs (Gear Up, 0° Flap) .... 83 KIAS

3.5 EMERGENCY PROCEDURES CHECKLIST

ENGINE FIRE DURING START

Start .... crank engine
Mixture .... idle cut-off
Throttle .... open
Electric fuel pump .... OFF
Fuel selector .... OFF
Abandon if fire continues

ENGINE POWER LOSS DURING TAKEOFF

If sufficient runway remains for a normal landing, leave gear down and land straight ahead.

If area ahead is rough, or if it is necessary to clear obstructions:
Gear selector switch .... UP

If sufficient altitude has been gained to attempt a restart:
Maintain safe airspeed
Fuel selector .... switch to tank containing fuel
Electric fuel pump .... check ON
Mixture .... check RICH
Alternate air .... OPEN
If power is not regained, proceed with power off landing.

ENGINE POWER LOSS IN FLIGHT

If at low altitude:

Airspeed .... MAINTAIN 83 KIAS Minimum

Prepare for power off landing.

ENGINE POWER LOSS IN FLIGHT (continued)

If altitude permits:

Fuel selector .... switch to tank containing fuel
Electric fuel pump .... ON
Mixture .... RICH
Alternate air .... OPEN
Engine gauges .... check for indication of cause of power loss

If no fuel flow is indicated, check tank selector position to be sure it is on a tank containing fuel.

When power is restored:
Alternate air .... CLOSED
Electric fuel pump .... OFF
Mixture .... adjust as necessary
If power is not restored prepare for power off landing.

POWER OFF LANDING

Trim for 83 KIAS
Locate suitable field.
Establish spiral pattern.
1000 ft. above field at downwind position for normal landing approach.
When field can easily be reached extend full flaps for shortest landing.

Touchdowns should normally be made at lowest possible airspeed with full flaps.

When committed to landing:
Landing gear selector .... DOWN
Flaps .... As desired
Throttle .... Close
Mixture .... idle cut-off
Magnetos .... OFF
Battery Master switch .... OFF
ALTR Switch .... OFF
Fuel selector .... OFF
Seat belt and harness .... tight

NOTE:

If battery master switch is OFF, the landing gear can not be retracted and the gear position lights and flaps will be inoperative

FIRE IN FLIGHT

Source of fire ....check

Electrical fire (smoke in cabin):

Batt. Master switch ....OFF

ALTR switch..OFF

Vents..open

Cabin heat..OFF

Land as soon as practicable.

Engine fire:

Fuel selector..OFF

Throttle ....CLOSED

Mixture..idle cut-off

Electric fuel pump ....check OFF

Heater and defroster..OFF

Proceed with power off landing procedure

NOTE:

The possibility of an engine fire in flight is extremely remote. The procedure given is general and Pilot judgment should be the determining factor for action in such an emergency.

LOSS OF OIL PRESSURE

Land as soon as possible and investigate cause. Prepare for power off landing.

LOSS OF FUEL FLOW

Electric fuel pump ....ON

Fuel selector..check on tank containing usable fuel

ENGINE DRIVEN FUEL PUMP FAILURE

Throttle ....retard

Electric fuel pump ....ON

Throttle..reset as required

CAUTION:

If normal engine operation and fuel flow is not immediately re-established, the electric fuel pump should be turned OFF. The lack of a fuel flow indication while the electric fuel pump is on could indicate a leak in the fuel system or fuel exhaustion. If fuel system leak is verified, switch fuel selector to off.

HIGH CYLINDER HEAD TEMPERATURE

Power ....Reduce
Mixture..Enrich
Airspeed...Increase, if practical

HIGH OIL TEMPERATURE

Land at nearest airport and investigate the problem. Prepare for power off landing.

TURBINE INLET TEMPERATURE (TIT) INDICATOR FAILURE

If failure occurs during takeoff, climb, or landing:

Mixture...Full Rich

If failure occurs prior to setting cruise power:

Power ....Set Power per POH Section 5
Power Setting Table
Mixture ....Lean to Approx. POH Section 5
Power Setting Table Fuel Flow
+4 GPH. Monitor CHT and Oil Temp.

CAUTION

Aircraft POH range and endurance data presented in Section 5 will no longer be applicable. Less range/endurance will result due to higher fuel flow/fuel consumption.

If failure occurs after setting cruise power and mixture:

Power...Note/Maintain Power Setting
Mixture ....Increase indicated Fuel Flow +1 GPH.
Monitor CHT and Oil Temp.

CAUTION

Aircraft POH range and endurance data presented in Section 5 will no longer be applicable. Less range/endurance will result due to higher fuel flow/fuel consumption.

If failure occurs prior to or during descent:

Power..Set for Descent
Mixture...Full Rich

ELECTRICAL FAILURES

Alternator Inop. light illuminated - Annunciator Panel

Verify Failure ....check ammeter

If ammeter shows zero

ALT switch ....OFF

Reduce electrical loads to minimum

ALT circuit breaker ....check and reset as required

ALT switch ....ON

If power not restored

ALT switch ....OFF

If alternator output cannot be restored, reduce electrical loads and land as soon as practical. The battery is the only remaining source of electrical power.

NOTE

LO BUS VOLTAGE annunciator will also be illuminated.

Land as soon as practical. Anticipate complete electrical failure. Duration of battery power available will be dependent on electrical load and battery condition prior to failure.

WARNING

Compass error may exceed 10° with alternator inop.

NOTE

If the battery is depleted, the landing gear must be lowered using the emergency extension procedure. The gear position lights will be inoperative. The flaps will also be inoperative and a flaps up landing will be required.

ELECTRICAL OVERLOAD (ALTERNATOR OVER 20 AMPS ABOVE KNOWN ELECTRICAL LOAD)

ALT switch ....ON

BAT switch ....OFF

If alternator loads are reduced

Electrical load ....reduce to minimum

Land as soon as practical.

ELECTRICAL OVERLOAD (ALTERNATOR OVER 20 AMPS ABOVE KNOWN ELECTRICAL LOAD) (CONT'D)

NOTE

Due to increased system voltage and radio frequency noise, operation with ALT switch ON and BAT switch OFF should be made only when required by an electrical system failure.

If alternator loads are not reduced
ALT switch..OFF
BAT switch ....as required

Land as soon as possible. Anticipate complete electrical failure.

NOTE

If the battery is depleted, the landing gear must be lowered using the emergency extension procedure. The gear position lights and flaps will be inoperative.

TURBOCHARGER FAILURE OR MALFUNCTION

WARNING

IN WORST-CASE CONDITIONS A COMPLETE LOSS OF ENGINE POWER MAY RESULT.

CAUTION:

If a TURBOCHARGER FAILURE is the result of loose, disconnected or burned through exhaust system components, a potentially serious fire hazard exists as well as the risk of carbon monoxide migration into the passenger compartment of the aircraft. If a failure within the exhaust system is suspected in flight, immediately reduce power to idle (or as low a power setting as possible) and LAND AS SOON AS POSSIBLE. If a suspected exhaust system failure occurs prior to takeoff, DO NOT FLY THE AIRCRAFT

PROPELLER OVERSPEED

Throttle .... retard
Oil pressure .... check
Prop control .... full DECREASE rpm, then set if any control available
Airspeed .... reduce
Throttle .... as required to remain below 2500 rpm

EMERGENCY LANDING GEAR EXTENSION

NOTE:

Refer to paragraph 4.39 for differences when emergency gear extension is being performed for training purposes.

Prior to emergency extension procedure:
Batt. Master switch .... check ON
ALTR switch .... check ON
Circuit breakers .... check
Day /night dimming switch (in daytime) .... day
Gear indicator bulbs .... check by depressing Annunc. test

If landing gear does not check down and locked:
Airspeed .... Reduce below 90 KIAS
Landing gear selector .... GEAR DOWN POSITION

If landing gear still does not check down and locked:
Emergency gear knob .... PULL, while fish tailing airplane (under normal conditions will take approx. 10 seconds to be down and locked)

If all electrical power has been lost, the landing gear must be extended using the above procedures. The gear position indicator lights will not illuminate.

SPIN RECOVERY

Rudder....full opposite to direction of rotation

Control wheel....full forward while neutralizing ailerons

Throttle....idle
Rudder....neutral (when rotation stops)

Control wheel....as required to smoothly regain level flight attitude

OPEN DOOR

If the door latch is open, the door will trail slightly open and airspeeds will be reduced slightly.

To close the door in flight:
Slow airplane to 90 KIAS
Cabin vents....close
Storm window....open

If door latch is open....pull on armrest while moving latch handle to latched position

ENGINE ROUGHNESS

Mixture....check too rich or lean
Alternate air....open
Electric fuel pump....on
Fuel selector....switch to another tank with fuel
Engine gauges....check, if abnormal proceed accordingly
Magnetos....check left then right, proceed to first available airport on good magneto

If roughness persists, prepare for precautionary landing. Land at first available airport.

3.7 AMPLIFIED EMERGENCY PROCEDURES (GENERAL)

The following paragraphs are presented to supply additional information for the purpose of providing the pilot with a more complete understanding of the recommended course of action and probable cause of an emergency situation.

3.9 ENGINE FIRE DURING START

Engine fires during start are usually the result of overpriming. The first attempt to extinguish the fire is to try to start the engine and draw the excess fuel back into the induction system.

If a fire is present before the engine has started, move the mixture control to idle cut-off, open the throttle and crank the engine. This is an attempt to draw the fire back into the engine.

If the engine has started, continue operating to try to pull the fire into the engine.

In either case (above), if fire continues more than a few seconds, the fire should be extinguished by the best available external means.

The fuel selector valve should be OFF and the mixture at idle cut-off if an external fire extinguishing method is to be used.

3.11 ENGINE POWER LOSS DURING TAKEOFF

The proper action to be taken if loss of power occurs during takeoff will depend on the circumstances of the particular situation.

If sufficient runway remains to complete a normal landing, leave the landing gear down and land straight ahead.

If the area ahead is rough, or if it is necessary to clear obstructions, move the gear selector switch to the UP position.

If sufficient altitude has been gained to attempt a restart, maintain a safe airspeed and switch the fuel selector to another tank containing fuel. Check the electric fuel pump to insure that it is ON and that the mixture is RICH. The alternate air should be OPEN.

If engine failure was caused by fuel exhaustion, power will not be regained after switching fuel tanks until the empty fuel lines are filled. This may require up to ten seconds.

If power is not regained, proceed with Power Off Landing procedure (refer to the emergency checklist and paragraph 3.15).

3.13 ENGINE POWER LOSS IN FLIGHT

Complete engine power loss is usually caused by fuel flow interruption and power will be restored shortly after fuel flow is restored. If power loss occurs at a low altitude, the first step is to prepare for a power off landing (refer to paragraph 3.15). An airspeed of at least 83 KIAS should be maintained.

If altitude permits, switch the fuel selector to another tank containing fuel and turn the electric fuel pump ON. Move the mixture control to RICH and the alternate air to OPEN. Check the engine gauges for an indication of the cause of the power loss. If no fuel flow is indicated, check the tank selector position to be sure it is on a tank containing fuel.

When power is restored move the alternate air to the CLOSED position, turn OFF the electric fuel pump and adjust the mixture control as necessary.

If the preceding steps do not restore power, prepare for an emergency landing.

If time permits, secure (OFF) one magneto at a time, then back to ON. Move the throttle and mixture control levers to different settings. This may restore power if the problem is too rich or too lean a mixture or if there is a partial fuel system restriction. Try other fuel tanks. Water in the fuel could take some time to be used up, and allowing the engine to windmill may restore power. If power loss is due to water, fuel flow indications will be normal.

If engine failure was caused by fuel exhaustion, power will not be restored after switching fuel tanks until the empty fuel lines are filled. This may require up to ten seconds.

If power is not regained, proceed with the Power Off Landing procedure (refer to the emergency checklist and paragraph 3.15).

3.15 POWER OFF LANDING

If loss of power occurs at altitude, trim the aircraft for best gliding angle (83 KIAS, Air Cond. off) and look for a suitable field. If measures taken to restore power are not effective, and if time permits, check your charts for airports in the immediate vicinity; it may be possible to land at one if you have sufficient altitude. At best gliding angle, with no wind, with the engine windmilling and the propeller control in full DECREASE rpm, the aircraft will travel approximately 1.5 miles for each thousand feet of altitude in a no wind condition. If possible, notify the FAA or any other authority, by radio of your difficulty and intentions. If another pilot or passenger is aboard, let them help.

When you have located a suitable field, establish a spiral pattern around this field. Try to be at 1000 feet above the field at the downwind position, to make a normal landing approach. When the field can easily be reached, extend full flaps for the shortest landing. Excess altitude may be lost by widening your pattern, using flaps or slipping, or a combination of these.

Whether to attempt a landing with gear up or down depends on many factors. If the field chosen is obviously smooth and firm, and long enough to bring the plane to a stop, the gear should be down. If there are stumps or rocks or other large obstacles in the field, the gear in the down position will better protect the occupants of the aircraft. If, however, the field is suspected to be excessively soft or short, or when landing in water of any depth, a wheels-up landing will normally be safer and do less damage to the airplane.

Touchdown should normally be made at the lowest possible airspeed with flaps fully extended.

When committed to landing, verify the landing gear selector position as required by field conditions. Lower the flaps as desired, close the throttle, move the mixture to idle cut-off, and shut off the magnetos. Turn the battery master and alternator switches OFF. Move the fuel selector valve to OFF. The seat belts and shoulder harness should be tightened.

NOTE

If the battery master switch is OFF, the gear cannot be retracted. The gear position lights and flaps will be inoperative.

3.17 FIRE IN FLIGHT

The presence of fire is noted through smoke, smell and heat in the cabin. It is essential that the source of the fire by promptly identified through instrument readings, character of smoke, or other indications since the action to be taken differs somewhat in each case.

Check for the source of the fire first.

If an electrical fire is indicated (smoke in the cabin), turn the battery master and alternator switches OFF. The cabin vents should be opened and the cabin heat turned OFF. A landing should be made as soon as possible.

If an engine fire is present, switch the fuel selector to OFF, close the throttle, and move the mixture to idle cut-off. Check that the electric fuel pump is OFF. In all cases, the heater and defroster should be OFF. If radio communication is not required select battery master and alternator switches OFF. If the terrain permits, a landing should be made immediately.

NOTE

The possibility of an engine fire in flight is extremely remote. The procedure given is general and pilot judgment should be the determining factor for action in such an emergency.

3.19 LOSS OF OIL PRESSURE

Loss of oil pressure may be either partial or complete. A partial loss of oil pressure usually indicates a malfunction in the oil pressure regulating system, and a landing should be made as soon as possible to investigate the cause and prevent engine damage.

A complete loss of oil pressure indication may signify oil exhaustion or may be the result of a faulty gauge. In either case, proceed toward the nearest airport and be prepared for a forced landing. If the problem is not a pressure gauge malfunction, the engine may stop suddenly. Maintain altitude until such time as a dead stick landing can be accomplished. Don't change power settings unnecessarily, as this may hasten complete power loss.

Depending on the circumstances, it may be advisable to make an off airport landing while power is still available, particularly if other indications of actual oil pressure loss, such as sudden increases in temperatures, or oil smoke, are apparent, and an airport is not close.

If engine stoppage occurs, proceed with Power Off Landing.

3.21 LOSS OF FUEL FLOW

The most probable cause of loss of fuel flow is either fuel depletion in the fuel tank selected or failure of the engine driven fuel pump. If loss of fuel flow occurs, turn ON the electric fuel pump and check that the fuel selector is on a tank containing usable fuel.

If loss of fuel pressure is due to failure of the engine driven fuel pump the electric fuel pump will supply sufficient fuel flow.

After fuel flow and power are regained, turn the electric fuel pump OFF. If fuel flow starts to drop, turn the electric fuel pump ON and land at the nearest suitable airport as soon as possible and have the cause investigated.

CAUTION

If normal engine operation and fuel flow is not immediately re-established, the electric fuel pump should be turned off. The lack of fuel flow indication with the electric fuel pump turned on could indicate a leak in the fuel system, or fuel exhaustion.

3.23 ENGINE DRIVEN FUEL PUMP FAILURE

If an engine driven fuel pump failure is indicated, retard the throttle and turn ON the electric fuel pump. The throttle should then be reset as required. A landing should be made at the nearest appropriate airport as soon as possible and the cause of the failure investigated.

CAUTION

If normal engine operation and fuel flow is not immediately re-established, the electric fuel pump should be turned off. The lack of a fuel flow indication while the electric fuel pump is on could indicate a leak in the fuel system, or fuel exhaustion. If fuel system leak is verified, switch fuel selector to off.

3.24 HIGH CYLINDER HEAD TEMPERATURE

Excessive cylinder head temperature may parallel excessive oil temperature. In any case, reduce power and/or enrich the mixture, and increase airspeed if practical. If the problem persists, land as soon as practical at an appropriate airport and have the cause investigated.

3.25 HIGH OIL TEMPERATURE

An abnormally high oil temperature indication may be caused by a low oil level, an obstruction in the oil cooler, damaged or improper baffle seals, a defective gauge, or other causes. Land as soon as practical at an appropriate airport and have the cause investigated.

A steady, rapid rise in oil temperature is a sign of trouble. Land at the nearest airport and let a mechanic investigate the problem. Watch the oil pressure gauge for an accompanying loss of pressure.

3.26 TURBINE INLET TEMPERATURE (TIT) INDICATOR FAILURE

In the event the Turbine Inlet Temperature (TIT) indicator or sensor fails during flight, continued flight is possible using conservative mixture/TIT settings. If TIT failure occurs during takeoff, climb, descent, or landing, maintain a full rich mixture to assure adequate fuel flow for engine cooling.

If TIT failure occurs prior to setting cruise power, set power per the POH Section 5 power setting table and then lean to the approximate POH power setting table fuel flow +4 GPH. This fuel flow will maintain adequate engine cooling and a TIT value below TIT limits. Monitor CHT and Oil Temperature for normal operation.

CAUTION

Aircraft POH range and endurance data presented in Section 5 will no longer be applicable. Less range/endurance will result due to higher fuel flow/fuel consumption.

If TIT failure occurs after setting cruise power and mixture per the POH Section 5 power setting table, maintain the power setting and increase indicated fuel flow by + 1 GPH. This fuel flow will maintain adequate engine cooling and TIT value below TIT limits. Monitor CHT and Oil Temperature for normal operation.

CAUTION

Aircraft POH range and endurance data presented in Section 5 will no longer be applicable. Less range/endurance will result due to higher fuel flow/fuel consumption.

The TIT indicating system should be repaired as soon as practical.

3.27 ELECTRICAL FAILURES

NOTE

LO BUS VOLTAGE annunciator will also be illuminated.

WARNING

Compass error may exceed 10° with alternator inop.

NOTE

If the battery is depleted, the landing gear must be lowered using the emergency extension procedure. The gear position lights will be inoperative. The flaps will also be inoperative and a flaps up landing will be required.

Loss of alternator output is detected through zero reading on the ammeter. Before executing the following procedure, insure that the reading is zero and not merely low by actuating an electrically powered device, such as the pitot heat, recognition light, etc. If no increase in the ammeter reading is noted, alternator failure can be assumed.

3.27 ELECTRICAL FAILURES (CONT'D)

The electrical load should be reduced as much as possible. Check the alternator circuit breakers for a popped circuit.

The next step is to attempt to reset the overvoltage relay. This is accomplished by moving the ALT switch to OFF for one second and then to ON. If the trouble was caused by a momentary overvoltage condition (30.5 volts and up) this procedure should return the ammeter to a normal reading.

If the ammeter continues to indicate "0" output, or if the alternator will not remain reset, turn off the ALT switch, maintain minimum electrical load and land as soon as practical. All electrical load is being supplied by the battery.

3.28 ELECTRICAL OVERLOAD (alternator over 20 amps above known electrical load)

If abnormally high alternator output is observed (more than 20 amps above known electrical load for the operating conditons) it may be caused by a low battery, a battery fault or other abnormal electrical load. If the cause is a low battery, the indication should begin to decrease toward normal within 5 minutes. If the overload condition persists attempt to reduce the load by turning off non-essential equipment.

Turn the BAT switch OFF and the ammeter should decrease. Turn the BAT switch ON and continue to monitor the ammeter. If the alternator output does not decrease within 5 minutes, turn the BAT switch OFF and land as soon as practical. All electrical loads are being supplied by the alternator.

NOTE

Due to higher voltage and radio frequency noise, operation with the ALT switch ON and the BAT switch OFF should be made only when required by an electrical failure.

NOTE

If the battery is depleted, the landing gear must be lowered using the emergency extension procedure. The gear position lights and flaps will be inoperative.

3.29 TURBOCHARGER FAILURE

WARNING

In worst - case conditions a complete loss of engine power may result.

CAUTION

If a TURBOCHARGER FAILURE is the result of loose, disconnected or burned through exhaust system components, a potentially serious fire hazard exists as well as the risk of carbon monoxide migration into the passenger compartment of the aircraft. If a failure within the exhaust system is suspected in flight, immediately reduce power to idle (or as low a power setting as possible) and LAND AS SOON AS POSSIBLE. If a suspected exhaust system failure occurs prior to takeoff, DO NOT FLY THE AIRCRAFT.

NOTE

A turbocharger malfunction may result in an overly rich fuel mixture, which could result in a partial power loss and/or a rough running engine. If the turbocharger wastegate fails in the OPEN position, a partial loss of power may result. If the turbocharger wastegae control fails in the CLOSED position, an engine power overboost may occur.

COMPLETE LOSS OF ENGINE POWER:

If a suspected turbocharger or turbocharger control system failure results in a complete loss of engine power, the following procedure is recommended. Retard the mixture control to the IDLE CUTOFF position. If necessary, reset the throttle to cruise power position and the propeller control to the full forward position. Slowly advance the mixture until the engine restarts and adjust for smooth engine operation. Reduce the power to the minimum required and ***land as soon as possible.***

Set the propeller and mixture control as necessary. ***Land as soon as possible.***

PARTIAL LOSS OF ENGINE POWER

If the turbocharger wastegate fails in the OPEN position, a partial loss of engine power may result. The following procedure is recommended if a suspected turbocharger or turbocharger wastegate control failure results in a partial loss of engine power.

3.29 TURBOCHARGER FAILURE (CONT'D)

Should a partial loss of engine power occur (i.e. wastegate fails open), the throttle, propeller and mixture controls can be set as required for flight. Monitor all engine gauges and ***land as soon as possible*** to have the cause of the power loss investigated.

ENGINE POWER OVERBOOST

If the turbocharger wastegate control fails in the CLOSED position, an engine power overboost condition may occur. The following procedure is recommended for an overboost condition:

Reduce the throttle as necessary to keep manifold pressure within limits. Expect manifold pressure response to throttle movements to be sensitive.

Set the propeller and mixture controls as necessary. ***Land as soon as possible.***

3.31 PROPELLER OVERSPEED

Propeller overspeed is caused by a malfunction in the propeller governor or low oil pressure which allows the propeller blades to rotate to full low pitch.

If propeller overspeed should occur, retard the throttle and check the oil pressure. The propeller control should be moved to full DECREASE rpm and then set if any control is available. Airspeed should be reduced and throttle used to maintain below 2500 RPM.

3.33 EMERGENCY LANDING GEAR EXTENSION

Prior to proceeding with an emergency gear extension, check to insure that the battery master and alternator switches are ON and that the circuit breakers have not opened. If it is daytime, the day/night dimmer switch should be in the day position. Check the landing gear indicators for faulty bulbs by depressing the annunciator press to test.

NOTE

Refer to Par. 4.39 for differences when emergency extension procedure is performed for training purposes.

If the landing gear does not check down and locked, reduce the airspeed to below 90 KIAS. Move the landing gear selector to the DOWN position. If the landing gear still does not check down and locked, PULL the emergency extend knob while fish tailing the airplane.

Under normal conditions, the above procedure, will require approximately 10 seconds for the gear to extend and lock down.

If all electrical power has been lost, the landing gear must be extended using the above procedure. The gear position indicator lights will not illuminate.

3.35 SPIN RECOVERY

Intentional spins are prohibited in this airplane. If a spin is inadvertently entered, immediately apply full rudder opposite to the direction of rotation. Move the control wheel full forward while neutralizing the ailerons. Move the throttle to IDLE. When the rotation stops, neutralize the rudder and ease back on the control wheel as required to smoothly regain a level flight attitude.

3.37 OPEN DOOR

The cabin door is latched through a pin mechanism, so the chances of its springing open in flight is remote. However, should you forget to fully engage the door latch, the door may spring partially open. This will usually happen at takeoff or soon afterward. A partially open door will not affect normal flight characteristics, and a normal landing can be made with the door open.

If the door latch is open, the door will trail slightly open, and airspeed will be reduced slightly.

To close the door in flight, slow the airplane to 90 KIAS, close the cabin vents and open the storm window. If the door latch is open, pull on the armrest while moving the latch handle to the latched position.

3.39 ENGINE ROUGHNESS

Engine roughness may be caused by dirt in the injector nozzles, induction filter icing, or ignition problems.

First adjust the mixture for maximum smoothness. The engine will run rough if the mixture is too rich or too lean.

Move the alternate air to OPEN and then turn ON the electric fuel pump.

Switch the fuel selector to another tank to see if fuel contamination is the problem.

Check the engine gauges for abnormal readings. If any gauge readings are abnormal proceed accordingly.

Secure (OFF) one magneto at a time, then back to ON. If operation is satisfactory on either magneto, proceed on that magneto at reduced power with full RICH mixture to a landing at the first available airport.

If roughness persists, prepare for a precautionary landing at pilot's discretion.

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SECTION 4

NORMAL PROCEDURES

4.1 GENERAL

This section describes the recommended procedures for the conduct of normal operations for the airplane. All of the required (FAA regulations) procedures and those necessary for operation of the airplane as determined by the operating and design features of the airplane are presented.

Normal procedures associated with those optional systems and equipment which require handbook supplements are provided in Section 9 (Supplements).

These procedures are provided to present a source of reference and review and to supply information on procedures which are not the same for all aircraft. Pilots should familiarize themselves with the procedures given in this section in order to become proficient in the normal operations of the airplane.

The first portion of this section consists of a short form check list which supplies an action sequence for normal operations with little emphasis on the operation of the systems.

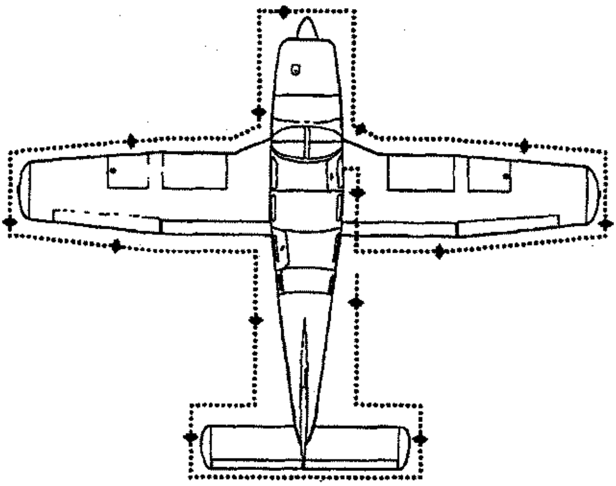
The remainder of the section is devoted to amplified normal procedures which provide detailed information and explanations of the procedures and how to perform them. This portion of the section is not intended for use as an in-flight reference due to the lengthy explanation. The short form checklist should be used for this purpose.

4.3 AIRSPEEDS FOR SAFE OPERATIONS

The following airspeeds are those which are significant to the operation of the airplane. These figures are for standard airplanes flown at gross weight under standard conditions at sea level.

Performance for a specific airplane may vary from published figures depending upon the equipment installed, the condition of the engine, airplane and equipment, atmospheric conditions and piloting technique.

(a) Best Rate of Climb Speed
gear down, flaps up ....81 KIAS
gear up, flaps up ....95 KIAS
(b)Turbulent Air Operating Speed (See Subsection 2.3)...............134 KIAS
(c)Maximum Flap Speed ....111 KIAS
(d)Landing Final Approach Speed (Full Flaps)...............................80 KIAS
(e)Maximum Demonstrated Crosswind Velocity ....17 KTS



WALK-AROUND
Figure 4-1

4.5 NORMAL PROCEDURES CHECKLIST

PREFLIGHT CHECK

COCKPIT

CAUTION: When draining any amount of fuel, care should be taken to ensure that no fire hazard exists before starting engine.

Fuel strainer............drain & check for water & sediment
Control wheel............release restraints
Gear Handle............down
Parking brake............set
Avionics............OFF
All switches............OFF
Mixture............idle cut-off
Magneto switches............OFF
Battery master switch............ON
Fuel gauges............check quantity
Annunciator panel............check
Flaps............extend
Battery master switch............OFF
Primary flight controls............proper operation
Trim............neutral
Pitot and static systems............drain
Windows............check clean
Required papers and POH............check on board
Tow bar and baggage............stow properly - secure
Baggage door-Rear............close and secure

RIGHT WING

Surface condition .... clear of ice, frost, snow
Flap and hinges .... check
Aileron and hinges .... check
Static wicks .... check - secure
Wing tip and nav/strobe lights .... check
Landing light .... check
Fuel tank .... check supply visually - secure cap
Fuel quantity gauge .... check
Fuel tank vent .... clear

CAUTION: When draining any amount of fuel, care should be taken to ensure that no fire hazard exists before starting engine.

Fuel tank sump .... drain and check for water, sediment and proper fuel
Tie down and chock .... remove
Main gear strut .... proper inflation (4.00 ± .25 in.)
Tire .... check
Brake block and disc .... check
Fresh air inlet .... clear

NOSE SECTION

General condition .... check
Windshield .... clean
Baggage door .... close and secure
Cowling .... secure
Propeller and spinner .... check
Air inlets .... clear
Engine baffle seals .... check
Chock .... remove
Nose gear strut .... proper inflation (3.25 ± .25 in.)
Nose Gear Doors .... check
Nose wheel tire .... check
Landing Light (s/n 3257001 thru 3257365 only) .... secure
Oil .... check quantity
Dipstick .... properly seated
Oil filler cap .... secure

LEFT WING

Surface condition....................clear of ice, frost, snow

Fresh air inlet....................clear

> **CAUTION**: When draining any amount of fuel, care should be taken to ensure that no fire hazard exists before starting engine.

Fuel tank sump....................drain and check for water, sediment and proper fuel
Tie down and chock....................remove
Main gear strut....................proper inflation (4.00 ± .25 in.)
Tire....................check
Brake block and disc....................check
Fuel tank vent....................clear
Fuel quantity gauge....................check
Fuel tank....................check supply visually - secure cap
Stall warning vanes....................check
Pitot head....................remove cover - holes clear
Landing light....................check
Wing tip and nav/strobe lights....................check
Aileron and hinges....................check
Flap and hinges....................check
Static wicks....................check secure

FUSELAGE
Antennas....................check
Static Vents....................clear
Oxygen Discharge Disc....................check for rupture
Empennage....................clear of ice, frost, snow
Stabilator and trim tab....................check
Tie down....................remove

MISCELLANEOUS

Battery master switch....................ON
Flaps....................retract
Interior lighting....................ON and check
Pitot heat switch....................ON
Pitot heat OFF/INOP annunciator....................OFF

> **CAUTION**: Care should be taken when an operational check of the heated pitot head is being performed. The unit becomes very hot. Ground operation should be limited to three minutes to avoid damaging the heater elements.

MISCELLANEOUS (CONT'D)

Exterior lighting switches .... ON and check
Pitot .... check - warm
Stall warning horn .... check
All lighting switches .... OFF
Pitot heat switch .... OFF
Pitot heat OFF/INOP annunciator .... ON
Battery master switch .... OFF
Passengers .... board
Doors .... Closed and secure
Seats .... Adjusted & Locked
Seat belts and harness .... fasten/adjust
check inertia reel

NOTE: With the shoulder harness fastened and adjusted, a pull test of it's locking restraint feature should be performed.

ENGINE START - GENERAL

CAUTION: Do not attempt flight if there is no indication of alternator output.

CAUTION: If a positive oil pressure is not indicated within 30 seconds following an engine start, stop the engine and determine the trouble. In cold weather it will take a few seconds longer to get a positive oil pressure indication.

NOTE: Starter manufacturers recommend that starter cranking periods be limited to 10 seconds with a 20 second rest period between cranking periods. Maximum of 6 start periods allowed. If start is not achieved on sixth attempt allow starter to cool for 30 minutes before attempting additional starts.

BEFORE STARTING ENGINE

Brakes .... set
Circuit breakers .... check in
Alternate air .... OFF
Propeller .... full INCREASE rpm
Avionics .... OFF
Fuel selector .... desired tank

NORMAL START - COLD ENGINE

Throttle....1/2 in. open
Battery master switch....ON
Primary Flight Display (PFD) (if installed)....Verify correct aircraft model software

NOTE: If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

Alternator switch....ON
Electric fuel pump....ON
Magneto switches....ON
Mixture....prime - then idle cut-off
Propeller....clear
Starter....engage
Mixture....full RICH
Throttle....adjust
Oil pressure....check

NORMAL START - HOT ENGINE

Throttle....1/2 in. open
Battery master switch....ON
Primary Flight Display (PFD) (if installed)....Verify correct aircraft model software

NOTE: If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

Alternator switch....ON
Electric fuel pump....ON
Magneto switches....ON
Mixture....idle cut-off
Propeller....clear
Starter....engage
Mixture....advance
Throttle....adjust
Oil pressure....check

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ENGINE START WHEN FLOODED

Throttle .... open full
Battery master switch .... ON
Primary Flight Display (PFD) (if installed) .... Verify correct aircraft model software

NOTE: If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

Alternator switch .... ON
Electric fuel pump .... OFF
Magneto switches .... ON
Mixture .... idle cut-off
Propeller .... clear
Starter .... engage
Mixture .... advance
Throttle .... retard
Oil Pressure .... check

STARTING WITH EXTERNAL POWER SOURCE

NOTE: If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

CAUTION: It is possible to use the ship's battery in parallel by turning only the battery master switch ON. This will give longer cranking capabilities, but will not increase the amperage. Care should be exercised because if the ship's battery has been depleted, the external power supply can be be reduced to the level of the ship's battery. This can be tested by turning on the battery master switch momentarily while the starter is engaged. If cranking speed increases, the ship's battery is at a higher level than the external power supply.

NOTE: For all normal operations using external power, the battery master and alternator switches should be OFF.

Battery master switch .... OFF
Alternator switch .... OFF
Electric fuel pump .... OFF
Magneto switches .... ON

STARTING WITH EXTERNAL POWER SOURCE (CONT'D)

All electrical equipment .... OFF
External power plug .... insert in fuselage
Proceed with normal start
Throttle .... lowest possible RPM
External power plug .... disconnect from fuselage
Battery master switch .... ON
Alternator switch .... ON - check ammeter
Oil pressure .... check

WARM-UP

Throttle .... 1000 to 1200 RPM

TAXIING

Taxi area .... clear
Parking brake .... release
Prop .... high RPM
Throttle .... apply slowly
Brakes .... check
Steering .... check
Flight Instruments .... check

> **NOTE:** During taxi in hot and/or high altitude conditions, activation of electric fuel pump may be required for smooth engine operation.

GROUND CHECK

Parking brake .... set
Propeller .... full INCREASE
Throttle .... 2000 RPM
Magnetos .... max. drop 175 RPM - max. diff. 50 RPM
Propeller .... exercise - then full INCREASE

CAUTION: Alternate air is unfiltered, use of alternate air during ground or flight operations when dust or other contaminant's are present may result in damage from particle ingestion.

Alternate air .... check
Oil temperature .... check
Oil pressure .... check
Vacuum .... check - within normal operating range
Annunciator panel .... press-to-test
Air conditioner .... check
Ammeter .... check
Electric fuel pump .... OFF
Fuel flow .... check
Throttle .... retard
Autopilot Master Switch .... Select ON/Verify self test completed

NOTE: Refer to the S-Tec System 55X Autopilot Supplement for autopilot and electric trim preflight checks.

NOTE: If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

BEFORE TAKEOFF

Battery master switch .... Verify ON
Alternator switch .... Verify ON
Electric fuel pump .... ON
Magneto switches .... Verify ON
Engine gauges .... check
Flight instruments .... check
Propeller .... set
Mixture .... Full forward
Alternate air .... CLOSED
Flaps .... set
Fuel selector .... proper tank
Trim .... set

BEFORE TAKEOFF (continued)

Air conditioner....................OFF
Controls....................free
Doors....................latched
Seats....................Adjusted & Locked
Seat backs....................erect

NOTE: With the shoulder harness fastened and adjusted, a pull test of its locking restraint feature should be performed.

Belts/harness....................fastened/check
Empty seats....................seat belts, securely fastened

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TAKEOFF

NORMAL TECHNIQUE

Flaps .... retracted
Trim .... set
Power .... set to maximum
Liftoff .... 80 KIAS
Obstacle Clearance Speed .... 85 KIAS
Landing gear (when straight ahead
landing on runway not possible) .... UP

SHORT FIELD, OBSTACLE CLEARANCE

NOTE: Gear warning will sound when the landing gear is retracted with the flaps extended more than 10°.

Flaps .... 25°
Trim .... set
Brakes .... apply
Power .... set to maximum
Brakes .... release
Liftoff .... 70 KIAS
Obstacle Clearance Speed .... 75 KIAS
Landing gear .... up
Accelerate to climb speed
Flaps .... retract slowly

CLIMB

Best rate (3600 lb) (gear down) (flaps up) .... 80 KIAS
Best rate (3600 lb) (gear up) (flaps up) .... 95 KIAS
Enroute .... 105 KIAS
Electric fuel pump .... ON
Mixture .... Full forward

CRUISE

Power ....set per power table
Electric fuel pump ....OFF
Mixture ....adjust

APPROACH AND LANDING

Fuel selector ....proper tank
Seats ....Adjusted & Locked
Seat backs ....erect
Belts/harness ....fasten/adjust
Electric fuel pump ....ON
Mixture ....Full forward
Propeller ....full increase
Gear ....down - 132 KIAS max.
Flaps ....set - 110 knots max.
Air conditioner ....OFF

NORMAL TECHNIQUE

Flaps ....as required
Trim ....90 KIAS
Throttle ....as required

SHORT FIELD TECHNIQUE

Flaps ....40°
Trim ....80 KIAS
Throttle ....as required

GO-AROUND

Propeller ....full INCREASE
Throttle ....full FORWARD
Control wheel ....back pressure to rotate to climb attitude
Airspeed ....80 KIAS
Flaps ....retract slowly
Gear ....UP
Trim ....as required

STOPPING ENGINE

CAUTION:
The flaps must be placed in the up position for the flap stop to support weight. Passengers should be cautioned accordingly.

Flaps .... retract
Electric fuel pump .... OFF
Air conditioner .... OFF
Avionics .... OFF
Electrical switches .... OFF
Propeller .... full INCREASE
Throttle .... closed
Mixture .... idle cut-off
Magneto Switches .... OFF
Alternator switch .... OFF
Battery master switch .... OFF

MOORING

Parking brake .... set
Flaps .... full up
Control wheel .... secured with belts
Wheel chocks .... in place
Tie downs .... secure

4.7 PREFLIGHT CHECK

Prior to entering the cockpit place a container under the fuel strainer valve located under the fuselage. The airplane should be given a thorough preflight and walk-around check. The preflight should include a check of the airplane's operational status, computation of weight and C.G. limits, takeoff distance and in-flight performance. A weather briefing should be obtained for the intended flight path, and any other factors relating to a safe flight should be checked before takeoff.

CAUTION

The flap position should be noted before boarding the airplane. The flaps must be placed in the UP position before they will lock and support weight on the step.

COCKPIT

CAUTION

When draining any amount of fuel, care should be taken to ensure that no fire hazard exists before starting engine.

Upon entering the cockpit, drain the fuel strainer by pressing down on the lever located on the forward side of the spar behind the copilots seat. The fuel selector should be positioned in the following sequence while draining the strainer: "OFF," "LEFT" and "RIGHT." This is done to insure that the fuel in the lines between each tank outlet and the fuel strainer is drained, as well as the fuel in the fuel strainer. When the fuel tanks are full, it will take approximately six seconds to drain all the fuel in one of the lines from a tank to the fuel strainer. If the fuel tanks are less than full, it will take a few seconds longer. After draining the fuel strainer, check for leakage and for water and sediment at the drain under the aircraft with the fuel selector on a tank position.

Release the seat belts securing the control wheel and check that the gear selector is in the down position. Set the parking brake by first depressing and holding the toe brake pedals and then pull the parking brake lever while depressing the knob attached to the top of he handle. Insure that all electrical switches are OFF. Turn OFF all avionics equipment (to save power and prevent wear on the units). The mixture should be in idle cut-off and the magneto switches in the OFF position. . Turn ON the battery master switch, check the fuel quantity gauges for adequate supply, check that the annunciator panel illuminates and check the flaps for proper operation. Turn OFF the battery master switch. Check the primary flight controls for proper operation and set the trim to neutral. Open the pitot and static drains to remove any moisture that has accumulated in the lines. Check the windows for cleanliness and that the required papers are on board. Properly stow and secure the tow bar and baggage. Close and secure the rear baggage door.

RIGHT WING

Begin the walk-around at the trailing edge of the right wing by checking that the wing surface and control surfaces are clear of ice, frost, snow or other extraneous substances. Check the flap, aileron and hinges for damage and operational interference. Static wicks should be firmly attached and in good condition. Check the wing tip and nav/strobe lights for damage. Verify condition of landing light/lens.

Open the fuel cap and visually check the fuel supply. Check the fuel indicator gauge. Each inboard tank is furnished with an external fuel quantity indicator to assist the pilot in determining fuel quantities of less than 35 gallons. The quantity should match the indication that was on the fuel quantity gauge. Replace cap securely. The fuel tank vent should be clear of obstructions.

Place a container under the quick drain. Drain the fuel tanks through the quick drain located at the lower inboard rear corner of each tank, making sure that enough fuel has been drained to verify the proper fuel and insure that all water and sediment is removed. The fuel system should be drained daily prior to the first flight and after each refueling.

CAUTION

When draining any amount of fuel, care should be taken to insure that no fire hazard exists before starting engine.

Remove the tie down and chock.

Next, complete a check of the landing gear. Check the gear strut for proper inflation; there should be 4.00 ± .25 inches of strut exposure under a normal static load. Check the tire for cuts, wear, and proper inflation. Make a visual check of the brake block and disc.

Check that the fresh air inlet is clear of foreign matter.

NOSE SECTION

Check the general condition of the nose section. Verify that the nose baggage door is closed, secure, and locked. Look for oil or fluid leakage and that the cowling is secure. Check the windshield and clean if necessary. The propeller and spinner should be checked for detrimental nicks, cracks, or other defects. The air inlets should be clear of obstructions. Check the condition of the engine baffle seals. Check the general condition of the nose wheel door and for excessive play.

Remove the chock and check the nose gear strut for proper inflation; there should be 3.25 ± .25 inches of strut exposure under a normal static load. Check the tire for cuts, wear, and proper inflation. The landing light should be checked for cleanliness and security (s/n 3257001 thru 3257365 only). Check the oil level; make sure that the dipstick has been properly seated and that the oil filler cap has been properly secured.

LEFT WING

The wing surface should be clear of ice, frost, snow, or other extraneous substances. Check that the fresh air inlet is clear of foreign matter and remove the tie down and chock. Check the main gear strut for proper inflation: there should be 4.00 ± .25 inches of strut exposure under a normal static load. Check the tire and the brake block and disc.

Open the fuel cap and visually check the fuel supply. The quantity should match the indication that was on the fuel quantity gauge. Replace cap securely. (See RIGHT WING for further fuel system description.) The fuel tank vent should be clear of obstructions. Place a container under the quick drain. Drain enough fuel to verify the proper fuel and to insure that all water and sediment has been removed.

Remove the cover from the pitot head on the underside of the wing. Make sure the holes are open and clear of obstructions. Verify the condition of the landing light/lens. Check the wing tip and nav/strobe lights for damage. Check the aileron, flap, and hinges for damage and operational interference. Check that the static wicks are firmly attached and in good condition.

FUSELAGE

Check the condition of any antennas located on the fuselage. Check that the static vent holes are free of obstructions. Check aft oxygen discharge disc for rupture. All surfaces of the empennage should be examined for damage and operational interference. Fairings and access covers should be attached properly. Check the baggage to be sure it is stowed properly. Check that the lights on the tail are clean and intact. The stabilator and rudder should be operational and free from interference of any type. Check the condition of the tabs and insure that all hinges and push rods are sound and operational. If the tail has been tied down, remove the tie down rope.

MISCELLANEOUS

Turn the battery master switch "ON" and begin checking the interior lights by turning "ON" the necessary switches. After the interior lights are checked, turn "ON" the pitot heat switch and the exterior light switches. Verify the pitot heat OFF/INOP annunciator extinguishes when pitot heat is selected. Next, perform a walk-around check on the exterior lights and examine and dispose of the contents in the container placed under the fuel strainer drain.

With 0° flaps check the stall warning horn by moving the inboard lift detector slightly up. Reset the flaps to 25° or 40° and check the outboard lift detector. Check the heated pitot head for proper heating. Turn all electrical switches OFF and verify the pitot heat OFF/INOP annunciator illuminates. Turn the battery master switch OFF.

CAUTION:

Care should be taken when an operational check of the heated pitot head is being performed. The unit becomes very hot. Ground operation should be limited to three minutes maximum to avoid damaging the heating elements.

When all passengers are on board, the pilot should check the cabin doors for proper closing and latching procedures. The rear door should be closed, and the overhead latch button turned to the ``LOCK'' position. The front door should be held closed with the armrest while moving the side door latch down to the LATCHED position. Seat belts on empty seats should be snugly fastened. All passengers should fasten their seat belts and shoulder harnesses and check that the seats are adjusted and locked in position.

NOTE:

With the shoulder harness fastened and adjusted, a pull test of it's locking restraint feature should be performed.

ENGINE START - GENERAL

CAUTION :

Do not attempt flight if there is no indication of alternator output.

CAUTION:

If a positive oil pressure is not indicated within 30 seconds following an engine start, stop the engine and determine the trouble. In cold weather it will take a few seconds longer to get a positive oil pressure indication.

NOTE :

Starter manufacturer recommends that starter cranking periods be limited to 10 seconds with a 20 second rest period between cranking periods. Maximum of 6 start periods allowed. If start is not achieved on sixth attempt allow starter to cool for 30 minutes before attempting additional starts.

4.9 BEFORE STARTING ENGINE

Before starting the engine, the brakes should be set and the propeller lever moved to the full INCREASE rpm position. The fuel selector should then be moved to the desired tank. Check to make sure all the circuit breakers are in and the radios are OFF.

4.11 STARTING ENGINE

(a) NORMAL START: Cold Engine

NOTE: If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

Open the throttle lever approximately 1/2 inch. Turn ON the battery master. Verify correct aircraft model software if the optional Avidyne Primary Display is installed. Turn on the alternator, electric fuel pump, and magneto switches. Move the mixture control to full RICH for approximately 4 seconds. The engine is now primed.

Move the mixture control to idle cut-off, verify that the propeller area is clear, and engage the starter. When the engine fires, release the starter switch, advance the mixture control to full RICH and move the throttle to the desired setting. Check for proper oil pressure indication.

If the engine does not fire within five to ten seconds, disengage the starter and reprime.

(b) NORMAL START: Hot Engine

NOTE: If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

Open the throttle approximately 1/2 inch. Turn ON the battery master, alternator, electric fuel pump, and magneto switches. Leave the mixture control in idle cut-off. Verify that the propeller area is clear, and engage the starter. When the engine fires, release the starter switch, advance the mixture and move the throttle to the desired setting. Check for proper oil pressure indication.

4.11 STARTING ENGINE (continued)

(c) Starting Engine When Flooded

NOTE: If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

The throttle lever should be full OPEN. Turn ON the battery master, alternator, and magneto switches. Turn OFF the electric fuel pump. Move the mixture control to idle cut-off, verify that the propeller area is clear, and engage the starter. When the engine fires, release the starter switch, advance the mixture and retard the throttle. Check for proper oil pressure indication

(d) Starting Engine With External Power Sources

CAUTION

It is possible to use the ship's battery in parallel by turning the battery master switch ON. This will give longer cranking capabilities, but will not increase the amperage. Care should be exercised because if the ship's battery has been depleted, the external power supply can be reduced to the level of the ship's battery. This can be tested by turning the master switch ON momentarily while the starter is engaged. If cranking speed increases, the ship's battery is at a higher level than the external power supply.

NOTE

For all normal operations using the PEP jumper cables, the master switch should be OFF.

An optional feature called the Piper External Power (PEP) allows the operator to use an external battery to crank the engine without having to gain access to the airplane's battery.

4.11 STARTING ENGINE (continued)

(d) Starting Engine With External Power Sources (continued)

Verify the battery master and alternator switches are OFF, magneto switches are ON, and all electrical equipment is OFF. Connect the RED lead of the PEP kit jumper cable to the POSITIVE (+) terminal of an external 24-volt battery and the BLACK lead to the NEGATIVE (-) terminal. Insert the plug of the jumper cable into the socket located on the right aft fuselage. Note that when the plug is inserted, the electrical system is ON. Turn the magneto switches ON and proceed with the normal starting technique. Battery master and alternator switches will be OFF.

After the engine has started, reduce power to the lowest possible RPM, (to reduce sparking on disconnect), and disconnect the jumper cable from the aircraft. Turn the master and alternator switches ON and check the ammeter for an indication of output. DO NOT ATTEMPT FLIGHT IF THERE IS NO INDICATION OF ALTERNATOR OUTPUT.

When the engine is firing evenly, advance the throttle to 800 RPM. If oil pressure is not indicated within thirty seconds, stop the engine and determine the trouble. In cold weather it will take a few seconds longer to get an oil pressure indication. If the engine has failed to start, refer to the Lycoming Operating Handbook, Engine Troubles and Their Remedies.

Starter manufacturers recommend that starter cranking periods be limited to 10 seconds with a 20 second cool down between cranking periods. Repeat no more than 6 times. If start is not achieved on the sixth attempt, let starter cool for 30 minutes before reattempt. Longer cranking periods will shorten the life of the starter.

4.13 WARM-UP

Warm up the engine at 1000 to 1200 RPM. Avoid prolonged idling at low RPM, as this practice may result in fouled spark plugs.

Takeoff may be made as soon as the ground check is completed and the engine is warm.

Do not operate the engine at high RPM when running up or taxiing over ground containing loose stones, gravel or any loose material that may cause damage to the propeller blades.

4.15 TAXIING

Before attempting to taxi the airplane, ground personnel should be instructed and approved by a qualified person authorized by the owner. Ascertain that the chocks have been removed and that propeller back blast and taxi areas are clear. Release the parking brake.

Power should be applied slowly to start the taxi roll. Taxi a few feet forward and apply the brakes to determine their effectiveness. Taxi with the propeller set in low pitch, high RPM setting. While taxiing, make slight turns to ascertain the effectiveness of the steering.

Observe wing clearances when taxiing near buildings or other stationary objects. If possible, station an observer outside the airplane.

Avoid holes and ruts when taxiing over uneven ground.

Do not operate the engine at high RPM when running up or taxiing over ground containing loose stones, gravel or any loose material that may cause damage to the propeller blades.

4.17 GROUND CHECK

Set the parking brake. The magnetos should be checked at 2000 RPM with the propeller set at high RPM. Drop off on either magneto should not exceed 175 RPM and the difference between the magnetos should not exceed 50 RPM. Operation on one magneto should not exceed 10 seconds.

The propeller control should be moved through its complete range to check for proper operation and then placed in full INCREASE rpm for takeoff. To obtain maximum rpm, push the pedestal mounted control fully forward on the instrument panel. Do not allow a drop of more than 500 rpm during this check. In cold weather, the propeller control should be cycled from high to low RPM at least three times before takeoff to make sure that warm engine oil has circulated. Check the alternate air.

CAUTION:

Alternate air is unfiltered. Use of alternate air during ground or flight operations when dust or other contaminant's are present may result in damage from particle ingestion.

Check oil temperature and oil pressure. The temperature may be low for some time if the engine is being run for the first time of the day. Check the vacuum gauge; the indicator should read within the normal operating range at 2000 RPM.

Check the annunciator panel lights with the press-to-test button. Check the air conditioner and the ammeter for proper operation. The ammeter can be checked by temporary activation of the pitot heat or landing light and observing an increase on the ammeter.

The electric fuel pump should be turned OFF briefly after starting or during warm-up to make sure that the engine-driven pump is operating. Prior to takeoff, the electric pump should be turned ON again to prevent loss of power during takeoff, should the engine-driven pump fail.

NOTE:

If the optional Avidyne Flightmax Entegra Primary Flight/Multi-Function Displays are installed. Refer to Supplements 20 or 24 found in Section 9 for additional operating instructions.

4.19 BEFORE TAKEOFF

All aspects of each particular takeoff should be considered prior to executing the takeoff procedure.

After all aspects of the takeoff are considered, a pre-takeoff check procedure must be performed.

Ensure that the battery master, alternator, electric fuel pump and magneto switches are ON. Check the engine gauges (refer to Section 7, Paragraph 7.19a for engine instrument self test parameters). Check and set all of the flight instruments as required. The propeller lever should be advanced and mixture set to full forward. The alternate air should be in the CLOSED position.

Exercise and set the flaps and trim tab. Check the fuel selector to make sure it is on the proper tank (fullest). On air conditioned models, the air conditioner must be OFF to insure normal takeoff performance. Insure proper flight control movement and response. All doors should be properly secured and latched.

NOTE

With the shoulder harness fastened and adjusted, a pull test of its locking restraint feature should be performed.

All seat backs should be erect, the seats adjusted and locked in position. All seat belts and shoulder harness must be fastened. Fasten the seat belts snugly around the empty seats.

4.21 TAKEOFF

NORMAL TECHNIQUE (SEE CHART, SECTION 5)

When the available runway length is well in excess of that required and obstacle clearance is no factor, the normal takeoff technique may be used. Retract the flaps in accordance with the Normal Procedure Takeoff Performance, 0° Flaps chart found in section 5. Position the pitch trim slightly aft of neutral. Set maximum power before brake release and accelerate the airplane to 80 KIAS for liftoff. After liftoff, adjust the airplane attitude as required to achieve the obstacle clearance speed of 85 KIAS passing through 50 foot of altitude. Once immediate obstacles are cleared, retract the landing gear and establish the desired enroute climb configuration and speed.

SHORT FIELD TECHNIQUE (SEE CHART, SECTION 5)

NOTE: Gear warning will sound when the landing gear is retracted with the flaps extended more than 10°.

For departure from short runways or runways with adjacent obstructions, a short field takeoff technique with flaps set to 25° should be used in accordance with the Maximum Effort Takeoff Performance 25° flaps chart. Maximum power is established before brake release and the airplane is accelerated to 70 KIAS for liftoff. After liftoff, control the airplane attitude to accelerate to 75 KIAS passing through the 50 foot obstacle height. Once clear of the obstacle retract the landing gear and accelerate through 90 KIAS while retracting the flaps. Then establish the desired enroute climb configuration and speed.

4.23 CLIMB

NOTE: The standby fuel pump must be ON during ALL climb conditions.

The best rate of climb at gross weight and maximum continuous power will be obtained at 95 KIAS. The recommended procedure for climb is to use maximum continuous power with the mixture full rich and standby fuel pump ON. For climbing en route, a speed of 105 KIAS is recommended. This will produce better forward speed and increased visibility over the nose during the climb.

Upon reaching cruise altitude, the standby fuel pump may be turned off after setting cruise manifold pressure and propeller RPM per the power setting table in section 5 of this manual. Leaning the mixture (per POH section 5) should take place after standby fuel pump deactivation.

4.25 CRUISING

The cruising speed is determined by many factors, including power setting, altitude, temperature, loading and equipment installed in the airplane.

When leveling off at cruise altitude, the pilot may reduce to a cruise power setting in accordance with the *power setting tables in section 5 of this manual.

To obtain the desired power, set the manifold pressure, RPM, and mixture according to the section 5 power setting tables. The electric fuel pump should be turned off prior to leaning the mixture.

CAUTION: Fuel pump deactivation at peak TIT can cause a small decrease in fuel flow resulting in an increase in TIT and possibly a TIT overtemp condition and/or excessively lean mixture condition.

CRUISING (CONT'D)

For the maximum engine service life, cylinder head temperatures should be maintained below 435° F. This temperature can be maintained by reducing power or enriching the mixture.

Use of the mixture control in cruising flight reduces fuel consumption significantly, especially at higher altitudes. The mixture should be leaned during cruising operation per the *power setting tables in section 5 of this manual.

*To obtain the performance presented in the Performance Section of this handbook, all conditions listed on the performance charts must be met.

The pilot should monitor weather conditions while flying and should be alert to conditions which might lead to icing. If induction system icing is expected, place the alternate air control in the ON position.

During flight, keep account of time and fuel used in connection with power settings to determine how the fuel flow and fuel quantity gauge systems are operating. If the fuel flow indication is considerably higher than the fuel actually being consumed, a fuel nozzle may be clogged and require cleaning.

There are no mechanical uplocks in the landing gear system. In the event of a hydraulic system malfunction, the landing gear will free-fall to the gear down position. The true airspeed with gear down is approximately 75% of the gear retracted airspeed for any given power setting. Allowances for the reduction in airspeed and range should be made when planning extended flight between remote airfields or flight over water.

In order to keep the airplane in best lateral trim during cruise flight, the fuel should be used alternately from each tank at one hour intervals.

Always remember that the electric fuel pump should be turned ON before switching tanks, and should be left on for a short period thereafter. To preclude making a hasty selection, and to provide continuity of flow, the selector should be changed to another tank before fuel is exhausted from the tank in use. The electric fuel pump should be normally OFF so that any malfunction of the engine driven fuel pump is immediately apparent. If signs of fuel starvation should occur at any time during flight, fuel exhaustion should be suspected, at which time the fuel selector should be immediately positioned to the fullest tank and the electric fuel pump switched to the ON position.

4.27 APPROACH AND LANDING

Accomplish the Landing Checklist early in the landing approach.

NOTE

With the shoulder harness fastened and adjusted, a pull test of its locking restraint feature should be performed. Check that all seats are adjusted and locked in position.

Depending on field length and other factors the following procedures are appropriate:

NORMAL TECHNIQUE (No Performance Chart Furnished)

When available runway length is in excess of required runway length, a normal approach and landing technique may be utilized. The aircraft should be flown down the final approach course at 90 KIAS with power required to maintain the desired approach angle. Mixture should be set to full forward. The amount of flap used during approach and landing and the speed of the aircraft at contact with the runway should be varied according to the conditions of wind and aircraft loading. It is generally good practice to contact the ground at the minimum possible safe speed consistent with existing conditions. As landing distances with this technique will vary, performance charts are not furnished.

SHORT FIELD LANDING APPROACH POWER OFF (See Chart, Section 5)

When available runway length is minimal or obstacle clearance to landing is of major concern, this approach/landing technique may be employed. The aircraft should be flown on the final approach at 80 KIAS with full flaps, gear down and idle power. The glide path should be stabilized as early as possible. Reduce the speed slightly during landing flareout and contact the ground close to stall speed. After ground contact, retract the flaps and apply full aft travel on the control wheel and maximum braking consistent with existing conditions.

4.29 GO-AROUND

To initiate a go-around from a landing approach, the prop control should be set to full INCREASE and the throttle should be advanced to full throttle while the pitch attitude is increased to obtain the balked landing climb speed of 80 KIAS. Retract the landing gear and slowly retract the flaps when a positive climb is established. Allow the airplane to accelerate to the best rate of climb speed (95 KIAS). Reset the longitudinal trim as required.

4.31 STOPPING ENGINE

Prior to shutdown, all radio and electrical equipment should be turned OFF.

At the pilot's discretion, the flaps should be raised and the electric fuel pump turned OFF.

NOTE

The flaps must be placed in the UP position for the flap step to support weight. Passengers should be cautioned accordingly.

The air conditioner should be turned OFF, the propeller set in the full INCREASE position, and the engine stopped by disengaging the mixture control lock and pulling the mixture control back to idle cut-off. The throttle should be left full aft to avoid engine vibration while stopping. Then the magneto, alternator, and master switches must be turned OFF.

4.33 MOORING

Set the parking brake. If necessary, the airplane should be moved on the ground with the aid of the nose wheel tow bar provided with each airplane and secured behind the rear seats. The aileron and stabilator controls should be secured by looping the safety belt through the control wheel and pulling it snug. The flaps are locked when in the UP position and should be left retracted.

Tie downs can be secured to rings provided under each wing and to the tail skid. The rudder is held in position by its connections to the nose wheel steering and normally does not have to be secured.

4.35 STALLS

The stall characteristics of the Saratoga II TC are conventional. An approaching stall is indicated by a stall warning horn which is activated between five and ten knots above stall speed. Mild airframe buffeting and gentle pitching may also precede the stall.

The gross weight stalling speed with power off and full flaps is 63 KIAS. With the flaps up this speed is increased 4 KTS. Loss of altitude during stalls can be as great as 400 feet, depending on configuration and power.

NOTE

The stall warning system is inoperative with the master switch OFF.

During preflight, the stall warning system should be checked by turning the master switch on, setting the flaps to 25° or 40° and raising the outboard lift detector to determine if the horn is actuated. The flaps should then be reset to 0° and the inboard lift detector raised to determine if the horn is actuated.

4.37 TURBULENT AIR OPERATION

In keeping with good operating practice used in all aircraft, it is recommended that when turbulent air is encountered or expected, the airspeed be reduced to maneuvering speed to reduce the structural loads caused by gusts and to allow for inadvertent speed build-ups, which may occur as a result of the turbulence or of distractions caused by the conditions.

4.39 LANDING GEAR

The pilot should become familiar with the function and significance of the landing gear position indicators and warning lights.

The red gear warning light on the instrument panel and the horn operate simultaneously in flight when the throttle is reduced to where the manifold pressure is approximately 14 inches of mercury or below, and the gear selector switch is not in the DOWN position.

The red gear warning light in the annunciator cluster and the horn will operate simultaneously on the ground when the master switch is ON and the gear selector switch is in the UP position.

The three green lights on the instrument panel operate individually as each associated gear is locked in the extended position.

4.39 LANDING GEAR (CONT'D)

When the Emergency Landing Gear Extension Procedure (Par. 3.33) is performed for training purposes, the following changes must be made to the procedure in order to prevent the hydraulic pump from activating during the procedure. Pull the LANDING GEAR PUMP circuit breaker prior to executing the emergency extension procedure. The circuit breaker must be reset after completion of the procedure to allow normal gear system operation.

4.41 WEIGHT AND BALANCE

It is the responsibility of the owner and pilot to determine that the airplane remains within the allowable weight vs. center of gravity envelope while in flight.

For weight and balance data, refer to Section 6 (Weight and Balance).

4.43 NOISE LEVEL

The corrected noise level of this aircraft is 76.6 dB(A).

The corrected noise level of this aircraft as measured per F.A.R. 36 Appendix G is 76.6 dB (A).

No determination has been made by the Federal Aviation Administration that the noise levels of this airplane are or should be acceptable or unacceptable for operation at, into, or out of, any airport.

The above statement notwithstanding the noise level stated above has been verified by and approved by the Federal Aviation Administration in noise level test flights conducted in accordance with F.A.R. 36, Noise Standards - Aircraft Type and Airworthiness Certification. This aircraft model is in compliance with all F.A.R. 36 noise standards applicable to this type.

The corrected noise level of this aircraft as measured per ICAO Annex 16 Chapter 10 is 79.6 dB (A).

PRESSURE ALTITUDE (FEET)	LONG RANGE CRUISE (25"/2200 RPM or 24"/2300RPM)					ECONOMY CRUISE (28"/2200 RPM or 27"/2300 RPM)				
	ISA - 20° C	ISA	ISA + 10°C	ISA + 20° C	ISA + 30° C	ISA - 20° C	ISA	ISA + 10°C	ISA + 20° C	ISA + 30° C
Sea-Level										
2000										
4000										
6000			Lean to peak TIT.					Lean to peak TIT.		
8000			Not to exceed 1650° F					Not to exceed 1650° F		
10000			Approx. fuel flow 12.5 GPH					Approx. fuel flow 14.5 GPH		
12000										
14000										
16000										
18000					APPROX.					APPROX.
20000					14.5 GPH					16.5 GPH

POWER SETTING TABLE
Long Range & Economy Cruise
Figure 5-17

Note
Engine operation at peak TIT (not to exceed 1650° F) is approved.
Setting the approximate fuel flows noted in the shaded areas above will yield cylinder head temperatures below 435° F and is recommended by the engine manufacturer for maximum service life.

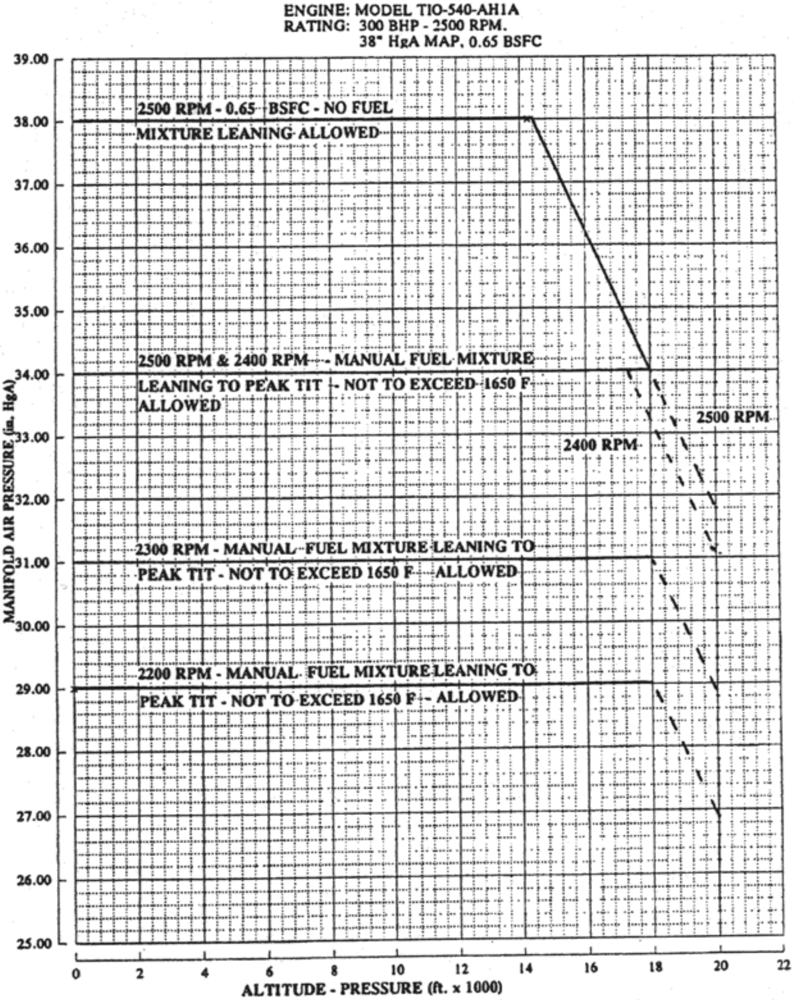
PRESSURE ALTITUDE (FEET)	NORMAL CRUISE (30"/2300 RPM or 29"/2400 RPM)					HIGH PERFORMANCE CRUISE (33"/2400 RPM or 32"/2500 RPM)				
	ISA - 20° C	ISA	ISA + 10°C	ISA + 20° C	ISA + 30° C	ISA - 20° C	ISA	ISA + 10°C	ISA + 20° C	ISA + 30° C
Sea-Level										
2000										
4000										
6000			Lean to peak TIT.					Lean to peak TIT.		
8000			Not to exceed 1650° F					Not to exceed 1650° F		
10000			Approx. fuel flow 16.5 GPH					Approx. fuel flow 20.0 GPH		
12000										
14000										
16000										
18000				APPROX.					APPROX.	
20000				19.0 GPH					23.0 GPH	

POWER SETTING TABLE
Normal & High Performance Cruise
Figure 5-19

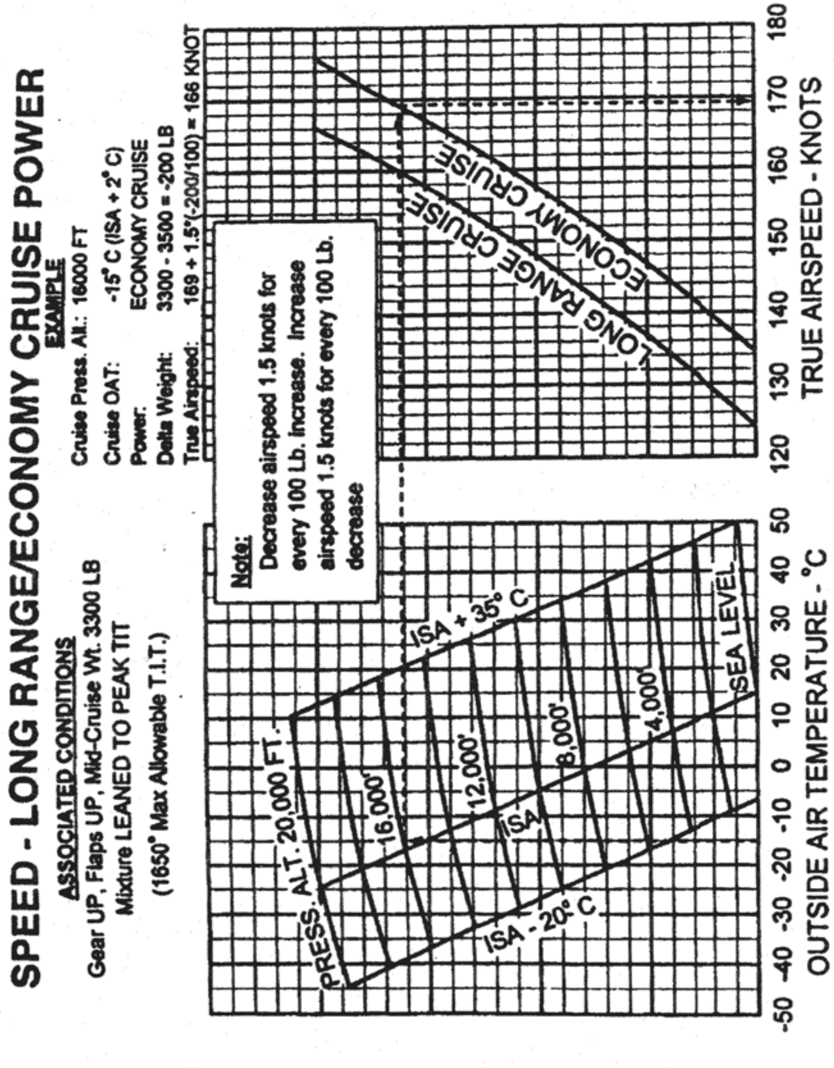
Note
Engine operation at peak TIT (not to exceed 1650° F) is approved.
Setting the approximate fuel flows noted in the shaded areas above will yield cylinder head temperatures below 435° F and is recommended by the engine manufacturer for maximum service life.

