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INTRODUCTION

The Douglas DC-3 is equipped with two air-cooled, twin row radial Pratt & Whitney 1830-92 engines.



Pratt & Whitney 1830-92

Each engine has 14 cylinders with a total displacement of 1830 cubic inches. Each engine is equipped with a Bendix Scintilla high-tension ignition system and a Bendix Stromberg carburetor. This chapter provides a general overview of the DC-3 Powerplant System as well as normal operations and limitations.

GENERAL

STARTER

The engine starter is a 24 V. DC direct cranking starter mounted on the rear section of the engine and controlled by switches on the overhead switch panel. The starter circuit is protected by circuit breaker No. 21 in the main electrical J-Box located below the radio rack.

IGNITION SYSTEM

The ignition system consists of two magnetos with integral distributors, an ignition manifold, and 28 spark plugs. For starting the engine, an auxiliary source of electrical power for ignition is supplied by a booster coil. The output of the booster coil flows through the system in the same manner as the magneto output during normal operation and fires the spark plugs in all cylinders. DC power to the booster coil is supplied through circuit breaker No. 21 in the main electrical J-Box located below the radio rack.

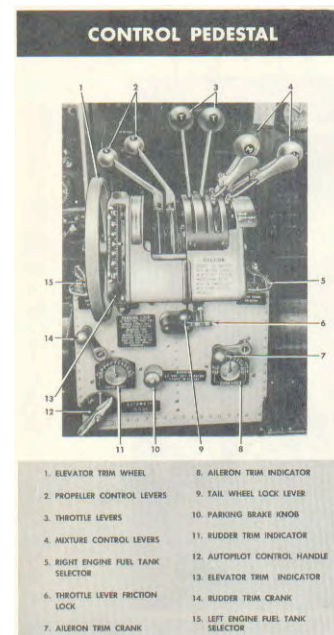
CARBURETOR AND AIR INDUCTION

During normal operations ram air is supplied to the carburetor through an air duct on the top of the ring cowl. When heated air is required for the carburetor, a carburetor heat door can be operated to close off the ram air duct and open a passage through which heated air from the engine section can flow to the carburetor.

Metered fuel from the carburetor is discharged from a valve directly into the blower chamber. Primer fuel is discharged directly into the blower chamber through the primer nozzles.

CARBURETOR MIXTURE CONTROL

The fuel control unit contains: An idle mixture metering jet, a four-position mixture control selector valve, fixed metering jets, and a power enrichment valve. The idle mixture metering jet is mechanically connected to the throttle and controls the mixture throughout the idle range of speeds. The carburetor fuel/air mixture is controlled by a mixture control lever located on the control pedestal in the pilot's compartment.



Carburetor Mixture Control

The four positions of the mixture control are:

- IDLE CUT OFF
- AUTO RICH (Takeoff and Climb),
- AUTO LEAN (Cruise), and
- EMERGENCY RICH.

- EMER RICH - In this position the automatic mixture control bypass valve is open providing full fuel flow and bypassing the auto mixture control unit. At sea level and at standard temperature, the fuel flow in EMER RICH is approximately the same as the fuel flow in the AUTO RICH position. The increase in richness above AUTO RICH fuel flow provided by EMER RICH increases with altitude.
- AUTO RICH (After Start, Takeoff, and Climb) – This is the normal operating position after engine start and for takeoff and climb power settings. In this position, the mixture control automatically maintains the desired fuel/air ratios at all engine speeds and loads. Adjustments are automatically made for changes in altitude, temperature, propeller setting, supercharger speed, or throttle position.
- AUTO LEAN (Cruise) – This position is a leaner setting than AUTO RICH and is suitable for cruising under favorable conditions. This setting may be too lean for good engine acceleration, however. When the mixture control is in this position, the automatic rich jets are closed allowing fuel to flow only through the automatic lean jet and the two vent jets. The automatic mixture control is also operative in this position. Automatic adjustments are made for changes in altitude, temperature, propeller setting, supercharger speed, and throttle position. The maximum RPM while AUTO LEAN is selected is 2050 RPM.
- IDLE CUT OFF (Stop and before start position) – In the IDLE CUT OFF position all fuel ports are closed and all fuel flow through the carburetor nozzle is stopped. This position is intended principally for stopping the engine without the hazard of backfiring.

EXHAUST SYSTEM



Exhaust Manifold



Exhaust Stack

DC-3 Exhaust System

The DC-3 Maximizer Exhaust System is comprised of eight exhaust ducts which connect into one stainless steel manifold and exhaust overboard on the outboard side of the nacelle.

