DC-6
OPERATION MANUAL

Developed for Microsoft Flight Simulator

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ABOUT THIS MANUAL

This PMDG DC-6 Operation Manual is designed to help simulator pilots learn the mechanical systems and technical details of the PMDG DC-6. This manual shows how each system is configured, how it is operated and how the crew is required to interact with the airplane.

HOW TO USE THIS MANUAL

This manual should be used by simulator pilots who are interested in learning how the DC-6 operates and how to utilize the various systems on the airplane effectively in all phases of flight.

The DC-6 is a fairly complex airliner. In spite of this complexity, it is important that pilots have a comprehensive understanding of what each system on the airplane is doing, how it is controlled, and what operations might be impeded in the event of a failure.

This manual is broken into chapters with each chapter providing detail on one particular subsystem or system type. You can read through an individual chapter to learn how a system on the DC-6 is operated, or you can read through the entire manual section by section to learn how the entire airplane is operated.

GAINING THE MOST FROM THIS MANUAL

The best method to improve your understanding of this airplane is to launch the simulator, then load the DC-6 and sit in the virtual cockpit while reading through this material. This technique will allow you to touch, feel and explore the systems operation of the DC-6 and see how the airplane responds to pilot interaction.

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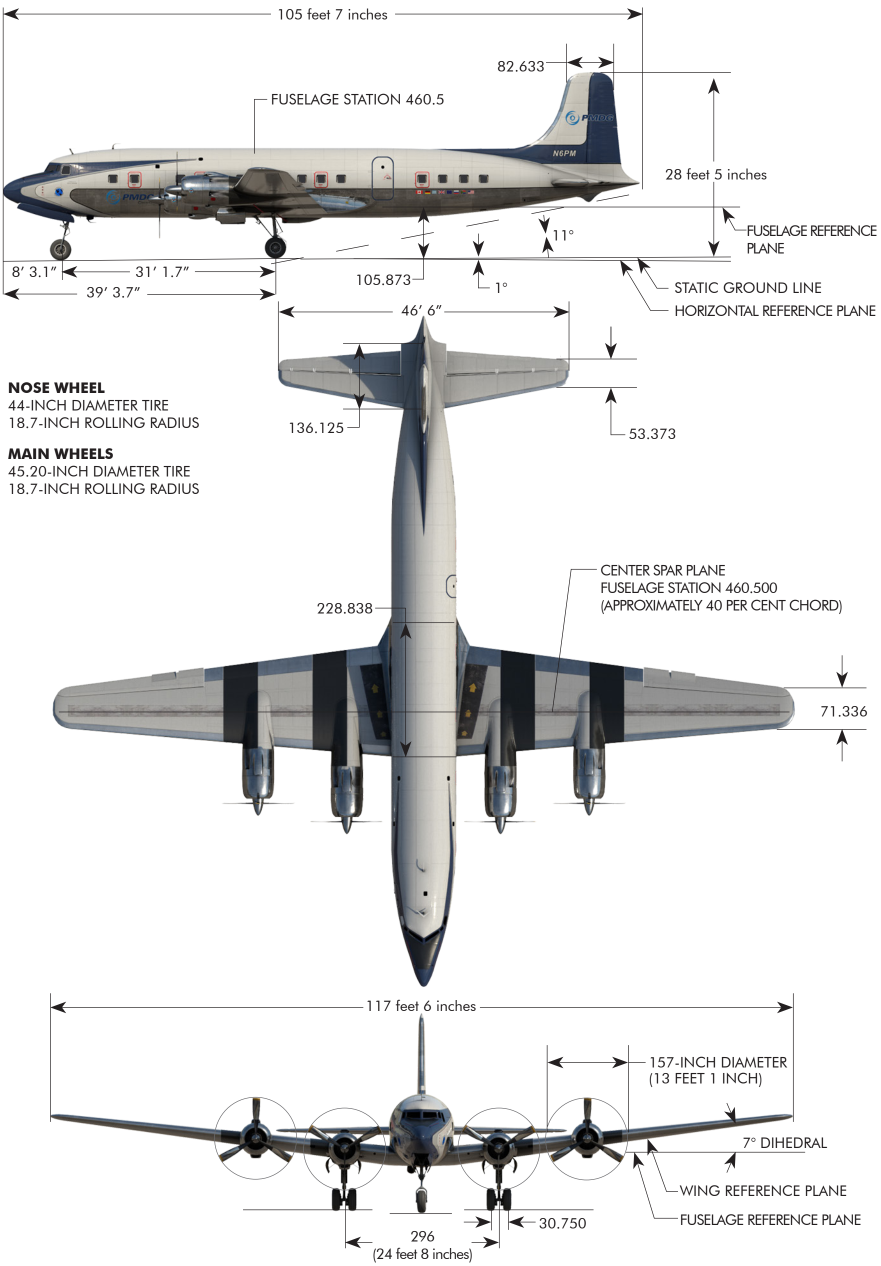

Three-View of Airplane

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Section I
GENERAL

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Section I
GENERAL

1. GENERAL

The DC-6 airplane, built by Douglas Aircraft Co., Inc., is a long range, low wing monoplane with full cantilever wing and empennage, semi-monocoque fuselage, and fully retractable tricycle landing gear. The DC-6, featuring air conditioning and a completely pressurized cabin for high-altitude flight, is designed for use as a passenger and cargo commercial transport and is suitable for operation both as a dayplane and a sleeper.

Power is supplied by four Pratt & Whitney Double Wasp, 18-cylinder, 2800-cubic-inch-displacement radial engines, with a gear ratio of 0.450:1. The engines are equipped with Hamilton Standard propellers and water/alcohol injection for higher take-off power.

Depending on equipment installation, the manufacturer's weight empty will vary from approximately 49,000 to 55,000 pounds; the operator's weight empty, which includes passenger equipment, will vary from approximately 50,000 to 58,500 pounds.

1.1. FUSELAGE

The fuselage is of semi-stressed skin, all-metal construction, incorporating transverse frames and longitudinal stiffeners covered with smooth aluminum-alloy sheet. It is composed of three sections: a nose section, a center section, and a tail section. The sides of the fuselage are provided with ice protector strips in a line with the plane of rotation of the inboard propellers. The nose and tail sections are attached to the fuselage center section by bolted butt joints. Pressure bulkheads are installed wherever necessary.

1.2. WING GROUP

The wing is full cantilever, of multicellular skin-stressed construction, and incorporates a center section, two outer panels, and two wing tips. The center section is integral with the fuselage. The outer panels attach to the center section by bolted fittings and the wing tips bolt to the outer panels.

Six of the wing fuel tanks are built as integral parts of the wing.

The engine nacelles aft of the firewall are integral with the wing structure. Each engine mount, forward of the firewall, is made of steel tubing and is bolted to the nacelle at four points. The engine is shock mounted to minimize transmission of vibration and is completely cowled with contoured removable metal cowling. The nacelles are equipped with electrically operated cowl flaps.

The wing flaps extend from the inboard end of the ailerons at the junction of the wing center section and the outer wing panels to the wing-to-fuselage fillet. They are of all-metal construction, hydraulically operated with a cable follow-up system, and are mechanically connected by a bus cable system.

Metal-covered, aerodynamically balanced ailerons extend along the trailing edge of each outer wing panel; the ailerons are dynamically and statically mass balanced by lead weights bolted to the nose channel. The right aileron has a trim tab, which is operated by a control wheel on the aft face of the control pedestal. The left aileron has a two-piece spring control tab (a type of flying tab), which provides aerodynamic boost.

1.3. TAIL GROUP

The horizontal and vertical stabilizers are of all-metal, full cantilever construction and are attached in fixed alignment to the fuselage.

The fabric-covered rudder and metal-covered elevators, both aerodynamically balanced, are of metal frame construction and are mass balanced dynamically and statically by lead weights attached to the leading edge skin. The rudder is equipped with a fabric-covered tab that functions both as a trim and control tab; the tab is controllable for trim in flight by means of the control wheel located in the V of the windshield.

The elevators have two tabs each: a two-piece spring control tab and a two-piece trim tab. The trim tabs are operated conventionally by dual control wheels on the control pedestal side panels. The spring control tab systems are a type of flying tab that provides aerodynamic boost.

1.4. LANDING GEAR

The landing gear consists of three hydraulically operated units:

the two fully retractable main gear assemblies, with brakes and dual wheels, and a fully retractable nose gear with a steerable wheel. A faired, non-retracting, shock-supported tail skid guards against tail damage.

1.5. FLIGHT CONTROLS

The flight controls in the cockpit are of the conventional cable, pulley, bell-crank type. They are conventional in operation; that is, the elevators are moved by fore and aft movements of the control columns, the ailerons are moved by turning the control column wheels, and the rudder responds to movements of the adjustable foot pedals. The hinged rudder pedals operate the main gear hydraulic brakes by application of toe pressure.

2. DIMENSIONS AND AREAS.

2.1. GENERAL

Span	117 feet 6 inches
Length (over-all, including pitot tubes and tail light)	105 feet 7 inches
Height	28 feet 5 inches

2.2. WING GROUP

Span:	
Ailerons (each side)	23 feet 5 inches
Flaps (each side)	29 feet 6 inches
Areas:	
Wings (gross)	1463 square feet
Ailerons (total, aft of hinge line)	85 square feet
Flaps (total, including vane)	229.4 square feet
Trim tab (RH aileron, aft of hinge line)	2.6 square feet
Spring control tab (LH aileron, aft of hinge line):	
Inboard section:	2.4 square feet
Outboard section	2.1 square feet
Wing Chords:	
Chord at root (theoretical)	228.8 inches
Chord at tip (theoretical)	71.3 inches

Flap Chords (total, including vane):
  Inboard end..57.4 inches
  Outboard end..35.8 inches

Wing taper ratio: 0.312

Wing angle of incidence (N.A.C.A. chord line to wing reference plane):
  Root ....+4 degrees
  Joint ....+4 degrees
  Tip .... +1 degree

Wing dihedral (measured at reference plane) .... 7 degrees
Wing sweepback at center spar plane .... 0 degrees
Wing aspect ratio 9.44
Wing MAC .... 164.2 inches
Flap maximum deflection .... 50 degrees

2.3. HORIZONTAL TAIL SURFACES

Span (over-all) .... 46 feet 6 inches
Areas:
  Horizontal Surfaces (gross)... 365.6 square feet
  Horizontal stabilizer (gross area minus movable surface).. 210.9 square feet
  Elevator (aft of hinge line, including tabs) .... 108.9 square feet
  Spring control tabs (total on both sides, aft of hinge line) .... 7.2 square feet
  Trim tabs (total on both sides, aft of hinge line) .... 9.9 square feet

Chords:
  Root (theoretical)..136.1 inches
  Tip (theoretical)..53.4 inches
  Dihedral .... 0 degrees
  Incidence .... +2 degrees

2.4. VERTICAL TAIL SURFACES

Height (elevator hinge line to tip) .... 18 feet 5 inches
Areas:
  Total exposed (including dorsal fin) .... 159.9 square feet
  Vertical stabilizer (total exposed minus movable surface)... 93.4 square feet
  Rudder (aft of hinge line) .... 49.0 square feet

Rudder tab (aft of hinge line)	4.7 square feet

2.5. FUSELAGE

Height (maximum cross section)	11 feet 6 inches
Width (maximum cross section)	10 feet 5 inches

2.6. RANGES OF MOVEMENT OF CONTROL SURFACES

Ailerons- UP travel	17 degrees
Ailerons- DOWN travel	17 degrees
Aileron spring control tab (left aileron) – UP travel	15 degrees
Aileron spring control tab (left aileron) – DOWN travel	15 degrees
Aileron trim tab (right aileron) – UP travel	7.5 degrees
Aileron trim tab (right aileron) – DOWN travel	7.5 degrees
Wing flaps – DOWN travel	50 degrees
Elevators – UP travel	25 degrees
Elevators – DOWN travel	12 degrees
Elevator spring control tabs – UP travel	8 degrees
Elevator spring control tabs – DOWN travel	20 degrees
Elevator trim tabs – UP travel	10 degrees
Elevator trim tabs – DOWN travel	15 degrees
Rudder – RIGHT travel	20 degrees
Rudder – LEFT travel	20 degrees
Rudder spring control tab – RIGHT travel	20 degrees
Rudder spring control tab – LEFT travel	20 degrees

2.7. MAIN GEAR

Type	Two hydraulically retractable, single-shock-strut, dual-wheel units
Tread (outboard wheels, center to center)	24 feet 8 inches
Wheel base	31 feet 2.4 inches
Shock strut	Oleopneumatic, Douglas 5240510
Tires	20-ply rating, nylon-rib tread, 15.50x20
Brakes	Goodyear, self-adjusting, single-disc spot

2.8. NOSE GEAR

Type	Steerable, hydraulically retractable, single-shock-strut, single-wheel unit
Shock strut	Oleopneumatic, Douglas 5240509
Tire	44-inch, smooth-contour, 10-ply, nylon-rib tread

2.9. ENGINES

Number	4
Type	Twin-row, radial, 18-cylinder, Pratt & Whitney Double Wasp
Gear ratio, CB-16	0.4375:1

2.10. HAMILTON STANDARD PROPELLERS

Type	Dural
Hub type	43D60
Blade type	6851A-0 or 6873A-0
Diameter	13 feet 1 inch
Number of blades	3
Propeller settings at station 42.0—blade type, 6851A-0:	
Low pitch	29.0°
High pitch	None
Feather	94.0°
Reverse	–18.0°

Type	Steel
Hub type	23260
Blade type	2H17F3-48R
Diameter	13 feet
Number of blades	3
Propeller settings at station 42.0—blade type, 2H17F3-48R:	
Low pitch	13.0°
High pitch	None
Feather	80.0°
Reverse	–27.0°

Type	Dural
Hub type	43E60
Blade type	6895A-8
Diameter	13 feet 6 inches
Number of blades	3

Propeller settings at station 42.0—blade type, 6895A-8:

Low pitch	30.0°
High pitch	None
Feather	96.0° (approx.)
Reverse	–8.0°

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3. FLUIDS AND CAPACITIES.

3.1. FUEL

Fuel specification .... Grade 100/130

USABLE TANK CAPACITIES

Tanks	8-Tank System	
	U.S. Gal	Pounds
No.1 Main	695	4170
No.1 Alternate	580	3480
No.2 Main	719	4314
No.2 Alternate	762	4572
No.3 Alternate	762	4572
No.3 Main	719	4314
No.4 Alternate	580	3480
No.4 Main	695	4170
TOTAL CAPACITY	5512	33072

3.2. ENGINE OIL

Oil specification .... AN-0-8, grade 1100 for winter summer operation

	CAPACITY PER TANK (U.S. Gal)	TOTAL CAPACITY (U.S. Gal)
Engine section oil tanks capacity:		
Hamilton Standard hydromatic propellers (usable quantity)	35	140
Auxiliary oil tank capacity:		
50 per cent oil, specification AN-0-8, grade 1100, winter and summer; 50 per cent fuel, grade 100/130	26	26

3.3. WATER/ALCOHOL

Fluid: CAA approved standard mixtures for use with Pratt & Whitney aircraft reciprocating engines:

MIXTURE NO.	COMPOSITION (PARTS BY VOLUME BEFORE MIXING)*		SPECIFIC GRAVITY AT 15/4°C**	INITIAL FREEZING POINT °F MAX
1	Methyl Alcohol	48-52	0.9225 to 0.9340	-45°
	Water	48-52		
2	Methyl Alcohol	24-26	0.9255 to 0.9380	-32°
	Ethyl Alcohol	24-26		
	Water	48-52		
3	Methyl Alcohol	58-62	0.9050 to 0.9150	-65°
	Water	38-42		

* The composition of the various mixtures is based on measurements of the volume of the components at 15°C (59°F). Relative proportions of constituents measured at other temperatures will vary somewhat from those measured at 15°C (59°F) due to the effects of thermal expansion.

** The values of specific gravity of the mixtures are based on the density of the mixtures at 15°C (59°F) referred to water at 4°C (39.2°F).

Methyl Alcohol used in the above mixtures must conform to Specification AMS-3004, Ethyl Alcohol must conform to Specification AMS-3002 (Do not use anti-corrosion compounds in the mixtures).

The water used in the above mixtures should conform to the following requirements:

INGREDIENTS	QUANTITY
Total Solids	175 parts per million maximum
pH	6.0 to 8.0
Chlorides	15 parts per million maximum
Sulfates	10 parts per million maximum

British Methanol Water Specification mixture for foreign operators approved by CAA for use with Pratt & Whitney reciprocating engines is as follows:

Denatured Methanol	60 parts by volume
Inhibited Distilled Water	41 parts by volume

99 parts by volume of Methyl Alcohol, meeting British Standard Specification No. 506-1933.

1 part by volume of Motor Benzole, meeting British Standard Specification No. 135-1939.

The Inhibited Distilled Water is defined by the British Ministry of Supply Material Specification No. D. Eng. R.D. 2470 as being composed of 40 parts distilled water by volume and anti-corrosion oil, Stores Reference 34A/193, one part by volume.

For detail description of the mixtures, preparation, specifications, and handling and usage precautions, refer to the Pratt & Whitney Aircraft Corp. Installation Bulletin No.32, revision date of Feb. 15, 1950.

Usable capacity, CA-15, CA-18 engines (one tank per engine)	U.S. gallons
Total usable capacity, CA-15, CA-18 engines (four tanks)	20 U.S. gallons
Usable capacity, CB-16 engines (one tanks per engine)	10 U.S. gallons
Total usable capacity, CB-16 (four tanks)	40 U.S. gallons

3.4. HYDRAULIC FLUID

Fluid	Hydraulic fluid, conforming to AAF Specification No. 3580
Total System Capacity	17.2 U.S. gallons
Reservoir Capacity:	
Engine-driven hydraulic pump supply	2.9 U.S. gallons
Auxiliary hydraulic pump supply	2.5 U.S. gallons

3.5. ANTI-COOLING ALCOHOL

Alcohol	Isopropyl alcohol, conforming to Specification No. AN-F-13
Anti-icing supply tank capacity	17.2 U.S. gallons

3.6. WATER

Aft water tank (sleeper airplane)	15 U.S. gallons
Forward water tank (sleeper airplane)	15 U.S. gallons
Forward water tank (dayplane)	15 U.S. gallons
Dental bowl water supply (one tank in each lounge, sleeper airplane)	2 U.S. gallons each

3.7. CARBON DIOXIDE (FIRE PROTECTION SYSTEM)

Main CO_2 system – 6 cylinders (capacity each) :	
Standard charge	15 pounds
Winterized charge	11.66 pounds
Heater CO2 system – 4 cylinders (capacity each):	
Winterized charge	1.03 pounds

3.8. OXYGEN

3.8.1. Low-Pressure System

Type F-1 cylinder (1)	7 cubic feet
Type G-1 cylinder (1)	14.5 cubic feet

3.8.2. High-Pressure System (Individual Cylinder Installation)

Crew supply	38.4 cubic feet
Passenger supply	107 cubic feet

3.8.3. High-Pressure System (Interconnected Cylinder Installation)

Crew and passenger supply (total capacity)	96 cubic feet

4. CENTER OF GRAVITY LIMITS.

Maximum forward CG limit (gear up position)	12 per cent MAC
Maximum aft CG limit (gear up position)	34 per cent MAC
Maximum forward CG limit (gear down position) to 90,200 pounds gross take-off weight with a straight line variation between 14.0 percent and 18.0 percent MAC at 102,800 pounds gross take-off weight (this is a nose gear structural limitation for ground operation-flight stability is 14.0 per cent to 102,800 pounds)	14 per cent MAC
Maximum aft CG limit	35 per cent MAC

5. WING AND POWER LOADING.

DC-6 airplanes are licensed for a number of different take-off, landing, and zero fuel gross weights. These variations are dependent upon structural provisions, the type of propellers used, and the incorporation of a water/alcohol injection system. The wing and power loadings corresponding to only the heaviest of the gross weights are given below.

Wing Loading: (Based on 1,463 square feet.)

102,800 pounds maximum take-off gross weight	66.4 pounds per square foot
80,000 pounds maximum landing gross weight	54.6 pounds per square foot
74,000 pounds maximum zero fuel gross weight	50.6 pounds per square foot

Power Loading: (Based on 2400 horsepower engine with W/A and 100/130 octane fuel.)

102,800 pounds maximum take-off gross weight	10.1 pounds per horse power
80,000 pounds maximum landing gross weight	8.3 pounds per horse power

6. EFFECTIVITY OF CONTROLS.

Rudder: On the take-off run, the rudder first becomes effective at approximately 60 knots ground speed, reaching full effectiveness at the minimum control speed of 83 Knots IAS.

7. BAGGAGE COMPARTMENT CAPACITIES.

Lower forward baggage compartment	2840 pounds max.
Lower aft baggage compartment	2390 pounds max.
Upper baggage compartment, left side (variable capacity)	1350 pounds max.
Upper baggage compartment, right side (variable capacity)	1100 pounds max.
Coatroom (variable capacity)	880 pounds max.
Buffet (variable capacity)	750 pounds max.

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AIRPLANE SYSTEMS AND EQUIPMENT

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Section II
AIRPLANE SYSTEMS AND EQUIPMENT

1. GENERAL ARRANGEMENT

The information given in this section is for normal operation of the airplane systems. For emergency operation or for en route trouble shooting of a malfunctioning system, see Section VI, Trouble Shooting and Emergency Procedures. For easy reference, operating restrictions and limitations are presented in tabular form in Section IV.

