

SECTION II
LIMITATIONS**POWERPLANT LIMITATIONS**

Horsepower 230 HP
Manifold Pressure 28 in. Hg
Propeller Speed (All other models) 2600 RPM
Propeller Speed (Q and R models) 2400 RPM

INSTRUMENT MARKINGS

Manifold Pressure Gage
Red-Line 28 in. Hg
Normal Operating Range (Green-Arc) 15-23 in. Hg

Fuel Pressure Gage
Warning (Red-Arc) 0-1.5 psi
Cautionary (Yellow-Arc) 1.5-4.0 psi
Normal (Green Arc) 4.0-7.0 psi

FUEL

Both electric fuel pumps must be operational for takeoff.

Minimum Fuel Grade 100LL (Blue)

PLACARDS

Installed above or below, as appropriate, Red ALT INOP Light:

**ALT
INOP**

Installed above or below, as appropriate, Red FUEL PRES LOW Light:

**FUEL
PRES LOW**

Installed above or below, as appropriate, Fuel Pump No. 1 Switch:

**FUEL
PUMP 1**

PLACARDS (Continued)

Installed above or below, as appropriate, Fuel Pump No. 2 Switch:

**FUEL
PUMP 2**

Installed on the sub-panel lip below the circuit breakers but above the boost-cutoff control:

**BOOST CUTOFF
PULL**



Installed near Manifold Pressure Indicator and in plane view of the pilot:

BOOST CUTOFF MAP LIMITATIONS	
For Altitude MSL (ft)	MAP Limit (inHg)
-1,000	28.0
0	27.9
1,000	26.9
2,000	25.8
3,000	24.8
4,000	23.8
5,000	22.9
6,000	22.0
7,000	21.1
8,000	20.2
9,000	19.4
10,000	18.6
11,000	17.8
12,000	17.0
13,000	16.3
14,000	15.6
15,000	14.9
16,000	14.2
18,000	13.0
20,000	11.8

ENGINE FAILURES**DURING TAKEOFF GROUND ROLL**

1. Throttle IDLE
2. Brakes APPLY
3. Mixture CUTOFF
4. Fuel Selector Valve OFF
5. Ignition Switch OFF
6. Master (Battery) Switch OFF

IMMEDIATELY AFTER TAKEOFF

1. Land STRAIGHT AHEAD
2. Throttle IDLE
3. Airspeed (Q and R models)
70 KIAS (Flaps 0°) or 65 KIAS (Flaps 40°)
4. Airspeed (All other models)
80-90 MPH (Flaps 0°) or 70-80 MPH (Flaps 40°)
5. Mixture CUTOFF
6. Fuel Selector Valve OFF
7. Ignition Switch OFF
8. Wing Flaps AS REQUIRED (40° Recommended)
9. Master (Battery) Switch OFF

IN-FLIGHT

1. Fuel Pump 1 AND 2 BOTH ON
2. Airspeed BEST GLIDE SPEED
3. Fuel Selector BOTH
4. Mixture FULL RICH (unless engine is rough)
5. Ignition Switch CHECK BOTH
(START if propeller is stopped)
6. Carburetor Heat APPLY
7. Primer IN/LOCKED

ENGINE FAILURES (Continued)**IN-FLIGHT (Continued)***If Engine Power IS restored:*

1. FLIGHT CONTINUE NORMAL

NOTE

Only one fuel pump is required for normal engine operations, however, if one pump is suspected to be faulty, leave both pumps on and troubleshoot problem before the next flight.

If Engine Power IS NOT restored:

1. FUEL PRES LOW Annun/Fuel Pressure Gage CHECK

If FUEL PRES LOW is Annunciated and/or Gage indicates within Red Arc

- a. BOOST CUTOFF PULL FULLY
- b. Mixture FULL RICH
- c. Propeller FULL
- d. Throttle FULL
- e. Power SEE WARNING BELOW
- f. Follow In-Flight LOW FUEL PRESSURE

PROCEDURES to LAND AS SOON AS PRACTICAL.

WARNING

To increase power, use the throttle first. When full throttle is reached and more power is needed, slowly push in the boost cutoff control, but do not exceed boost cutoff MAP limitations.

To decrease power, pull out the boost cutoff control first. When boost cutoff control is out fully and a further reduction in power is needed, use the throttle control to reduce power.