ENGINE COOLING

Cowl Flaps



Cowl Flaps



Cowl Flap Actuator

Cowl Flap System

Hydraulically actuated cowl flaps are installed at the trailing edge of the engine ring cowl to control the flow of air over the engine.

Cowl Flap Controls



Cowl Flap Controls

The controls for the cowl flaps are located on the right side of the cockpit and have five positions:

- CLOSE
- OFF
- TRAIL
- OFF
- OPEN

Normally the OFF position will be used after the cowl flaps have been positioned to CLOSE or OPEN. In the termination checklist, however, the cowl flap control valve will be placed in the OPEN position to allow for system pressure relief in the event of thermal expansion in the hydraulic lines.

For additional information about the Cowl Flap system, see the Hydraulics Chapter in this manual.

Residual Heat Doors



Residual Heat Door Scoop

Two residual heat doors are installed in the ram air duct and droop open until airflow forces them closed.

Cylinder Head Temperature

Cylinder head temperature is measured on No. 13 cylinder of the left engine and on No. 3 cylinder of the right engine.



Cylinder Head Temperature Gauge

Cowl flaps should be adjusted as necessary to maintain the cylinder head temperature within the desired range of 90°-220°C.

OIL SYSTEM - GENERAL

The oil system for each engine contains an oil tank, an oil cooling radiator, an engine-driven oil pump, a scavenging pump, and pressure and temperature indicating systems. The oil system uses Phillips Petroleum SAE 60 Radial Engine Oil. The oil tank capacity is 29 gallons. The total capacity of each oil system is 32 gallons. The oil pump is a three-section gear type pump. This oil pump is comprised of one pressure pump and two scavenge pumps.

Oil Tanks



Engine Oil Tank

A 29 gallon aluminum oil tank is installed in each engine nacelle aft of the firewall. The tank is vented to the engine accessory case.

Oil Filler Neck**Oil Filler Neck**

Each tank is equipped with a filler neck accessible from the top inboard side of its respective nacelle. Engine oil is supplied from a standpipe inside the oil tank.

If the oil quantity decreases to less than 2.8 gallons, no oil will be available for engine lubrication. Propeller feathering oil is supplied from the bottom of the oil tank. This arrangement assures that 2.8 gallons of oil will be remaining for the Propeller Feathering System should a leak in the Engine Oil System deplete the engine oil supply.

**Oil Quantity Check**

Oil quantity should be verified prior to flight by observing the oil level close to the top of the filler neck.

Oil Coolers**Oil Cooler**

A radiator is installed in the oil return line between each engine and its oil tank. This provides cooling for the oil as it circulates. A thermostatic temperature control valve mounted on the cooler automatically regulates the oil temperature.

Oil Shutoff Valves**Oil Shutoff Valve**

Oil shutoff valves are installed in each nacelle aft of the firewall. When closed, these valves will immediately shut off the flow of oil to the respective engine.

**Oil & Hydraulic Shutoff Handles**

Selectors for these valves are located on the control pedestal next to the Left Engine fuel tank selector. Each selector is blocked in the OPEN position by a slide latch and should remain in the OPEN position unless required by an emergency.

OIL GAUGES & WARNING SYSTEMS**Oil Pressure Gauge****Oil Pressure Gauge**

A dual direct indicating oil pressure gauge on the center instrument panel provides oil pressure indications.

Oil Pressure Warning Lights



Engine Warning Lights

One amber low oil pressure warning light for each engine is located with other engine warning lights on each instrument panel below the flight instrument cluster. It illuminates when the oil pressure drops below the operating minimum (40 psi).

Oil Temperature Indicator



Oil Temperature Indicator

A dual oil temperature gauge on the center instrument panel provides oil temperature indications. The normal oil temperature is 70° – 90° C.

Low Oil Quantity Warning Lights



Low Oil Quantity Warning Light

Two red DC powered press-to-test low oil quantity warning lights are located on the Pilot's overhead console just above the respective Prop Feather button. The warning light will illuminate when the oil quantity in its respective tank falls below approximately 13 gallons.

OPERATION

STARTING ENGINES

(See Normal Procedures Chapter of the Flight Training Manual.)

CAUTION

In case of starter failure no attempt shall be made to start an engine by any means other than replacement of the faulty starter.