NOTE

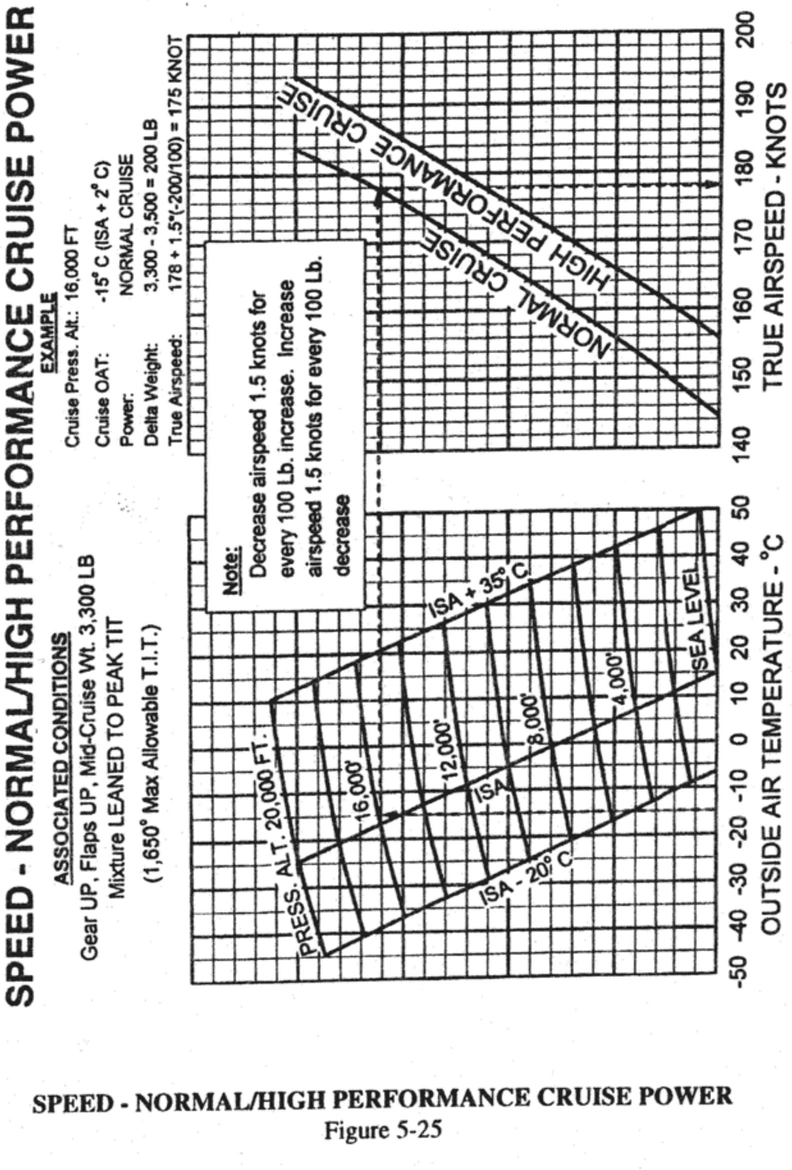
This chart defines the maximum manifold pressure allowed for normal operations and should not be exceeded. Under standard day conditions, 300 bhp (38" MAP @ 2500 rpm) is available at 12,000 ft. altitude minimum.



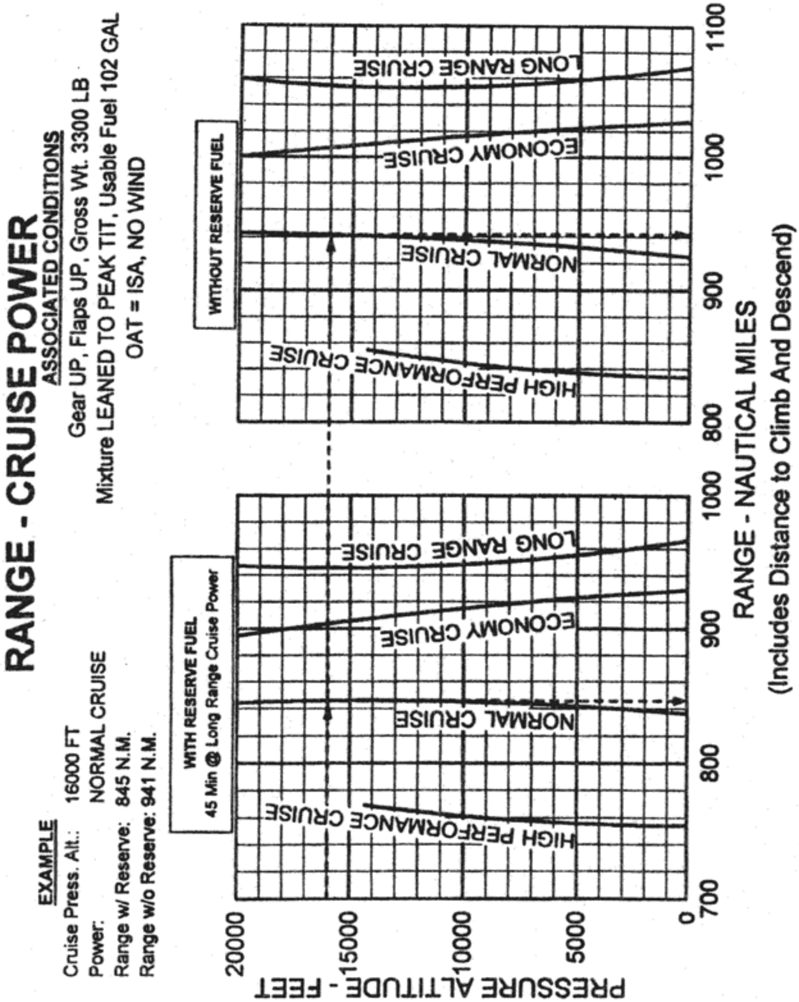
MAXIMUM MANIFOLD PRESSURE
Vs. PRESSURE ALTITUDE
Figure 5-21



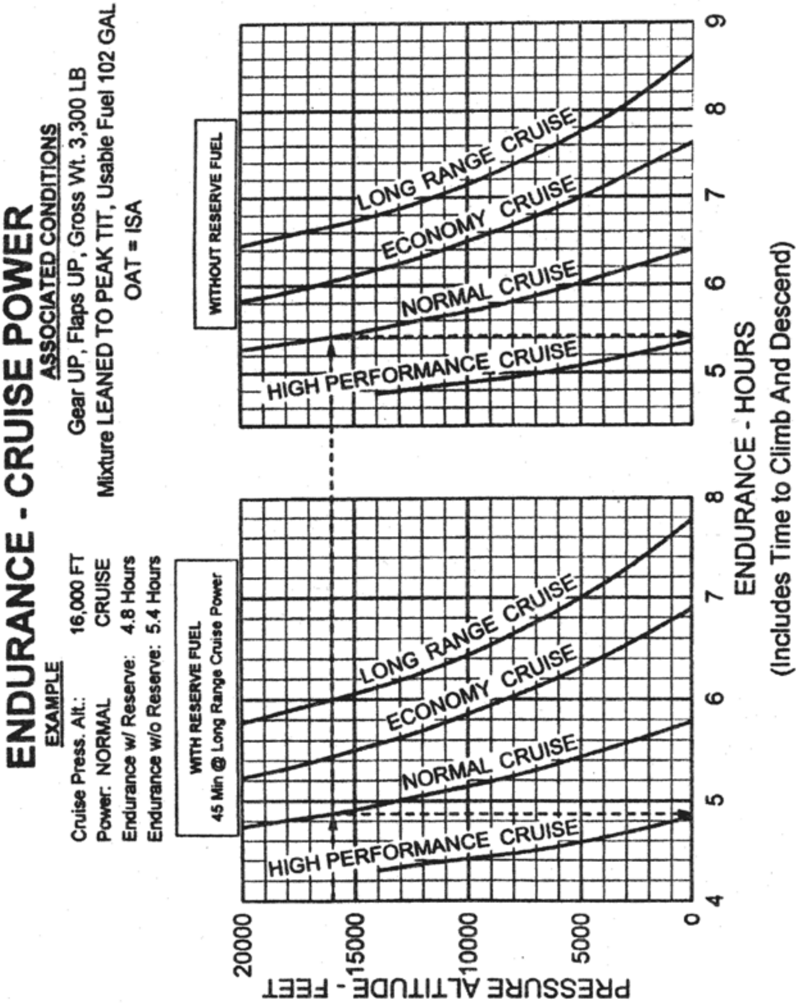
SPEED - LONG RANGE/ECONOMY CRUISE POWER
Figure 5-23



SPEED - NORMAL/HIGH PERFORMANCE CRUISE POWER
Figure 5-25

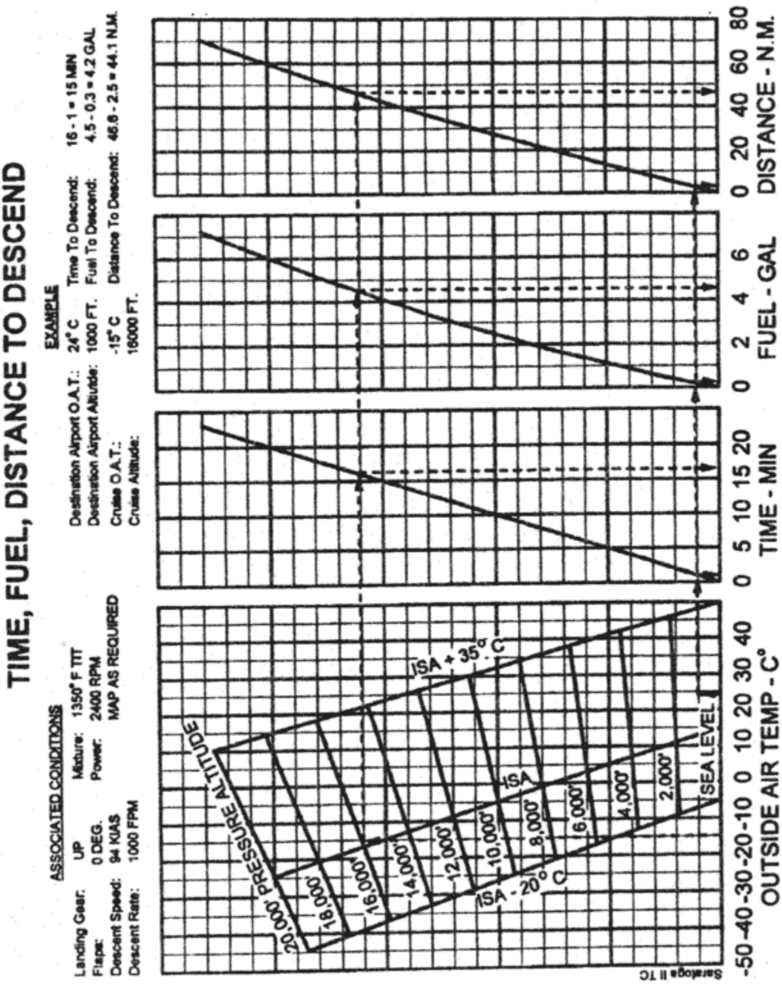


RANGE - CRUISE POWER, 102 GAL. USABLE
Figure 5-29

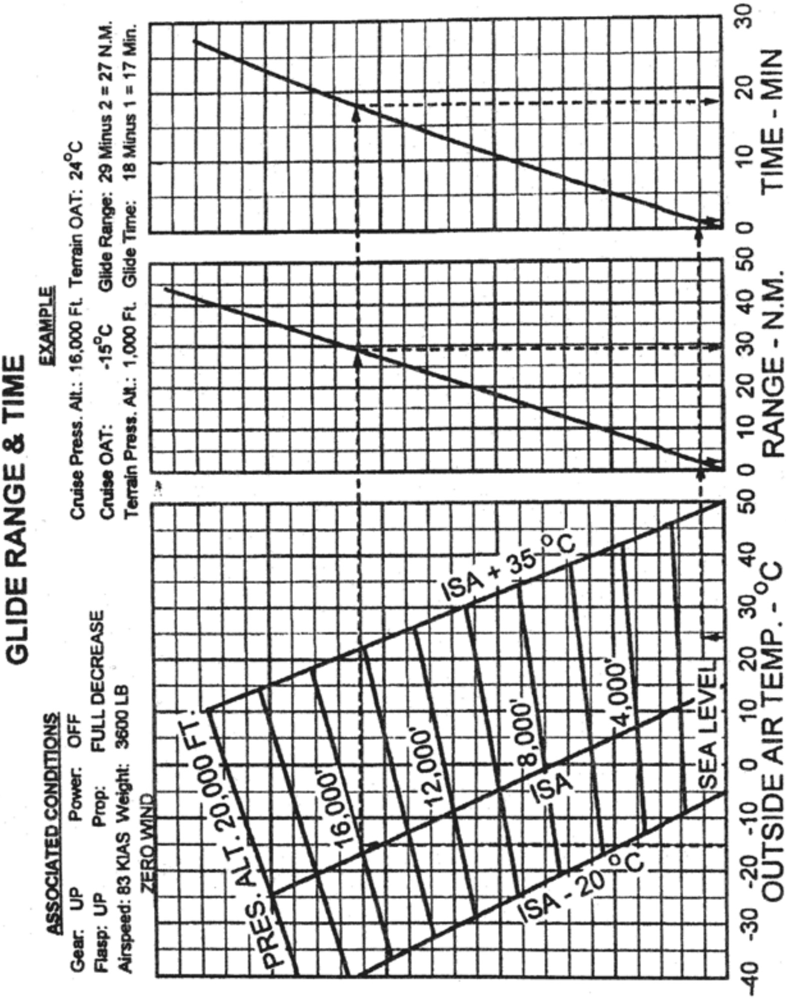


ENDURANCE - 102 GAL. USABLE

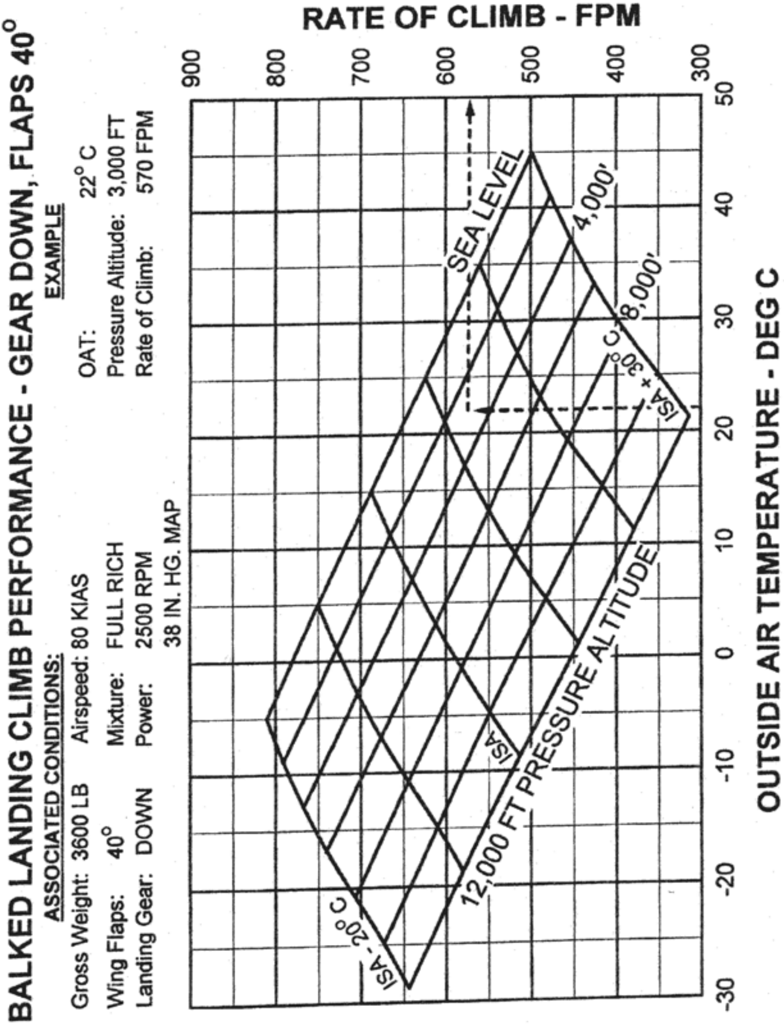
Figure 5-31



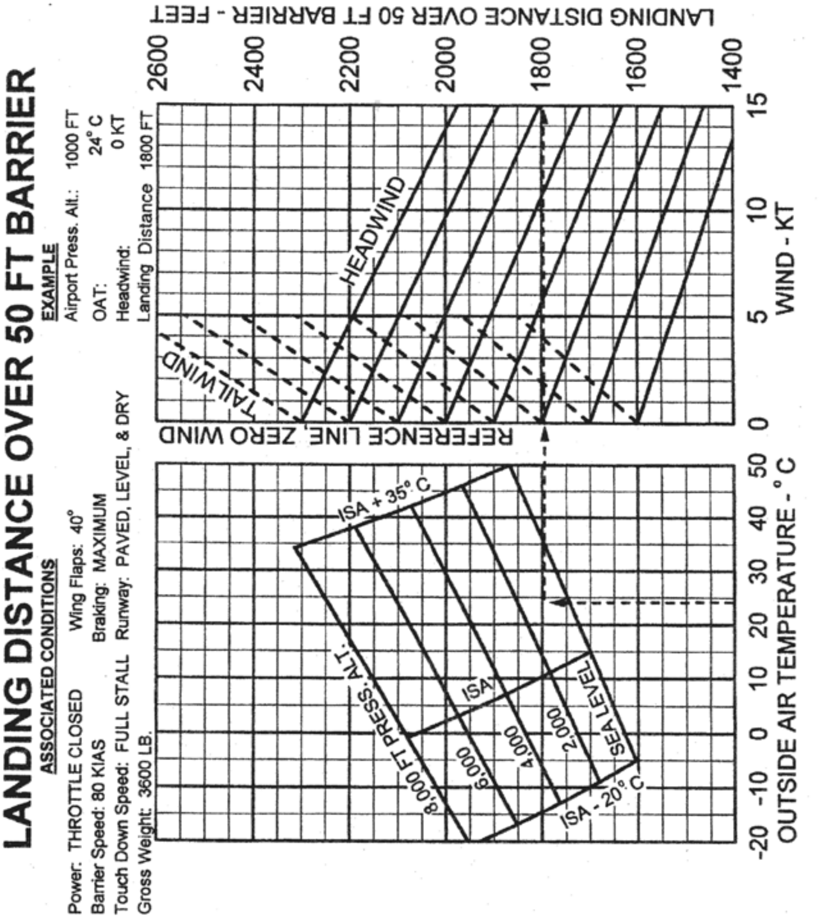
FUEL, TIME, AND DISTANCE TO DESCEND
Figure 5-33



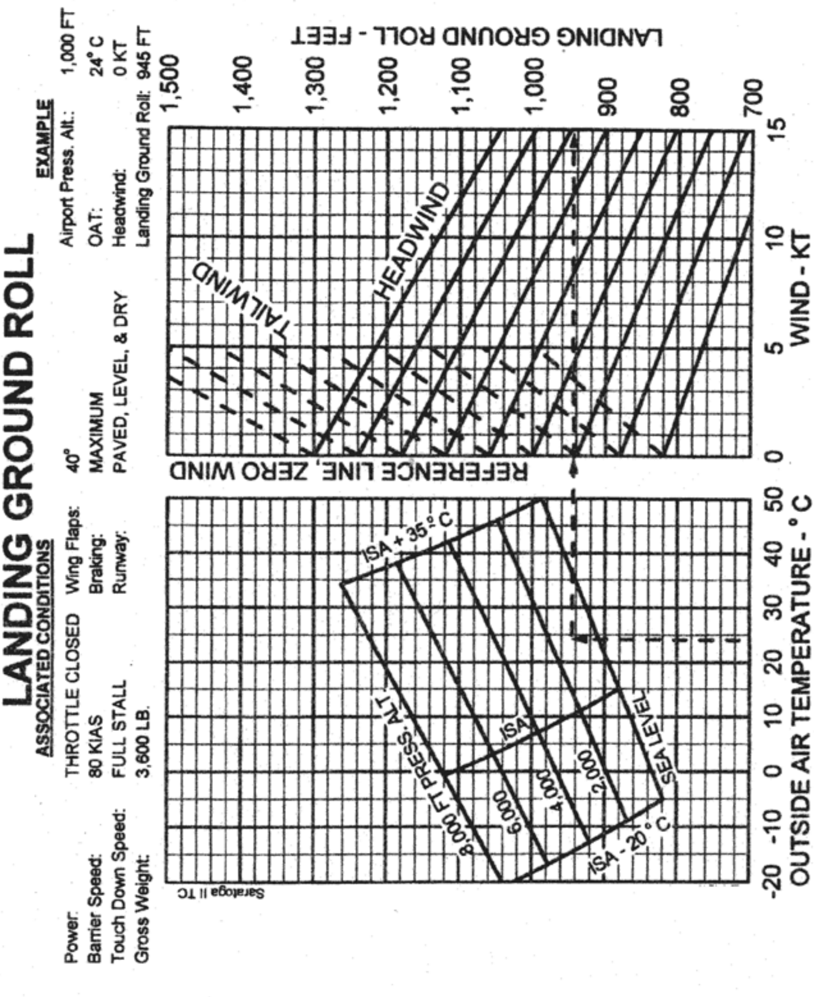
GLIDE RANGE
Figure 5-35



BALKED LANDING PERFORMANCE
Figure 5-37



LANDING PERFORMANCE
Figure 5-39



LANDING GROUND ROLL
Figure 5-41

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SECTION 6

WEIGHT AND BALANCE

SECTION 6

WEIGHT AND BALANCE

6.1 GENERAL

In order to achieve the performance and flying characteristics which are designed into the airplane, it must be flown with the weight and center of gravity (C.G.) position within the approved operating range (envelope). Although the airplane offers flexibility of loading, it cannot be flown with the maximum number of adult passengers, full fuel tanks and maximum baggage. With the flexibility comes responsibility. The pilot must ensure that the airplane is loaded within the loading envelope before he makes a takeoff.

Misloading carries consequences for any aircraft. An overloaded airplane will not take off, climb or cruise as well as a properly loaded one. The heavier the airplane is loaded, the less climb performance it will have.

Center of gravity is a determining factor in flight characteristics. If the C.G. is too far forward in any airplane, it may be difficult to rotate for takeoff or landing. If the C.G. is too far aft, the airplane may rotate prematurely on takeoff or tend to pitch up during climb. Longitudinal stability will be reduced. This can lead to inadvertent stalls and even spins, and spin recovery becomes more difficult as the center of gravity moves aft of the approved limit.

A properly loaded airplane, however, will perform as intended. Before the airplane is licensed, it is weighed, and a basic empty weight and C.G. location is computed (basic empty weight consists of the standard empty weight of the airplane plus the optional equipment). Using the basic empty weight and C.G. location, the pilot can determine the weight and C.G. position for the loaded airplane by computing the total weight and moment and then determining whether they are within the approved envelope.

The basic empty weight and C.G. location are recorded in the Weight and Balance Data Form (Figure 6-5) and the Weight and Balance Record (Figure 6-7). The current values should always be used. Whenever new equipment is added or any modification work is done, the mechanic responsible for the work is required to compute a new basic empty weight and C.G. position and to write these in the Aircraft Log Book and the Weight and Balance Record. The owner should make sure that it is done.

A weight and balance calculation is necessary in determining how much fuel or baggage can be boarded so as to keep within allowable limits. Check calculations prior to adding fuel to insure against improper loading.

The following pages are forms used in weighing an airplane in production and in computing basic empty weight, C.G. position, and useful load. Note that the useful load includes usable fuel, baggage, cargo and passengers. Following this is the method for computing takeoff weight and C.G.

6.3 AIRPLANE WEIGHING PROCEDURE

At the time of licensing, Piper provides each airplane with the basic empty weight and center of gravity location. This data is supplied by Figure 6-5.

The removal or addition of equipment or airplane modifications can affect the basic empty weight and center of gravity. The following is a weighing procedure to determine this basic empty weight and center of gravity location:

(a) Preparation

(1) Be certain that all items checked in the airplane equipment list are installed in the proper location in the airplane.

(2) Remove excessive dirt, grease, moisture, and foreign items such as rags and tools, from the airplane before weighing.

(3) Defuel airplane. Then open all fuel drains until all remaining fuel is drained. Operate engine on each tank until all undrainable fuel is used and engine stops. Then add the unusable fuel (5 gallons total, 2.5 gallons each wing).

CAUTION

Whenever the fuel system is completely drained and fuel is replenished it will be necessary to run the engine for a minimum of three minutes at 1000 RPM on each tank to insure that no air exists in the fuel supply lines.

(4) Fill with oil to full capacity.

(5) Place pilot and copilot seats in fourth (4th) notch, aft of forward position. Put flaps in the fully retracted position and all control surfaces in the neutral position . Tow bar should be in the proper location and all entrance and baggage doors closed.

(6) Weigh the airplane inside a closed building to prevent errors in scale readings due to wind.

(b) Leveling

(1) With airplane on scales, block main gear oleo pistons in the fully extended position.

(2) Level airplane (refer to Figure 6-3) deflating nose wheel tire, to center bubble on level.

(c) Weighing - Airplane Basic Empty Weight

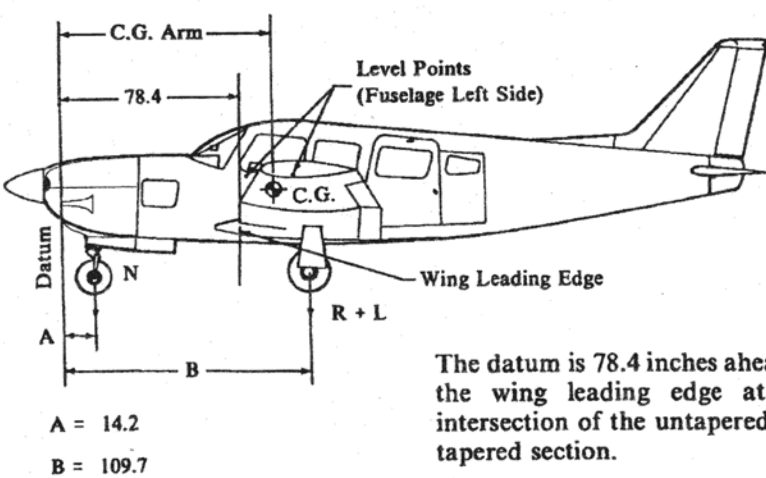
(1) With the airplane level and brakes released, record the weight shown on each scale. Deduct the tare, if any, from each reading.

Scale Position and Symbol		Scale Reading	Tare	Net Weight
Nose Wheel	(N)			
Right Main Wheel	(R)			
Left Main Wheel	(L)			
Basic Empty Weight, as Weighed	(T)			

WEIGHING FORM
Figure 6-1

(d) Basic Empty Weight Center of Gravity

(1) The following geometry applies to the PA-32R-301T airplane when it is level. Refer to Leveling paragraph 6.3 (b).



The datum is 78.4 inches ahead of the wing leading edge at the intersection of the untapered and tapered section.

LEVELING DIAGRAM
Figure 6-3

(2) The basic empty weight center of gravity (as weighed including optional equipment, full oil and unusable fuel) can be determined by the following formula:

$$\text{C.G. Arm} = \frac{N(A) + (R + L)(B)}{T} \quad \text{inches}$$

Where: $T = N + R + L$

6.5 WEIGHT AND BALANCE DATA AND RECORD

The Basic Empty Weight, Center of Gravity Location and Useful Load listed in Figure 6-5 are for the airplane as licensed at the factory. These figures apply only to the specific airplane serial number and registration number shown.

The basic empty weight of the airplane, as licensed at the factory, has been entered in the Weight and Balance Record (Figure 6-7). This form is provided to present the current status of the airplane basic empty weight and a complete history of previous modifications. Any change to the permanently installed equipment or modification which affects weight or moment must be entered in the Weight and Balance Record.

MODEL PA-32R-301T SARATOGA II TC

Airplane Serial Number 3257096

Registration Number N8454E

Date 6/5/99

AIRPLANE BASIC EMPTY WEIGHT

Item		Weight (Lbs)	x C.G. Arm (Inches Aft of Datum)	= Moment (In-Lbs)
Standard Empty Weight*	Actual	2458.4	85.0	208940
	~~Computed~~			
Optional Equipment		122.0	131.7	16069
Basic Empty Weight		2580.4	87.2	225009

*The standard empty weight includes full oil capacity and 5.0 gallons of unusable fuel.

AIRPLANE USEFUL LOAD - NORMAL CATEGORY OPERATION

(Ramp Weight) - (Basic Empty Weight) = Useful Load

(3615 lbs) - (2580.4 lbs) = 1034.6 lbs.

THIS BASIC EMPTY WEIGHT, C.G. AND USEFUL LOAD ARE FOR THE AIRPLANE AS LICENSED AT THE FACTORY. REFER TO APPROPRIATE AIRCRAFT RECORD WHEN ALTERATIONS HAVE BEEN MADE.

WEIGHT AND BALANCE DATA FORM
Figure 6-5

Aircraft Weigh Form

Date: 11/03/2021

Aircraft	
Tail No:	N8454E
Make:	Piper
Model:	PA-32R-301T
Serial:	3257096
Time:	
TCD No:	

Registered Owner	
Name:	Peter Spies
Address:	,

Method of Weighing			
Equipment Make:	Weigh systems, inc.	Model:	
Calibration Date:	03/2021	Serial #:	2106,2107,2108

1. Datum is located: 78.4 forward of leading edge at intersection
2. Leveling Means: Fuselage screws
3. Main Wheel weighing point is located: ______ Forward 109.7 Aft of Datum.
4. Actual measured distance from the main weigh point center line to the tail (or nose) point center line is: ______
5. Nose or tail wheel weighing point is located: ______ Forward 14.2 Aft of Datum.
6. Aircraft weighed with: full qts. of engine oil and 5 gals. of unusable fuel.

Weighing Point	Scale Reading	Arm	Moment
Nose	609	14.2	8647.80
Tail	0	0	
Left Main	920	109.7	100924.00
Right Main	930	109.7	102021.00
Total Weight	**2459.00**		**211592.80**

7. Moment: **211592.80** / Weight **2459.00** = CG **86.05**

Notes: Right center seat not installed.

Aircraft Gross Weight: 3615.00

Aircraft Empty Weight: 2459.00

Aircraft Useful Load: 1156.00

Prepared By: Jake Clemens
Daytona Aircraft Services, Inc.
561 Pearl Harbor Dr
Daytona Beach Florida 32114

Signature: [signature]

Printed Name: Jake Clemens

Certificate Number: CRS DYTR262K

Form ZA-AWFWCG

6.7 GENERAL LOADING RECOMMENDATIONS

The following general loading recommendation is intended only as a guide. The charts, graphs and instructions should be checked to assure that the airplane is within the allowable weight vs. center of gravity envelope.

(a) Pilot Only
Load rear baggage compartment to capacity first. Without aft baggage, fuel load may be limited by forward envelope for some combinations of optional equipment.

(b) 2 Occupants - Pilot and Passenger in Front
Load rear baggage compartment first. Without aft baggage, fuel load may be limited by fwd. envelope for some combinations of optional equipment.

(c) 3 Occupants - 2 in front, 1 in middle
Load rear baggage compartment to capacity first. Baggage in nose may be limited by fwd. envelope. Without aft baggage, fuel may be limited by fwd. envelope for some combinations of optional equipment.

(d) 4 Occupants - 2 in front, 1 in middle, 1 in rear
Load rear baggage compartment first. Baggage in nose may be limited by fwd. envelope. Without aft baggage, fuel may be limited by fwd. envelope for some combinations of optional equipment.

(e) 5 Occupants - 2 in front, 1 in middle, 2 in rear
With five occupants, the aft passengers weight, fuel and baggage may be limited by envelope. Note Placard if installed. Investigation is required to determine optimum loading for baggage.

OPTIONAL SIX SEAT CONFIGURATION

(d) 4 Occupants - 2 in front, 2 in middle
Load rear baggage compartment to capacity first. Baggage in nose may be limited by forward envelope. Without aft baggage, fuel may be limited by fwd. envelope for some combinations of optional equipment.

(e) 5 Occupants - 2 in front, 2 in middle, 1 in rear
Investigation is required to determine optimum loading for baggage.

6.7 GENERAL LOADING RECOMMENDATIONS (CONT'D)

OPTIONAL SIX SEAT CONFIGURATION (Cont'd)

(e) 5 Occupants - 1 in front, 2 in middle, 2 in rear
Load forward baggage compartment to capacity first. Aft baggage and/or fuel load may be limited by aft envelope.

(f) 6 Occupants - 2 in front, 2 in middle, 2 in rear
With six occupants, the aft passengers weight, fuel and baggage may be limited by envelope. Investigation is required to determine optimum location for baggage. Note placard if installed.

For all airplane configurations, it is the responsibility of the pilot in command to make sure that the airplane always remains within the allowable weight vs. center of gravity while in flight.

6.9 WEIGHT AND BALANCE DETERMINATION FOR FLIGHT

(a) Add the weight of all items to be loaded to the basic empty weight.

(b) Use the Loading Graph (Figure 6-13) to determine the moment of all items to be carried in the airplane.

(c) Add the moment of all items to be loaded to the basic empty weight moment.

(d) Divide the total moment by the total weight to determine the C.G. location.

(e) By using the figures of item (a) and item (d) (above), locate a point on the C.G. range and weight graph (Figure 6-15). If the point falls within the C.G. envelope, the loading meets the weight and balance requirements.

	Weight (Lbs)	Arm Aft Datum (Inches)	Moment (In-Lbs)
Basic Empty Weight	2272	83.4	189485
Pilot and Front Passenger	340.0	85.5	29070
Passengers (Center Seats) (Aft Facing)		119.1	
Passengers (Rear Seats)	340.0	157.6	53584
Fuel (102 Gallon Maximum)	500	94.0	47000
Baggage (Forward) (100 Lb. Limit)	100	42.0	4200
Baggage (Aft) (100 Lb. Limit)	63	178.7	11258
Ramp Weight (3615 Lbs. Max.)	3615	92.6	334597
Fuel Allowance for Engine Start, Taxi & Runup	-15.0	94.0	-1410
Take-off Weight (3600 Lbs. Max.)	3600	92.6	333187

The center of gravity (C.G.) for the take-off weight of this sample loading problem is at 92.6 inches aft of the datum line. Locate this point (92.6) on the C.G. range and weight graph. Since this point falls within the weight - C.G. envelope, this loading meets the weight and balance requirements.

Take-off Weight	3600	92.6	333187
Minus Estimated Fuel Burn-off (climb & cruise) @ 6.0 Lbs/Gal.	-360	94.0	-33840
Landing Weight	3240	92.4	299347

Locate the center of gravity of the landing weight on the C.G. range and weight graph. Since this point falls within the weight - C.G. envelope, the loading may be assumed acceptable for landing.

IT IS THE RESPONSIBILITY OF THE PILOT AND AIRCRAFT OWNER TO INSURE THAT THE AIRPLANE IS LOADED PROPERLY AT ALL TIMES.

SAMPLE LOADING PROBLEM
(NORMAL CATEGORY)
Figure 6-9

	Weight (Lbs)	Arm Aft Datum (Inches)	Moment (In-Lbs)
Basic Empty Weight			
Pilot and Front Passenger		85.5	
Passengers (Center Seats) (Aft Facing)		119.1	
Passengers (Rear Seats)		157.6	
Fuel (102 Gallon Maximum)		94.0	
Baggage (Forward) (100 Lb. Limit)		42.0	
Baggage (Aft) (100 Lb. Limit)		178.7	
Ramp Weight (3615 Lbs. Max.)			
Fuel Allowance for Engine Start, Taxi & Runup	-15.0	94.0	-1410
Take-off Weight (3600 Lbs. Max.)			

The center of gravity (C.G.) for the take-off weight of this loading problem is at inches aft of the datum line. Locate this point on the C.G. range and weight graph. Since this point falls within the weight - C.G. envelope, this loading meets the weight and balance requirements.

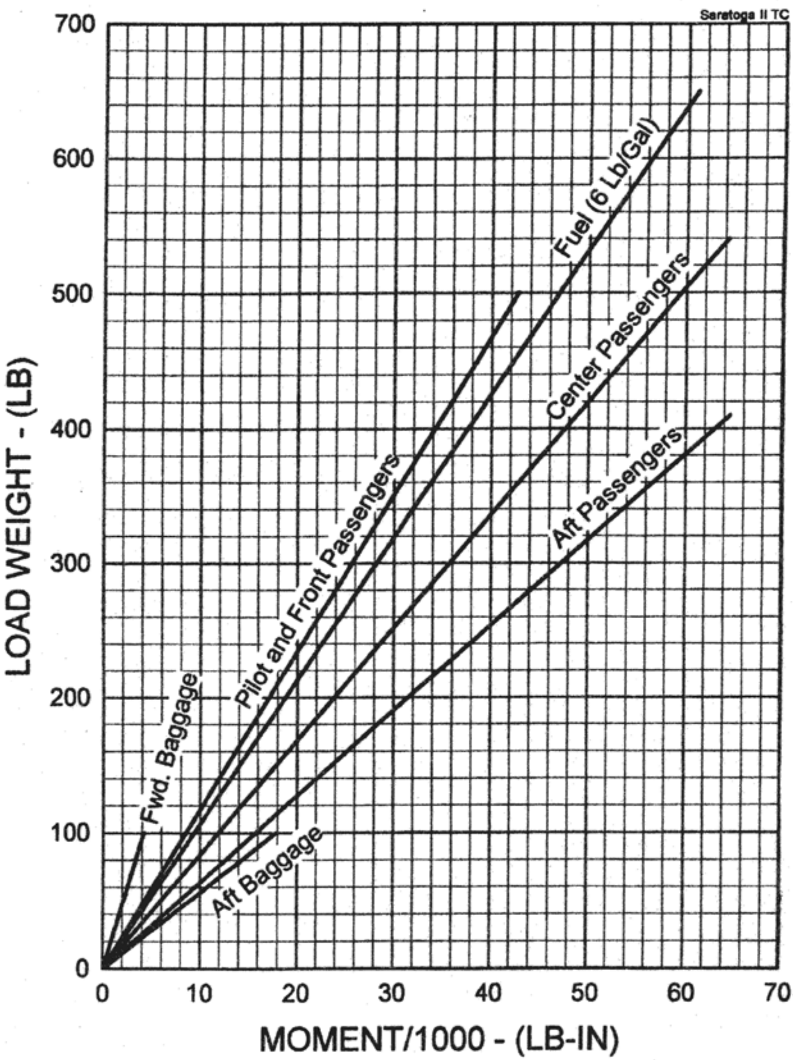
Take-off Weight			
Minus Estimated Fuel Burn-off (climb & cruise) @ 6.0 Lbs/Gal.		94.0	
Landing Weight			

Locate the center of gravity of the landing weight on the C.G. range and weight graph. Since this point falls within the weight - C.G. envelope, the loading may be assumed acceptable for landing.

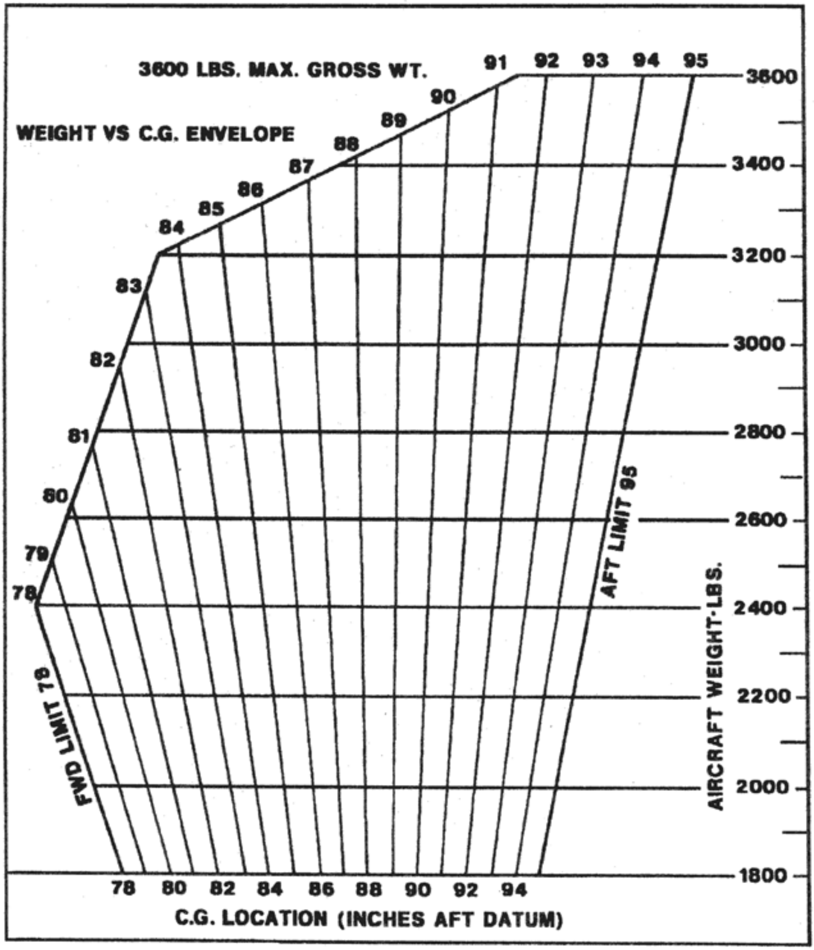
IT IS THE RESPONSIBILITY OF THE PILOT AND AIRCRAFT OWNER TO INSURE THAT THE AIRPLANE IS LOADED PROPERLY AT ALL TIMES.

WEIGHT AND BALANCE LOADING FORM (NORMAL CATEGORY)

Figure 6-11



LOADING GRAPH
Figure 6-13



C.G. RANGE AND WEIGHT
Figure 6-15

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SECTION 7

DESCRIPTION AND OPERATION OF THE AIRPLANE AND ITS SYSTEMS

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SECTION 7

DESCRIPTION AND OPERATION OF THE AIRPLANE AND ITS SYSTEMS

7.1 THE AIRPLANE

The Saratoga II TC is a single engine, low wing, retractable landing gear airplane. It is all metal, seats up to six occupants, and has two separate one hundred pound capacity baggage compartments.

7.3 AIRFRAME

With the exception of the steel engine mount, parts of the landing gear, miscellaneous steel parts, the cowling, and the lightweight plastic extremities (tips of wings, tail fin and stabilator etc.), the basic airframe is of aluminum alloy. Aerobatics are prohibited in this airplane since the structure is not designed for aerobatic loads.

The fuselage is a semi-monocoque structure. There is a front door on the right side and a rear door on the left. A cargo door is installed aft of the rear passenger door. When both rear doors are open, large pieces of cargo can be loaded through the extra-wide opening. A door on the right side of the nose section gives access to the nose baggage compartment.

The wing is of a semi-tapered design and employs a laminar flow NACA 65_2-415 airfoil section. The main spar is located at approximately 40% of the chord aft of the leading edge. The wings are attached to the fuselage by the insertion of the butt ends of the spar into a spar box carry-through, which is an integral part of the fuselage structure. The bolting of the spar ends into the spar box carry-through structure, which is located under the center seats, provides in effect a continuous main spar. The wings are also attached fore and aft of the main spar by an auxiliary front spar and a rear spar. The rear spar, in addition to taking torque and drag loads, provides a mount for flaps and ailerons. Each wing contains two interconnected fuel tanks. Both tanks on one side are filled through a single filler neck located in the outboard tank.

A vertical stabilizer, an all-movable horizontal stabilator, and a rudder make up the empennage. The stabilator incorporates an anti-servo tab which provides longitudinal stability and longitudinal trim. This tab moves in the same direction as the stabilator, but with increased travel.

7.5 ENGINE AND PROPELLER

The six cylinder, horizontally opposed, fuel injected, turbocharged engine is rated at 300 horsepower at 2500 rpm and 38 inches of MAP. Oil flow is thermostatically controlled through a remote mounted oil cooler, and filtration is provided by an engine mounted oil filter. The turbocharger control system consists of a hydraulically activated wastegate bypass valve, a sloped controller and turbocharger. Automatic wastegate control of the turbocharger provides a constant manifold pressure from sea level to critical altitude.

The engine induction system has two independent air sources, an induction air filter box with filter and an alternate air box inside the cowling between the filter box and turbocharger. The primary air inlet is located just under the spinner on the front of the cowling. It consists of a filter mounted in an airbox that attaches to the inside of the cowling. The filter box connects to an alternate air diverter valve which connects to the turbocharger. The alternate air diverter valve contains a valve which selects either the primary or alternate air source. The primary source air flows through the filter, into the airbox and past the selector valve and then directly to the turbocharger. The alternate source air flows from inside of the cowling through an intake on the front of the diverter box, past the diverter valve and into the turbocharger. The alternate air source is unfiltered and therefore contaminates might enter the system. The primary (filtered air) induction source should always be used for take off.

A turbocharger on the engine is operated by the engine exhaust gases. The exhaust gases drive a turbine wheel which is coaxial with a compressor impeller. Induction air entering the compressor impeller is compressed and flowed to the engine induction distribution system and subsequently to each cylinder. The amount of induction air compression is a function of engine power - low power, low compression, high power, higher compression. Excessive pressure and flow above the established limit is expelled by the overboost valve previously discussed.

The fuel injection system incorporates a metering system which measures the rate at which turbocharged air is being used by the engine and dispenses fuel to the cylinders proportionally. Injector nozzle and engine fuel pump pressure is referenced to deck pressure (turbocharger lower out-pressure).

Fuel flow is determined via a fuel flow sensor and Horizon instrument microprocessors. Fuel flow information in gals/hour is then presented as an analog display on a Horizon dual indicator (TIT/Fuel Flow) and digitally displayed on the Horizon DDMP (Digital Display Monitoring Panel). Fuel totalizer/fuel used information is also derived from the fuel flow sensor and Horizon microprocessors and presented in digital format on the Horizon DDMP.

Manifold Pressure is determined via a manifold pressure sensor and Horizon instrument microprocessors. Manifold Pressure information in inches hg. is then presented as an analog display on a Horizon indicator (MAP) and digitally displayed on the Horizon DDMP (Digital Display Monitoring Panel)

To obtain maximum efficiency and time from the engine, follow the procedures recommended in the Textron Lycoming Operators Manual provided with the airplane.

The constant speed propeller is controlled by a governor mounted at the left forward side of the crankcase. Control from the engine control quadrant is provided by a push-pull control.

7.7 ENGINE CONTROLS

Engine controls consist of a throttle control, a propeller control and a mixture control lever. These controls are located on the control quadrant on the lower center of the instrument panel (Figure 7-1) where they are accessible to both the pilot and the copilot. The controls utilize teflon-lined control cables to reduce friction and binding.

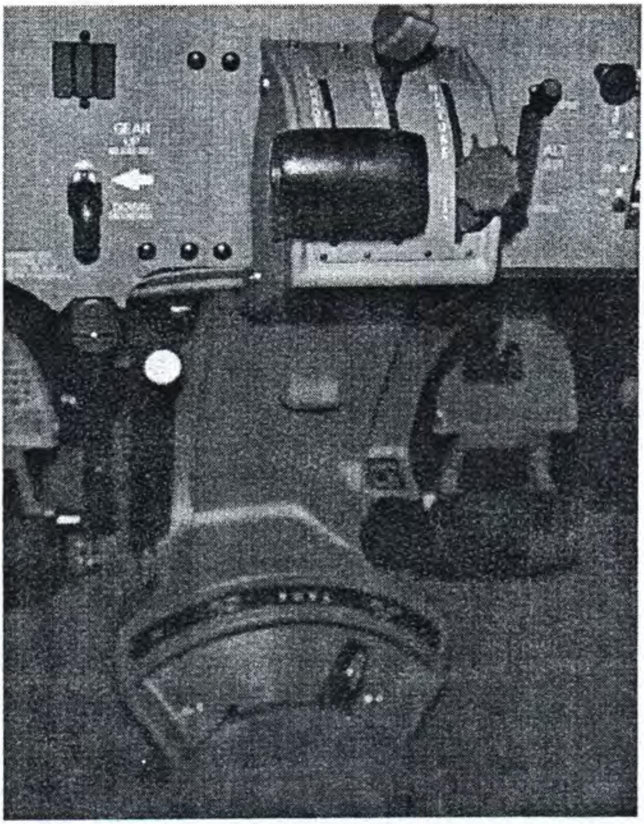
The throttle lever is used to adjust the manifold pressure. It incorporates a gear up warning horn switch which is activated during the last portion of travel of the throttle lever to the low power position. If the landing gear is not locked down, the horn will sound until the gear is down and locked or until the power setting is increased. This is a feature to prevent an inadvertent gear up landing.

The propeller control lever is used to adjust the propeller speed from high RPM to low RPM.

The mixture control lever is used to adjust the air to fuel ratio. The engine is shut down by the placing of the mixture control lever in the full lean position. In addition, the mixture control has a lock to prevent activation of the mixture control instead of the pitch control. For information on the leaning procedure, see the Textron-Lycoming Operator's Manual and the leaning procedure in Section 4 of this handbook.

The friction adjustment lever on the right side of the control quadrant may be adjusted to increase or decrease the friction holding the throttle, propeller, and mixture controls or to lock the controls in a selected position.

The alternate air control is located to the right of the control quadrant. When the alternate air lever is in the up, or closed, position the engine is operating on filtered air; when the lever is in the down, or open, position the engine is operating on unfiltered, heated air. The control is operated by pressing the knob to the left to clear the retaining gate and then moved in the desired direction (refer to Figure 7-1).



CONTROL QUADRANT AND CONSOLE
Figure 7-1

LANDING GEAR SELECTOR

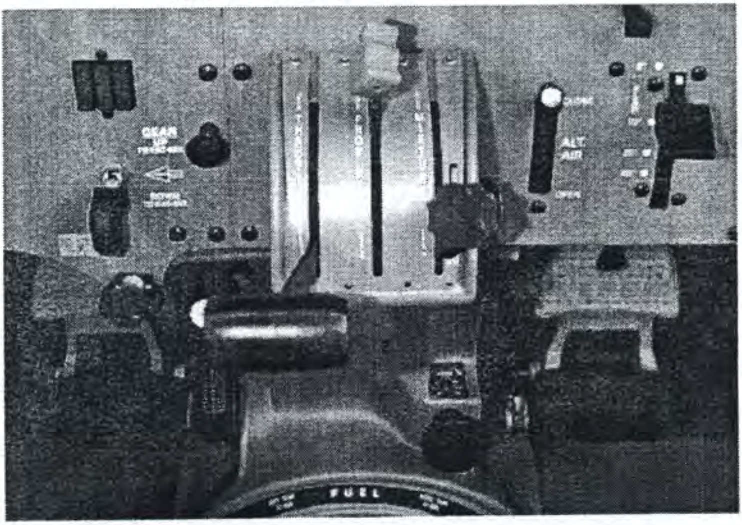


Figure 7-3

7.9 LANDING GEAR

The airplane is equipped with a retractable tricycle landing gear, which is hydraulically actuated by an electrically powered reversible pump. The pump is controlled by a selector switch on the instrument panel to the left of the control quadrant (Figure 7-3). The landing gear is retracted or extended in about seven seconds.

EMERGENCY GEAR extension system allows the landing gear to free fall, with spring assist on the nose gear, into the extended position where the mechanical locks engage. If a gear system malfunction has been indicated and the EMERGENCY Gear extension system used, it is recommended that the EMERGENCY GEAR extension control be left in the pulled position until the aircraft is safely on jacks. See the Service Manual for proper landing gear system check-out procedures. If the aircraft is being used for training purposes or a pilot check-out flight the EMERGENCY GEAR extension control and HYD PUMP circuit breaker must be reset in order for hydraulic pressure to be generated in the UP side of the system and the gear retracted.

Gear down and locked positions are indicated by three green lights located above the selector, and a red " GEAR WARN" light located in the annunciator cluster. An all lights out condition indicates the gear is up. The landing gear should not be retracted above a speed of 110 KIAS and should not be extended above a speed of 132 KIAS.

NOTE:

Day/night dimmer switch must be in the DAY position to obtain full intensity of the gear position indicator lights during daytime flying. When aircraft is operated at night, the switch should be in the NIGHT position to dim the gear lights.

Two micro-switches in the throttle quadrant activate a warning horn and red "GEAR WARN" light under the following conditions:

(1) Gear up and power reduced below approximately 14 inches of manifold pressure.

(2) Gear selector switch UP while on the ground and throttle in retarded position.

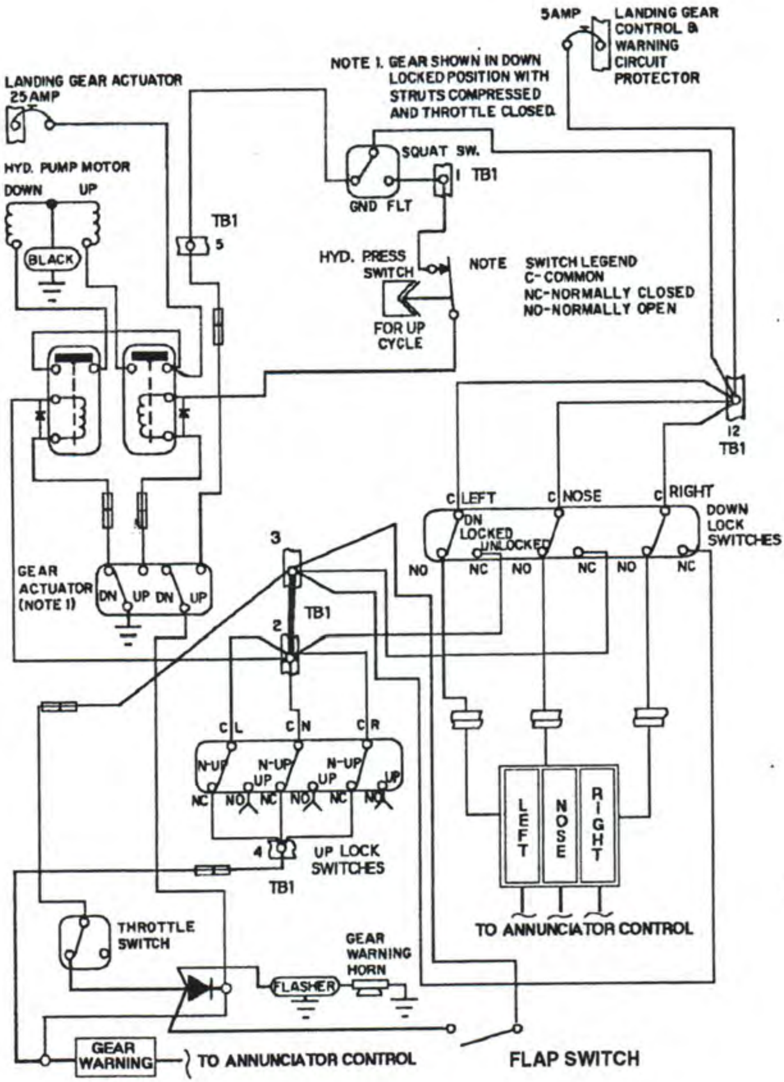
(3) Whenever the flaps are extended beyond the approach position (10°)and the landing gear is not down and locked.

The gear warning horn emits a 90 cycle per minute beeping sound in contrast to the stall warning horn which emits a continuous sound.

The nose gear is steerable through a 22.5 degree arc each side of center through the use of the rudder pedals. As the nose wheel retracts, the steering linkage disengages to reduce rudder pedal loads in flight. The nose wheel is equipped with a hydraulic shimmy dampener to reduce nose wheel shimmy.

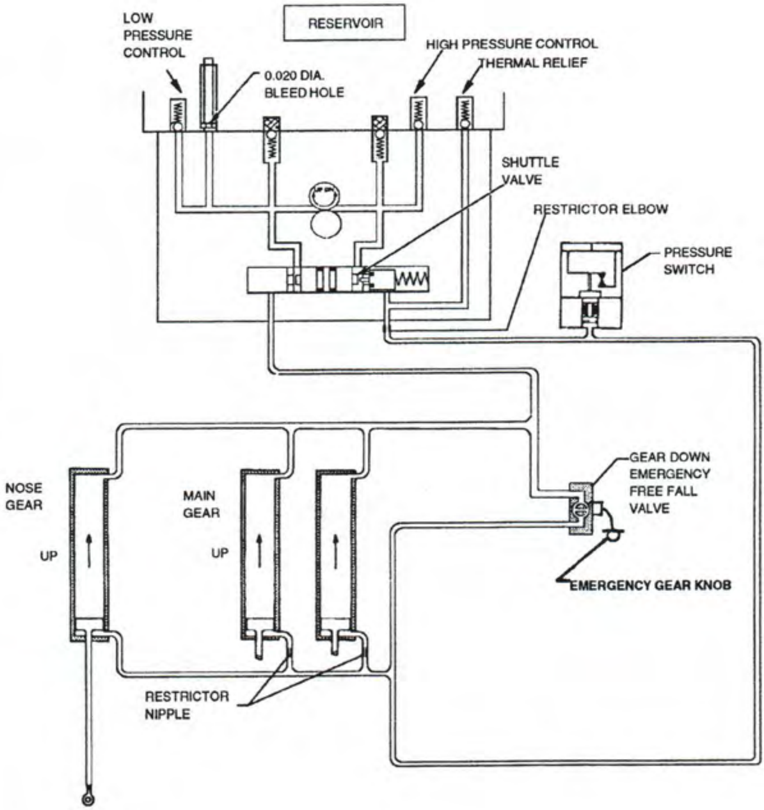
The oleo struts are of the air-oil type, with normal extension being 3.25 ± .25 inches for the nose gear and 4.5 ± .5 inches for the main gear under normal static load (empty weight of airplane plus full fuel and oil).

The standard brake system includes toe brakes on the left and right set of rudder pedals and a hand brake located below and near the center of the instrument panel. The toe brakes and the hand brake have individual brake cylinders, but all cylinders use a common reservoir. The parking brake is incorporated in the lever brake and is operated by first depressing and holding the toe brake pedals and then pulling back on the lever and depressing the knob attached to the top of the handle. To release the parking brake, first depress and hold the toe brake pedals and then pull back on the brake lever; then allow the handle to swing forward.



LANDING GEAR ELECTRICAL SCHEMATIC

Figure 7-5



LANDING GEAR HYDRAULIC SYSTEM SCHEMATIC
Figure 7-7

7.11 FLIGHT CONTROLS

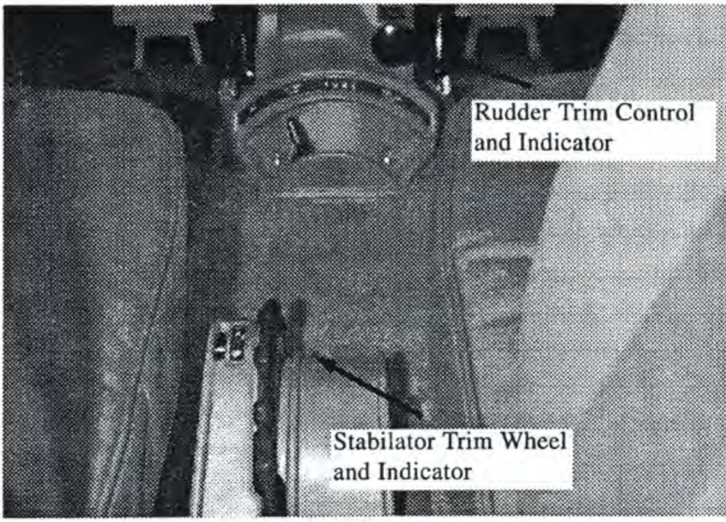
Dual flight controls are provided as standard equipment. A cable system provides actuation of the control surfaces when the flight controls are moved in their respective directions.

The horizontal surface (stabilator) features a trim tab/servo mounted on the trailing edge. This tab serves the dual function of providing trim control and pitch control forces. The trim function is controlled by a trim control wheel located on the control console between the two front seats (Figure 7-9). Rotating the wheel forward gives nose down trim and rotation aft gives nose up trim.

The rudder is conventional in design and incorporates a rudder trim. The trim mechanism is a spring-loaded recentering device. The trim control is located on the right side of the pedestal below the throttle quadrant. Turning the trim control clockwise gives nose right trim and counterclockwise rotation gives nose left trim.

The wing flaps are electrically controlled (fig. 7-10) by a selector lever mounted on the instrument panel to the right of the control pedestal. A flap annunciator light is provided as part of the annunciator panel located in the upper center section of the instrument panel. Selection of a new flap position will activate the flap motor and the light. When the flaps reach the desired position, the flap motor is automatically switched off and the indicator light goes out.

In the event of a flap drive malfunction; move the flap lever until the light goes out. The position of the flap lever relative to the instrument panel markings indicates the approximate flap position.

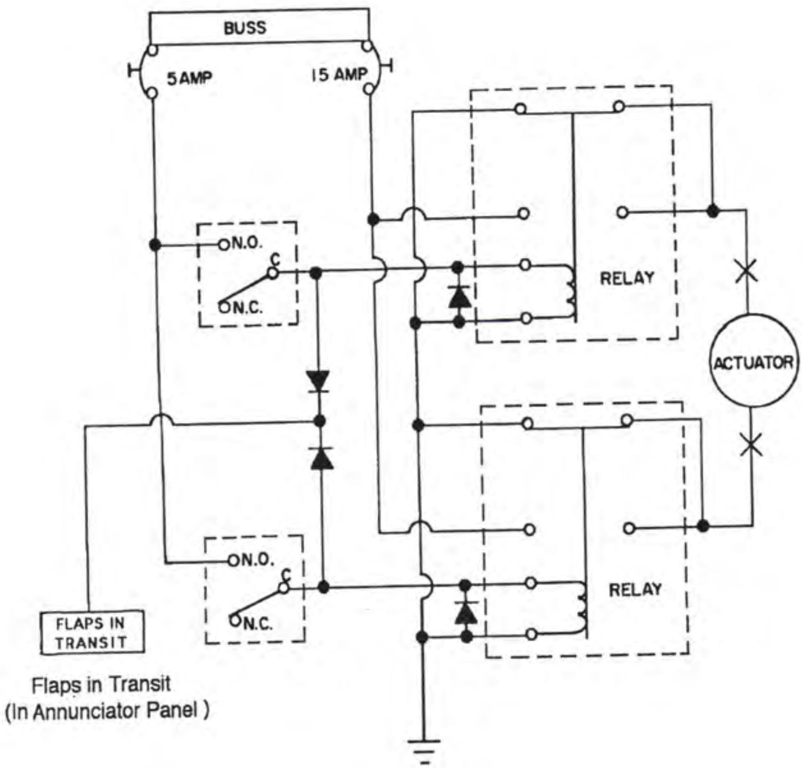


FLIGHT CONTROL CONSOLE
Figure 7-9

There are four stops for the flap control lever, full up (0° flap), 1st notch (10° flap), 2nd notch (25° flap) and full down (40° flap).
When extending or retracting flaps, there is a pitch change in the aircraft. This pitch change can be corrected either by stabilator trim or increased control wheel force. When the flaps are in the retracted position the right flap is provided with a over-center lock mechanism which acts as a step.

NOTE

The right flap will support a load only in the fully retracted (up) position. When loading and unloading passengers make sure the flaps are in the retracted (up) position.



ELECTRIC FLAP SCHEMATIC
Figure 7-10

7.13 FUEL SYSTEM

The standard fuel capacity of the Saratoga II TC is 107 gallons, of which 102 gallons are usable. The inboard tank is attached to the wing structure with screws and nut plates and can be removed for service or inspection. The outboard tank consists of a bladder fuel cell that is interconnected with the inboard tank. A flush fuel cap is located in the outboard tank only.

When using less than the standard 107 gallon capacity of the tanks, fuel should be distributed equally between each side.

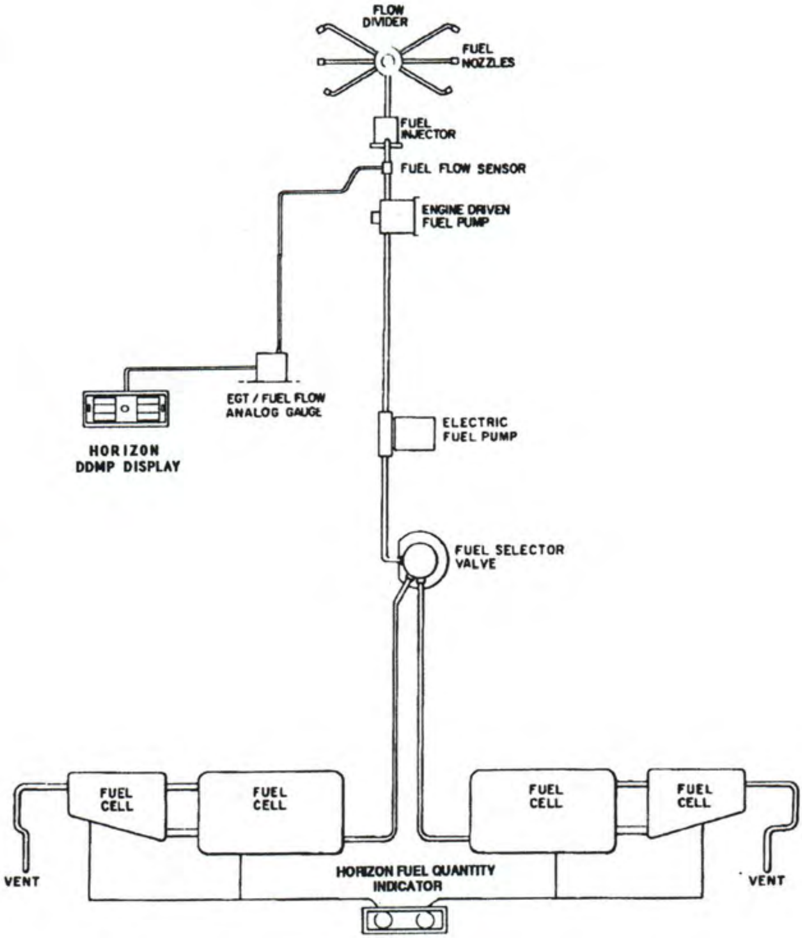
The fuel selector control is located below the center of the instrument panel on the sloping face of the control tunnel (refer to Figure 7-1). It has three positions, one position corresponding to each wing tank plus an OFF position.

To avoid the accumulation of water and sediment, the fuel tank sumps and strainer should be drained daily prior to first flight and after refueling. Each inboard tank is equipped with an individual quick drain located at the lower inboard rear corner of the tank. The fuel strainer and a system quick drain valve are located in the fuselage at the lowest point of the fuel system. It is important that the fuel system be drained in the following manner:

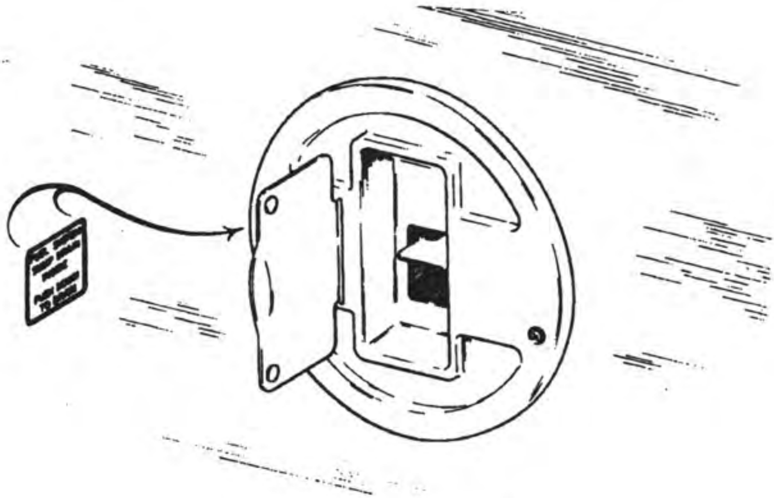
1. Drain each tank sump through its individual quick drain located at the lower inboard rear corner of the tank, making sure that enough fuel has flowed to ensure the removal of all water and sediment.
2. Place a container beneath the fuel strainer sump drain outlet located under the fuselage.
3. Drain the fuel strainer sump by pressing down on the lever located on the right side of the cabin on the forward edge of the wing spar housing (Figure 7-13). Move the selector through the following sequence: OFF position, left, right, while draining the strainer sump. Make sure that enough fuel has flowed to drain the fuel line between each tank outlet and the fuel strainer, as well as the strainer itself. With full fuel tanks, it will take approximately 6 seconds to drain all of the fuel from the line from either tank to the fuel strainer. When the tanks are less than full, it will take a few seconds longer.
4. Examine the contents of the container placed under the fuel sump drain outlet. When the fuel flow is free of water and sediment, close the drain and dispose of the contents of the bottle.

CAUTION

When draining fuel, care should be taken to ensure that no fire hazard exists before starting the engine.



FUEL SYSTEM SCHEMATIC
Figure 7-11



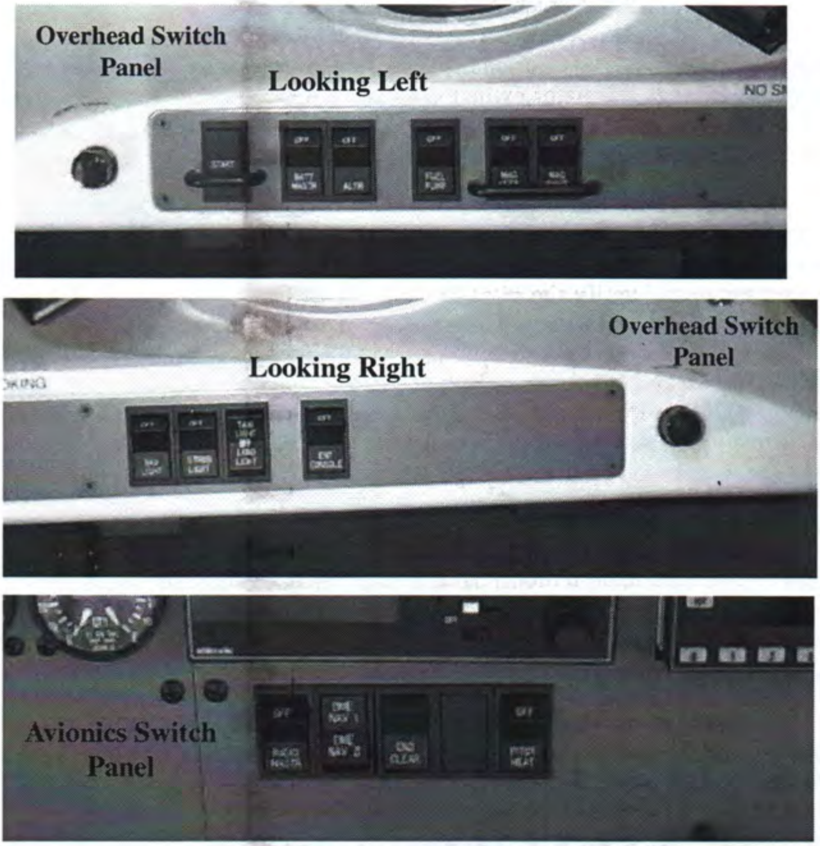
FUEL DRAIN LEVER
Figure 7-13

After using the underseat quick drain, check from the outside to make sure that it has closed completely and is not leaking.

A dual analog fuel quantity gauge is located in the lower right portion of the Horizon instrument installation. Gauges are electrical and will operate when the battery master switch is on.

A fuel quantity indicator to measure the fuel not visible through the filler neck in each wing is installed in the inboard fuel tank. This gauge indicates usable fuel quantities from 5 gallons to 35 gallons in the ground attitude. The sole purpose of this gauge is to assist the pilot in determining fuel quantities of less than 35 gallons during the preflight inspection.

An electric fuel pump is provided for use in case of failure of the engine driven pump. The electric pump operates from a single switch and independent circuit protector. It should be ON for all takeoffs, climbs and landings.



SWITCH PANELS
Figure 7-15

7.15 ELECTRICAL SYSTEM

The 28-volt electrical system includes a 24-volt battery for starting and to back up alternator output. Electrical power is supplied by a 90 ampere alternator. The battery, a master switch relay, and an external power relay are located on the right hand side of the aft fuselage. Access to these electrical components is gained by removing the aft fuselage access panel in the rear baggage compartment.