If this is not followed, engine power fluctuations may occur. If power fluctuations do occur, pull boost-cutoff control out fully and apply full throttle, then continue making power changes as described above.

ENGINE FAILURES (Continued)**IN-FLIGHT (Continued)***If Engine Power is STILL NOT restored:*

1. Airspeed BEST GLIDE SPEED
2. Flaps CONFIRM UP
3. Follow EMERGENCY LANDING WITHOUT POWER
PROCEDURE (below)

FORCED LANDINGS**EMERGENCY LANDING WITHOUT ENGINE POWER**

1. Airspeed BEST GLIDE SPEED
2. Land .. LOCATE MOST FAVORABLE LANDING SITE
3. Establish spiral pattern to make a normal landing approach
from a downwind position.
4. When committed to land:
 - a. Airspeed AFM Normal Landing Speeds
 - b. Flaps AS DESIRED
 - c. Throttle CLOSE
 - d. Mixture CUTOFF
 - e. Magnetos OFF
 - f. Master (Battery) Switch OFF
 - g. Fuel Selector OFF
 - h. Seat Belts ON/TIGHTEN
 - i. Doors UNLATCH PRIOR TO TOUCHDOWN
 - j. Touchdown SLIGHTLY TAIL LOW
 - k. Brakes APPLY HEAVILY

PRECAUTIONARY LANDING WITH ENGINE POWER

See basic AFM except DO NOT TURN OFF FUEL PUMPS.

DITCHING

See basic AFM

STATIC SOURCE BLOCKAGE

See basic AFM

LANDING WITH A FLAT MAIN TIRE

See basic AFM

ELECTRICAL POWER SUPPLY SYSTEM MALFUNCTIONS**OVER-VOLTAGE LIGHT ILLUMINATES (IF INSTALLED)**

1. Avionics Power Switch OFF
2. Master (Battery) Switch CYCLE QUICKLY
3. Engine Power AS REQUIRED

NOTE

Leaving Master Switch OFF will shut down the fuel pumps which will lead to possible engine power fluctuations. The Low Fuel Pressure warning will not be annunciated because the light is inoperative.

If OVER-VOLTAGE light extinguishes:

4. Avionics Power Switch ON
5. Flight CONTINUE

If OVER-VOLTAGE light illuminates again:

6. Avionics Power Switch ON
7. LAND AS SOON AS PRACTICAL
8. See CAUTION below.

CAUTION

Do not turn off Master, Ignition, and Fuel Pump switches.

ELECTRICAL POWER SUPPLY SYSTEM MALFUNCTIONS
(Continued)**ALT INOP ANNUNCIATION OR AMMETER SHOWS
DISCHARGE****NOTE**

ALL aircraft power is now being supplied by the battery. Illumination of the ALT INOP light may occur during low RPM conditions or during high electrical loads on the system. Under these conditions, the light will go out at higher RPM or when electrical loads are reduced.

1. Master (Battery) Switch CHECK ON
2. Ammeter CHECK
 - a. *If showing zero or a charge, the annunciator is malfunctioning:*
 1. Flight CONTINUE
 2. Ammeter MONITOR
 - b. *If showing a discharge:*
 1. Alternator OFF
 2. Non-Essential Equipment listed below OFF
 - One Fuel Pump
 - COMM 2/NAV 2/ADF
 - Radio/Cabin Lights
 - Pitot Heat
 - Any other high load equipment
 - Supplemental Navigation (i.e. LORAN)
 - All Exterior Lights except landing light, when required.
3. Land AS SOON AS PRACTICAL
4. See WARNING on next page

ELECTRICAL POWER SUPPLY SYSTEM MALFUNCTIONS**(Continued)****ALT INOP ANNUNCIATION OR AMMETER SHOWS
DISCHARGE (Continued)****WARNING**

Pilot must be vigilant about observing other traffic because all position and anti-collision lights will be turned off.

Duration of battery power will be dependent on electrical loads and battery condition. Tests have demonstrated a fully charged battery in normal condition has the capacity to power essential equipment and one fuel pump FOR ONLY 1-HOUR following an alternator failure. Continued flight beyond 1-hour will likely cause complete depletion of the battery resulting in a loss of electrical power to essential equipment, annunciators, and fuel pumps. If flight must continue beyond 1-hour, anticipate a complete electrical failure and prepare to follow LOW FUEL PRESSURE procedure.