The pressurized cockpit and flight compartment contain all the instruments, controls, and equipment necessary for the operation of the airplane. Crew accommodations consist of two upholstered, adjustable seats for the captain and the first officer. The seats adjust fore-and-aft and vertically and are equipped with adjustable safety belts. A jump seat, installed just aft of the control pedestal and over the step, is for the use of the flight engineer and folds up and stows against the inboard face of the radio rack. Optional installations can be made for a radio operator and a navigator.

The V-shaped high-strength windshield is double-paned to permit heated air to flow between the panels for vinyl warming and for anti-icing. A hydraulically actuated windshield wiper, with the control adjacent to the nose wheel steering wheel, is installed on each side of the V. The curved corner windows, of laminated semi-tempered glass, open inwardly and latch in a pressure-tight position by means of the handle on the aft edge of the window. The side windows slide aft into the fuselage side wall and are locked forward in a pressure-tight position by means of the handle aft of the window. Pushing up on the handle unlocks the window and allows it to slide aft on a track.

The area aft of the flight compartment door comprises the upper baggage compartment—left and right sides—which is equipped with cargo webbing gates and folding shelves. A radio rack and a soundproof compartment are located just aft of the captain's seat.

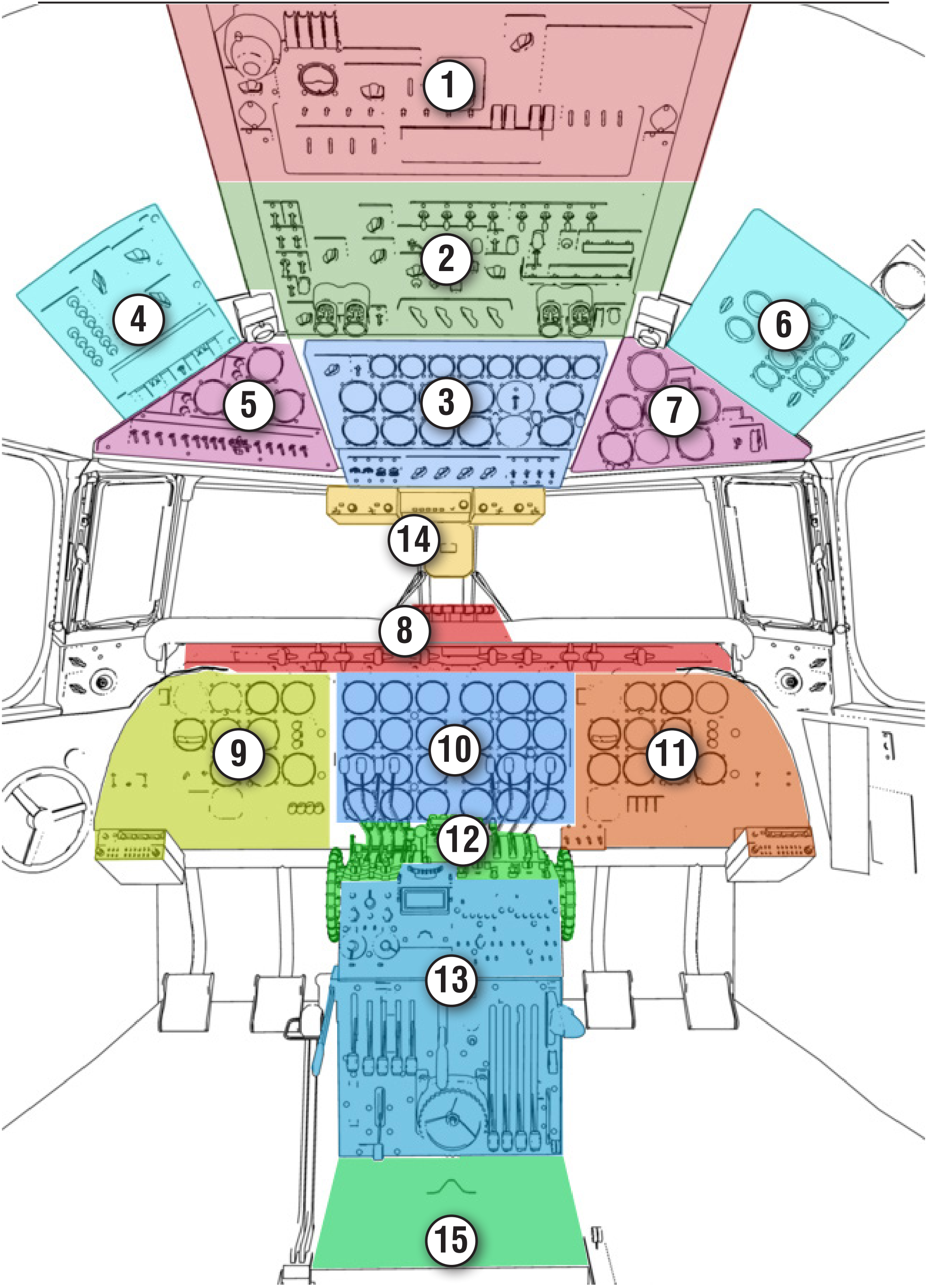
The forward lounge, installed immediately aft of the upper baggage compartment in the sleeper airplane, extends the full width of the fuselage and is for the use of male passengers and crew members. A connecting door between the lounge and the flight compartment is provided with a combination lock on the aft side. In the dayplane, two lounges are located in this forward area—a right lounge for men, and a left for women.

As a dayplane, the pressurized main cabin seats 16 to 68 passengers, depending on the type of seats installed and the seating arrangement; as a sleeper, accommodations are provided for 8 to 42 passengers. The main cabin is separated into two sections by the buffet and coat room located at the main cabin door. Illuminated signs are installed at visible locations for flight instructions to passengers. An aft lounge (installed in the sleeper airplane only) is located in the extreme aft portion of the main cabin and is for the use of female passengers and stewardesses.

Six of the main cabin windows provide a means of emergency exit. Each window, or hatch, is equipped with an escape rope mounted at the top of the hatch. The flight compartment door and the main cabin door are also each provided with an escape rope. An emergency ladder is stowed in the coat room or in the ceiling of the buffet area. Hand fire extinguishers are placed at strategic locations in the airplane. For over-water flights, provisions are made for the stowage of life rafts, emergency transmitters, and life vests.

The pressurized lower forward and aft baggage compartments are for the stowage of large quantities of cargo and baggage and are accessible from the right exterior of the airplane. The installation of pre-loaded cargo containers in these lower compartments is optional. Emergency access doors are installed in. the floor of the main cabin.

All of the outer doors of the airplane—the flight compartment, main cabin, and the belly compartments— are equipped with safety switches which actuate warning lights on the cabin supercharger panel, in the cockpit to indicate whether the doors are properly latched.



DC-6 Cockpit Arrangement

1. Propeller Deicer Ammeter Selector
2. Propeller Deicer Ammeter Needle
3. Emergency Deice Switches
4. Emergency Deice Switches Guard
5. Auxiliary Oil Tank Selector Knob
6. Auxiliary Oil Transfer Switch
7. 3rd Crew Member Map Light Switch
8. Performance Table
17. Engine Spark Advance Switches
18. Engine Spark Advance Sw. Guard
19. Engine 1 Oil Dilution Switch
20. Engine 2 Oil Dilution Switch
21. Engine 3 Oil Dilution Switch
22. Engine 4 Oil Dilution Switch
23. Engine 1 Water Injection Pump Switch
24. Engine 2 Water Injection Pump Switch
25. Engine 3 Water Injection Pump Switch
26. Engine 4 Water Injection Pump Switch
27. Main Fuel Booster Pump Eng 1 CB
28. Main Fuel Booster Pump Eng 2 CB
29. Main Fuel Booster Pump Eng 3 CB
30. Main Fuel Booster Pump Eng 4 CB
31. Alt Fuel Booster Pump Eng 1 CB
32. Alt Fuel Booster Pump Eng 2 CB
33. Alt Fuel Booster Pump Eng 3 CB
34. Alt Fuel Booster Pump Eng 4 CB
35. CB Switches Guard

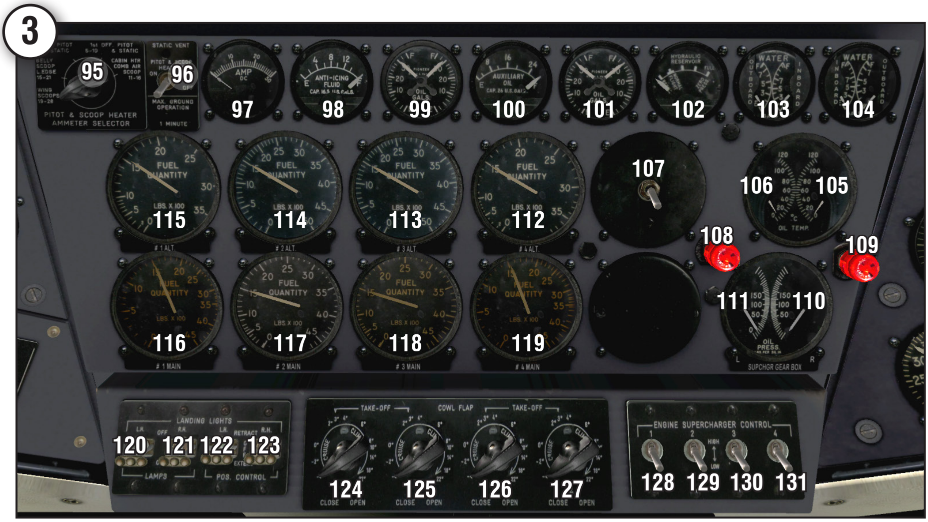
DC-6 Cockpit Arrangement - 01 - Aft Overhead Panel

36. Entrance Lights Switch
37. Flood Light Switch
38. No Smoking Switch
39. Seat Belt Switch
40. Position Light - Flash/Steady Switch
41. Beacon Light Switch
42. Wing Illumination Light Switch
43. Engine Instrument Panel Lights Switch
44. Engine 1 Auto Feather Test Switch
45. Engine 2 Auto Feather Test Switch
46. Engine 1 Feather Switch
47. Engine 2 Feather Switch
48. Upper Instrument Panel Lights Red
49. Main Instrument Panel Lights White
50. Magnetic Compass Light Red
51. Automatic Feathering Switch
52. Engine 1 Ignition
53. Engine 2 Ignition
54. Engine 3 Ignition
55. Engine 4 Ignition
56. Cabin Attendant Call
57. Mechanic's Call
58. Upper Instrument Panel Lights Red
59. Engine Start Safety Switch
60. Prime - Start - Boost Switches
61. Engine Start Selector
62. Inverter 1 and 2 Flip Switch
63. Inverter 1
64. Inverter 2
65. CA Instrument and Radio Inverter
66. Volt Regulator O/heat Warning Light
66a. Auxiliary Blower Switch
67. Wheel Well Lights Switch
68. Wheel Well Lights Warning Light
69. Main Fuel Booster Pump 1
70. Main Fuel Booster Pump 2
71. Main Fuel Booster Pump 3
72. Main Fuel Booster Pump 4
73. Alternate Fuel Booster Pump 1
74. Alternate Fuel Booster Pump 2

DC-6 Cockpit Arrangement - 02 - Forward Overhead Panel

75. Alternate Fuel Booster Pump 3
76. Alternate Fuel Booster Pump 4
77. Ground Power Light
78. Plane Battery Ground Power Switch
79. Take Off Cabin Low Press Warning Cutout
80. Emergency Instrument Power and Inst. Lighting Switch
82. Battery and Ground Power Switch
83. Generator 1 Control Switch
84. Generator 2 Control Switch
85. Generator 3 Control Switch
86. Generator 4 Control Switch
87. Master Battery and Generator Control Power Cutoff
88. Engine 3 Feather Switch
89. Engine 4 Feather Switch
90. Engine 3 Auto Feather Test Switch
91. Engine 4 Auto Feather Test Switch
92. Emergency Exit Lights Switch
93. Emergency Exit Lights Guard
94. Emergency Exit Lights Warning Light

DC-6 Cockpit Arrangement - 02 - Forward Overhead Panel (continued...)



95. Pitot/Scoop Heater Ammeter Selector
96. Pitot and Scoop Heaters
97. Pitot/Scoop Heater Ammeter
98. Anti Icing Fluid Needle
99. Engine 1 & 2 Oil Qty
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121. RH Landing Light Lamp
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128. Engine 1 Supercharger Switch
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130. Engine 3 Supercharger Switch
131. Engine 4 Supercharger Switch

DC-6 Cockpit Arrangement - 03 - Upper Instrument Panel

172. Cockpit Temperature Knob
173. Windshield Heat/Radome Anti Icing
174. Cockpit Flood Light Switch
175. Fire Detection Test Zone 1
176. Fire Detection Test Zones 2 & 3
177. Fire Detection Test Forward Baggage
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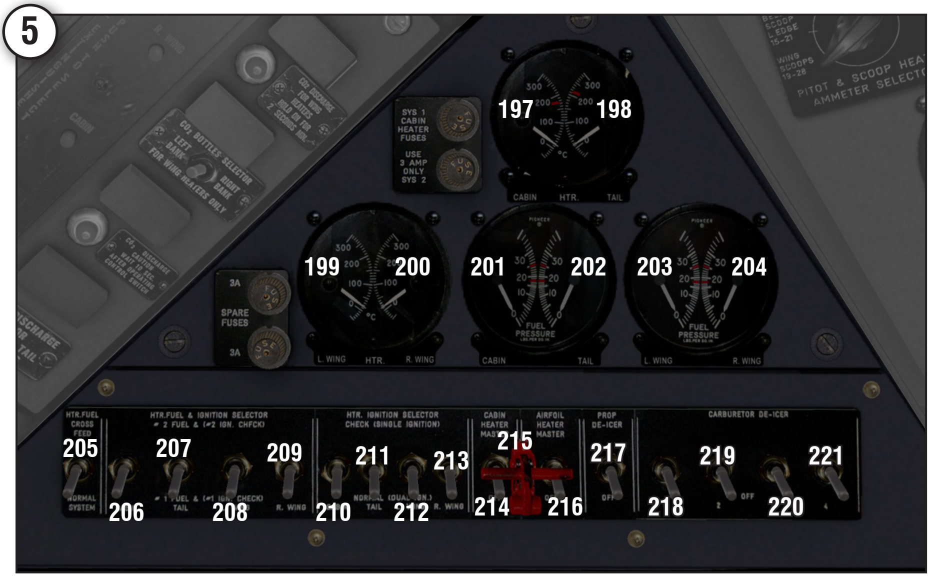
190. Fire Extinguisher L Wing Heater Light
191. Fire Extinguisher R Wing Heater Light
192. Fire Extinguisher Cabin Heater Light
193. Fire Extinguisher Tail Heater Light
194. Fire Ext. Wing Heaters Discharge
195. Fire Ext. CO2 Bottles Selector
196. Fire Ext. Cabin/Tail Heaters Discharge

DC-6 Cockpit Arrangement - 04 - Heater Fire Control Panel



197. Heater temperature dual indicators
198. Heater temperature dual indicators
199. Heater temperature dual indicators
200. Heater temperature dual indicators
201. Heater fuel pressure dual indicators
202. Heater fuel pressure dual indicators
203. Heater fuel pressure dual indicators
204. Heater fuel pressure dual indicators
205. *Heater Fuel Crossfeed*
206. *Heater Fuel & Ignition Selectors*
207. *Heater Fuel & Ignition Selectors*
208. *Heater Fuel & Ignition Selectors*
209. *Heater Fuel & Ignition Selectors*
210. *Heater Ignition Selectors*
211. *Heater Ignition Selectors*
212. *Heater Ignition Selectors*
213. *Heater Ignition Selectors*
214. Cabin Heater Master
215. Airfoil/Cabin Heater Guard
216. Airfoil Heater Master
217. Prop De-icer
218. Engine 1 Carburetor De-icer
219. Engine 2 Carburetor De-icer
220. Engine 3 Carburetor De-icer
221. Engine 4 Carburetor De-icer

NOTE: Text in ***Grey Italics*** indicate INOP items.

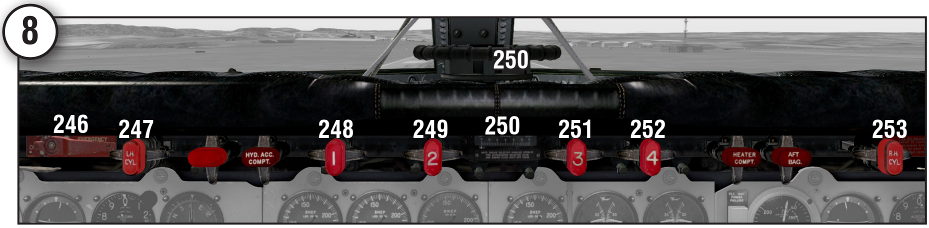
DC-6 Cockpit Arrangement - 05 - Heater Control Panel

222. Cockpit Temperature Knob
223. Cabin Temperature Fahrenheit
224. Cabin Temp. Mix Valve Position
225. Generator DC Ammeter 1
226. Generator DC Ammeter 2
227. Generator DC Ammeter 3
228. Generator DC Ammeter 4
229. AC Voltmeter Selector Switch
230. Volt Meter AC
231. Volt Meter DC
232. DC Voltmeter Selector Switch
233. Manifold Pressure Gauge (used as standby altimeter/barometer)

DC-6 Cockpit Arrangement - 06 - Ammeter Voltmeter Panel

234. Cabin Differential Pressure Indicator
235. Cabin Altimeter
236. Cabin Pressure Regulator
237. Left Cabin Supercharger Airflow Rate
238. Right Cabin Supercharger Airflow Rate
239. Cabin & Cockpit Doors Warning Light
240. Cabin Rate-of-Climb Indicator
241. Belly Doors Warning Light
242. Cabin Altitude Manual Control
243. Cabin Pressurization Control
244. Cabin Pressurization Control Guard
245. Cooling Turbine Switch

DC-6 Cockpit Arrangement - 07 - Cabin Supercharger Panel



246. Emergency Air Brake Control
247. CO_2 Discharge Handle (Left Bank)
248. Engine 1 CO_2 Selector Valve Handle
249. Engine 2 CO_2 Selector Valve Handle
250. Rudder Trim Wheel and Trim Tab Indicator
251. Engine 3 CO_2 Selector Valve Handle
252. Engine 4 CO_2 Selector Valve Handle
253. CO_2 Discharge Handle (Right Bank)

DC-6 Cockpit Arrangement - 08 - Main CO_2 Panel

9

254. Bendix KDI572 DME Receiver
255. Flight Instr. Power Failure Annun.
256. Airspeed Indicator
257. Attitude Indicator
258. Altimeter
259. Automatic Direction Finder 1 & 2
260. Turn Coordinator
261. Garmin GPS/VOR/LOC/GS Indicator
262. Vertical Speed Indicator
263. Outer Marker Annunciator
264. Middle Marker Annunciator
265. Inner Marker Annunciator
266. Gyro Heading Increase/Decrease
267. Directional Gyro Slaving Cutoff
268. VOR Indicator 1 & 2
269. Automatic Direction Finder 1
270. Gyro Compass Indicator
271. Water Pressure Safe Indicator Eng 1
272. Water Pressure Safe Indicator Eng 2
273. Water Pressure Safe Indicator Eng 3
274. Water Pressure Safe Indicator Eng 4
275. BENDIX KT76A Transponder
276. BENDIX KMA24 Audio Panel
276a. DFC Analogue Clock
276b. Transponder 1/2 Selector Switch

DC-6 Cockpit Arrangement - 09 - Captain's Flight Instrument Panel

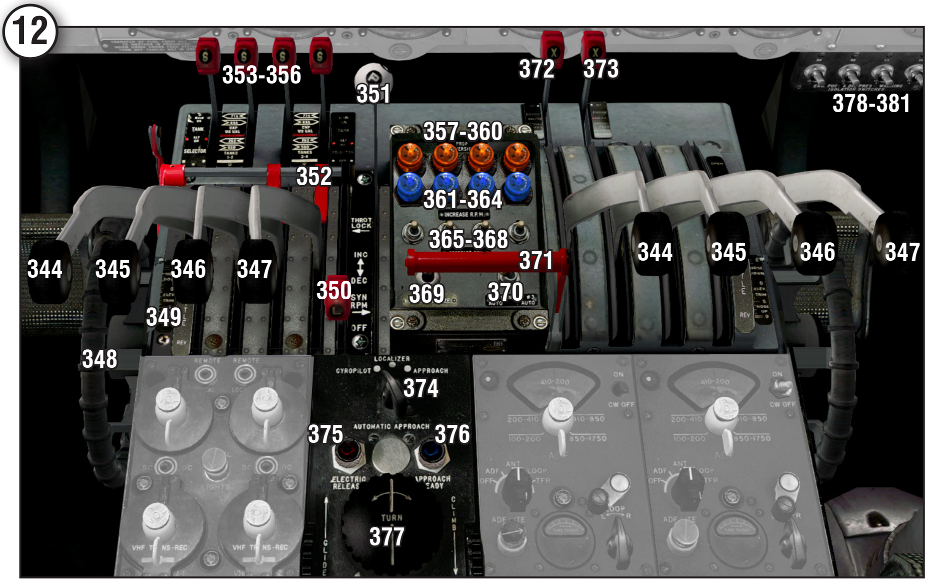
277. BMEP Indicator Eng 1
278. BMEP Indicator Eng 2
279. BMEP Indicator Eng 3
280. BMEP Indicator Eng 4
281. Fuel Pressure Eng 1
282. Fuel Pressure Eng 2
283. Fuel Pressure Eng 3
284. Fuel Pressure Eng 4
284a. Fuel Pressure Warning Light
285. Manifold Pressure Eng 1
286. Manifold Pressure Eng 2
287. Manifold Pressure Eng 3
288. Manifold Pressure Eng 4
289. Fuel Flow Eng 1
290. Fuel Flow Eng 2
291. Fuel Flow Eng 3
292. Fuel Flow Eng 4
293. Oil Pressure Eng 1
294. Oil Pressure Eng 2
294a. Oil Pressure Warning Light
295. Oil Pressure Eng 3
296. Oil Pressure Eng 4
297. Engine RPM Eng 1
298. Engine RPM Eng 2
299. Engine RPM Eng 3
300. Engine RPM Eng 4
301. Wing Flap Position Indicator
302. O.A.T. Indicator
303. Oil Temperature Eng 1
304. Oil Temperature Eng 2
305. Oil Temperature Eng 3
306. Oil Temperature Eng 4
307. Cylinder Head Temp Eng 1
308. Cylinder Head Temp Eng 2
309. Cylinder Head Temp Eng 3
310. Cylinder Head Temp Eng 4