All powerplant and exterior light switches are grouped in an overhead switch panel with all avionics switches grouped in a switch panel located just above the throttle quadrant. (figure 7-15). The circuit breaker panel is located on the lower right side of the instrument panel (figure 7-19). Each breaker is clearly marked to show which circuit it protects. Also, circuit provisions are made to handle the addition of communications and navigational equipment.

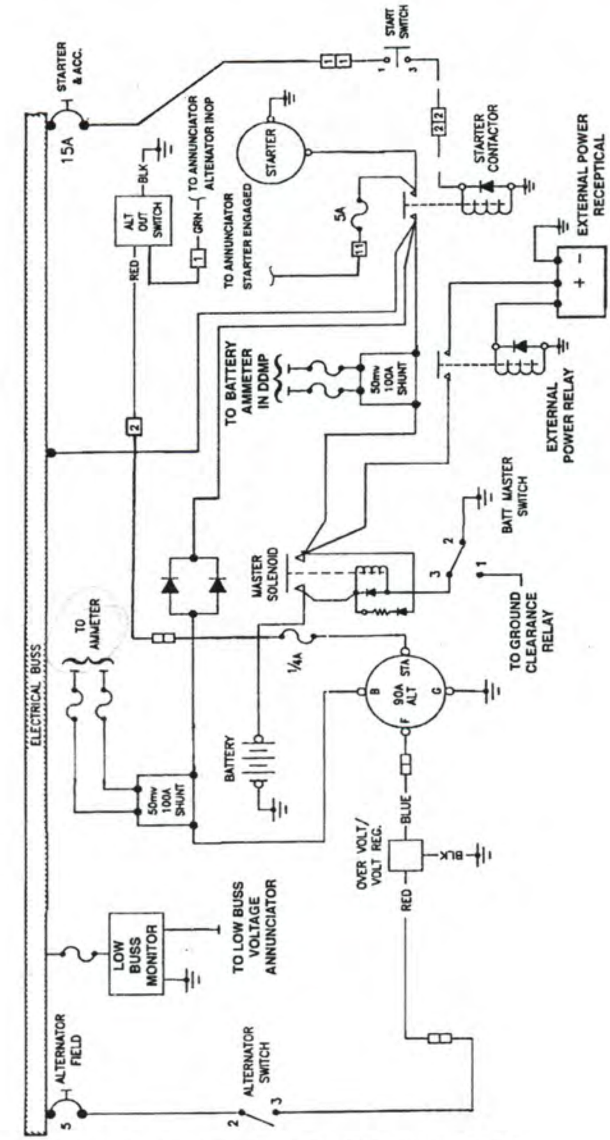
Standard electrical accessories include the starter, the electric fuel pump, the stall warning horn, and the annunciator panel. The annunciator panel includes, alternator inop, oil pressure, gear warn, flaps in transit, starter engaged, low bus voltage, pitot heat off/inop, vacuum inop, and baggage door ajar indicator lights and provisions for optional, air conditioner door open. The annunciator panel lights are provided only as a warning to the pilot that a system may not be operating properly, and that the applicable system gauge should be checked and monitored to determine when or if any corrective action is required.

Electrical accessories include the navigation lights, anti-collision strobe lights, instrument panel lighting and cabin courtesy lights. The cabin courtesy light installation consists of a light and switch above the forward cabin entrance and a light above the rear entrance door with the switch in the side panel adjacent to the rear door. Make sure the lights are off when leaving the aircraft. Leaving the lights on for an extended period of time could cause depletion of the battery.

Two lights, mounted in the overhead panel, provide instrument and cockpit lighting for night flying. The lights are controlled by rheostats adjacent to the overhead switch panel. A map light window in each lens is actuated by an adjacent switch. A wing recognition/landing light system, consisting of 2 lights (one in each wing), is operated by a rocker type switch mounted in the overhead switch panel. A single light is mounted on the nose gear which operates when the switch is in landing or taxi position (s/n 3257001 thru 3257365 only).

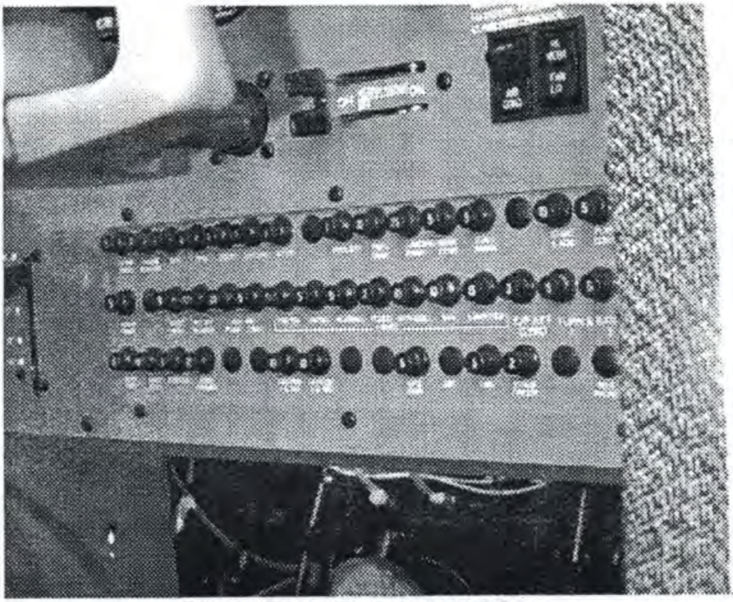
Circuit provisions are made to handle the addition of communications and navigational equipment.

The alternator ammeter in the DDMP displays in amperes the load placed on the alternator. The Batt ammeter displays in amperes the amount of charge or discharge of the battery.



ALTERNATOR AND STARTER SCHEMATIC

Figure 7-17



CIRCUIT BREAKER PANEL
Figure 7-19

For Abnormal and/or Emergency procedures, see Section 3.

WARNING

Anti-collision lights should not be operating when flying through cloud, fog or haze, since the reflected light can produce spatial disorientation. Strobe lights should not be used in close proximity to the ground such as during taxiing, takeoff or landing.

7.17 VACUUM SYSTEM

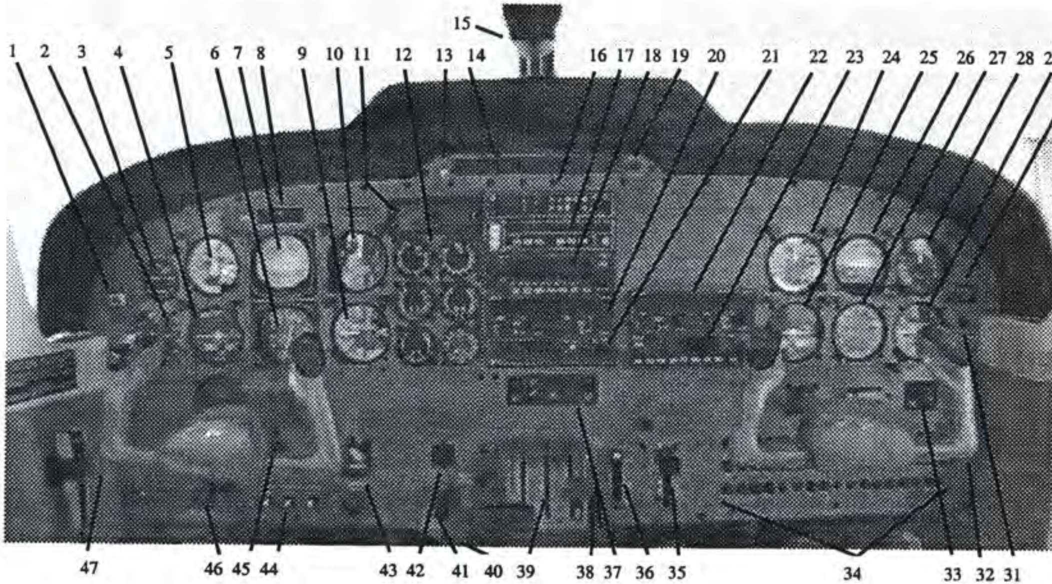
The vacuum system is designed to operate the air driven gyro instruments. This includes the directional and attitude gyros when installed. The system consists of an engine driven vacuum pump, vacuum regulator, vacuum inop annunciator light/relay, filter and the necessary plumbing.

The vacuum pump is a dry type pump which eliminates the need for an air/oil separator and its plumbing. A shear drive protects the engine from damage. If the drive shears the gyros will become inoperative.

The vacuum gauge is a dual instrument (cylinder head temperature/vacuum pressure), located in the left lower portion of the Horizon instrument installation, (refer to Figure 7-21) which provides valuable information to the pilot about the operation of the vacuum system. A decrease in pressure in a system that has remained constant over an extended period, may indicate a dirty filter, dirty screens, possibly a sticking vacuum regulator or leak in the system. Vacuum pressure which falls below approximately 4.0 in. hg. will illuminate the vacuum inop annunciator light indicating unreliable vacuum driven gyro readings. Zero pressure would indicate a sheared pump drive, defective pump, possibly a defective gauge or collapsed line. In the event of any gauge variation from the norm, the pilot should have a mechanic check the system to prevent possible damage to the system components or eventual failure of the system.

A vacuum regulator is provided in the system to protect the gyros. The valve is set so the normal vacuum reads within the normal operating range, a setting which provides sufficient vacuum to operate all the gyros at their rated RPM. Higher settings will damage the gyros and with a low setting the gyros will be unreliable. The regulator is located behind the instrument panel.

1. AUX VACUUM SW.
2. LOC/VOR/GS IND.
3. CLOCK
4. TURN & BANK
5. AIRSPEED IND.
6. H.S.I.
7. FLT. COMAND IND.
8. A/P ANNUNCIATOR
9. VERT. SPEED IND.
10. ALTIMETER
11. DDMP
12. ENGINE INSTRUMENTS TOP TO BOTTOM, LEFT TO RIGHT:
    MAP; PROP RPM;
    TIT/FUEL FLOW;
    OIL TEMP/OIL PRESS
    VACUUM/CHT;
    L & R FUEL QUANTITY
13. ANN. DAY/NITE SW
14. ANNUNC. PANEL
15. WET COMPASS
16. AUDIO AMP.
17. AUTOPILOT
18. G.P.S.
19. ANN. PRESS TO TEST
20. AVIONIC EQUIPMENT
21. AVIONIC EQUIPMENT
22. INTERCOMM SYSTEM
23. AVIONIC EQUIPMENT COPILOT INST (OPT)
24. AIRSPEED
25. TURN & BANK
26. ATITUDE GYRO
27. DIRECTIONAL GYRO
28. ALTIMETER
29. VERT. SPEED IND.
30. ENGINE HOUR METER
31. DATA LOADER PLUG
32. MIKE & PHONE JACK
33. CLIMATE CONTROL
34. CKT. BREAKER PANEL
35. WING FLAP SELECTOR
36. ALT. AIR CONTROL
37. SWITCH PANEL
38. FRICTION LOCK
39. THROTTLE QUAD.
40. EMERG. GEAR EXTEN.
41. GEAR SELECTOR
42. GEAR LIGHTS
43. OXY GAGE & CONTROL
44. DIMMING CONTROLS
45. SLAVE METER ACC.
46. E.L.T. SWITCH
47. MIKE/PHONE JACKS



TYPICAL INSTRUMENT PANEL
Figure 7-21

7.19 INSTRUMENT PANEL

The instrument panel (Figure 7-21) is designed to accommodate the customary advanced flight instruments and the normally required power plant instruments. The pilots artificial horizon is vacuum operated while the directional gyro (HSI) and turn and bank are electrically operated. The vacuum gauge is located on the bottom left of the instrument stack and is marked with a green arc from 4.8 to 5.2 in.Hg. to indicate the system is supplying adequate vacuum to the various instruments. The turn coordinator, located to the left of the directional gyro, is electrically operated.

The annunciator panel is located above the left avionics stack. Panel arrangement contains sixteen annunciators, eight across and two high. The annunciator panel incorporates a press-to-test feature (located to the right) and a day/night switch (located to the left). The annunciator provides a visual warning of possible malfunctions including failure alert and precautionary warnings.

Annunciator Cluster

While the illumination of some of these lights in flight is an indication of a possible system malfunction, illumination of others is just an indication of a system condition. The pilot should closely monitor instrument panel gauges to check the condition of a system whose corresponding light on the annunciator panel illuminates.

During preflight the operational status of the annunciator panel should be tested by use of the press-to-test button. When the button is depressed all annunciator panel lights should illuminate.

The engine gauges are 2 in. round instruments located vertically in two columns. (see Fig. 7-21 for exact location). Included are manifold pressure, tachometer (RPM), turbine inlet temperature (TIT), fuel flow, oil temperature oil pressure and cylinder head temperature. The normal operating range for ground and flight operation is indicated on the instruments by a green arc. Yellow arcs indicate a caution range while red lines dictate minimum or maximum limits.

7.19 INSTRUMENT PANEL (CONT'D)

Engine and electrical switches are located in a single row switch cluster in an overhead switch panel. The row of switches include the battery master, alternator, standby fuel pump, left and right magnetos, starter and entertainment console. Navigation, strobe, recognition/landing and taxi light (taxi lights are installed on airplane serial numbers 3257001 thru 3257365 only) switches are located to the far right in the overhead switch panel.

Instrument panel lighting is provided by post lights, overhead panel lights and internally lighted engine gauges, avionics and switches. Optimum cockpit lighting for night flying is achieved by using a combination of the panel lights and the overhead flood lights. The panel lights are adjusted by three rheostats labeled switch, panel and avionics located below the pilots control column. The overhead lights are adjusted by rheostats adjacent the overhead switch panel. A white map light can be selected from either overhead flood light.

Radios are mounted in two stacks above and to the right of the control quadrant in the upper instrument panel. A radio master (radio mstr) switch is located below the left avionics stack. It controls the power to all radios through the radio master contactor. When the radio master (radio mstr) switch is turned on, ground is removed from the radio master switch relays, allowing the contactor to spring closed and permitting current flow to the radios.

Ground clearance energy saver system provides direct power to comm #1 with the battery master switch in the off position. An internally lit switch, located below the right avionics stack provides annunciation for engagement of the system. When the spring loaded switch is engaged, direct aircraft battery power is applied to comm #1, audio amplifier and radio accessories. Ground clearance must be turned off or depletion of battery could result. To turn off the ground clearance, turn the battery master switch on momentarily, then off.

NOTE:

The battery master switch must be in the off position for ground clearance system to operate.

The control quadrant - throttles, propeller and mixture controls is in the center of the lower instrument panel. To the left of the control quadrant is the landing gear selector and the emergency landing gear extender knob. To the right of the control quadrant is the control friction lock and the four position, electric flap control.

The optional copilot's flight instruments are on the upper right instrument panel. Jacks for the copilot's microphone and headset are to the right of the circuit breaker panel.

7.19a HORIZON ENGINE INSTRUMENT/ENGINE MONITORING SYSTEM

The Horizon Engine Instrument/Engine Monitoring System is a microprocessor based instrument with analog and digital format displays of engine related instruments. The Engine Instrument/Engine Monitoring System can be divided into two parts: 1) the Digital Display Monitoring Panel (DDMP) and 2) the single/dual analog instrument displays (see Figure 1).

The DDMP is a microprocessor which monitors/records engine parameter exceedences and provides the interface between a GPS receiver and engine parameter sensors for digital display of the analog instruments, engine power, electrical system status, outside/cabin air temperature, and fuel management. The DDMP displays its information on 6 eight character displays which are controlled via an Up/Dwn button, a Select button, and a rotary mode selection knob.

NOTE

When both analog and digital presentations exist for an aircraft instrument, analog formats are the primary source of information and digital displays are considered as advisory only.

The rotary mode selection knob allows the user to cycle through the 6 top level operations:

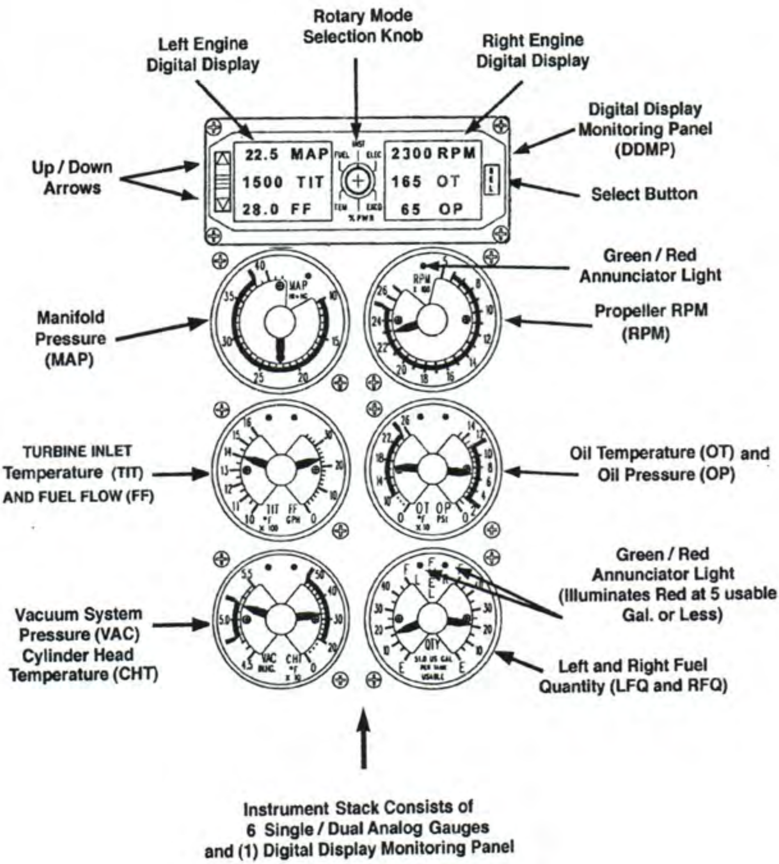
1. FUEL - Fuel management
2. INST - Engine instrument display
3. ELEC - Electrical parameter display
4. EXCD - Exceedence record display
5. %PWR - Engine per cent power display/determination
6. TEMP - Temperature display

7.19a HORIZON ENGINE INSTRUMENT/ENGINE MONITORING SYSTEM (CONT'D)

Below the DDMP are two vertical stacks of analog instruments which display (going top to bottom/left to right), manifold pressure (MAP), Propeller RPM (RPM), turbine inlet temperature (TIT), fuel flow (FF), oil temperature (OT), oil pressure (OP), vacuum system pressure (VAC), cylinder head temperature (CHT), and left/right fuel quantity (QTY). Each analog indicator displays its respective engine parameter and provides data for the DDMP. Analog instruments consist of a 2 inch nonreflective glass face/dial, controllable backlighting, and an annunciator light capable of showing steady green or steady/flashing red. A steady green annunciator indicates that analog parameter is being displayed digitally in the DDMP. A steady red annunciator is illuminated when an engine parameter limit has been exceeded. Any exceedence condition will override the current DDMP display and show the parameter in exceedence, the exceedence value, illuminate a red annunciator light, (see Figure 2) and activate an audible tone. The exceedence audible tone and DDMP exceedence display will continue until the select switch is depressed. The red annunciator light will remain illuminated until the parameter is no longer in exceedence. If multiple exceedences occur, the operator must acknowledge each exceedence individually to mute the audible alarm. A steady red annunciator light in the fuel quantity gauge indicates 5 gallons or less of usable fuel remaining. Brightness of the analog instrument backlighting and DDMP display can be adjusted using the cockpit panel lighting control. Analog instrument annunciator light intensity is controlled using the panel annunciator Day/Night dimmer switch.

The Engine Instrument/Engine Monitoring System performs the following self-test sequence during initial power up to verify proper system operation:

1. DDMP displays aircraft model and Horizon Revision number.
2. Current Date/Time will be displayed.
3. Illumination of Red annunciator lights.
4. Analog indicator pointers will go to full scale.
5. Red annunciator lights will extinguish.
6. Illumination of Green annunciator lights.
7. Audible horn will sound for approximately 1 second.
8. Analog indicator pointers will return to rest position.
9. Green annunciator lights will extinguish.
10. Illumination of all 8 characters in each DDMP display window.
11. Internal system checks.



HORIZON ENGINE INSTRUMENT/ENGINE MONITORING SYSTEM
Fig. 1

7.19a HORIZON ENGINE INSTRUMENT/ENGINE MONITORING SYSTEM (CONT'D)

During normal operations, all indicators and their associated sensors will have continuous system health monitoring. In the event an indicator or sensor error is detected during the self-test sequence or normal operations, an audible horn will sound for 3 seconds, a DDMP instrument fail message will be shown (see Fig. 3), and a flashing red annunciator light will illuminate indicating the following:

1. 2 flashes/second - instrument failure.
2. 4 flashes/second - sensor failure.

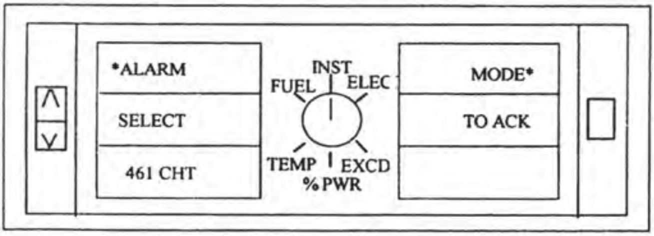


Figure 2

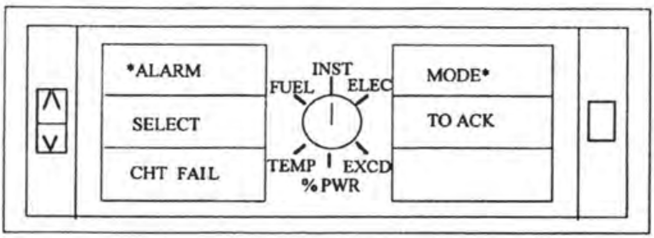


Figure 3

TOP LEVEL OPERATIONS:

FUEL MANAGEMENT (FUEL)

The fuel management mode provides fuel management functions based on inputs from pilot fuel loading entries, fuel flow sensors, and the Global Positioning System (GPS). This information is intended to assist the pilot in fuel management but should be considered as advisory only. No allowances for deviations (weather, ATC delays, etc..) or fuel reserves are factored into fuel management calculations, therefore the pilot is the final authority for all fuel management decisions.

All fuel management functions are based on total usable fuel available, therefore it is very important to visually verify and input accurate fuel loadings.

NOTE:

Usable fuel load entries are the combined total of all fuel tanks and not a per tank value.

Once an accurate fuel loading has been determined, fuel loading entry into the DDMP is initiated by placing the rotary selection knob on FUEL. Press the Select button until the Fuel Loading window is displayed (See Figure 4). The 3 options of 1) full fuel loading, 2) partial fuel loading, or 3) cancel to terminate the fuel loading procedure can be chosen.

To enter a fuel load, use the Up/Down arrows to position the cursor next to "FULL" or "PARTIAL" and press Select. "FULL" defaults to 102 gallons (maximum usable fuel) and allows the pilot to decrease the fuel loading to lower fuel loading values if desired. "PARTIAL" defaults to 0 gallons and allows the pilot to increase the fuel loading value to any value up to maximum usable fuel (102 gallons). Pressing Select again will bring up the fuel loading confirmation window. Choose yes or no using the Up/Down arrows then press Select to enter. If the fuel loading window has been selected in error, the CANCEL option can be chosen using the Up/Down arrows then the Select button to terminate the fuel loading sequence.

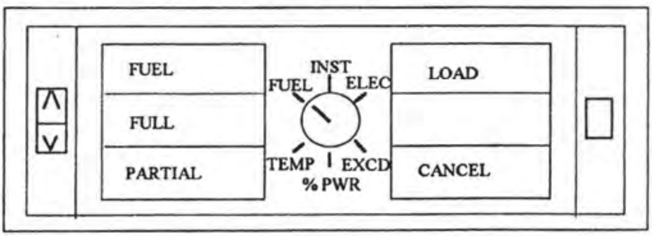


Figure 4

Once an accurate loading of usable fuel is entered in the DDMP, two additional fuel management displays (Figures 5 and 6) can be presented by pressing the Select button. More depressions of the Select button will simply cycle through the fuel load entree and two fuel management displays.

7.19a HORIZON ENGINE INSTRUMENT/ENGINE MONITORING SYSTEM (CONT'D)

FUEL MANAGEMENT DISPLAY #1

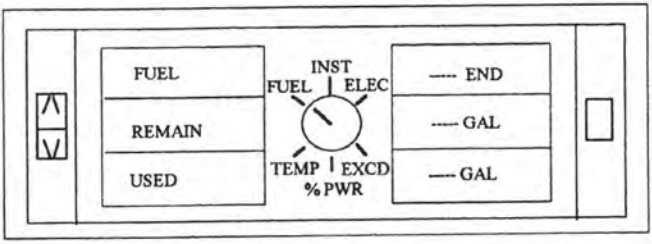


Figure 5

END - Endurance/flight time remaining. This calculation is based on current fuel flow rate and usable fuel remaining.
REMAIN - Fuel remaining in tank. This calculation is based on last usable fuel load entree and fuel used.
USED - Fuel used. This calculation is based on fuel used since last usable fuel load entree.

FUEL MANAGEMENT DISPLAY #2

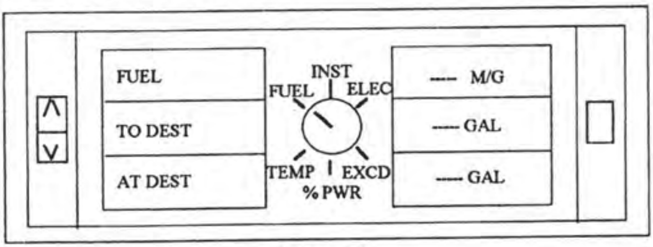


Figure 6

M/G - Nautical miles/gallon of fuel. This calculation is based on current fuel flow rate and GPS ground speed.
To DEST - fuel required to destination (current GPS waypoint). This calculation is based on current fuel flow rate, GPS distance to waypoint, and GPS ground speed.
At DEST - fuel remaining at destination (current GPS waypoint). This calculation is based on current usable fuel remaining, fuel flow rate, GPS distance to waypoint, and GPS ground speed.

ENGINE INSTRUMENT DISPLAY (INST)

The INST mode of operation enables the user to digitally display any of the engine related analog instruments in the 6 DDMP windows (See figure 7). The INST mode is selected by placing the rotary selection knob on INST. The Select button is then used to choose the parameter display location in one of the 6 DDMP windows. Once the DDMP display window is determined, the Up/Down button can be used to sequence through the appropriate analog instruments and choose the display parameter. This process would be repeated until all 6 DDMP windows are configured. The default DDMP instrument configuration after each Horizon system power up is MAP, RPM, TIT ,Oil Temp., Fuel Flow, and Oil Pressure.

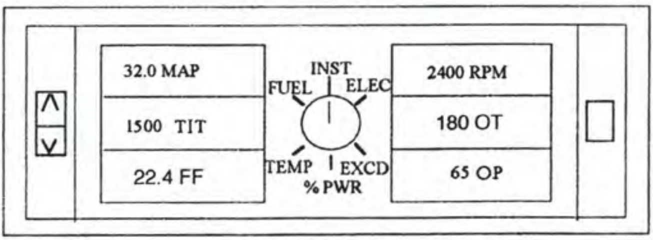


Figure 7

ELECTRICAL DISPLAY (ELEC)

The electrical mode displays electrical system information on alternator amperage output, main bus voltage, and battery charge/discharge rate (see Figure 8).

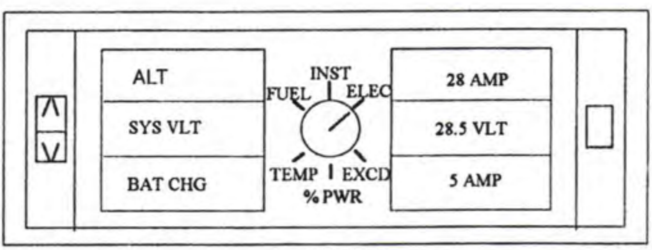


Figure 8

7.19a HORIZON ENGINE INSTRUMENT/ENGINE MONITORING SYSTEM (CONT'D)

EXCEEDENCE DISPLAY (EXCD)

The EXCD mode of operation enables the user to display any parameter limitation exceedence that has occurred during ground/flight operations. Parameter name, duration of exceedence (hrs:min:sec), exceedence peak value, exceedence sequence number, time of day, and date are recorded during each occurrence in chronological order for over 200 exceedence records. Any exceedences beyond the DDMP memory limit will start to overwrite old exceedence records. Display of exceedences is accomplished by placing the rotary knob on EXCD. The DDMP will display the most resent exceedence in the format shown in figure 9. Additional exceedence records can be viewed in chronological order using the up/down arrows. Exceedence records can be cleared from the DDMP display by pressing Select which brings up the menu in Figure 10. Using the Up/Down arrows you can move to the "Clear All" window and then press select which clears all exceedences from the DDMP display. Choosing Cancel will revert back to the exceedence display format in Figure 9.

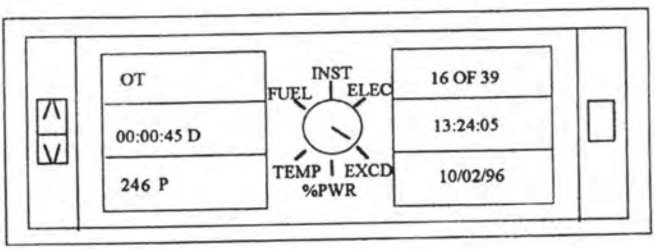


Figure 9

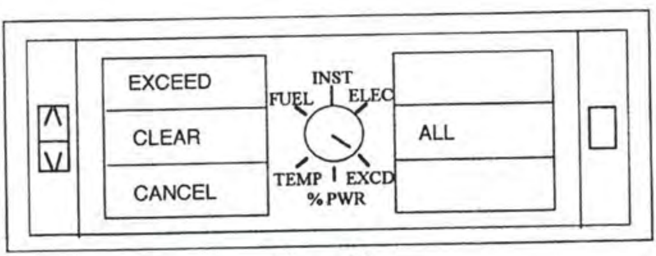


Figure 10

The following abbreviations are used in the exceedence mode:

1.	LO VLT	Low System Voltage
2.	HI VLT	High System Voltage
3.	MAP	High Manifold Pressure
4.	RPM	High RPM
5.	TIT	High Turbine Inlet Temperature
6.	CHT	High Cylinder Head Temperature
7.	OT	High Oil Temperature
8.	LOP	Low Oil Pressure
9.	HOP	High Oil Pressure
10.	LO VAC	Low Vacuum
11.	HI VAC	High Vacuum
12.	LFQ	Low Left Fuel Quantity
13.	RFQ	Low Right Fuel Quantity

PERCENT POWER DISPLAY (%PWR)

The percent power mode initially displays current cruise power output in (5% increments), manifold pressure, and RPM, fuel flow, and TIT (see Figure 11). Any engine powers outside of the cruise range (50 % to 80 %) will produce - - - -'s in the DDMP % power window.

NOTE:

The Pilots Operating Handbook (Report: VB 1647) shall be the final authority if any inconsistency exists between DDMP % Power Display information and the Pilot's Operating Handbook performance charts.

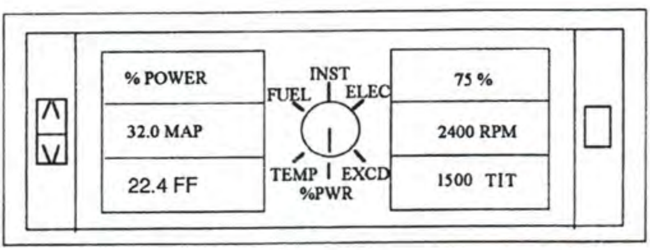


Figure 11

7.19a HORIZON ENGINE INSTRUMENT/ENGINE MONITORING SYSTEM (CONT'D)

A desired percent power setting can be chosen by pressing the select button to bring up the display shown in Figure 12. Initially, current values of %PWR, RPM, and MAP are displayed. %PWR can be incrementally changed using the Up/Down arrows from 50% to 85% power in 5% increments. As %PWR is changed, a suggested RPM (close to current engine RPM) will be displayed along with approximate values of MAP. Fuel flows will be based ON selected percent power and corresponding leaning procedures (below 75% power best economy leaning procedures, 75% power and above - best power leaning procedures). If a different engine RPM is desired, the Select button is pressed to navigate to the RPM window and the Up/Down arrows used to vary the RPM in 100 RPM increments. This variation in RPM changes expected values of MAP and fuel flow accordingly. Once the desired %PWR and RPM combination are chosen, subsequent pressing of the Select button will choose the Return window and then cycle back to the original percent power display (Figure 11).

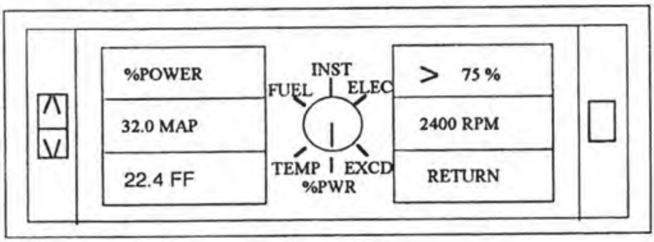


Figure 12

TEMPERATURE DISPLAY (TEMP)

The temperature mode displays outside air temperature and cabin air temperature in both degrees F and degrees C. The Select button will cycle the temperature display between degrees F and degrees C. (See Figure 13).

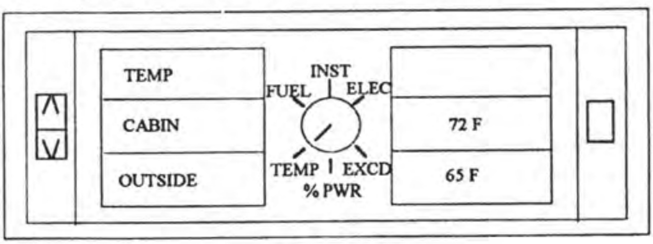


Figure 13

DDMP MAINTENANCE MODE

The maintenance mode provides maintenance operations, System Self Test, and time of day/date adjustment functions to the operator . This mode is entered by depressing the Up/Down arrow and the Select keys while in the ELEC Mode in the following sequence:

1. Up arrow
2. Down arrow
3. Up arrow - twice
4. Select Key

The DDMP will then display the format seen in Figure 14.

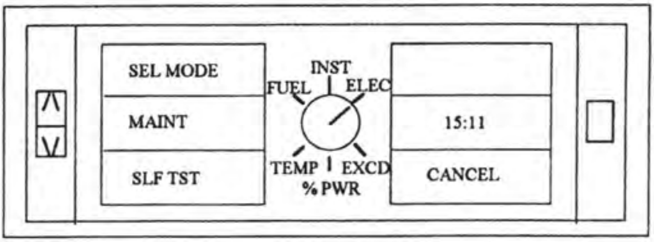


Figure 14

The MAINT menu provides access to factory calibrations of instruments and should not be entered/tampered with by unauthorized personnel. Access to this menu is limited to personnel with knowledge of the 4 character access code.

The SLF TST menu allows the operator to activate the system self test sequence that occurs during initial power up.

The Date and time menus allow initial input of date and time into system memory (see Figure 15). Maneuver to the desired window (time or date) using Up/Down buttons and press Select to open the menu. Press Select again to activate the left most pair of digits and increment the numbers to the desired setting using the Up/Down arrows. This procedure of pressing Select to activate the adjacent digit pairs and incrementing using Up/Down arrows is repeated until the new date or time is entered. Date and time will be retained in memory indefinitely until further adjustment is necessary. Termination of the date/time menu is initiated by choosing Return using the Up/Dwn arrows and then the Select button.

The Cancel option Maint menu (Fig. 14) returns the DDMP back to the ELEC display.

7.19a HORIZON ENGINE INSTRUMENT/ENGINE MONITORING SYSTEM (CONT'D)

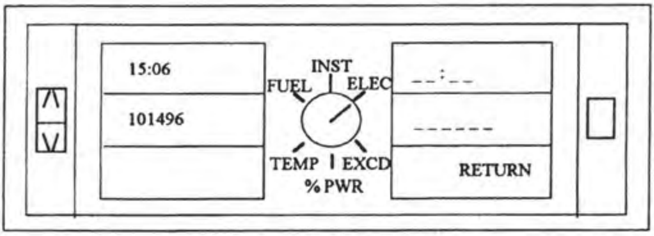


Figure 15

AUXILIARY COMMUNICATIONS

DDMP information can be accessed/stored on a personal computer via a RS-232 connection (located under pilot's side instrument panel) and standard terminal emulation software. DDMP data can be accessed using the terminal emulation software instructions and the following required settings:

Baud Rate:	9600
Parity:	None
Data Bits	8
Stop Bits:	1

Upon connection, the operator should select the "Data Dump" option. The DDMP will then send current instrument data to the connected device enabling a permanent record of the flight to be stored to disk. Data is sent approximately every 5 seconds in a comma delimited ASCII format for each of the following parameters:

Parameter	Units
Manifold Pressure	In Hg
Propeller RPM	RPM
turbine inlet Temperature	°F
Fuel Flow	Gal/Hr
Cylinder Head Temperature	°F
Oil Temperature	°F
Oil Pressure	PSI
Vacuum Pressure	In Hg
Fuel Quantity	Gal
Cabin Air Temperature	°F
Outside Air Temperature	°F
Pressure Altitude	Ft
System Voltage	Volts
Alternator Current	Amps
Battery Charge Current	Amps

Additional auxiliary communication options may be found in the Horizon Instrument Maintenance Manual.

7.21 PITOT-STATIC SYSTEM

Pitot pressure for the airspeed indicator is sensed by a heated pitot head installed on the bottom of the left wing and is carried through lines within the wing and fuselage to the gauge on the instrument panel (refer to Figure 7-23). Static pressure for the altimeter, vertical speed and airspeed indicators is sensed by two static source pads, one on each side of the rear fuselage forward of the elevator. The dual pickups balance out differences in static pressure caused by slight side slips or skids.

An alternate static source is provided as standard equipment. The control valve is located below the left side of the instrument panel. When the valve is set in the alternate position, the altimeter, vertical speed indicator and airspeed indicator will be using cabin air for static pressure. The storm window and cabin vents must be closed and the cabin heater and defroster must be on during alternate static source operation. The altimeter error is less than 50 feet unless otherwise placarded.

7.21 PITOT-STATIC SYSTEM (CONT'D)

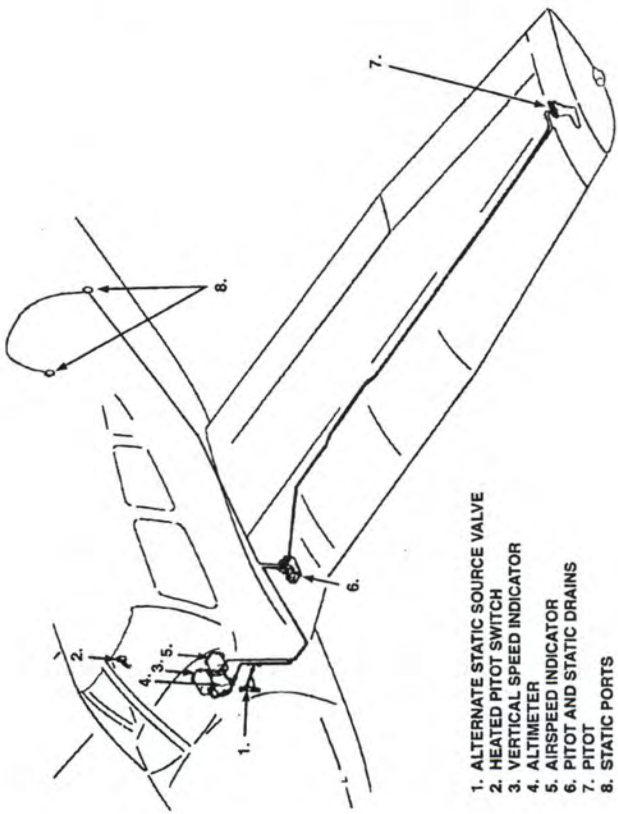
If one or more of the pitot static instruments malfunction, the system should be checked for dirt, leaks or moisture. The static lines may be drained by a valve located on the side panels next to the pilot's seat. The pitot system drains through the pitot mast.

The holes in the sensors for pitot and static pressure must be fully open and free from blockage. Blocked sensor holes will give erratic or zero readings on the instruments.

NOTE

During preflight, check to make sure the pitot cover is removed.

A heated pitot head, which alleviates problems with icing and heavy rain is installed as standard equipment. The switch for pitot heat is located in the switch panel located just above the throttle quadrant. The pitot heat system has a separate circuit breaker located in the circuit breaker panel and labeled PITOT/STALL, WARN HEAT. Static source pads have been demonstrated to be non-icing: however, in the event icing does occur, selecting the alternate static source will alleviate the problem.



PITOT-STATIC SYSTEM
Figure 7-23

7.23 CABIN FEATURES

Cabin entry for the front seats is made through the cabin door on the right side of the airplane. To close the cabin door, hold the door closed with the armrest while moving the side door latch (Figure 7-25) down to the LATCHED position.

Cabin entry for the center and rear seats is made through the aft cabin door on the left side of the airplane. This door is double latched. To close the aft cabin door, pull the door closed with both the arm rest and the upper assist strap. Then engage the bottom and top latch to the LATCHED position. Both latches must be secure before flight.

The aft cargo door is opened by a lever located on the forward edge of the door. Pulling down on the lever disengages two locking pins from the frame.

FRONT CABIN DOOR SIDE LATCH
Figure 7-25

STANDARD FEATURES

Standard front cabin features include door locks (fore and aft cabin and nose baggage), a pilot's storm window, map pockets, and sun visors. An armrest is located on the side panel adjacent to each front seat. Additional standard cabin items are pockets on the front seat backs, cabin sound-proofing, passenger assist straps and baggage restraint straps in the nose and aft baggage areas.

SEATS

All seat backs have three positions: normal, intermediate and recline. An adjustment lever is located at the base of each seat back on the outboard side.

The pilots and co-pilots seats are adjustable fore, aft and vertically. They are adjustable fore and aft by lifting the bar below the seat front and moving to the desired position. Release the handle and move the seat until the locking pin engages. Pivoting armrests are provided on the inboard side of each front seat.

To raise the vertically adjustable pilot and copilot seats, push back on the pushbutton located at the lower right of each seat, relieve the weight from the seat and it will rise. To lower the seat, push the button and apply weight until the proper position is reached.

The center and rear seats are easily removed to provide room for bulky items. Removal of the seats is accomplished by removing the two bolts holding the aft attach points and sliding the seat aft.

NOTE

To remove the center seats, retainers securing the back legs of the seats must be unlocked. Releasing the retainers is accomplished by depressing the plunger behind each rear leg. Any time the seats are installed in the airplane, the retainers should be in the locked position.

To remove the rear seats, depress the plunger behind each front leg and slide seat to rear.

CAUTION

Removal of any seats(s) require Weight and Balance computations. Refer to Section 6 of this POH to determine suitability for flight with seats removed.

SEAT BELTS AND SHOULDER HARNESSES

Seat belts and adjustable shoulder harnesses with inertial reels are standard on all seat locations. The pilot should adjust this fixed seat belt strap so that all controls are accessible while maintaining adequate restraint for the occupant. The seat belt should be snugly fastened over each unoccupied seat.

7.23 CABIN FEATURES (Continued)

The shoulder harness is routed over the shoulder adjacent to the window and attached to the seat belt in the general area of the occupant's inboard hip. A check of the inertial reel mechanism is made by pulling sharply on the strap. The reel should lock in place and prevent the strap from extending. For normal body movements, the strap will extend or retract as required.

Shoulder harnesses shall be worn during takeoff, landing and during an emergency situation.

Other features suiting individual needs are headrests, a fire extinguisher, an oxygen system, and a special cabin sound-proofing package are just a few.

Another feature is the entertainment/executive console in place of the right hand aft facing seat. Some of the features are a horizontally sliding, pull out table, an area set up for a multi-media entertainment system, a monitor, a phone and pilots reference material compartment. (See Figure 7-27.)

OPTIONAL FEATURES

Air conditioning is among the very few cabin options. This option if installed will enhance the environment of the aircraft cabin by supplying conditioned air that is adjustable by the user. Complete details of this option can be found in Section 9, Supplement 1 at the end of this book.

7.25 BAGGAGE AREA

The airplane has two separate baggage areas, each with a 100 pound capacity. A 7 cubic foot forward luggage compartment, located just aft of the fire wall, is accessible through a 16 x 22 inch door on the right side of the fuselage. A 17.3 cubic foot aft compartment is located behind the fifth and sixth seats and is accessible through the cargo door on the aft side of the fuselage and during flight from inside the cabin.

An automatic forward baggage compartment light feature is available which utilizes a magnetic reed switch and a magnet for activation. The switch and magnet are mounted just above the hinge line of the forward baggage door.

Opening the baggage door fully, activates the switch which turns on the baggage compartment light. The baggage compartment light is independent of the aircraft master switch; therefore, the light will illuminate regardless of the position of the master switch. The baggage door should not be left open for extended time periods, as battery depletion could result.

An optional forward baggage door ajar annunciation system is available which senses baggage door latch pin position. Failing to latch the forward baggage door will illuminate an amber light located on the pilot's annunciator panel. The annunciation, when illuminated, is "BAGG DOOR AJAR" advising the pilot of this condition.

NOTE

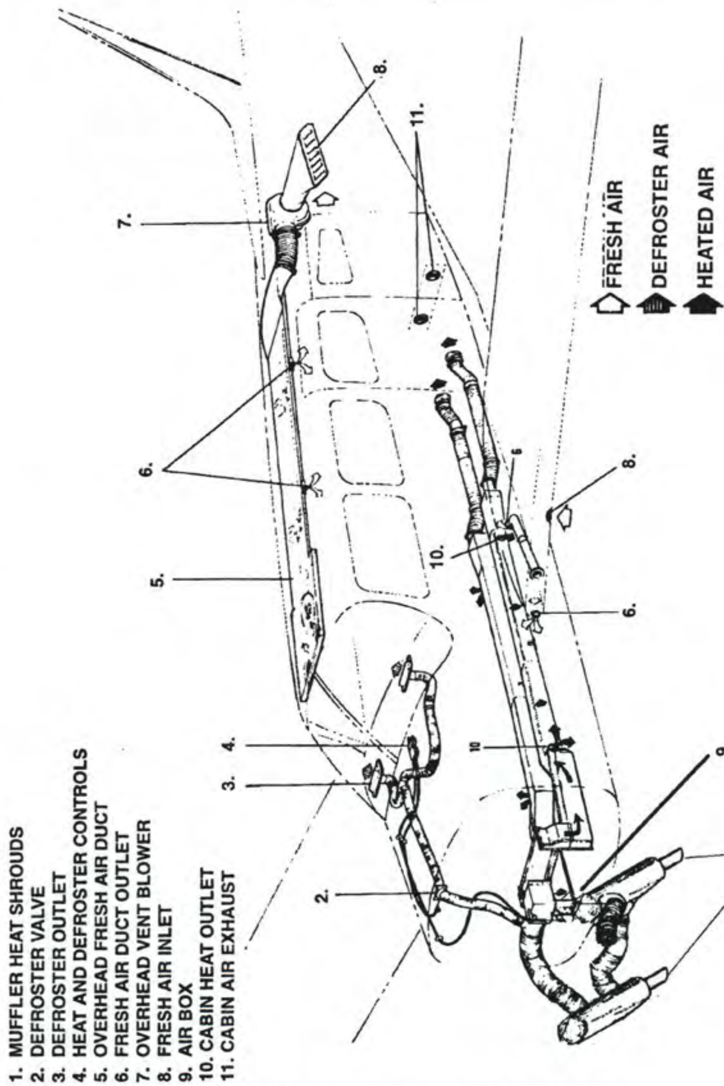
It is the pilot's responsibility to be sure when the baggage is loaded that the airplane's C.G. falls within the allowable C.G. range. (Refer to Weight and Balance Section.)

7.27 HEATING AND VENTILATING SYSTEM

Fresh air is ducted from a vent in the forward left lower cowling to the left heater muff by a flexible hose. It is then routed to the right heater muff by flexible hose Hot air from the right heater muff is routed through a flexible hose on the right side of the engine compartment, to the valve box mounted on the fire wall just above the tunnel cut out. It is then ducted down each side of the tunnel below the baggage floor to the cabin ducting and outlets (Figure 7-29).

CAUTION

When cabin heat is operated, heat duct surface becomes hot. This could result in burns if arms or legs are placed too close to heat duct outlets or surface.



HEATING AND VENTILATING SYSTEM
Figure 7-29

Defrost heat is bled off from the main flow at the heater muff and routed through flexible hose to a shut-off valve located to the right of center at the top of the fire wall. From this point, it is ducted to the defroster outlets.

Fresh air inlets are located in the leading edge of each wing and in the left side of the tail cone. Two adjustable outlets are located on each side of the cabin, one forward and one aft of the front seat near the floor. There are also adjustable outlets above each seat. In airplanes without air conditioning, an optional blower may be added to the overhead vent system to aid in the circulation of cabin air.

7.29 STALL WARNING

An approaching stall is indicated by a stall warning horn which is activated between five and ten knots above stall speed. Mild to moderate airframe buffeting may also precede the stall. Stall speeds are shown on graphs in the Performance Section. The stall warning horn emits a continuous sound. The landing gear warning horn is different in that it emits a 90 cycle per minute beeping sound. The stall warning horn is activated by lift detectors installed on the leading edge of the left wing. During preflight, the stall warning system should be checked by turning the master switch ON, lifting the detectors and checking to determine if the horn is actuated.

7.31 FINISH

All exterior surfaces are primed with etching primer and finished with acrylic lacquer. To keep the finish attractive looking, economy size spray cans of touch-up paint are available from Piper Dealers.

An optional polyurethane enamel finish is available.

7.33 AIR CONDITIONING*

The air conditioning system is a recirculating air system. The major components include an evaporator, a condenser, a compressor, a blower, switches and temperature control.

The evaporator is located behind the rear baggage compartment. This cools the air used for the air conditioning system.

*Optional equipment

The condenser is mounted on a retractable scoop located on the bottom of the fuselage and to the rear of the baggage compartment area. The scoop extends when the air conditioner is ON and retracts to a flush position when the system is OFF.

The compressor is mounted on the forward left underside of the engine. It has an electric clutch which automatically engages or disengages the compressor to the belt drive system of the compressor.

Air from the baggage area is drawn through the evaporator by the blower and distributed through an overhead duct to individual outlets located adjacent to each occupant.

The switches and temperature control are located on the lower right side of the instrument panel just above the circuit breaker panel. The temperature control regulates the temperature of the cabin. Turning the control clockwise increases cooling; counterclockwise decreases cooling.

The fan speed switch and the air conditioning ON-OFF switch are inboard of the temperature control. The fan can be operated independently of the air conditioning; however, the fan must be on for air conditioner operation. Turning either switch off will disengage the compressor clutch and retract the condenser door. Cooling air should be felt within one minute after the air conditioner is turned on.

NOTE

If the system is not operating in 5 minutes, turn the system OFF until the fault is corrected.

The fan switch allows operation of the fan with the air conditioner turned OFF to aid in cabin air circulation. "LOW" or "HIGH" can be selected to direct a flow of air through the air conditioner outlets in the overhead duct. These outlets can be adjusted or turned off individually.

The condenser door light is located in the annunciator panel and illuminates when the door is open and is off when the door is closed.

A circuit breaker on the circuit breaker panel protects the air conditioning electrical system.

Whenever the throttle is in the full forward position, it activates a micro switch which disengages the compressor and retracts the scoop. This allows maximum power and maximum rate of climb. The fan continues to operate and the air will remain cool for about one minute. When the throttle is retarded approximately 1/4 inch, the clutch will engage, the scoop will extend, and the system will again supply cool, dry air.

7.35 EXTERNAL POWER

An external receptacle located on the aft lower portion of the right hand side of the fuselage is provided as a source of external power. A 24 VDC external power source can be connected to the receptacle, thus allowing the operator to crank the engine without having to gain access to the airplane's battery.

7.37 EMERGENCY LOCATOR TRANSMITTER*

The Emergency Locator Transmitter (ELT), when installed, is located in the aft portion of the fuselage just below the stabilator leading edge and is accessible through a plate on the right side of the fuselage. This plate is attached with slotted-head nylon screws for ease of removal; these screws may be readily removed with a variety of common items, such as a dime, a key, a knife blade, etc. If there are no tools available in an emergency, the screw heads may be broken off by any means. The ELT is an emergency locator transmitter which meets the requirements of FAR 91.52.

A battery replacement date is marked on the transmitter. To comply with FAA regulations, the battery must be replaced on or before this date. The battery must also be replaced if the transmitter has been used in an emergency situation or if the accumulated test time exceeds one hour or if the unit has been inadvertently activated for an undetermined time period.

NOTE

If for any reason a test transmission is necessary, the test transmission should be conducted only in the first five minutes of any hour and limited to three audio sweeps. If the tests must be made at any other time, the tests should be coordinated with the nearest FAA tower or flight service station.

*Optional equipment

ARTEX 110-4 ELT OPERATION

On the ELT unit itself is a two position switch placarded ON and OFF. The OFF position is selected when the transmitter is installed at the factory and the switch should remain in that position whenever the unit is installed in the airplane.

A pilots remote switch, placarded ON and ARM is located on the pilot's lower left instrument panel to allow the transmitter to be armed or turned on from inside the cabin. The switch is normally in ARM position. Moving the switch to ON will activate the transmitter. A warning light located above the remote switch will alert you when ever the ELT is activated.

Should the ELT be activated inadvertently it can be reset by either positioning the remote switch to the ON then immediately relocating it to the ARM position, or by setting the switch on the ELT to ON and then back to OFF.

In the event the transmitter is activated by an impact, it can be turned off by moving the ELT switch to ON and then back to OFF. It may also be turned off and reset by positioning the remote switch to the ON and then immediately to the ARM position.

The transmitter can be activated manually at any time by placing either the remote switch or the ELT switch to the ON position.

NOTE:

Three sweeps of the emergency tone and an illuminated warning light indicates a normally functioning unit. The warning light must illuminate during the first 3 second test period. If it does not illuminate, a problem is indicated such as a "G" switch failure.

The ELT should be checked during postflight to make certain the unit has not been activated. Check by selecting 121.50 MHz on an operating receiver. If a downward sweeping audio tone is heard the ELT may have been activated. Set the remote switch to ON. If there is no change in the volume of the signal, your airplane's ELT is probably transmitting. Setting the remote switch back to OFF will automatically reset the ELT and should stop the signal being received on 121.50 MHz.

GARMIN Ltd. or its subsidiaries
c/o GARMIN International, Inc.
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Olathe, Kansas 66062 U.S.A.

FAA APPROVED AIRPLANE FLIGHT MANUAL SUPPLEMENT

GFC 500 Autopilot with ESP

Installed in

Piper PA-32(R) Series

Dwg. Number: 190-02291-27 Rev. 3

This Supplement must be attached to the FAA Approved Airplane Flight Manual when the GFC 500 Autopilot system is installed in accordance with STC SA01866WI. The information contained herein supplements the information of the basic Airplane Flight Manual. For Limitations, Procedures, and Performance information not contained in this Supplement consult the basic Pilot's Operating Handbook and FAA Approved Airplane Flight Manual.

Airplane Serial Number: ____________________

Airplane Registration Number: ____________________

FAA Approved By: Erik Frisk

Erik Frisk
ODA STC Unit Administrator
Garmin International, Inc
ODA-240087-CE

Date: 10-SEP-2020

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Log of Revisions

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REV NO.	PAGE NO(S)	DESCRIPTION	DATE OF APPROVAL	FAA APPROVED
1	ALL	Original Issue	07/30/2019	Erik Frisk Garmin ODA STC Unit Administrator
2	ALL	Various Procedure Updates	12/16/19	Robert G. Murray Garmin ODA STC Unit Administrator
3	ALL	Add GI 275 Information	See Cover	See Cover

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Table of Contents

SECTION 1 — GENERAL

The information in this supplement is FAA-approved material and must be attached to the Pilot's Operating Handbook and FAA Approved Airplane Flight Manual (POH/AFM) when the airplane has been modified by installation of the Garmin GFC 500 Autopilot system in accordance with Garmin International, Inc. approved data.

The information in this supplement supersedes or adds to the basic POH/AFM only as set forth below. Users of the manual are advised to always refer to the supplement for possibly superseding information and placarding applicable to operation of the airplane.

USE OF THE SUPPLEMENT

The following definitions apply to WARNINGS, CAUTIONS and NOTES found throughout the supplement:

WARNING

Operating procedures, techniques, etc., which may result in personal injury or loss of life if not carefully followed.

CAUTION

Operating procedures, techniques, etc., which may result in damage to equipment if not carefully followed.

NOTE

Operating procedures, techniques, etc., which is considered essential to emphasize.

ABBREVIATIONS AND TERMINOLOGY

The following glossary is applicable within the airplane flight manual supplement

AFCS	Automatic Flight Control System
AFM	Airplane Flight Manual
AFMS	Airplane Flight Manual Supplement
AGL	Above Ground Level
AHRS	Attitude and Heading Reference System
ALT	Altitude
AP	Autopilot
APR	Approach
ATC	Air Traffic Control
BC	Back Course Approach
CDI	Course Deviation Indicator
DA	Decision Altitude
DISC	Disconnect
DWG	Drawing
ESP	Electronic Stability and Protection
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FD	Flight Director
GA	Go Around
GFC 500	Garmin Autopilot
GMC 507	Autopilot Mode Control Panel
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GS	Glideslope
GSA	Garmin Servo Actuator
HDG	AFCS heading mode
IAS	Indicated Airspeed
ILS	Instrument Landing System
INT	Interrupt
KIAS	Knots Indicated Airspeed
LNAV	Lateral Navigation
LNAV+V	Lateral Navigation with Advisory Vertical Guidance
LNAV/VNAV	Lateral Navigation / Vertical Navigation Approach
LOC	Localizer (no glideslope available)
LP	Localizer Performance
LP+V	Localizer Performance with Advisory Vertical Guidance
LPV	Localizer Performance with Vertical Guidance
LVL	Level
MDA	Minimum Descent Altitude
PFT	Preflight Test
POH	Pilot’s Operating Handbook
STC	Supplemental Type Certificate
TO	Takeoff
TRK	Track
VHF	Very High Frequency
VNAV	Vertical Navigation
VOR	VHF Omni-directional Range
VS	Vertical Speed
YD	Yaw Damper

INSTALLED EQUIPMENT INTERFACES

The following is the list of installed equipment and functions associated with the GFC 500 Autopilot installation in this airplane.

Table 1-1: Table of Installed Equipment Interfaces

DEVICE TYPE	**Manufacturer / Model** If not installed, note N/A	**Additional Information**
GPS Navigator #1		Is Navigator #1 interfaced to GFC 500? ☐ YES ☐ NO
VHF Nav Radio #1		Is VHF Nav Radio #1 interfaced to GFC 500? ☐ YES ☐ NO
VHF Nav Radio #2		
Pitch Trim Servo		
Yaw Damper		

INSTALLED FEATURES CHECKLIST

The checked autopilot modes and features are available on this aircraft.

Basic AP Features

- ☒ Flight Director
- ☐ Electric Pitch Trim
- ☐ Yaw Damper
- ☒ Overspeed Protection
- ☒ Underspeed Protection

Vertical Autopilot Modes

- ☒ Pitch (PIT)
- ☒ Level (Zero vertical speed)
- ☒ Go Around (GA)
- ☒ Altitude Hold (ALT)
- ☒ Vertical Speed (VS)
- ☒ Altitude Capture via Altitude Preselect
- ☒ Indicated Airspeed (IAS)
- ☐ Vertical Navigation (VNAV)
- ☐ GPS Approach Glidepath
- ☐ ILS Glideslope

Electronic Stability and Protection

- ☒ Pitch/Roll Attitude
- ☒ High Speed Protection
- ☐ Low Speed Protection

Lateral Autopilot Modes

- ☒ Roll (ROL)
- ☒ Level (Wings Level)
- ☒ Go Around (GA)
- ☐ Heading
- ☒ Track
- ☐ GPS Navigation
- ☐ VHF Navigation
- ☐ Approach Mode
    - ☐ GPS
    - ☐ VOR/LOC

SECTION 2 — LIMITATIONS

The Garmin G5 Electronic Flight Instrument Pilot's Guide for Certified Aircraft, part number 190-01112-12 Rev C (or later approved revisions), must be immediately available to the flight crew (when G5 is installed).

The Garmin G3X Touch Pilot's Guide for Certified Aircraft, part number 190-02472-00, Rev A (or later approved revisions) must be immediately available to the flight crew (when G3X EFIS system is installed).

The Garmin GI 275 Pilot's Guide for Certified Aircraft, part number 190-02246-01, Rev B (or later approved revisions) must be immediately available to the flight crew (when GI 275 system is installed).

This AFMS is applicable to the software versions shown below:

Software Item	Software Version (or later FAA Approved version for this STC)
G5 Software Version	6.40
G3X Software Version	8.30
GI 275 Software Version	2.11

A pilot must be seated in the left pilot's seat, with seatbelt fastened, during all autopilot operations.

Do not use autopilot or yaw damper during takeoff and landing.

The GFC 500 AFCS preflight test must complete successfully prior to use of the autopilot or flight director.

The maximum fuel imbalance with the autopilot engaged is 15 gallons.

Autopilot maximum engagement speed is 187 KIAS.

Autopilot minimum engagement speed is 71 KIAS.

The autopilot must be disengaged below 200 feet AGL during approach operations.

The autopilot must be disengaged below 800 feet AGL for all operations other than approach operations.

The GFC 500 autopilot is approved for Category 1 precision approaches and non-precision approaches only.

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SECTION 3 — EMERGENCY PROCEDURES

Some emergency situations require immediate memorized corrective action. These steps are printed in bold in the emergency procedures and should be accomplished without the aid of the checklist.

AUTOPILOT MALFUNCTION / PITCH TRIM RUNAWAY

If the airplane deviates unexpectedly from the planned flight path:

1. **Control Wheel .... GRIP FIRMLY**
2. **AP DISC / TRIM INT Button .... PRESS AND HOLD**

CAUTION

Be prepared for high elevator control forces.

3. **Aircraft Attitude .... MAINTAIN / REGAIN AIRCRAFT CONTROL**
4. Elevator Trim .... RE-TRIM if necessary using Elevator Trim Control Wheel
5. Autopilot Circuit Breaker .... PULL

NOTE

Do not release the AP DISC / TRIM INT Button until after pulling the autopilot Circuit Breaker.

Pulling the autopilot circuit breaker will render the autopilot, yaw damper (if installed), and ESP inoperative.

6. AP DISC / TRIM INT Button .... RELEASE

WARNING

In flight, do not overpower the autopilot. The trim will operate in the direction opposing the overpower force, which will result in large out-of-trim forces.

Do not attempt to re-engage the autopilot or use manual electric pitch trim until the cause of the malfunction has been corrected.

AUTOPILOT FAILURE / ABNORMAL DISCONNECT

(Red AP in autopilot status box on display, continuous aural disconnect tone.)

1. AP DISC / TRIM INT Button or:
   - G5 Knob
   - G3X Autopilot Status bar
   - GI 275 Knob or Autopilot Status Button......................................PRESS AND RELEASE (to cancel disconnect tone)
2. Aircraft Attitude.. MAINTAIN / REGAIN AIRCRAFT CONTROL

NOTE

The autopilot disconnect may be accompanied by a red AFCS in the autopilot status box, indicating the Automatic Flight Control System has failed. The flight director will not be available and the autopilot cannot be re-engaged with this annunciation present.

If the disconnect is accompanied by an amber AP with a red X, the autopilot will not be available. However, the flight director will still be functional.

In the event of a GMC failure, pressing the G5 knob, GI 275 knob or autopilot status button, or G3X Autopilot Status bar will acknowledge the disconnect tone.

YAW AXIS FAILURE / ABNORMAL YAW DAMPER DISCONNECT

(Red YD in autopilot status box on display)

This procedure applies only if the optional yaw servo is installed:

1. AP DISC / TRIM INT Button, YD Button on GMC, G5 Knob, G3X Autopilot Status Bar, or GI 275 Knob or Autopilot Status Button..PRESS AND RELEASE (to acknowledge the disconnect)
2. Aircraft Attitude.. MAINTAIN / REGAIN AIRCRAFT CONTROL

NOTE

The yaw damper disconnect may be accompanied by an amber YD with a red X in the autopilot status box. The YD is inoperative and will not be available. The autopilot may be re-engaged and disengaged normally, but the yaw damper will remain inoperative.

PITCH TRIM FAILURE

(Red PTRIM on G5, G3X, or GI 275 display)

This procedure applies only if the optional pitch trim servo is installed:

1. Indicates a failure of the pitch trim servo.
2. Control Wheel .... GRIP FIRMLY
3. AP DISC / TRIM INT Button... PRESS and RELEASE (Be prepared for high elevator control forces)
4. Elevator Trim..................................AS REQUIRED USING ELEVATOR TRIM CONTROL WHEEL

NOTE

The autopilot may be re-engaged. Refer to the normal procedures section of this AFMS, MANUAL PITCH TRIM WITH AUTOPILOT ENGAGED.

5. Yaw Damper ....ENGAGE AS REQUIRED

ESP ACTIVATION

1. **Throttle .... AS REQUIRED**
2. **Aircraft Attitude .... MAINTAIN / REGAIN AIRCRAFT CONTROL**

NOTE

If ESP is active for approximately 10 seconds, the autopilot will automatically engage in LVL mode, an aural 'ENGAGING AUTOPILOT' will be played (or a Sonalert tone will sound for installations without a supported audio panel), and the autopilot will roll the wings level and fly at zero vertical speed. Refer to Section 7, System Description for further information.

ESP will be disabled by pressing and holding the AP DISC / TRIM INT button. Releasing the button will allow ESP to function.

OVERSPEED PROTECTION (MAXSPD)

(MAXSPD displayed on G5, GI 275, or G3X, AIRSPEED – AIRSPEED Aural sounds)

1. **Throttle .... REDUCE**
2. **Aircraft Attitude and Altitude .... MONITOR**

After overspeed condition is corrected*:*

3. Autopilot .... RESELECT VERTICAL AND LATERAL MODES (if necessary)
4. Throttle .... ADJUST as necessary

NOTE

Overspeed protection mode provides a pitch up command to decelerate the airplane to or below the maximum autopilot operating speed.

UNDERSPEED PROTECTION (MINSPD)

(MINSPD displayed on G5, GI 275, or G3X, AIRSPEED – AIRSPEED Aural sounds)

1. **Throttle .... INCREASE POWER AS REQUIRED TO CORRECT UNDERSPEED**
2. **Aircraft Attitude and Altitude .... MONITOR**

After underspeed condition is corrected:

3. Autopilot .... RESELECT VERTICAL AND LATERAL MODES (if necessary)
4. Throttle .... ADJUST as necessary

NOTE

Autopilot Underspeed Protection Mode provides a pitch down command to maintain 71 KIAS.

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SECTION 3A – ABNORMAL PROCEDURES

AUTOPILOT PRE-FLIGHT TEST FAIL

(Amber AP with a red X in G5, GI 275, or G3X autopilot status box)

1. Indicates the AFCS system failed the automatic Pre-Flight test.

NOTE

The autopilot, yaw damper (if installed), ESP, and electric elevator trim will be inoperative.

LOSS OF NAVIGATION INFORMATION

This procedure applies only if the optional GPS and/or VHF navigator is installed:

(Amber GPS, VOR, LOC, or BC flashes for 10 seconds on G5, GI 275, or G3X.)

NOTE

If a navigation signal is lost while the autopilot is tracking it, the autopilot will roll the aircraft wings level and default to roll mode (ROL).

1. GMC 507 Mode Panel.. SET desired heading and SELECT HDG mode
2. NAV Source .... SELECT a valid NAV source
3. NAV Key..PRESS

If on an instrument approach at the time the navigation signal is lost:

4. Missed Approach Procedure.. EXECUTE (as necessary)

LOSS OF AIRSPEED DATA

(Red X through airspeed tape on the G5, GI 275, or G3X display, amber AP with a red X in autopilot status box)

NOTE

If airspeed data is lost while the autopilot is tracking airspeed, the flight director will default to pitch mode (PIT).

1. AP DISC / TRIM INT Button...PRESS AND RELEASE (to cancel disconnect tone)
2. Aircraft Attitude... MAINTAIN / REGAIN AIRCRAFT CONTROL
3. Manual Elevator Trim .... TRIM as required

NOTE

The autopilot cannot be re-engaged. The flight director will be available however IAS mode cannot be selected. Loss of airspeed will be accompanied by a red PTRIM indication on the G5, GI 275, or G3X (if a pitch trim servo is installed).

LOSS OF ALTITUDE DATA

(Red X through altitude tape on the G5, GI 275, or G3X display)

NOTE

If altitude data is lost while the autopilot is tracking altitude, the autopilot will default to pitch mode (PIT).

1. Autopilot .... SELECT different vertical mode

LOSS OF GPS INFORMATION

This procedure applies only if the optional GPS navigator is installed:

(GPS position information is lost to the autopilot.)

NOTE

If GPS position data is lost while the autopilot is tracking a GPS, VOR, LOC or Back Course the autopilot will default to roll mode (ROL). The autopilot will default to pitch mode (PIT) if GPS information is lost while tracking an ILS. The autopilot uses GPS aiding in VOR, LOC and BC modes.

1. Autopilot .... SELECT different lateral and/or vertical mode (as necessary)

If on an instrument approach:

1. AP DISC / TRIM INT button ....PRESS, Continue the approach manually

   Or

2. Missed Approach Procedure... EXECUTE (as necessary)

HEADING DATA SOURCE FAILURE

This procedure applies only if the optional heading source to the navigator is installed:

1. Autopilot .... SELECT different lateral mode (as necessary)

NOTE

Track information will be displayed on the G5, GI 275, or G3X.

GPSS will not be provided to the autopilot for heading legs.

ELEVATOR MISTRIM

(Amber TRIM UP or TRIM DOWN displayed on the G5, GI 275, or G3X)

This annunciation indicates a mistrim of the elevator while the autopilot is engaged. If an optional pitch trim servo is installed, the autopilot will normally trim the airplane as required. However, during rapid acceleration, deceleration, configuration changes, or near either end of the elevator trim limits, momentary illumination of this message may occur. If the autopilot is disconnected while this message is displayed, high elevator control forces are possible.

If the optional pitch trim servo is NOT installed:

1. Refer to the Normal Procedures section of this AFMS, MANUAL PITCH TRIM WITH AUTOPILOT ENGAGED.

If the optional pitch trim servo is installed:

WARNING

Do not attempt to overpower the autopilot in the event of a pitch mistrim. The autopilot servo will oppose pilot input and will cause pitch trim to run opposite the direction of pilot input. This will lead to a significant out-of-trim condition, resulting in large control wheel force when disengaging the autopilot.

NOTE

Momentary display of the TRIM UP or TRIM DOWN message during configuration changes or large airspeed changes is normal.

1. Control Wheel .... GRIP FIRMLY

WARNING

Be prepared for significant sustained control forces in the direction of the mistrim annunciation. For example, TRIM DOWN indicates nose down control wheel force will be required upon autopilot disconnect.

2. AP DISC / TRIM INT Button..PRESS AND RELEASE
3. Manual Elevator Trim .... RE-TRIM as required

NOTE

Electric pitch trim should be considered inoperative until the cause of the mistrim has been investigated and corrected.

YAW DAMPER DISCONNECT

(Amber YD displayed in autopilot status box on display)

This failure will only occur if the optional yaw servo is installed.

1. YD Button on GMC or G5 Knob..PRESS AND RELEASE (to cancel disconnect tone)
2. Aircraft Attitude... MAINTAIN / REGAIN AIRCRAFT CONTROL

NOTE

A flashing amber 'YD' in the autopilot status box indicates that the yaw damper has disconnected. If the disconnect was not pilot initiated, Refer to Section 3 – Emergency Procedures, YAW AXIS FAILURE / ABNORMAL DISCONNECT, for further information.