FUEL SYSTEM**ABNORMAL FUEL PRESSURE INDICATIONS****NOTE**

Abnormal fuel pressure is indicative of fuel pressure readings between 1.5 and 4 psig. This may occur when a single fuel pump is operating and it fails or during the initial stages of a dual fuel pump failure (i.e. loss of all electrical power)

1. Fuel Pumps BOTH ON
2. Mixture FULL RICH
3. Fuel Selector BOTH

a. If normal indications are restored

1. Flight CONTINUE
2. Fuel Pressure MONITOR

b. If normal indications are NOT restored:

1. Prepare for LOW FUEL PRESSURE PROCEDURES

FUEL SYSTEM (Continued)**LOW FUEL PRESSURE****NOTE**

Low fuel pressure will be indicated by either the FUEL PRES LOW annunciator being illuminated or fuel pressure indication below 1.5 psig.

CAUTION

The FUEL PRES LOW Annunciator will not illuminate if the alternator is inoperative and the battery is depleted, or Master (battery) switch is selected off.

NOTE

Low fuel pressure may be caused by the fuel selector set to OFF or to an empty fuel tank, or a fuel pump failure, or a complete loss of electrical power. In all cases follow the procedure below.

On-Ground:

1. Fuel Pump 1 ON
2. Fuel Pump 2 ON
3. Fuel Selector BOTH
4. Mixture FULL RICH
5. If Annunciator extinguishes and Fuel Pressure is Normal
CONTINUE, however, see WARNING below.
6. If Annunciator DOES NOT extinguish OR Fuel Pressure
is not normal..... FLIGHT PROHIBITED

TROUBLESHOOT PROBLEM BEFORE NEXT FLIGHT**WARNING**

If one of the fuel pumps is suspected to be faulty,
DO NOT TAKEOFF. FLIGHT IS PROHIBITED.

FUEL SYSTEM (Continued)**LOW FUEL PRESSURE (Continued)****During Takeoff Ground Roll**

1. Throttle IDLE
2. Brakes APPLY
3. Fuel Selector Valve OFF
4. Master (Battery) Switch OFF

Immediately After Takeoff and Loss of Engine Power Occurs

1. Land STRAIGHT AHEAD
2. Throttle IDLE
3. Airspeed (Q and R models)
70 KIAS (Flaps 0°) or 65 KIAS (Flaps 40°)
4. Airspeed (All other models)
80-90 MPH (Flaps 0°) or 70-80 MPH (Flaps 40°)
5. Mixture CUTOFF
6. Fuel Selector Valve OFF
7. Ignition Switch OFF
8. Master (Battery) Switch OFF

In-Flight

1. Fuel Pumps 1 AND 2 ON
2. Fuel Selector Valve BOTH
3. Mixture FULL RICH
4. FUEL PRES LOW Light/Fuel Pressure Gage..... CHECK

a. If FUEL PRES LOW light is extinguished and fuel pressure is normal:

1. Throttle AS REQ'D
2. Mixture LEAN AS REQ'D
3. Flight CONTINUE
4. Fuel Pressure MONITOR
5. Flight CONTINUE

NOTE

One fuel pump is required for normal engine operations.

FUEL SYSTEM (Continued)**LOW FUEL PRESSURE (Continued)****In-Flight (Continued)**

b. If FUEL PRES LOW light DOES NOT extinguish and/or fuel pressure remains at or below 1.5 psig:

1. BOOST CUTOFF PULL FULLY
2. USE FOLLOWING PROCEDURES TO
OPERATE ENGINE ON GRAVITY FLOW AND
LAND AS SOON AS PRACTICAL.

To Climb, Cruise, Descend:

- a. ... Mixture FULL RICH, lean as required
in cruise or descent
- b. ... Propeller FULL
- c. ... Power SEE WARNING ON NEXT PAGE
- d. ... Airspeed Per AFM
- e. ... Cowl Flaps AS REQ'D

WARNING

To increase power, use the throttle first. When full throttle is reached and more power is needed, slowly push in the boost cutoff control, but do not exceed boost cutoff MAP limitations.

To decrease power, pull out the boost cutoff control first. When boost cutoff control is out fully and a further reduction in power is needed, use the throttle control to reduce power.

If this is not followed, engine power fluctuations may occur. If power fluctuations do occur, pull boost-cutoff control out fully and apply full throttle, then continue making power changes as described above.