DC-6 Cockpit Arrangement - 10 - Center Engine Instrument Panel

311. Water Pressure Eng 1
312. Water Pressure Eng 2
313. Water Pressure Eng 3
314. Water Pressure Eng 4
315. Carb Air Temp Eng 1
316. Carb Air Temp Eng 2
317. Carb Air Temp Eng 3
318. Carb Air Temp Eng 4

319. Flight Instr. Power Failure Annun.
320. Airspeed Indicator
321. Attitude Indicator
322. Altimeter
323. Turn Coordinator
324. Garmin VOR/LOC/GS Indicator
325. Vertical Speed Indicator
326. Outer Marker Annunciator
327. Middle Marker Annunciator
328. Inner Marker Annunciator
329. Automatic Direction Finder 1 & 2
330. VOR Indicator 1 & 2
331. Automatic Direction Finder 1
332. Gyro Compass Indicator
333. DME (Distance Measuring Equipment) Display
334. Landing Gear Warning Unsafe
335. Landing Gear Warning Left
336. Landing Gear Warning Nose
337. Landing Gear Warning Right
338. Fuel & Oil Press. Warn Isolation Eng 1
339. Fuel & Oil Press. Warn Isolation Eng 2
340. Fuel & Oil Press. Warn Isolation Eng 3
341. Fuel & Oil Press. Warn Isolation Eng 4
342. BENDIX KT76A Transponder
343. BENDIX KMA24 Audio Panel

DC-6 Cockpit Arrangement - 11 - First Officer's Flight Instrument Panel



344. Throttle Lever Eng 1
345. Throttle Lever Eng 2
346. Throttle Lever Eng 3
347. Throttle Lever Eng 4
348. Elevator Trim Wheel
349. Elevator Trim Indicator
350. Throttle Lock Lever
351. Propeller Pitch Lever
352. Throttle Cage (attached to Gust Lock)
353. Fuel Selector Tank 1
354. Fuel Selector Tank 2
355. Fuel Selector Tank 3
356. Fuel Selector Tank 4
357. Propeller Reverse Light Eng 1
358. Propeller Reverse Light Eng 2
359. Propeller Reverse Light Eng 3
360. Propeller Reverse Light Eng 4
361. Propeller Pitch Light Eng 1
362. Propeller Pitch Light Eng 2
363. Propeller Pitch Light Eng 3
364. Propeller Pitch Light Eng 4
365. Propeller Pitch Switch Eng 1
366. Propeller Pitch Switch Eng 2
367. Propeller Pitch Switch Eng 3
368. Propeller Pitch Switch Eng 4
369. Propeller Resynchronize Switch
370. Propeller Sync Auto/Manual Switch
371. Propeller Reverse Pitch Selector
372. Left Hand Cross-feed Selector
373. Right Hand Cross-feed Selector
374. Sperry Autopilot Mode Switch
375. Autopilot Electric Release Light
376. Approach Ready Light
377. Autopilot Turn Knob

DC-6 Cockpit Arrangement - 12 - Upper Pedestal (1)

378. Engine Fuel & Oil Pressure Warning Isolation Switch Eng 1
379. Engine Fuel & Oil Pressure Warning Isolation Switch Eng 2
380. Engine Fuel & Oil Pressure Warning Isolation Switch Eng 3
381. Engine Fuel & Oil Pressure Warning Isolation Switch Eng 4

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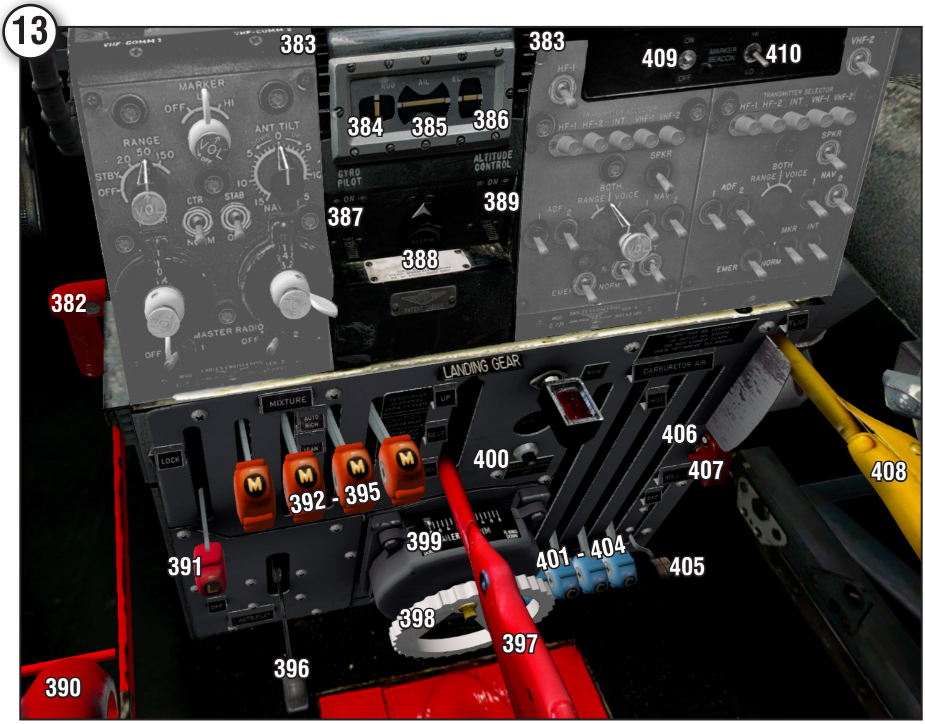
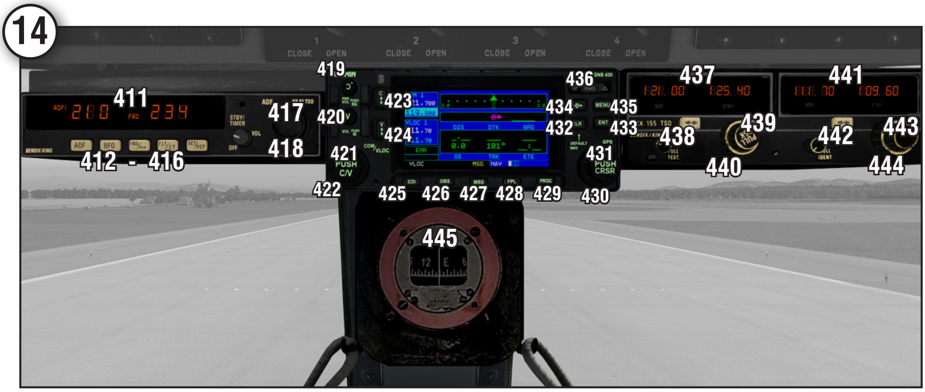
DC-6 Cockpit Arrangement - 12 - Upper Pedestal (2)



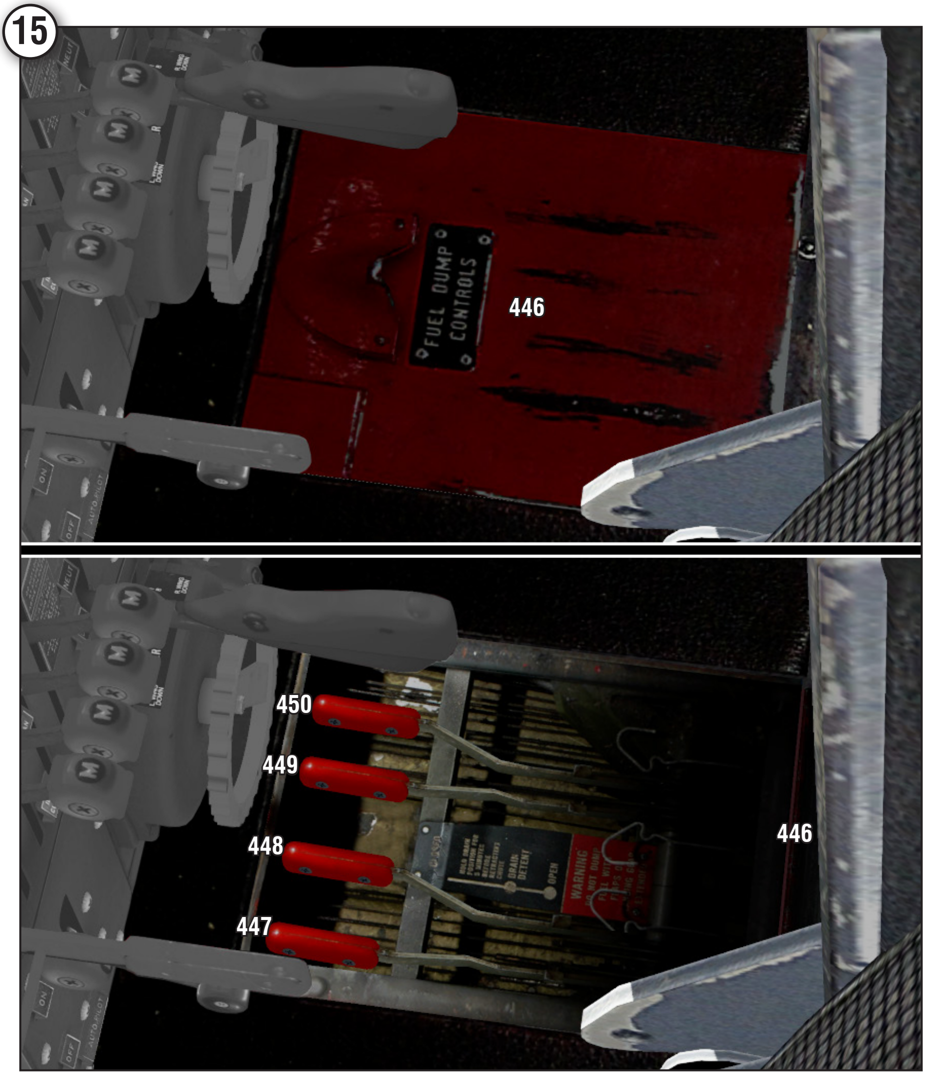
382. Park Brake Lever
383. AP Pitch Control Knobs
384. AP Rudder Axis Signal Meter
385. AP Aileron Axis Signal Meter
386. AP Elevator Axis Signal Meter
387. Gyro Pilot (AP) On/Off Switch
388. AP Aileron Trim Knob
389. AP Altitude Control Switch
390. Gust Lock Lever
391. Mixture Lock Lever
392. Mixture Lever Eng 1
393. Mixture Lever Eng 2
394. Mixture Lever Eng 3
395. Mixture Lever Eng 4
396. AP ON/OFF Switch
397. Landing Gear Lever
398. Aileron Trim Wheel
399. Aileron Trim Indicator
400. Landing Gear Warning Horn Off
401. Carburetor Air Eng 1
402. Carburetor Air Eng 2
403. Carburetor Air Eng 3
404. Carburetor Air Eng 4
405. Hydraulic Sys. Bypass Control Lever
406. Emergency Hyd. Pump Switch
407. Emer. Hyd. Pump Switch Guard
408. Flap Selector Lever
409. Marker Beacon Audio On/Off Switch
410. Marker Beacon Audio Hi/Lo Switch

DC-6 Cockpit Arrangement - 13 - Lower Pedestal



411. Bendix King KR 87 ADF
412. ADF1/ADF2 Mode Button
413. *BFO Button*
414. Frequency Transfer Button
415. FLT/ET Button
416. SET/RST Button
417. Inner Frequency Knob ADF
418. Outer Frequency Knob ADF
419. GNS430 COM Power/Volume
420. GNS430 VLOC Volume
421. GNS430 Small left knob
422. GNS430 Large left knob
423. GNS430 COM Flip-flop
424. GNS430 VLOC Flip-flop
425. GNS430 CDI Button
426. GNS430 OBS Button
427. GNS430 MSG (Message) Button
428. GNS430 FPL (Flight Plan) Button
429. GNS430 PROC (Procedures) Button
430. GNS430 Large right knob
431. GNS430 Small right knob
432. GNS430 CLR (Clear) Button
433. GNS430 ENT (Enter) Button
434. GNS430 Direct-to Button
435. GNS430 MENU Button
436. GNS430 RNG (Map Range) Button
437. Bendix King KX 155 COM2
438. Frequency Transfer COM2
439. Inner Frequency Knob COM2
440. Outer Frequency Knob COM2
441. Bendix King KX 155 NAV2
442. Frequency Transfer NAV2
443. Inner Frequency Knob NAV2
444. Outer Frequency Knob NAV2
445. Magnetic Compass

DC-6 Cockpit Arrangement - 14 - GPS, COM & NAV Radios



446. Fuel Dump Controls Floor Plate Cover
447. Nacelle 1 Fuel Dump Valve Control Handle
448. Nacelle 2 Fuel Dump Valve Control Handle
449. Nacelle 3 Fuel Dump Valve Control Handle
450. Nacelle 4 Fuel Dump Valve Control Handle

DC-6 Cockpit Arrangement - 15 - Fuel Dump Controls

2. FLIGHT CONTROLS

The airplane is controlled in flight by ailerons, wing flaps, elevators and a rudder, aided by trim tabs for trimming purposes and spring control tabs for aerodynamic boost. All primary cockpit controls are arranged side by side, with the trim and flap controls located centrally between the captain and first officer.

The dual rudder pedals are hinged for toe operation of the hydraulic brakes. A latch at the inside edge of each rudder pedal permits fore-and-aft adjustment of the pedal.

2.1. GUST LOCKS — The rudder, elevator, and aileron control systems are provided with a mechanical gust lock, a device for mechanically holding the control surfaces rigidly in the neutral position to prevent possible damage to the control surfaces and their linkage as a result of gusts or high-wind velocities while the airplane is on the ground. With the flight controls in neutral, the gust lock mechanism is operated by pulling the gust lock lever, on the floor inboard of the captain's seat, to an upright position. The lever is held in the locked (upright) position by a red warning tape, from the ceiling. The tape is engaged with the gust lock lever by pulling the tape down and aft of the left elevator trim tab control wheel, under the projecting pin aft of and below the tab control wheel, and then aft to the gust lock lever. A latch on the floor secures the gust lock lever in the DISENGAGED (horizontal) position.

Since the partial movement of the flight controls is possible with the gust lock ENGAGED, due to the spring control tab linkage, it is imperative that a full-throw control check be made just prior to take-off to make certain that the gust lock is DISENGAGED.

2.1.1. GUST LOCK — THROTTLE INTERLOCK (MODIFICATION ITEM) — On some airplanes, the gust lock lever is connected through linkage to a protecting guard installed on a hexagonal shaft mounted on the top of the control pedestal between the captain's bank of throttles and the fuel tank selector valve control levers. When the gust lock lever is in the ENGAGED position (full UP), the linkage lowers the guard to a horizontal position and prevents two of the four throttles from being advanced more than approximately 22 inches Hg at sea level (approximately 1500 rpm). The surface of the guard is painted red for identification in this position. For engine run-up, with the gust lock ENGAGED, the guard can be moved from one side of the throttle bank to the other, thus releasing different throttles. For example, both outboard engines may be run-up simultaneously or both engines on one side, but not both inboard engines simultaneously. With the gust lock lever in the DISENGAGED position (horizontal), the guard stands upright and offers no obstruction to throttle movement. If the gust lock is in advertently engaged while the throttles are advanced above the 22 inches Hg sea level position, the guard will lower and retard two of the throttles as a warning.

2.2. TRIM TAB CONTROLS — The rudder tab, a combination trim and control tab, provides both aerodynamic boost and trimming action and is controlled, for trimming purposes only, by a handwheel mounted on top of the glareshield in the V of the windshield. The tab indicating quadrant, which extends through the panel between the center fire extinguisher selector valve handles below the glareshield, is marked in increments of 1 from the center, or neutral, position of "0" to the "15 LEFT" and "15 RIGHT"' positions. A wheel stop limits the control wheel to approximately 6 ⅓ revolutions.

The elevator trim tabs provide a means of balancing nose-heavy or tail-heavy attitudes and are controlled by dual handwheels mounted on the side panels of the control pedestal; the wheels are mounted on a common shaft. The tab control quadrant, located on top of the pedestal, adjacent to each wheel, is marked in increments of 1 from the neutral position of "0" to the "9 NOSE UP" and "6 NOSE DOWN" positions.

The aileron trim tab provides a means of correcting lateral trim of the airplane and is controlled by a single wheel on the lower aft face of the control pedestal. The control quadrant is marked in increments of 1 from the neutral position of "0" to the "8 L. WING DOWN" and "8 R. WING DOWN" positions.

The airplane should be trimmed in flight as follows: Adjust to cruising power and stabilize the airspeed; then adjust the elevator trim tabs to maintain level flight attitude. After assuming a level longitudinal attitude, set the aileron and rudder trim tabs to zero-degree trim. Hold the wings level with the ailerons and adjust the rudder trim tab until a constant heading is maintained, as indicated by the directional gyro. Then adjust the aileron trim tab to maintain a level wing attitude.

If at any time, the airplane does not respond to initial movement of the trim tab controls, immediately return the controls to the zero setting. It is imperative that the trim controls be treated with the same respect accorded the primary flight controls.

2.3. SPRING CONTROL TABS (NOTE: Spring Control Tabs are not simulated. Included for eudcational purposes only.**) —** The left aileron, both elevators, and the rudder are equipped with spring control tabs, with the rudder tab also acting as a trim tab. The spring control tab is a spring-loaded type of flying tab designed to utilize the aerodynamic loads on the spring control tabs to provide aerodynamic boost to the main control surfaces themselves, thus reducing what would otherwise be high stick forces.

The spring control tab is actually an intermediate arrangement, giving stick forces somewhere between those obtained by controlling the main surfaces directly (a direct control system) and those forces obtained by controlling a tab directly (a pure flying tab or servo tab system). Spring tabs have been found necessary because the pilot forces arising from the use of direct control were too high, while those obtained by using a servo tab were much too low (too low pilot forces deprive the pilot of “feel,” since friction in the control system conceals the small forces).

In brief, a spring control tab system functions as follows: the pilot force required to move the main control surface directly is about ten times the force required to operate a control tab directly and having it, in turn, move the main surface. Suppose, for example, a 100-pound stick force is required for direct control and a 10-pound stick force is required using a springloaded servo tab. By applying 8 pounds of pilot force to the tab, $^8/_{10}$ of the total work required to move the main surface is performed by the tab itself. By applying an additional 20 pounds of stick force to the main surface, the remaining $^2/_{10}$ of the required 100 pounds stick force is made up, and the total pilot effort is 28 pounds.

Theoretically, it is possible, by suitably adjusting the linkage, to make the pilot force lie anywhere between the 10-pound and the 100-pound limits. However, for practical purposes, the range of adjustment is limited by minimum link lengths and structural clearances. Since it is possible to adjust the aerodynamic balance of the main surface, which affects the 100-pound figure used in the example, and to adjust the spring normally applied to the control tab, thereby modifying the 10-pound figure, it is therefore possible to obtain desirable pilot forces for almost any size airplane with a spring tab control system of practical design.

The spring on the control tab is preloaded to overcome system friction and to “center” the tab. Except for the rudder system, the preload is set to just overcome the system friction. The rudder preload is much higher in order to make the control forces heavier.

This it does by preventing the tab from helping the main surface until approximately 65 pounds of pilot force is applied.

This type of control has been chosen for the DC-6 airplane since boost that is obtained by aerodynamic power is always available, and, in an emergency, the stand-by control systems and emergency actuator disconnects that are usually required by designs incorporating power boost, are not needed. In addition, use of the less complicated spring tab system reduces specialized maintenance to a minimum.

It should be noted that a spring-control tab system operates quite differently on the ground (no airload). Movement of the stick under these conditions moves the main surface; the tab remains fixed at the neutral position (due to the springs) until the main surface reaches its stops. At this point, continued movement of the stick will deflect the tab, and a stick force will be felt as a result of the action of the tab springs. However, this has nothing to do with actual flight conditions. When a high stick acceleration (jerking) is applied to the control surface, the response of the surface is very rapid as a result of the low inertia of the tab and the light control forces. As a result, airplane response is also rapid, and a consequent "whipping" action of the airplane occurs. This is true at all airspeeds.

2.4. WING FLAP CONTROL — The hydraulically actuated wing flaps are controlled by a pre-position griptype control handle on the lower right aft face of the control pedestal. The position of the flaps is indicated by a remote indicator mounted on the engine instrument section of the main instrument panel. A quadrant is mounted on the inboard of the control lever for the use of the captain and another quadrant is mounted on the right side of the control pedestal for the use of the first officer. In the full "DOWN" position, the flaps are 50 degrees down. To operate the wing flaps, squeeze the lever handle to release the handle, and move the handle to the desired setting. An automatic follow-up system returns the wing flap hydraulic valve to an off position when the flaps reach the specified setting. A cable bus system checks any tendency of one flap to travel ahead of the other. There is no neutral, or off, position for the control handle; therefore it is left in the pre-set position until a new position is desired.