POWER SETTINGS

Avoid excessive cylinder pressure when changing power by using the following sequence:

- When increasing power, set the engine controls in the following order:
 - Mixture controls
 - Propeller controls
 - Throttle controls
 - Mixture controls – readjust if necessary.
- When decreasing power, set the engine controls in the following order:
 - Throttle controls
 - Propeller controls
 - Throttle controls – readjust if necessary
 - Mixture controls.
- Takeoff - Maximum takeoff manifold pressure (48 IMP) may be used regardless of the ambient atmospheric conditions when AUTO RICH has been selected on the mixture control. 42 IMP is the standard takeoff power setting and should be used to preserve engine life when gross weight and runway length are not limiting factors. Mixture leaning is not permitted for takeoff.
- Climb & Cruise - See Performance Chapter of this manual.

CARBURETOR HEAT

(See Ice and Rain Protection Chapter of this manual.)

IN FLIGHT IGNITION CHECKS

In-flight ignition checks are necessary only when a malfunction is suspected. When checking magnetos:

Mixture AUTO RICH
 Carburetor Heat COLD

LIMITATIONS

Minimum Idle RPM	550 ± 50
Max T.O. Pwr (1200 HP)	
.....	48"/ 2700 ± 25 (1 min.)
METO (1050 HP)	42"/ 2550
Cruise (625 HP)	Chart/ 2050
Maximum RPM in AUTO LEAN	2050

At 1700 RPM do not exceed 31 IMP in AUTO LEAN or 36 IMP in AUTO RICH. On all descents, except final approach and ILS approach, maintain a square engine (IMP greater than or equal to RPM)

Oil Quantity Limits

Min. for dispatch	29 gal.
Minimum oil required for feathering	2.8 gal.

Oil Pressure Limits

Low Oil Pressure Warning Lt.	10 psi
Min. for power check	55 psi
Min. cruise	65 psi
Desired cruise	70-90 psi
Max. any operation	100 psi

Oil temperature limits

Min. for power check	50°C.
Desired cruise	70° - 90°C.
Max. takeoff & climb	105°C.

Engine Fuel Pressure Limits

Low Fuel Pressure Warning Lt.	12 psi
Normal	14 - 16 psi
Max.	17 psi

Cylinder Head Temperature Limits

Normal range	90° - 220°C.
Maximum (red line)	245°C.

Carburetor Heat Limits

Temperature (Min.)	40°C.
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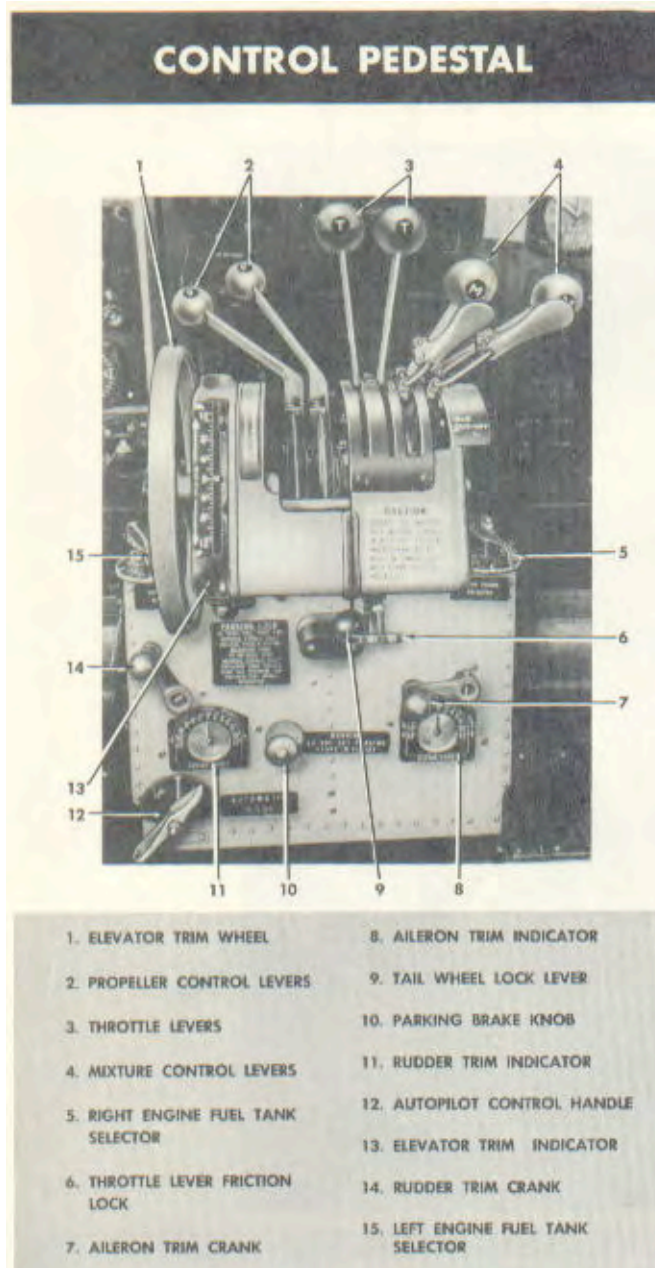
RPM