FUEL SYSTEM (Continued)**LOW FUEL PRESSURE (Continued)****In-Flight (Continued)****CAUTION**

As the aircraft climbs, the boost cutoff must be adjusted so that manifold pressure does not exceed the placarded boost cutoff MAP limitations.

To Approach/Land:

- a. Fuel Selector Valve BOTH
- b. Mixture LEAN AS REQ'D
- c. Propeller FULL RPM
- d. Power SEE WARNING ON PREVIOUS PAGE
- e. Airspeed FOR FLAPS UP
70-80 KIAS (Q and R models)
80 to 90 MPH (All other models)
- f. Wing Flaps AS DESIRED
0° below 140 KIAS (Q and R models)
10° to 40° below 95 KIAS (Q and R models)
0° to 40° below 110 MPH (All other models)
- g. Airspeed FOR FLAPS DOWN
60-70 KIAS (Q and R models)
70 to 80 MPH (All other models)
- h. Touchdown MAIN WHEELS FIRST
- i. Landing Roll LOWER NOSE WHEEL GENTLY
- j. Braking AS REQUIRED

Balked Landing:

- a. Mixture FULL
- b. Propeller FULL
- c. Throttle FULL
- d. Boost Cutoff SLOWLY ADVANCE TO BOOST
CUTOFF MAP LIMITATIONS
AT LANDING FIELD ELEVATIONS
- e. Carburetor Heat COLD (PUSHED IN)
- f. Flaps RETRACT TO 20°
- g. Climb Speed PER AFM
- h. Flaps RETRACT SLOWLY
- i. Cowl Flaps OPEN

FUEL SYSTEM (Continued)**LOW FUEL PRESSURE (Continued)****In-Flight (Continued)**

After Landing:

- a. Boost Cutoff FULL FORWARD
- b. Wing Flaps RETRACT
- c. Cowl Flaps OPEN
- d. Carburetor Heat COLD (PUSHED IN)
- e. Avionics..... AS REQ'D

REPAIR PROBLEM BEFORE NEXT FLIGHT.

ROUGH RUNNING ENGINE

1. Fuel Pumps BOTH ON
2. Fuel Pressure..... CHECK
3. Mixture FULL RICH (lean as req'd)
4. Magnetos CHECK LEFT then RIGHT
5. Carburetor Heat APPLY
6. Oil Pressure CHECK

CAUTION

If roughness continues, LAND AS SOON AS PRACTICAL. Prepare for possible ENGINE FAILURE.

SUPERCHARGER BELT FAILURE**NOTE**

Failure of the supercharger belt will result in a sudden reduction in manifold pressure without changing throttle. Engine will continue to operate, but will be normally aspirated with reduced available power. An over-rich mixture may result in engine roughness.

1. Mixture RICHEN, THEN LEAN AS REQ'D
2. Land AS SOON AS PRACTICAL
USING NORMAL PROCEDURES

LOW OIL PRESSURE

See basic AFM if procedure exists.

ENGINE OVERBOOST (Manifold Pressure above 28 in. Hg)

1. Throttle REDUCE TO 28 in. Hg.

STARTING(Cont.)**NOTE**

ALT INOP may be illuminated at low power settings.

NOTE

Shutoff engine if no oil pressure indication appears within 30 seconds in normal temperatures and 60 seconds in cold temperatures.

BEFORE TAKE-OFF

1. Parking Brake ON
2. Primer IN/LOCKED
3. Fuel Selector Valve BOTH
4. Fuel Pump Check
 - a. FUEL PRES LOW Light ILLUMINATED
 - b. Fuel Pressure Gage AT OR BELOW 1.5 PSIG
 - c. Fuel Pump No. 1 ON
 - d. FUEL PRES LOW Light EXTINGUISHED
 - e. Fuel Pressure Gage NORMAL
 - f. Fuel Pump No. 1 OFF
 - g. Fuel Pump No. 2 ON
 - h. FUEL PRES LOW Light EXTINGUISHED
 - i. Fuel Pressure Gage NORMAL
 - j. Fuel Pump No. 1 AND 2 BOTH ON

NOTE

Minor engine roughness may occur on the ground when engine is hot and electric fuel pumps are operating. If roughness occurs, set throttle to idle, turn off pumps for approximately one minute, then turn pumps back on. Repeat, if necessary.