A wing flap down relief valve provides overload protection while the airplane is being operated *within placarded airspeeds*. The valve relieves the pressure in the down line, allowing the flaps to blow back up, returning to the pre-set position when airspeeds are reduced.

The down relief valve will not afford protection if the flaps are operated in excess of placarded speeds (see paragraph 2, Section IV, for applicable gross weight limitations vs. speed limitations), a practice that may result in structural damage to the flaps as a result of the inability of the relief valve to accurately record the loads in the flaps and linkage.

A warning horn will sound if the No. 1 or No. 3 throttle is advanced more than 35 degrees from the retarded position (approximately 35 inches Hg at sea level) and the wing flaps are positioned for a take-off setting of less than 13 degrees. However, this warning horn is not installed on those airplanes with a maximum permissible take-off gross weight of 93,200 pounds, or above, which permits a take-off flap setting of zero degrees.

The recommended IAS and wing flap settings to be used during a normal approach and landing at a maximum landing weight of 80,000 pounds are as follows:

CONDITION	IAS (knots)	FLAP SETTING
Downwind leg	To 156	20°
Base leg	121 to 139	30°
Final leg	104 to 112	50°
Field boundary	91 to 95	50°

On the ground, the flaps will completely extend in 10 (± 2) seconds and retract in 21 (±3.1) seconds. In flight, the required time to extend the flaps may increase slightly as a result of airload. A two-speed flap valve is installed on some DC-6 airplanes for the purpose of restricting the flap retraction speed. From 50 degrees down to 20 degrees down the flap retraction time is 9 (±1.3) seconds. From 20 degrees down to full up, retraction time is 12 (±1.8) seconds.

3. FUEL SYSTEM

The fuel system of the airplane, designed primarily for use as a suction system, consists basically of either eight or ten fuel tanks, with selector valves, cross-feed valves, engine-driven pumps, electric fuel booster pumps, and a priming system. While various tank-to-engine combinations of fuel feeding may be obtained by proper positioning of selector and crossfeed valves for normal operation, the system is considered to consist of four independent fuel system units—one for each engine. An emergency shut-off valve and strainer are installed in each engine main supply line between the tank selector valve and the engine-driven pump. A check valve with a thermal expansion bleed is installed in each main supply line between the tank shut-off and drain valve and the selector valve. A flowmeter between the carburetor and the fuel discharge nozzle in the blower case registers the consumption of fuel in pounds per hour. A fuel-dumping system is installed for jettisoning fuel overboard from all tanks to reduce the gross weight of the airplane.

For emergency operation of the fuel system, refer to Section VI, Trouble Shooting and Emergency Procedures.

3.1. FUEL TANKS — Each tank—main, alternate or auxiliary—is equipped with an electrically driven, centrifugal fuel booster pump, a sump drain, and capacitor-type quantity indicating units. The four main wing tanks and the outboard alternate tanks are integrally built into the wing center and outer structures. All seams and juncture points are coated with plastic sealant to prevent fuel leakage. The inboard alternate tanks and the left and right auxiliary tanks consist of interconnected bladder-type cell tanks. All tanks are suitable for the use of aromatic fuels.

The fuel line from each tank is equipped with a combination three-position tank shut-off and drain valve. The access door through which each valve is accessible when the airplane is on the ground incorporates a safety feature to prevent the door from closing when the valve is in any position except “TANK TO SYSTEM.”

Vapor vent return lines are connected to each engine carburetor. The vapor vent lines from the No. 1 and 2 carburetors are routed back to the No. 2 main fuel tank; the vapor vent lines from the No. 3 and 4 carburetors are routed back to the No. 3 main tank. The vapor vent system returns to the fuel tanks any vapor, plus a small amount of fuel that is vented from the D and E chambers of the carburetor. The normal return, flow may be four to five gallons per engine per hour; however, if the vent float sticks or is damaged, it is possible to obtain a maximum flow of 20 to 30 gallons per engine per hour. For this reason, the fuel level of the No. 2 and 3 main fuel tanks should be checked periodically throughout flight to avoid overfilling, although adherence to the fuel loading chart will usually prevent overfilling.

Each tank is vented overboard through a vent chamber, which prevents surging fuel from draining from the vent line during normal ground and flight operations. The outboard tanks vent overboard near the wing tip; the remaining tanks vent overboard through a vent recess, just outboard of the flaps and just forward of the aileron.

The airfoil anti-icing heaters receive their normal fuel supply from the No. 3 main tank, the cabin heater receives its normal fuel supply from the No. 2 main tank.

3.2. FUEL SERVICING — The recommended straight-flow tank-to-engine method of fuel system management (see paragraph 3.11) is dependent on the manner of loading fuel into the tanks. It is important that the total fuel weight be distributed equally between the left and right sides of the airplane.

3.3. FUEL EMERGENCY SHUT-OFF VALVES — A fuel emergency shut-off valve, located in the fuel supply line and on the aft side of the firewall, in each nacelle, is installed for the purpose of shutting off the supply of fuel to the engine in an emergency. The emergency shut-off valves are cable-operated by the four fire extinguisher selector valve handles located at the top of the main instrument panel, below the glareshield. The valves are closed by pulling the respective handles full OUT to the limits of their travel. The valves should be closed whenever it is desired to shut off the supply of fuel to the engine or whenever there is evidence of fuel line failure ahead of the firewall (see Section VI, Emergency Procedures and Trouble Shooting).

3.4. FUEL SYSTEM CHECK VALVES (Modification Item) — The DC-6 fuel system is not designed for the transfer of fuel from one tank to another, since excessive tank pressures, causing structural damage, may result, as well as loss of fuel from overfilling. To prevent fuel transfer, check valves, incorporating a thermal expansion bleed, are installed in each fuel tank system between the tank shut-off and drain valve and the selector valve.

3.5. ENGINE-DRIVEN FUEL PUMPS — A positive-displacement vane-type fuel pump, driven by each engine, is used to pump fuel from the tanks to the engines. Each pump incorporates an adjustable relief valve to regulate fuel pressure and a by-pass valve to permit fuel under pressure from the electric fuel booster pump to flow through the pump during starting operations and in the event of engine-driven pump failure. As the engine-driven pumps are suction-type pumps, they may cavitate under certain, conditions such as decreased pump inlet pressure (increased altitude) and high fuel temperatures as evidenced by a decrease in fuel pressure or pressure and flow fluctuations. In this event, it will become necessary to assist the pumps by use of the electrically driven fuel booster pumps.

3.6. ELECTRICALLY DRIVEN FUEL BOOSTER PUMPS AND CONTROLS — Electrically driven fuel booster pumps are used to supplement the engine-driven pumps by keeping the engine-driven pump inlet fuel pressure above the cavitation range.

A screen mounted on the booster pump at each tank outlet prevents foreign matter from entering the fuel pumps or lines from the tanks.

The electrically driven fuel booster pumps are controlled by individual three-position switches grouped on the torward overhead panel and having the following positions: “LOW” “OFF,” and “HIGH.” The booster pump switches should be placed in the “OFF” positions except for emergency and whenever fuel pressure cannot be maintained with the engine-driven pumps alone. The pumps should be operated in the “LOW” Speed whenever possible; “HIGH” speed is provided primarily for use in the event of engine-driven pump failure. The switches are fitted with a locking collar that requires the switches to be pulled OUTWARD to move them into either “LOW” or “HIGH” boost. It is recommended that the engines be started with the booster pumps in the “LOW” positions. However, in extremely cold weather, “HIGH” boost may be used for starting the engines, provided “LOW” boost is used first to pressurize the system up to the carburetor before placing the switch in “HIGH” boost. The switch from “LOW” to “HIGH” boost should be made as rapidly as possible. *In turning the fuel booster pumps off, turn them off one at a time*, making certain that each engine-driven pump is supplying sufficient pressure after the booster pump is turned off.

The recommended operating fuel pressures, with the booster pumps “OFF,” are as follows:

Idling	16 psi
Fuel pressure warning light, ON at	18 (±5) psi
Minimum	22 psi
Desired	23 psi
Maximum	24 psi

With the booster pumps operating in "HIGH" boost and the engines inoperative, fuel pressures may reach higher than normal values and can even reach 30 psi; with "LOW" boost and the engines inoperative, pressures can reach 14 psi.

The booster pump circuit breakers are located on the aft overhead panel in the cockpit.

It should be noted that when the booster pumps are used, the entire fuel system, from the tanks to the carburetors, is under pressure. Consequently, the booster pumps should not be operated in any system where it is known or suspected that a leaking or broken fuel line exists. Operation of the fuel system, with the booster pumps "OFF" will allow air to enter the system through any line break or bad fitting, which will result in pressure fluctuations on the fuel pressure gauge(s). With the booster pumps operating, the pilot will have no cockpit indication of a minor line leakage, and, in addition, fuel will be pumped into the area of the leak, creating a fire hazard.

3.7. RECOMMENDED USE OF FUEL BOOSTER PUMPS — It is recommended that the electric fuel booster pumps be operated in "LOW" boost under the following conditions:

1. For engine start.
2. For take-off at any time the ground temperature is above 75°F
3. For take-offs above 2500 feet
4. During climb after reaching 10,000 feet (if takeoff was made under the preceding condition, leave the booster pumps on throughout climb to cruising altitude).
5. When selecting a new fuel supply.
6. For 1½ hours on selected fuel tanks after reaching cruise altitude.
7. And at any time that fuel pressure drops below 22 psi or fluctuates.

Always shut booster pumps off one at a time, and watch to make certain pressure can he maintained by the engine driven pumps.

Since the boiling point characteristics of fuel vary with each production-run, and each run varies with age and the conditioning* it receives, it is very difficult to predict the exact moment and condition under which booster pumps should be applied. The above recommended operating procedures are based upon critical conditions with 110°F fuel.

As day-to-day flying will seldom result in 110°F fuel conditions, it is recommended that the following procedure be used at any time that the cruise altitude is reached with booster pumps on or that new tanks have been selected:

> *Conditioning of the fuel may be illustrated by reference to a bottle of soda water; when a fresh bottle is uncapped, the momentary bubbling is similar to that occurring in fuel during a rapid climb to altitude. As the soda water ages with the cap off, or is conditioned by shaking, the quantity of gas released is greatly decreased Similarly, aviation fuel will be made less volatile through bubbling, and the bubbling can be accelerated by churning the fuel with the booster pump.

Conditioning the fuel for 1½ hours by booster pump agitation covers most of the critical fuel conditions that may occur in the DC-6 fuel system. While it is realized that this 1½-hour period will be extremely liberal in a great many instances (with O.A.T.'s below 75° F) , it should be remembered that with high altitudes and/or high O. A. T. it will be necessary to condition the fuel for longer periods. Therefore, make the following test for fuel stability:

> Sometime after the airplane has been stabilized at the cruise altitude, momentarily turn one of the selected booster pumps off and at the same time watch the fuel pressure. If the fuel pressure drops or fluctuates, leave the booster pump in operation for a longer period. If the pressure remains steady, that booster pump may be turned off. Repeat this procedure on the remaining booster pumps.

3.8. FUEL STRAINERS — Four fuel strainers, one mounted in each lower aft nacelle section, trap sediment and water in the fuel coming from the tanks. The strainers must be drained daily to remove any accumulated water. Periodic cleanings will remove any accumulation of sediment.

3.9. FUEL TANK SELECTOR VALVES AND CONTROLS — Essentially, the fuel system consists of four independent fuel system units. Each unit is comprised of one main and one alternate tank, and normally supplies its respective engine. Each unit of a main and an alternate tank has a three-position selector valve for selecting the fuel supply from either tank and delivering it to the respective engine. The four selector valve control levers are located on the left forward upper face of the control pedestal and are marked with the following positions: “MAIN ON” (forward position, green band), “ALT ON” (center position, red band), and “OFF” (aft position, white band).

The selector valve controls should be in the "OFF" position whenever the engines are inoperative and during fueling operations.

If a fuel line failure occurs between the tank selector valve and the emergency shut-off valve, the leak can be controlled by shutting "OFF" the selector valve.

3.10. CROSS-FEED VALVES AND CONTROLS — A fuel cross-feed line and two three-position cross-feed valves are installed in the fuel supply system on the engine side of the fuel tank selector valves, providing a link between all tanks and engines. Two cross-feed valve control levers are located on the right forward upper face of the control pedestal and have the following positions: "OFF"—forward position, white band; "ENGINE 1-2" (left control) and "ENGINE 3-4" (right control)—center position, red band; and "ALL ENG TO CROSS-FEED"—aft position, green band.

For a normal take-off, the cross-feed controls should be in the full forward position, "OFF." Both cross-feed levers should be in the "OFF" position during fueling operations and at all times when flow is not desired through the cross-feed system.

In the event of fuel line failure aft of the firewall, do not use the cross-feed valve on that side of the airplane, and do not use cross-ship cross-feed (the crossfeed lines tie into the tank-to-engine supply lines between the emergency shut-off valves and the selector valves).

A thermal expansion relief valve, pre-set to open at 65 to 85 psi, is installed in the left cross-feed fitting to relieve the thermal expansion of fuel in the cross-feed system.

3.11. FUEL SYSTEM MANAGEMENT — Various tank-to-engine combinations of fuel feeding may be obtained by the proper positioning of the selector and cross-feed valve controls. Prior to take-off, check for unobstructed fuel flow by operating each engine on both its main and alternate tanks. For normal operation, take-off is made with fuel flow from the main tanks to the respective engines.

When a switch is made from one tank to another, turn the fuel booster pump for the new source to "LOW" first to insure proper flow of fuel to the engine; then turn on the new source before shutting off the old. If a tank is run dry, close the throttle before selecting the new source to prevent propeller overspeeding. After normal fuel pressure has been established, the booster pumps may be turned "OFF."

No difficulty should be encountered in the management of the fuel system if it is remembered that each selector valve merely "selects" which of the two tanks in that engine fuel system will supply fuel to the respective engine. When the selector valves are opened and the cross-feed valves are left in the "OFF" position, the fuel flows directly from the selected open tanks to the respective engines. Cross-feeding is equally simple in that the cross-feed valves merely "direct" the flow of fuel to its ultimate destination, if other than direct tank-to-engine feed is necessary. For example, with the selector valve for the tank supplying the No. 1 engine in the closed ("OFF" position), place the left cross-feed valve control lever in the "ENGINE 1-2" position (red band, center position). This accomplishes just what the placard says: the fuel flowing through the No. 2 selector valve is being fed to both the No, 1 and 2 engines. If it is necessary to feed all engines from one tank, place the cross-feed control levers in the "ALL ENG TO CROSSFEED" positions and then place the selector valve control levers for the remaining engines in the "OFF" positions.

If an emergency condition exists that requires fuel to be drawn from the tanks in a manner other than that shown in the routine operating procedures, and there is a choice of fuel selection from either the inboard or outboard tank systems, the fuel should always be fed from the inboard tanks first. This sequence is desirable because the resulting fuel weight distribution will have the most favorable effect on the wing structure, as explained in Section V, paragraphs 4 through 4.5.

3.11.1 Eight-Tank Fuel System Management — The management of the eight-tank fuel system is similar to that of the ten-tank system; however, since the auxiliary tanks are not installed, the selector valve controls for those tanks are eliminated. The procedure of direct fuel feeding follows the same sequence as that shown, in Figure 18. When the flight was started with a full fuel load, 79 gallons of fuel will be left in the inboard main tanks after the other tanks are run down; these 79 gallons are sufficient for 20 to 30 minutes of flight at cruise power. Because in the eight-tank system the wing structure is critical in flight when the fuel weight in

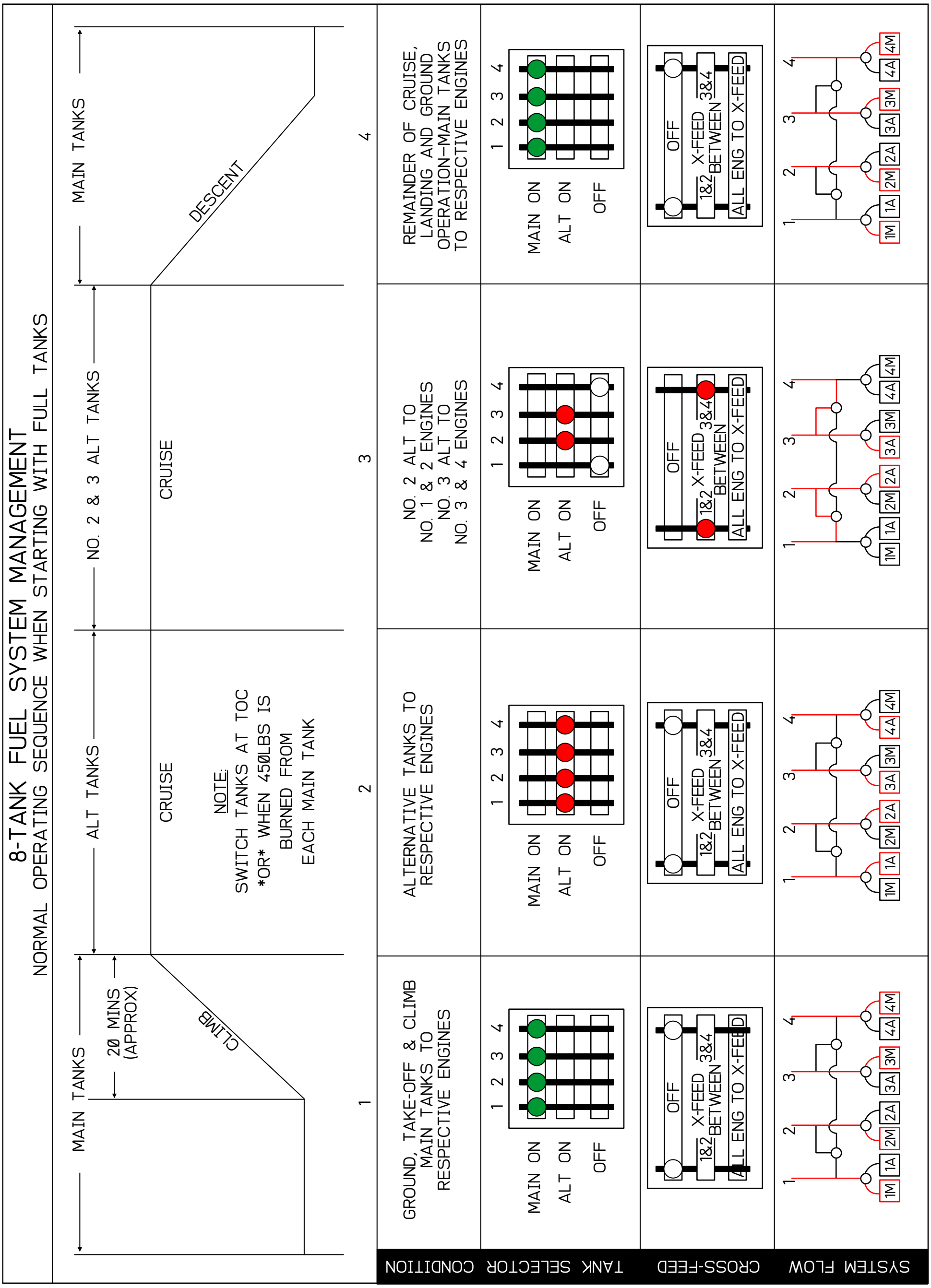


Figure 18 - Eight Tank Fuel System Management - Normal Operating Sequence

the inboard tanks materially exceeds that in the outboard tanks (this principle is explained in Section V, paragraph 4.1, “Importance of Fuel Distribution”), this additional fuel must be cross-fed out.

3.11.2 Normal and Cross-Ship Fuel Cross-Feed Operation — With the recommended system of fuel loading, the use of fuel cross-feeding will not be necessary during normal routine flight; however, there will be times when cross-feeding will become necessary. An example would be the loss of an engine, in which event the unused fuel must be disposed of between the remaining operative engines. In the DC-6 airplane, fuel cross-feeding is divided into two systems: Normal Cross-Feed Operation (cross-feeding between two engines on one side) and Cross-Ship Cross Feed (feeding all four engines from one tank). In both cases, use of the fuel booster pump will probably be necessary.

The diagram in Figure 20 gives an example of Normal Cross-Feeding for eight-tank system.

The need for Cross-Ship Cross-Feed operation, in which fuel is supplied from the tanks on one side of the airplane to the engines on both sides of the airplane, might arise from carburetion or from engine failure. The diagram shown in Figure 21 gives an example of Cross-Ship Cross-Feeding for the eight-tank fuel system. It is important to remember that failure of the fuel supply during Cross-Ship Cross-Feeding will affect all four engines, and such operation should be limited to an altitude that will allow sufficient time to switch back to normal independent systems should interruption occur. If an engine failure occurs during Cross-Ship Cross-Feed operation, return each engine to its respective main tank and then turn off all cross-feed or alternate sources of supply.