SECTION 4 — NORMAL PROCEDURES

GFC 500 POWER UP

During the preflight test the G5, GI 275, or G3X will display PFT in the autopilot status box. When the GFC 500 passes preflight test, PFT will be removed from the autopilot status box.

FLIGHT DIRECTOR / AUTOPILOT NORMAL OPERATING PROCEDURES

Autopilot/Flight Director mode annunciations are displayed at the top of the G5 Electronic Flight Instrument, at the top of the G3X Electronic Flight Instrument System PFD, or at the bottom of the GI 275 Electronic Flight Instrument ADI. Green text indicates active autopilot/flight director modes. Armed modes are indicated in white text. Normal mode transitions will flash inverse video for 10 seconds before becoming steady. Abnormal mode transitions will flash for 10 seconds in amber text before the default mode is annunciated as the active mode in green text. Default autopilot/flight director modes are Roll (ROL) and Pitch (PIT) modes.

The autopilot status box displays the autopilot engagement status as well as armed and active flight director modes.

Autopilot Engagement with Flight Director Off — Upon engagement, the autopilot will be set to hold the current attitude of the airplane if the flight director was not previously on. In this case, ‘ROL’ and ‘PIT’ will be annunciated.

Autopilot Engagement with Flight Director On — If the flight director is on, the autopilot will smoothly pitch and roll the airplane to capture the FD command bars. The prior flight director modes remain unchanged.

Autopilot Disengagement — The most common way to disconnect the autopilot is to press and release the AP DISC / TRIM INT button located on the control wheel. An autopilot disconnect tone will sound and an amber AP will be annunciated on the G5, GI 275, or G3X autopilot status box. If the optional yaw damper is installed, the AP DISC / TRIM INT button will also disconnect the yaw damper, and a disconnect tone will sound and an amber YD will be annunciated on the G5, GI 275, or G3X autopilot status box.

Other ways to disconnect the autopilot include:

– Pressing the AP Key on the GMC 507 Mode Controller. If the optional yaw damper is installed, it will remain engaged until the YD Key is pressed, or the red AP DISC / TRIM INT button is pressed.

– Operating the Electric Pitch Trim Switch (located on the control wheel). If the optional yaw damper is installed, it will remain engaged until the YD Key is pressed, or the red AP DISC / TRIM INT button is pressed.

– Pulling the autopilot circuit breaker.

In the event of unexpected autopilot behavior, pressing and holding the AP DISC / TRIM INT button will disconnect the autopilot and remove all power to the servos.

Yaw Damper Engagement with Autopilot On –- Upon engagement of the autopilot, if the yaw damper is installed, it will automatically engage to provide yaw damping, and turn coordination. YD will be annunciated in the autopilot status box.

Yaw Damper Engagement with Autopilot Off –- The yaw damper, if installed, may be engaged with the autopilot disengaged. This will provide yaw damping and turn coordination. YD will be annunciated in the autopilot status box.

MANUAL AUTOPILOT DISCONNECT

If necessary, the autopilot may be manually disconnected using any one of the following methods:

1. AP DISC / TRIM INT Button.. PRESS and RELEASE (Pilot's control wheel)
2. AP Key ....PRESS
3. Pitch Trim Switch .... ACTIVATE
4. Autopilot Circuit Breaker ....PULL

VERTICAL MODES

VERTICAL SPEED (VS) MODE

1. Altitude Preselect .... SET to Desired Altitude
2. VS Key ....PRESS, autopilot synchronizes to the airplane's current vertical speed
3. Vertical Speed Reference ....ADJUST using UP / DN Wheel
4. Green ALT... VERIFY Upon Altitude Capture

INDICATED AIRSPEED (IAS) MODE

1. Altitude Preselect .... SET to Desired Altitude
2. Press IAS Key, autopilot synchronizes to the airplane's current indicated airspeed.
3. AIRSPEED Reference ....ADJUST using UP / DN Wheel
4. Throttle .... ADJUST, INCREASE POWER to climb DECREASE POWER to descend
5. Green ALT... VERIFY Upon Altitude Capture

ALTITUDE HOLD (ALT) MODE, MANUAL CAPTURE

1. When at the desired altitude ....PRESS ALT key

NOTE

If climbing or descending at a high rate when the ALT key is pressed, the airplane will overshoot the reference altitude and then return to it. The amount of overshoot will depend on the vertical speed when the ALT key is pressed.

The altitude reference is displayed in the autopilot status box. The reference may be changed by +/- 200 FT using the UP / DN wheel.

VERTICAL NAVIGATION (VNAV)

1. Navigation Source .... SELECT CDI to GPS
2. Vertical Navigation Profile .... LOAD into the GPS navigator's flight plan
3. Altitude Preselect .... SET to the vertical clearance limit

   When ATC clearance received.
4. GMC 507 Mode Panel .... PRESS VNAV

NOTE

Vertical navigation will not function for the following conditions:

- Selected navigation source is not GPS navigation. VNAV will not function if the navigation source is VOR or Localizer.
- VNAV is not enabled on the GPS Navigator
- If the altitude preselect is not set below the current aircraft altitude.
- No waypoints with altitude constraints in the flight plan
- Glideslope or Glidepath is the active flight director pitch mode.
- OBS mode is active
- Dead Reckoning mode is active
- Parallel track is active
- Aircraft is on the ground

Vertical navigation is not available between the final approach fix (FAF) and the missed approach point (MAP)

ALTV will be the armed vertical mode during the descent if the altitude preselect is set to a lower altitude than the VNAV reference altitude. This indicates the autopilot / flight director will capture the VNAV altitude reference. ALTS will be the armed mode during the descent if the altitude preselect is set at or above the VNAV reference altitude, indicating that the autopilot / flight director will capture the altitude preselect altitude reference.

GO AROUND

1. GO AROUND button .... PRESS – Verify GA / GA on G5, GI 275, or G3X (autopilot will not disengage)
2. Autopilot (if engaged) .... VERIFY airplane pitches up following flight director command bars
3. Throttle .... APPLY Go Around power
4. GMC 507 Mode Panel.................................... PRESS NAV to couple to selected navigation source
   OR
   PRESS HDG to Fly ATC Assigned Missed Approach Heading
5. Altitude Preselect .... VERIFY
   Set to appropriate altitude.

NOTE

The pilot is responsible for initial missed approach guidance in accordance with published procedure. When the GA button is pressed the Flight Director command bars will command go-around pitch attitude and wings level. The pilot must set Go Around power, then select the CDI to the appropriate navigation source and select the desired lateral and vertical flight director modes.

MANUAL PITCH TRIM WITH AUTOPILOT ENGAGED

(Amber TRIM UP or TRIM DOWN displayed on G5, GI 275, or G3X)

NOTE

If the aircraft is not equipped with a pitch trim servo, the pilot must manually adjust the pitch trim when airspeed and aircraft configuration changes are made.

A message will be displayed on the G5, GI 275, or G3X display to indicate the pitch servo is holding sustained force, and the pilot must manually trim the aircraft.

1. If TRIM UP message is displayed .... MANUALLY TRIM nose up
2. If TRIM DOWN message is displayed .... MANUALLY TRIM nose down

LATERAL MODES

HEADING MODE (HDG)

1. HDG/TRK Knob..Rotate to set heading bug to desired heading.
2. HDG Key ....PRESS
   The autopilot will turn the airplane in the direction of the heading bug.

TRACK MODE (TRK)

1. HDG/TRK Knob..Rotate to set track bug to desired track.
2. TRK Key..PRESS
   The autopilot will turn the airplane in the direction of the track bug.

NAVIGATION (VOR)

This mode will only be available if the optional VHF navigator is installed.

1. Navigation Source. ....SELECT CDI to VHF NAV
   Tune and identify the station frequency.
2. Course Pointer ....SET CDI to the Desired Course
3. Intercept Heading .... ESTABLISH in HDG, TRK or ROL mode
4. NAV Key..PRESS

NOTE

If the Course Deviation Indicator (CDI) is greater than one dot from center, the autopilot will arm the VOR mode when the NAV key is pressed. The pilot must ensure that the current heading will result in a capture of the selected course. If the CDI is one dot or less from center, the autopilot will enter the capture mode when the NAV key is pressed.

NAVIGATION (GPS)

This mode will only be available if the optional GPS navigator is installed.

1. Navigation Source..SELECT CDI to GPS
2. Waypoint .... SELECT on Navigation Source
3. Course Pointer ....VERIFY CDI set to the Desired Course
4. Intercept Heading..ESTABLISH in HDG or ROL mode
5. NAV Key..PRESS

NOTE

If the Course Deviation Indicator (CDI) is greater than one dot from center, the autopilot will arm the GPS mode. The pilot must ensure that the current heading will result in a capture of the selected course. If the CDI is one dot or less from center, the autopilot will enter the capture mode when the NAV key is pressed.

APPROACHES

ILS APPROACH

This mode will only be available if the optional VHF and GPS navigator is installed.

1. Navigation Source...SELECT CDI to VHF Nav
   Tune and Identify an ILS station frequency.
2. CDI .... SET to front LOC course

NOTE

Ensure that the current heading will result in a capture of the selected course prior to the final Approach Fix.

3. APR Key.. PRESS, verify LOC and GS ARMED
4. LOC and GS Mode..VERIFY airplane Captures and Tracks LOC and GS
5. Missed Approach Altitude .... SET in Altitude preselect.

At Decision Altitude (DA),

6. AP DISC / TRIM INT button .... PRESS, Continue visually for a normal landing

   Or

7. GO AROUND (GA) button ....PRESS, Execute Missed Approach Procedure
8. Apply GA power.

NOTE

Pressing the GA button will not disconnect the autopilot. Select NAV or HDG mode to fly the missed approach procedure.

If the Course Deviation Indicator (CDI) is greater than half scale deflection, the autopilot will arm the LOC mode. The pilot must ensure that the current heading will result in a capture of the selected course. If the CDI is within half scale deflection, the autopilot will enter the capture mode when the APR key is pressed.

When the selected navigation source is an ILS, glideslope coupling is automatically armed when the APR key is pressed. The glideslope cannot be captured until the localizer is captured. The autopilot can capture the glideslope from above or below the glideslope.

LOC APPROACH (GS out)

This procedure applies only if the optional VHF and GPS navigator is installed:

1. Navigation Source .... SELECT CDI to VHF Nav
   Tune and Identify an ILS station frequency.
2. Course Pointer .... SET to front LOC course

NOTE

Ensure that the current heading will result in a capture of the selected course.

3. NAV Key.. PRESS, verify LOC ARMED
4. LOC Mode... VERIFY airplane Captures and Tracks LOC Course
5. Altitude Preselect ....SET to next required step-down altitude
6. Missed Approach Altitude ....SET when in ALT mode at the MDA

At Missed Approach Point,

7. AP DISC / TRIM INT button .... PRESS, Continue visually for a normal landing

   Or

8. GO AROUND (GA) button ....PRESS, Execute Missed Approach Procedure
9. Apply GA power.

NOTE

Pressing the GA button will not disconnect the autopilot. Select NAV or HDG mode to fly the missed approach procedure.

GPS APPROACH (LPV, LNAV/VNAV, LP+V, or LNAV+V)

This procedure applies only if the optional GPS navigator is installed:

1. Navigation Source .... SELECT CDI to GPS
2. Course Pointer ....VERIFY CDI set to the Desired Course

NOTE

Ensure that the current heading will result in a capture of the selected course.

3. APR Key.. PRESS, verify GPS and GP ARMED
4. GPS and GP Mode ....VERIFY airplane Captures and Tracks GPS and GP
5. Missed Approach Altitude ....SET after GP capture
6. ALT Key ....PRESS to level off at the MDA for a LP+V or LNAV+V approach

At DA (LPV or LNAV/VNAV approach), or MDA and Missed Approach Point (LP+V or LNAV+V),

7. AP DISC / TRIM INT button .... PRESS, Continue visually for a normal landing

   Or

8. GO AROUND (GA) button ....PRESS, Execute Missed Approach Procedure
9. Apply GA power.

NOTE

Pressing the GA button will not disconnect the autopilot. Select NAV or HDG mode to fly the missed approach procedure.

GPS APPROACH (LP, LNAV)

This procedure applies only if the optional GPS navigator is installed:

1. Navigation Source... SELECT GPS on the CDI
2. Course Pointer ....VERIFY CDI set on the Desired Course

NOTE

Ensure that the current heading will result in a capture of the selected course.

3. NAV Key.. PRESS, verify GPS ARMED
4. GPS Mode... VERIFY airplane Captures and Tracks GPS Course
5. Altitude Preselect ....SET to next required step-down altitude
6. Missed Approach Altitude ....SET when in ALT mode at the MDA

At Missed Approach Point,

7. AP DISC / TRIM INT button .... PRESS, Continue visually for a normal landing

   Or

8. GO AROUND (GA) button ....PRESS, Execute Missed Approach Procedure
9. Apply GA power.

NOTE

Pressing the GA button will not disconnect the autopilot. Select NAV or HDG mode to fly the missed approach procedure.

LOC BC APPROACH

This procedure applies only if the optional VHF and GPS navigator is installed:

1. Navigation Source. .... SELECT CDI to VHF Nav
   Tune and Identify an ILS station frequency
2. Course Pointer .... SET CDI to LOC Front Course

NOTE

Ensure that the current heading will result in a capture of the selected course.

3. NAV Key .... PRESS, verify BC ARMED
   (when heading is within 75 degrees of Back Course)
4. BC Mode .... VERIFY airplane Captures and Tracks Back Course
5. Altitude Preselect .... SET to next required step down altitude
6. Missed Approach Altitude .... SET when in ALT mode at the MDA

At Missed Approach Point:

7. AP DISC / TRIM INT button .... PRESS, Continue visually for a normal landing

   Or

8. GO AROUND (GA) button .... PRESS, Execute Missed Approach Procedure
9. Apply GA power.

NOTE

Pressing the GA button will not disconnect the autopilot. Select NAV or HDG mode to fly the missed approach procedure.

VOR APPROACH

This procedure applies only if the optional VHF navigator is installed:

1. Navigation Source. .... SELECT CDI to VHF Nav
   Tune and identify the station frequency
2. Course Pointer .... SET CDI to the Desired Course

NOTE

Ensure that the current heading will result in a capture of the selected course.

3. NAV Key.. PRESS, verify VOR ARMED
4. VOR Mode .... VERIFY airplane Captures and Tracks VOR Course
5. Altitude Preselect .... SET to next required step-down altitude
6. Missed Approach Altitude .... SET when in ALT mode at the MDA

At Missed Approach Point,

7. AP DISC / TRIM INT button .... PRESS, Continue visually for a normal landing

   Or

8. GO AROUND (GA) button .... PRESS, Execute Missed Approach Procedure
9. Apply GA power.

NOTE

Pressing the GA button will not disconnect the autopilot. Select NAV or HDG mode to fly the missed approach procedure.

DISABLING ESP

ESP can be disabled on the G5 attitude indicator with the following procedure. ESP will default to “Enabled” on the next power cycle.

1. G5 Knob. .... PRESS
2. ESP .... SELECT
3. G5 Knob .... PRESS

ESP can be disabled on the G3X with the following procedure. ESP will default to “Enabled” on the next power cycle.

1. Autopilot Status Box .... TOUCH
2. ESP Button .... TOUCH
3. Back Button .... PRESS

ESP can be disabled on the GI 275 with the following procedure. ESP will default to “Enabled” on the next power cycle.

1. GI 275 Knob .... PRESS and HOLD
2. Options .... SELECT
3. ESP Button .... SELECT
4. Back Button .... PRESS and HOLD

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SECTION 5 — PERFORMANCE

No Change.

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SECTION 6 — WEIGHT AND BALANCE

No change to loading information. Refer to current weight and balance report and equipment list for changes to empty weight/moment and installed equipment.

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SECTION 7 — SYSTEM DESCRIPTION

AFCS OVERVIEW

The GFC 500 is a digital Automatic Flight Control System (AFCS). It is a two-axis autopilot, with optional 3rd axis yaw damper, and flight director system which provides the pilot with the following features:

G5 Outputs to Autopilot — The G5 flight instrument (when installed) provides attitude, rate, and acceleration information to the servos. Additionally, indicated airspeed, vertical speed, pressure altitude and GPS information are sent to the autopilot for mode control.

G3X Outputs to Autopilot — The G3X electronic flight instrument system provides attitude, rate, and acceleration information to the servos. Additionally, indicated airspeed, vertical speed, pressure altitude and GPS information are sent to the autopilot for mode control.

GI 275 Outputs to Autopilot — The GI 275 electronic flight instrument system provides attitude, rate, and acceleration information to the servos. Additionally, indicated airspeed, vertical speed, pressure altitude and GPS information are sent to the autopilot for mode control.

Flight Director (FD) — The flight director processing occurs in the G5, GI 275, or G3X instrument. Selected modes for the flight director are displayed on the G5, GI 275, or G3X autopilot status box.

The flight director provides:

- Command Bars showing pitch/roll guidance
- Vertical / lateral mode selection and processing

Autopilot (AP) — Autopilot operation occurs within the pitch, roll, and optional pitch trim servo. It also provides servo monitoring, and automatic flight control in response to flight director steering commands, attitude and rate information, and airspeed.

Optional Electric Pitch Trim — The pitch trim servo provides manual electric pitch trim capability when the autopilot is not engaged. The trim servo provides automatic pitch trim when the autopilot is engaged and the airplane is in the air. Automatic trim functionality is disabled on the ground.

Optional Yaw Damper (YD) — The yaw servo provides Dutch roll damping and turn coordination in response to yaw rate, roll angle, lateral acceleration, and airspeed.

GMC 507 — Pilot commands to the autopilot and flight director are entered through the GMC 507 autopilot mode panel. The GMC 507 contains internal sensors which calculate the aircraft attitude, attitude rate and accelerations. These inertial sensors are completely independent from the sensors within the G5, GI 275, or G3X and the rest of the autopilot system, and are not used for the flight director, autopilot, or ESP functions. They are used solely to provide independent monitoring of the GFC 500.

Airspeed and Altitude Information — The GFC 500 requires airspeed and altitude information from the G5 instrument or G3X system.

Other components of the AFCS include the GSA 28 pitch, roll, and optional pitch trim servo, optional yaw servo, that also contain autopilot processors, control wheel mounted elevator trim switch (if trim servo is installed), control wheel mounted autopilot / yaw damper disconnect and trim interrupt button (AP DISC / TRIM INT), and a Go-Around (GA) button.

Underspeed Protection (USP) — The GFC 500 will provide Underspeed Protection when the autopilot is engaged.

When 71 KIAS is reached, a visual MINSPD message will appear above the airspeed tape and the autopilot will lower the nose to maintain 71 KIAS. An aural “AIRSPEED, AIRSPEED” voice alert will sound for installations connected to an audio panel.

Underspeed Protection is exited automatically when airspeed exceeds 76 KIAS.

Overspeed Protection (OSP) — The GFC 500 will provide Overspeed Protection when the autopilot is engaged.

When the maximum airspeed of 187 KIAS is reached, visual MAXSPD message will appear above the airspeed tape and the autopilot will raise the nose of the aircraft to avoid exceeding the maximum configured airspeed. An aural "AIRSPEED, AIRSPEED" voice alert will sound for installations connected to an audio panel.

Overspeed Protection is exited automatically when airspeed is reduced below 188 KIAS.

Coupled Go-Around — Pressing the GA button will not disengage the autopilot. Instead, the autopilot will attempt to capture and track the flight director command bars. If insufficient airplane performance is available to follow the commands, the autopilot will enter Underspeed Protection mode at the minimum airspeed.

Electronic Stability and Protection (ESP) — The GFC 500 will provide Electronic Stability and Protection when the autopilot is not engaged.

Electronic Stability and Protection uses the autopilot servos to assist the pilot in maintaining the airplane in a safe flight condition within the airplane's normal pitch, roll and airspeed envelopes.

Electronic Stability and Protection is invoked when the pilot allows the airplane to exceed one or more conditions beyond normal flight defined below:

- Pitch attitude beyond normal flight (+20°, -15°)
- Roll attitude beyond normal flight (45°)
- High airspeed beyond normal flight (above 198 KIAS)
- Low airspeed below normal flight (below 71 KIAS)

The conditions that are required for ESP to be available are:

- Pitch and Roll servos available
- Autopilot not engaged
- The GPS altitude above ground is more than 200 feet (for low airspeed mode)
- Aircraft is within the autopilot engagement envelope (+/-50° in pitch and +/-75° in roll)

Protection for excessive Pitch, Roll, and Airspeed is provided when the limit thresholds are first exceeded, which engages the appropriate servo in ESP mode at a nominal torque level to bring the airplane back within the normal flight envelope. If the airplane deviates further from the normal flight envelope, the servo torque will increase until the maximum torque level is reached in an attempt to return the airplane into the normal flight envelope. Once the airplane returns to within the normal flight envelope, ESP will deactivate the autopilot servos.

When the normal flight envelope thresholds have been exceeded for more than 10 seconds, ESP Autolevel Mode is activated. Autolevel Mode engages the autopilot to bring the airplane back into straight and level flight based on 0° roll angle and 0 FPM vertical speed. An aural "ENGAGING AUTOPILOT" alert (or a Sonalert tone) sounds and the Flight Director mode annunciation will indicate LVL for the pitch and roll modes.

Anytime an ESP mode is active, the pilot can interrupt ESP by using the Autopilot Disconnect (AP DISC / TRIM INT) switch, or simply override ESP by overpowering the autopilot servos. The pilot may also disable ESP through a G5, GI 275, or G3X menu option.

The engagement and disengagement attitude limits are displayed with double hash marks on the roll indicator according to the airplane attitude and whether or not ESP is active in roll. When ESP is inactive (roll attitude within nominal limits) only the engagement limit indications are displayed in order to reduce clutter on the roll indicator.

Display symbology implemented for ESP is illustrated in the following figures.

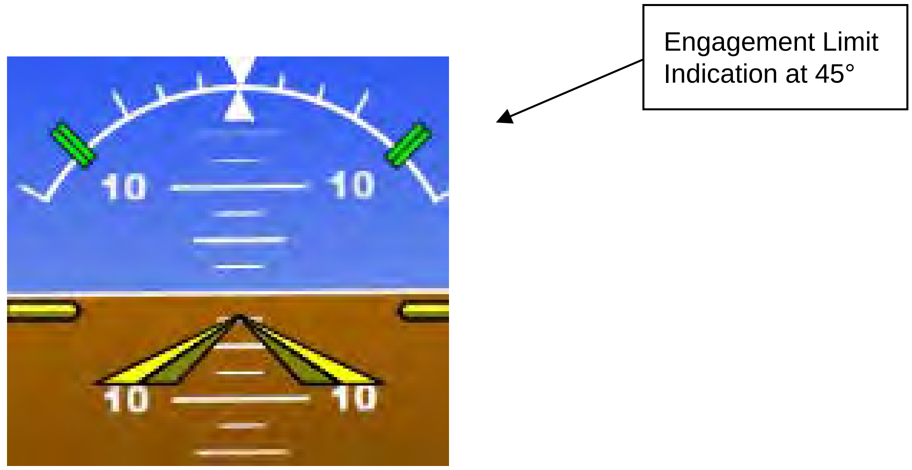

Figure 7-1: Nominal Roll Attitude ESP Engagement Limit Indications

Once ESP becomes active in roll, the engagement limit indication that was crossed (either Left or Right) will move to the lower disengagement limit indication. The opposite roll limit remains at the engagement limit.

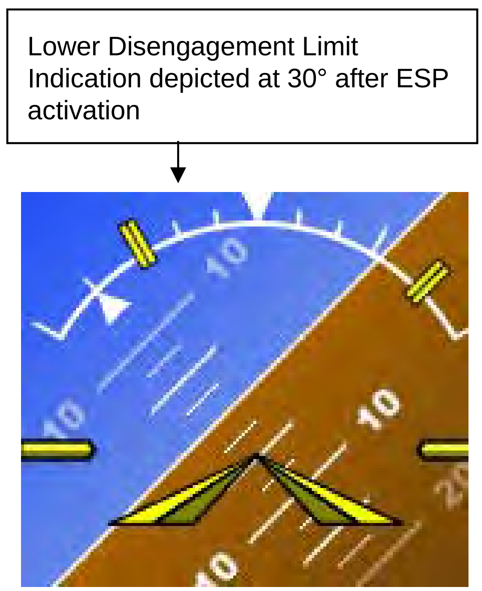

Figure 7-2: Engagement Limit Indications Upon ESP Activation

Disconnect Methods

The following conditions will cause the autopilot to automatically disconnect:

- Electrical power failure, including pulling the autopilot circuit breaker.
- Internal autopilot system failure (including internal AHRS failure).

The following pilot actions will cause the autopilot to disconnect:

- Pressing the red AP DISC / TRIM INT button on the pilot's control wheel.
- Actuating the manual electric trim switch (if installed).
- Pushing the AP Key on the GMC 507 mode controller when the autopilot is engaged.
- Pulling the autopilot circuit breaker.

AUTOPILOT CONTROL UNIT AND DISPLAY

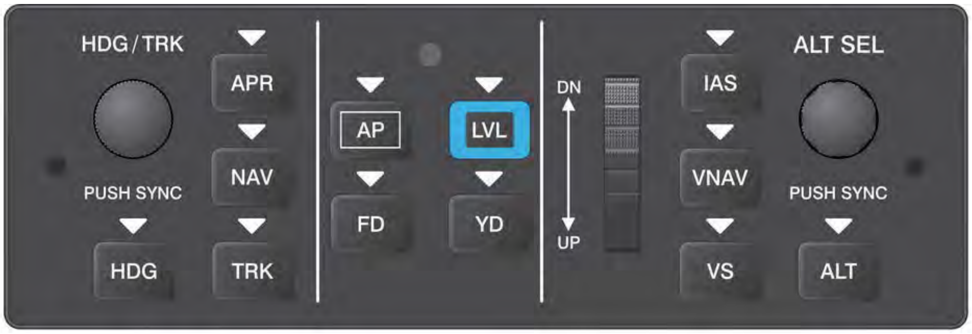

Figure 7-3: GMC 507 Control Unit (Reference Only)

Figure 7-4: G5 Display (Reference Only)

The following tables list the available AFCS vertical and lateral modes with their corresponding controls and annunciations. The UP/DN wheel can be used to change the vertical mode reference while operating in Pitch Hold, Vertical Speed, Altitude Hold, or IAS mode. Increments of change and maximum ranges of values for each of these references using the UP/DN wheel are also listed in the table.

AFCS VERTICAL MODES

Vertical Mode	Control	Annunciation	Reference Range	Reference Change Increment
Pitch Hold	(default)	PIT	20° Nose Up 15° Nose Down	0.5°
Selected Altitude Capture	*	ALTS		
Altitude Hold	**ALT** Key	ALT nnnnn		10 FT
Vertical Speed	**VS** Key	VS nnnn	-2000 to +2000 FPM	100 FPM
IAS Hold	**IAS** Key	IAS nnn	71 to 187 KIAS	1 KT
Vertical Path Tracking (VNAV)	**VNAV** Key	VNAV		
VNAV Target Altitude Capture	**	ALTV		
Glidepath	**APR** Key	GP		
Glideslope		GS		
Takeoff or Go Around	**GA** Button	TO or GA	7°	
Level (LVL)	**LVL** Key	LVL	Zero Vertical Speed	
ESP High Pitch Engagement			ESP High Pitch Attitude engages at 20° nose up	
ESP Low Pitch Engagement			ESP Low Pitch Attitude engages at 15° nose down	
ESP High Airspeed Engagement			ESP High Airspeed engages at 198 KIAS	
ESP Low Airspeed Engagement			When above 200 FT AGL, ESP Low Airspeed engages at 71 KIAS. (This mode only available if height above terrain is available from a compatible Garmin GPS).	

* ALTS arms automatically when PIT, VS, IAS, or GA is active, and when VNAV is active if the Selected Altitude is to be captured instead of the VNAV Target Altitude.

** ALTV arms automatically if the VNAV Target Altitude is to be captured instead of the Selected Altitude.

AFCS LATERAL MODES

Lateral Mode	Control	Annunciation	Maximum Roll Command Limit
Roll Mode	(default)	ROL	30°
Heading Select	**HDG** Key	HDG	30°
Track Select	**TRK** Key	TRK	30°
Navigation, GPS Arm/Capture/Track	**NAV** Key	GPS	30°
Navigation, VOR Enroute and Approach Arm/Capture/Track		VOR	30°
Navigation, LOC Arm/Capture/Track (No Glideslope)		LOC	30°
Backcourse Arm/Capture/Track		BC	30°
Approach, GPS Arm/Capture/Track (Glidepath Mode Automatically Armed, if available)	**APR** Key	GPS	30°
Approach, ILS Arm/Capture/Track (Glideslope Mode Automatically Armed)		LOC	30°
Takeoff or Go Around	**GA** Button	TO or GA	Wings Level
LVL (Level)	**LVL** Key	LVL	Wings Level
ESP Roll Attitude Engagement	ESP Roll Attitude engages at 45°		

The autopilot may be engaged within the following ranges:

Pitch 50° nose up to 50° nose down

Roll ±75°

If the above pitch or roll limits are exceeded while the autopilot is engaged, the autopilot will disconnect. Engaging the autopilot outside of its command limits, but within its engagement limits, will cause the autopilot to return the aircraft within command limits. The autopilot is capable of commanding the aircraft in the following ranges:

Pitch 20° nose up to 15° nose down

Roll ±30°

PREFLIGHT TEST

During the preflight test the G5, GI 275, or G3X will display PFT in the autopilot status box. At the completion of the preflight test, the PFT annunciation is removed. If GFC 500 fails the PFT, a yellow AP with a red X is displayed in the autopilot status box on the G5, GI 275, or G3X.

MESSAGES AND ANNUNCIATIONS

Autopilot Messages	
AFCS Controller Key Stuck	The system has sensed a key input on the GMC 507 for 30 seconds or longer.
AFCS Controller Audio Database Missing	The audio database is missing from the GMC 507. The aural voice alerts will not be heard.
Servo Clutch Fault	One or more autopilot servos has a stuck clutch. The servo needs service.
Servo Trim Input Fault	The inputs to the trim system are invalid. The trim system needs service.
Autopilot Annunciations	
AFCS	Autopilot has failed. Autopilot is inoperative and flight director is not available.
AP	Autopilot normal disconnect.
AP	Autopilot abnormal disconnect.
AP	Autopilot has failed. The autopilot is inoperative. FD modes may still be available.
MAXSPD	Autopilot Overspeed Protection mode is active. Autopilot will raise the nose to limit the aircraft's speed.
MINSPD	Autopilot Underspeed Protection mode is active. Autopilot will lower the nose to prevent the aircraft's speed from decreasing.
PFT	Autopilot preflight test is in progress.
PTRIM	Pitch Trim Fail – Manual Electric Pitch Trim is inoperative.
TRIM DOWN	Elevator Trim Down – Autopilot is holding elevator nose down force. The pitch trim needs to be adjusted nose down.
TRIM UP	Elevator Trim Up – Autopilot is holding elevator nose up force. The pitch trim needs to be adjusted nose up.
YD	Yaw Damper normal disconnect.

YD	Yaw Damper abnormal disconnect.
YD	Yaw Damper has failed. The Yaw Damper is inoperative.

LIGHTING

When the aircraft's dimming bus is selected off, or full dim, GMC 507 mode control panel lighting is controlled by integrated photocells which sense the ambient cockpit lighting. When the aircraft's dimming bus is used to control cockpit lighting, the GMC 507 mode control panel lighting is controlled by the dimming bus.

NOTE

In order to accommodate clearer type, larger charts and graphs, and more detailed illustrations, this edition of the TIO-540 Operator's Manual, Lycoming Part Number 60297-23A is presented in an 8-1/2 x 11 inch format. This edition is a complete manual of all TIO-540 model engines that employ angle valve cylinder heads. These Lycoming engines are TIO-540-A1A, -A1B, -A2A, -A2B, -A2C, -F2BD, -J2B, -J2BD, -N2BD, -R2AD, -S1AD, -U2A, -V2AD, -W2A, -AH1A and -AJ1A. This manual is current as of the date of issue. All previously issued revisions are included.

This manual will be kept current by revisions available from Lycoming distributors or from the factory. All revisions will be accompanied by an Operator's Manual Revision page which will identify the revision level, the date of the revision, and the pages revised, added or deleted. All revisions will be supplied in the 8-1/2 x 11 inch format.

Operator's Manual

Lycoming

TIO-540 Series

Angle Valve Cylinder Heads

Approved by FAA

4th Edition Part No. 60297-23A

LYCOMING

November 2005

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570/323-6181

TIO-540 Series Angle Valve Cylinder Heads Operator's Manual
Lycoming Part Number: 60297-23A

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LYCOMING

OPERATOR'S MANUAL REVISION

REVISION NO.	PUBLICATION	PUBLICATION NO.	PUBLICATION DATE
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The page(s) in this revision replace, add to, or delete current pages in the operator's manual.

PREVIOUS REVISION	CURRENT REVISION
August 2006 3-3, 3-4 **May 2008** 2-3; 3-55, 3-56, 3-57	**January 2013** 3-4

ATTENTION

OWNERS, OPERATORS, AND MAINTENANCE PERSONNEL

This operator’s manual contains a description of the engine, its specifications, and detailed information on how to operate and maintain it. Such maintenance procedures that may be required in conjunction with periodic inspections are also included. This manual is intended for use by owners, pilots and maintenance personnel responsible for care of Lycoming powered aircraft. Modifications and repair procedures are contained in Lycoming overhaul manuals; maintenance personnel should refer to these for such procedures.

SAFETY WARNING

NEGLECTING TO FOLLOW THE OPERATING INSTRUCTIONS AND TO CARRY OUT PERIODIC MAINTENANCE PROCEDURES CAN RESULT IN POOR ENGINE PERFORMANCE AND POWER LOSS. ALSO, IF POWER AND SPEED LIMITATIONS SPECIFIED IN THIS MANUAL ARE EXCEEDED, FOR ANY REASON; DAMAGE TO THE ENGINE AND PERSONAL INJURY CAN HAPPEN. CONSULT YOUR LOCAL FAA APPROVED MAINTENANCE FACILITY.

SERVICE BULLETINS, INSTRUCTIONS, AND LETTERS

Although the information contained in this manual is up-to-date at time of publication, users are urged to keep abreast of later information through Lycoming Service Bulletins, Instructions and Service Letters which are available from all Lycoming distributors or from the factory by subscription. Consult the latest revision of Service Letter No. L114 for subscription information.

SPECIAL NOTE

The illustrations, pictures and drawings in this publication are typical of the subject matter they portray; in no instance are they to be interpreted as examples of any specific engine, equipment or part thereof.

IMPORTANT SAFETY NOTICE

Proper service and repair is essential to increase the safe, reliable operation of all aircraft engines. The service procedures recommended by Lycoming are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the task. These special tools must be used when and as recommended.

It is important to note that most Lycoming publications contain various Warnings and Cautions which must be carefully read in order to minimize the risk of personal injury or the use of improper service methods that may damage the engine or render it unsafe.

It is also important to understand that these Warnings and Cautions are not all inclusive. Lycoming could not possibly know, evaluate or advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences that may be involved. Accordingly, anyone who uses a service procedure must first satisfy themselves thoroughly that neither their safety nor aircraft safety will be jeopardized by the service procedure they select.

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SECTION 1
DESCRIPTION

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SECTION 1

DESCRIPTION

The TIO-540 series listed in this manual are six cylinder, direct drive, horizontally opposed, fuel injected, turbocharged, air cooled engines with angle head valves.

In referring to the location of the various engine components, the parts are described in their relationship to the engine as installed in the airframe. Thus, the power take-off end is considered the front and the accessory drive end the rear. The sump section is considered the bottom and the opposite side of the engine where the shroud tubes are located the top. Reference to the left and right side is made with the observer facing the rear of the engine. The cylinders are numbered from front to rear, odd numbers on the right, even numbers on the left. The direction of rotation for accessory drives is determined with the observer facing the drive pad.

Cylinders – The cylinders are of conventional air-cooled construction with the two major parts, head and barrel, screwed and shrunk together. The heads are made from an aluminum alloy casting with a fully machined combustion chamber. Rocker shaft bearing supports are cast integral with the head along with housings to form the rocker boxes for both valve rockers. The cylinder barrels, which are machined from chrome nickel molybdenum steel forgings, have deep integral cooling fins and the inside of the barrels are ground and honed to a specified finish.

Valve Operating Mechanism – A conventional type camshaft is located above and parallel to the crankshaft. The camshaft actuates hydraulic tappets which operate the valves through push rods and valve rockers. The valve rockers are supported on full floating steel shafts. The valve springs bear against hardened steel seats and are retained on the valve stems by means of split keys.

Crankcase – The crankcase assembly consists of two reinforced aluminum alloy castings, fastened together by means of studs, bolts and nuts. The mating surfaces of the two castings are joined without the use of a gasket, and the main bearing bores are machined for use of precision type main bearing inserts.

Crankshaft – The crankshaft is made from a chrome nickel molybdenum steel forging. All bearing journal surfaces are nitrided. Freedom from torsional vibration is assured by a system of pendulum type dynamic counterweights.

Connecting Rods – The connecting rods are made in the form of "H" section from alloy steel forgings. They have replaceable bearing inserts in the crankshaft ends and bronze bushings in the piston ends. The bearing caps on the crankshaft ends are retained by two bolts and nuts through each cap.

Pistons – The pistons are machined from an aluminum alloy forging. The piston pin is a full floating type with a plug located in each end of the pin. Depending on the cylinder assembly, pistons may be machined for either three or four rings and may employ either half wedge or full wedge rings. Consult the latest revision of Service Instruction No. 1037 for proper piston and ring combinations.

Accessory Housing – The accessory housing is made from an aluminum casting and is fastened to the rear of the crankcase and the top rear of the sump. It forms a housing for the oil pump and the various accessory drives.

Oil Sump and Induction Assembly – This assembly consists of the oil sump bolted to a mated cover containing intake pipe extensions for the induction system. When bolted together they form a mounting pad for the air inlet housing. Fuel drain plugs are provided in the cover and the sump incorporates oil drain plugs and an oil suction screen.

Cooling System – These engines are designed to be cooled by air pressure actuated by the forward speed of the aircraft. Baffles are provided to build up a pressure and force the air through the cylinder fins. The air is then exhausted to the atmosphere through gills or augmentor tubes usually located at the rear of the cowling.

Induction System – The Lycoming TIO-540 series employs a Bendix or Precision Airmotive (PAC) RSA type fuel injection system.

The Bendix or PAC RSA type fuel injection system is based on the principle of measuring air flow and using the air flow signal in a stem type regulator to convert the air force into a fuel force. This fuel force (fuel pressure differential) when applied across the fuel metering section (jetting system) makes fuel flow proportional to air flow.

Turbocharger System – A turbocharger is mounted as an integral part of the TIO-540 series engines. The function of the turbocharger is to provide constant air density to the fuel injector inlet from sea level to critical altitude. Regulating the amount of exhaust gas fed to the turbine wheel controls the output which determines engine power. This factor is regulated by the control system which has three components, namely, the density controller, the differential pressure controller, the exhaust bypass valve (waste gate) and the TIO-540-AJ1A engine model incorporates a Slope controller. The position of the waste gate is determined by oil pressure acting on a piston which is connected to the butterfly valve by linkage. Increasing oil pressure on the piston closes the waste gate valve and increases power; decreasing oil pressure opens the valve and decreases power. The bleed oil required to activate the piston is controlled by either the density controller or the differential pressure controller.

These controllers each act independently to regulate the pressure on the exhaust bypass piston. The density controller regulates bleed oil at full throttle only. The differential pressure controller takes over whenever part throttle settings are being used. If this unit was not used, the density controller would attempt to position the exhaust bypass so that the air density at the injector entrance was always that required for maximum power. Since this is not required for part throttle operation the differential pressure controller is used to reduce this air pressure and allow the exhaust bypass valve to modulate over as high an operating range as possible. The Slope controller provides constant manifold pressure from sea level to critical altitude at full throttle and a reduced deck pressure at part throttle settings. The waste gate control is servo operated by engine oil pressure.

NOTE

The letter "L" in the model prefix denotes the reverse rotation of the basic model. Example – model TIO-540-F2BD has clockwise rotation of the crankshaft. Therefore, the LTIO-540-F2BD has counterclockwise rotation. Likewise, the rotation of the accessory drives of the LTIO-540-F2BD are opposite those of the basic model as listed in Section 2 of this manual.

The letter "D" used as the 4th or 5th character in the model suffix means that the engine is equipped with a dual magneto housed in a single housing. Example – TIO-540-N2BD.

Operational aspects of engines are the same and performance data and specifications for the basic model will apply.

SECTION 2
SPECIFICATIONS

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SECTION 2

SPECIFICATIONS

TIO-540-A1A, -A1B, -A2A, -A2B, -A2C

FAA Type Certificate	E14EA
Rated horsepower	310 @ 15,000 ft.
Rated speed, RPM	2575
Bore, inches	5.125
Stroke, inches	4.375
Displacement, cubic inches	541.5
Compression ratio	7.3:1
Firing order	1-4-5-2-3-6
Spark occurs, degrees BTC	20
Valve rocker clearance (hydraulic tappets collapsed)	.028-.080
Prop. drive ratio	1:1
Prop. driven rotation	Clockwise

TIO-540-F2BD

FAA Type Certificate	E14EA
Rated horsepower	325
Rated speed, RPM	2575
Bore, inches	5.125
Stroke, inches	4.375
Displacement, cubic inches	541.5
Compression ratio	7.3:1
Firing order	1-4-5-2-3-6
Spark occurs, degrees BTC	20
Valve rocker clearance (hydraulic tappets collapsed)	.028-.080
Prop. drive ratio	1:1
Prop. driven rotation	Clockwise

TIO-540-J2B, -J2BD, -N2BD

FAA Type Certificate	E14EA
Rated horsepower	350 @ 15,000 ft.
Rated speed, RPM	2575
Bore, inches	5.125
Stroke, inches	4.375
Displacement, cubic inches	541.5
Compression ratio	7.3:1
Firing order	1-4-5-2-3-6
Spark occurs, degrees BTC	20
Valve rocker clearance (hydraulic tappets collapsed)	.028-.080
Prop. drive ratio	1:1
Prop. driven rotation	Clockwise

SPECIFICATIONS (CONT.)

TIO-540-R2AD*

FAA Type Certificate E14EA
Rated horsepower.. 340
Rated speed, RPM.. 2500
Bore, inches.. 5.125
Stroke, inches.. 4.375
Displacement, cubic inches.. 541.5
Compression ratio 7.3:1
Firing order 1-4-5-2-3-6
Spark occurs, degrees BTC.. 20
Valve rocker clearance (hydraulic tappets collapsed) .... .028-.080
Prop. drive ratio 1:1
Prop. driven rotation .... Clockwise

TIO-540-S1AD

FAA Type Certificate E14EA
Rated horsepower.. 300 @ 12,000 ft.
Rated speed, RPM.. 2700
Bore, inches.. 5.125
Stroke, inches.. 4.375
Displacement, cubic inches.. 541.5
Compression ratio 7.3:1
Firing order 1-4-5-2-3-6
Spark occurs, degrees BTC.. 20
Valve rocker clearance (hydraulic tappets collapsed) .... .028-.080
Prop. drive ratio 1:1
Prop. driven rotation .... Clockwise

TIO-540-U2A

FAA Type Certificate E14EA
Rated horsepower.. 350 @ 15,000 ft.
Rated speed, RPM.. 2500
Bore, inches.. 5.125
Stroke, inches.. 4.375
Displacement, cubic inches.. 541.5
Compression ratio 7.3:1
Firing order 1-4-5-2-3-6
Spark occurs, degrees BTC.. 20
Valve rocker clearance (hydraulic tappets collapsed) .... .028-.080
Prop. drive ratio 1:1
Prop. driven rotation .... Clockwise

* - TIO-540-R2AD has an alternate rating of 350 horsepower at 2575 RPM at standard altitude conditions.

SPECIFICATIONS (CONT.)

TIO-540-V2AD

FAA Type Certificate E14EA
Rated horsepower 350*
Rated speed, RPM 2600
Bore, inches 5.125
Stroke, inches 4.375
Displacement, cubic inches 541.5
Compression ratio 7.3:1
Firing order 1-4-5-2-3-6
Spark occurs, degrees BTC 20
Valve rocker clearance (hydraulic tappets collapsed) .... .028-.080
Prop. drive ratio 1:1
Prop. drive rotation .... Clockwise

TIO-540-W2A

FAA Type Certificate E14EA
Rated horsepower .... 350 @ 15,000 ft.
Rated speed, RPM 2600
Bore, inches 5.125
Stroke, inches 4.375
Displacement, cubic inches 541.5
Compression ratio 7.3:1
Firing order 1-4-5-2-3-6
Spark occurs, degrees BTC 20
Valve rocker clearance (hydraulic tappets collapsed) .... .028-.080
Prop. drive ratio 1:1
Prop. drive rotation .... Clockwise

TIO-540-AH1A■

FAA Type Certificate E14EA
Rated horsepower .... 300 @ 12,000 ft.
Rated speed, RPM 2500
Bore, inches 5.125
Stroke, inches 4.375
Displacement, cubic inches 541.5
Compression ratio 7.3:1
Firing order 1-4-5-2-3-6
Spark occurs, degrees BTC 20
Valve rocker clearance (hydraulic tappets collapsed) .... .028-.080
Prop. drive ratio 1:1
Prop. drive rotation .... Clockwise

* - At propeller shaft under 10 hp extracted at the accessory drive.

■ – TIO-540-AH1A has an alternate take-off rating of 40 in. Hg. manifold pressure at 2500 RPM to 5,000 feet pressure altitude.

SPECIFICATIONS (CONT.)

TIO-540-AJ1A

FAA Type Certificate E14EA
Rated horsepower.. 310 @ 14,000 ft.
Rated speed, RPM..2500
Bore, inches..5.125
Stroke, inches..4.375
Displacement, cubic inches..541.5
Compression ratio 7.3:1
Firing order 1-4-5-2-3-6
Spark occurs, degrees BTC..20
Valve rocker clearance (hydraulic tappets collapsed) .... .028-.080
Prop. drive ratio 1:1
Prop. driven ratio ....Clockwise

*Accessory Drive	Drive Ratio	**Direction of Rotation
Starter	16.556:1	Counterclockwise
Generator	1.910:1	Clockwise
Generator (Optional)	2.500:1	Clockwise
Alternator	3.200:1	Clockwise
Alternator (Optional)	3.630:1	Clockwise
Vacuum Pump	1.300:1	Counterclockwise
Hydraulic Pump	1.385:1	Clockwise
Hydraulic Pump†	1.300:1	Clockwise
Tachometer	.500:1	Clockwise
Propeller Governor	.895:1	Clockwise
Propeller Governor‡	.947:1	Clockwise
Magneto Drive: Single	1.500:1	Clockwise
Magneto Drive: Dual	.750:1	Clockwise
Fuel Pump - AN♦	1.000:1	Counterclockwise
Fuel Pump – Plunger Operated	.500:1	Counterclockwise

* - When applicable.
** - Viewed facing drive pad – NOTE that engines with "L" in the prefix will have opposite rotation to the above.
† - Dual magneto engines.
‡ - Wide cylinder flange series.
♦ - Fuel pump drive has clockwise rotation on dual magneto engines.

1. STANDARD ENGINE, DRY WEIGHT.

MODEL	LBS.
TIO-540-S1AD	533
TIO-540-A1A, -A1B, -A2A, -A2B, -A2C	537
TIO-540-AH1A, -F2BD	542
TIO-540-J2BD, -R2AD	548

1. STANDARD ENGINE, DRY WEIGHT (CONT.)

MODEL	LBS.
TIO-540-N2BD	549
TIO-540-J2B	565
TIO-540-V2AD	565
TIO-540-U2A	578

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SECTION 3
OPERATING INSTRUCTIONS

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SECTION 3

OPERATING INSTRUCTIONS

1. GENERAL. Close adherence to these instructions will greatly contribute to long life, economy and satisfactory operation of the engine.

NOTE

YOUR ATTENTION IS DIRECTED TO THE WARRANTIES THAT APPEAR IN THE FRONT OF THIS MANUAL REGARDING ENGINE SPEED, THE USE OF SPECIFIED FUELS AND LUBRICANTS, REPAIRS AND ALTERATIONS. PERHAPS NO OTHER ITEM OF ENGINE OPERATION AND MAINTENANCE CONTRIBUTES QUITE SO MUCH TO SATISFACTORY PERFORMANCE AND LONG LIFE AS THE CONSTANT USE OF CORRECT GRADES OF FUEL AND OIL, CORRECT ENGINE TIMING, AND FLYING THE AIRCRAFT AT ALL TIMES WITHIN THE SPEED AND POWER RANGE SPECIFIED FOR THE ENGINE. DO NOT FORGET THAT VIOLATION OF THE OPERATION AND MAINTENANCE SPECIFICATIONS FOR YOUR ENGINE WILL NOT ONLY VOID YOUR WARRANTY BUT WILL SHORTEN THE LIFE OF YOUR ENGINE AFTER ITS WARRANTY PERIOD HAS PASSED.

New engines have been carefully run-in by Lycoming and therefore, no further break-in is necessary insofar as operation is concerned. New or newly overhauled engines should be operated using only the lubricating oil recommended in the latest revision of Service Instruction No. 1014.

NOTE

Cruising should be done at 65% to 75% power until a total of 50 hours has accumulated or oil consumption has stabilized. This is to insure proper seating of the rings and is applicable to new engines, and engines in service following cylinder replacement or top overhaul of one or more cylinders

The minimum fuel octane rating is listed in the flight chart, Part 8 of this section. Under no circumstances should fuel of a lower octane rating or automotive fuel (regardless of octane rating) be used.

2. PRESTARTING ITEMS OF MAINTENANCE. Before starting the aircraft engine for the first flight of the day, there are several items of maintenance inspection that should be performed. These are described in Section 4 under Daily Pre-Flight inspection. They must be observed before the engine is started.

3. STARTING PROCEDURES.

The following starting procedures are recommended; however, the starting characteristics of various installations will necessitate some variation from these procedures.

NOTE

Cranking periods should be limited to ten (10) to twelve (12) seconds with 5 minutes rest between cranking periods.

a. *TIO-540 Series (Cold Engine).*

(1) Perform pre-flight inspection.

(2) Set propeller governor in "Full RPM".

(3) Turn fuel valve to "on" position.

(4) Open throttle approximately ¼ travel.

(5) Turn boost pump on and move mixture control to "Full Rich" position until a slight but steady flow is indicated.

(6) Return mixture control to "Idle Cut-Off" position.

(7) Set magneto selector switch. Consult airframe manufacturer's handbook for correct position.

(8) Engage starter.

(9) When engine starts, place magneto selector switch in "Both" position.

(10) Move mixture control slowly and smoothly to "Full Rich".

(11) Check oil pressure gage for indicated pressure. If oil pressure is not indicated within thirty seconds, stop the engine and determine trouble.

NOTE

If engine fails to achieve a normal start, assume it to be flooded and use standard clearing procedure. Then repeat above procedure.

b. *TIO-540 Series (Hot Engine) –* Because of the fact that the fuel percolates and the system must be cleared of vapor, it is recommended that the same procedure, as outlined above, be used for starting a hot engine.

4. COLD WEATHER STARTING. During extreme cold weather, it may be necessary to preheat the engine and oil before starting.

5. GROUND RUNNING AND WARM-UP. Subject engines are air pressure cooled and depend on the forward movement of the aircraft to maintain proper cooling. Particular care is necessary, therefore, when operating these engines on the ground. To prevent overheating, it is recommended that the following precautions be observed.

NOTE

Any ground check that requires full throttle operation must be limited to three minutes, or less if indicated cylinder head temperature should exceed the maximum stated in this manual.

a. Head the aircraft into the wind.

b. Leave mixture in "Full Rich".

c. Operate the engine on the ground only with the propeller in minimum blade angle setting.

d. Warm up at approximately 1000-1200 RPM. Avoid prolonged idling and do not exceed 2200 RPM on the ground.

e. Engine is warm enough for take-off when the throttle can be opened without the engine faltering Take-off with turbocharged engines should not be started if indicated lubricating oil pressure due to cold temperature, is above maximum. Excessive oil pressure can cause over boost and consequent engine damage.

6. GROUND CHECK.

a. Warm up as directed above.

b. Check both oil pressure and oil temperature.

c. Leave mixture in "Full Rich".

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

e. A proper magneto check is important. Additional factors, other than the ignition system, affect magneto drop-off. They are load-power output, propeller pitch and mixture strength. The important thing is that the engine runs smoothly because magneto drop-off is affected by the variables listed above. Make the magneto check in accordance with the following procedures.

(1) (Controllable Pitch Propeller.) With propeller in minimum pitch angle, set the engine to produce 50-65% power as indicated by the manifold pressure gage unless otherwise specified in the aircraft manufacturer's manual. Set the mixture control to the full rich position. At these settings, the ignition system and spark plugs must work harder because of the greater pressure within the cylinders. Under these conditions ignition problems, if they exist, will occur. Mag checks at low power settings will only indicate fuel-air distribution quality.

NOTE

Aircraft that are equipped with fixed pitch propellers, or not equipped with manifold pressure gage, may check magneto drop-off with engine operating at approximately 2100-2200 RPM.

(2) Switch from both magnetos to one and note drop-off, return to both until engine regains speed and switch to the other magneto and note drop-off, then return to both. Drop-off should not exceed 175 RPM and should not exceed 50 RPM between magnetos. A smooth drop-off past the normal specification of 175 RPM is usually a sign of a too lean or too rich mixture.

(3) If the RPM drop exceeds 175 RPM, slowly lean the mixture until the RPM peaks. Then retard the throttle to the RPM specified in step e. (1) for the magneto check and repeat the check. If the drop-off does not exceed 175 RPM, the difference between the magnetos does not exceed 50 RPM, and the engine is running smoothly, then the ignition system is operating properly. Return the mixture to full rich.

f. Do not operate on a single magneto for too long a period, a few seconds is usually sufficient to check drop-off and will minimize plug fouling.

7. OPERATING IN FLIGHT.

a. Subject engines are equipped with a dynamic counterweight system and must be operated accordingly. Throttle movements from full power to idle or from idle to full power are full range movements. Full range throttle movements must be performed over a minimum time duration of 4 seconds. Performing a full range throttle movement at a rate of less than 2 seconds is considered a rapid or instant movement. Performing rapid movements may result in detuned counterweights which may lead to failure of the counterweight lobes and subsequent engine damage.

b. See airframe manufacturer's instructions for recommended power settings.

c. Fuel Mixture Leaning Procedure.

Improper fuel/air mixture during flight is responsible for many engine problems, particularly during take-off and climb power settings. The procedures described in this manual provide proper fuel/air mixture when leaning Lycoming engines; they have proven to be both economical and practical by eliminating excessive fuel consumption and reducing damaged parts replacement. It is therefore recommended that operators of all Lycoming aircraft power-plants utilize the instructions in this publication any time the fuel/air mixture is adjusted during flight.

Manual leaning may be monitored by exhaust gas temperature indication, fuel flow indication, and by observation of engine speed and/or airspeed. However, whatever instruments are used in leaning the mixture, the following general rules should be observed by the operator of Lycoming aircraft engines.

GENERAL RULES

Never exceed the maximum red line cylinder head temperature limit.

For maximum service life, cylinder head temperatures should be maintained below 435°F (224°C) during high performance cruise operation and below 400°F (205°C) for economy cruise powers.

All take-offs are to be made with the mixture controls in the full rich position regardless of field elevation. Turbocharging permits the engine to develop rated power regardless of field elevation. However, it may be necessary to manually lean the engine for ground operation at idle or off idle engine speeds.

Leaning during climb, usually 85% of rated power, is permitted only if and to the limits described in the aircraft operator's handbook. Engine temperature instruments must be monitored and temperatures must be maintained within the prescribed limits.

During let-down flight operations it may be necessary to manually lean engine to obtain smooth operation.

On turbocharged engines never exceed 1650°F turbine inlet temperature (TIT).

1. LEANING TO TURBINE INLET TEMPERATURE OR EXHAUST GAS TEMPERATURE GAGE.

a. Turbocharged engines.

(1) Best Economy Cruise – Lean to peak turbine inlet temperature (TIT) or 1650°F, whichever occurs first.

(2) Maximum Power Cruise – The engine must always be operated on the rich side of peak TIT. Before leaning to obtain maximum power mixture it is necessary to establish a reference point. This is accomplished as follows:

(a) Establish a peak TIT for best economy operation at the highest economy cruise power without exceeding 1650°F.

(b) Deduct 125°F from this temperature and thus establish the temperature reference point for use when operating at maximum power mixture.

(c) Return mixture control to full rich and adjust the RPM and manifold pressure for desired performance cruise operation.

(d) Lean out mixture until TIT is the value established in Step (b). This sets the mixture at best power.

2. LEANING TO FLOWMETER.

Lean to applicable fuel-flow tables or lean to indicator marked for correct fuel-flow for each power setting.

3. LEANING WITH MANUAL MIXTURE CONTROL (Without flowmeter or TIT gage).

a. Slowly move mixture control from "Full Rich" position toward lean position.

b. Continue leaning until slight loss of power is noted (loss of power may or may not be accompanied by roughness).

c. Enrich until engine runs smoothly and power is regained.

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8. ENGINE FLIGHT CHART.

FUEL –	*Aviation Grade Fuel
All Models	100/100LL octane minimum

* - Refer to the latest revision of Service Instruction No. 1070.

OIL – (All Models) –

Average Ambient Temperature	*Recommended Grade Oil MIL-L-6082B SAE Grades	MIL-L-22851 Ashless Dispersant SAE Grades
All temperatures	---	15W-50 or 20W-50
Above 80°F	60	60
Above 60°F	50	40 or 50
30°F to 90°F	40	40
0°F to 70°F	30	30, 40 or 20W-40
Below 10°F	20	30 or 20W-30

* - Refer to latest revision of Service Instruction No. 1014.

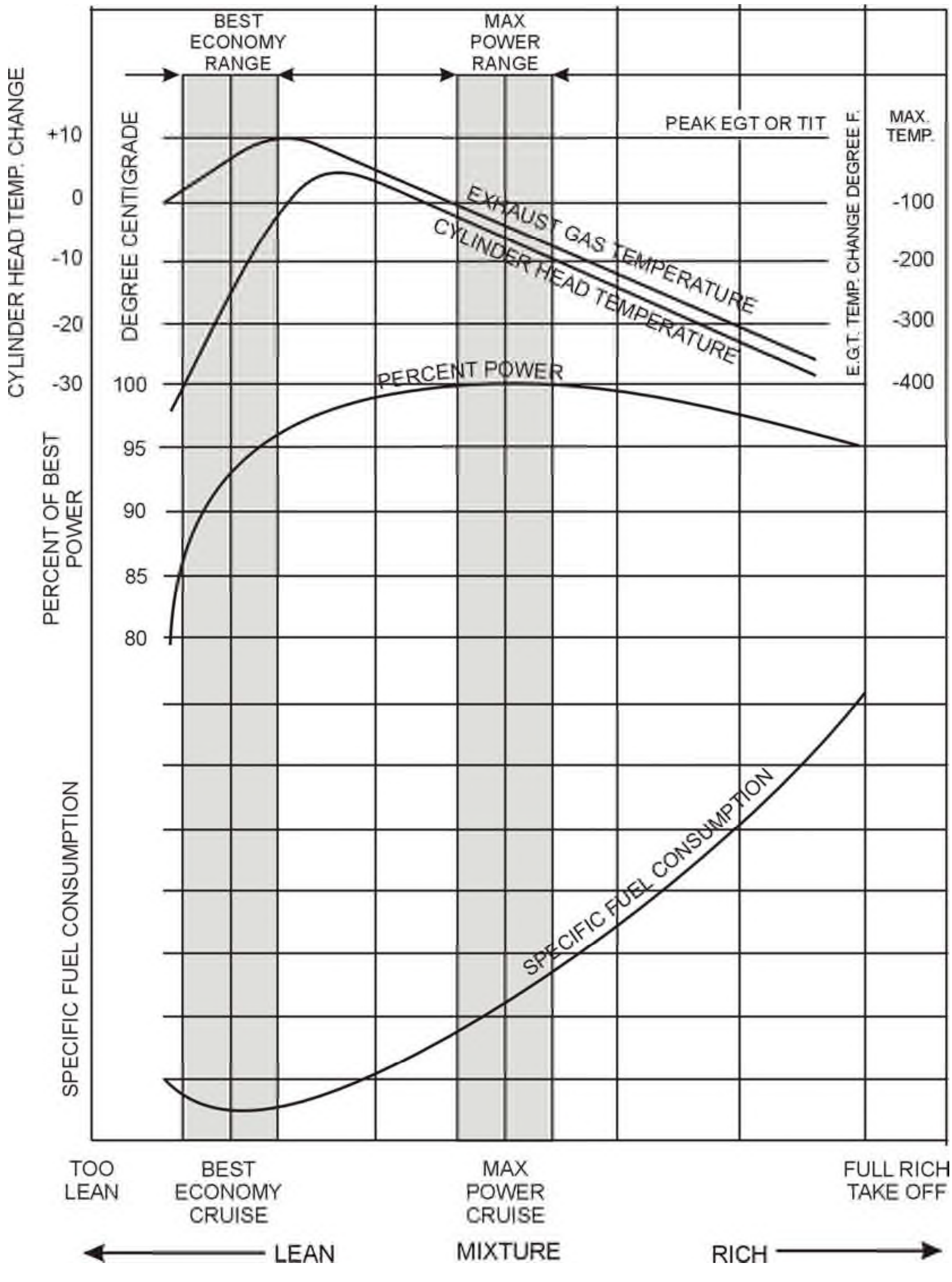

Figure 3-1. Representative Effect of Leaning on Cylinder Head Temperature, EGT (Exhaust Gas Temperature) or TIT (Turbine Inlet Temperature), Engine Power and Specific Fuel Consumption at Constant Engine RPM and Manifold Pressure

OIL – (All Models) (Cont.) –

Oil Sump Capacity	Maximum	Minimum Safe Quantity
TIO-540 series except below	12 U.S. Quarts	2-3/4 U.S. Quarts
-V2AD	13 U.S. Quarts	4 U.S. Quarts
-W2A, -AJ1A	11 U.S. Quarts	4 U.S. Quarts

OPERATING CONDITIONS

Average Ambient Air	*Oil Inlet Temperature Desired	Maximum
Above 60°F	180°F (82°C)	245°F (118°C)
30°F to 90°F	180°F (82°C)	245°F (118°C)
0°F to 70°F	170°F (77°C)	245°F (118°C)
Below 10°F	160°F (71°C)	245°F (118°C)

* - Engine oil temperature should not be below 140°F (60°C) during continuous operation.

OIL PRESSURE – PSI –

Normal Operation	Maximum	Minimum	Idling	Start and Warm-Up
All Models	95	55	25	115

FUEL PRESSURE – PSI –

	MIN.	MAX.	IDLE MIN.
TIO-540-A1A, -A1B, -A2A, -A2B, -A2C			
Inlet to fuel pump	-2	65	
Inlet to fuel injector	25	65	12
TIO-540-F2BD, -U2A			
Inlet to fuel pump	-2	65	
Inlet to fuel injector	30	65	12
TIO-540-J2B, -J2BD, -N2BD, -R2AD			
Inlet to fuel pump	-2	65	
Inlet to fuel injector	34	65	12
TIO-540-S1AD			
Inlet to fuel pump	-2	65	
Inlet to fuel injector	25	65	12
TIO-540-AH1A, -V2AD			
Inlet to fuel pump	-2	65	
Inlet to fuel injector	27	65	12
TIO-540-AJ1A			
Inlet to fuel pump	-2	55	
Inlet to fuel injector	20	55	12

OPERATING CONDITIONS (CONT.)

FUEL PRESSURE – PSI (CONT.) –

	MIN.	MAX.	IDLE MIN.
TIO-540-W2A			
Inlet to fuel pump	-2	65	
Inlet to fuel injector	31	65	12

Operation	RPM	HP	Fuel Cons. Gal./Hr.	Max. Oil Cons. Qts./Hr.	**Max. Cyl. Head Temp.
***TIO-540-A1A, -A1B, -A2A, -A2B, -A2C**					
Normal Rated	2575	310	26.3	1.38	475°F (246°C)
Performance Cruise (75% Rated)	2575	230	20.5	0.77	475°F (246°C)
Economy Cruise (60% Rated)	2200	185	13.5	0.66	475°F (246°C)
***TIO-540-F2BD**					
Normal Rated	2575	325	-----	1.45	475°F (246°C)
Performance Cruise (75% Rated)	2575	245	21.0	0.82	475°F (246°C)
Economy Cruise (60% Rated)	2200	195	14.0	0.65	475°F (246°C)
***TIO-540-J2B, -J2BD, -N2BD**					
Normal Rated	2575	350	-----	1.56	475°F (246°C)
Performance Cruise (75% Rated)	2575	260	22.0	0.87	475°F (246°C)
Economy Cruise (60% Rated)	2200	210	15.0	0.70	475°F (246°C)
***TIO-540-R2AD**					
Normal Rated	2500	340	-----	2.07	475°F (246°C)
Performance Cruise (75% Rated)	2500	260	23.5	0.47	475°F (246°C)
Economy Cruise (60% Rated)	2200	210	15.3	0.70	475°F (246°C)

* - MAXIMUM TURBINE INLET TEMPERATURE 1650°F (898.8°C).
** - At Bayonet Location – For maximum service life of the engine maintain cylinder head temperature between 150°F (65.5°C) and 435°F (223.86°C) during continuous operation.

OPERATING CONDITIONS (CONT.)

Operation	RPM	HP	Fuel Cons. Gal./Hr.	Max. Oil Cons. Qts./Hr.	**Max. Cyl. Head Temp.
			***TIO-540-S1AD**		
Normal Rated	2700	300	-----	1.33	475°F (246°C)
Performance Cruise (75% Rated)	2400	225	19.0	0.75	475°F (264°C)
Economy Cruise (60% Rated)	2200	180	13.6	0.60	475°F (246°C)
			***TIO-540-U2A**		
Normal Rated	2500	350	-----	1.16	500°F (260°C)
Performance Cruise (75% Rated)	2400	260	22.0	0.86	500°F (260°C)
Economy Cruise (60% Rated)	2200	210	15.0	0.70	500°F (260°C)
			***TIO-540-V2AD**		
Normal Rated	2600	350†	38.3	1.16	480°F (249°C)
Performance Cruise (75% Rated)	2400	260	23.0	0.86	480°F (249°C)
Economy Cruise (60% Rated)	2200	210	15.9	0.70	480°F (249°C)

† - Horsepower at propeller shaft, after 10 horsepower extracted at the accessory drives.

Operation	RPM	HP	Fuel Cons. Gal./Hr.	Max. Oil Cons. Qts./Hr.	**Max. Cyl. Head Temp.
			***TIO-540-W2A**		
Normal Rated	2600	350†	43.0	1.16	480°F (249°C)
Performance Cruise (75% Rated)	2400	260	23.0	0.86	480°F (249°C)
Economy Cruise (60% Rated)	2200	210	15.9	0.70	480°F (249°C)

† - Horsepower at propeller shaft, after 10 horsepower extracted at the accessory drives.

* - MAXIMUM TURBINE INLET TEMPERATURE 1650°F (898.8°C).
** - At Bayonet Location – For maximum service life of the engine maintain cylinder head temperature between 150°F (65.6°C) and 435°F (223.86°C) for continuous operation.

OPERATING CONDITIONS (CONT.)

Operation	RPM	HP	Fuel Cons. Gal./Hr.	Max. Oil Cons. Qts./Hr.	**Max. Cyl. Head Temp.
			***TIO-540-AH1A**		
Normal Rated	2500	300	33.2	0.97	500°F (260°C)
Performance Cruise (75% Rated)	2400	225	19.2	0.73	500°F (260°C)
Economy Cruise (60% Rated)	2350	180	13.2	0.58	500°F (260°C)
			***TIO-540-AJ1A**		
Normal Rated	2500	310	34.3	1.00	480°F (249°C)
Performance Cruise (75% Rated)	2400	233	19.8	0.76	480°F (249°C)
Economy Cruise (60% Rated)	2200	201	14.7	0.65	480°F (249°C)

* - MAXIMUM TURBINE INLET TEMPERATURE 1650°F (898.8°C).
** - At Bayonet Location – For maximum service life of the engine maintain cylinder head temperature between 150°F (65.6°C) and 435°F (223.86°C) during continuous operation.

e. Engine Shut-Down Procedure.

(1) Set propeller at minimum blade angle (high RPM).

(2) Idle until there is a decided decrease in cylinder head temperature.

(3) Move mixture control to "Idle Cut-Off".

(4) When engine stops, turn ignition switch off.