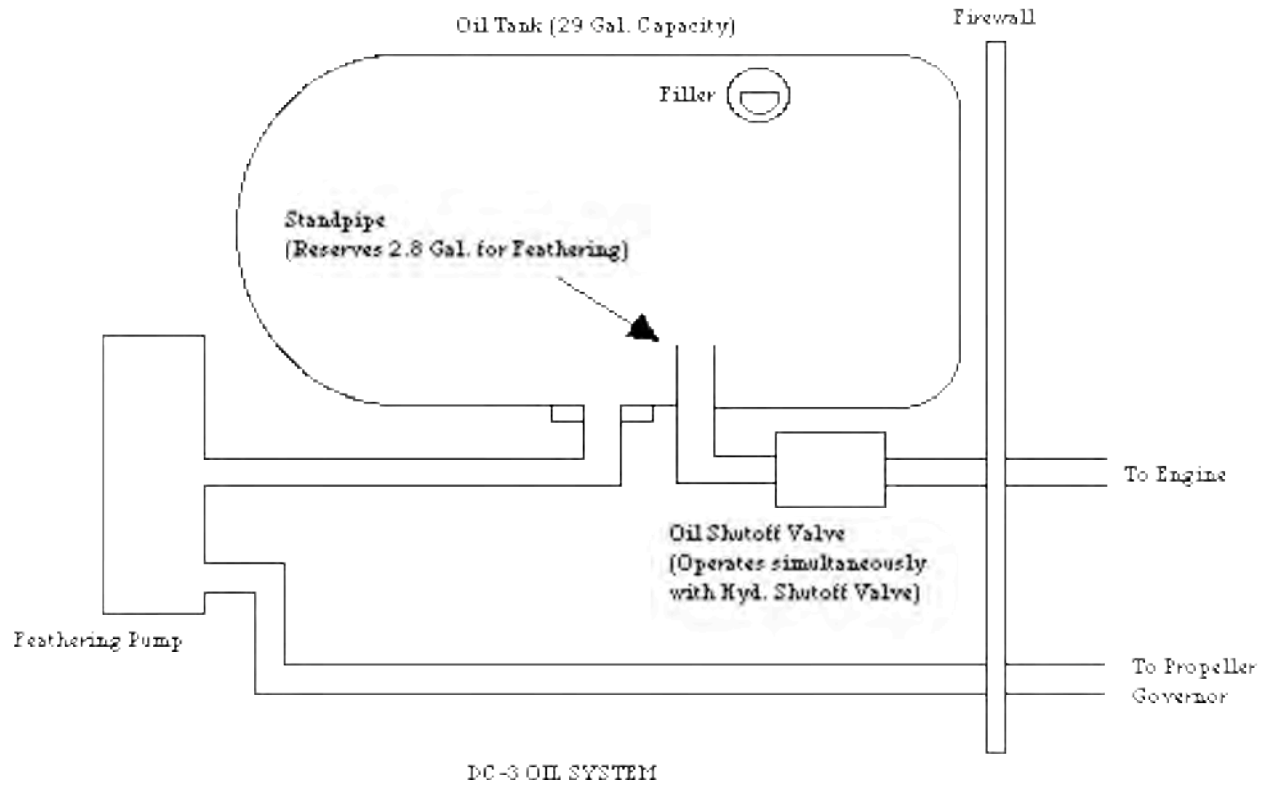
Throttle warning horn	17 IMP
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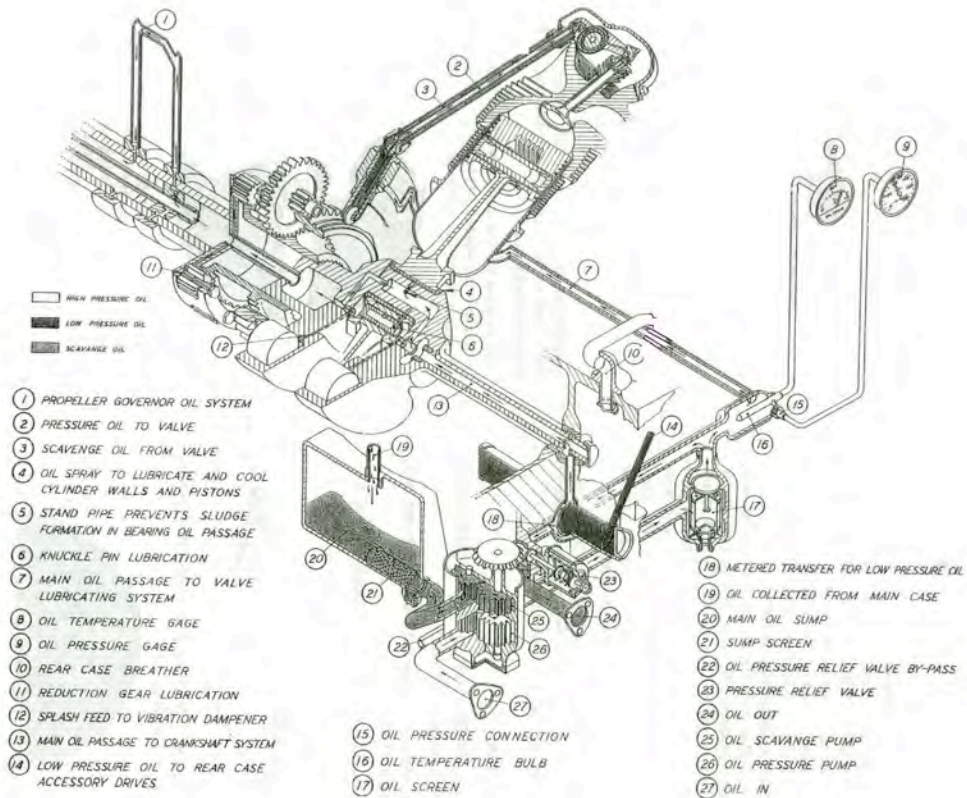
Starter System Limits