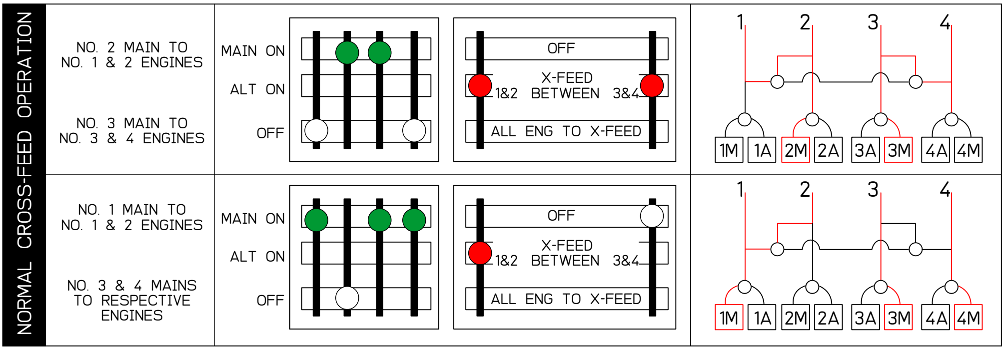


Figure 20 - Normal Cross-Feed Management - Eight Tank Fuel System

If the engine does not restart on its normal fuel system, isolate the engine and determine the cause (see Section VI, Emergency Procedures and Trouble Shooting).

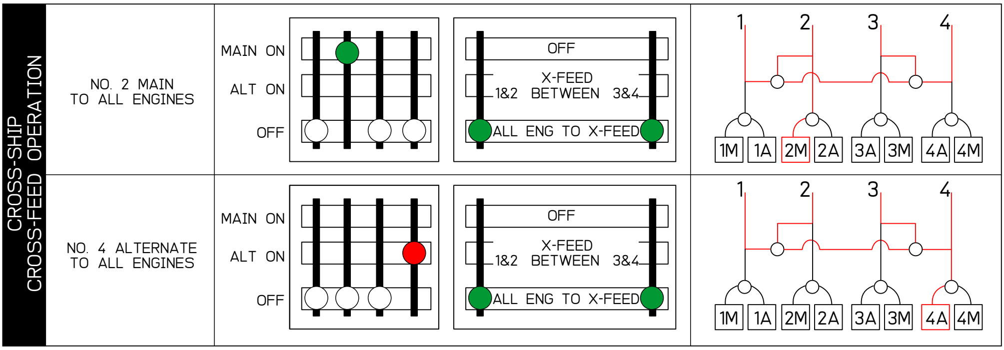


Figure 21 - Cross-Ship Cross-Feed Management - Eight Tank Fuel System

3.12. FUEL PRESSURE INDICATION — A transmitter, mounted on a bracket in each engine accessory section, transmits the fuel pressure to dual fuel pressure indicators on the engine instrument section of the main instrument panel. A red warning light, located beneath the indicators, illuminates when the pressure at one or more carburetors falls below 18 (±½) psi. The warning light operates on a separate circuit from the fuel pressure transmitter.

3.13. FUEL QUANTITY AND FLOW INDLCATION — Fuel quantity is registered by capacitor indicating systems installed in each tank. Because capacitor systems automatically compensate for fuel density changes, the weight rather than the volume of the fuel is indicated. Indicators, one for each tank, on the upper instrument panel, give quantity indication in pounds. A flowmeter, installed between each carburetor and the fuel discharge nozzle, measures the rate of fuel consumption in pounds per hour. Two dual indicators on the engine instrument panel give flow indication. A fuel quantity measuring stick is stowed in the nose gear well.

3.14. FUEL DUMP SYSTEM AND CONTROLS — Fuel dumping facilities are provided for the emergency jettisoning of fuel in flight in order to decrease airplane gross weight. Each main, alternate, and auxiliary tank is fitted with a dump valve. A standpipe is installed in each main tank so that when all possible fuel is dumped, in level flight, sufficient fuel will remain in the main tanks for 45 minutes of flight at 75 per cent of rated (METO) power. Fuel is dumped overboard from an extended chute at the rear of each nacelle. Dump valves and chutes open and extend in coordinated operation by means of four cable-rigged controls beneath the floor plate, aft of the control pedestal. Each handle controls one dump chute and its respective dump valves and has three positions: “CLOSED,” “DRAIN,” and “OPEN.” Pulling the handle full back to the “OPEN” position extends the dump chute and opens the dump valve. After the dumping operation is complete, push the handle forward to the “DRAIN” position (which closes the dump valve and leaves the chute extended) and leave it there for five minutes to allow all residual fuel to drain from the dumping system. Then retract the chute by returning the handle to the “CLOSED” position. The dumping rates are designed to meet CAA requirements. For operation of the fuel dumping system, see Section VI.3., Emergency Procedures and Trouble Shooting.

The maximum speed at which fuel may be dumped is 185 KIAS. Both landing gear and wing flaps must be up during the dumping operation.

4. OIL SYSTEM

Four independent engine section oil systems supply lubricating oil to the engines. An engine-driven pressure pump circulates oil through the engine. The scavenge pumps pick up the oil and pump it into an oil cooler beneath each nacelle, and up to the engine section oil tank. The oil then flows by gravity to the engine through an emergency shut-off valve mounted at the outlet of the tank.

4.1. ENGINE SECTION OIL TANKS — The engine section oil tanks, one attached to the upper section of each engine mount, forward of the firewall, have a capacity (exclusive of expansion space) of approximately 35 usable U.S. gallons each with the Hamilton Standard propeller installation.

For the Hamilton Standard propeller, a standpipe in the oil tank maintains a reserve of approximately 2.5 gallons for propeller feathering. The feathering oil supply line by-passes the emergency oil shut-off valve and is routed from the oil tank through a feathering pump to the propeller assembly. The feathering pump acts as a shut-off valve when it is inoperative. The tank is equipped with a cylindrical hopper, which aids in the de-aeration of returning oil from the engine, reduces foaming action within the tank, and aids in rapid engine oil warm-up.

While there is no minimum capacity limitation, it is recommended that no take-off be made with less than 15 U.S. gallons or a 30-to-l fuel/oil ratio, whichever is greater, in each engine section tank. Engine section oil tanks must not be filled above the 20-gallon level by use of the oil transfer system.

4.1A. AUXILIARY OIL TRANSFER SYSTEM — An auxiliary engine oil tank and transfer system is installed on some airplanes to meet the required fuel-to-oil ratio when additional fuel tanks are installed. The auxiliary oil tank is in the left wing fillet and has a total capacity of 26 usable gallons.

The tank is filled with 50 per cent oil, Specification AN-0-8, grade 1100 summer and winter, and 50 per cent fuel, grade 100/130. The oil transfer system consists of a combination oil pump and motor, a tank selector switch, a solenoid operated, four-way selector valve, and a momentary-contact pump actuating switch. Oil can be transferred from the auxiliary tank to any one of the main system oil tanks by positioning the auxiliary oil tank selector switch to the desired main tank and then operating the pump actuator switch. Release the pump actuator switch when the desired amount of oil has been transferred. After oil has been transferred, the transfer system lines must be evacuated by reversing the pump actuating switch.

The auxiliary oil tank selector switch and the auxiliary oil pump actuating switch are located on the aft overhead panel. The oil quantity indicator for the auxiliary oil transfer system is located on the upper instrument panel. Engine section oil tanks must not be filled above the 20-gallon level by use of the oil transfer system.

4.2. DELETED.

4.3. OIL DILUTION SYSTEM — An oil dilution system is provided to dilute the engine oil when a cold weather start is anticipated. An oil dilution solenoid valve controls the flow of fuel from the main fuel supply line in each nacelle to the main oil supply line at the bottom of the engine section oil tank. Each solenoid is controlled by one of four "ON-OFF" momentary contact switches on the aft overhead panel. *The fuel tank booster pumps must be on* "LOW" *boost during the oil dilution operation to furnish fuel pressure*, since the line is teed into the inlet side of the engine-driven fuel pump. For this reason, no fuel pressure indicator drop will occur during dilution. The Hamilton Standard propeller system may be diluted by partially feathering the propeller during the dilution period. For operation of the oil dilution system, see Section VII, Extreme Weather Operation.

4.4. OIL EMERGENCY SHUT-OFF VALVES — The oil emergency shut-off valves cut off the supply of oil to the engines at the engine section oil tanks and are controlled by the four center fire extinguisher selector valve handles below the glareshield. If the propeller fails to feather completely and continues to windmill, the fire extinguisher selector valve handle for that engine can be pushed in until it is stopped by its spring latch. This will open the oil emergency shut-off valve approximately halfway and permit sufficient oil to enter the engine to prevent it from seizing. This action will not open the fuel or hydraulic fluid emergency shut-off valves.

4.5. OIL TEMPERATURE, PRESSURE, AND QUANTITY INDICATION — The temperature of the oil being supplied to the engine is measured electrically by a resistance bulb which extends into each engine section oil tank outlet. Two dual oil temperature indicators, calibrated in degrees centigrade, are mounted on the engine instrument panel.

Oil pressure is measured by a transmitter connected to the engine restrictor fitting on the top of the rear case, and is shown by two dual indicators on the engine instrument panel. A pressure warning switch, operating on a separate electric circuit from the oil pressure transmitter, is set to close at 50 (±5) psi. A single oil pressure warning light, located below the dual oil pressure indicators on the engine instrument panel, is operated by any one or more of the switches.

OIL PRESSURE SAFE OPERATING RANGE

2000 to 2200 rpm	60 to 100 psi
1600 rpm	55 to 90 psi
1400 rpm	50 psi minimum
Idling	25 psi minimum

Oil quantity is measured by a transmitter connected to an arm-and-float mechanism inside each engine section oil tank and is indicated by two dual indicators mounted on the upper instrument panel. A stick gauge is installed near the filler neck of each oil tank. For malfunctioning of the oil system, see Section VI, Emergency Procedures and Trouble Shooting.

5. HYDRAULIC SYSTEM

The constant-pressure type hydraulic system, with a system pressure of 2600 to 3050 psi, extends and retracts the nose and main landing gears, operates the nose wheel steering system, actuates the windshield wipers, and operates the brakes and wing flaps. The DC-6 hydraulic system may be considered as consisting of four individual but integrated systems:

(1) The pressure supply system (engine-driven pumps) and the pressure regulating system, installed between the dash pot check valve and the hydraulic reservoir.

(2) The pressure accumulator system, located between the pressure accumulator check valve and the dash pot check valve, and installed in the hydraulic system between the pressure supply and the hydraulically actuated units.

(3) The hydraulically actuated units themselves— wing flaps, landing gear, etc.

(4) The emergency, or auxiliary, system, which is an entirely separate hydraulic system supplied with pressure by an electrically actuated auxiliary hydraulic pump.

Each individual system is provided with a means of preventing undue pressures caused by thermal expansion. Shut-off valves are installed to isolate the different systems for maintenance. The entire system can be ground checked through fittings in the hydraulic accessories compartment. Main hydraulic system pressure is indicated by a pressure gauge on the hydraulic instrument panel, located outboard of the first officer. Total system capacity is 17.2 U.S. gallons, including reservoir capacity.

For emergency operation and en route trouble shooting of the hydraulic system, see Section VI, Emergency Procedures and Trouble Shooting.

5.1. HYDRAULIC RESERVOIR

The hydraulic reservoir, located in the hydraulic accessories compartment, has a capacity of 5.4 U.S. gallons. Of the total fluid capacity, 2.9 gallons are available to the two enginedriven hydraulic pumps. A reserve fluid supply of 2.5 gallons is provided in the reservoir for the auxiliary (emergency) pump. A foaming space of 3.8 gallons is provided above the filler neck.

A paper disc-type filter in the reservoir cleans the hydraulic fluid as it returns from the system. The filter is retained by a spring, which allows the returning fluid (at three psi) to by-pass the filter if it becomes clogged.

Fluid level in the reservoir is indicated by a sight gauge on the side of the tank and by a remote indicator mounted on the upper instrument panel in the cockpit and actuated by a Liquidometer float-type transmitter in the reservoir. The indicator is placarded “REFILL,” “NORMAL FLIGHT,” and “FULL, ZERO PRESSURE.” With engines inoperative, the fluid level should indicate at “FULL, ZERO PRESSURE.” With the engines operative, the fluid level should indicate at “NORMAL FLIGHT.”

A relief valve on the hydraulic reservoir maintains a uniform air pressure of eight psi in the reservoir, so that fluid in the supply lines to the engine-driven pumps is under constant pressure.

5.2. HYDRAULIC FLUID EMERGENCY SHUT-OFF VALVE — A hydraulic fluid emergency shut-off valve is installed in the engine pump supply line in each inboard nacelle, aft of the firewall. The valves are operated by the first half of the travel of the respective inboard engine fire extinguisher selector valve handles below the glareshield.

5.3. HYDRAULIC PUMPS — Pressure is supplied to the hydraulic system by two engine-driven pumps, one mounted on the accessory case of each inboard engine. Each pump has a normal output capacity of six gallons per minute. A noise filter, similar in construction to a pressure accumulator, is mounted on the firewall to dampen the impact of pump pulsations against system pressure.

Failure of an engine-driven hydraulic pump will be evidenced by a reduced rate of system pressure build-up during operation.

An electrically driven auxiliary hydraulic pump, mounted in the hydraulic accessories compartment, provides an emergency source of pressure. The momentary contact controlling switch is marked “HYD. EMERG.” and is located aft of the hydraulic instrument panel. The auxiliary pump can be used if the engine-driven pumps fail or if pressure is desired while the airplane is on the ground and the engines are inoperative.

It is well to remember that an emergency operation of the auxiliary hydraulic pump with a leak in the system will pump the total available fluid overboard in 3.3 minutes of continuous operation.

5.4. AUXILIARY (EMERGENCY) PUMP SELECTOR VALVE AND CONTROL — The auxiliary (emergency) pump selector valve, mounted on the hydraulic power panel manifold, is cable operated from a control lever on the floor to the left of the first officer. The threeposition valve permits the pump to furnish pressure for the various units with or without pumping up the accumulators, depending on the port chosen. The selector valve control has three positions: “BRAKE SYSTEM” (forward), “GENERAL SYSTEM” (center), and “PRESSURE ACCUMULATOR” (aft). Pressure from the auxiliary pump will automatically be delivered to the brake system in either of the three positions. In the “BRAKE SYSTEM” position, pressure from the pump will be delivered to the brakes as well as the rest of the system, with the brake system being prioritized, and it is recommended that the control lever normally be left in this position unless other operation is desired. In the “GENERAL SYSTEM” position, only the general system and the brake system will be pressurized.

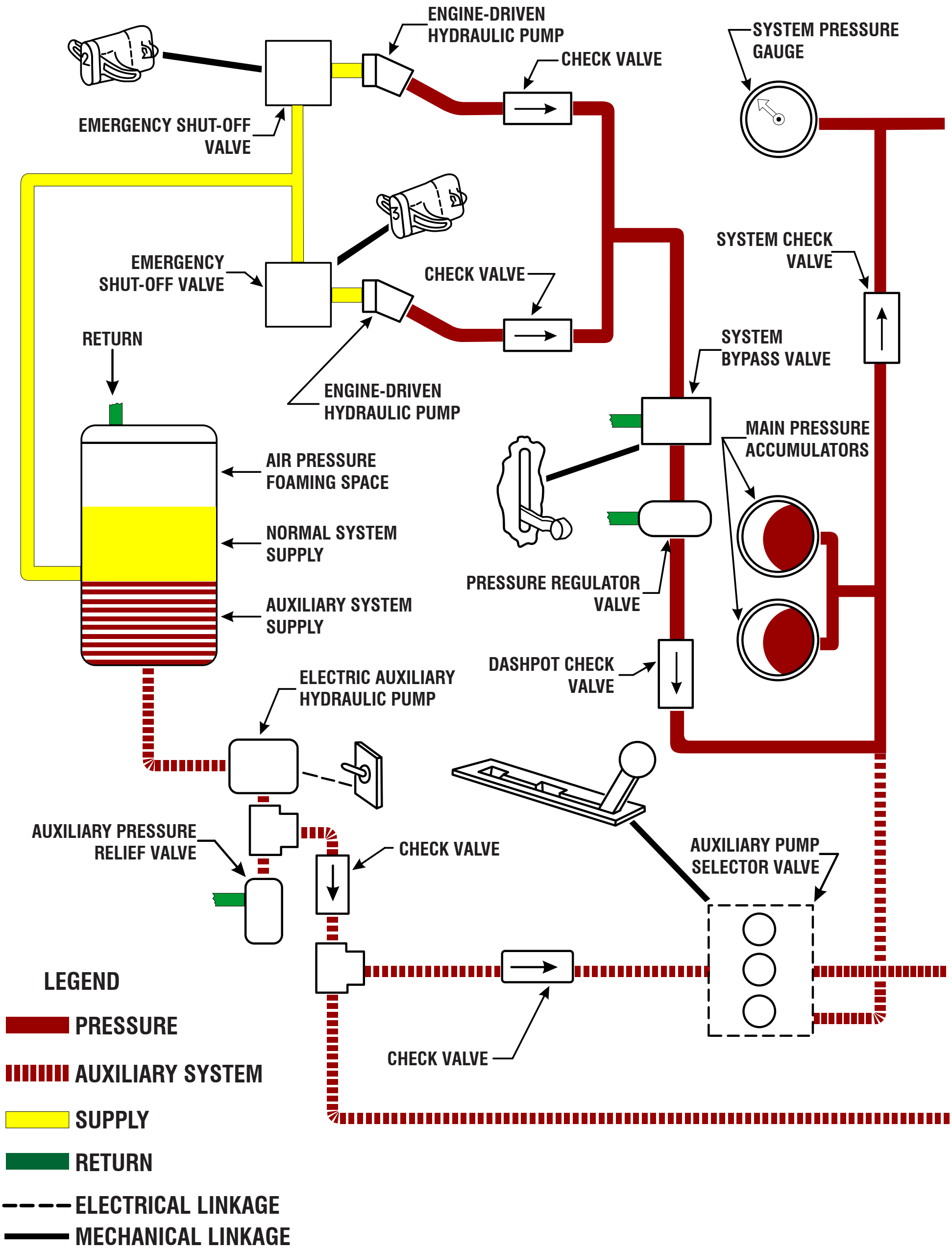


Figure 28 (Sheet 1 of 2 Sheets) — Normal and Auxiliary Hydraulic Systems

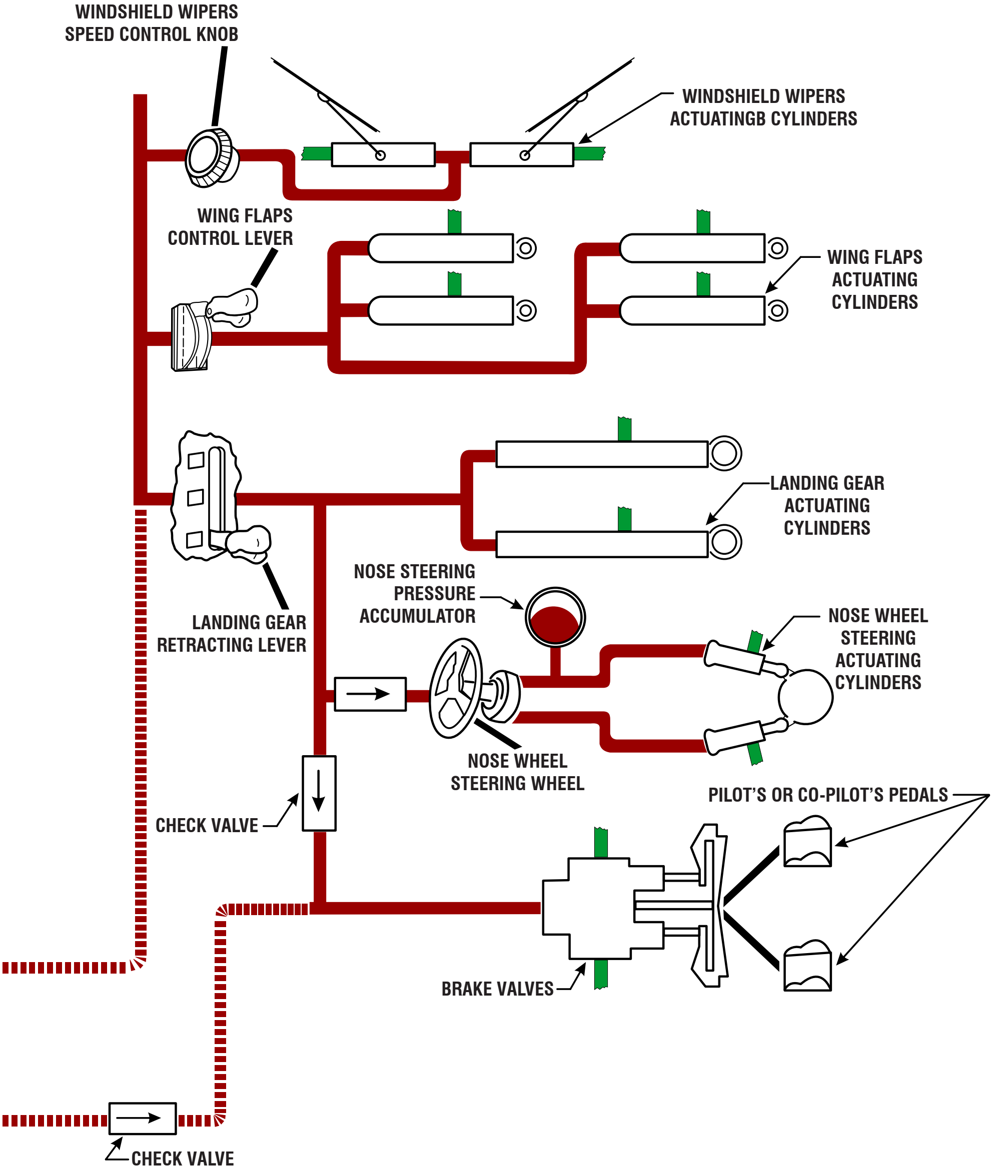


Figure 28 (Sheet 2 of 2 Sheets) — Normal and Auxiliary Hydraulic Systems

In the “PRESSURE ACCUMULATOR” position, the general system, the accumulator system and the brake system will be pressurized. From the hydraulic system schematic shown in Figure 28, it will be seen that each system is protected by check valves and that the auxiliary pump selector valve should not be positioned to a system containing a known leak. However, the auxiliary pump and its selector valve can be used in flight to trouble shoot the hydraulic system to determine and isolate a malfunctioning system (see Section VI, paragraph 6).