5. Mixture FULL RICH
6. Throttle 1700 RPM
7. Magnetos CHECK
(50 RPM max differential between mags)
8. Propeller Cycle from HIGH to LOW RPM , then HIGH
(LESS THAN 300 RPM DROP)

BEFORE TAKE-OFF (Cont.)

9. Boost Cutoff Control PULL, VERIFY MANIFOLD
PRESSURE DROP, THEN FULL FWD
10. Carburetor Heat CHECK FOR RPM DROP
(Then set cold (pushed in) unless icing conditions prevail)
11. Engine Instruments CHECK
12. Ammeter CHECK, NO DISCHARGE
13. Suction Gage CHECK
14. Throttle REDUCE to IDLE
15. Wing Flaps CHECK, SET
16. Cowl Flaps Full OPEN
17. Elevator and Rudder Trim TAKEOFF
18. Cabin Doors/Windows CLOSED AND LOCKED
19. Flight Instruments/Radios/Nav CHECK/SET
20. Autopilot (if installed) OFF
21. Annunciators EXTINGUISHED
22. Throttle Friction Lock (if installed) ADJUST
23. Transponder ALT
24. Fuel Pumps BOTH ON
25. Parking Brake RELEASE

TAKE-OFF**CAUTION**

Below 7,000 feet it is possible to exceed 28 in. Hg
MAP limit with less than full throttle.

NORMAL TAKE-OFF

1. Wing Flaps 0°-20° (Q or R Models)
0° (All other Models)
 2. Carburetor Heat COLD (Pushed In)
 3. Power .. 28 INCHES Hg and 2400 RPM (Q and R models)
28 INCHES Hg and 2600 RPM (All other Models)
 4. Elevator Control RAISE NOSEWHEEL AT
50 KIAS (Q and R models)
60 MPH (All other models)
 5. Climb Speed 80 KIAS (Q and R models)
90 MPH (All other models)
- UNTIL CLEAR OF OBSTACLES

SECTION VII
DESCRIPTION AND OPERATING DETAILS**SUPERCHARGER**

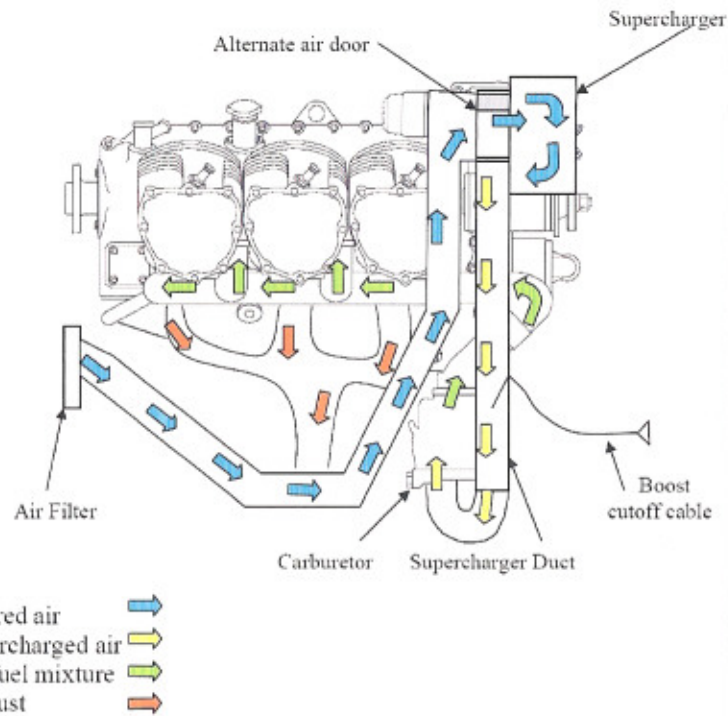
A belt-driven supercharger is installed to boost manifold pressure and thereby increase engine power output when operating at altitude. The supercharger is driven from an engine accessory drive and is mounted at the rear of the engine on the left side. Induction air is supplied to the supercharger through the original air inlet and air filter. Air discharged from the supercharger is then routed to the carburetor. This system is both simple and reliable, and unlike turbocharger systems, does not connect to the engine exhaust system.

The engine power rating is unchanged at 230 hp. Maximum power output is held to the original rating by limiting maximum manifold pressure to 28 Inches Hg. Below approximately 7,000 feet the pilot must not open the throttle fully; otherwise the engine can be over boosted. A red radial is marked on the manifold pressure gage to show the 28 Inches Hg limit. As the aircraft climbs the throttle must be opened gradually to maintain a specific manifold pressure setting. Above approximately 7,000 feet where 28 Inches Hg can no longer be exceeded, wide-open-throttle operation is normal. By boosting atmospheric pressure, the supercharger delays the decrease in power output with increasing altitude, which improves aircraft climb and cruise performance.