- The starter duty cycle limit is:
 - 60 sec. ON/ 60 sec. OFF
 - 60 sec. ON/ 5 min. OFF.

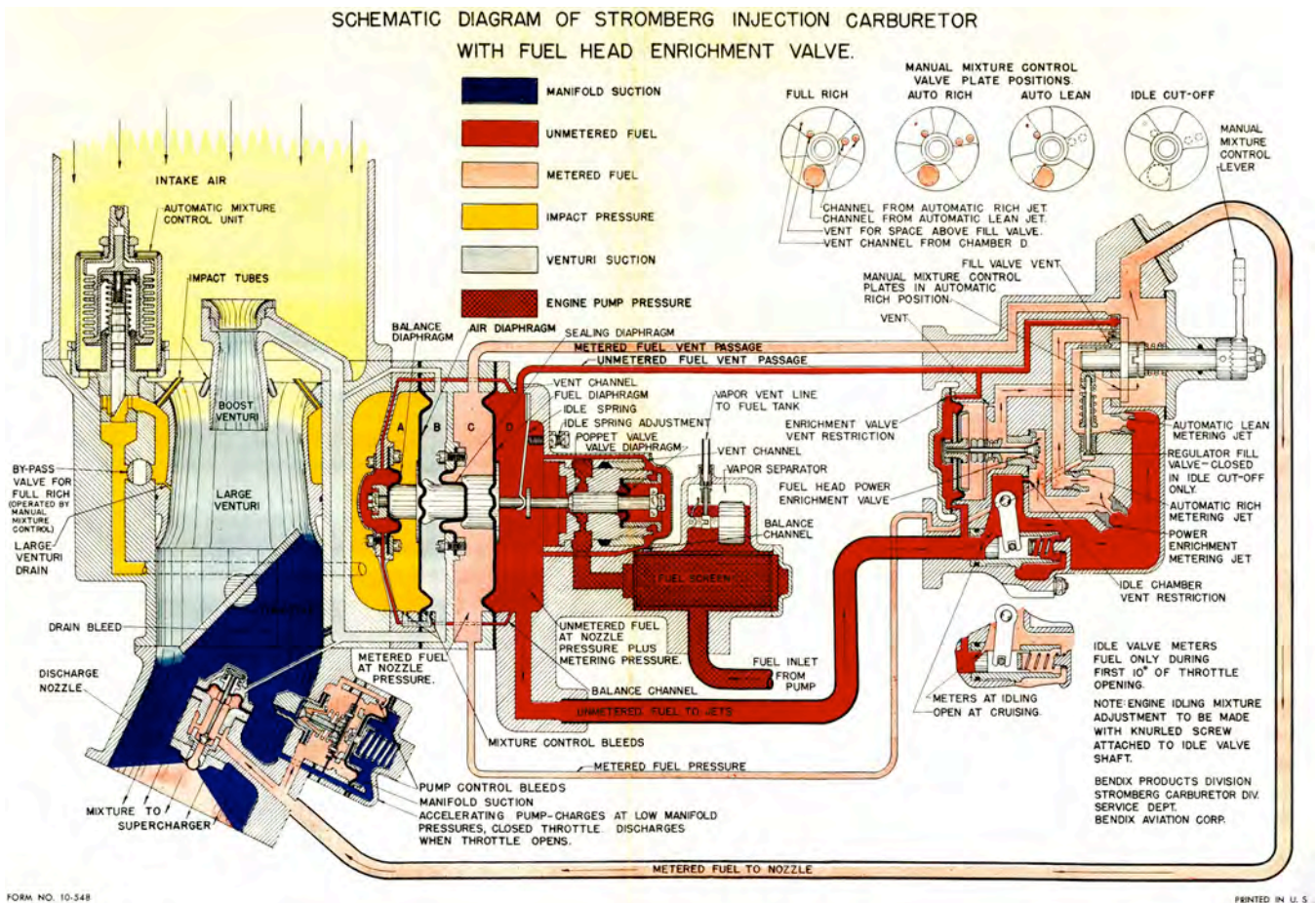
Engine Operating Limitations										
Fuel Pressure - desired 14 - 16 psi Fuel: 100 Octane							Oil Pressure Desired: 70 - 100 psi			
(See Oil Limitations on the last line)										
Operation	H.P.	Manifold Pressure	RPM	Critical Density Altitude	Mixture Control Position	Max Cylinder Head Temp (°C)	Cowl Flaps	Oil Press Limits*	Oil Temp Limits** (°C)	Maximum Duration
STARTING	-	1/8 to 1/4 Throttle	Full Low Pitch	-	IDLE CUTOFF then AUTO RICH	-	OPEN	Indicates in 30 Sec.	-	-
WARM UP	-	-	800 - 1000	-	AUTO RICH	245	OPEN	70 - 100	-	-
RUN-UP	-	30"	2300	-	AUTO RICH	245	OPEN	70 - 100	70 - 90	-
TAKEOFF	1200	48" Full Throttle	2700	S/L - 4000	AUTO RICH	245	TRAIL	70 - 100	70 - 90	1 min.
ATO	1100	42"	2700	S/L - 4000	AUTO RICH	245	TRAIL	70 - 100	70 - 90	1 min.
METO	1050	42"	2550	S/L - 4000	AUTO RICH	245	TRAIL	70 - 100	70 - 90	CONT
CLIMB	800	36"	2350	S/L - 4000	AUTO RICH	245	TRAIL	70 - 100	70 - 90	CONT
CRUISE/ CLIMB	700	31"	2050	0 - 11,000	AUTO RICH	245	TRAIL	70 - 100	70 - 90	CONT
CRUISE/ CLIMB	700	See Chart	2050	0 - 11,000	AUTO RICH	245	TRAIL	70 - 100	70 - 90	No Limit
STANDARD CRUISE	625	See Chart	2050	0 - 10,000	AUTO LEAN	245	CLOSED	70 - 100	70 - 90	No Limit
DESCENT	625	See Chart	2050	10,000 - 0	AUTO LEAN	245	CLOSED	70 - 100	70 - 90	No Limit
SINGLE ENGINE CONTINUOUS	1050 max	42"	2550	Sea Level	AUTO RICH	245	As Req'd	70 - 100	70 - 90	No Limit
* Oil Pressure will be set at 85 psi by Maintenance. Any variation from limits noted above should be recorded in the aircraft logbook.										
** Oil temperatures will be set for 70 - 90 °C. Variations from this under stabilized conditions should be recorded in the aircraft logbook.										







Oil System Diagram



DC-3 Carburetor

———— End of Chapter ————