5.5. HYDRAULIC SYSTEM (BY-PASS) CONTROL — A slide-type, manually operated by-pass valve permits the hydraulic fluid to be by-passed directly from the engine-driven pumps to the reservoir to reduce wear on both the pressure regulator and the engine-driven pumps when pressure to the various units is not desired during flight. Placing the hydraulic system by-pass control on the aft right face of the control pedestal in the “OFF” (system inoperative) position opens the by-pass valve, allowing fluid to by-pass the pressure regulator and causing it to become inactive.

The by-pass valve may also be used in the event of pressure regulator failure, since continuous flow through the system relief valve will result in excessive heating of the fluid (indicated by excessive pressure on the pressure gauge), endangering the operation of the engine-driven pumps and other units of the hydraulic system. ‘The hydraulic system by-pass control should be placed in the “OFF” position whenever operation of the hydraulically operated units is not desired (however, this does not apply during takeoffs, landings or ground operation).

The by-pass valve does not require positioning for operation of the auxiliary pump.

5.6. HYDRAULIC SYSTEM PRESSURE REGULATOR — A pressure regulator maintains pressure in the system between a minimum of 2600 and a maximum of 3050 psi, by-passing hydraulic fluid from the pumps to the reservoir when the system pressure exceeds the maximum operating pressure.

5.7. HYDRAULIC SYSTEM RELIEF VALVE — The hydraulic system relief valve prevents excessive system pressure from developing if the pressure regulator fails to by-pass fluid when pressure exceeds the operating range. The valve starts to relieve at 3300 psi.

5.8. MAIN PRESSURE ACCUMULATORS — Two pressure accumulators, connected in parallel, provide a reserve supply of fluid under pressure and dampen the high impact loads on lines and units to which they would be subjected if pressure in the system were allowed to rise immediately from zero to maximum; the air in the accumulators absorbs the shock of pump output and enables the system pressure to rise gradually. The main system pressure is indicated on a gauge on the hydraulic instrument panel.

5.9. BRAKE PRESSURE ACCUMULATOR (Not Installed on Some Airplanes) — A brake pressure accumulator is installed on most DC-6 airplanes to provide a reserve hydraulic pressure for operating the parking brakes. A check valve prevents loss of brake accumulator pressure when the main system pressure falls below 3000 psi. A brake accumulator pressure gauge is mounted below the main system pressure gauge on the hydraulic instrument panel.

5.10. BRAKES

5.10.1. Hydraulic Brakes — The main landing gear brakes are single-disc, self-adjusting spot brakes operated by hydraulic pressure, which is available only when the landing gear control lever is in the "DOWN" position. The brake consists of two opposing units of brake lining, separated by a floating annular disc keyed to rotate with the main gear wheel. Stopping action is accomplished by hydraulic pressure, which presses the linings against the floating disc. No adjustment of the brake is required during the lifetime of the lining, as the lining clearance remains constant.

The brakes operate under a pressure which is suitably reduced from the main system pressure by the brake control valve. Pressure from the brake control valve, as determined by the pressure applied at the rudder pedal toe brakes, is transmitted to each brake through a lock-out cylinder, which prevents failure of one brake on a dual wheel from affecting the operation of the other brake. Pressure applied to the brakes is in proportion to the toe pressure applied to the brake pedals.

The rudder pedals are hinged so that toe pressure applied to the tops of the pedals operates linkage that, in turn, applies pressure to the brake control valve.

Use care in operating the brakes, which provide adequate braking power for any normal situation. The brakes should not be used immediately after making contact with the ground during landing, as the tires are very likely to skid, with even a light application of braking, due to the low coefficient of rolling friction. Use as much of the runway as possible before applying the brakes smoothly and steadily to slow the airplane down to a safe turning speed. Avoid using the brakes during taxiing, if possible, until approaching the ramp.

5.10.2. Parking Brakes — The main gear hydraulic brakes can be set for parking by a rotating cam which blocks the brake control valve in the "ON" position. The cam is operated by a lever on the left side of the control pedestal. The parking brakes will only operate when there is hydraulic system or accumulator pressure. To set the parking brakes, depress the brake pedals first; then turn the parking brake lever to the "ON" position. Release the brake pedals while holding the parking brake lever in position. Freedom of movement of the parking brake lever indicates that the brakes are in the parked position. Depressing the brake pedals releases the parking brakes, allowing the parking brake lever to return to the "OFF" position. The parking brakes should be operated from the captain's side only, and should not be engaged in flight.

5.10.3. Air Brakes — An emergency air brake system is available for operation of the brakes when the hydraulic system becomes inoperative. Air, at 1500 (± 50) psi, is stored in a cylinder in the nose gear well. Air pressure is indicated by a pressure gauge on the hydraulic instrument panel. Air is released from the cylinder and the brakes are applied by turning the control handle clockwise. The handle is mounted at the extreme left of the fire extinguisher selector valve handles.

The air brake valve is a metering type incorporating a "HOLD," or center, position in which the amount of braking applied can be held static. Turning the handle clockwise past this point to the "ON" position (extreme right) applies additional brake; turning the handle counterclockwise past the "HOLD" position spills the air overboard and releases the brakes. In applying the air brakes, the handle should be turned full to the "ON" position, and then returned to the "HOLD" position immediately when braking is felt. If the braking applied is not sufficient after the first application, place the handle "ON" again and immediately return to "HOLD." If it is found that too much braking is applied, turn the handle counterclockwise past "HOLD" and spill some of the air overboard. Do not turn the handle to "ON" and leave it in that position, as the full application of air is more than sufficient to completely lock the brakes and skid the tires. It should be noted that braking power will not be immediately felt the instant air pressure is applied, but that operation will slightly lag behind the application of air. After the airplane has been brought to a stop, no further application of air should be applied. Taxiing is not recommended as the supply of air is limited.

After the air brakes have been used, it is necessary to bleed the hydraulic brake system to remove the air before hydraulic braking will again function properly. Make certain that the air bottle is reinflated after having been used.

5.11. WINDSHIELD WIPERS — The two windshield wipers are operated by a hydraulic wiper system on full system pressure and in synchronized movement. The speed control valve, immediately adjacent to the nose wheel steering wheel, acts as an on-off control and regulates wiper speed. The blades are locked in position when the speed control is turned "OFF." Full or partial stoppage of one blade will not interfere with complete operation of the other blade.

6. LANDING GEAR

6.1. MAIN GEAR — The two main gears are attached to the forward and center spars in the wing center section, aft of the center of gravity of the airplane, and retract forward into the gear wells of the inboard nacelles. Doors, operated by the landing gear retracting mechanism, close to form the bottom contour of the nacelle when the gear is fully retracted. Both the nose and main gears retract and extend under hydraulic system pressure controlled by a selector valve in the hydraulic accessories compartment. The selector valve is cable-operated by the landing gear control lever on the aft face of the control pedestal. The first part of travel of one lever operates a cable system which releases the uplatches before operation of the selector valve occurs. The selector valve controls the flow of fluid to the conventional two-way actuating strut at both the nose and main gears. However, only the "UP" position of the selector valve applies pressure to the bungee piston, which unlocks the nose gear downlatch.

The two wheels of each main gear are mounted on opposite sides of a single oleo-pneumatic shock strut. Fore and aft loads on the landing gear are absorbed by drag linkage incorporating a downlatch, which is held in the latched position by spring-loaded linkage. In the retracted position, the gear hangs from a mechanically operated uplatch hook. The hydraulic brake system may be used to halt rotation of the main gear wheels in the event of a tire off-balance condition (distinguished by severe shaking of the airplane), provided such action is taken prior to retraction.

The grip-type landing gear control lever on the aft face of the control pedestal has three positions: "UP," "NEUTRAL," and "DOWN." *The control must be left in the "DOWN" position at all times when the gear is extended.* During flight, after the gear has been retracted, the lever should be placed in the "NEUTRAL" position, which opens both up and down ports to return and allows the landing gear to settle on the uplatch hooks. The valve control lever should be placed in the "UP" position during rough weather; this will remove the weight of the gear from the uplatches and prevent the dural shear bolts in the uplatch mechanism from, shearing. Before placing the lever in the " UP " position, however, close the system by-pass valve.

For emergency operation of the main landing gear, refer to Section VI, Emergency Procedures and Trouble Shooting.

6.2. NOSE GEAR — The nose gear, located in the nose gear well, is hydraulically steerable, retracts forward with the main gear, and is suspended from the sidewalls of the gear well. Doors operated by the retracting mechanism, close after retraction is complete and form a contoured surface for the fuselage nose undersurface. The steerable wheel is supported by a yoke attached to the lower end of the shock strut piston. Hydraulic steering struts turn the nose wheel, for steering purposes. A self-centering cam turns the nose wheel to a straight forward position as weight is removed from the gear during take-off and before retraction occurs.

The steering control wheel is located on the fuselage wall to the left of the captain. When the steering wheel is turned, cables to the steering wheel control valve actuate the valve and admit full hydraulic system pressure to either the right or left steering strut, turning the nose wheel. When movement of the steering wheel is stopped, follow-up cables automatically return the control, valve to a neutral position. The nose wheel steering pressure accumulator maintains fluid in the steering struts at all times, thereby dampening any tendency of the nose wheel to shimmy. As the steering system hydraulic supply is tapped off the landing gear down line, operation of the steering system is prevented while the gear is retracted.

The nose wheel is limited to a 67-degree turn in either direction front center. A constant, steady pressure should be applied to the steering wheel to turn the nose wheel. Additional pressure applied to the wheel will not result in a greater or more rapid reaction of the nose wheel. However, the nose wheel will not steer when the shock strut is not compressed. During landing, if the steering mechanism will not function, push forward on the control column to bring the nose down more firmly. If the steering system fails, the airplane can be maneuvered by use of the brakes and differential engine power, as the wheel will caster freely when pressure is not being applied.

Steering of the airplane by means of the nose wheel, particularly during a cross-wind take-off, should not be attempted after the airplane exceeds 43 knots ground speed. At high speeds, the weight on the nose wheel is so light that reaction from urning the wheel is negligible, resulting in the nose wheel skidding sidewise on the ground without altering the forward course of the airplane. Under this condition, it may be possible to have the nose wheel turned past the self-centering point at the time of retraction, resulting in incomplete retraction and probable damage to the nose gear mechanism.

6.3. LANDING GEAR SAFETY AND WARNING DEVICES — A landing gear control lever safety switch, mounted on the right main gear shock strut center door, energizes and de-energizes a spring-loaded solenoid at the base of the landing gear control lever on the aft face of the control pedestal. The solenoid, when de-energized, projects a latch across the landing gear control lever quadrant and prevents inadvertent retraction of the landing gear while the airplane is on the ground. When the airplane is airborne and all weight is off the landing gear, the safety switch on the shock strut door closes and energizes the solenoid, which retracts the safety latch pin and permits operation of the landing gear control lever. A finger hole in the face of the control pedestal, adjacent to the landing gear control lever, provides a means of manually releasing the solenoid.

The landing gear control valve assembly contains two valves, one of which is an anti-retraction safety valve that is automatically operated by a cable control from the left shock strut torque links. When the weight of the airplane is on the landing gear, the cable tension is relieved, allowing a slide to close, which prevents fluid from going to the UP line and at the same time opens the UP line to the reservoir, thus preventing the gear retraction mechanism from functioning.

The position of the landing gear is indicated by three green lights (one for each gear) and one red light on the first officer's flight instrument panel. Each of the three green lights is illuminated when its respective gear is down and latched. The red warning light is illuminated when all or one of the gears is in any intermediate position. All of the lights will be out when the gear is up and latched.

When the gear is up and latched or in any intermediate position, and one or more throttles are retarded past the one-quarter-open position, a warning horn will sound and the red warning light will glow. A mirror mounted on the right beam of the nose gear well enables the first officer to see the nose gear downlatch to determine whether the gear is down and latched. A snap-fastened hinged door in the flight compartment floor, on the right side of the control pedestal, permits the first officer to look through a glass window and into the mirror. A light, installed in the nose gear well, is set to shine directly on the downlatch and is controlled by a switch on the forward overhead panel.

White painted "targets" are mounted between the upper flanges of the down-latch pulley arms of the main gear and are only visible through the open cockpit side windows when the main gears are down and latched. If the main gear is down and the targets do not show, the gear is not latched. A focused light for night use is installed in each inboard nacelle and is controlled by a switch on the forward overhead panel. The lights can also be used for general nacelle illumination while on the ground.

The position of the gear can also be checked by means of the drift meter, if installed.

6.4. TAIL SKID — A tail skid, located on the undersurface of the tail section, prevents damage to the airplane structure in the event of a tail-down landing. The tail skid consists of a hinged skid plate supported by an oleo-pneumatic shock strut housed in a telescoping fairing.

7. AUTOMATIC PILOT (SPERRY A-12)

The Sperry A-12 automatic pilot is a gyroscopically controlled, electrically actuated system which automatically operates the flight controls to hold the airplane on any desired magnetic heading and in a normal stabilized attitude. Directional, or yaw, control is maintained by the gyro-stabilized, self-synchronous Gyrosyn compass control, which is a directional gyro "slaved" to the earth's magnetic field by means of the Flux Valve. The Flux Valve picks up or detects this magnetic field and establishes the directional reference. Pitch and bank stabilization is maintained by the vertical gyro control, which is an electrically driven gyro spinning about a vertical axis.

In addition, the system provides constant altitude control, coordinated turn control, and automatic elevator trim tab compensation for changes in weight distribution.

The A-12 automatic pilot system comprises the following components; a Gyrosyn compass control unit and a vertical gyro control unit in the hydraulic accessories compartment; a Flux Valve in the tail cone; an amplifier assembly in the radio rack; a servo control motor generator in the inverter compartment; four control servos in the hydraulic accessories compartment; Gyrosyn compass repeater indicator mounted on the first officer's flight instrument panel; a repeater amplifier in the radio rack; a pedestal controller on the control pedestal;

and an auto pilot engaging control on the lower left aft face of the pedestal. Power is supplied to the A-12 automatic pilot electrical system whenever the first officer's instrument and auto-pilot inverter switch on the forward overhead panel is positioned to either "UPPER" or "LOWER." The A-12 automatic pilot is engaged by means of the pilot switch on the pedestal controller and the clutch lever on the lower aft face of the control pedestal. The system can be disengaged either by turning the pilot switch "OFF," by depressing the emergency electrical disconnect buttons on either aileron control wheel horn, or by the engaging control levers on the lower aft face of the control pedestal. An interlock circuit virtually eliminates the possibility of improper engaging of the A-12 automatic pilot.

The captain's Gyrosyn compass system, including a Flux Valve in the tail cone, a Gyrosyn compass control unit in the hydraulic accessories compartment, a repeater amplifier in the radio rack, and a Gyrosyn compass repeater indicator mounted on the captain's flight instrument panel, is entirely independent of the first officer's Gyrosyn compass and the A-12 automatic pilot system.

For en route trouble shooting of a malfunctioning A-12 automatic pilot system, refer to Section VI, Emergency Procedures and Trouble Shooting.

7.1. THEORETICAL OPERATION OF A-12 AUTOMATIC PILOT SYSTEM — The entire principle of automatic flight is based on the simple characteristic of a gyro's inertia, being used to maintain an erect position that gives a reference point for current (signal) comparison. As the gyro is universally mounted within its case or frame and the case is secured to the airplane's structure, the case will change its position relative to the gyro as the airplane attitude changes from the norm. Each gyro unit includes a flight Synchro composed of a stator attached to the case of the gyro and in which the flight signal originates, and a rotor attached to the gimbal ring of the spinning gyro itself. It is the comparison of the voltages induced between the rotor and stator that determines whether the gyro will send a corrective signal to the servo unit.

As an example, take the vertical gyro: When the airplane assumes a level lateral attitude, the position of the stator with respect to the rotor is such that voltage in the stator is zero, and no corrective signals are transmitted. As the airplane starts to assume an attitude away from the level, due to transients, the stator rotates with respect to the rotor and away from the zero-voltage point, producing an in-phase or out-of-phase voltage, depending on which way the rotation occurs.

The sensing of this phase difference is accomplished in the servo amplifier in the radio rack by comparing the phase of the flight signal to the constant phase of the Gyropilot power supply. The flight signal from the vertical gyro is then sent from the amplifier to the servo control, which is, in effect, a motor generator which merely serves to boost the signal strength, and from there to the respective servo unit; in this case the aileron servo.

However, as the servo itself starts to rotate, it, in turn, creates a repeatback signal (sometimes called a followup signal) which is proportionate to the amount of control surface displacement. The purpose of this delayed repeatback signal is merely to allow a high initial signal from the servo control to overcome servo inertia and to enable the servo to determine how much it must move, after which the repeatback signal acts to damp the gyro signal to provide a smoother reaction and also to ensure the return of the control surfaces to their original positions despite control system friction.

Other signals from the pedestal controller may be superimposed upon the original signal for manual control and adjustments.

7.2. A-12 GYROSYN COMPASS CONTROL SYSTEM — Directional control of the airplane is established by the Flux Valve and the Gyrosyn compass control. The Flux Valve electrically detects the direction of the lines of force which make up the earth's magnetic field. The Gyrosyn compass control unit is "slaved" to the direction set up by the Flux Valve and establishes the directional reference for the Gyrosyn compass repeater indicator on the first officer's flight instrument panel and for the automatic pilot. The Gyrosyn compass control has no northerly turning error, thus eliminating drift and requiring no resetting. Indications are deadbeat, without oscillation or swinging.

The gyro in the Gyrosyn compass control spins about a horizontal axis, maintained by an erection control switch and a leveling torque motor. The gyro is erected automatically when power is supplied to the automatic pilot system; approximately two minutes are required to bring the gyro to the proper operating attitude.

In some installations, a repeater indicator is provided for the radio operator or navigator, which duplicates the readings of the first officer's indicator with a minimum margin of error.

7.3. A-12 VERTICAL GYRO CONTROL — The vertical gyro control, located in the hydraulic accessories compartment, is an electric gyro spinning about a vertical axis, and contains two Synchros to detect movements of the airplane about the roll and pitch axes. The gyro is maintained in a vertical position by an erection system, similar to that in the Gyrosyn compass control, which automatically erects the gyro when power is supplied to the A-12 automatic pilot system. Approximately two minutes are required for the gyro to come up to speed and complete the erection process after power is supplied to the system.

7.4. A-12 CONSTANT ALTITUDE CONTROL — The constant altitude control unit, located in the amplifier assembly in the radio rack, maintains the airplane at any desired barometric pressure altitude as long as desired. In addition to level flight usage, the constant altitude control unit may be turned on during a climb or descent and the airplane will level off and hold altitude within the limits of the altitude control (6 degrees). Altitude will continue to be maintained during turns with the unit in operation. When traffic control conditions require it, the control can be used to hold to a specified altitude at any time during the descent or ascent operation. The altitude control is placed in operation by turning the altitude control switch on the pedestal controller to the “ON” position. An interlock system prevents operation of the altitude control switch if the servos are not engaged with the flight control systems.

7.5. A-12 ELEVATOR TRIM TAB CONTROL — The elevator trim tab servo in the hydraulic accessories compartment constantly maintains trim about the pitch axis by operating the elevator trim tab controls on long-sustained signals caused by out-of-balance conditions. Therefore, en route movement of passengers and crew members, the decrease of fuel weight through consumption, and power changes are constantly corrected automatically, ensuring in-trim operation at all times. The servo only operates when a sustained signal in the elevator control circuit indicates an out-of-trim condition.

7.6. A-12 PEDESTAL CONTROLLER — The A-12 pedestal controller unit, recessed into the top of the control pedestal, provides a means of maneuvering the airplane while the automatic pilot is engaged.

Figure 36 — Sperry A-12 Pedestal Controller

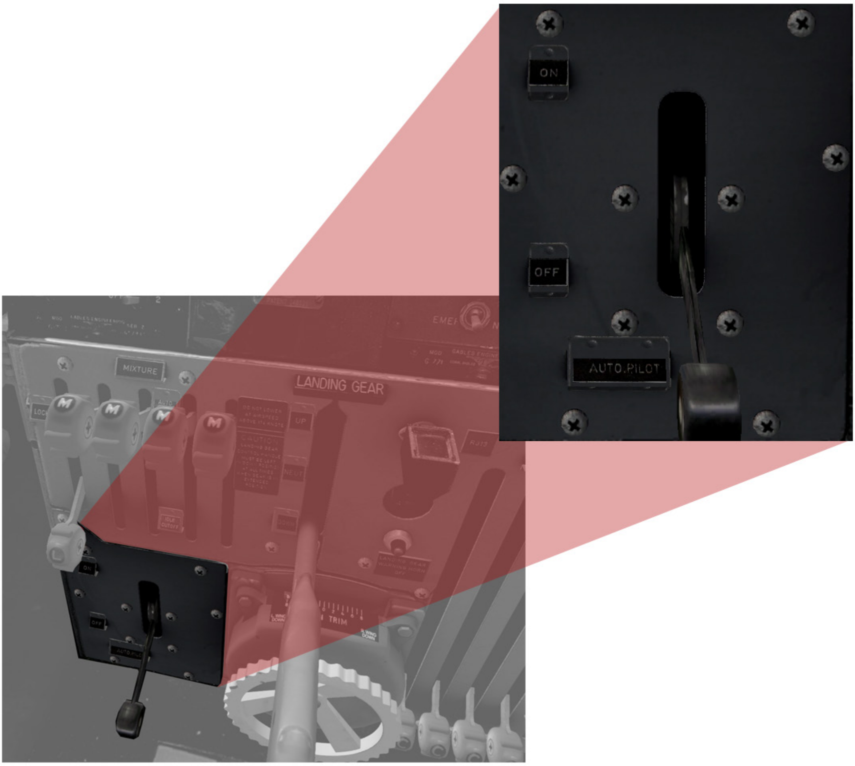


Figure 37 — Sperry A-12 Automatic Pilot Mechanical Disconnect Lever

The airplane is controlled in pitch attitude by means of either of the two pitch control knobs flanking the center turn control knob. Rotating the pitch control knobs toward the nose of the airplane results in a nose-down attitude; rotating the knobs aft, away from the nose, produces a nose-up attitude.