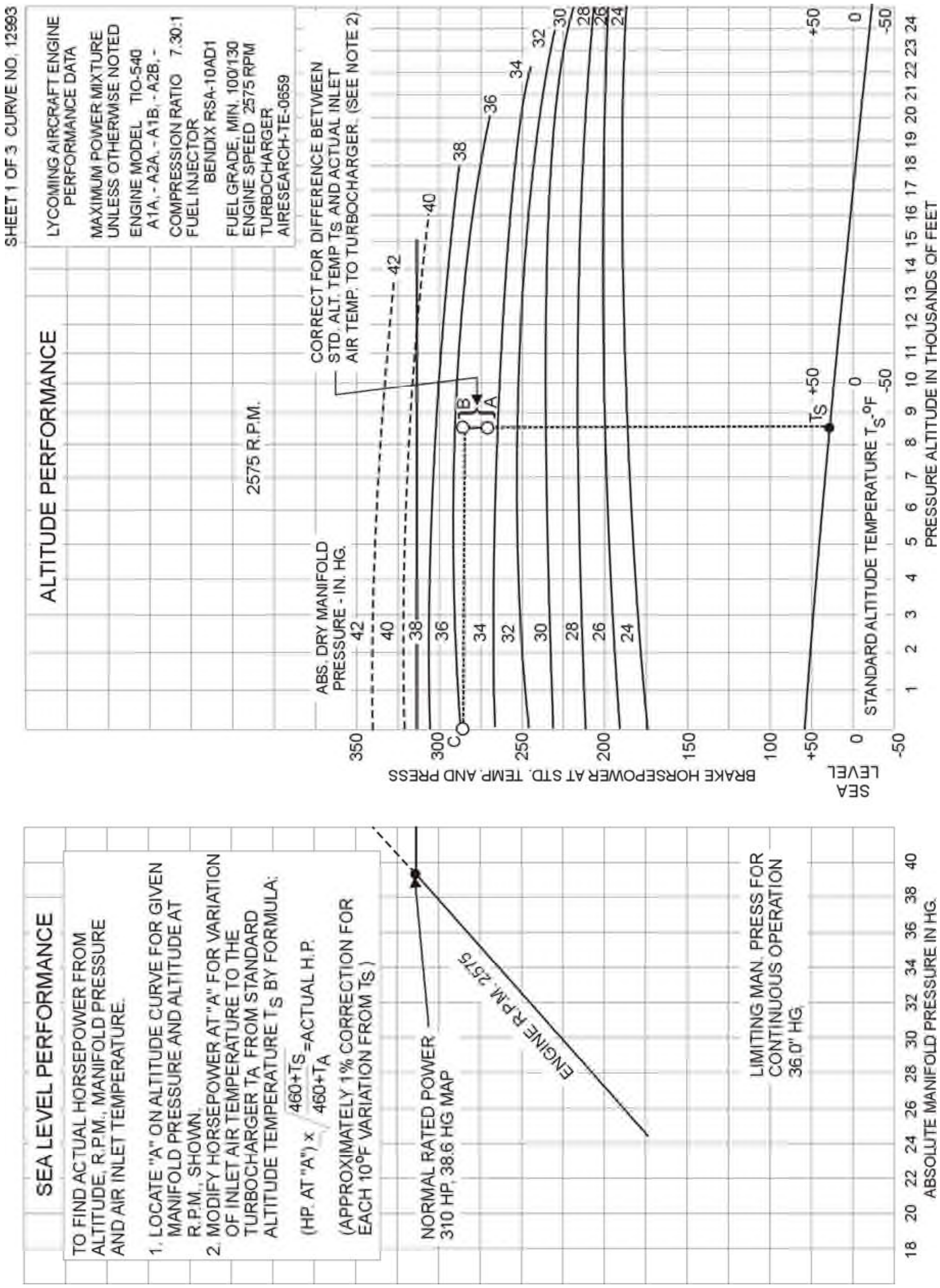

Figure 3-2. Sea Level/Altitude Performance Curve –
TIO-540-A1A, -A2A, -A1B, -A2B (Sheet 1 of 3)

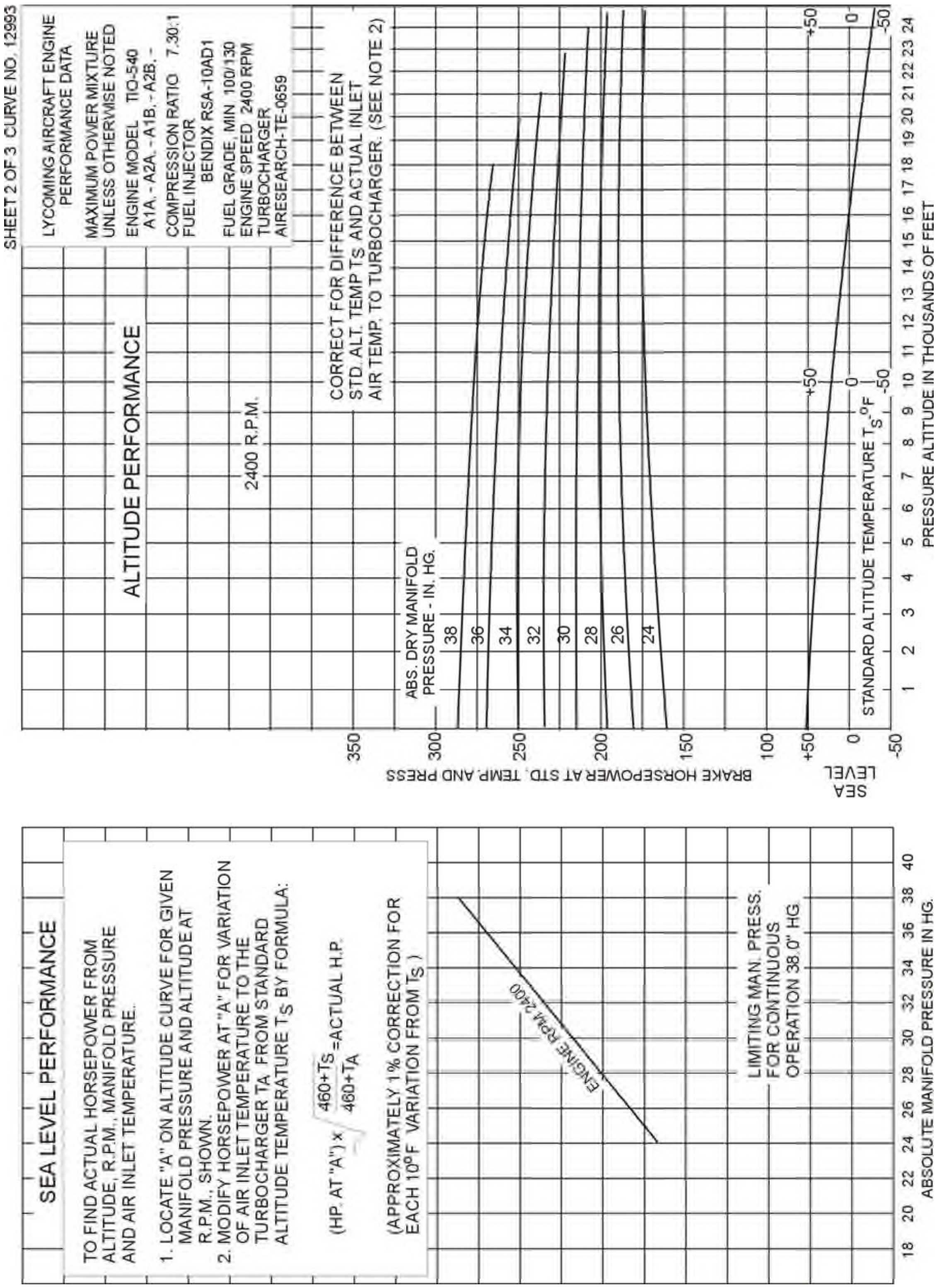

Figure 3-3. Sea Level/Altitude Performance Curve –
TIO-540-A1A, -A2A, -A1B, -A2B (Sheet 2 of 3)

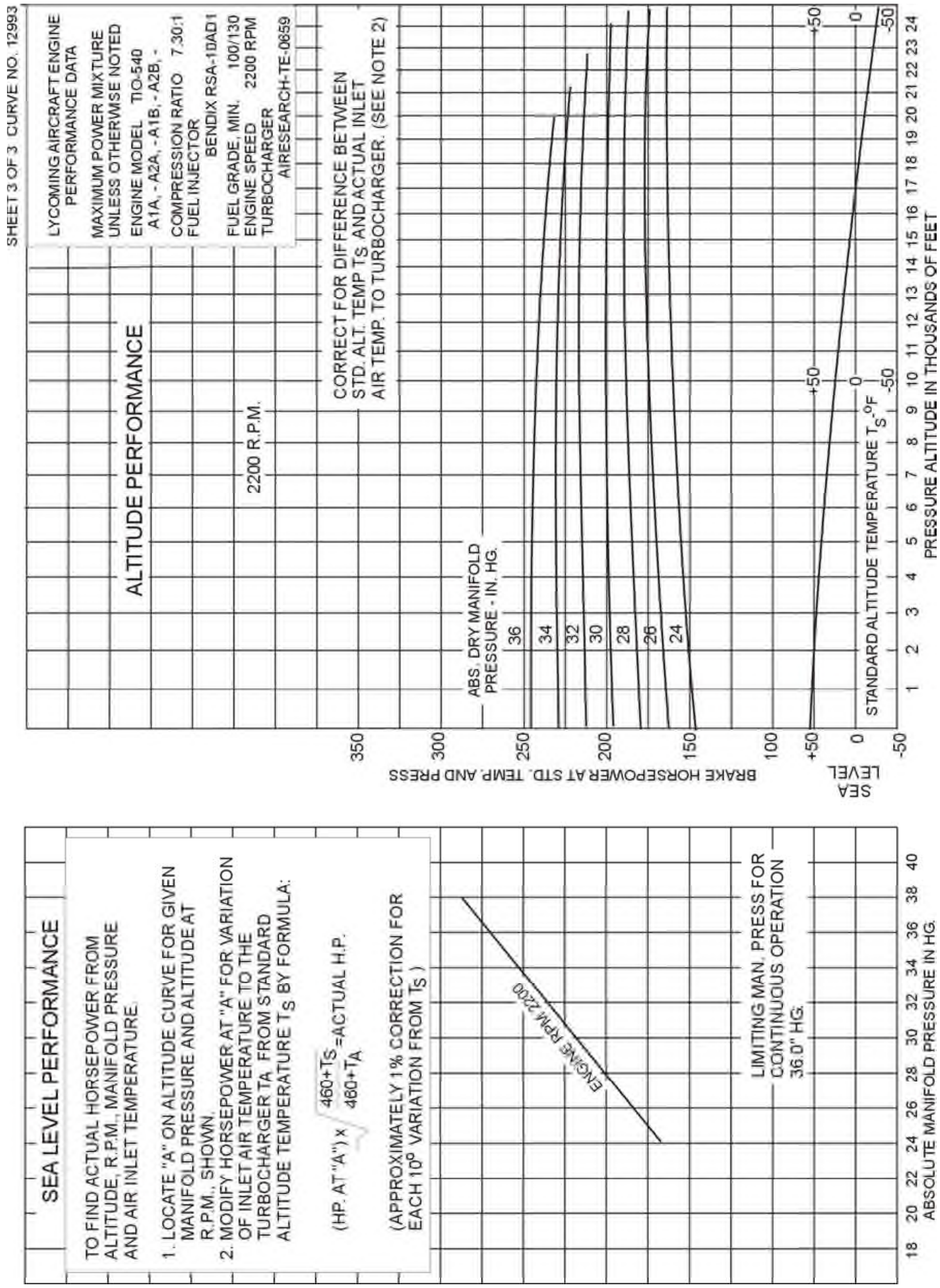

Figure 3-4. Sea Level/Altitude Performance Curve –
TIO-540-A1A, -A2A, -A1B, -A2B (Sheet 3 of 3)

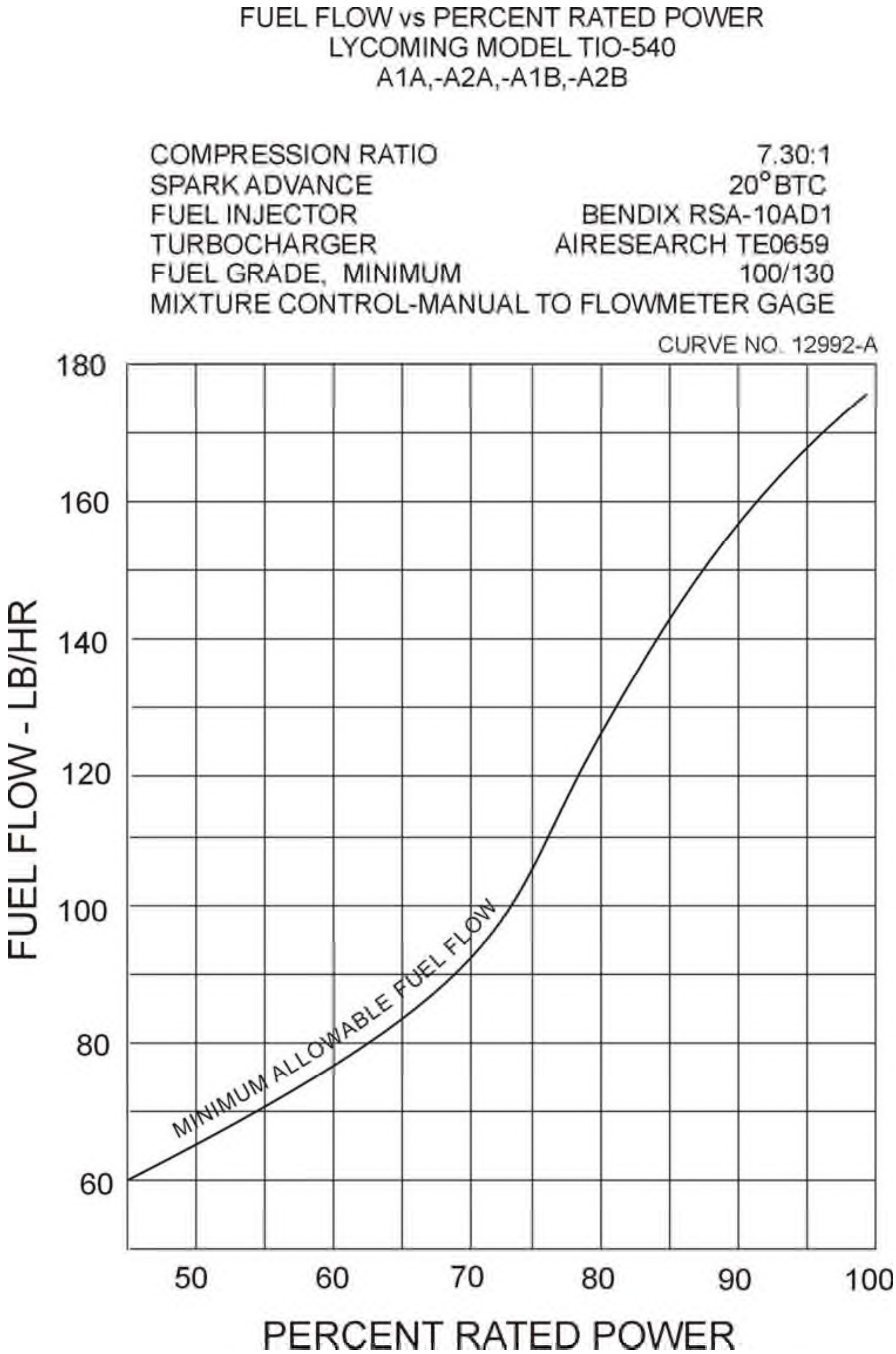

Figure 3-5. Fuel Flow vs Percent Rated Power Curve –
TIO-540-A1A, -A2A, -A1B, -A2B

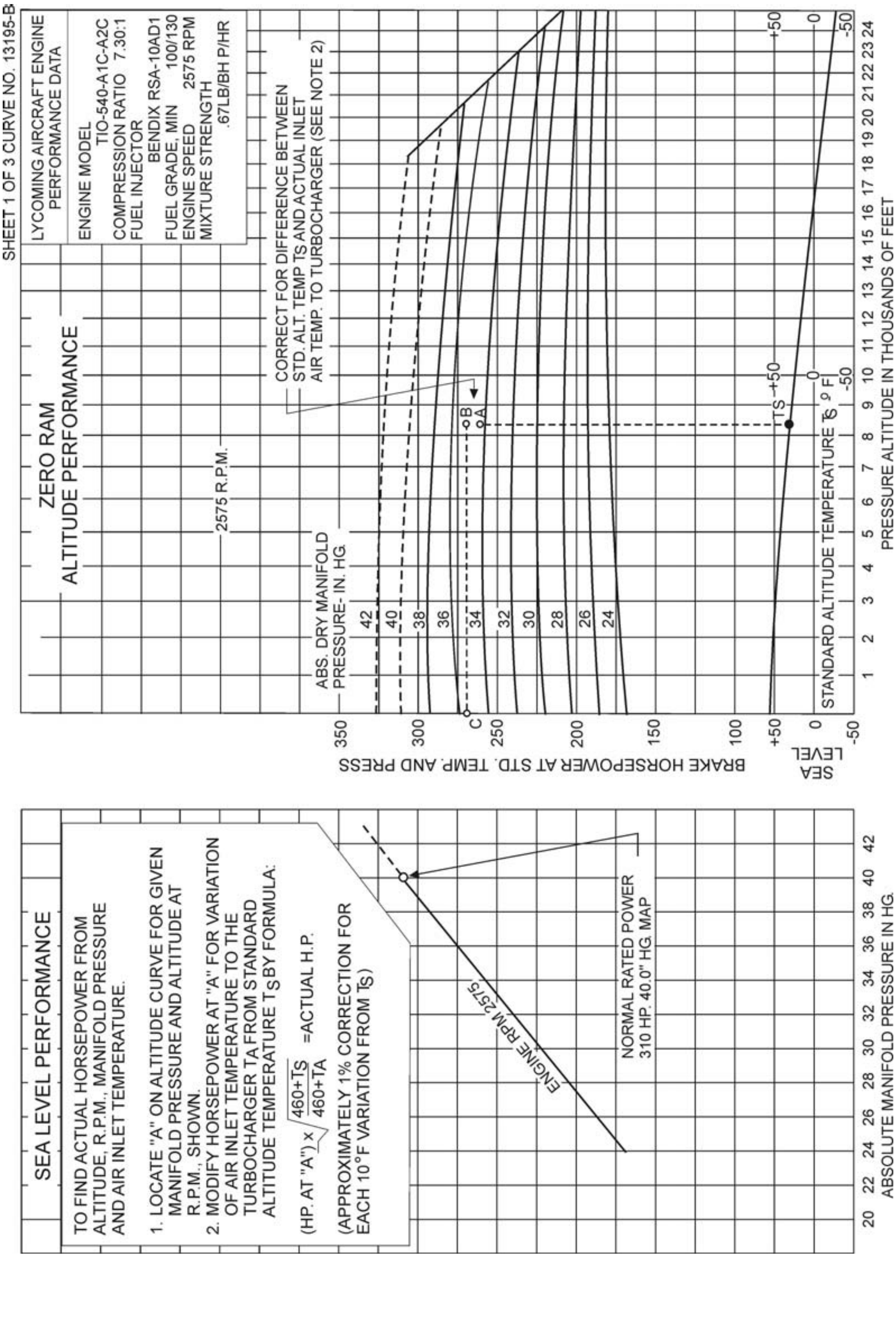

Figure 3-6. Sea Level/Altitude Performance Curve –
TIO-540-A2C (Sheet 1 of 3)

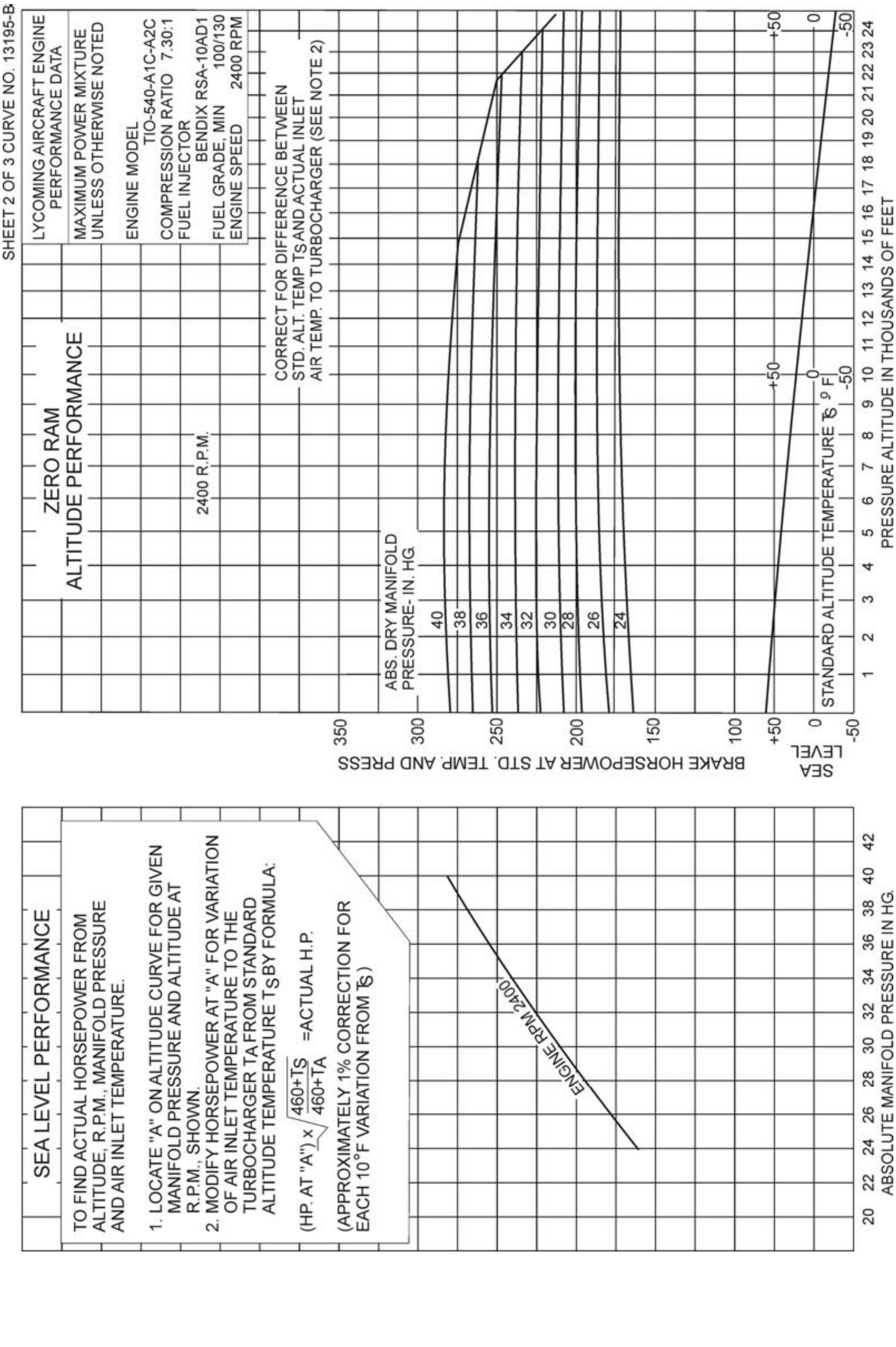

Figure 3-7. Sea Level/Altitude Performance Curve –
TIO-540-A2C (Sheet 2 of 3)

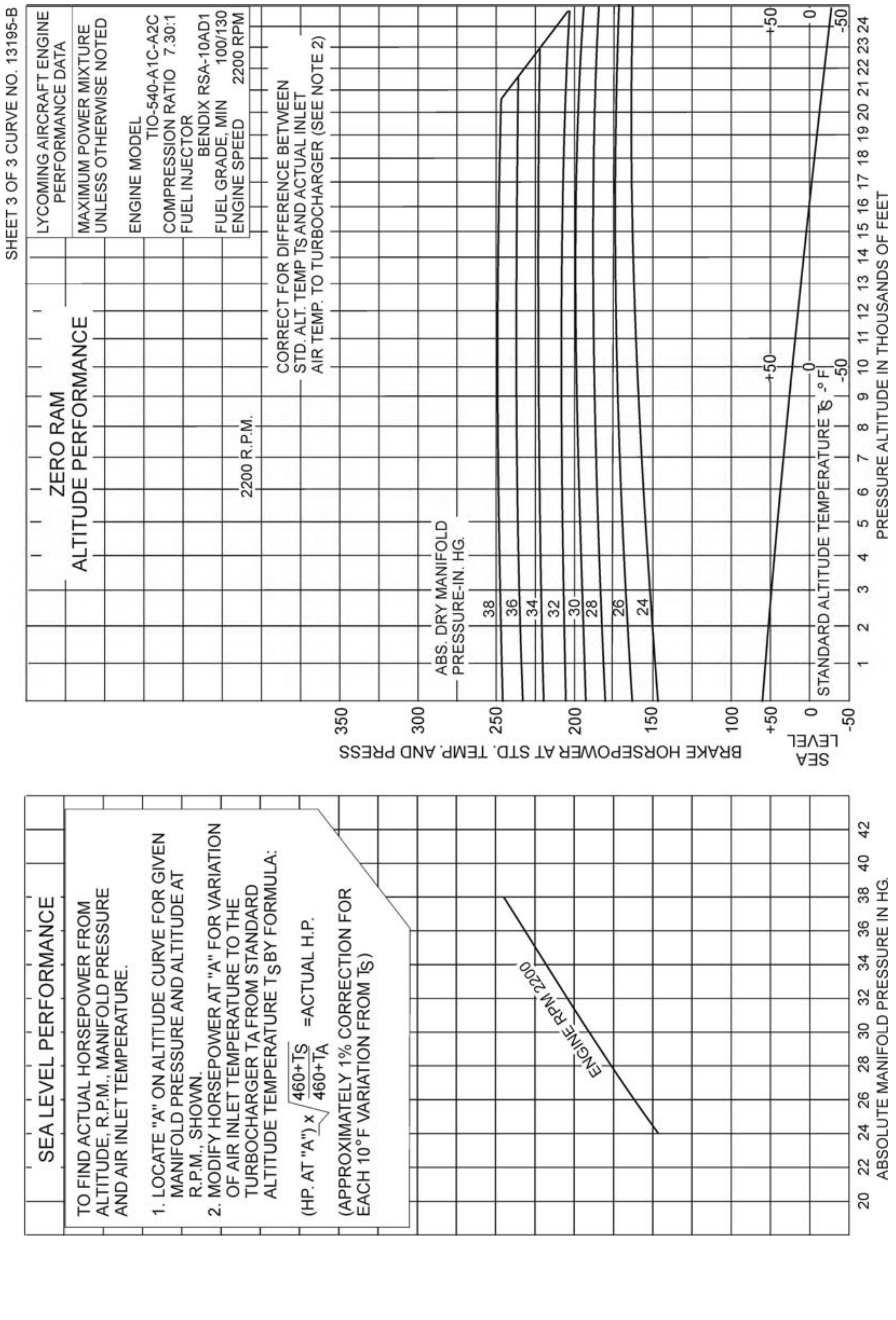

Figure 3-8. Sea Level/Altitude Performance Curve –
TIO-540-A2C (Sheet 3 of 3)

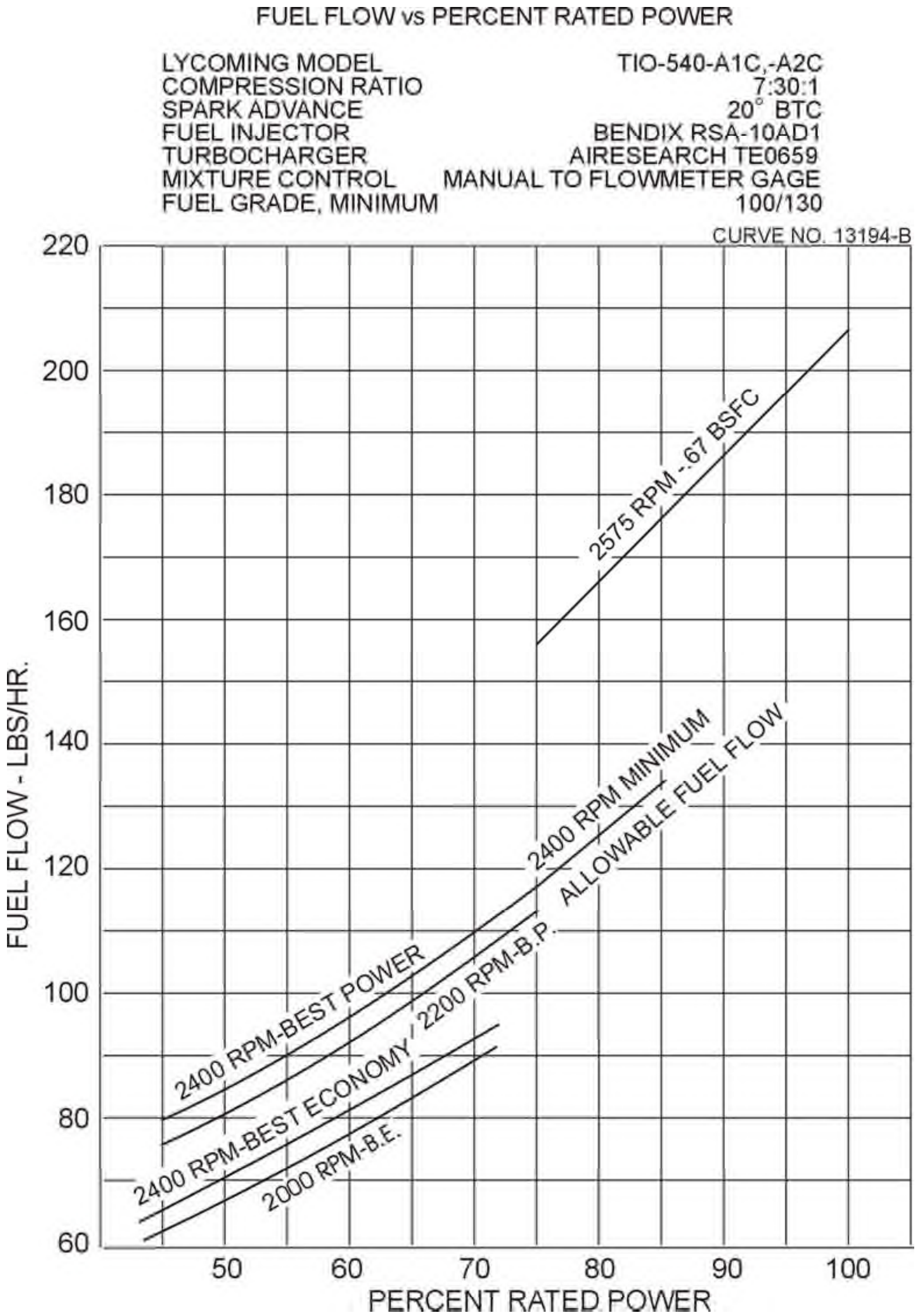

Figure 3-9. Fuel Flow vs Percent Rated Power –
TIO-540-A2C

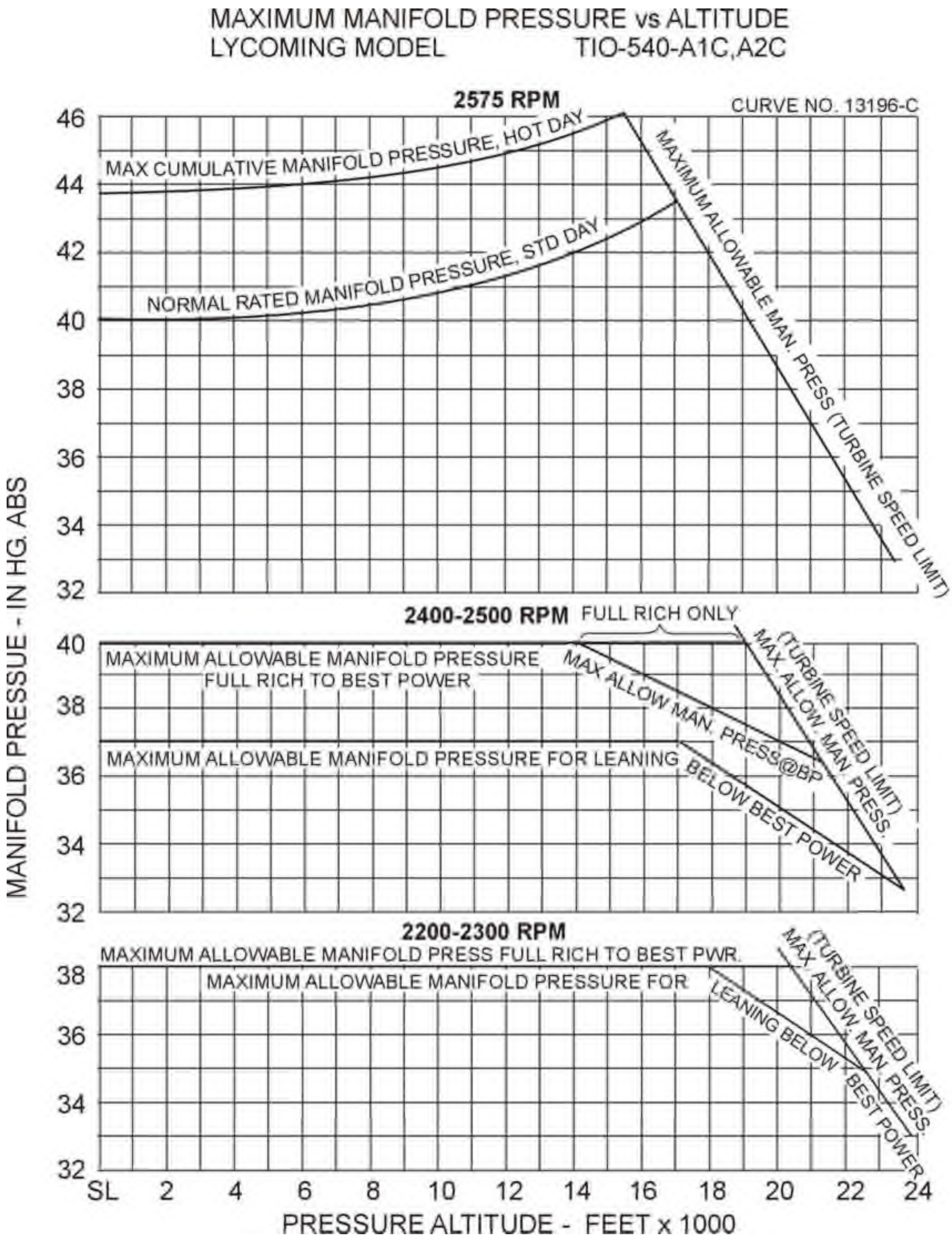

Figure 3-10. Limiting Manifold Pressure vs Altitude –
TIO-540-A2C

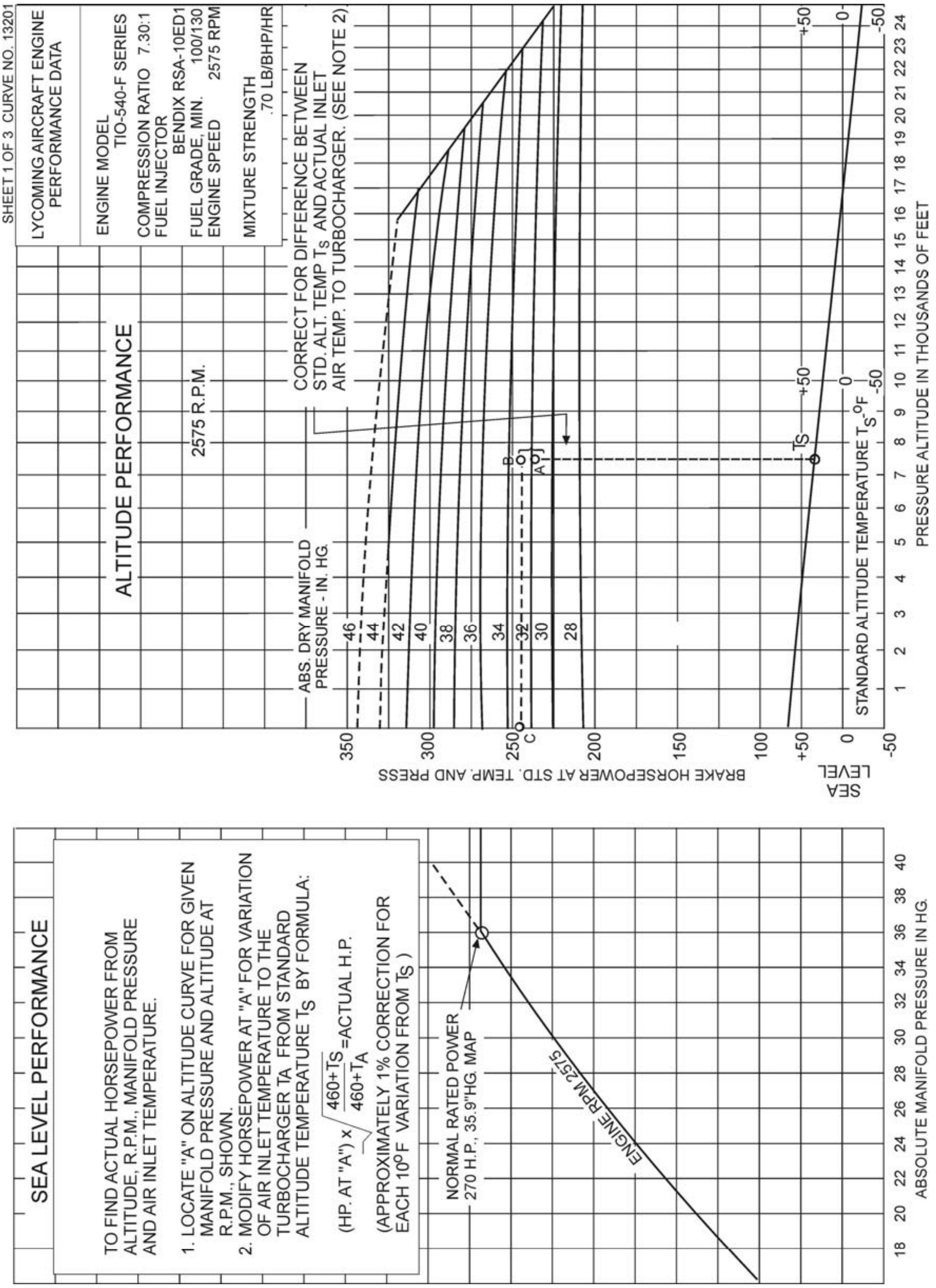

Figure 3-11. Sea Level/Altitude Performance Curve –
TIO-540-F2BD (Sheet 1 of 3)

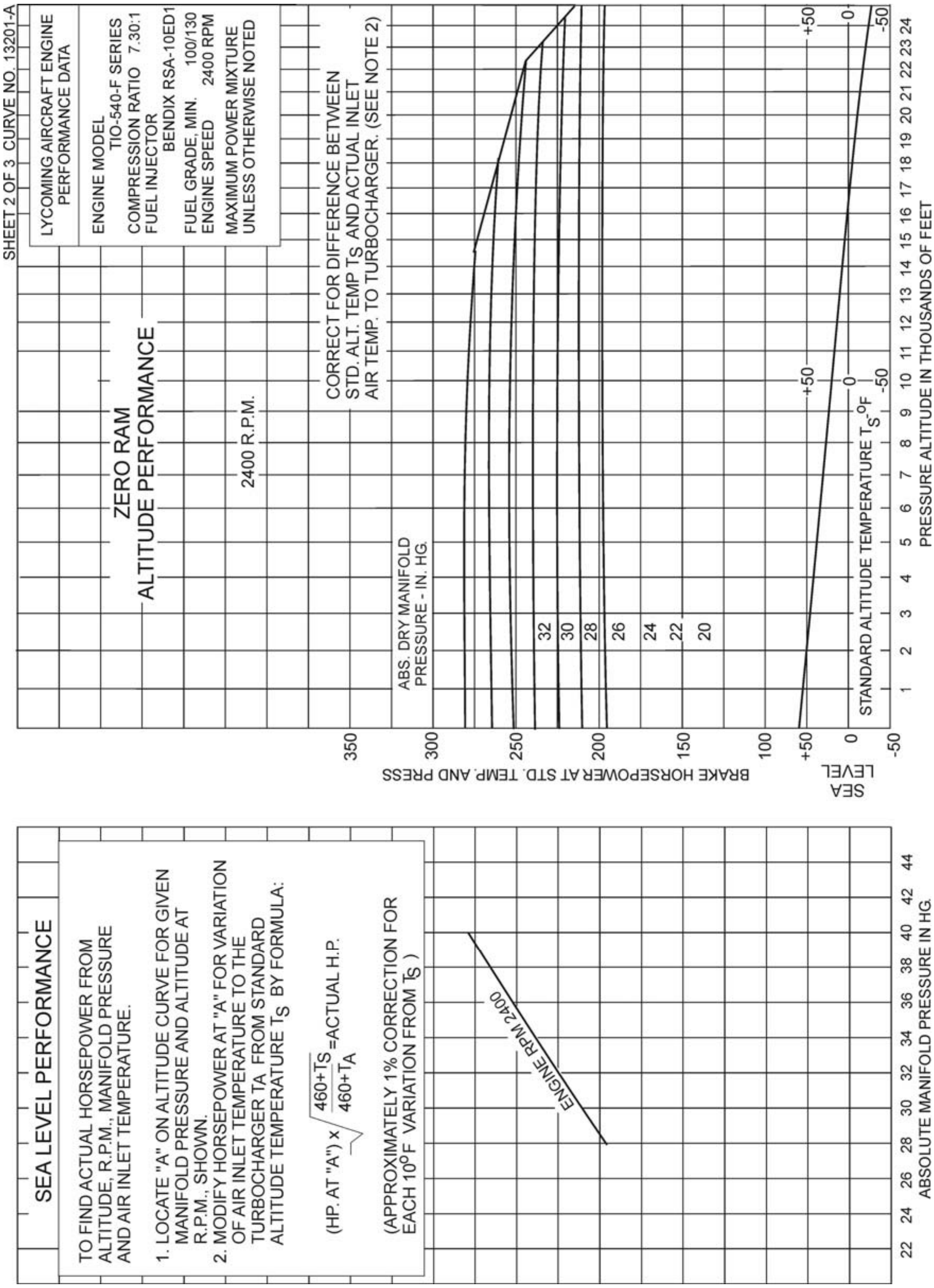

Figure 3-12. Sea Level/Altitude Performance Curve –
TIO-540-F2BD (Sheet 2 of 3)

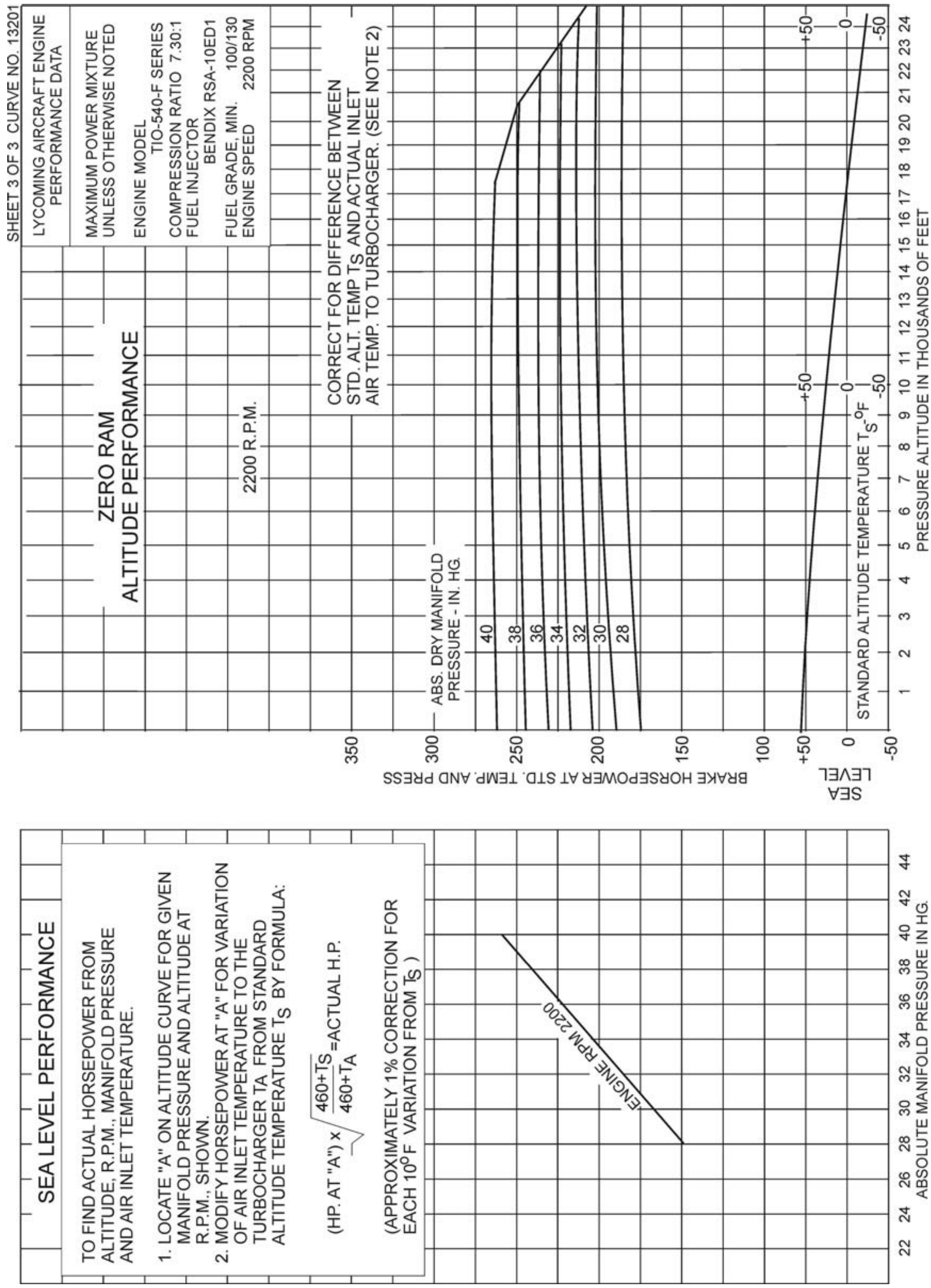

Figure 3-13. Sea Level/Altitude Performance Curve –
TIO-540-F2BD (Sheet 3 of 3)

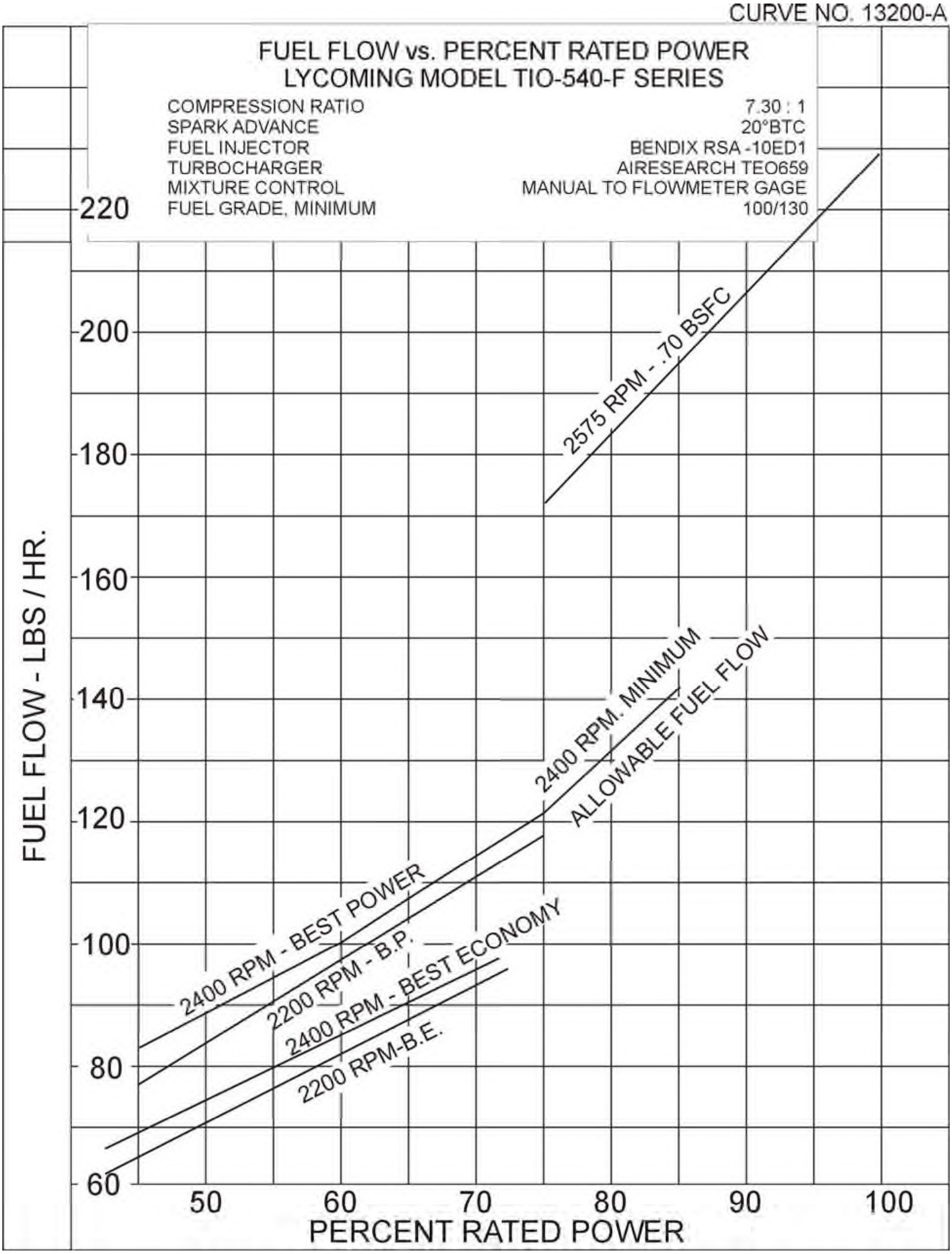

Figure 3-14. Fuel Flow vs Percent Rated Power –
TIO-540-F2BD

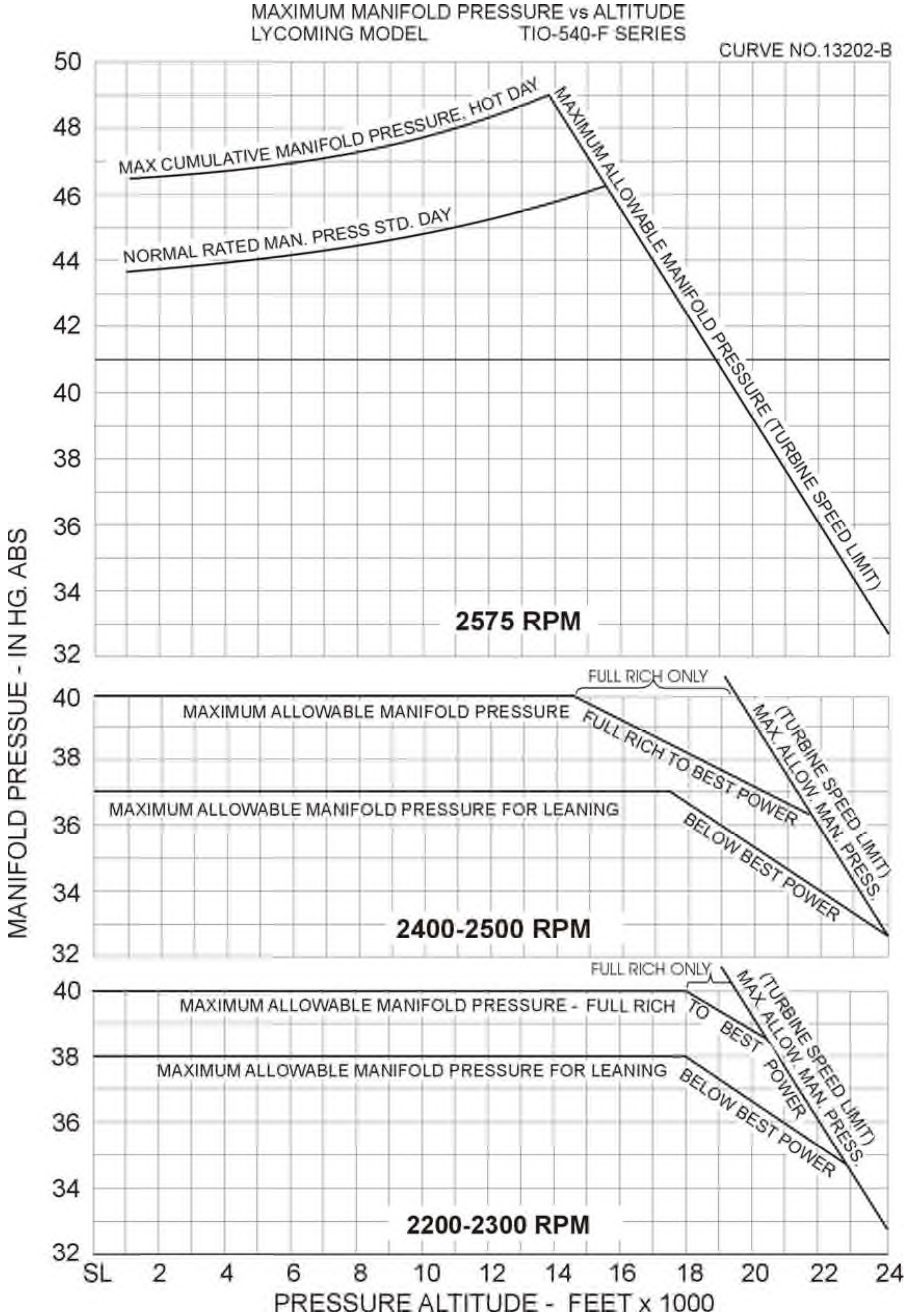

Figure 3-15. Maximum Manifold Pressure vs Altitude –
TIO-540-F2BD

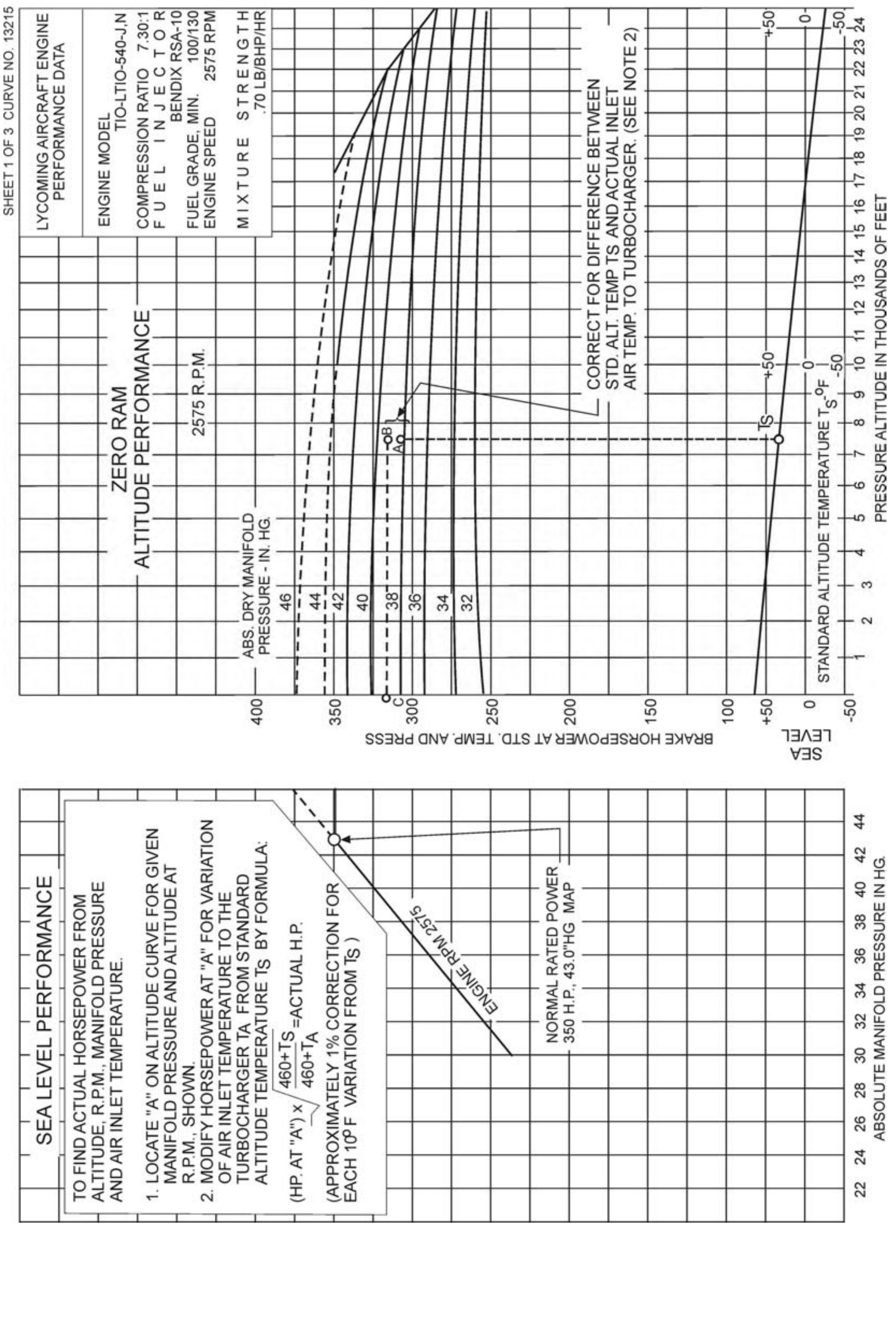

Figure 3-16. Sea Level/Altitude Performance Curve –
TIO-540-J2B, -J2BD, -N2BD (Sheet 1 of 3)

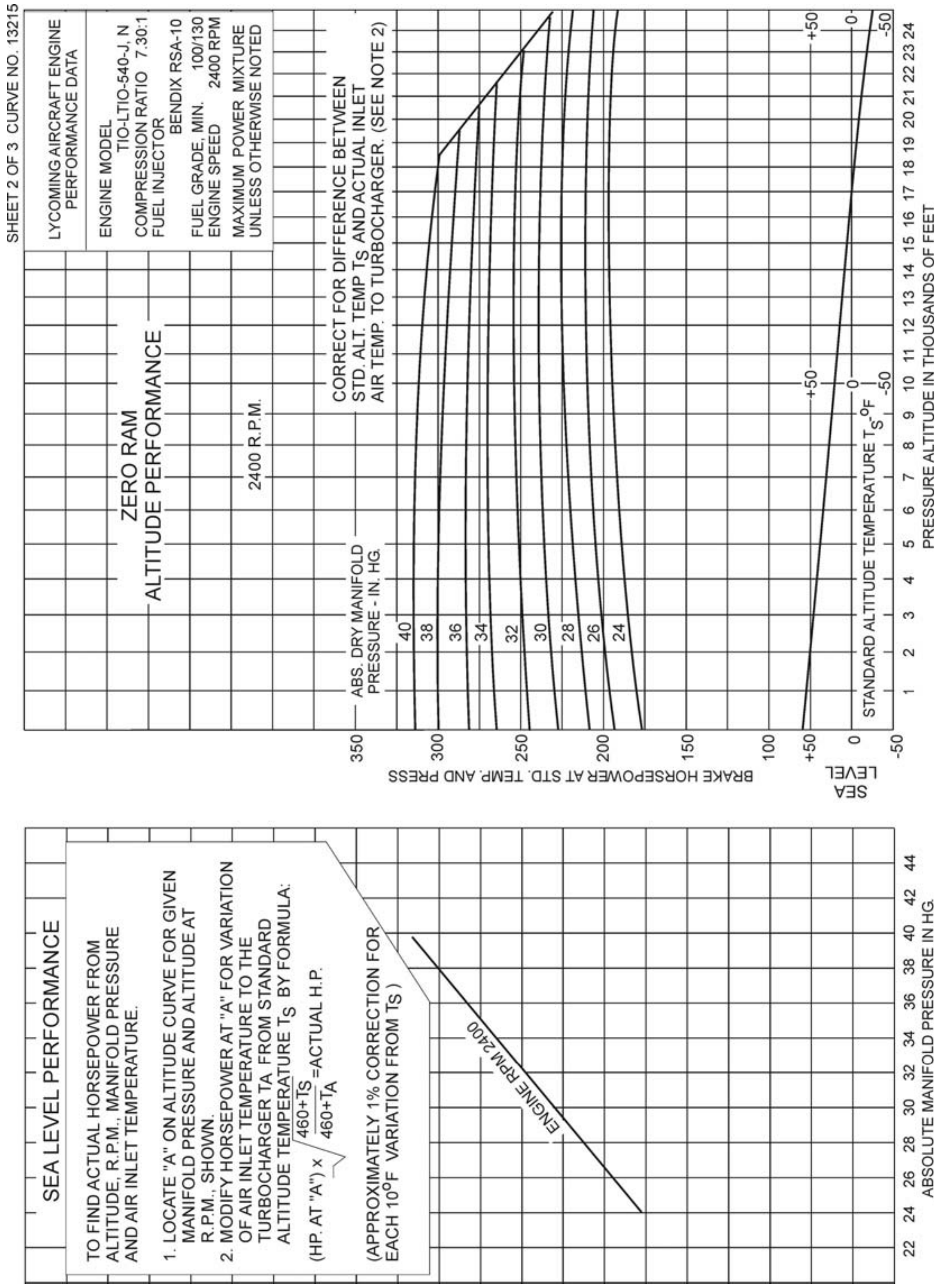

Figure 3-17. Sea Level/Altitude Performance Curve –
TIO-540-J2B, -J2BD, -N2BD (Sheet 2 of 3)

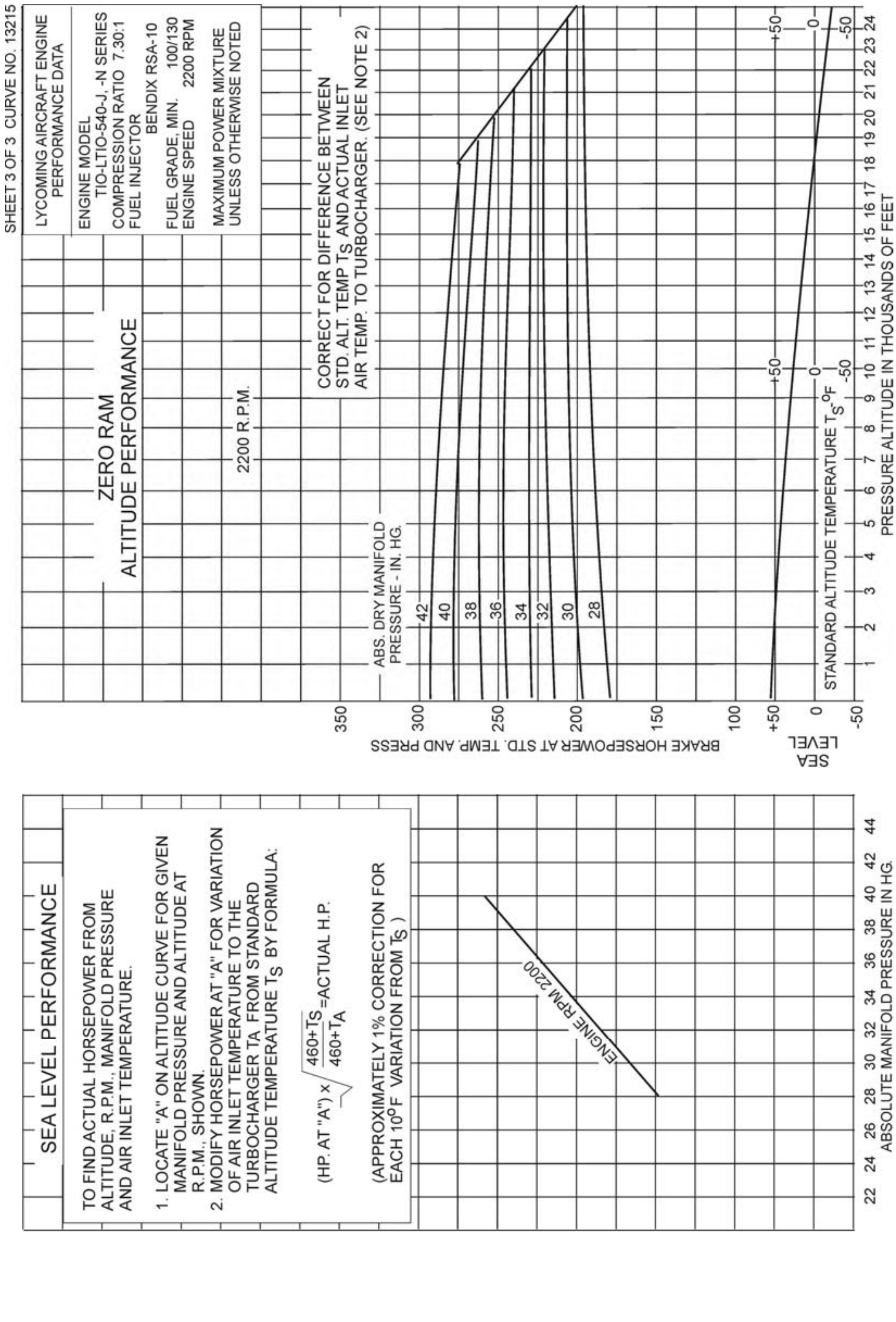

Figure 3-18. Sea Level/Altitude Performance Curve –
TIO-540-J2B, -J2BD, -N2BD (Sheet 3 of 3)

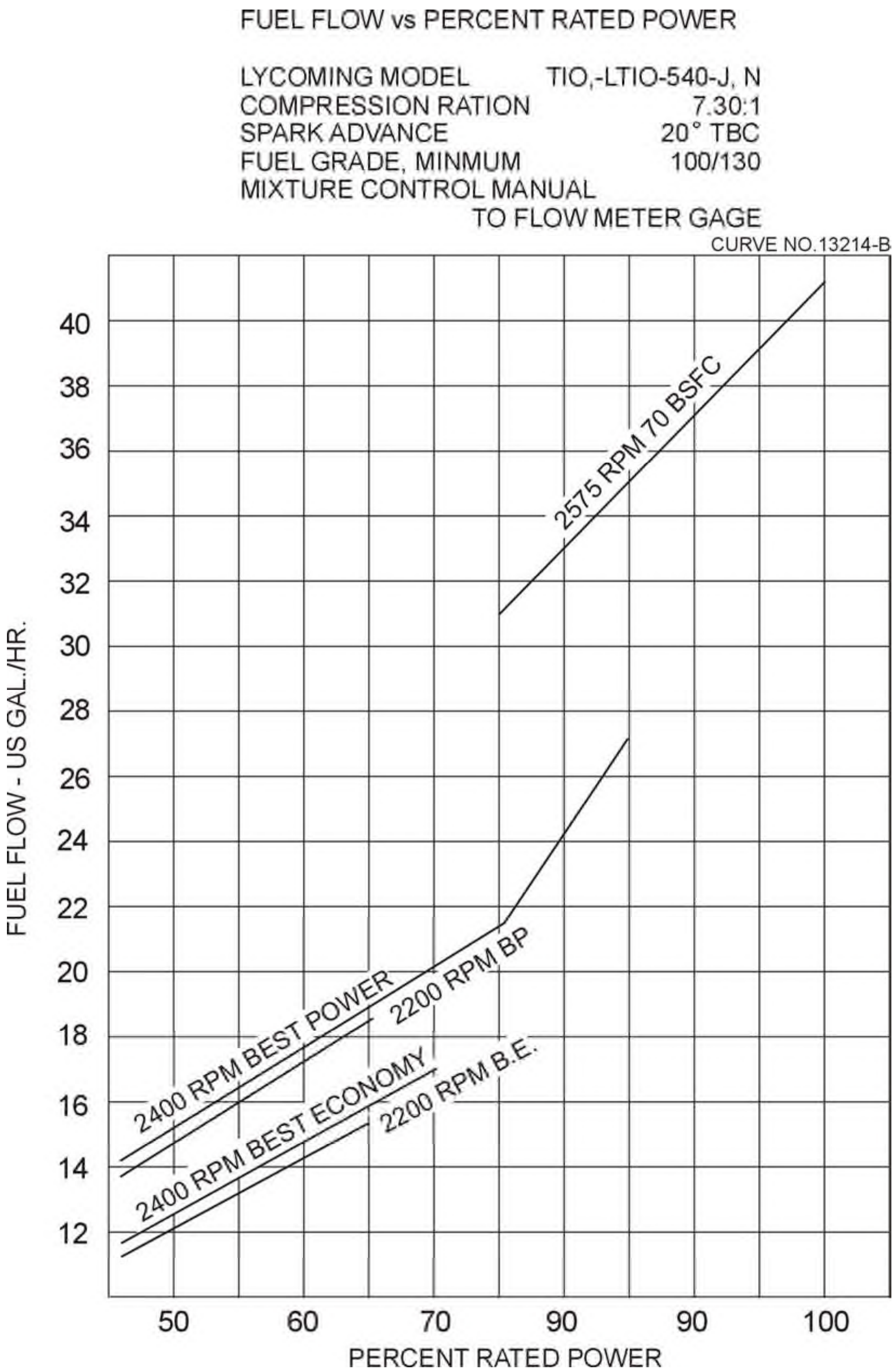

Figure 3-19. Fuel Flow vs Percent Rated Power –
TIO-540-J2B, -J2BD, -N2BD

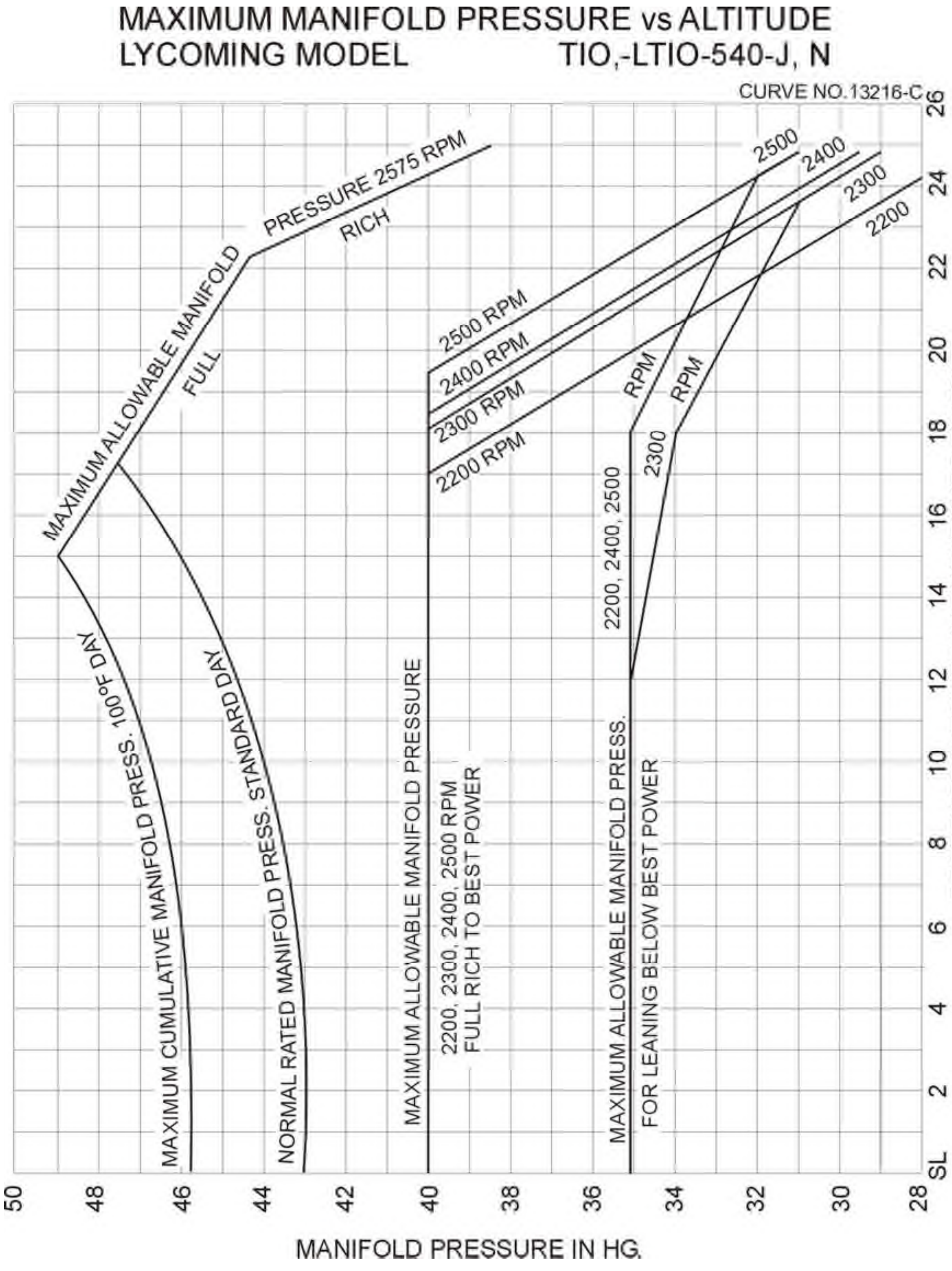

Figure 3-20. Maximum Manifold Pressure vs Altitude –
TIO-540-J2B, -J2BD, -N2BD

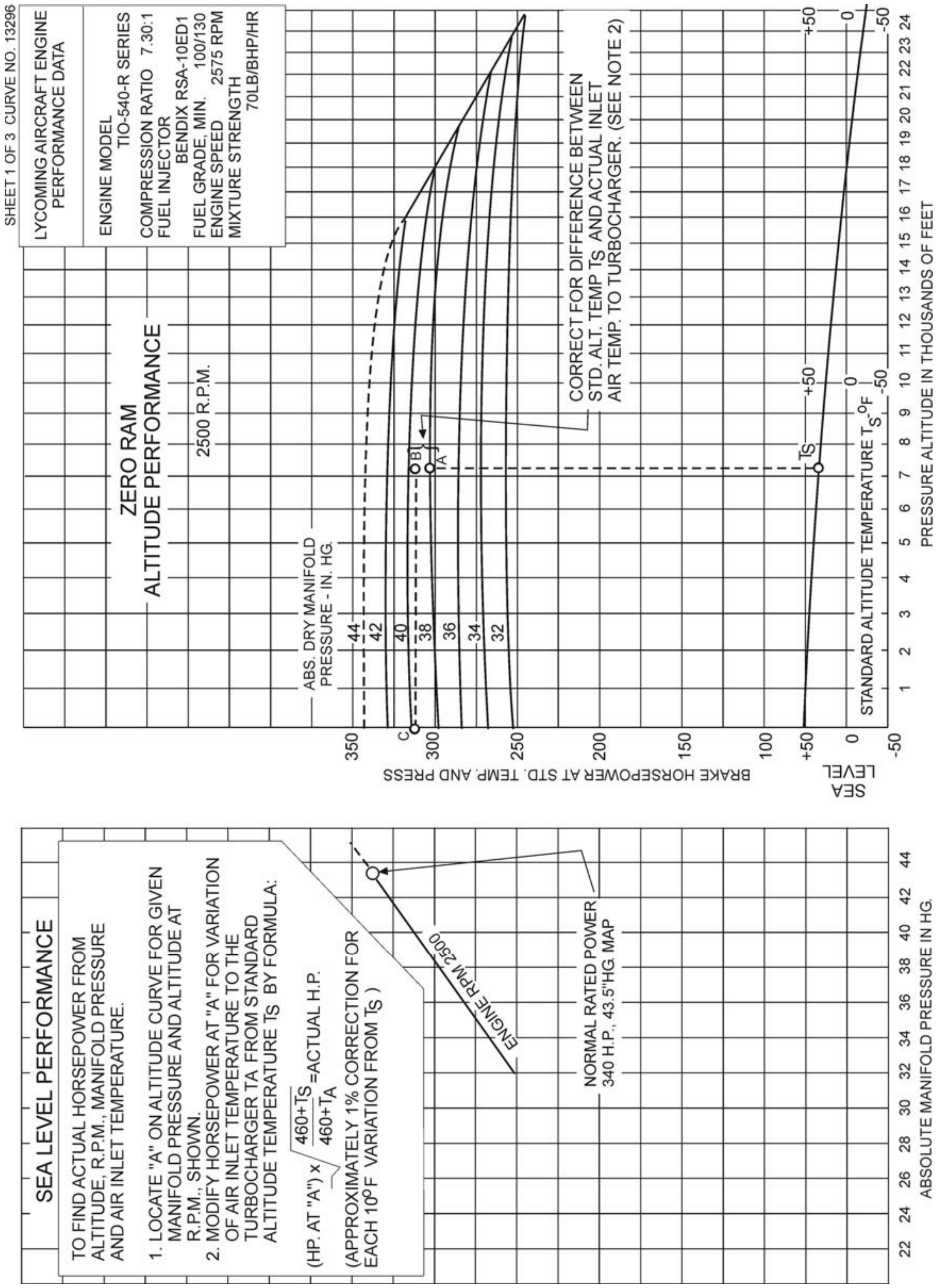

Figure 3-21. Sea Level/Altitude Performance Curve –
TIO-540-R2AD (Sheet 1 of 3)