INDUCTION SYSTEM

The original airbox on the lower nose cowl has been modified to reroute induction air to a new secondary airbox installed at the inlet to the supercharger. The secondary airbox mixes primary air and alternate heated air as selected by the pilot using the original carburetor heat push-pull control. A drain is provided in the lower section of the duct from the supercharger to the carburetor to drain any moisture and possible fuel.

In the supply duct between the supercharger and carburetor, a "boost cutoff" valve is installed. This valve is controlled via push-pull cable control located below the throttle in the cockpit. This valve is used only in emergency situations whenever both fuel boost pumps become inoperative. As a general rule, the throttle should be wide open when using the boost cutoff to control manifold pressure.

**OIL SYSTEM**

A small amount of oil is diverted from the engine to lubricate the supercharger. After this oil passes through the supercharger, it is returned directly to the engine oil sump. Engine oil is then screened and filtered before re-entering the engine.

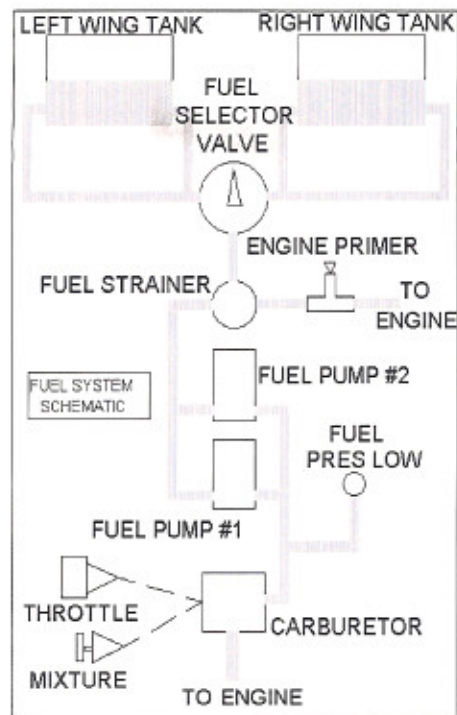
FUEL SYSTEM

Because the supercharger supplies boosted engine induction air, it is necessary to boost fuel pressure to ensure an unimpeded flow of fuel through the carburetor. Two electrically powered fuel pumps are installed in the engine compartment to supply fuel to the carburetor at the required pressure. Either pump alone will supply sufficient fuel pressure for engine operation, but two are installed to provide a backup in case of a pump failure. In the cockpit a circuit breaker and switch

for each respective pump supplies electrical power and allows the pilot to select either or both pumps for operation.

A fuel pressure gage is installed in the cockpit for the pilot to monitor fuel pressure. The gage is range marked to show normal, abnormal, and low fuel pressure. Also, a FUEL PRES LOW annunciator is located near the primary flight instruments and will illuminate to warn the pilot when pressure is critically low (1.5 psig or lower). See SECTION III, EMERGENCY PROCEDURES for the appropriate responsive action.

In case of a complete electrical failure (alternator and battery), the engine can be operated using gravity-fed fuel at un-boosted manifold pressures using the BOOST CUTOFF control located on the lower left side of the throttle quadrant. When the BOOST CUTOFF control is pulled, pressurized air from the supercharger is dumped into the engine compartment before reaching the carburetor. This lowers the carburetor's requirement for pressurized fuel and allows normally-aspirated engine operation. See SECTION III, EMERGENCY PROCEDURES for Boost Cutoff operations.



Rod Sage

SA10232SC SECTION VIII
HANDLING, SERVICING, AND MAINT.

SECTION VIII
HANDLING, SERVICE and MAINTENANCE
(CARE OF AIRPLANE)

MAINTENANCE PROCEDURES

Engine and Supercharger TBO - 1400 Hours

SERVICING INTERVALS CHECK LIST

FIRST 2 HOURS

SUPERCHARGER DRIVE BELT – check tension and check for wear per Instructions for Continued Airworthiness.

EACH 100 HOURS

SUPERCHARGER DRIVE BELT – check tension and check for wear per Instructions for Continued Airworthiness.

END