The pitch control knobs do not need to be centered when engaging the A-12 automatic pilot with the flight control system. *The pitch control knobs are inoperative when the altitude control switch is* "ON."

The turn control knob, located on the top of the pedestal controller, produces coordinated turns of the airplane at any airspeed. The turn control knob must be in the centered position — marked by a detent and by a white fore-and-aft line — before engaging the automatic pilot. If the knob is not centered in the detent position, the pilot switch cannot be turned "ON" and consequently the automatic pilot cannot be put into operation. A bank integrator unit is incorporated in the amplifier unit to ensure smooth banking and to compensate for abrupt movement or overcontrolling of the turn control knob.

The attitude of the airplane about the roll axis is controlled by the aileron trim control knob on the aft face of the pedestal controller. Turning the knob toward the high wing will bring the airplane to a level attitude, the magnitude of reaction being proportional to the amount of knob rotation and limited to eight degrees wing bank in either direction.

The pilot switch, mounted on the aft face of the pedestal controller, provides a means of controlling power to the units of the A-12 automatic pilot system. An interlock system prevents the pilot switch from moving to the "ON" position if any one of the following conditions exists:

- All other units of the A-12 automatic pilot system are not correctly positioned.
- The airplane's a-c and d-c power supplies exceed or fall below operating limits.
- A-c power is not on for a minimum of two minutes (to allow gyros to come up to speed).
- Servo handles are not in the "DISENGAGE" position.
- The turn control knob is not in the detent position.
- The electrical release buttons on the aileron control wheel horns are not in the normal OUT position.

Three signal meters mounted on the aft face of the pedestal controller provide visual indication of A-12 automatic pilot signals in each axis. A constant deflection of the indicator needle in any axis shows that the automatic pilot is correcting an out-of-trim condition. It is not necessary that the indicators be exactly centered, although a divergence of greater than one-point width indicates an excessive out-of-trim condition and should be corrected by retrimming in that axis. The elevator, "EL," axis is automatically trimmed by the elevator trim tab servo; the aileron, "AIL," and the rudder, "RUD," axes should be retrimmed by operating the respective trim tab with the automatic pilot engaged until the pointers are aligned with the indices. In the event of an engine failure, the automatic pilot will hold the airplane substantially to its course, but the "RUD" and "AIL" meters will indicate an outof- trim condition. Retrim the airplane until the "RUD" and "AIL" meters are again centered.

7.7. A-12 SERVO ENGAGING CONTROL — The servo, or mechanical, engaging control consists of a lever located on the lower aft face of the control pedestal, and mechanically connects the rudder, aileron and elevator trim tab servos with the control surface cable systems. The lever has two positions: "ENGAGE" (up) and "DISENGAGE" (down). The lever mechanism is so constructed that no intermediate position is possible; an off-center toggle mechanism holds the lever in either the up or down position, thus eliminating the possibility of the lever being left in any intermediate position.

An electrical interlock system prevents turning the A-12 pilot switch "ON" when the servo lever is in the "ENGAGE" position.

7.8. ELECTRICAL RELEASE BUTTONS — The electrical release push buttons, one located on the outboard horn of each aileron control wheel, provide a means of instantly disengaging the automatic pilot electrically. When either button is depressed, both the pilot and the altitude control switches will automatically return to the "OFF" positions.

However, when the automatic pilot is disengaged in this manner, it will be necessary for the pilot to overpower the servo friction, which has a tendency to produce unnatural forces on the flight controls.

7.9. A-12 AUTOMATIC APPROACH EQUIPMENT — The Sperry A-12 automatic approach equipment consists of an approach amplifier in the radio rack and a three-position switch and approach- ready light on the top face of the pedestal controller. The equipment operates in conjunction with the localizer and glide path receivers to provide automatic approach under low ceiling and visibility conditions.

The approach amplifier interprets the electrical signals from the localizer and glide path receivers and applies them to the servo operating circuits in the Gyropilot amplifier. The signals used are the same as those applied to the instrument landing cross-pointer indicators (ILS) on the captain's and first officer's flight instrument panels, which give visual indication of the position of the airplane relative to the localizer and glide path beams.

The three-position switch provides the following operations: "GYROPILOT," used for normal automatic flight; "LOCALIZER," used to permit automatic yaw correction on the localizer beam; and "APPROACH," used to make the final letdown. The approach-ready light indicates that the power has been supplied to the automatic approach control and that the Gyropilot has been turned on electrically.

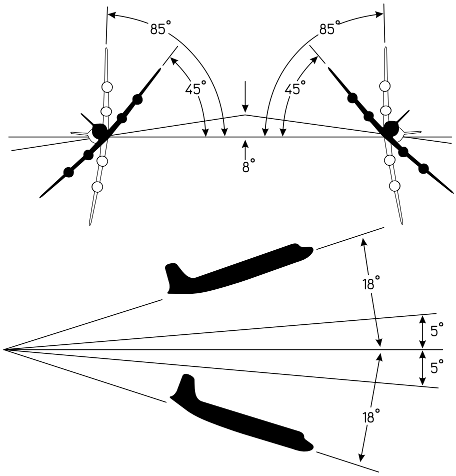
The approach equipment is disengaged simultaneously with the Gyropilot by pressing the electrical release button on either aileron control wheel horn or by returning the pilot switch to the "OFF" position.

When passing over the localizer transmitter or changing Nav frequencies, it is desirable to disengage Beam Coupler control to avoid erratic control action. Radio Beam Coupler control is disengaged by disengaging A-12 control or by returning the Selector Switch to the "GYROPILOT" position.

7.10. A-12 ELECTRICAL RELEASE LIGHT — A lamp marked "ELECTRICAL RELEASE," located on the top face of the pedestal controller, gives visual indication when the automatic pilot has been disengaged by means of the electrical release buttons or pilot switch while the servos are still engaged. The light goes out when the clutch is disengaged.

7.11. DELETED.

7.12. A-12 AUTOMATIC PILOT OPERATING LIMITS — Figure 38 graphically shows the operating limits of the A-12 automatic pilot. (The applied forces of the automatic pilot to the flight control system and the overpowering forces necessary may require quick action by a member of the flight crew.)



OPERATING LIMITS

All specifications given are maximum, and are measured from the normal level flight reference position.

ON GYROPILOT	
BANK	45 degrees in either direction
CLIMB and DESCENT	18 degrees
ALTITUDE CONTROL	5 degrees (approx)
AILERON TRIM	8 degrees wing bank in either direction
ON MANUAL CONTROL	
GYRO TILT .... (Vertical Gyro Control and Gyrosyn Compass Control)	85 degrees in either direction from operating level position before hitting stops. (This applies also when the Gyropilot is engaged.)

Figure 38 — Automatic Pilot Operating Limits (Sperry A-12)

7.13. A-12 AUTOMATIC PILOT OPERATION — During the preflight check, the following system operation check-out should be performed. A two-minute waiting period must be observed after a-c power is supplied to the automatic pilot before turning the pilot switch “ON” or operating any of the controls to allow the gyros to attain an erect position. Until the gyros are erect, the pilot switch is locked in the “OFF” position.

7.13.1. Before Starting A-12 Automatic Pilot

(1) Pilot switch — "OFF."

(2) Altitude control switch — "OFF."

(3) Turn control knob in center (detent) position.

(4) Aileron trim control knob centered.

(5) Automatic approach controller — "GYROPILOT."

(6) Servo engage handles — "DISENGAGE."

7.13.2. After Starting A-12 Automatic Pilot

(1) Pilot switch — "ON."

(2) With the airplane's a-c power supply ON, note that the three signal indicator meter pointers are approximately centered and stationary.

(3) Servo engage handles — "ENGAGE."

7.13.3. After Starting A-12 Automatic Pilot

(1) Disengage gust lock for surface controls.

(2) Rotate the pitch knob on the pedestal controller fore or aft, approximately 25 per cent of the cockpit control movement, to simulate ascent and descent. The control column should move in the corresponding direction.

(3) Rotate the aileron knob to the left and right, approximately 25 per cent of the cockpit control movement. The control wheel should move ac cordingly.

(4) Rotate the turn control knob to the left and right of the detent position sufficiently to allow the control surfaces to start moving (about five de grees) and return to the center position. The rudder pedals and control wheel should move correspondingly. When checking the turn charac teristics of the automatic pilot, it is necessary to manually hold the control wheel to cushion its movements to the limit stops.

(5) Turn the altitude control switch to the "ON" position — little or no movement of the control column should occur.

(6) Push the electrical release button. The pilot and altitude control switches should automatically snap to the "OFF" positions and lock.

(7) Manually operate the flight controls to ascertain freedom of movement. (More friction will be evident while servo engage handles are "ENGAGED.")

(8) The blue approach-ready light should be on.

(9) Return the servo engage handles to "DISENGAGE," and again check for freedom and full movement of all control surfaces.

7.13.4. Before Take-Off, A-12 Automatic Pilot

(1) Servo control handle — "DISENGAGE.

(2) Pilot switch — either "ON" or "OFF."

7.13.5. Engaging A-12 Automatic Pilot in Flight — The Gyropilot may be engaged during any normal straight or level Eight, and during any normal straight climb or descent within the operating limits of the equipment (see Figure 38).

(1) Trim the airplane.

(2) Pilot switch — "ON." it is' not necessary to pre-align the Gyropilot manually before engaging.

(3) Servo-engage lever — "ENGAGE."

(4) Altitude control switch — "ON" to maintain a specified altitude (if desired). However, the airplane cannot be made to change vertical attitude until the switch is turned "OFF."

(5) Aileron trim knob — rotate to left or right, as necessary, for trimming purposes while under Gyropilot control and when the airplane is not level about its roll axis. In the event of failure of one engine during automatic flight, manually trim the airplane until the "RUD" meter on the pedestal controller unit is in a zero, or center, position to ensure correct trim for a smooth switch-over from automatic to manual control.

7.13.6. Maneuvering A-12 Automatic Pilot in Flight.

(1) To descend or climb — rotate the pitch knob forward or aft.

(2) To turn — rotate the turn knob in the direction of the desired turn.

(3) To execute a climbing or descending turn — rotate the pitch and turn knobs simultaneously in the direction desired.

(4) To resume straight and level flight — return the knob to center position and rotate the pitch knob until airplane is in level light position.

7.13.7. Disengaging A-12 Automatic Pilot During Flight

(1) To disengage — move the servo engage levers to "DISENGAGE." If the altitude switch is "ON," it will automatically return to the "OFF" position and lock. Or, push the electric release button on either aileron control wheel horn. Pressing the button will automatically turn the pilot and altitude control switches "OFF" and lock them in that position. The Gyrosyn compass indicators continue to give indication when the Gyro pilot is disengaged.

8. INSTRUMENT SYSTEMS

The main instrument panel is located in front of the captain and the first officer and extends the full width of the light compartment: the left section is the captain's flight instrument panel; the right section is the first officer's flight instrument panel; and the center portion is the engine instrument panel, left and right sections. The upper panel, flanked on the left and right by the heater control and cabin supercharger panels, is in the ceiling of the cockpit, directly above and aft of the windshield V. The forward and aft overhead panels are aft of the upper instrument panel. The hydraulic and oxygen instrument panels are forward and outboard of the first officer. The instrument panels are constructed of non-magnetic materials that will not affect the operation of the magnetic compass. All the instrument panels, with the exception of the hydraulic and oxygen instrument panels, are secured to the fuselage structure through vibration-absorbing units and are quickly removable. All instruments are placed with regard to grouping of related systems. In general, the flight and navigation instruments are electrically operated; however, in some installations the flight and navigation instruments are vacuum or pitot-static operated and are marked "AIR DRIVEN." The engine and miscellaneous instruments are actuated by pressure and by impulses transmitted electrically or through fluid medium. Most of the electrical indicating systems consist of a transmitter and an indicator acting as a receiving unit for the transmitter. Essentially, this system is an electrical method of transmitting mechanical measurements to a point remote from the place of measurement, thus reducing fire hazards and mechanical difficulties.

The fuel flowmeter transmitters are individually calibrated. Calibration cards for the transmitters are supplied with each airplane and should be kept with their individual transmitters in the radio rack.

All instruments are subject to certain error of indication as a result of calibration and scale. It must be remembered that in the case of dual instruments, one instrument may be at its plus tolerance while the other is at its minus tolerance.

8.1. INSTRUMENT LIMIT MARKINGS — A four-color system for designating approved operating ranges and limits has been generally established to facilitate the proper cruising operation of aircraft. The colors used and their meanings are as follows (see Figure 41):

Green arc	Normal operating range
Red radial line	Maximum or minimum limits
Yellow arc	Cautionary range
White arc	Index mark on flap operating range

8.2. PITOT SYSTEM — A dual pitot system supplies the ram air pressure necessary for the operation of the captain's and first officer's airspeed indicators on the captain's and first officer's flight instrument panels. The pitot systems are entirely separate, each consisting of a pitot tube in the nose of the airplane and the necessary lines to the respective instrument panel. The left pitot tube supplies ram air for the captain's airspeed indicator, and the right tube supplies ram air for the first officer's airspeed indicator. Each pitot head may be heated by an electric element controlled by the pitot heater switch in the forward overhead panel.

8.3. STATIC SYSTEM — A dual or a common static system is installed to supply the static air pressure necessary for operation of the airspeed, rate-of-climb, and altimeter indicators in the captain's and first officer's flight instrument panels, and also for operation of the automatic pilot constant-altitude control unit.

A second ice-free static source is located inside the fuselage at station 985, aft of the pressure dome. Two valves, one outboard of the captain and one outboard of the first officer, permit selection of the alternative source in case of icing or malfunctioning of the main static source. A momentary variation in instrument reading will be noticed when the static source is changed.

The common static system consists of two static vents, one on each side of the nose section and forward of the windshield, a common, drain and equalizer manifold, and a drain valve in the nose wheel well. Lines are routed from the equalizer manifold to the static source selector valves outboard of the captain and the first officer. The common drain and equalizer manifold balances the static pressure from the two vents and also serves as a water trap. From the trap, a line is routed to the static drain valve on the left side of the nose wheel well tunnel. The drain valve knob should be depressed daily to drain the static lines and manifold.

The dual static system consists of four static vents, two on each side of the nose section, forward of the windshield, and two drain and equalizer manifolds and two drain valves in the nose wheel well. A line from the aft manifold is routed to the captain's instruments through the static source selector valve outboard of the captain's seat. A line from the forward manifold is routed to the first officer's instruments through the static selector valve outboard of the first officer's seat. Therefore, in this installation, icing or malfunctioning of one static source will only affect one set of instruments. Either set of instruments can be operated from the alternative static source independently. A drain valve for each manifold is provided on the left side of the nose wheel well tunnel, and it should be drained daily to prevent excessive accumulation of moisture and water.

8.3.1. Airspeed Indicators — Two standard airspeed indicators are installed, one in the captain's flight instrument panel and one in the first officer's. The air speed indicators operate from both the pitot (ram) system and the static (atmospheric) system.

8.4. VACUUM SYSTEMS (If Installed) — A vacuum system is installed in some airplanes to provide the negative pressure required to operate turn-and-bank, gyro horizon, and directional gyro instruments. Two vacuum pumps, one installed in each inboard engine, supply the negative pressure; lines from the pumps are routed through vacuum relief valves, which maintain a constant pressure.

FUEL PRESSURE INDICATOR
Red radial at 16 PSI
Green Arc from 22 PSI to 24 PSI
Red Radial at 25.5 PSI

HYDRAULIC PRESSURE GAUGE
Red radial at 3200 PSI
Green arc from 2600 PSI to 3100 PSI

OIL PRESSURE INDICATOR
Red radial at 50 PSI
Green arc from 75 PSI to 95 PSI
Red radial at 110 PSI

CABIN SUPERCHARGER GEARBOX OIL PRESSURE INDICATOR
Red radial at 30 PSI
Red radial at 120 PSI

MANIFOLD PRESSURE GAUGE
Red radial to 55 in. Hg.
Green arc from 20 in. Hg. to 46 in. Hg.
Yellow arc from 46 in. Hg. to 55 in. Hg.
Long red radial at 59.5 in. Hg.

W / A PRESSURE GAUGE
Red arc from 21 to 32
Green arc from 21 to 23

Figure 41 (Sheet 1 of 4 Sheets) — Instrument Limit Markings

WING ANTI-ICING HEATER AIR TEMPERATURE INDICATOR
Red radial at 210°C

CABIN HEATER AIR TEMPERATURE INDICATOR
Red radial at 200°C

TAIL ANTI-ICE HEATER AIR TEMP. INDICATOR
Red radial at 210°C

OIL TEMPERATURE INDICATOR
Red radial at 40°C
Green arc from 60°C to 75°C
Red radial at 100°C

CARBURETOR AIR TEMPERATURE INDICATOR
Red radial at +38°C
Yellow arc from -10°C to +15°C
Green arc from +15°C to +38°C

ENGINE CYLINDER-HEAD TEMPERATURE INDICATOR
Red radial at 260°C
Green arc from 170°C to 210°C

Figure 41 (Sheet 2 of 4 Sheets) — Instrument Limit Markings

TACHOMETER INDICATOR
Red radial at 2800 rpm
Green arc from 1600 rpm to 2600 rpm

CABIN SUPERCHARGER GEAR BOX OIL TEMPERATURE INDICATOR
Red radial at 100°C
Yellow radial at 15°C

Figure 41 (Sheet 3 of 4 Sheets) — Instrument Limit Markings

AIRSPEED INDICATOR
(for 93,200 pound airplane)
0 degrees take-off flaps or water/alcohol injection for take-off

Red radial at 312 KIAS
Green arc from 110 to 260 KIAS
Yellow arc from 260 to 312 KIAS
White arc from 81 to 147 KIAS

Maximum Take-off Gross Weight	Lower Limit of Green Arc KIAS
87,900	105
97.200	111

White Arc:

Maximum Landing Gross Weight (pounds)	Upper Limit (KIAS)	Lower Limit (KIAS)
73,000	139	75
75,000	139	76
78,000	143	78
80,000	145	79

The Red Radial limit and upper limit of green arc IV, and V respectively) must be reduced at altitude.

Reduce V1 5 knots per each 1,000 feet above “A” feet.
Reduce V1 5 knots per each 1,000 feet above “B” feet.

For this airplane, which is subsequent to serial number 42901 —

A is 10,000 feet.   B is 15,000 feet.

Figure 41 (Sheet 4 of 5 Sheets) — Instrument Limit Markings

Airspeed indicators are to be marked in accordance with the maximum gross take-oft weight tor which the airplane is certified. An example of the manner of marking is given for a 93,200 pound airplane. The red radial, yellow, green, and white arcs for airplanes of different maximum take-off gross weights should be computed from the following information: (The speeds given below are knots TIAS).

Red Radial: The red radial should be marked at 312 knots on all airplanes except on those airplanes that are being operated at 70,000 pounds zero fuel gross weight. Airplanes within the above exception should be red lined at 298 knots.

Yellow Arc: The yellow arc should be marked between 260 and 312 knots on all airplanes except on those airplanes that are being operated at 70,000 pounds zero fuel gross weight. Airplanes within the above exception should have theyellow arc marked between 249 and 298 knots. Airplanes that are operated at 68,000 pounds zero fuel gross weight should have the yellow arc marked between 260 and 312 knots.

Green Arc: Upper limit — The upper limit of the green arc is 260 knots on all airplanes except on those airplanes that are being operated at 70,000 pounds zero fuel gross weight. Airplanes within the above exception should have the upper limit of the green arc marked at 249 knots. Airplanes that are operated at 68,000 pounds zero fuel gross weight should have the upper limit of the green arc marked at 260 knots.

Lower Limit — The lower limit of the green arc is determined by the maximum take-off gross weight of the airplane. Values are given below for the two extreme limits of maximum take-off gross weights for which DC-6 airplanes are certified. The lower limit of the green arc can be determined by assuming a straight line variation between the two limits given.

Figure 41 (Sheet 5 of 5 Sheets) — Instrument Limit Markings

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9. ELECTRICAL SYSTEM

The DC-6 basic 24 to 28 volt electrical system is a single-wire type, in which the airplane's structure is used for the ground return, except in the vicinity of the magnetic compass, where a two-wire system is used to prevent magnetic interference. D-c power is delivered to a main electrical bus system by four engine driven generators, wired in parallel, and by two 12-volt batteries connected in series. An external receptacle permits the introduction of power from a ground source into the main bus when the engines are inoperative. Each generator is connected to the main electrical bus system by individual cables through protective devices. A-c power is supplied by two rotary-type inverters, either of which is capable of supplying the entire 115-volt, 400-cycle a-c load for instrument and electronic equipment operation. An emergency inverter is installed in some airplanes to supply a-c power to the flight instruments only in the event of failure of the two main inverters. A fourth inverter, a vibrator type razor inverter, supplies 110-volt, 60-cycle current to the lounge outlets, which are so designed that the inverter is automatically turned on whenever a cord is plugged in.