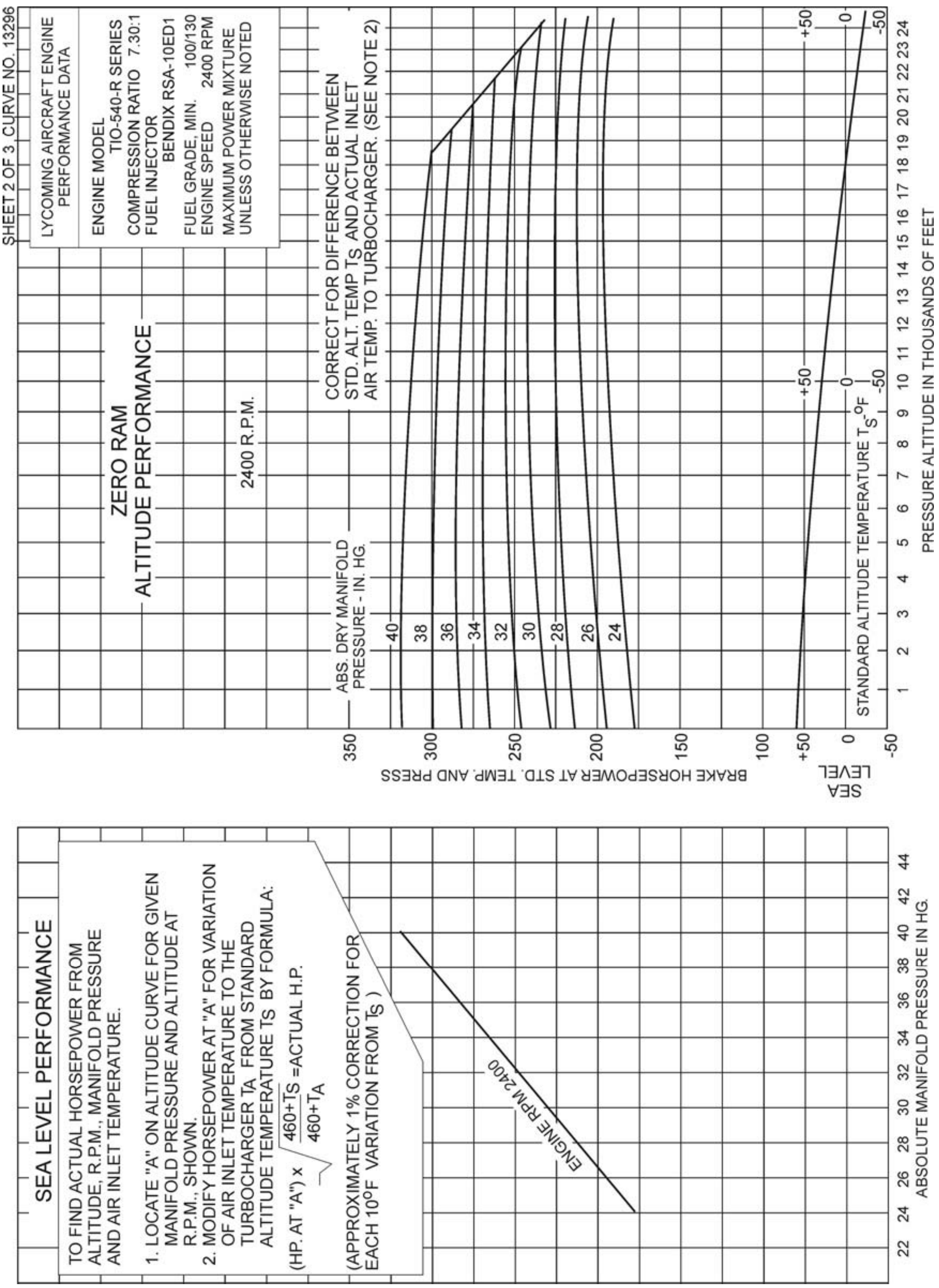

Figure 3-22. Sea Level/Altitude Performance Curve –
TIO-540-R2AD (Sheet 2 of 3)

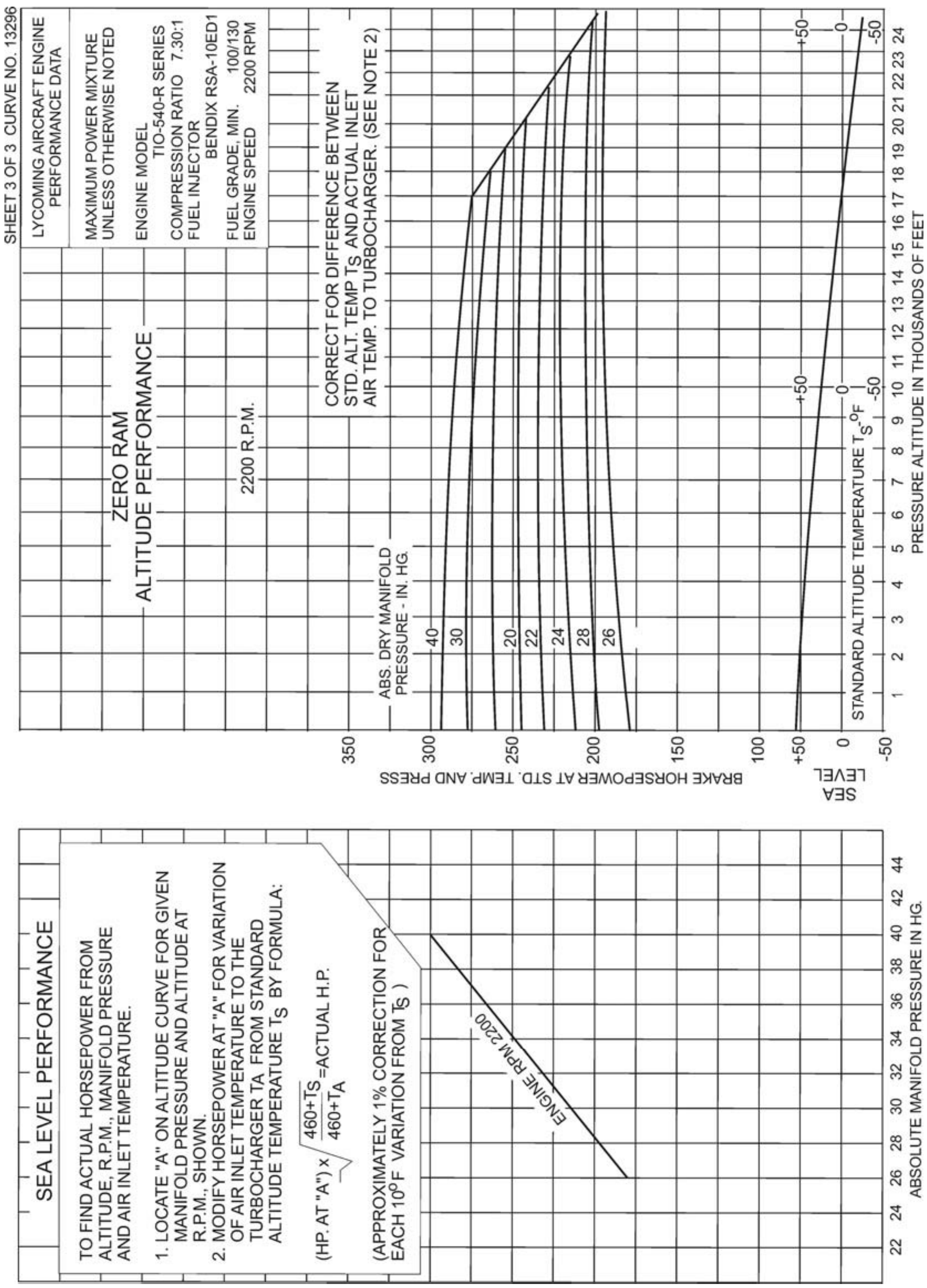

Figure 3-23. Sea Level/Altitude Performance Curve –
TIO-540-R2AD (Sheet 3 of 3)

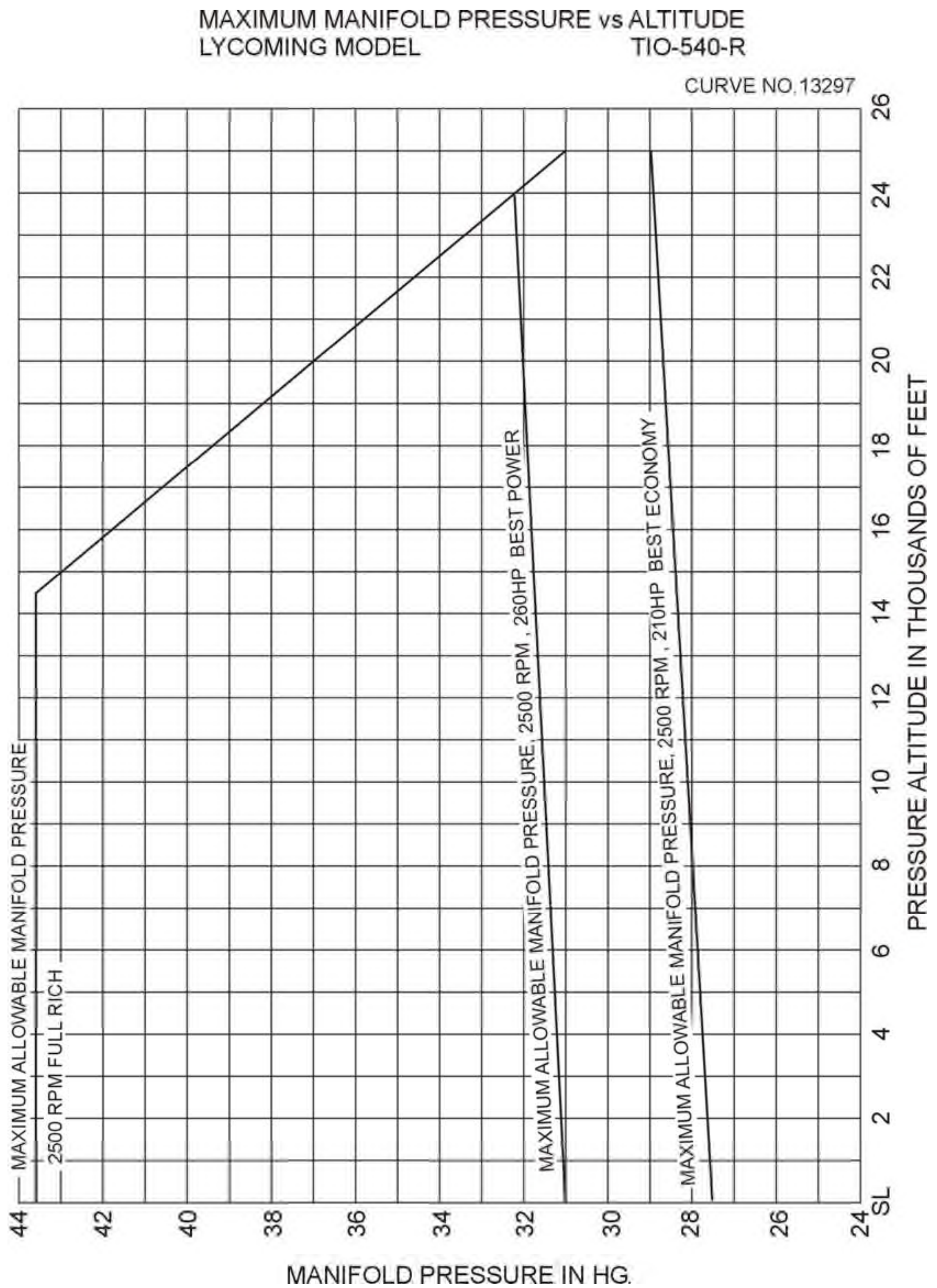

Figure 3-24. Maximum Manifold Pressure vs Altitude –
TIO-540-R2AD

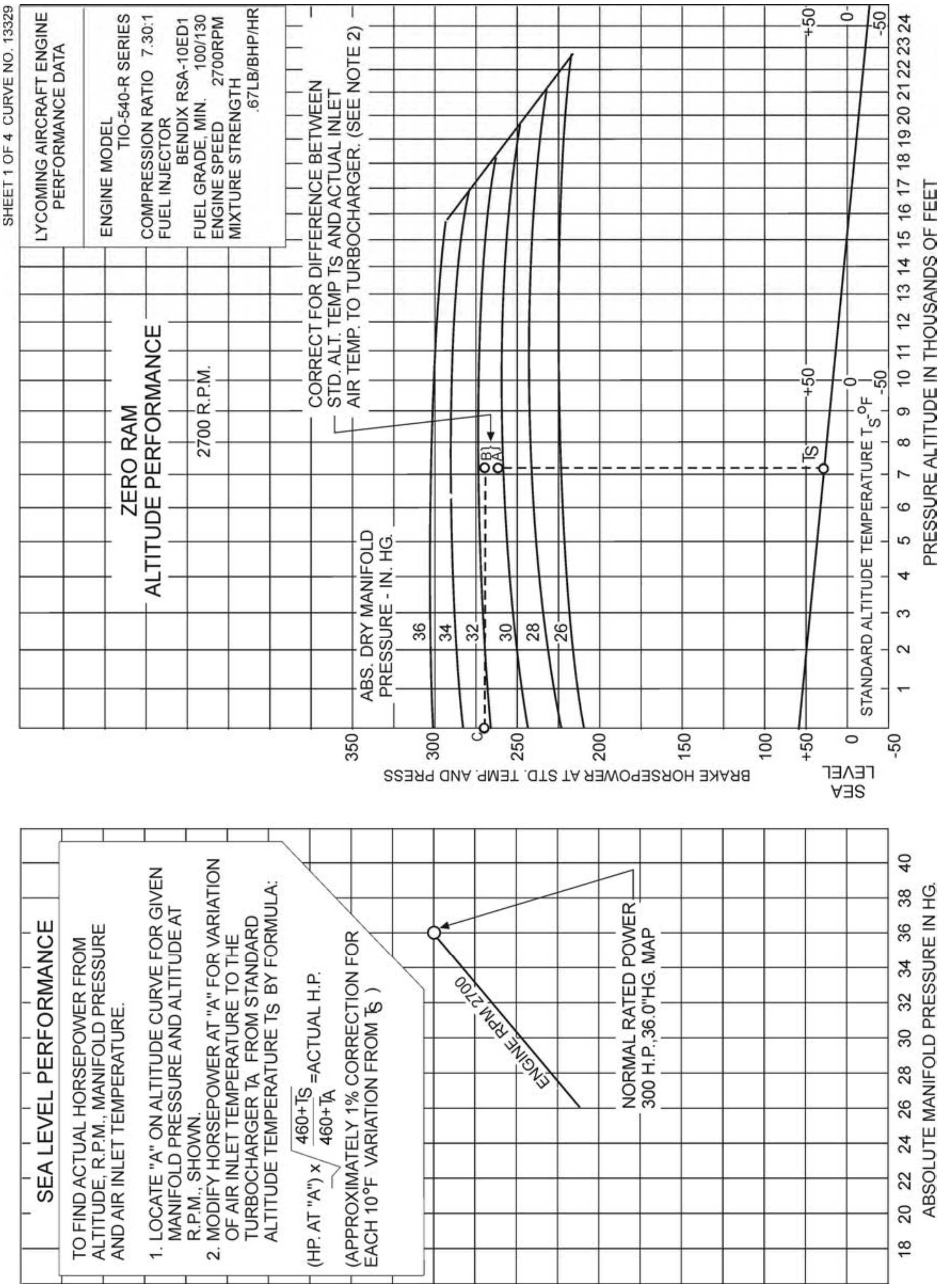

Figure 3-25. Sea Level/Altitude Performance Curve –
TIO-540-S1AD (Sheet 1 of 4)

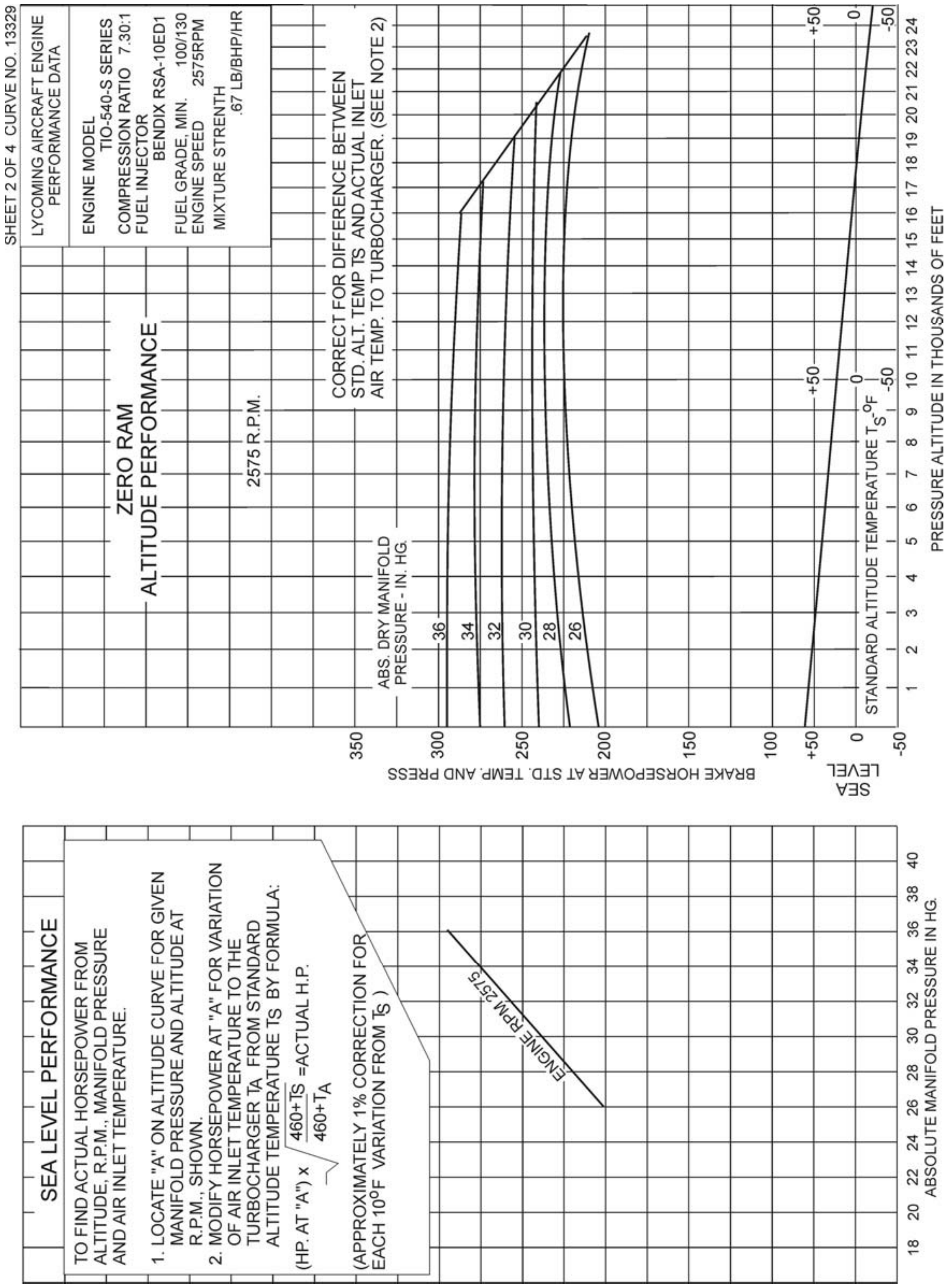

Figure 3-26. Sea Level/Altitude Performance Curve –
TIO-540-S1AD (Sheet 2 of 4)

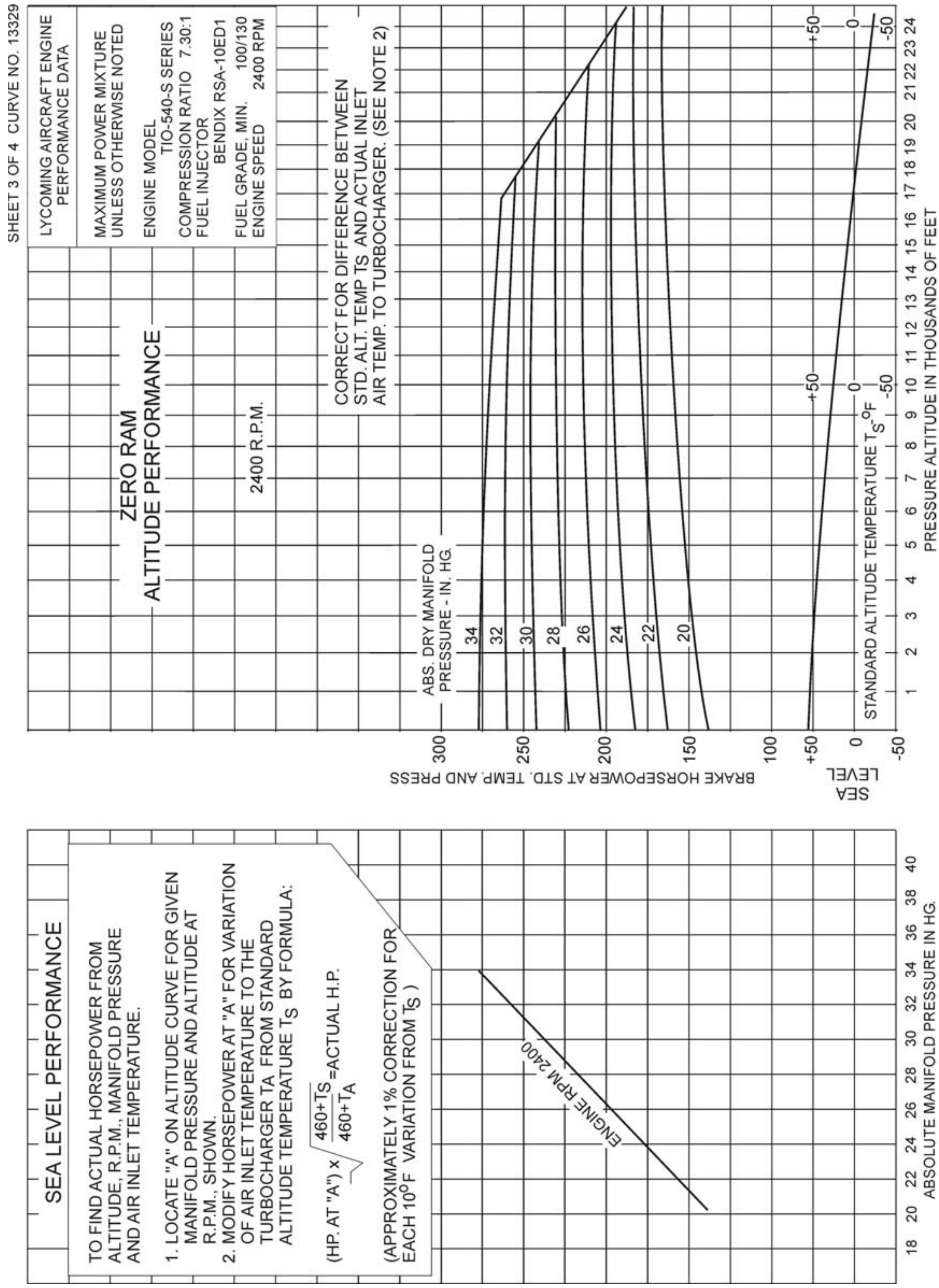

Figure 3-27. Sea Level/Altitude Performance Curve –
TIO-540-S1AD (Sheet 3 of 4)

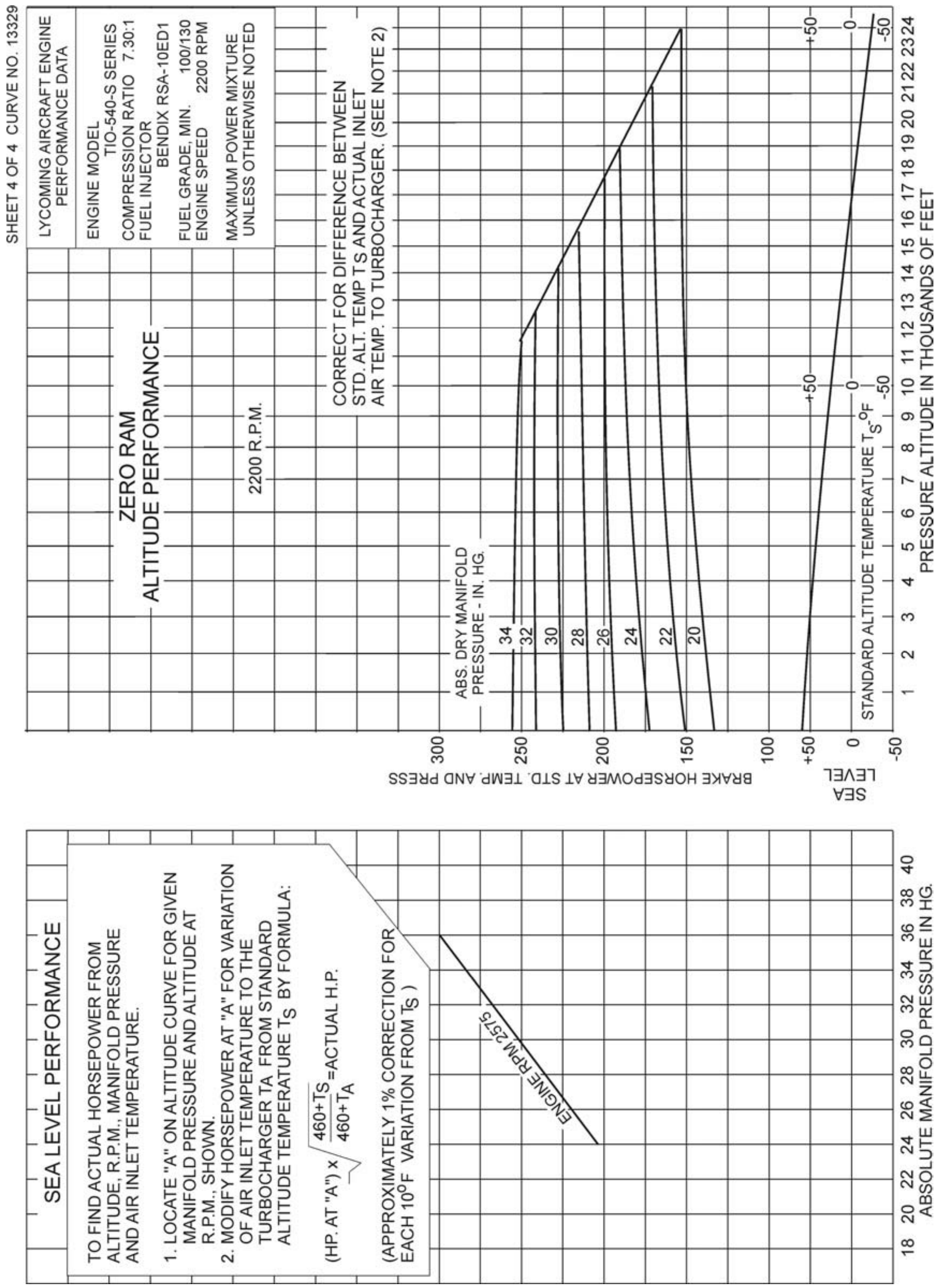

Figure 3-28. Sea Level/Altitude Performance Curve –
TIO-540-S1AD (Sheet 4 of 4)

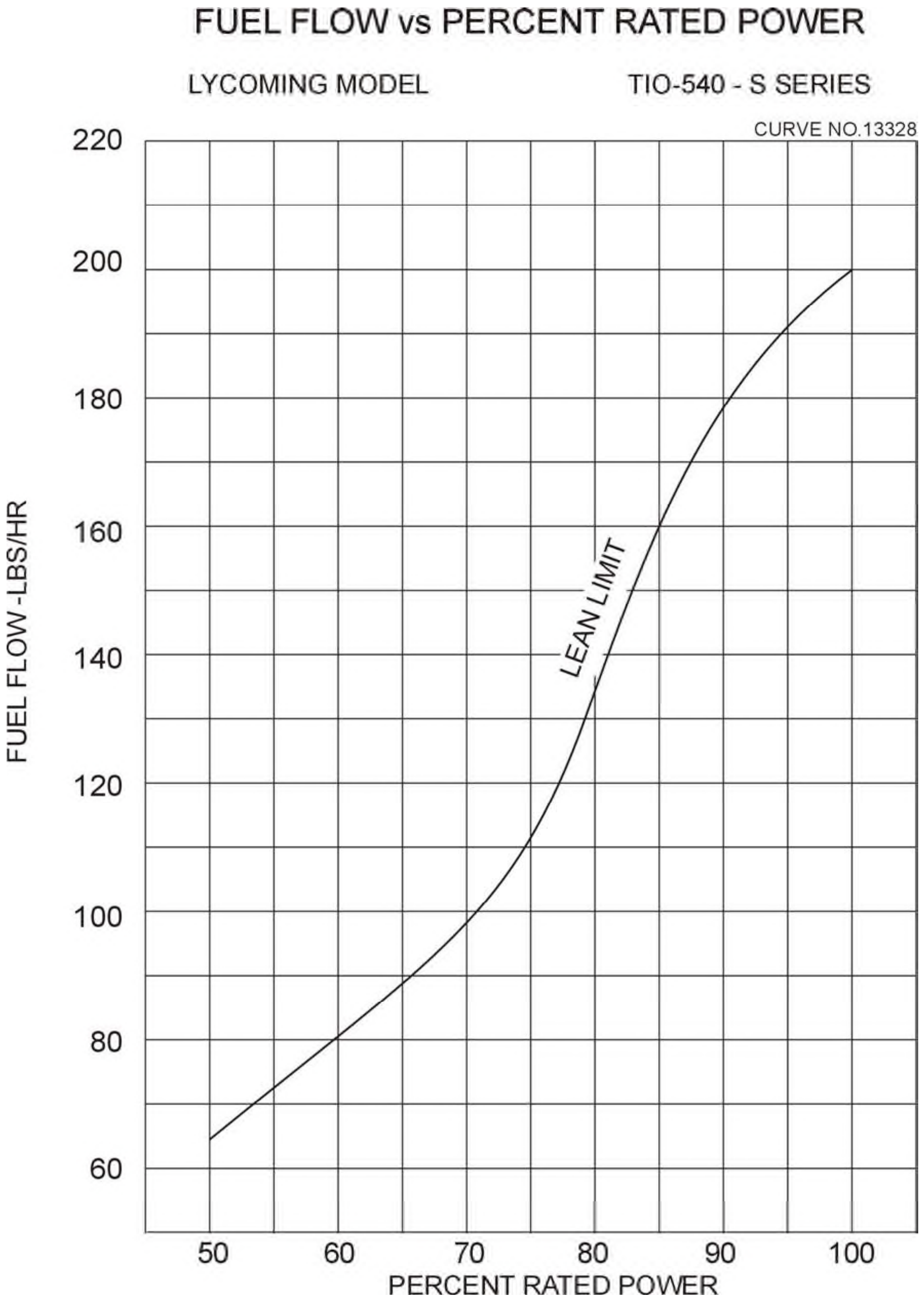

Figure 3-29. Fuel Flow vs Percent Rated Power –
TIO-540-S1AD

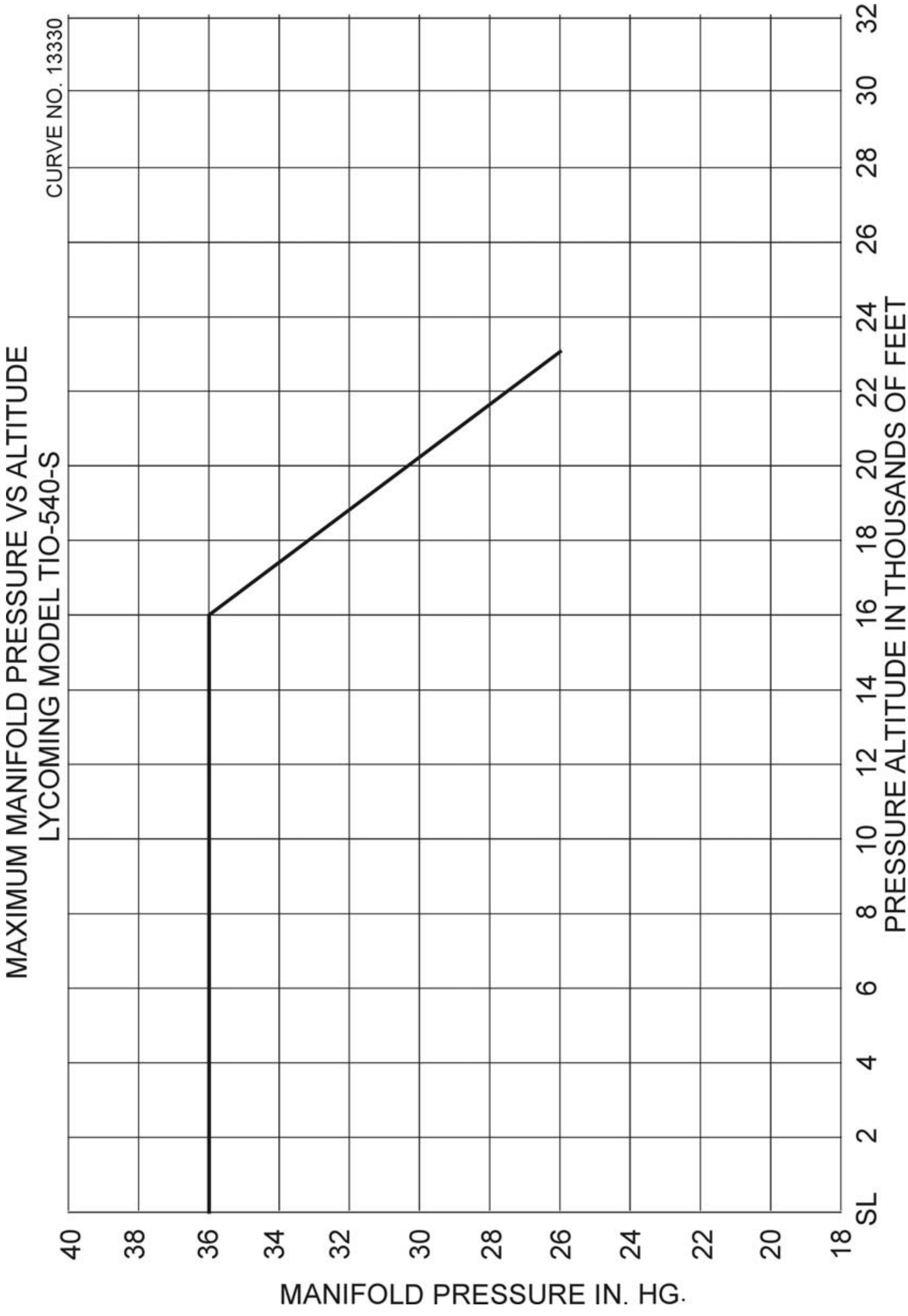

Figure 3-30. Maximum Manifold Pressure vs Altitude –
TIO-540-S1AD

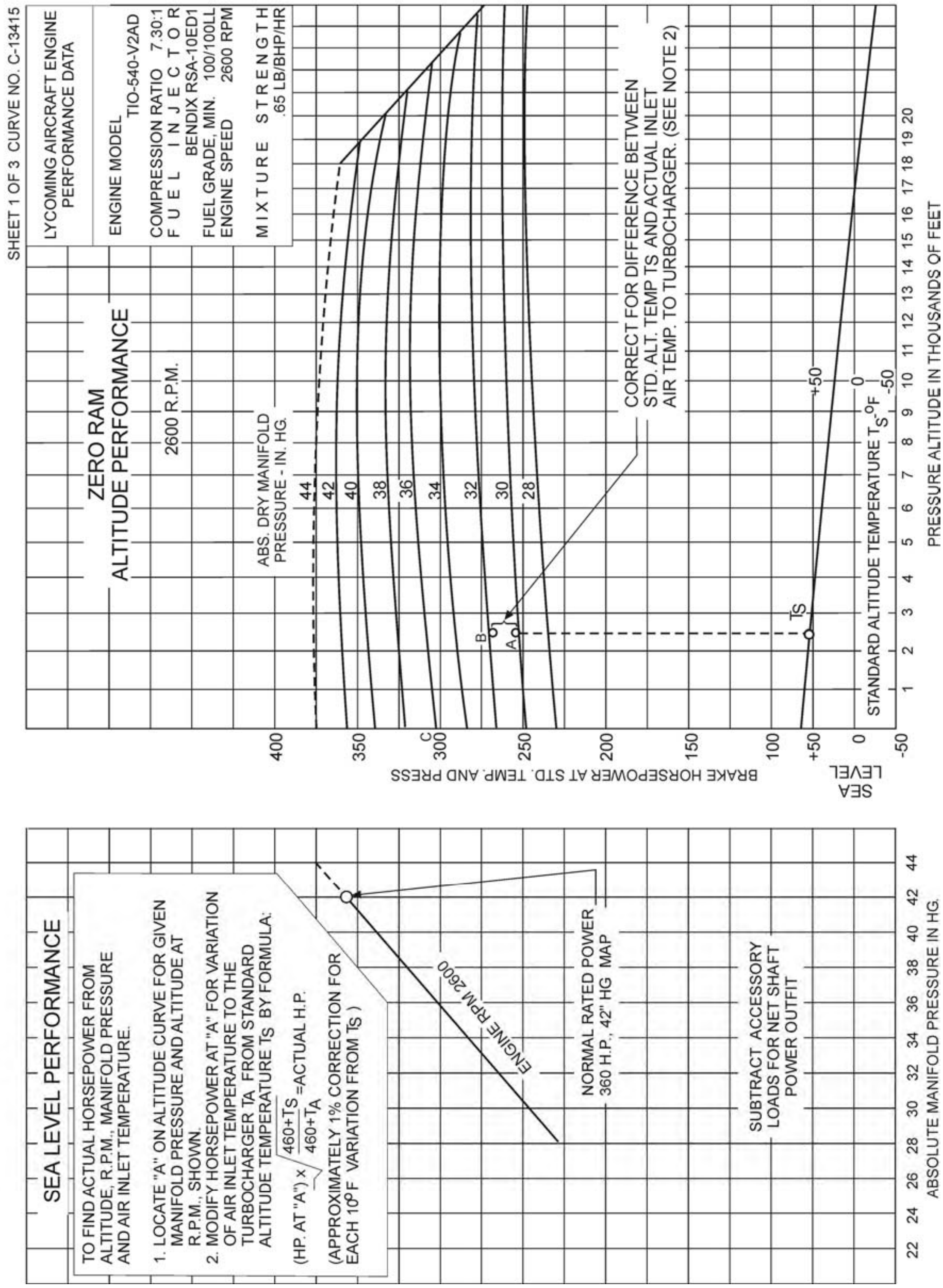

Figure 3-31. Sea Level/Altitude Performance Curve –
TIO-540-V2AD (Sheet 1 of 3)

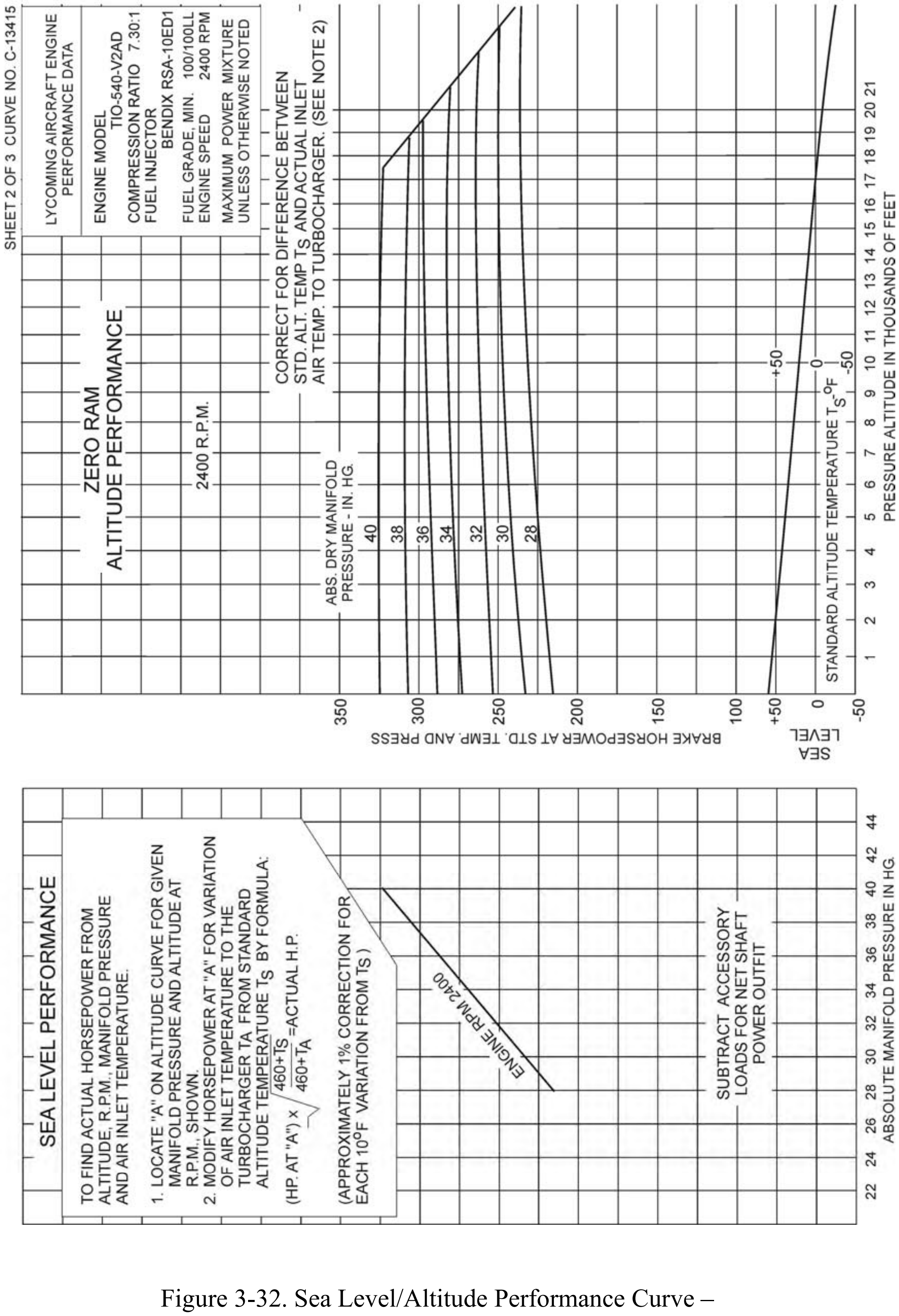

Figure 3-32. Sea Level/Altitude Performance Curve –
TIO-540-V2AD (Sheet 2 of 3)

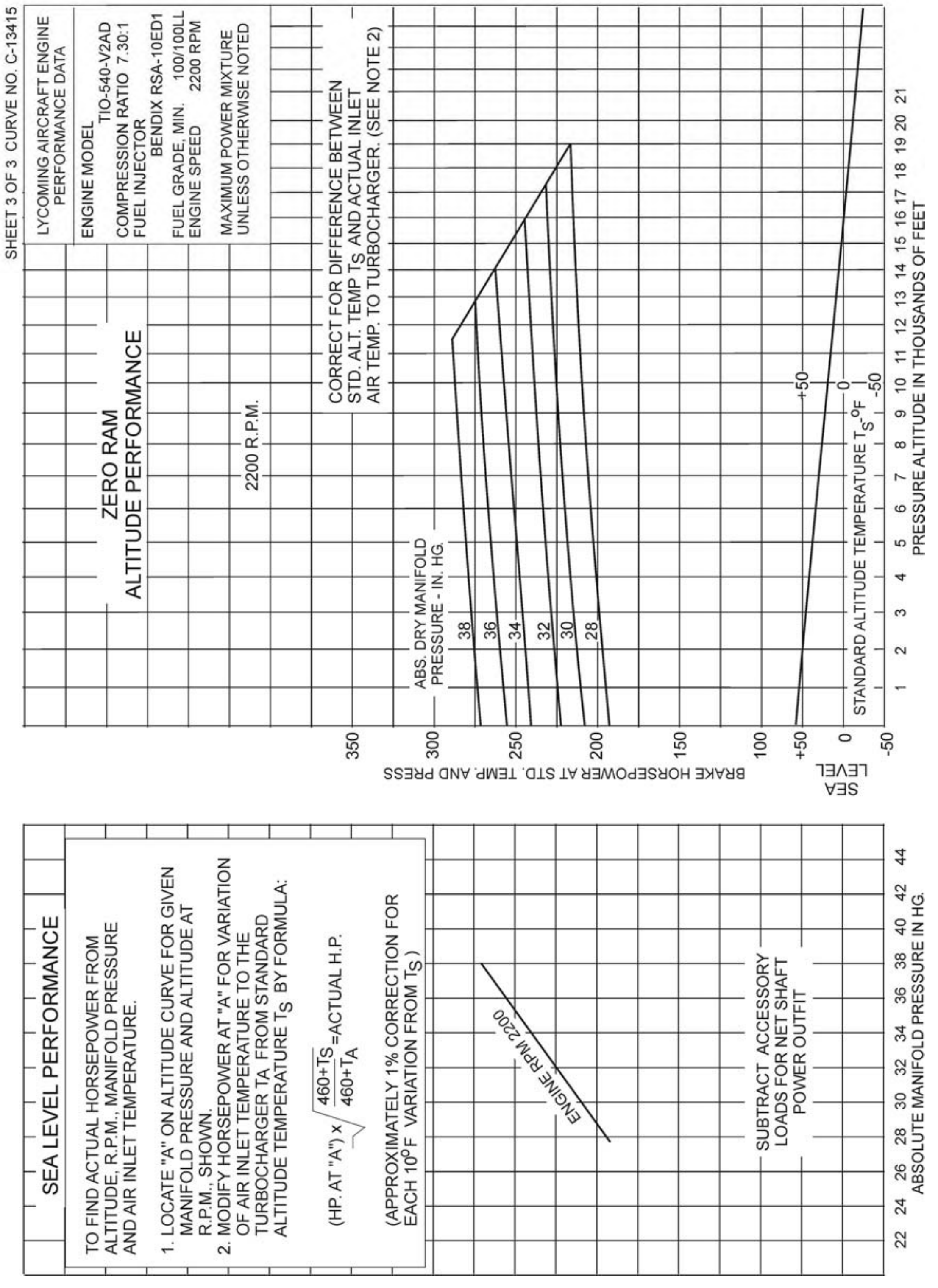

Figure 3-33. Sea Level/Altitude Performance Curve –
TIO-540-V2AD (Sheet 3 of 3)

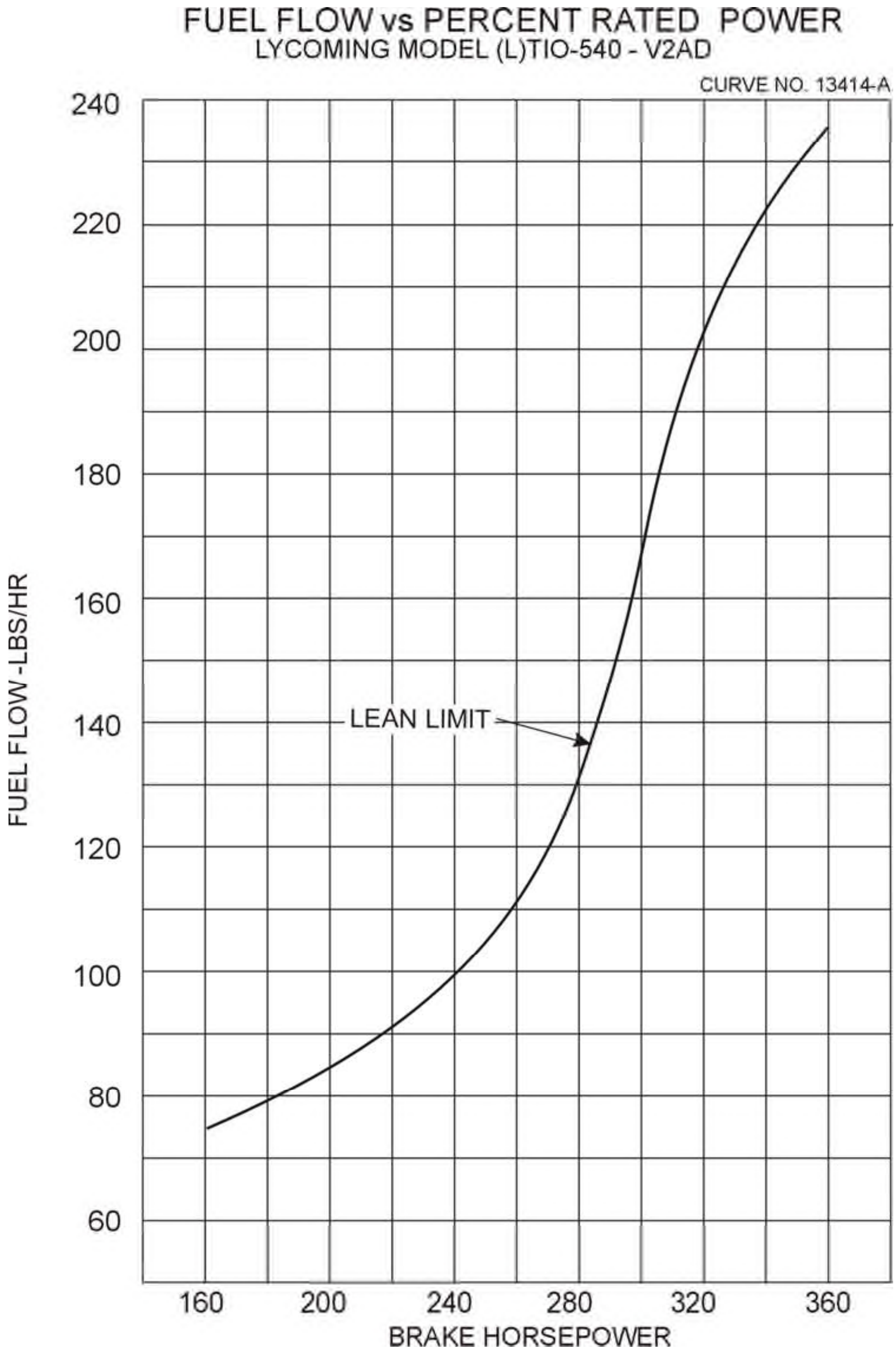

Figure 3-34. Fuel Flow vs Percent Rated Power –
TIO-540-V2AD

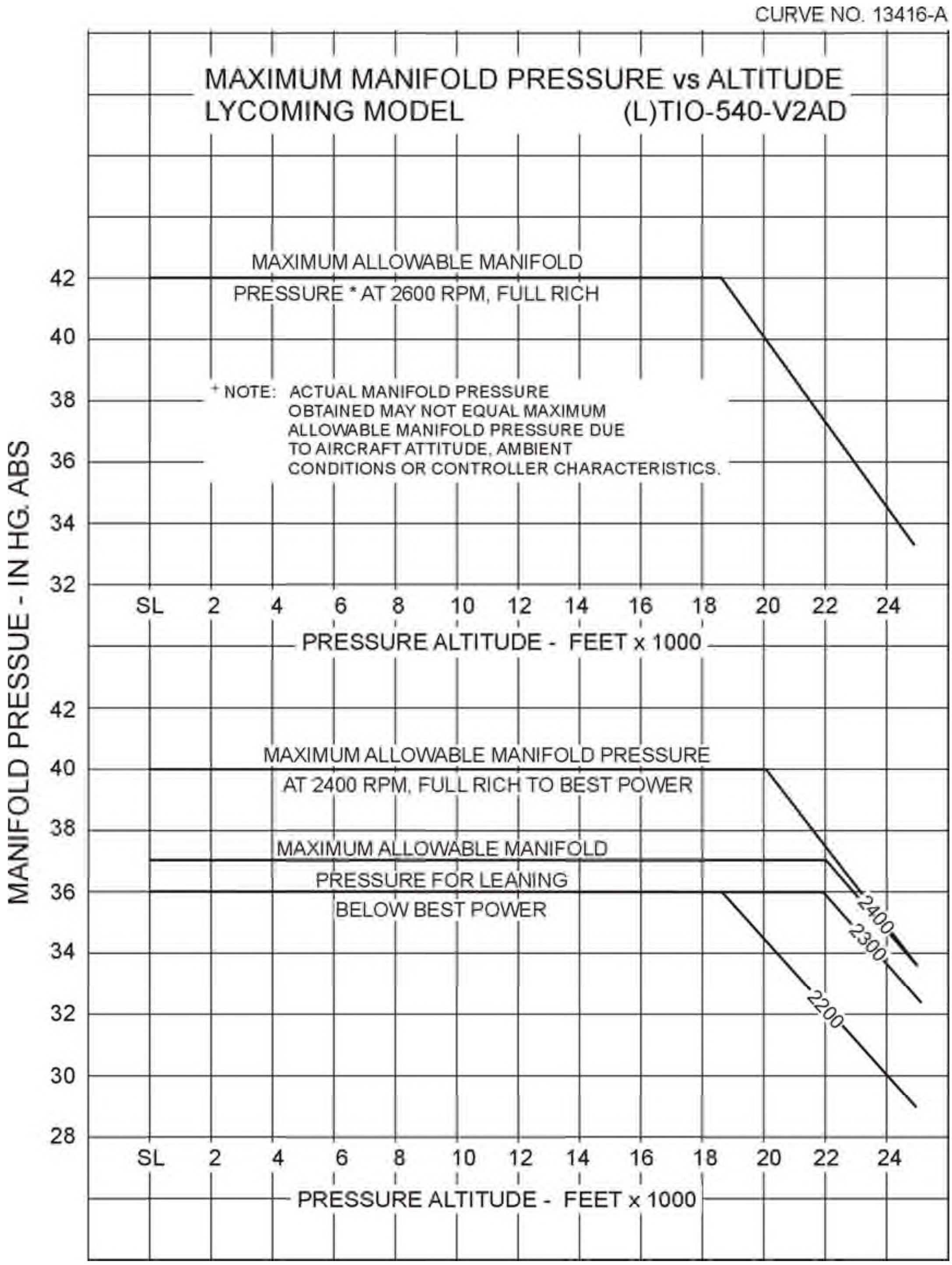

Figure 3-35. Maximum Manifold Pressure vs Altitude –
TIO-540-V2AD

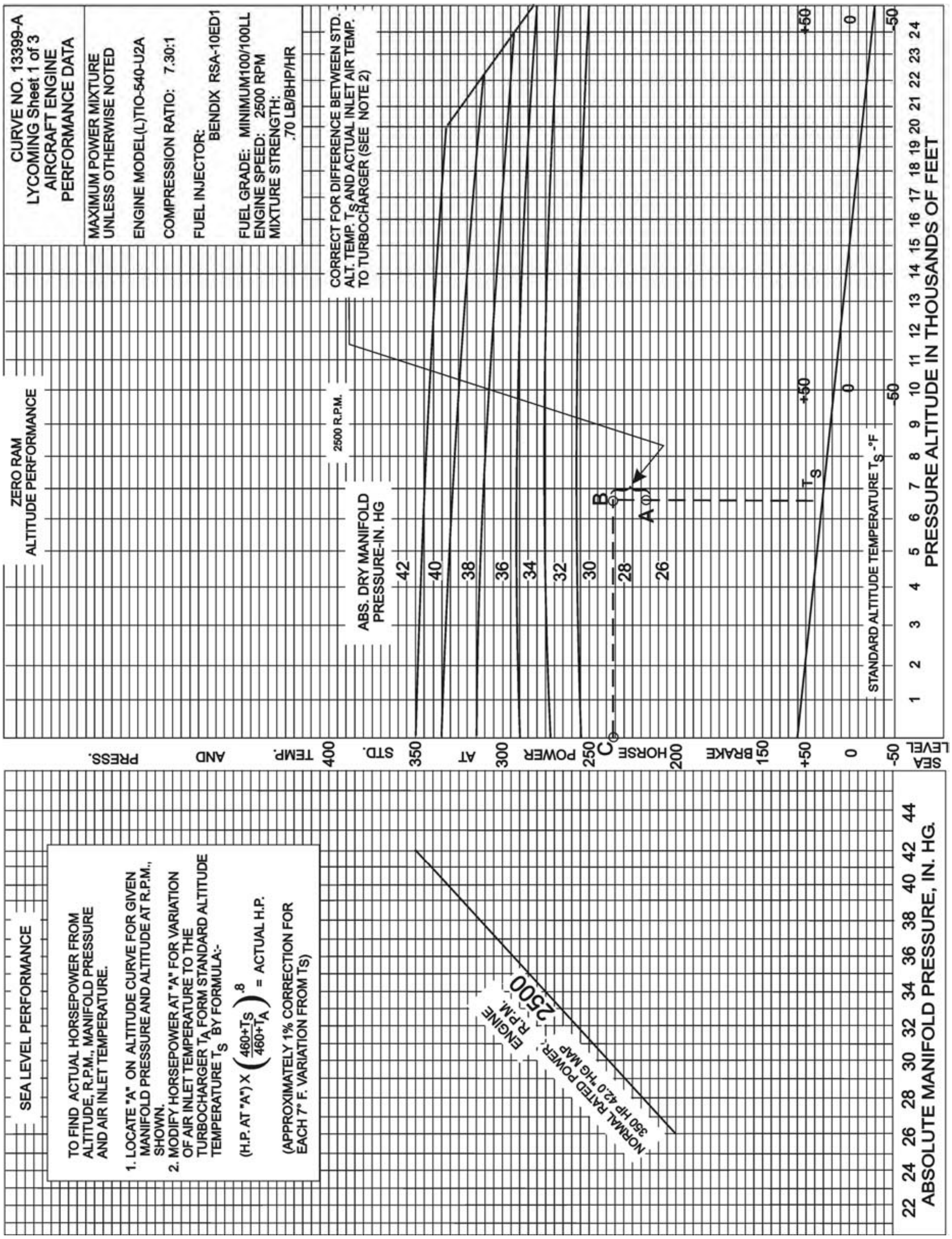

Figure 3-36. Sea Level/Altitude Performance Curve –
TIO-540-U2A (Sheet 1 of 3)

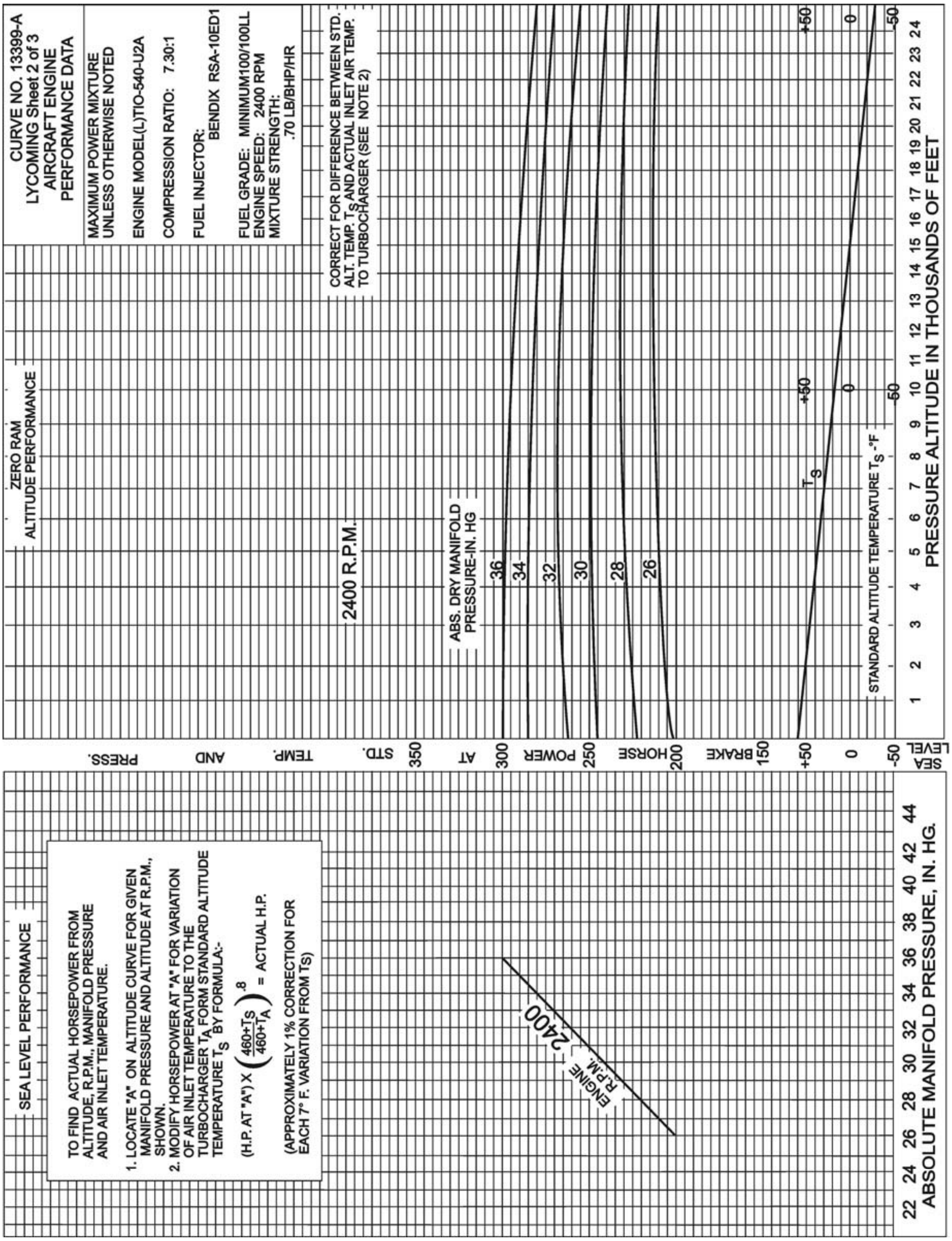

Figure 3-37. Sea Level/Altitude Performance Curve –
TIO-540-U2A (Sheet 2 of 3)

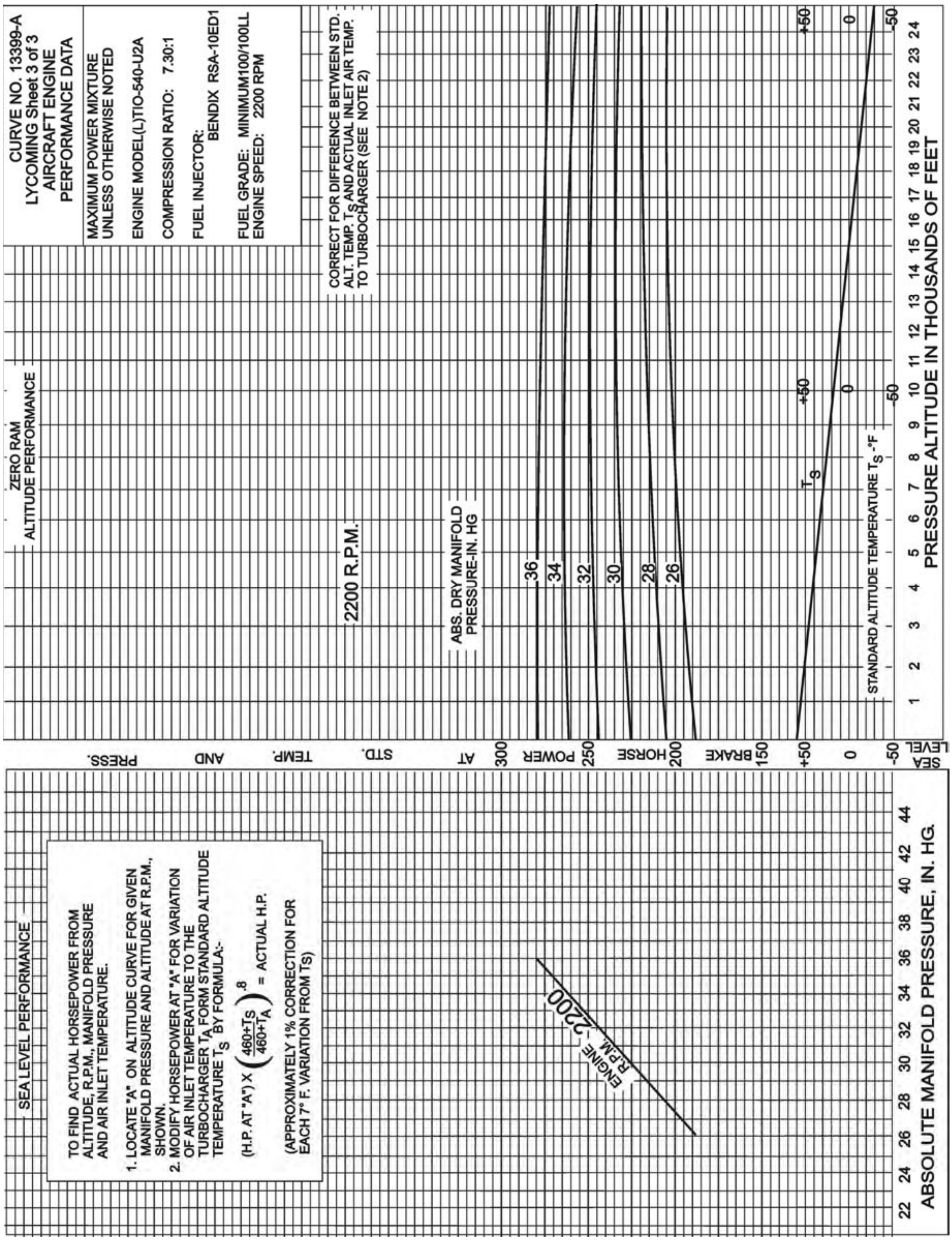

Figure 3-38. Sea Level/Altitude Performance Curve –
TIO-540-U2A (Sheet 3 of 3)

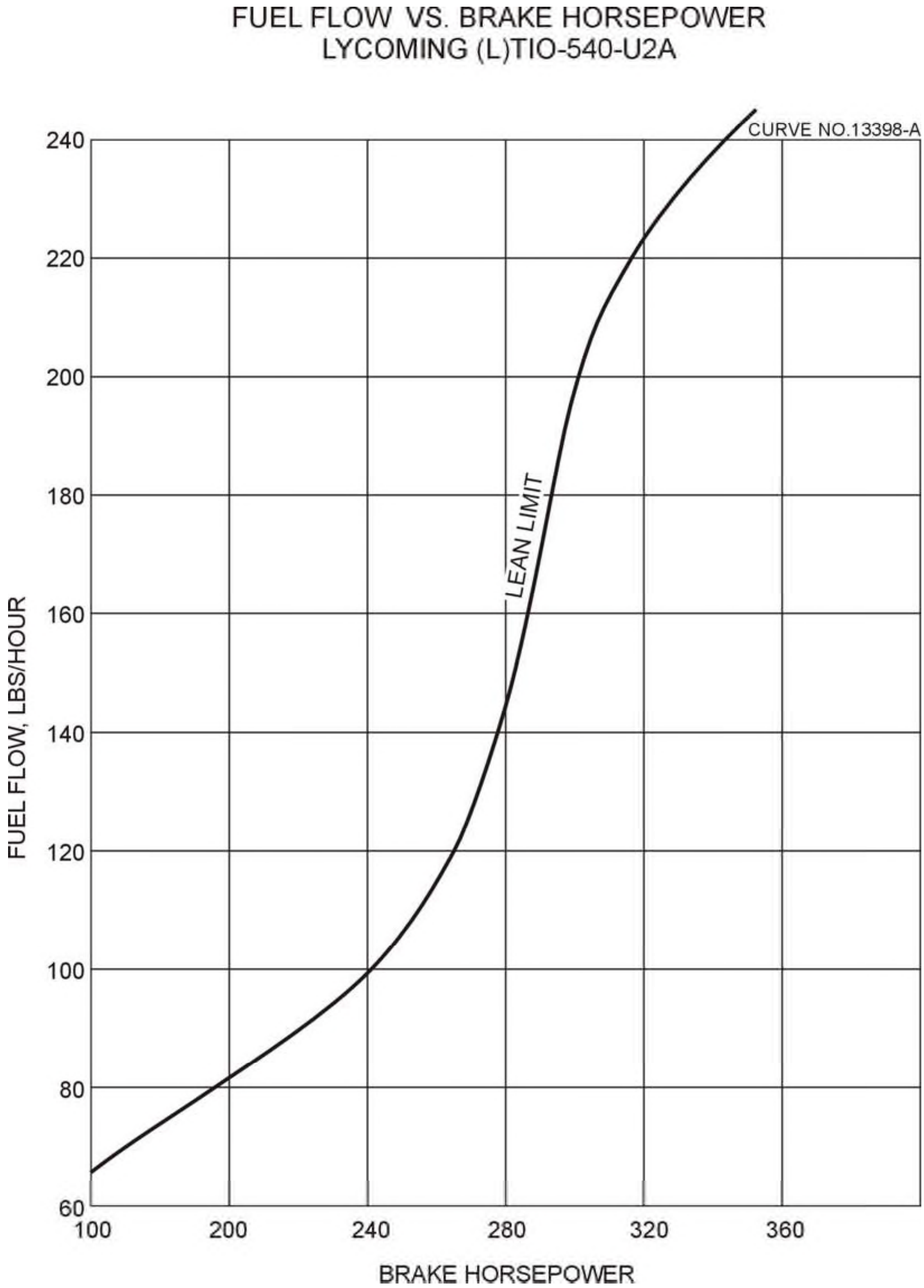

Figure 3-39. Fuel Flow vs Brake Horsepower –
TIO-540-U2A

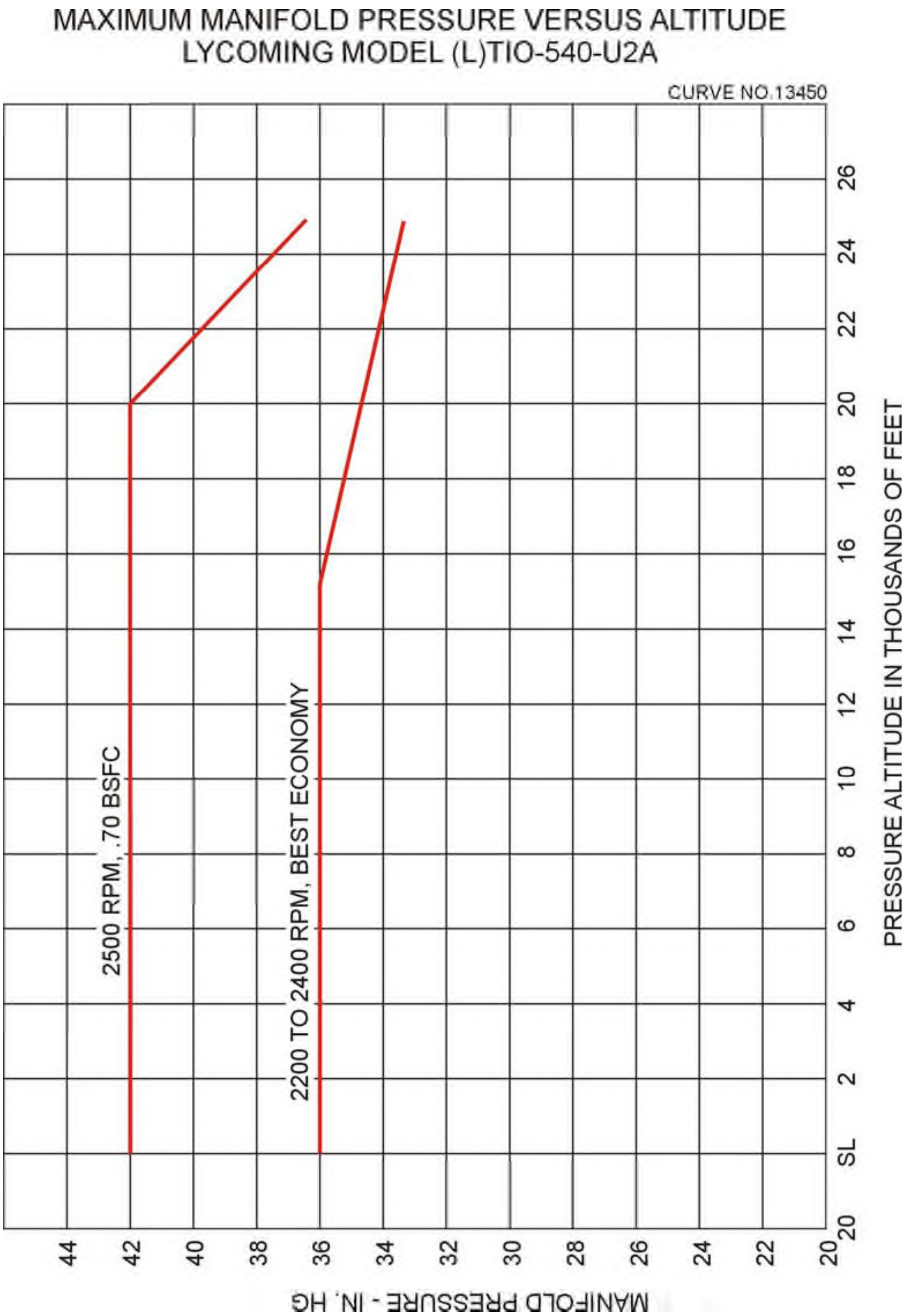

Figure 3-40. Maximum Manifold Pressure vs Altitude –
TIO-540-U2A

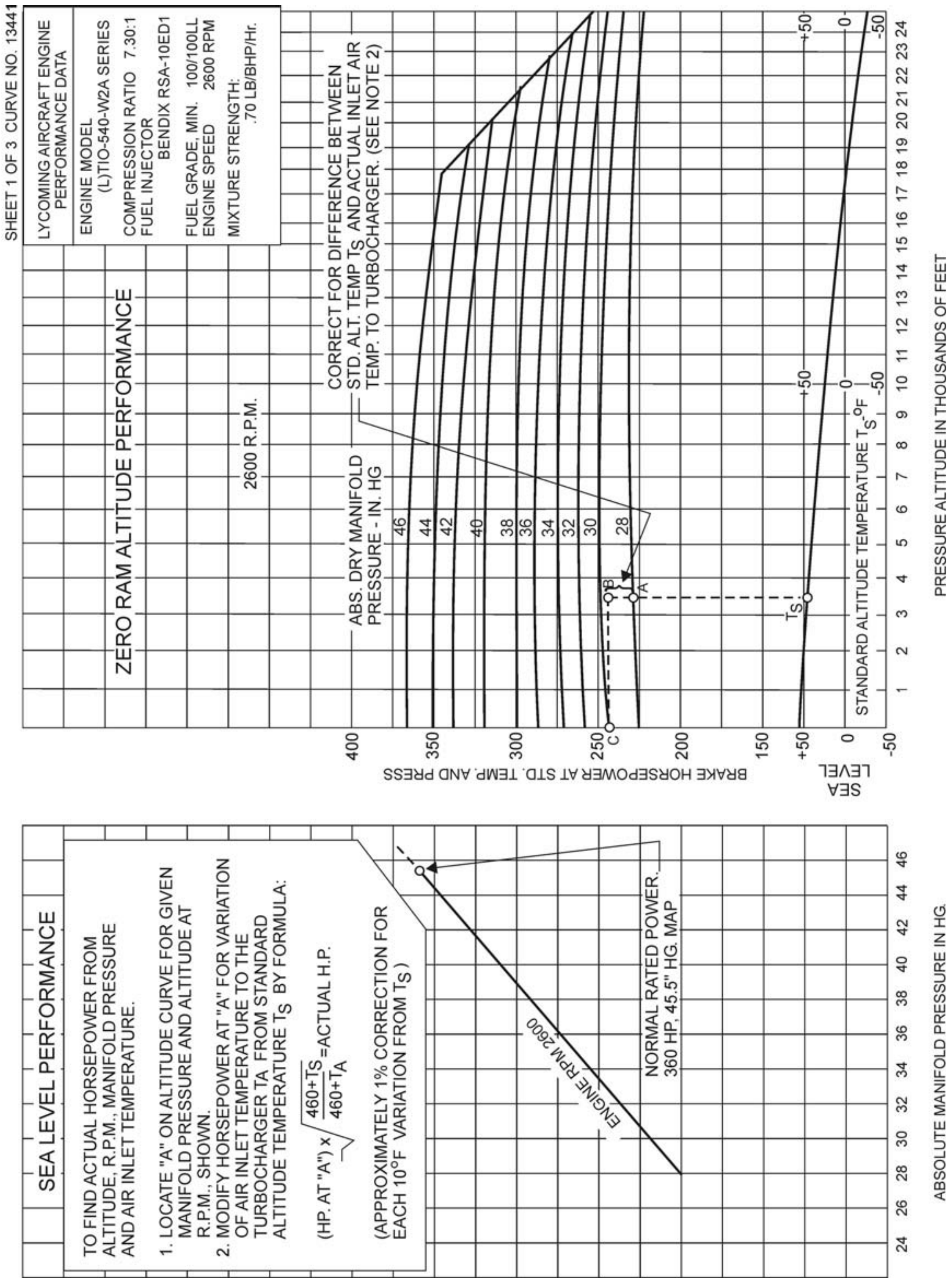

Figure 3-41. Sea Level/Altitude Performance Curve –
TIO-540-W2A (Sheet 1 of 3)

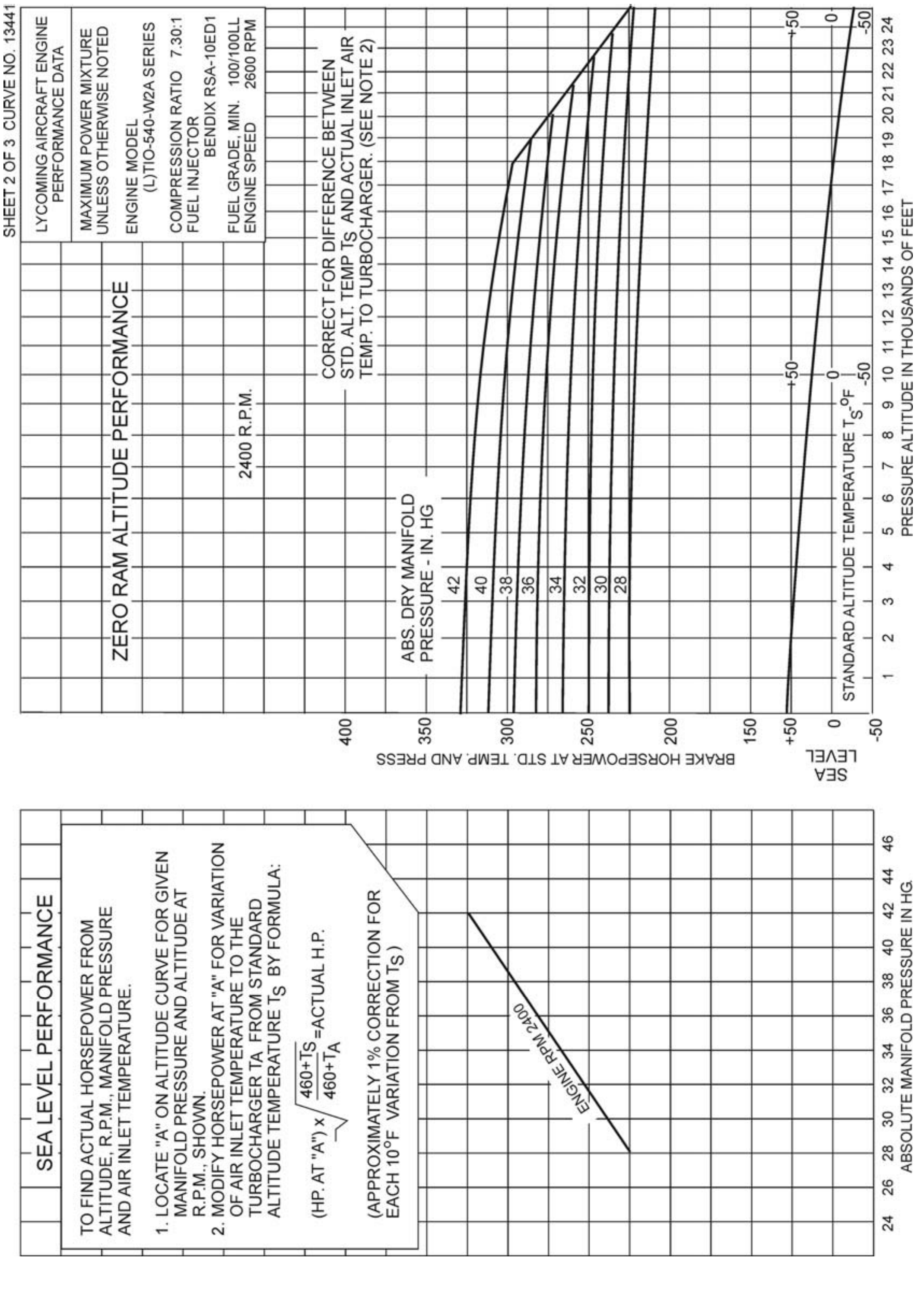

Figure 3-42. Sea Level/Altitude Performance Curve –
TIO-540-W2A (Sheet 2 of 3)

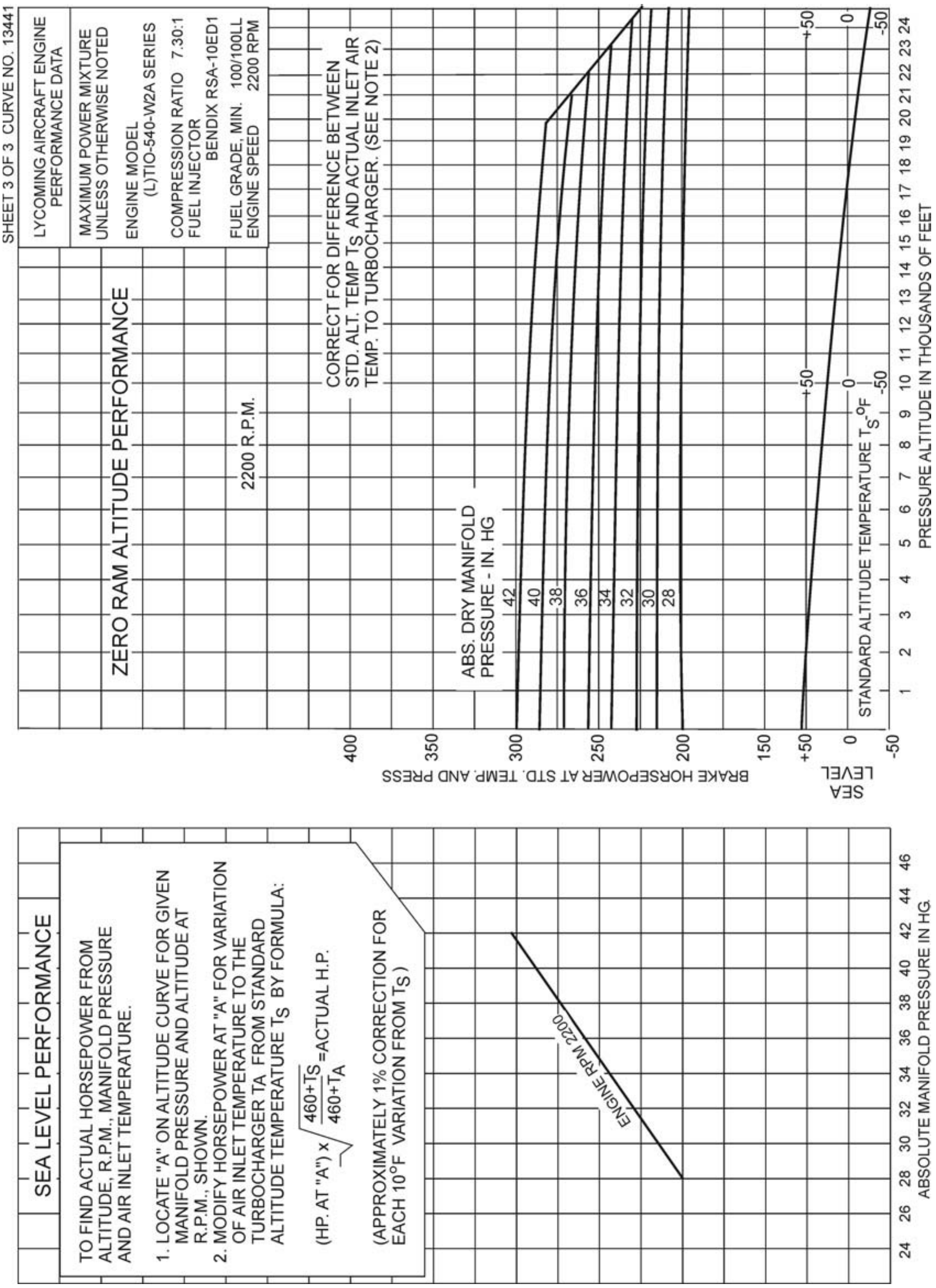

Figure 3-43. Sea Level/Altitude Performance Curve –
TIO-540-W2A (Sheet 3 of 3)

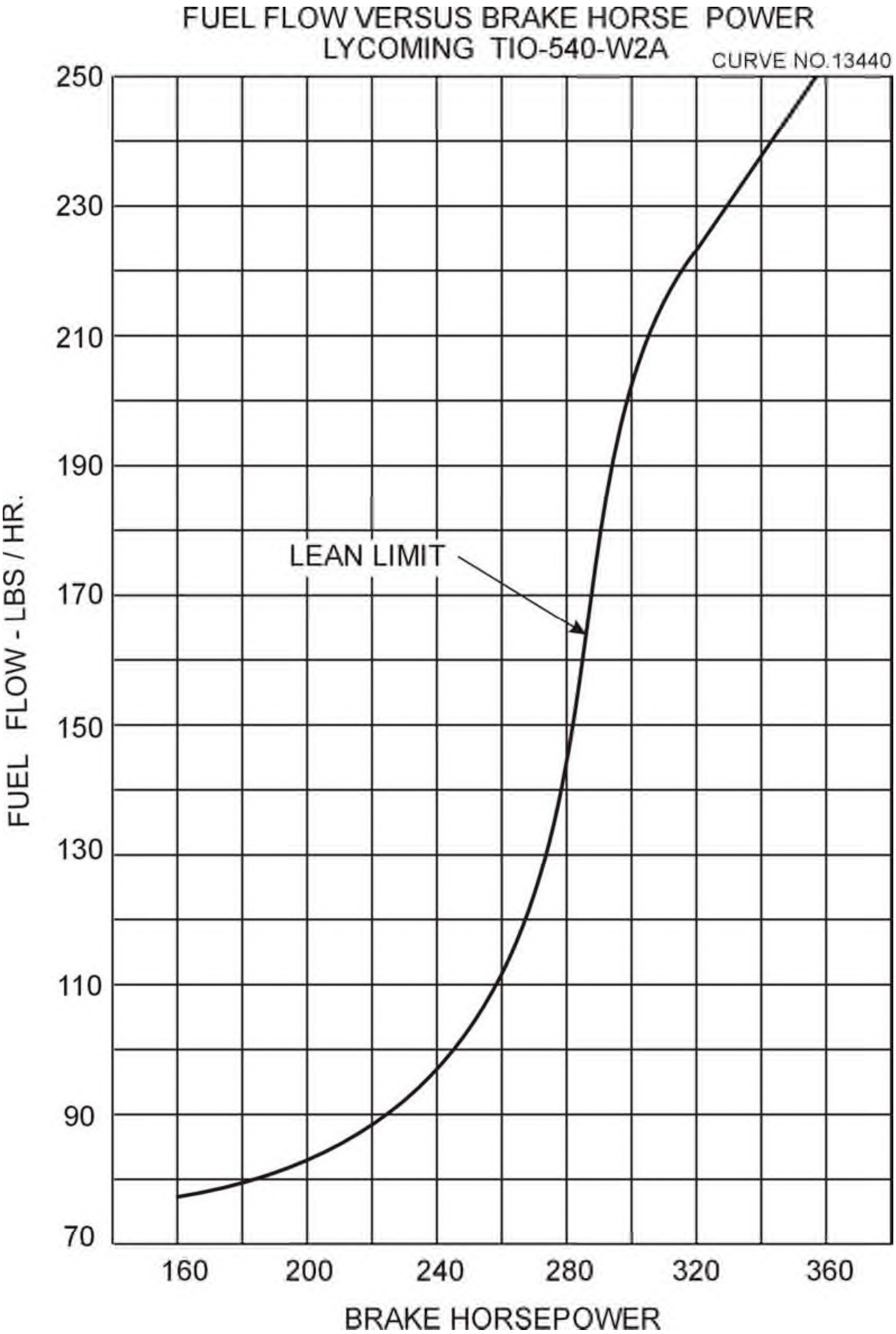

Figure 3-44. Fuel Flow vs Brake Horsepower –
TIO-540-W2A

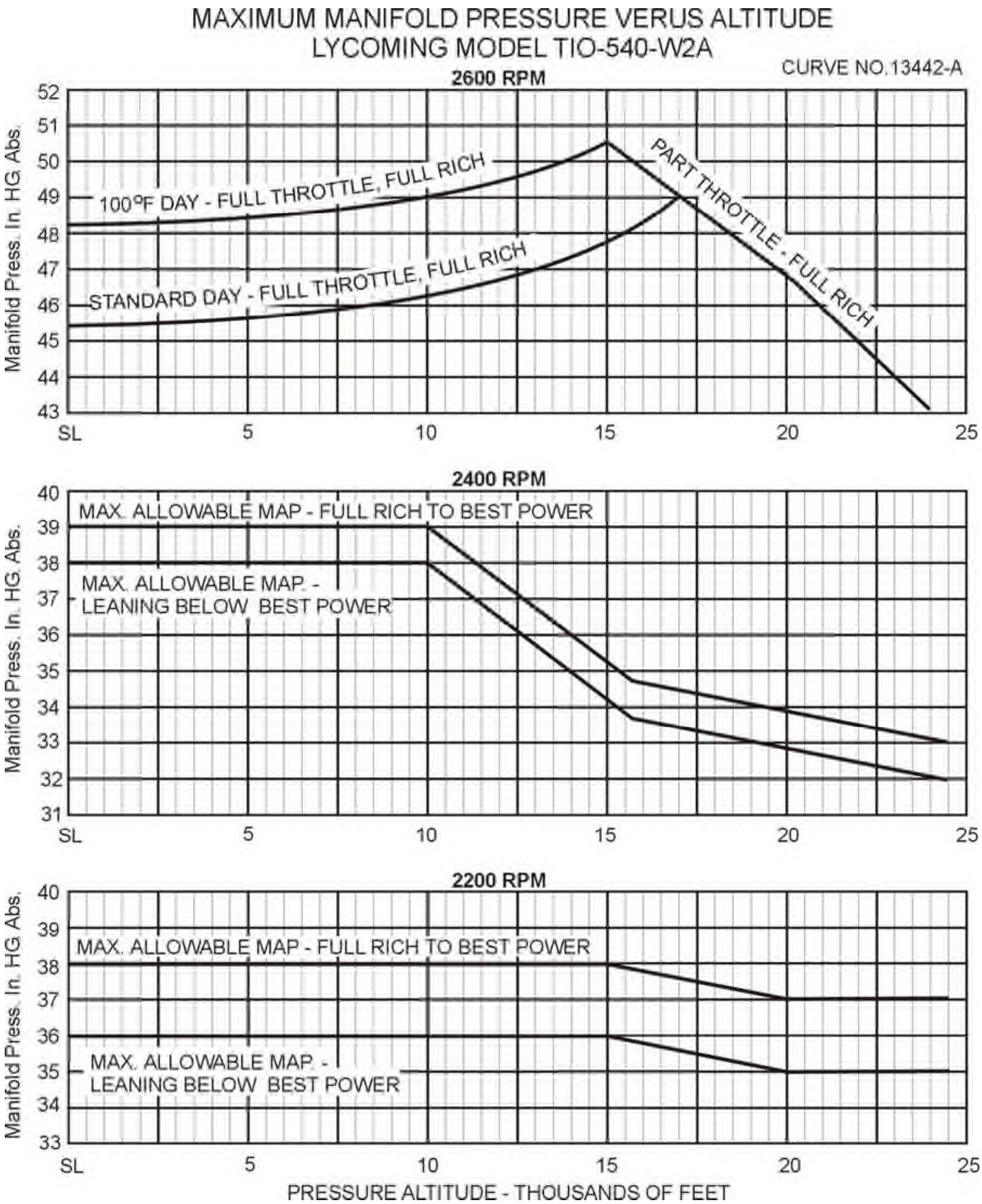

Figure 3-45. Maximum Manifold Pressure vs Altitude –
TIO-540-W2A

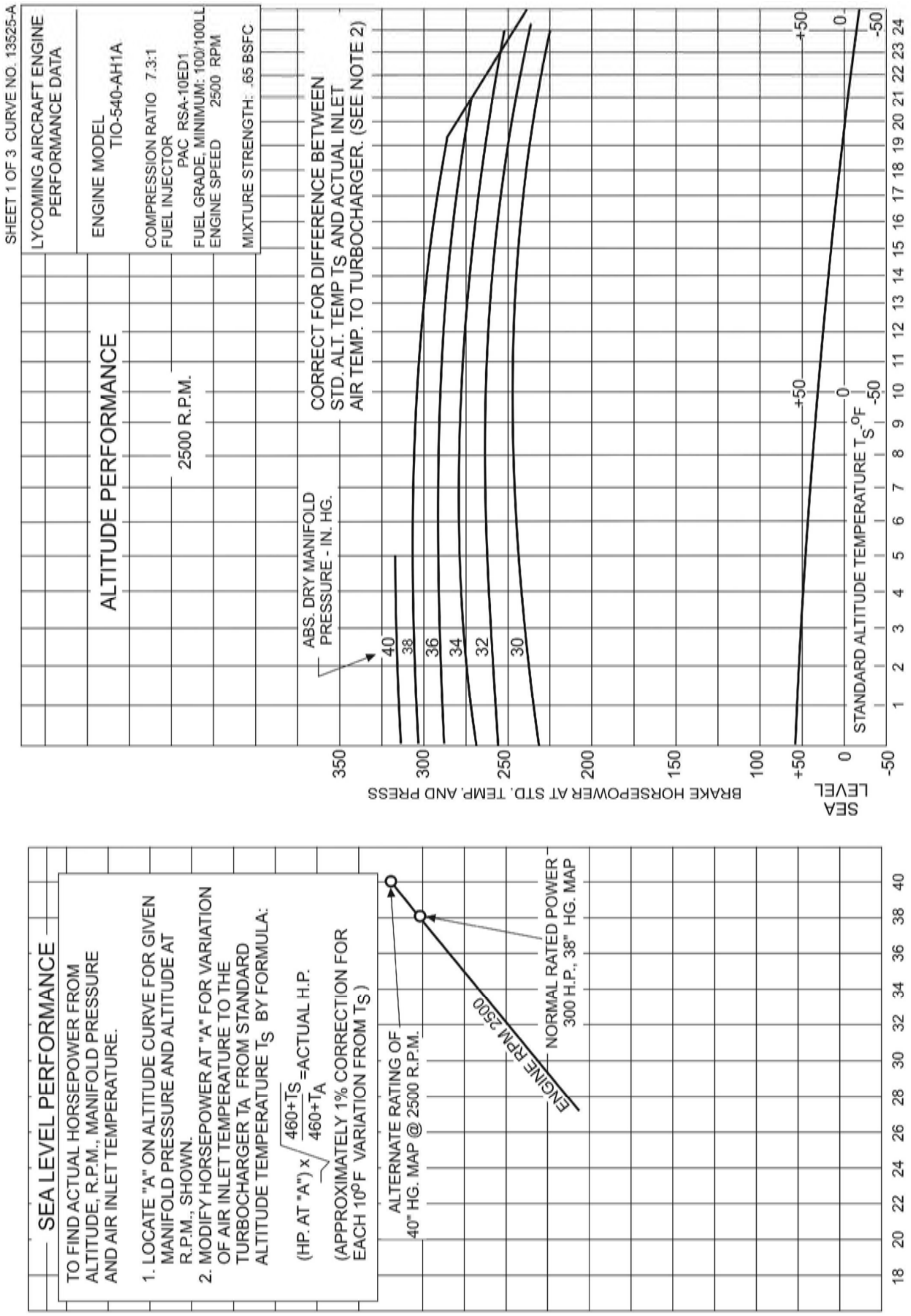

Figure 3-46. Sea Level/Altitude Performance Curve – 2500 RPM
TIO-540-AH1A (Sheet 1 of 3)

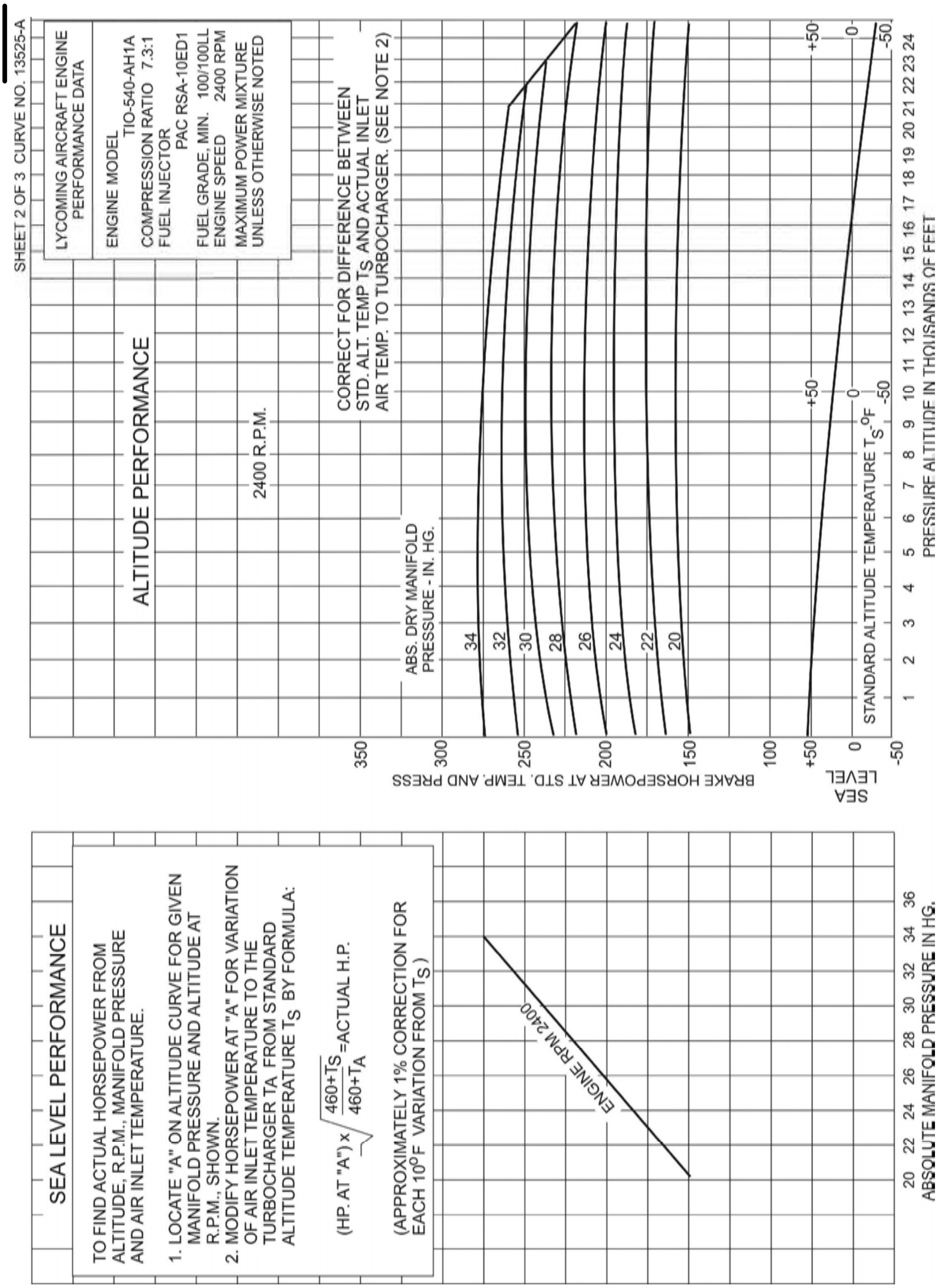

Figure 3-47. Sea Level/Altitude Performance Curve – 2400 RPM
TIO-540-AH1A (Sheet 2 of 3)

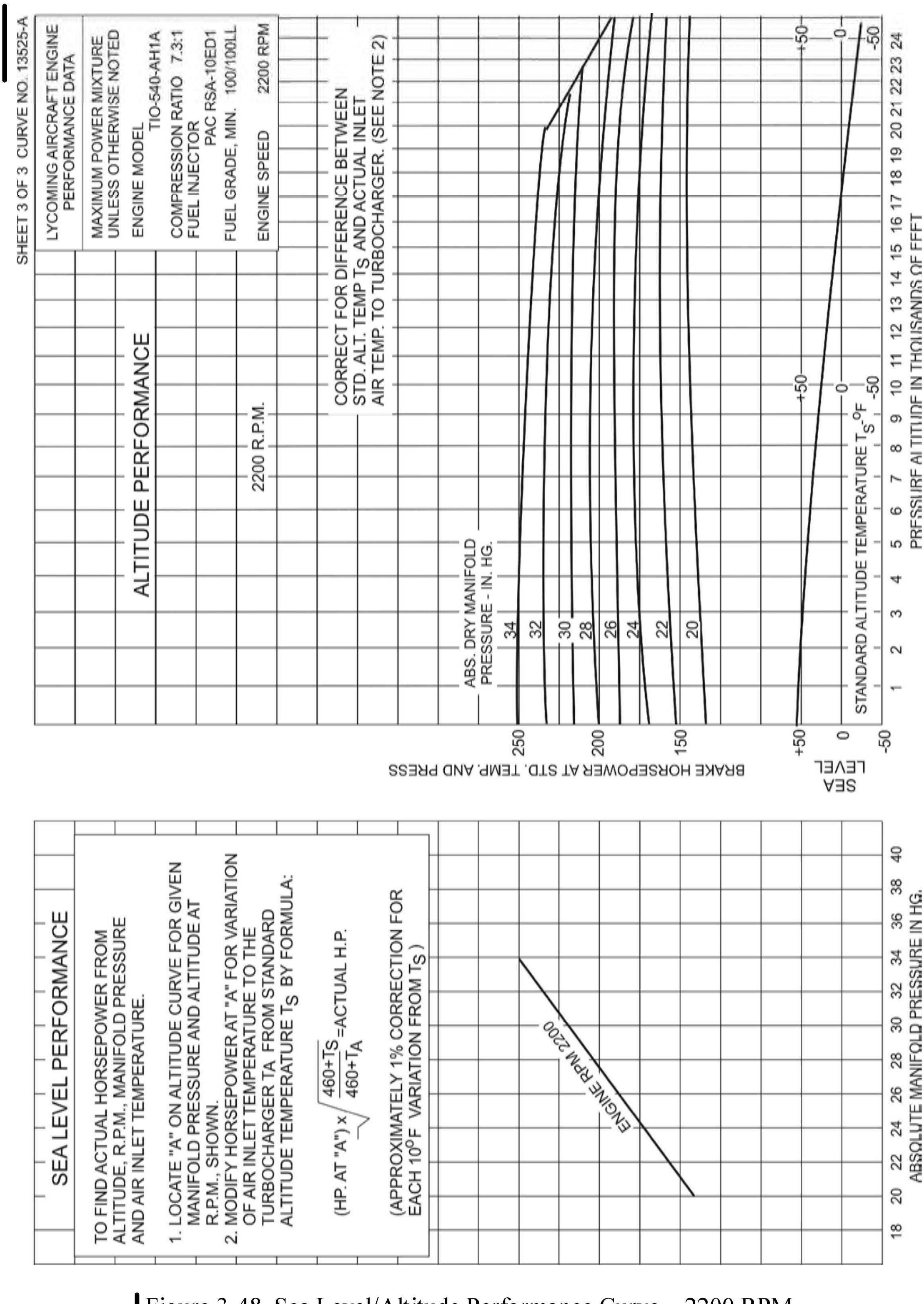

Figure 3-48. Sea Level/Altitude Performance Curve – 2200 RPM
TIO-540-AH1A (Sheet 3 of 3)

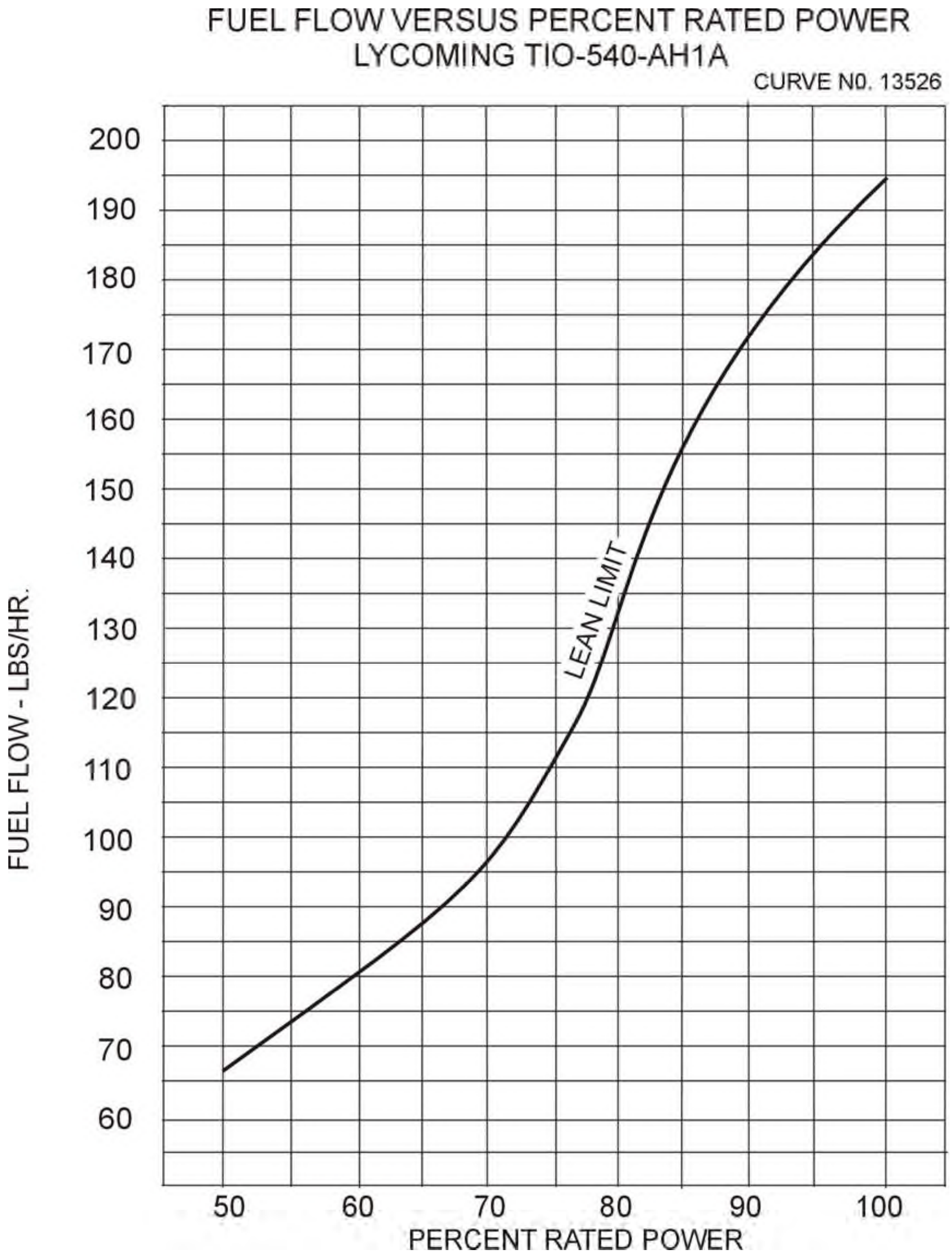

Figure 3-49. Fuel Flow vs Brake Horsepower –
TIO-540-AH1A

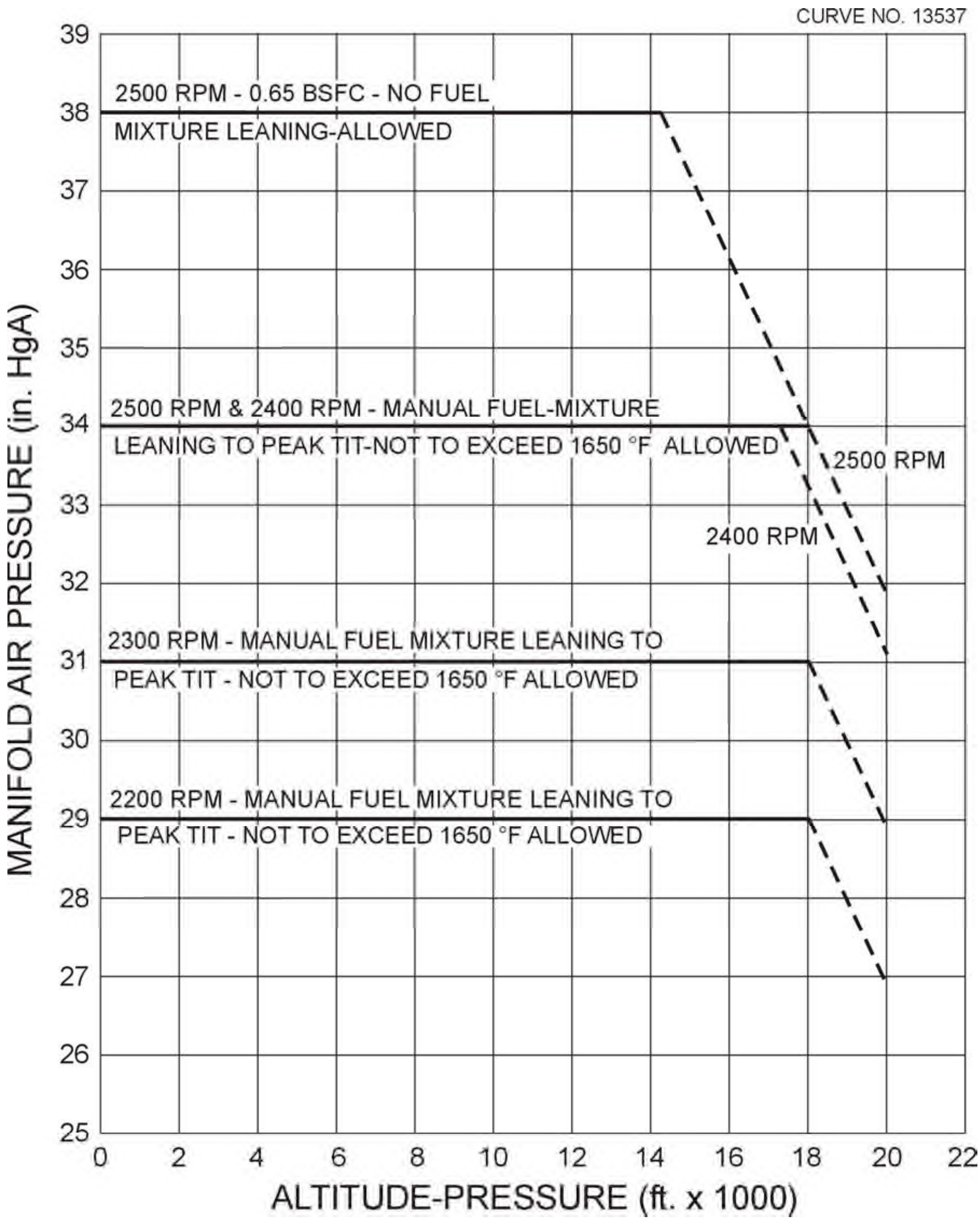

Figure 3-50. Maximum Manifold Pressure vs Altitude –
TIO-540-AH1A

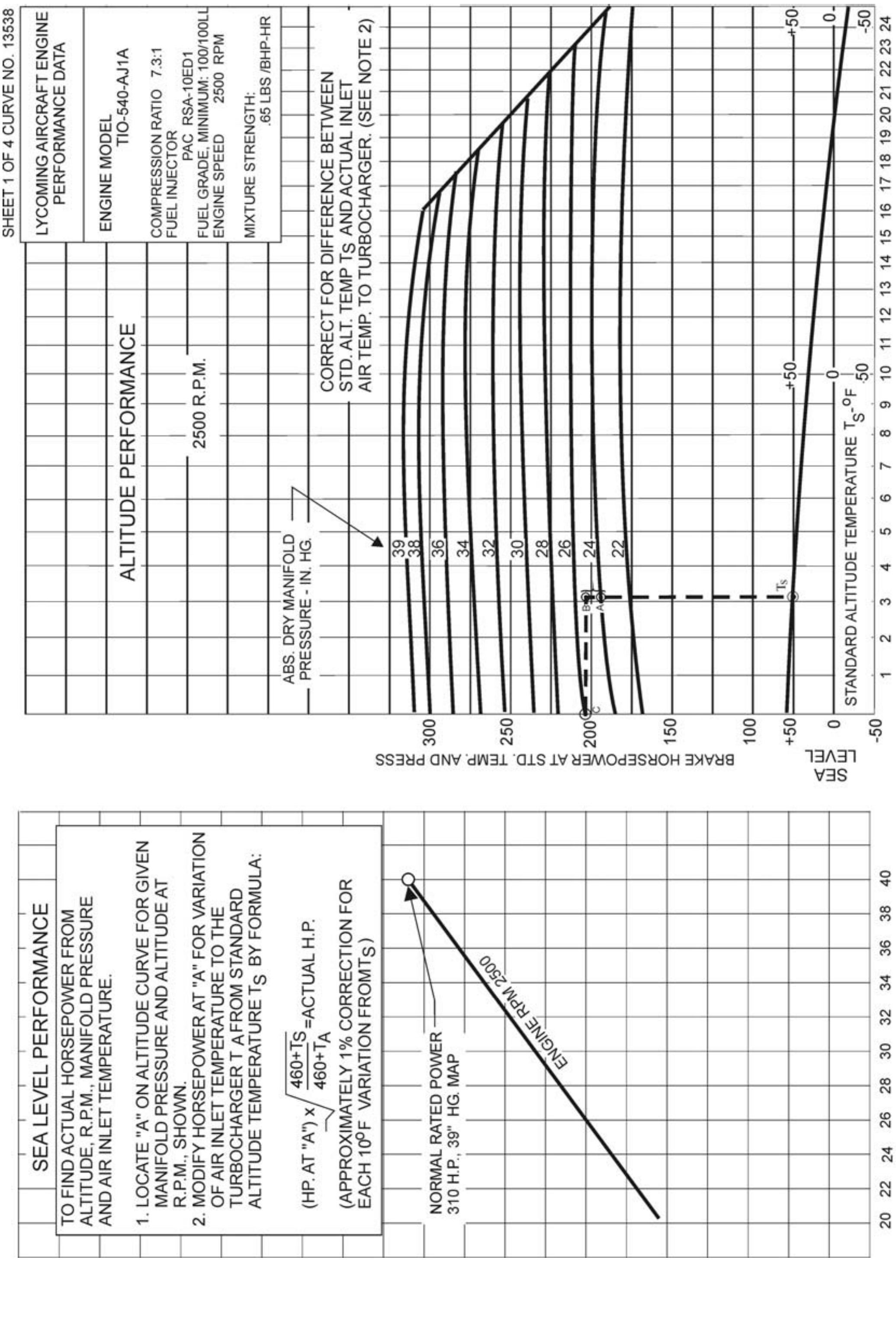

Figure 3-51. Sea Level/Altitude Performance Curve –
TIO-540-AJ1A (Sheet 1 of 4)

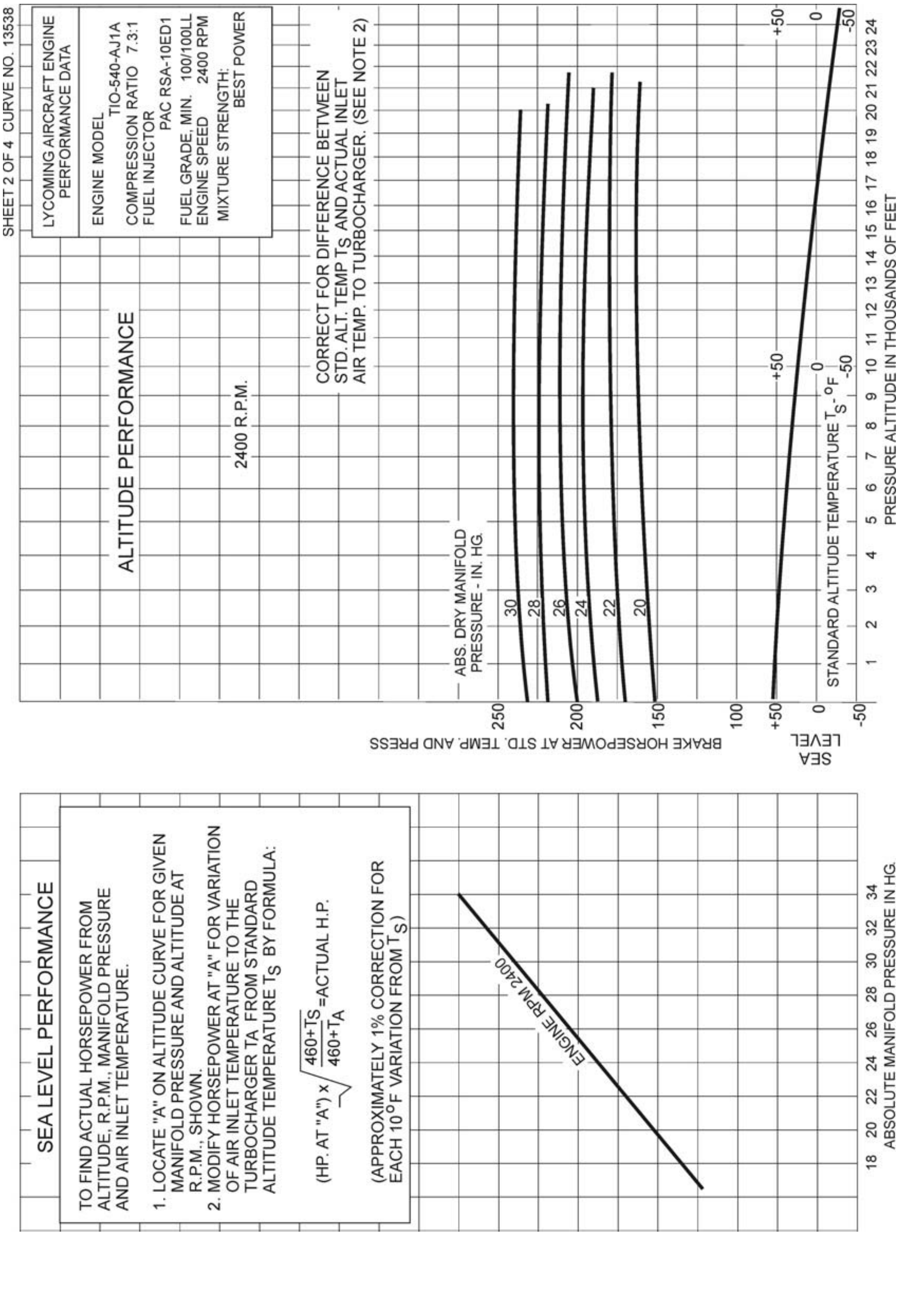

Figure 3-52. Sea Level/Altitude Performance Curve –
TIO-540-AJ1A (Sheet 2 of 4)

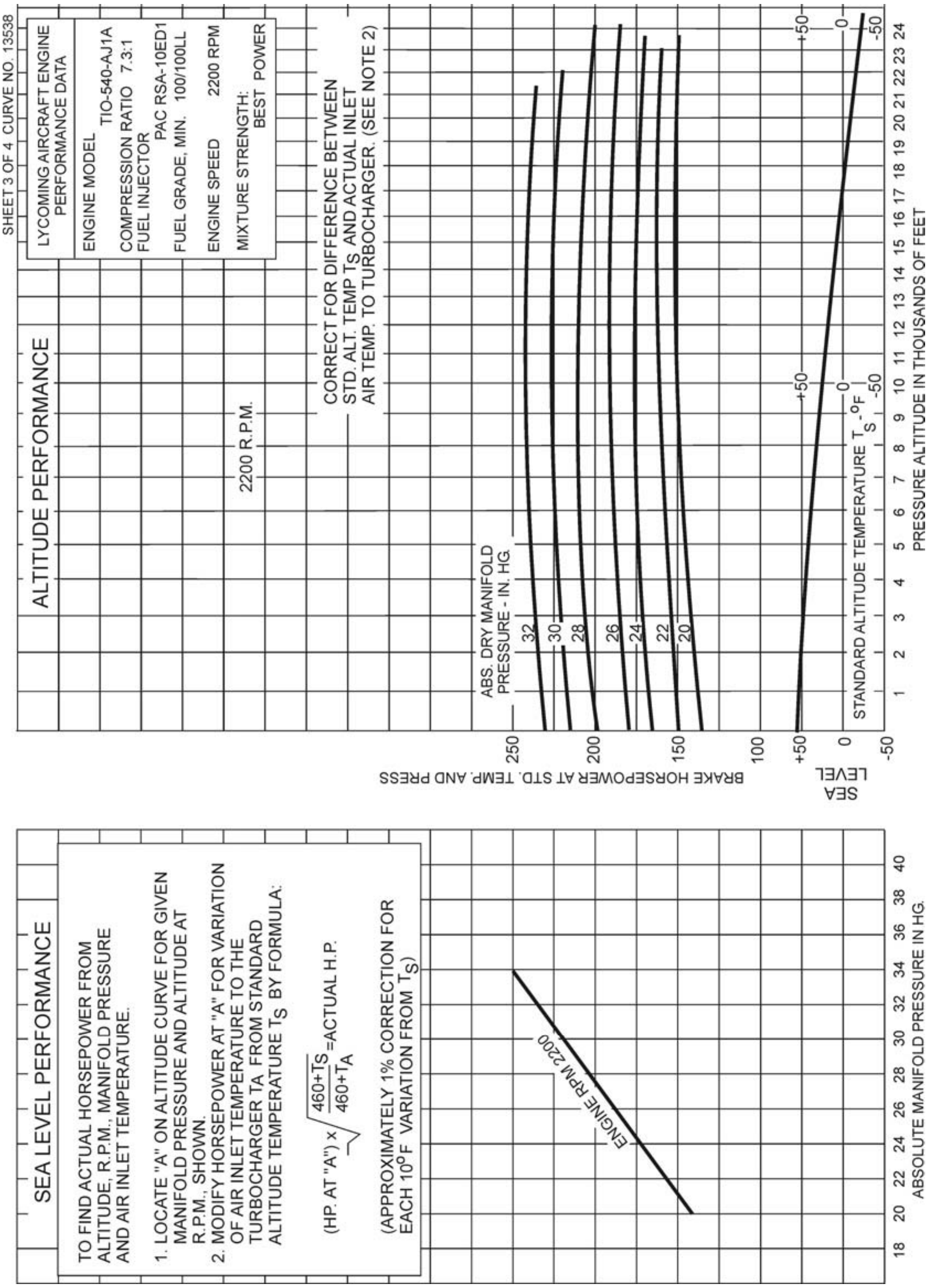

Figure 3-53. Sea Level/Altitude Performance Curve –
TIO-540-AJ1A (Sheet 3 of 4)

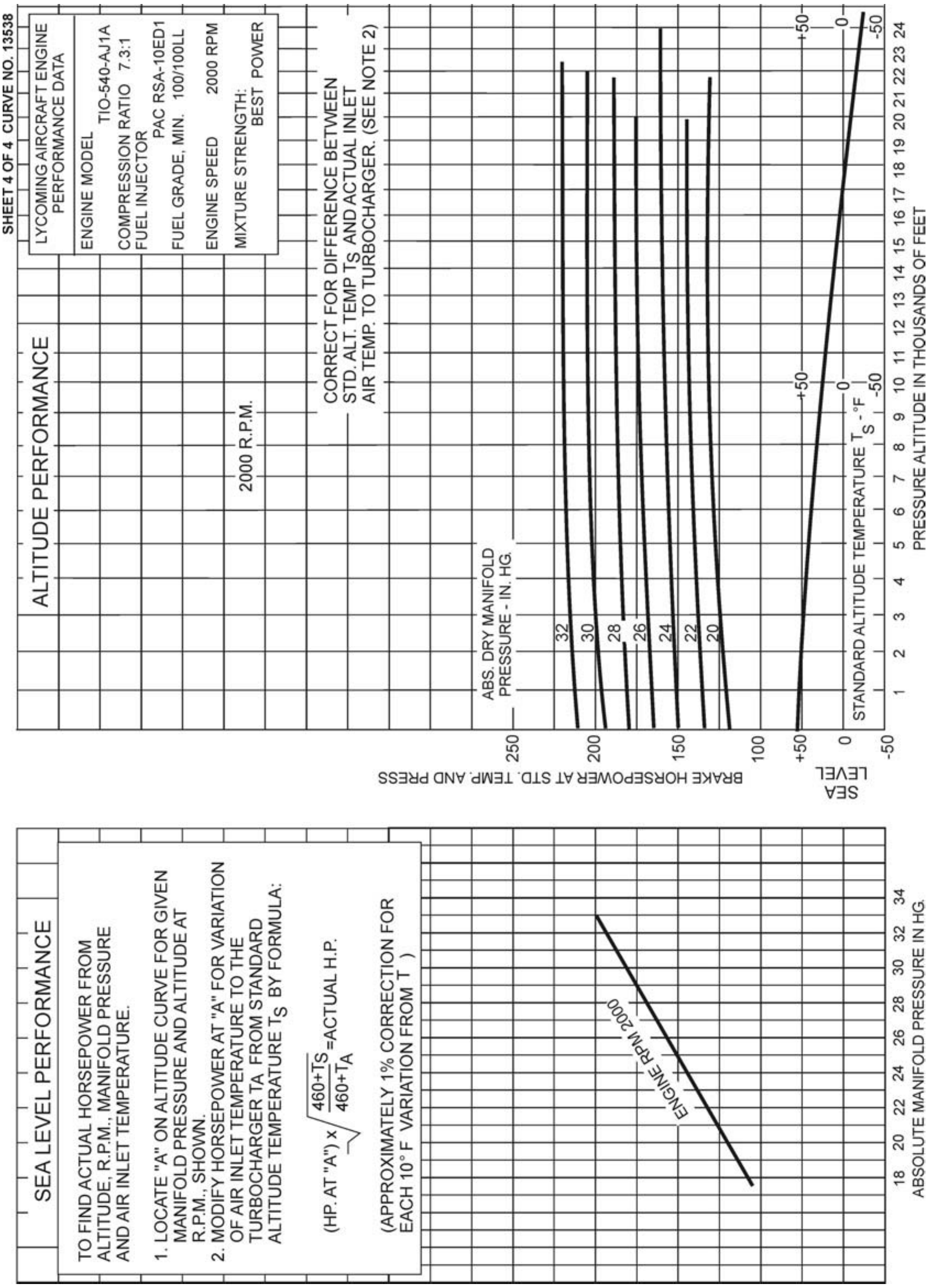

Figure 3-54. Sea Level/Altitude Performance Curve –
TIO-540-AJ1A (Sheet 4 of 4)

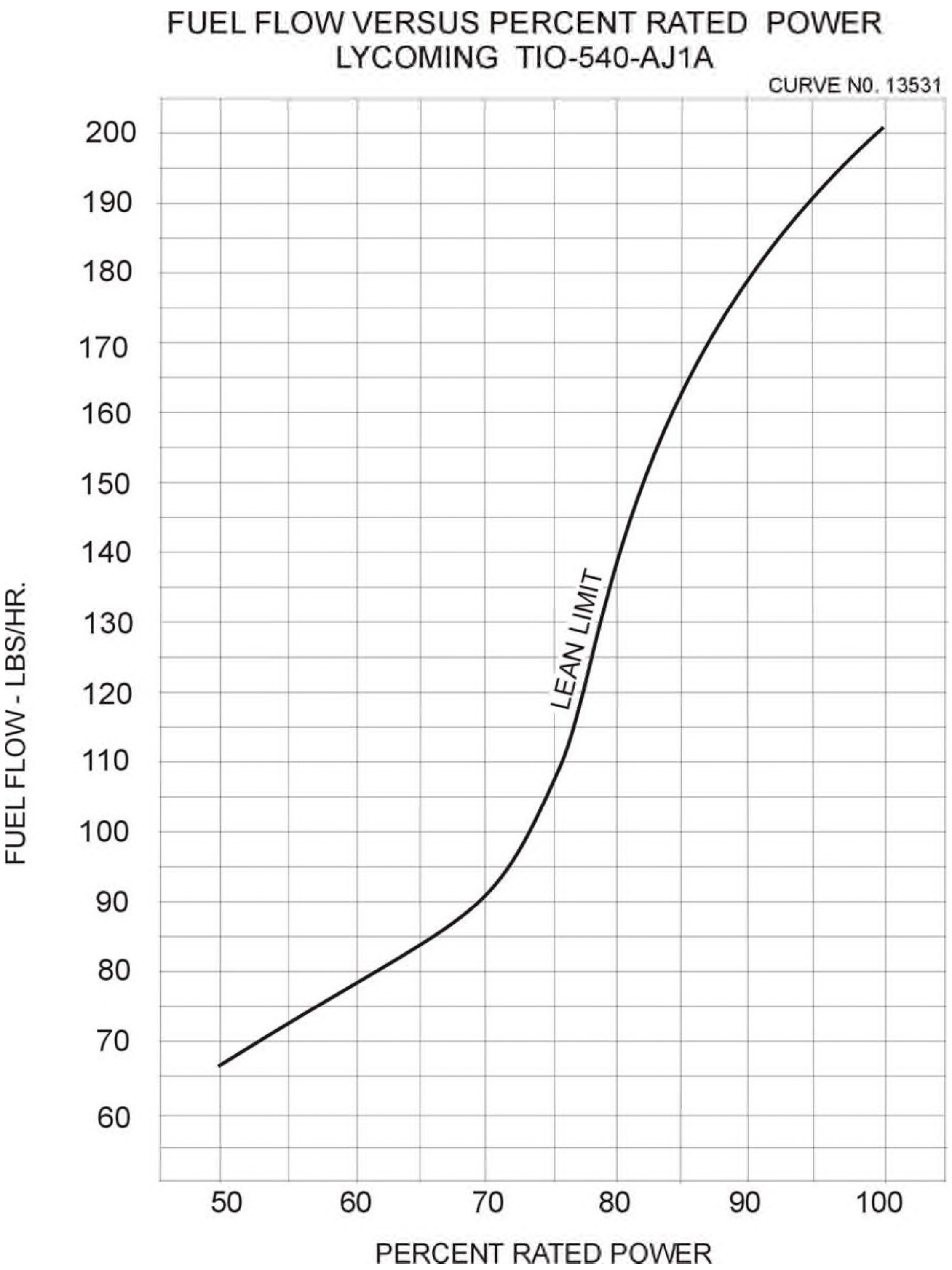

Figure 3-55. Fuel Flow vs Percent Rated Power –
TIO-540-AJ1A

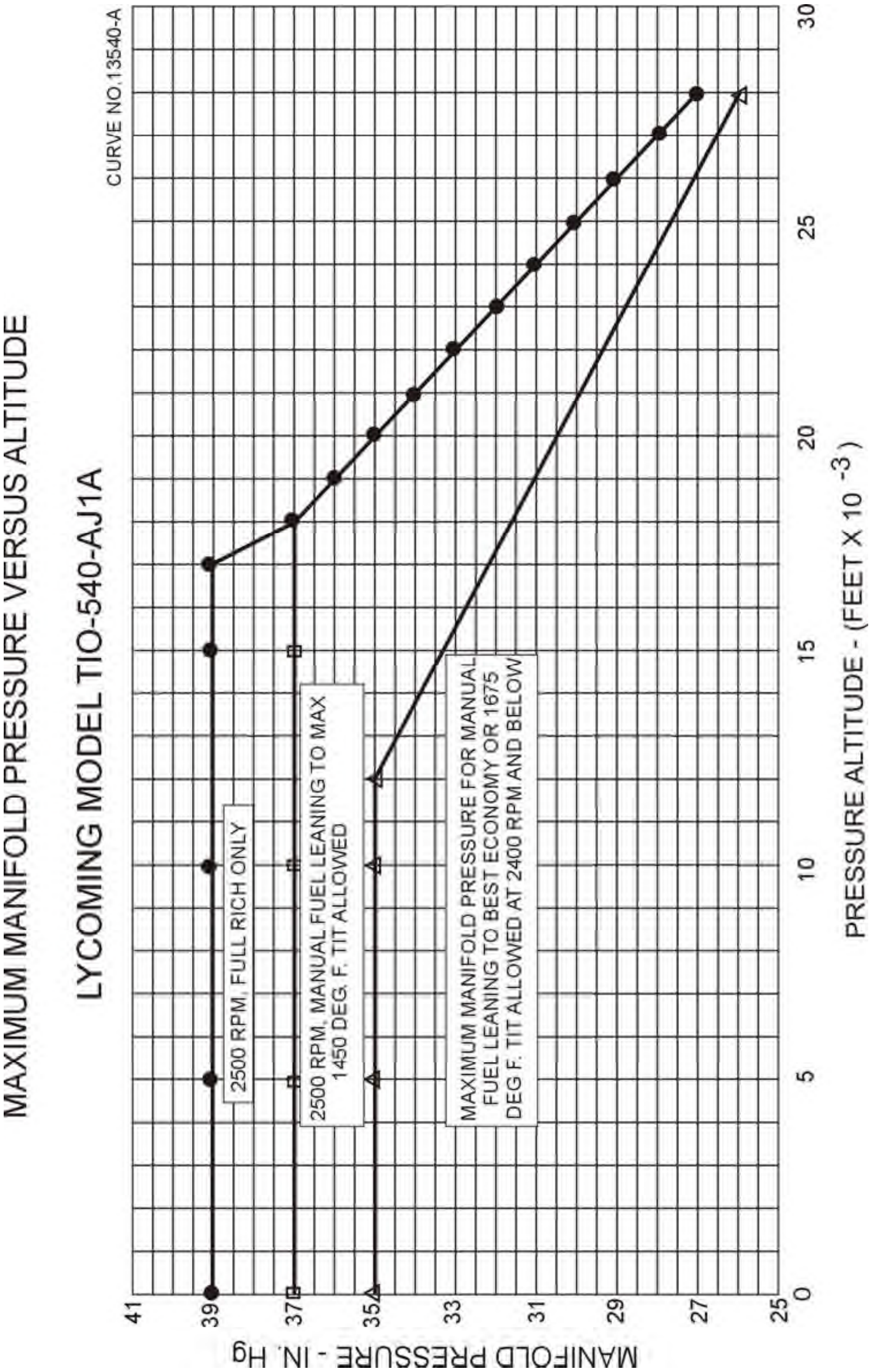

Figure 3-56. Maximum Manifold Pressure vs Altitude –
TIO-540-AJ1A

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SECTION 4
PERIODIC INSPECTIONS

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SECTION 4

PERIODIC INSPECTIONS

NOTE

Perhaps no other factor is quite so important to safety and durability of the aircraft and its components as faithful and diligent attention to regular checks for minor troubles and prompt repair when they are made.

The operator should bear in mind that the items listed in the following pages do not constitute a complete aircraft inspection, but are meant for the engine only. Consult the airframe manufacturer's handbook for additional instructions.

Pre-Starting Inspection – The daily pre-flight inspection is a check of the aircraft prior to the first flight of the day. This inspection is to determine the general condition of the aircraft and engine.

The importance of proper pre-flight inspection cannot be over emphasized. Statistics prove several hundred accidents occur yearly directly responsible to poor pre-flight inspections.

Among the major causes of poor pre-flight inspection are lack of concentration, reluctance to acknowledge the need for a check list, carelessness bred by familiarity and haste.

1. *DAILY PRE-FLIGHT (ENGINE).*

a. Be sure all switches are in the "Off" position.

b. Be sure magneto ground wires are connected.

c. Check oil level.

d. See that fuel tanks are full.

e. Check fuel and oil line connections, note minor indications for repair at 50-hour inspections. Repair any leaks before aircraft is flown.

f. Open the fuel drain to remove any accumulation of water and sediment.

g. Make sure all shields and cowling are in place and secure. If any are missing or damaged, repair, or replacement should be made before the aircraft is flown.

h. Check controls for general condition, travel, and freedom of operation.

i. Induction system air filter should be inspected and serviced in accordance with the airframe manufacturer's recommendations.

2. *DAILY PRE-FLIGHT (TURBOCHARGER).*

a. Inspect mounting and connections of turbocharger for security, oil leakage, and air or exhaust gas leakage.

b. Check engine crankcase breather for restrictions to breather.

3. *10-HOUR INSPECTION (ENGINE).* Within ten (10) hours of operating time, for new, rebuilt, or newly overhauled engines, replace the oil filter, and conduct an inspection of the contents of the used oil filter for traces of metal particles.

4. *25-HOUR INSPECTION (ENGINE).* After twenty-five (25) hours of operating time since the first inspection, new, rebuilt, or newly overhauled engines should undergo a 50-hour inspection including draining and renewing lubricating oil, replacing the oil filter, and inspecting the contents of the used oil filter.

NOTE

If an engine does not have a full-flow oil filter, change oil every 25 hours; also, inspect oil pressure and suction screens for metal contamination, and clean thoroughly before reinstallation.

5. *50-HOUR INSPECTION (ENGINE).* In addition to the items listed for daily pre-flight inspection, the following maintenance checks should be made after every fifty (50) hours of operation.

a. *Ignition System –*

(1) If fouling of spark plugs has been apparent, rotate bottom plugs to upper position.

(2) Examine spark plug leads of cable and ceramics for corrosion and deposits. This condition is evidence of either leaking spark plugs, improper cleaning of the spark plug walls or connector ends. Where this condition is found, clean the cable ends, spark plug walls and ceramics with a dry, clean cloth or a clean cloth moistened with methyl-ethyl ketone. All parts should be clean and dry before reassembly.

(3) Check ignition harness for security of mounting clamps and be sure connections are tight at spark plug and magnetic terminals.

b. *Fuel and Induction System* – Check the primer lines for leaks and security of the clamps. Remove and clean the fuel inlet strainers. Check the mixture control and throttle linkage for travel, freedom of movement, security of the clamps and lubricate if necessary. Check the air intake ducts for leaks, security, filter damage; evidence of dust or other solid material in the ducts is indicative of inadequate filter care or damaged filter. Check vent lines for evidence of fuel or oil seepage; if present, fuel pump may require replacement.

c. *Lubrication System –*

(1) Check oil lines for leaks, particularly at connections; for security of anchorage and for wear due to rubbing or vibration, for dents and cracks.

(2) Replace elements on external full flow oil filters. Before disposing of used element check interior folds for traces of metal particles that might be evidence of internal engine damage. Drain and renew lubricating oil on installations not employing replaceable full flow filters.

d. *Exhaust System* – Check attaching flanges at exhaust ports on cylinders for evidence of leakage. If they are loose, they must be removed and machined flat before they are reassembled and tightened. Examine exhaust manifold for general condition.

e. *Cooling System* – Check cowling and baffles for damage and secure anchorage. Any damaged or missing part of the cooling system must be repaired or replaced before the aircraft resumes operation.

f. *Cylinders* – Check rocker box covers for evidence of oil leaks. If found, replace gasket and tighten screws to specified torque (50 in.-lbs.).

Check cylinders for evidence of excessive heat which is indicated by burned paint on the cylinder. This condition is indicative of internal damage to the cylinder and, if found, its cause must be determined and corrected before the aircraft resumes operation.

Heavy discoloration and appearance of seepage at cylinder head and barrel attachment area is usually due to emission of thread lubricant used during assembly of the barrel at the factory, or by slight gas leakage which stops after the cylinder has been in service for a while. This condition is neither harmful nor detrimental to engine performance and operation. If it can be proven that leakage exceeds these conditions, the cylinder should be replaced.

g. *Turbocharger* – All fluid power lines and mounting brackets incorporated in turbocharger system should be checked for leaks, tightness and any damage that may cause a restriction.

Check for accumulation of dirt or other interference with the linkage between the bypass valve and the actuator which may impair operation of turbocharger. Clean or correct cause for interference.

The vent line from the actuator should be checked for oil leakage. Any constant oil leakage is cause for replacement of piston seal.

Check alternate air valve to be sure it swings free and seals tightly.

6. 100-HOUR INSPECTION. In addition to the items listed for daily pre-flight and 50-hour inspection, the following maintenance checks should be made after every 100 hours of operation.

a. Electrical System –

(1) Check all wiring connected to the engine or accessories. Any shielded cables that are damaged should be replaced. Replace clamps or loose wires and check terminals for security and cleanliness.

(2) Remove spark plugs; test, clean and regap. Replace if necessary.

b. Lubrication System – Drain and renew lubricating oil.

c. Magnetos – Check breaker points for pitting and minimum gap. Check for excessive oil in the breaker compartment; if found, wipe dry with a clean lintless cloth. The felt located at the breaker points should be lubricated in accordance with the magneto manufacturer's instructions. Check magneto to engine timing. Timing procedure is described in Section 5, 1, b of this manual.

NOTE

Engines equipped with pressurized ignition system should be checked using the Bendix Model 11-10090 airflow tester as described in latest revision of Service Instruction No. 1308.

d. Engine Accessories – Engine mounted accessories such as pumps, temperature and pressure sensing units should be checked for secure mounting, tight connections.

e. Cylinders – Check cylinders visually for cracked or broken fins.

f. Engine Mounts – Check engine mounting bolts and bushings for security and excessive wear. Replace any bushings that are excessively worn.

g. Fuel Injector Nozzles and Lines – Check fuel injector nozzles for looseness. Tighten to 60 in.-lbs. torque. Check fuel line for dye stains at connections (indicating linkage) and security of lines. Repair or replacement must be accomplished before aircraft resumes operation.

h. Turbocharger – Inspect all air ducting and connections in turbocharger system for leaks. Make inspection both with engine shut down and with engine running. Check at manifold connections to turbine inlet and at engine exhaust manifold gasket, for possible air leakage.

CAUTION

DO NOT OPERATE THE TURBOCHARGER IF LEAKS EXIST IN THE DUCTING, OR IF AIR CLEANER IS NOT FILTERING EFFICIENTLY. DUST LEAKING INTO AIR DUCTING CAN DAMAGE TURBOCHARGER AND ENGINE.

Check for dirt or dust build-up within the turbocharger. Check for uneven deposits on the impeller. Consult AiResearch Industrial Div. Manual TP-21 for method to remove all such foreign matter.

Check the condition of the flexible hoses in the turbocharger system. Stiffness of the hose is indicative of deterioration and if this condition is noted the hose should be replaced before further flight.

7. 400-HOUR INSPECTION. In addition to the items listed for daily pre-flight, 50-hour and 100-hour inspections, the following maintenance check should be made after every 400 hours of operation.

Valve Inspection – Remove rocker box covers and check for freedom of valve rockers when valves are closed. Look for evidence of abnormal wear or broken parts in the area of the valve tips, valve keeper, springs and spring seats. If any indications are found, the cylinder and all of its components should be removed (including the piston and connecting rod assembly) and inspected for further damage. Replace any parts that do not conform to limits shown in the latest revision of Special Service Publication No. SSP-1776.

8. NON-SCHEDULED INSPECTIONS. Occasionally, service bulletins or service instructions are issued by Lycoming that require inspection procedures that are not listed in this manual. Such publications, usually are limited to specified engine models and become obsolete after corrective modification has been accomplished. All such publications are available from Lycoming distributors, or from the factory by subscription. Consult the latest revision of Service Letter No. L114 for subscription information. Maintenance facilities should have an up-to-date file of these publications available at all times.

SECTION 5
MAINTENANCE PROCEDURES

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SECTION 5

MAINTENANCE PROCEDURES

The procedures described in this section are provided to guide and instruct personnel in performing such maintenance operations that may be required in conjunction with the periodic inspections listed in the preceding section. No attempt is made to include repair and replacement operations that will be found in the applicable Lycoming Overhaul Manual.

1. *IGNITION AND ELECTRICAL SYSTEM.*

a. *Ignition Harness and Wire Replacement* – In the event that an ignition harness or an individual lead is to be replaced, consult the wiring diagram to be sure harness is correctly installed. Mark location of clamps and clips to be certain the replacement is clamped at correct locations.

b. *Timing Magneto to Engine* –

(1) Remove a spark plug from No. 1 cylinder and place a thumb over the spark plug hole. Rotate the crankshaft in direction of normal rotation until the compression stroke is reached, this is indicated by a positive pressure inside the cylinder tending to push the thumb off the spark plug hole. Continue rotating the crankshaft until the advance timing mark on the front face of the starter ring gear is in alignment with the small hole located at the two o'clock position on the front face of the starter housing. (Ring gear may be marked at 20° and 25°. Consult specifications for correct timing mark for your installation.) At this point, the engine is ready for assembly of the magneto.

(2) *Single Magneto* – Remove the inspection plugs from both magnetos and turn the drive shaft in direction of normal rotation until (-1200 series) the applicable timing mark on the distributor gear is approximately aligned with the mark on the distributor block. See Figure 5-2. Being sure the gear does not move from this position, install gaskets and magnetos to the engine. Note that an adapter is used with all magnetos. Secure with (clamps on –1200 series) washers and nuts; tighten only finger tight.

(3) Using a battery powered timing light, attach the positive lead to a suitable terminal connected to the switch terminal of the magneto and the negative lead to any unpainted portion of the engine. Rotate the magneto in its mounting flange to a point where the light comes on, then slowly turn it in the opposite direction until the light goes out. Bring the magneto back slowly until the light just comes on. Repeat this with the second magneto.

(4) Back off the crankshaft a few degrees, the timing lights should go out. Bring the crankshaft slowly back in direction of normal rotation until the timing mark and the hole in the starter housing are in alignment. At this point, both lights should go on simultaneously. Tighten nuts to specified torque.

(5) *Dual Magnetos* – Place the engine in the No. 1 advance firing position as directed in paragraph 1, b, (1).

(6) Install the magneto-to-engine gasket on the magneto flange.

WARNING

DO NOT ATTACH HARNESS SPARK PLUG ENDS TO THE SPARK PLUGS UNTIL ALL MAGNETO-TO-ENGINE TIMING PROCEDURES AND MAGNETO-TO-SWITCH CONNECTIONS ARE ENTIRELY COMPLETED.

(7) To remove engine-to-magneto drive gear train backlash by turning engine magneto drive as far as possible in direction opposite to normal rotation and then return in the direction of normal rotation to timing mark on starter support.

(8) Remove the timing window plug from the most convenient side of the magneto housing and the plug from the rotor viewing location in the center of the housing.

(9) Turn the rotating magnet drive shaft in the normal direction of magneto rotation until the painted tooth of the large distributor gear is centered in the timing hole.

(10) Observe that at this time the built in pointer just ahead of the rotor viewing window aligns with the R or L mark on the rotor depending on whether the magneto is of right or left hand rotation as specified on the magneto nameplate.

(11) Hold the magneto in its No. 1 firing position (tooth in window center and pointer over R or L mark on rotor) and install magneto to the engine and loosely clamp in position.

(12) Attach red lead from the timing light to left switch adapter lead, green lead of timing light to right switch adapter lead and the black lead of the light to magneto housing.

(13) Turn the entire magneto in direction of rotor rotation until the red timing light comes on.

(14) Rotate the magneto in the opposite direction until the red light just goes off indicating left main breaker has opened. Then evenly tighten the magneto mounting clamps.

(15) Back the engine up approximately 10° and then carefully "bump" the engine forward at the same time observing the timing lights.

(16) At the No. 1 firing position of the engine, the red light should go off indicating left main breaker opening. The right main breaker, monitored by the green light, must open within ± 2 engine degrees of the No. 1 firing position.

(17) Repeat steps (13) thru (15) until the condition described in step (16) is obtained.

(18) Complete tightening of the magneto securing clamps by torquing to 150 in.-lbs.

(19) Recheck timing once more and if satisfactory disconnect timing light. Remove adapter leads.

(20) Reinstall plugs in timing inspection holes and torque to 12-15 in.-lbs.

NOTE

Some timing lights operate in the reverse manner as described. The light comes on when the breaker points open. Check your timing light instructions.

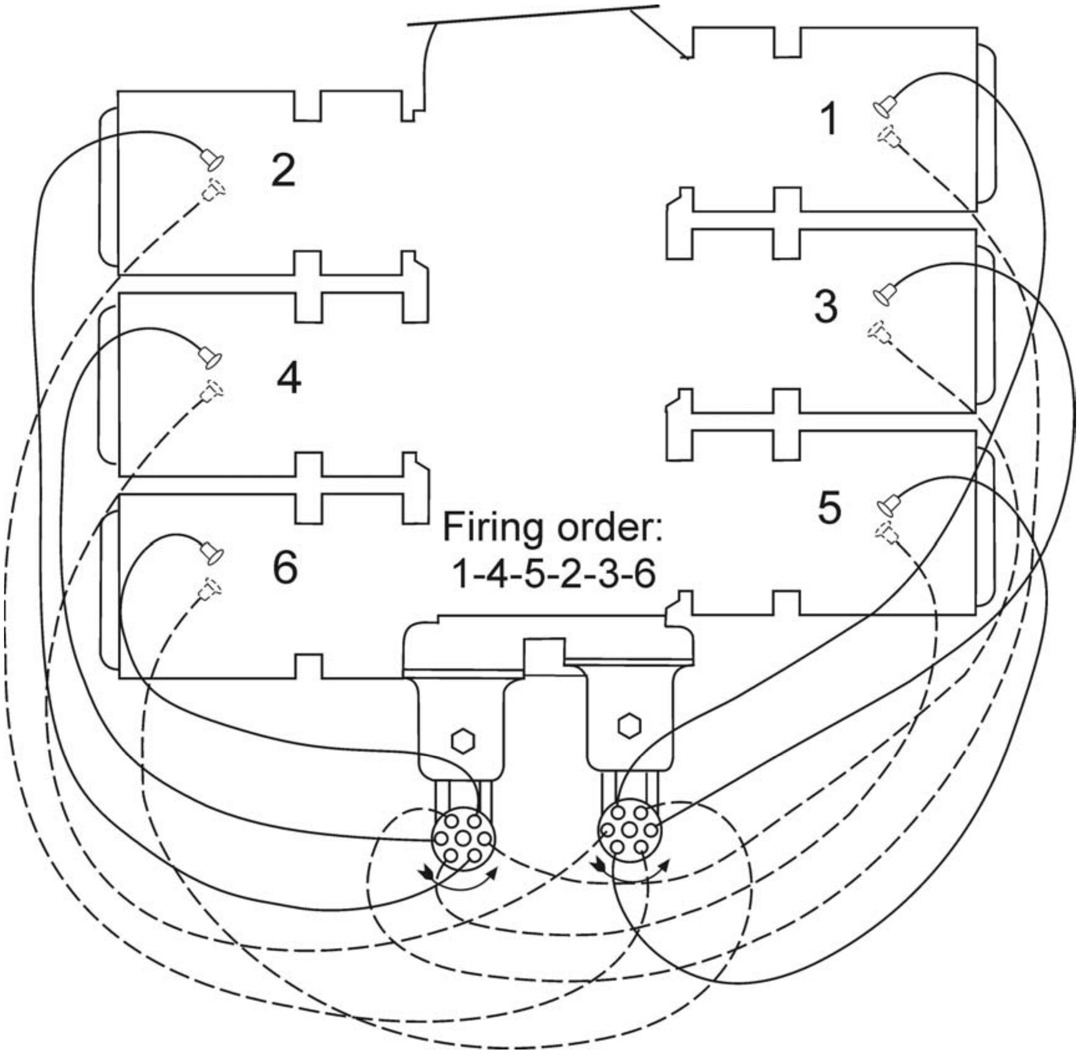

Figure 5-1. Ignition Wiring Diagram

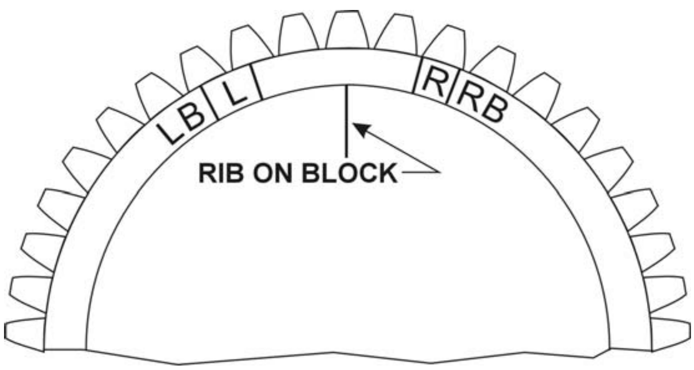

Figure 5-2. Timing Marks – 6 Cyl. –1200 Series

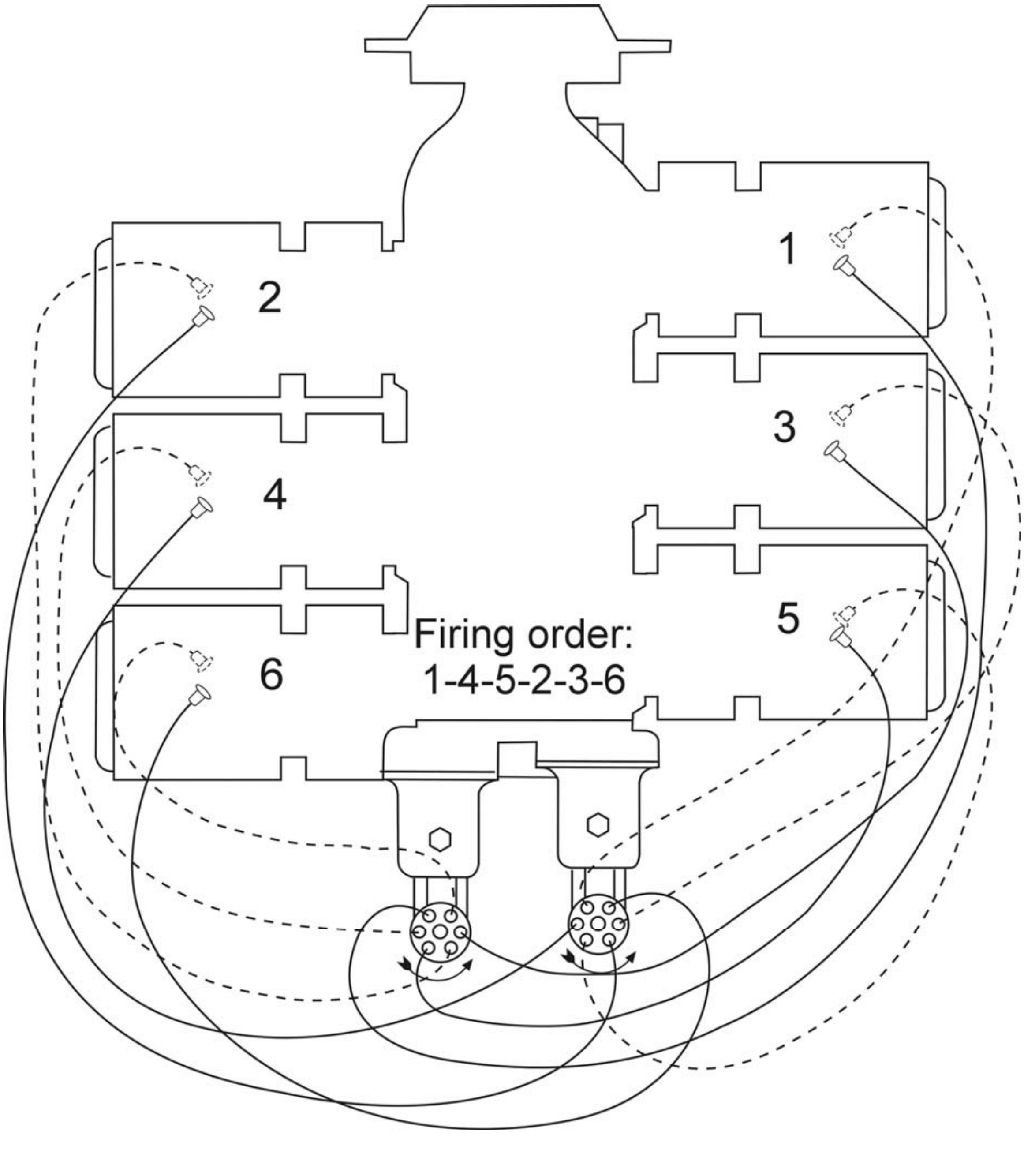

Figure 5-3. Ignition Wiring – Dual Magneto

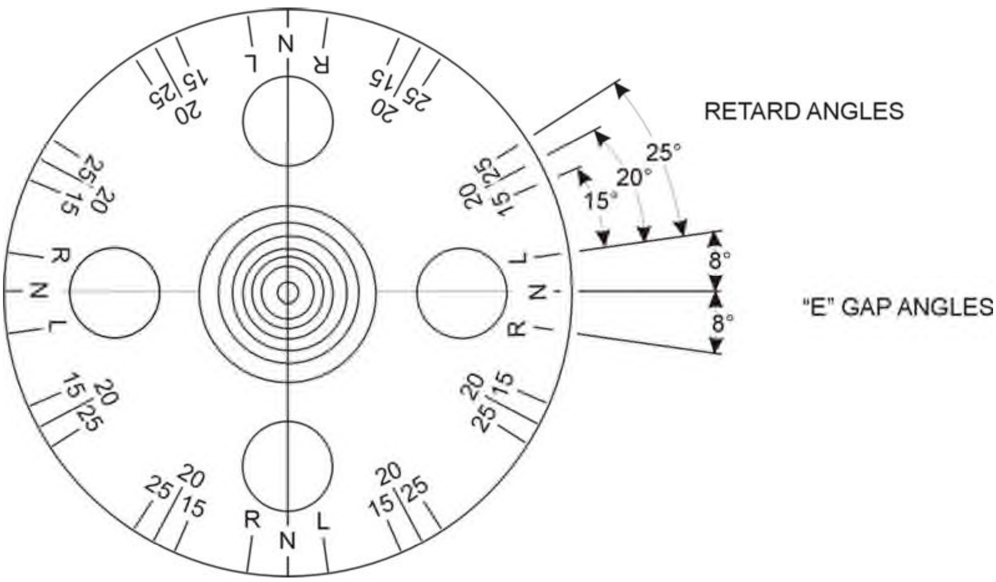

Figure 5-4. Timing Marks on Rotating Magneto

c. *Internal Timing – Dual Magneto –* Check the magneto internal timing and breaker synchronization in the following manner.

(1) *Main Breakers –* Connect the timing light negative lead to any unpainted surface of the magneto. Connect one positive lead to the left main breaker terminal and the second positive lead to the right main breaker terminal.

(2) Back the engine up a few degrees and again bump forward toward number one cylinder firing position while observing timing lights. Both lights should go out to indicate opening of the main breakers when the timing pointer is indicating within the width of the "L" or "R" mark. If breaker timing is incorrect, loosen breaker screws and correct. Retorque breaker screws to 2 to 25 in.-lbs.

(3) *Retard Breaker –* Remove timing light leads from the main breaker terminals. Attach one positive lead to retard breaker terminal, and second positive lead to the tachometer breaker terminal, if used.

(4) Back the engine up a few degrees and again bump forward toward number one cylinder firing position until pointer is aligned with 15° retard timing mark. See Figure 5-4. Retard breaker should just open at this position.

(5) If retard timing is not correct, loosen cam securing screw and turn the retard breaker cam as required to make retard breaker open per paragraph c(4). Retorque cam screw to 16-20 in. lbs.

(6) Observe that tachometer breaker is opened by the cam lobe. No synchronization of this breaker is required.

(7) Check action of impulse coupling (D-2000 series only). With the ignition switch off observe breaker cam end of rotor while manually cranking engine through a firing sequence. Rotor should alternately stop and then (with an audible snap) be rotated rapidly through a retard firing position.

d. *Generator or Alternator Output* – The generator or alternator (whichever is applicable) should be checked to determine that the specified voltage and current are being obtained.

2. *FUEL SYSTEM.*

a. *Repair of Fuel Leaks* – In the event a line or fitting in the fuel system is replaced, only a fuel soluble lubricant, such as clean engine oil or Loctite Hydraulic Sealant may be used. Do not use any other form of thread compound.

b. *Fuel Injector Inlet Screen Assembly* – Remove the assembly and check the screen for distortion or openings in the strainer. Replace for either of this conditions. Clean screen assembly in solvent and dry with compressed air. To install the screen assembly, place the gasket on the screen assembly and install the assembly in the throttle body and tighten to 60-70 in.-lbs. torque.

c. *Fuel Grades and Limitations* – See recommended fuel grades in Section 3.

In the event that the specified fuel is not available at some locations, it is permissible to use higher octane fuel. Fuel of a lower octane than specified is not to be used. Under no circumstances should automotive fuel be used (regardless of octane rating).

NOTE

It is recommended that personnel be familiar with the latest revision of Service Instruction No. 1070 regarding specified fuel for Lycoming engines.

d. *Air Intake Ducts and Filter* – Check all air intake ducts for dirt or restrictions. Inspect and service air filters as instructed in the airframe manufacturer's handbook.

e. *Idle Speed and Mixture Adjustment* –

(1) Start engine and warm-up in the usual manner until oil and cylinder head temperatures are normal.

(2) Check magnetos. If the "mag-drop" is normal, proceed with idle adjustment.

(3) Set throttle stop screw so that the engine idles at the airframe manufacturer's recommended idling RPM. If the RPM changes appreciably after making idle mixture adjustment during the succeeding steps, readjust the idle speed to the desired RPM.

(4) When the idling speed has been stabilized, move the cockpit mixture control lever with a smooth, steady pull toward the "Idle Cut-Off" position and observe the tachometer for any change during the leaning process. Caution must be exercised to return the mixture control to the "Full Rich" position before the RPM can drop to a point where the engine cuts out. An increase of more than 50 RPM while "leaning out" indicates an excessively rich idle mixture. An immediate decrease in RPM (if not preceded by a momentary increase) indicates the idle mixture is too lean.

If step (4) indicates that the idle adjustment is too rich or too lean, turn the idle mixture adjustment in the direction required for correction, and check this new position by repeating the procedure in step (4). Make additional adjustments as necessary until a check results in a momentary pick-up of approximately 50 RPM. Each time the adjustment is changed, the engine should be run up to 2000 RPM to clear the engine before proceeding with the RPM check. Make final adjustment of the idle speed adjustment to obtain the desired idling RPM with closed throttle. The above method aims at a setting that will obtain maximum RPM with minimum manifold pressure. In case the setting does not remain stable, check the idle linkage; any looseness in this linkage would cause erratic idling. In all cases, allowance should be made for the effect of weather conditions and field altitude upon idling adjustment.

3. LUBRICATION SYSTEM.

a. *Oil Grades and Limitations* – Service the engine in accordance with the recommendations shown in Section 3.

b. *Oil Suction and Oil Pressure Screens* – At each fifty hours inspection remove, inspect for metal particles, clean and reinstall.

NOTE

On installations employing external oil filters, step 3, b is not practical at this time. But should be observed at the 100-hour inspection

c. *Oil Relief Valve (Non-Adjustable)* – The function of the oil pressure relief valve is to maintain engine oil pressure within specified limits. The valve, although not adjustable, may be controlled by the addition of a maximum of nine STD-425 washers under the cap to increase pressure or the use of a spacer (Lycoming P/N 73629 or 73630) to decrease pressure. A modification on later models has eliminated the need for the spacers. Particles of metal or other foreign matter lodged between the ball and seat will result in faulty readings. It is advisable, therefore, to disassemble, inspect and clean the valve if excessive pressure fluctuations are noted.

d. *Oil Relief Valve (Adjustable)* – The adjustable oil relief valve enables the operator to maintain engine oil pressure within the specified limits. If the pressure under normal operating conditions should consistently exceed the maximum or minimum specified limits, adjust the valve as follows:

With the engine warmed up and running at approximately 2000 RPM, observe the reading on the oil pressure gage. If the pressure is above maximum or below minimum specified limits, stop engine and screw the adjusting screw out to decrease pressure and in to increase pressure. Depending on installation, the adjusting screw may have only a screw driver slot and is turned with a screw driver; or may have the screw driver slot plus a pinned .375-24 castellated nut and may be turned with either a screw driver or a box wrench.

4. CYLINDERS. It is recommended that as field operation, cylinder maintenance be confined to replacement of the entire assembly. For valve replacement, consult the proper Overhaul Manual. This should be undertaken only as an emergency measure.

a. *Removal of Cylinder Assembly –*

(1) Remove exhaust manifold.

(2) Remove rocker box drain tube, intake pipe, baffle and any clips that might interfere with the removal of the cylinder.

(3) Disconnect ignition cables and remove the bottom spark plug.

(4) Remove rocker box cover and rotate crankshaft until piston is approximately at top center of the compression stroke. This is indicated by a positive pressure inside of cylinder tending to push thumb off of bottom spark plug hole.

(5) Slide valve rocker shafts from cylinder head and remove the valve rockers. Valve rocker shafts can be removed when the cylinder is removed from the engine. Remove rotator cap from exhaust valve stem.

(6) Remove push rod by grasping ball end and pulling rod out of shroud tube. Detach shroud tube spring and lock plate and remove shroud tubes from cylinder head.

NOTE

The hydraulic tappets, push rods, rocker arms and valves must be assembled in the same location from which they were removed.

(7) Remove cylinder base nuts and hold down plates (where employed) than remove cylinder by pulling directly away from crankcase. Be careful not to allow the piston to drop against the crankcase, as the piston leaves the cylinder.

b. *Removal of Piston from Connecting Rod –* Remove the piston pin plugs. Insert piston pin puller through piston pin, assemble propeller nut; then proceed to remove piston pin. Do not allow connecting rod to rest on the cylinder bore of the crankcase. Support the connecting rod with heavy rubber band, discarded cylinder base oil ring seal, or any other non-marring method.

c. *Removal of Hydraulic Tappet Sockets and Plunger Assemblies –* It will be necessary to remove and bleed the hydraulic tappet plunger assembly so that dry tappet clearance can be checked when the cylinder assembly is reinstalled. This is accomplished in the following manner:

(1) Remove the hydraulic tappet push rod socket by inserting the forefinger into the concave end of the socket and withdrawing. If the socket cannot be removed in this manner, it may be removed by grasping the edge of the socket with a pair of needle nose pliers. However, care must be exercised to avoid scratching the socket.

(2) To remove the hydraulic tappet plunger assembly, use the special Lycoming service tool. In the event that the tool is not available, the hydraulic tappet plunger assembly may be removed by a hook in the end of a short piece of lockwire, inserting the wire so that the hook engages the spring of the plunger assembly. Draw the plunger assembly out of the tappet body by gently pulling the wire.

CAUTION

NEVER USE A MAGNET TO REMOVE HYDRUALIC PLUNGER ASSEMBLIES FROM THE CRANKCASE. THIS CAN CAUSE THE CHECK BALL TO REMAIN OFF ITS SEAT, RENDERING THE UNIT INOPERATIVE.

d. *Assembly of Hydraulic Tappet Plunger Assemblies* – To assemble the unit, unseat the ball by inserting a thin clean wire through the oil inlet hole. With the ball off its seat, insert the plunger and twist clockwise so that the spring catches. All oil must be removed before the plunger is inserted.

e. *Assembly of Cylinder and Related Parts* – Rotate the crankshaft so that the connecting rod of the cylinder being assembled is at top center of compression stroke. This can be checked by placing two fingers on the intake and exhaust tappet bodies. Rock crankshaft back and forth over top center. If the tappet bodies do not move the crankshaft is on the compression stroke.

(1) Place each plunger assembly in its respective tappet body and assemble the socket on top of plunger assembly.

(2) Assemble piston with rings so that the number stamped on the piston pin boss is toward the front of the engine. The piston pin should be of a hand push fit. If difficulty is experienced in inserting the piston, it is probably caused by carbon or burrs in the piston pin hole. During assembly, always use a generous amount of oil, both in the piston pin hole and on the piston pin.

(3) Assemble one piston pin plug at each end of the piston pin and place a new rubber oil seal ring around the cylinder skirt. Coat piston and rings and the inside of the cylinder generously with oil.

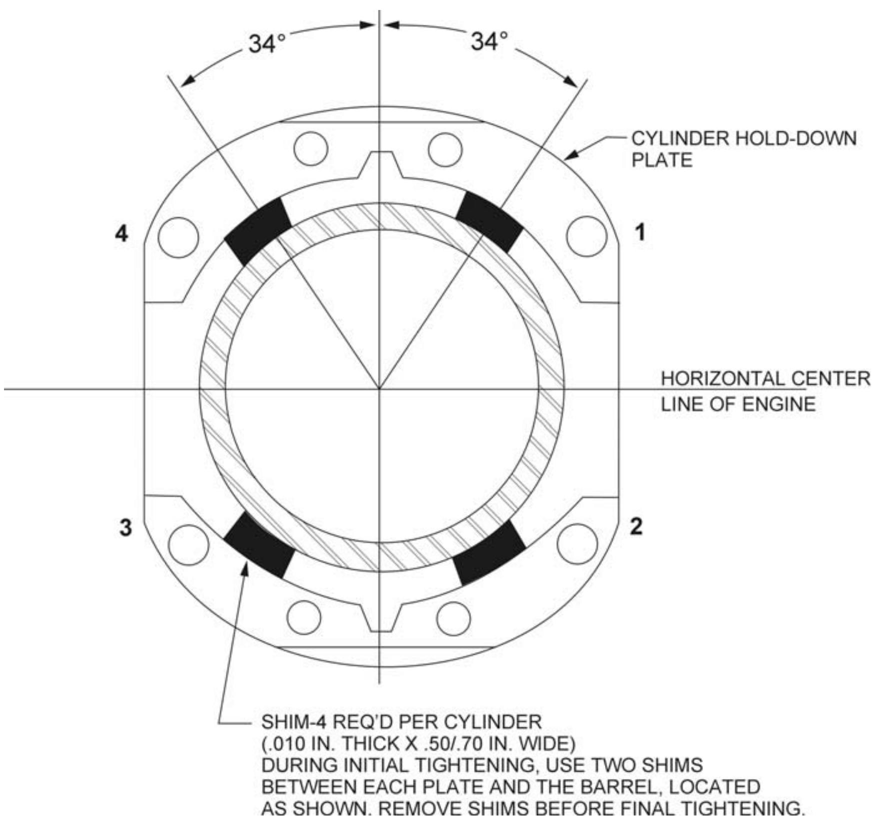

Figure 5-5. Location of Shims Between Cylinder Barrel and Hold-Down Plates (where applicable) and Sequence of Tightening Cylinder Base Hold-Down Nuts

(4) Using a piston ring compressor, assemble the cylinder over the piston so that the intake port is at the bottom of the engine. Push the cylinder all of the way on, catching the ring compressor as it is pushed off.

NOTE

Before installing cylinder hold-down nuts, lubricate crankcase thru-stud threads with any one of the following lubricants, or combination of lubricants.

1. *90% SAE 50W engine oil and 10% STP.*
2. *Parker Thread Lube.*
3. *60% SAE 30 engine oil and 40% Parker Thread Lube.*

(5) Assemble hold-down plates (where applicable) and cylinder base hold-down nuts and tighten as directed in the following steps.

NOTE

At any time a cylinder is replaced, it is necessary to retroque the thru-studs on the cylinder on the opposite side of the engine.

(a) *Engine Using Hold-Down Plates* – Install shims between cylinder base hold-down plates and cylinder barrel, as directed in Figure 5-5, and tighten ½ inch hold-down nuts to 300 in.-lbs. (25 ft.-lbs.) torque, using the sequence shown in Figure 5-5.

(b) Remove shims, and using the same sequence, tighten the ½ inch cylinder base nuts, to 600 in.-lbs. (50 ft.-lbs.) torque.

NOTE

Cylinder assemblies not using hold-down plate are tightened in the same manner as above omitting the shims.

(c) Tighten the ⅜ inch hold-down nuts to 300 in.-lbs. (25 ft.-lbs.) torque. Sequence of tightening is optional.

(d) As a final check, hold the torque wrench on each nut for about five seconds. If the nut does not turn, it may be presumed to be tightened to correct torque.

CAUTION

AFTER ALL CYLINDER BASE NUTS HAVE BEEN TIGHTENED, REMOVE ANY NICKS IN THE CYLINDER FINS BY FILING OR BURRING.

(6) Install new shroud tube oil seals on both ends of shroud tube. Install shroud tube and lock in place as required for type of cylinder.

(7) Assemble each push rod in its respective shroud tube, and assemble each rocker in its respective position by placing rocker between bosses and sliding valve rocker shaft in place to retain rocker. Before installing exhaust valve rocker, place rotator cap over end of exhaust valve stem.

(8) Be sure that the piston is at top center of compression stroke and that both valves are closed. Check clearance between the valve stem tip and the valve rocker. In order to check this clearance, place the thumb of one hand on the valve rocker directly over the end of the push rod and push down so as to compress the hydraulic tappet spring. While holding the spring compressed, the valve clearance should be between .028 and .080 inch. If clearance does not come within these limits, remove the push rod and insert a longer or shorter push rod, as required to correct clearance.

NOTE

Inserting a longer push rod will decrease the valve clearance.

(9) Install intercylinder baffles, rocker box covers, intake pipes, rocker box drain tubes and exhaust manifold.

5. TURBOCHARGER.

a. Density Controller – The density controller is adjusted at the factory to maintain a predetermined constant for desired horsepower.

The density controller is set to a curve, see Figure 5-6 thru 5-10, under the following conditions: Engines at operating temperatures, full throttle with oil pressure at 80 psi ± 5 psi.

If it is suspected that either the manifold pressure or compressor discharge pressure is not within limits, it may be checked to the curve. See AiResearch Industrial Division Manual TP-21 for detailed information for setting.

EXAMPLE

Operating at the stated conditions with a compressor discharge temperature of 120°F, the manifold pressure and compressor discharge pressure should be 38.6 in. Hg. ± 3 in. Hg.

If the manifold pressure is found to be out of limits, the cause might be found either in the density controller, the differential pressure controller, or the waste gate. It is recommended that an authorized overhaul facility check these controls.

6. GENERATOR OR ALTERNATOR DRIVE BELT TENSION.

Check the tension of a new belt 25 hours after installation. Refer to the latest revision of Service Instruction No. 1129 for methods of checking generator or alternator drive belt tension.

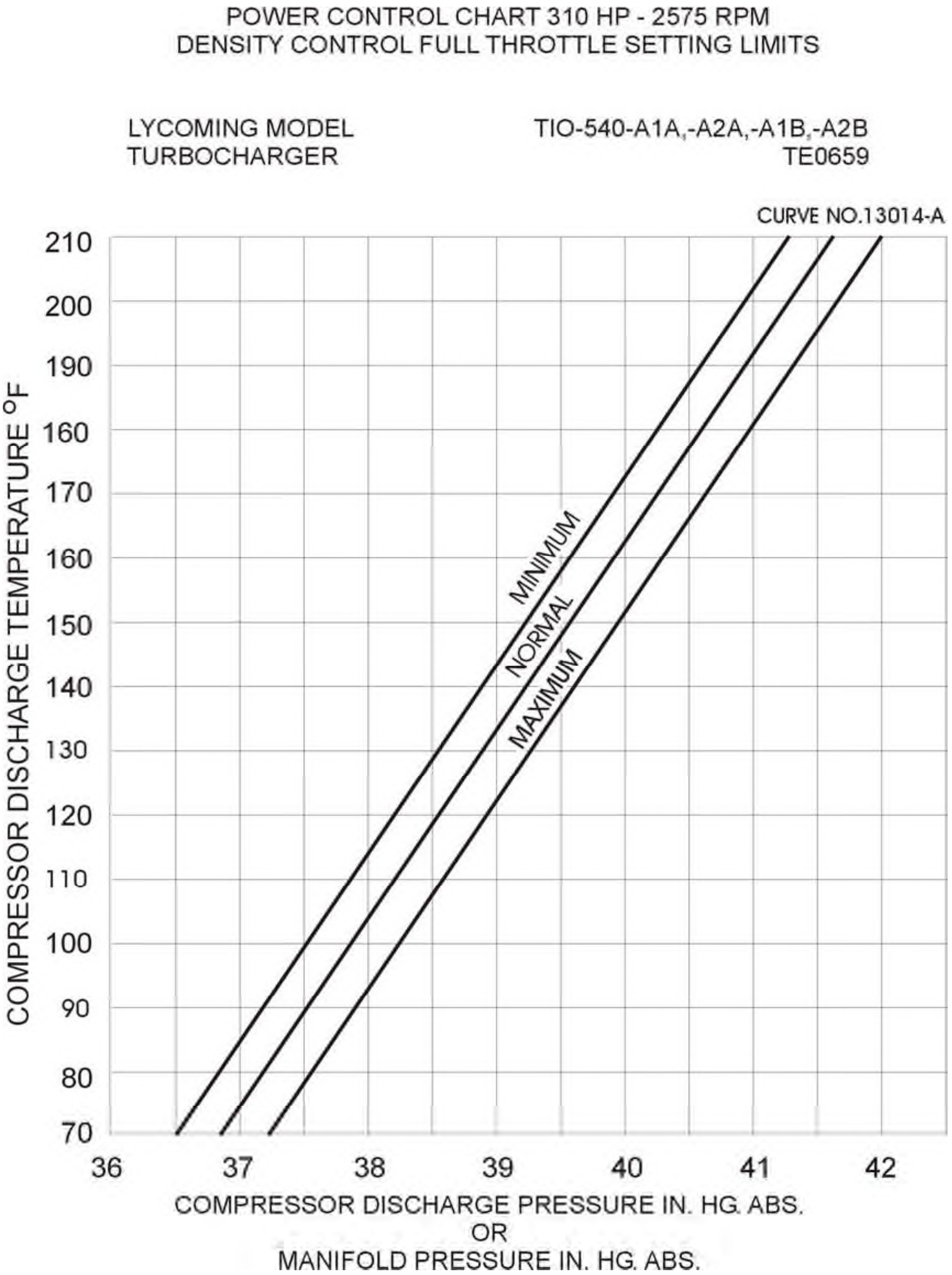

Figure 5-6. Density Control Full Throttle Setting Limits –
TIO-540-A1A, -A2A, -A1B, -A2B

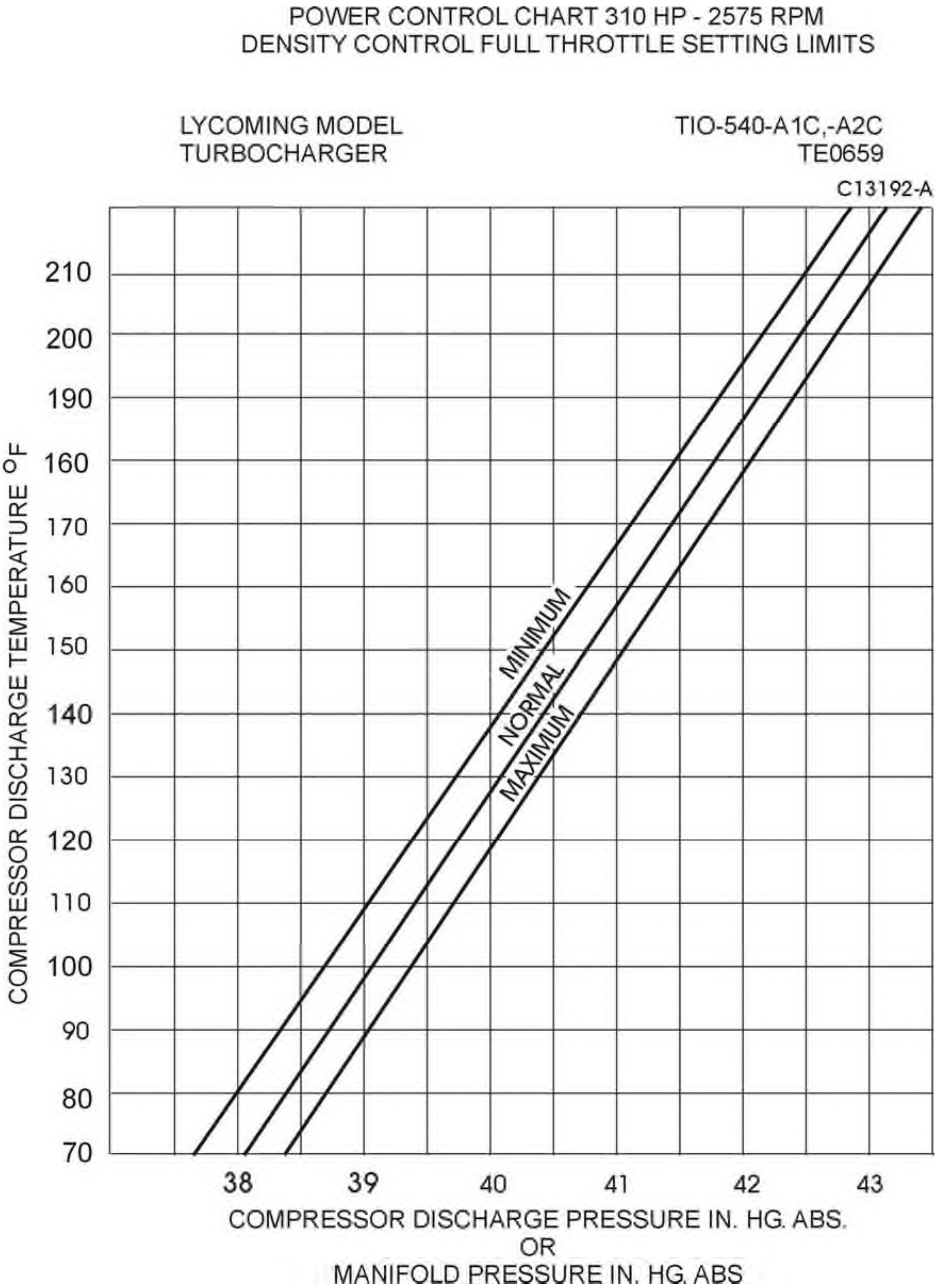

Figure 5-7. Density Control Full Throttle Setting Limits –
TIO-540-A2C

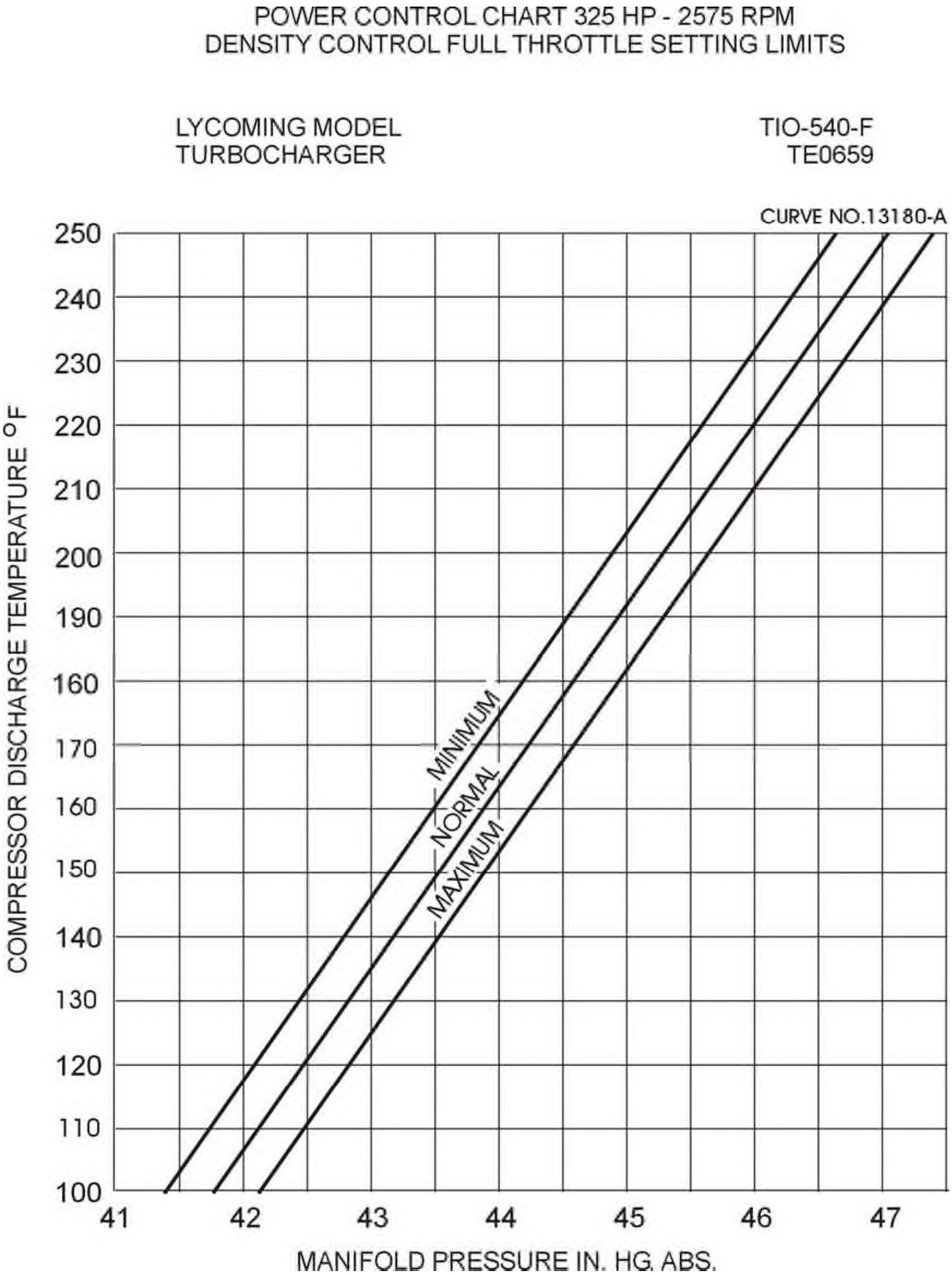

Figure 5-8. Density Control Full Throttle Setting Limits –
TIO-540-F2BD

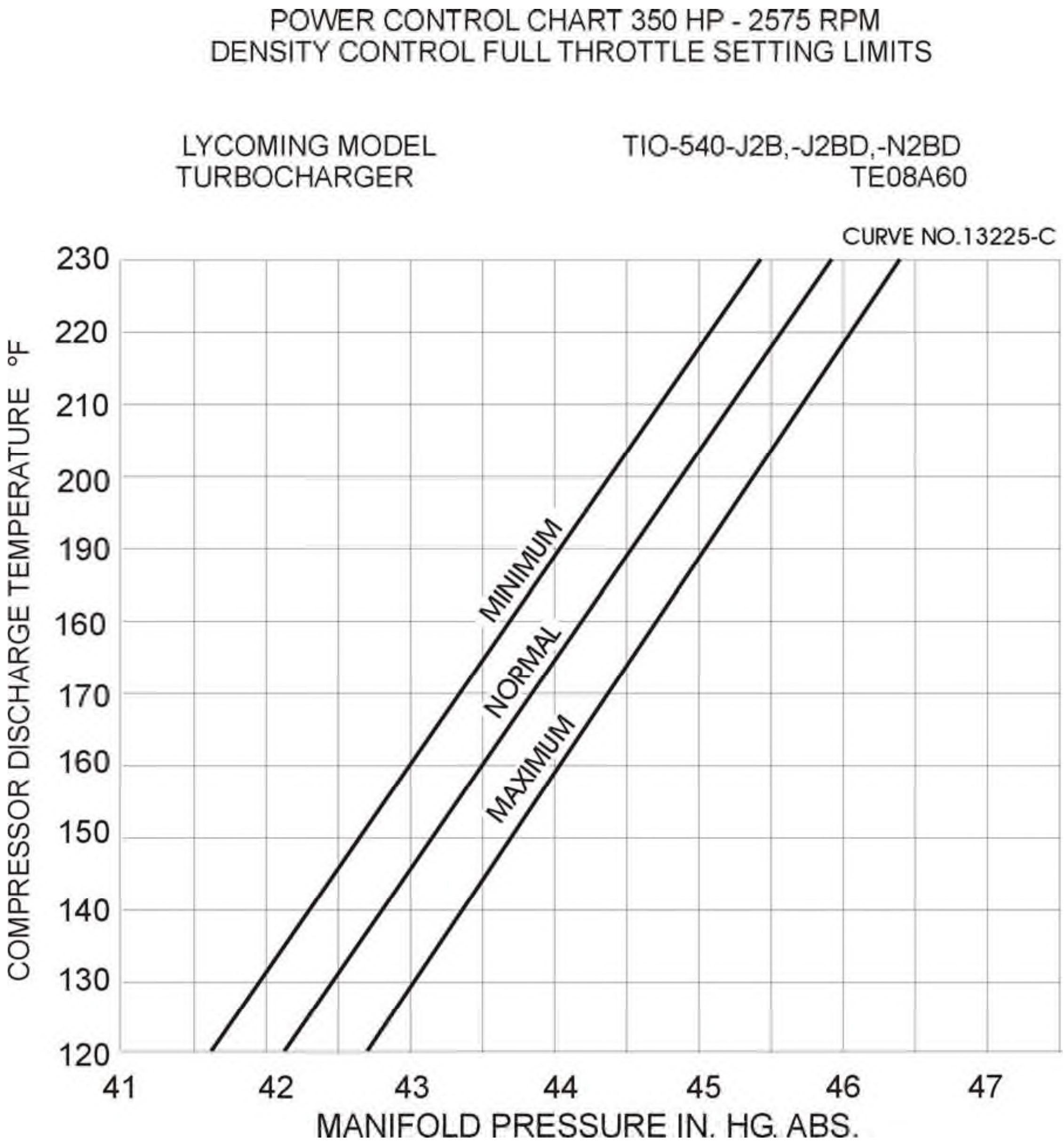

Figure 5-9. Density Control Full Throttle Setting Limits –
TIO-540-J2B, -J2BD, -N2BD

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SECTION 6
TROUBLE-SHOOTING – ENGINE

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SECTION 6

TROUBLE-SHOOTING

Experience has proven that the best method of trouble-shooting is to decide on the various causes of a given trouble and then to eliminate causes one by one, beginning with the most probable. The following charts list some of the more common troubles, which may be encountered in maintaining engines and turbochargers; their probable cause and remedies.

1. TROUBLE-SHOOTING – ENGINE.

TROUBLE	PROBABLE CAUSE	REMEDY
Failure of Engine to Start	Lack of fuel	Check fuel system for leaks. Fill fuel tank. Clean dirty lines, strainers, or fuel valves.
	Overpriming	Leave ignition "off" and mixture control in "Idle Cut-Off", open throttle and "unload" engine by cranking for a few seconds. Turn ignition switch on and proceed to start in a normal manner.
	Defective spark plug	Clean and adjust or replace spark plugs.
	Defective ignition wire	Check with electric tester, and replace any defective wires.
	Defective battery	Replace with charged battery.
	Improper operation of magneto breaker	Clean points. Check internal timing of magnetos.
	Lack of sufficient fuel flow	Disconnect fuel line and check fuel flow.
	Water in fuel injector or carb.	Drain fuel injector or carburetor and fuel lines.
	Internal failure	Check oil screens for metal particles. If found, complete overhaul of the engine may be indicated.

TROUBLE	PROBABLE CAUSE	REMEDY
Failure of Engine to Idle Properly	Incorrect idle mixture	Adjust mixture.
	Leak in induction system	Tighten all connections in the induction system. Replace any parts that are defective.
	Incorrect idle adjustment	Adjust throttle stop to obtain correct idle.
	Uneven cylinder compression	Check condition of piston rings and valve seats.
	Faulty ignition system	Check entire ignition system.
	Insufficient fuel pressure	Adjust fuel pressure.
	Leak in air bleed nozzle balance line	Check connection and replace if necessary.
	Plugged fuel injector nozzle	Clean or replace nozzle.
	Flow divider fitting plugged	Clean fitting.
Low Power and Uneven Running	Mixture too rich; indicated by sluggish engine operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust	Readjustment of fuel injector or carburetors by authorized personnel is indicated.
	Mixture too lean; indicated by overheating or backfiring	Check fuel lines for dirt or other restrictions. Readjustment of fuel injector or carburetor by authorized personnel is indicated.
	Leaks in induction system	Tighten all connections. Replace defective parts.
	Defective spark plugs	Clean and gap or replace spark plugs.
	Improper fuel	Fill tank with fuel of recommended grade.
	Magneto breaker points not working properly	Clean points. Check internal timing of magnetos.

TROUBLE	PROBABLE CAUSE	REMEDY
Low Power and Uneven Running (Cont.)	Defective ignition wire	Check wire with electric tester. Replace defective wire.
	Defective spark plug terminal connectors	Replace connectors on spark plug wire.
	Plugged fuel injector nozzle	Clean or replace nozzle.
Failure of Engine to Develop Full Power	Leak in induction system	Tighten all connections and replace defective parts.
	Plugged fuel injector nozzle	Clean or replace nozzle.
	Throttle lever out of adjustment	Adjust throttle lever.
	Improper fuel flow	Check strainer, gage and flow at the fuel line.
	Restriction in air scoop	Examine air scoop and remove restrictions.
	Improper fuel	Drain and refill tank with recommended fuel.
	Faulty ignition	Tighten all connections. Check system with tester. Check ignition timing.
Rough Engine	Cracked engine mount	Replace or repair mounting.
	Defective mounting bushings	Install new mounting bushings.
	Uneven compression	Check compression.
	Plugged fuel injector nozzle	Clean or replace nozzle.
Low Oil Pressure	Insufficient oil	Fill sump to proper level with recommended oil.
	Air lock or dirt in relief valve	Remove and clean oil pressure relief valve.
	Leak in suction line or pressure line	Check gasket between accessory housing and crankcase.
	High oil temperature	See "High Oil Temperature" in "Trouble" column.

TROUBLE	PROBABLE CAUSE	REMEDY
Low Oil Pressure (Cont.)	Defective pressure gage	Replace.
	Stoppage in oil pump intake passage	Check line for obstruction. Clean suction strainer.
High Oil Temperature	Insufficient oil supply	Fill oil sump to proper level with specified oil.
	Low grade of oil	Replace with oil conforming to specifications.
	Clogged oil lines or strainers	Remove and clean oil strainers.
	Excessive blow-by	Usually caused by worn or stuck rings.
	Failing or failed bearing	Examine sump for metal particles. If found, overhaul of engine is indicated.
	Defective temperature gage	Replace gage.
Excessive oil consumption	Low grade of oil	Fill tank with oil conforming to specification.
	Failing or failed bearings	Check sump for metal particles.
	Worn piston rings	Install new rings.
	Incorrect installation of piston rings	Install new rings.
	Failure of rings to seal (new nitrided cylinders)	Use mineral base oil. Climb to cruise altitude at full power and operate at 75% cruise power setting until oil consumption stabilizes.
High Fuel Flow Indicated On Fuel Gage	Plugged fuel injector nozzle	Clean or replace nozzles.

2. TROUBLE-SHOOTING – TURBOCHARGER.

TROUBLE	PROBABLE CAUSE	REMEDY
Excessive Noise or Vibration	Improper bearing lubrication	Supply required oil pressure. Clean or replace oil line; clean oil strainer. If trouble persists, overhaul turbocharger.
	Leak in engine intake or exhaust manifold	Tighten loose connections or replace manifold gaskets as necessary.
	Dirty impeller blades	Disassemble and clean.
Engine will not Deliver Rated Power	Clogged manifold assembly	Clean all ducting.
	Foreign material lodged in compressor impeller or turbine	Disassemble and clean.
	Excessive dirt build-up in compressor	Thoroughly clean compressor assembly. Service air cleaner and check for leakage.
	Leak in engine intake or exhaust	Tighten loose connections or replace manifold gaskets as necessary.
	Rotating assembly bearing seizure	Overhaul turbocharger.
	Restriction in return lines from actuator to exhaust bypass controller	Remove and clean lines.
	Exhaust bypass controller is in need of adjustment	Have exhaust bypass controller adjusted.
	Oil pressure too low	Tighten fittings. Replace lines or hoses, increase oil pressure to desired pressure.
	Inlet orifice to actuator clogged	Remove inlet line at actuator and clean orifice.
	Exhaust bypass controller malfunction	Replace unit.

TROUBLE	PROBABLE CAUSE	REMEDY
Engine will not Deliver Rated Power (Cont.)	Exhaust bypass butterfly not closing	Low pressure. Clogged orifice in inlet to actuator.
		Butterfly shaft binding. Check bearings.
	Turbocharger impeller binding, frozen or fouling housing	Check bearings. Replace turbo-charger.
	Piston seal in actuator leaking (usually accompanied by oil leakage at drain line)	Remove and replace actuator or disassemble and replace packing.
Critical Altitude Lower than Specified	Controller not getting enough oil pressure to close exhaust bypass	Check pump outlet pressure, oil filters, external lines for leaks or obstructions.
	Chips under metering valve in controller holding it open	Replace controller.
	Metering jet in actuator plugged	Remove actuator and clean jet.
	Actuator piston seal failed and leaking excessively	If there is oil leakage at actuator drain, clean cylinder and replace piston seal.
	Exhaust bypass valve sticking	Clean and free action.
Engine Surges or Smokes	Air in oil lines or actuator	Bleed system.
	Controller metering valve stem seal leaking oil into manifold	Replace controller.
	Clogged breather	Check breather for restrictions to air flow.

NOTE

Smoke would be normal if engine has idled for a prolonged period.

TROUBLE	PROBABLE CAUSE	REMEDY
High Deck Pressure (Compressor Discharge Pressure)	Controller metering valve not opening, aneroid bellow leaking	Replace controller assembly or replace aneroid bellows.
	Exhaust bypass sticking closed	Shut off valve in return line not working.
		Butterfly shaft binding. Check bearings.
		Replace exhaust bypass valve or correct linkage binding.

TROUBLE	PROBABLE CAUSE	REMEDY
High Deck Pressure (Compressor Discharge Pressure) (Cont.)	Controller return line restricted	Clean or replace line.
	Oil pressure too high	Check pressure 75 to 85 psi (80 psi desired) at exhaust bypass actuator inlet. If pressure on outlet side of actuator is too high, have exhaust bypass controller adjusted.
	Exhaust bypass valve actuator piston locked in full closed position (usually accompanied by oil leakage at actuator drain line) NOTE: Exhaust bypass normally closed in idle and low power conditions. Should open when actuator inlet line is disconnected	Remove and disassemble actuator, check condition of piston and packing or replace actuator assembly.
	Exhaust bypass controller malfunction	Replace controller.

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SECTION 7
INSTALLATION AND STORAGE

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SECTION 7

INSTALLATION AND STORAGE

1. *PREPARATION OF ENGINE FOR INSTALLATION.* Before installing an engine that has been prepared for storage, remove all dehydrator plugs, bags of desiccant and preservative oil from the engine. Preservation oil can be removed by removing the bottom spark plugs and turning the crankshaft three or four revolutions by hand. The preservative oil will then drain through the spark plug holes. Draining will be facilitated if the engine is tilted from side to side during the above operation. Preservative oil which has accumulated in the sump can be drained by removing the oil sump plug. Engines that have been stored in a cold place should be removed to an environment of at least 70°F (21°C) for a period of 24 hours before preservative oil is drained from the cylinders. If this is not possible, heat the cylinders with heat lamps before attempting to drain the engine.

After the oil sump has been drained, the plug should be replaced, safety-wired, and the sump refilled with lubricating oil. The crankshaft should again be turned several revolutions to saturate the interior of the engine with the clean oil. When installing spark plugs, make sure that they are clean, if not, wash them in clean petroleum solvent. Of course, there will be a small amount of preservative oil remaining in the engine, but this can cause no harm. However, after twenty-five hours of operation, the lubricating oil should be drained while the engine is hot. This will remove any residual preservative oil that may have been present.

CAUTION

DO NOT ROTATE THE CRANKSHAFT OF AN ENGINE CONTAINING PRESERVATIVE OIL BEFORE REMOVING THE SPARK PLUGS, BECAUSE IF THE CYLINDERS CONTAIN ANY APPRECIABLE AMOUNT OF THE MIXTURE, THE RESULTING ACTION, KNOWN AS HYDRAULICING, WILL CAUSE DAMAGE TO THE ENGINE. ALSO, ANY CONTACT OF THE PRESERVATIVE OIL WITH PAINTED SURFACES SHOULD BE AVOIDED.

General – Should any of the dehydrator plugs containing crystals of silica-gel or similar material, be broken during their term of storage or upon their removal from the engine, and if any of the contents should fall into the engine, that portion of the engine must be disassembled and thoroughly cleaned before using the engine. The oil strainers should be removed and cleaned in gasoline or some other hydrocarbon solvent. The fuel drain screen located in the fuel inlet of the carburetor or fuel injector should also be removed and cleaned in a hydrocarbon solvent. The operator should also note if any valves are sticking. If they are, this condition can be eliminated by coating the valve stem generously with a mixture of gasoline and lubrication oil.

Inspection of Engine Mounting – If the aircraft is one from which an engine has been removed, make sure that the engine mount is not bent or damaged by distortion or misalignment as this can produce abnormal stresses within the engine.

Attaching Engine to Mounts – See airframe manufacturer's recommendations for method of mounting the engine.

Oil and Fuel Line Connections – The oil and fuel line connections are called out on the accompanying installation drawings.

Propeller Installation – Consult the airframe manufacturer for information relative to propeller installation.

CORROSION PREVENTION IN ENGINE INSTALLED IN INACTIVE AIRCRAFT

Corrosion can occur, especially in new or overhauled engines, on cylinder walls of engines that will be inoperative for periods as brief as two days. Therefore, the following preservation procedure is recommended for inactive engines and will be effective in minimizing the corrosion condition for a period of up to thirty days.

NOTE

Ground running the engine for brief periods of time is not a substitute for the following procedure; in fact, the practice of ground running will tend to aggravate rather than minimize this corrosion condition.

a. As soon as possible after the engine is stopped, move the aircraft into the hangar, or other shelter where the preservation process is to be performed.

b. Remove sufficient cowling to gain access to the spark plugs and remove both spark plugs from each cylinder.

c. Spray the interior of each cylinder with approximately two (2) ounces of corrosion preventive oil while cranking the engine about five (5) revolutions with the starter. The spray gun nozzle may be placed in either of the spark plug holes.

NOTE

Spraying should be accomplished using an airless spray gun (Spraying Systems Co., "Gunjet" Model 24A-8395 or equivalent). In the event an airless spray gun is not available, personnel should install a moisture trap in the air line of a conventional spray gun and be certain oil is hot at the nozzle before spraying cylinders.

d. With the crankshaft stationary, again spray each cylinder through the spark plug holes with approximately two ounces of corrosion preventive oil. Assemble spark plugs and do not turn crankshaft after cylinders have been sprayed.

The corrosion preventive oil to be used in the foregoing procedure should conform to specification MIL-L-6529, Type 1 heated to 200°F/220°F (93°C/104°C) spray nozzle temperature. It is not necessary to flush preservative oil from the cylinder prior to flying the aircraft. The small quantity of oil coating the cylinders will be expelled from the engine during the first few minutes of operation.

NOTE

Oils of the type mentioned are to be used in Lycoming aircraft engines for corrosion prevention only, and not for lubrication. See the latest revision of Lycoming Service Instruction No. 1014 and Service Bulletin No. 318 for recommended lubricating oil.

SECTION 8
TABLES

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SECTION 8

TABLES

FOR TIGHTENING TORQUE RECOMMENDATIONS AND INFORMATION CONCERNING TOLERANCES AND DIMENSIONS THAT MUST BE MAINTAINED IN LYCOMING AIRCRAFT ENIGINES, CONSULT LATEST REVISION OF SPECIAL SERVICE PUBLICATION NO. SSP1776.

CONSULT LATEST REVISION OF SERVICE INSTRUCTION NO. 1029 AND NO. 1150 FOR INFORMATION PERTINENT TO CORRECTLY INSTALLING CYLINDER ASSEMBLY.

FIXED WING ONLY

GROUND RUN AFTER TOP OVERHAUL
OR CYLINDER CHANGE WITH NEW RINGS

(DO NOT USE AFTER MAJOR OVERHAUL)

1. Avoid dusty location and loose stones.
2. Head aircraft into the wind.
3. All cowling should be in place, cowl flaps open.
4. Accomplish ground run in full flat pitch.
5. Never exceed 200°F. oil temperature.
6. If cylinder head temperatures reach 400°F., shut down and allow engine to cool before continuing.

Type Aircraft____________________

Registration No.____________________

Aircraft No.____________________

Owner____________________

Engine Model____________________ S/N____________________

Date____________________

Run-Up By____________________

GROUND RUN

			Temperature				Pressure				Temperature			Fuel Flow	
Time	RPM	MAP	L. oil	R. oil	L. cyl.	R. cyl.	L. oil	R. oil	L. fuel	R. fuel	L. carb.	R. carb.	Amb. Air	Left	Right
5 min	1000														
10 min	1200														
10 min	1300														
5 min	1500														
5 min	1600														
5 min	1700														
5 min	1800														

Mag. Check

Power Check

Idle Check

Adjustment Required

After Completion of Ground Run

1. Visually inspect engine(s)
2. Check oil levels

FLIGHT TEST AFTER TOP OVERHAUL OR CYLINDER CHANGE WITH NEW RINGS

1. Test fly aircraft one hour.
2. Use standard power for climb, and at least 75% power for cruise.
3. Make climb shallow and at good airspeed for cooling.
4. Record engine instrument readings during climb and cruise.

Tested by____________________

FLIGHT TEST RECORD

			Temperature				Pressure				Temperature			Fuel Flow	
Time	RPM	MAP	L. oil	R. oil	L. cyl.	R. cyl.	L. oil	R. oil	L. fuel	R. fuel	L. carb	R. carb	Amb. Air	Left	Right
(Climb)															
Cruise															

Adjustment Required After Flight

After Test Flight.

1. Make careful visual inspection of engine(s).
2. Check oil level(s).
3. If oil consumption is excessive, (see operator's manual for limits), remove spark plugs and check cylinder barrels for scoring.

FULL THROTTLE HP AT ALTITUDE
(Normally Aspirated Engines

Altitude Ft.	% S.L. H.P.	Altitude Ft.	% S.L. H.P.	Altitude Ft.	% S.L. H.P.
0	100	10,000	70.8	19,000	49.1
500	98.5	11,000	68.3	20,000	48.0
1,000	96.8	12,000	65.8	20,500	47.6
2,000	93.6	13,000	63.4	21,000	46.0
2,500	92.0	14,000	61.0	21,500	45.2
3,000	90.5	15,000	58.7	22,000	44.0
4,000	87.5	16,000	56.5	22,500	43.3
5,000	84.6	17,000	54.3	23,000	42.2
6,000	81.7	17,500	53.1	23,500	41.4
7,000	78.9	18,000	52.1	24,000	40.3
8,000	76.2	18,500	51.4	24,500	39.5
9,000	73.5	19,000	50.0	25,000	38.5

TABLE OF SPEED EQUIVALENTS

Sec./Mi.	M.P.H.	Sec./Mi.	M.P.H.	Sec./Mi.	M.P.H.
72.0	50	24.0	150	14.4	250
60.0	60	22.5	160	13.8	260
51.4	70	21.2	170	13.3	270
45.0	80	20.0	180	12.8	280
40.0	90	18.9	190	12.4	290
36.0	100	18.0	200	12.0	300
32.7	110	17.1	210	11.6	310
30.0	120	16.4	220	11.2	320
27.7	130	15.6	230	10.9	330
25.7	140	15.0	240	10.6	340

CENTIGRADE-FAHRENHEIT CONVERSION TABLE

Example: To convert 20°C to Fahrenheit, find 20 in the center column headed (F-C); then read 68.0°F in the column (F) to the right. To convert 20°F to Centigrade; find 20 in the center column and read –6.67°C in the (C) column to the left.

C	F-C	F	C	F-C	C
-56.7	-70	-94.0	104.44	220	428.0
-51.1	-60	-76.0	110.00	230	446.0
-45.6	-50	-58.0	115.56	240	464.0
-40.0	-40	-40.0	121.11	250	482.0
-34.0	-30	-22.0	126.67	260	500.0
-28.9	-20	-4.0	132.22	270	518.0
-23.3	-10	14.0	137.78	280	536.0
-17.8	0	32.0	143.33	290	554.0
-12.22	10	50.0	148.89	300	572.0
-6.67	20	68.0	154.44	310	590.0
-1.11	30	86.0	160.00	320	608.0
4.44	40	104.0	165.56	330	626.0
10.00	50	122.0	171.11	340	644.0
15.56	60	140.0	176.67	350	662.0
21.11	70	158.0	182.22	360	680.0
26.67	80	176.0	187.78	370	698.0
32.22	90	194.0	193.33	380	716.0
37.78	100	212.0	198.89	390	734.0
43.33	110	230.0	204.44	400	752.0
48.89	120	248.0	210.00	410	770.0
54.44	130	266.0	215.56	420	788.0
60.00	140	284.0	221.11	430	806.0
65.56	150	302.0	226.67	440	824.0
71.00	160	320.0	232.22	450	842.0
76.67	170	338.0	237.78	460	860.0
82.22	180	356.0	243.33	470	878.0
87.78	190	374.0	248.89	480	896.0
93.33	200	392.0	254.44	490	914.0
98.89	210	410.0	260.00	500	932.0

INCH FRACTIONS CONVERSIONS
Decimals, Area of Circles and Millimeters

Inch Fraction	Decimal Equiv.	Area Sq. In.	MM Equiv.	Inch Fraction	Decimal Equiv.	Area Sq. In.	MM Equiv.
1/64	.0156	.0002	.397	1/2	.5	.1964	12.700
1/32	.0312	.0008	.794	17/32	.5312	.2217	13.494
3/64	.0469	.0017	1.191	35/64	.5469	.2349	13.891
1/16	.0625	.0031	1.587	9/16	.5625	.2485	14.288
3/32	.0937	.0069	2.381	19/32	.5937	.2769	15.081
7/64	.1094	.0094	2.778	39/64	.6094	.2916	15.478
1/8	.125	.0123	3.175	5/8	.625	.3068	15.875
5/32	.1562	.0192	3.969	21/32	.6562	.3382	16.669
11/64	.1719	.0232	4.366	43/64	.6719	.3545	17.065
3/16	.1875	.0276	4.762	11/16	.6875	.3712	17.462
7/32	.2187	.0376	5.556	23/32	.7187	.4057	18.256
15/64	.2344	.0431	5.593	47/64	.7344	.4235	18.653
1/4	.25	.0491	6.350	3/4	.75	.4418	19.050
9/32	.2812	.0621	7.144	25/32	.7812	.4794	19.844
19/64	.2969	.0692	7.540	51/64	.7969	.4986	20.241
5/16	.3125	.0767	7.937	13/16	.8125	.5185	20.637
11/32	.3437	.0928	8.731	27/32	.8437	.5591	21.431
23/64	.3594	.1014	9.128	55/64	.8594	.5800	21.828
3/8	.375	.1105	9.525	7/8	.875	.6013	22.225
13/32	.4062	.1296	10.319	29/32	.9062	.6450	23.019
27/64	.4219	.1398	10.716	59/64	.9219	.6675	23.416
7/16	.4375	.1503	11.112	15/16	.9375	.6903	23.812
15/32	.4687	.1725	11.906	31/32	.9687	.7371	24.606
31/64	.4844	.1842	12.303	63/64	.9844	.7610	25.003