As schematically shown in Figure 43, power output from the four generators is delivered to a main distribution line, or main bus, located in the main junction box installed in the flight compartment ceiling, aft of the flight compartment door. The main bus, in turn, delivers power to five secondary buses, which deliver power to the various operating units and systems. Each bus, with the exception of the emergency circuit bus, is protected individually by Burndy current limiters. In most cases, all circuit protectors—fuses, current limiters, and circuit breakers—are located in the main junction box or on the main circuit breaker panel. The generator bus system is so designed that if a short occurs in one or more generator supply lines, the faulty generator system will be automatically disconnected from the main distribution bus.

The importance of the electrical system in the DC-6 airplane must not be underrated, as all electronic and navigational equipment, all engine instruments, and practically all flight instruments depend solely on the electrical system for operation.

For en route trouble shooting and emergency operation of the electrical system, refer to Section VI, Trouble Shooting and Emergency Procedures.

9.1. D-C POWER SUPPLY - GENERATORS — Primary power for the electrical system is supplied by four engine-driven generators, each capable of delivering 300 amperes at 28 volts d-c, at normal temperatures, or 350 amperes at zero degree centigrade temperature. Each generator is capable of supplying, alone, sufficient power for flight necessities, provided all instruments and equipment ***not*** essential to flight are turned off. However, the total generator capacity versus the average total demand of the electrical system is such that, generally speaking, normal operation can be maintained on two generators. Each generator is connected to the main bus through a reverse-current relay.

9.1.1. Voltage Regulators — Voltage control is achieved by four carbon-pile type voltage regulators installed in the main junction box annex; the regulators maintain a constant voltage of 28 (± ½) volts output from each generator, after the generator has cut into the electrical system, regardless of engine rpm or electrical system loads.

When two or more generators are operated in parallel, the voltage regulators assist each generator in assuming its proportional share of the total load by reducing the voltage of the generators carrying the most current load and increasing the voltage of the generators carrying the least current load. This equalizer circuit is wired into the generator on-off switch and is connected to a reverse-current relay. This disconnects the equalizer circuit from any generator that is turned off or has been disconnected by the reverse current relay if voltage drops below bus voltage. Thus, the remaining paralleled generators assume the load without compensating for the inoperative generator.

The voltage regulators in the main junction box annex are cooled by a normal and/or an auxiliary ventilating blower, both, of which are mounted in the inverter compartment, and both of which exhaust into the fuselage side tunnel. The normal blower is automatically turned on when any of the inverter switches on the forward overhead panel are positioned to either inverter; the auxiliary blower is turned on when any of the inverter switches on the forward overhead panel are positioned to either inverter. If the normal blower fails to maintain an adequate temperature in the voltage regulator compartment, a warning light, mounted adjacent to the engine instrument inverter switch, will illuminate, indicating a voltage regulator overheat warning. If operation of both the blowers is not sufficient to lower the temperature and cause the warning light to go out, the inverter compartment door can be opened to allow greater air circulation.

9.1.2. Reverse-Current Relays — Four differential reverse-current relays, mounted in the main junction box, connect the generators in parallel to the main bus system and serve the following purposes:

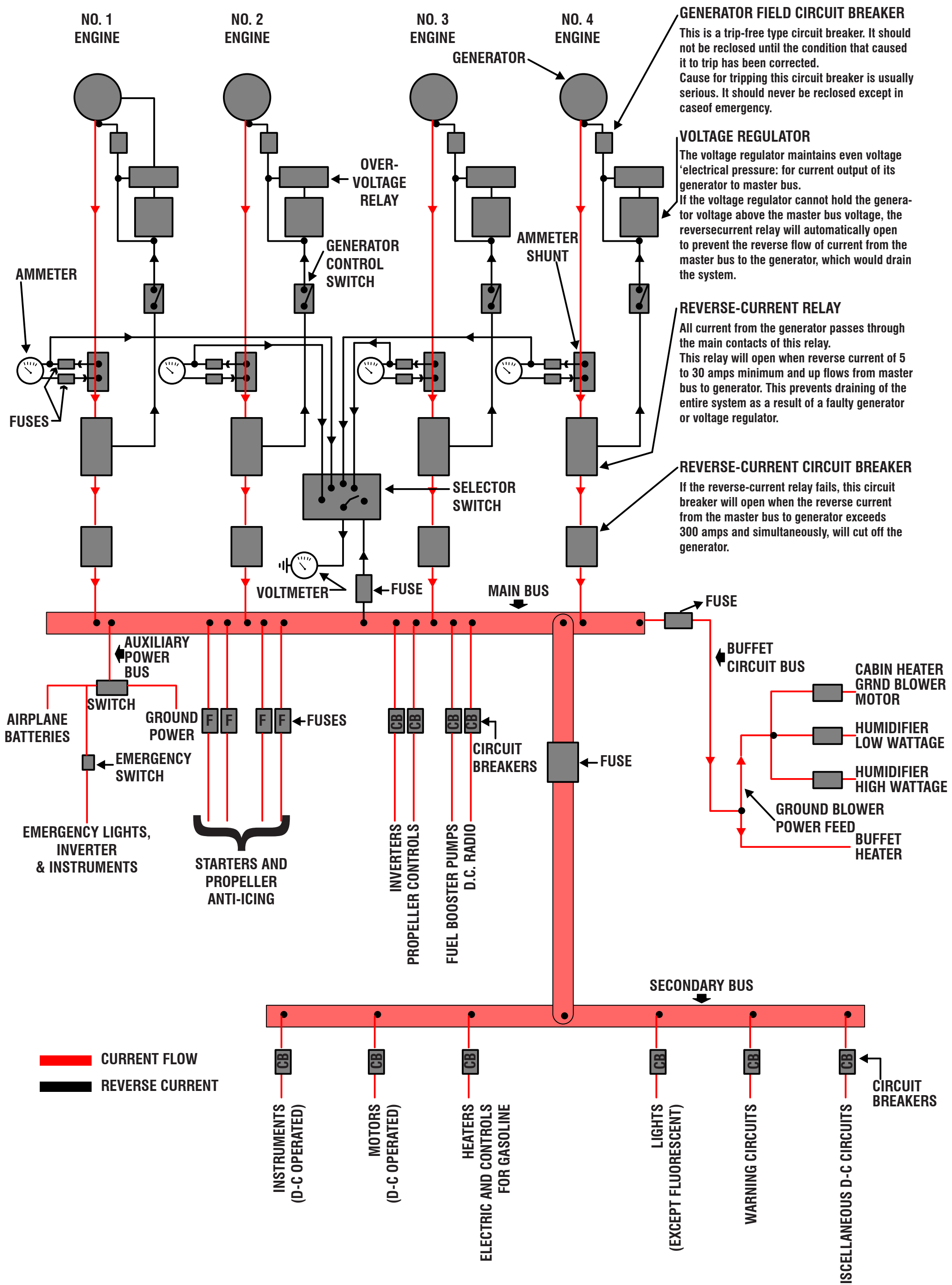
> To connect the generator to the main bus system when the generator voltage exceeds that of the system or battery voltage by 0.3 to 0.6 volt.
>
> To automatically disconnect the generator from the main electrical system, when the voltage differential is sufficient to cause reverse-current flow of 15 to 35 amperes toward the generator.

9.1.3. Generator Switches and Circuit Breakers — Each of the four generators is connected or disconnected from the main bus system by means of the generator on-off switches on the forward overhead panel. The switches actuate the pilot relay in the reverse-current relays which are in the positive lead from each generator and also disconnect the corresponding voltage regulator from the paralleling bus. Each switch should be turned "ON" after the respective engine has been started. If an engine is started without an external power source (using only the airplane's batteries), the generator switch for the engine first started should be turned "ON" after the start, and after the engine has warmed up sufficiently, the engine should be run up to a minimum of 1200 rpm to generate sufficient power to start the remaining engines.

Four generator field circuit breakers, one for each generator, are located on the main circuit breaker panel. Each circuit breaker has a continuous rating of 15 amperes and will trip under a load of 18 or 19 amperes, thereby disconnecting the generator in the event of excessive field current flow.

In the generator system, four reverse-current air circuit breakers, in addition to the reverse-current relays, are installed in the main junction box to disconnect a generator system when a heavy surge of reverse current flows in the circuit and the reverse-current relay fails to open. A time delay prevents operation of this circuit breaker under normal conditions that can be handled by the differential reverse-current relay. The air circuit breaker also incorporates a switch which opens whenever the circuit breaker trips and de-energizes the generator field, Indication that the circuit breaker has been tripped is provided by a yellow dot which appears in a window adjacent to the name plate. The circuit breaker must be reset manually by pushing on the flexible rubber cover.

In the Eclipse generator system, the circuits are protected by four over-voltage



GENERATOR FIELD CIRCUIT BREAKER

This is a trip-free type circuit breaker. It should not be reclosed until the condition that caused it to trip has been corrected.
Cause for tripping this circuit breaker is usually serious. It should never be reclosed except in caseof emergency.

VOLTAGE REGULATOR

The voltage regulator maintains even voltage ‘electrical pressure: for current output of its generator to master bus.
If the voltage regulator cannot hold the generator voltage above the master bus voltage, the reversecurrent relay will automatically open to prevent the reverse flow of current from the master bus to the generator, which would drain the system.

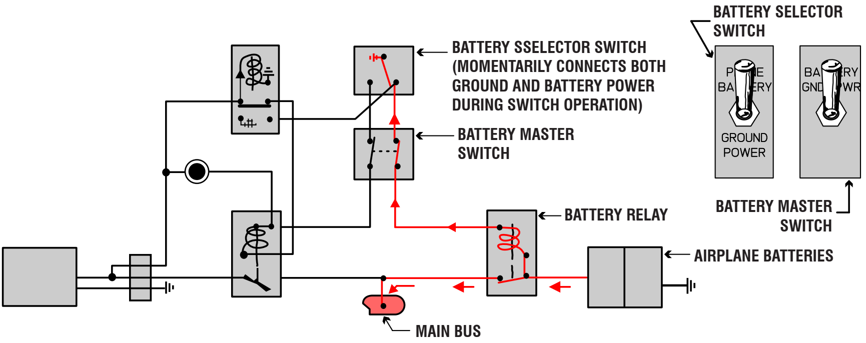
REVERSE-CURRENT RELAY

All current from the generator passes through the main contacts of this relay.
This relay will open when reverse current of 5 to 30 amps minimum and up flows from master bus to generator. This prevents draining of the entire system as a result of a faulty generator or voltage regulator.

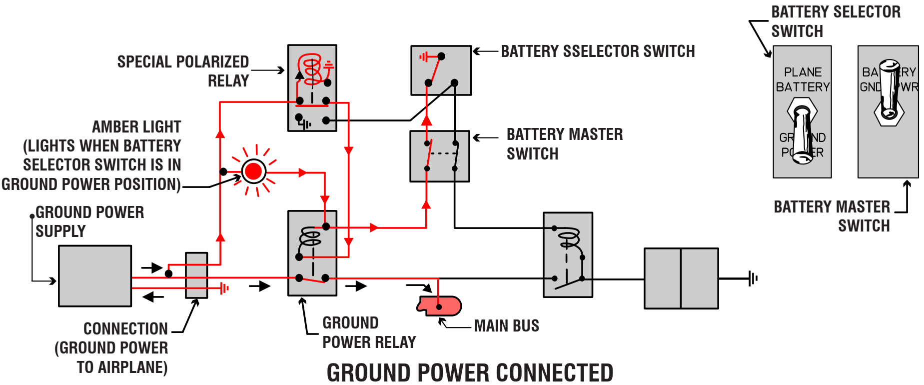
REVERSE-CURRENT CIRCUIT BREAKER

If the reverse-current relay fails, this circuit breaker will open when the reverse current from the master bus to generator exceeds 300 amps and simultaneously, will cut off the generator.

Figure 43 — Main Power Distribution Schematic

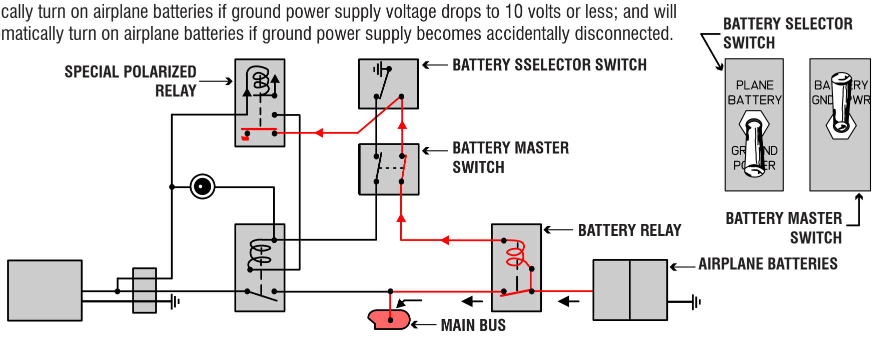


AIRPLANE BATTERIES CONNECTED



GROUND POWER CONNECTED

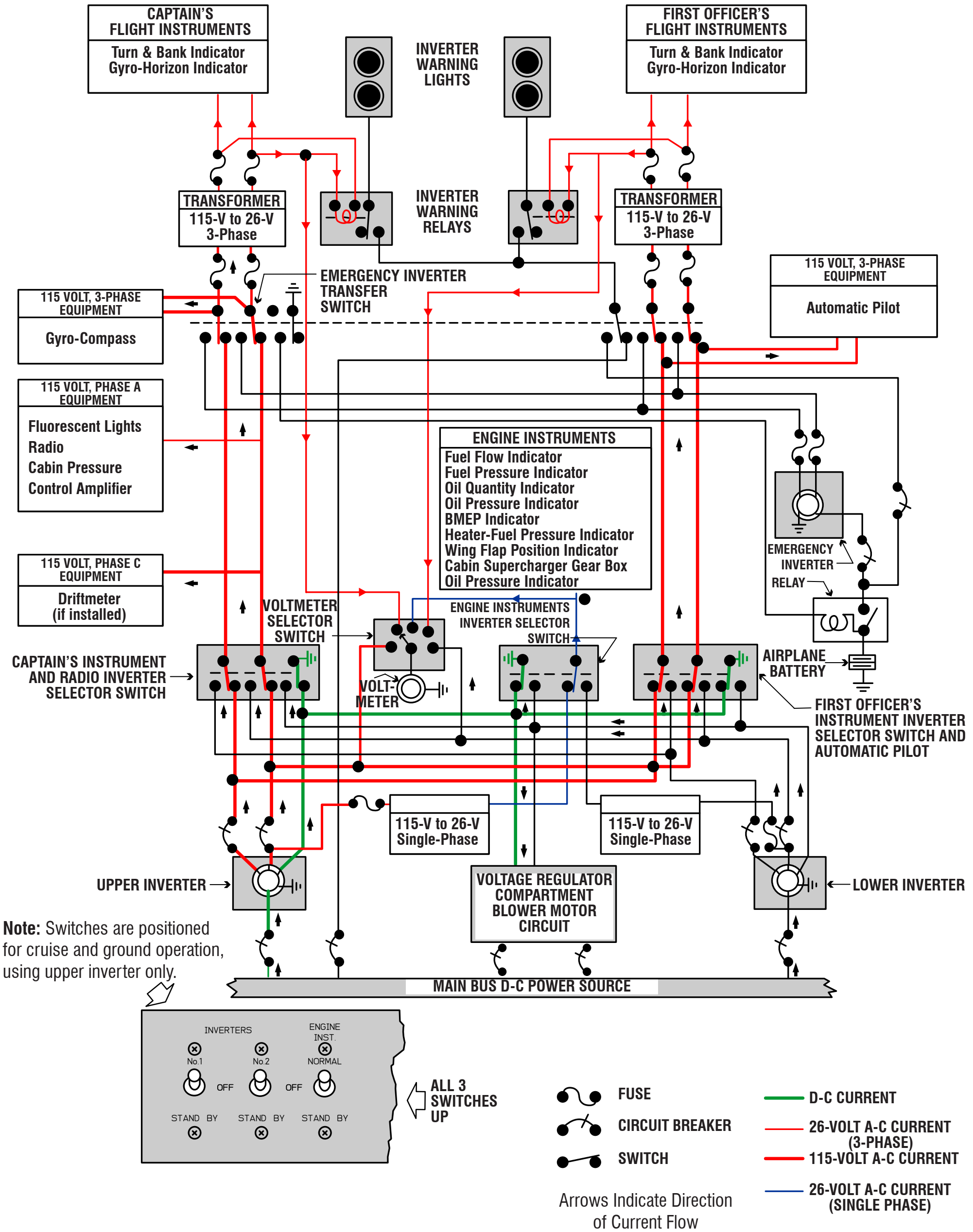
The special polarized relay will not permit ground power relay to close if polarity of ground power unit is reversed; will automatically turn on airplane batteries if ground power supply voltage drops to 10 volts or less; and will automatically turn on airplane batteries if ground power supply becomes accidentally disconnected.



GROUND POWER FAILURE — AIRPLANE BATTERIES CONNECTED

If ground power supply fails, the special polarized relay will transfer auxiliary power source to airplane batteries. This will occur when battery selector switch is in ground power position.

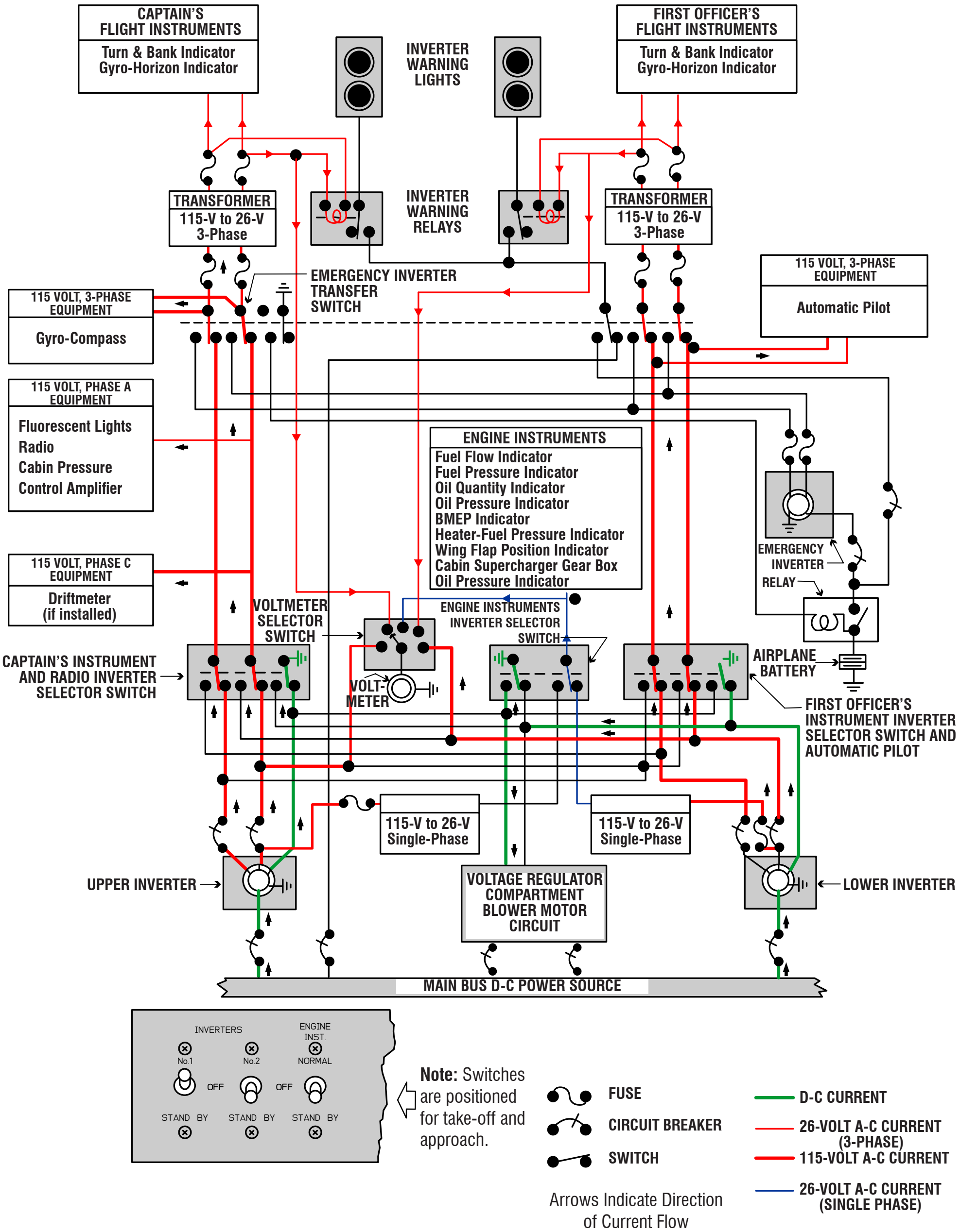
Figure 45 — Auxiliary Power Supply Schematic



Note: Switches are positioned for cruise and ground operation, using upper inverter only.

Arrows Indicate Direction of Current Flow

Figure 46 — A-C Power Supply System (Cruise and Ground Operation Condition)



Note: Switches are positioned for take-off and approach.

Arrows Indicate Direction of Current Flow

Figure 47 — A-C Power Supply System (Take-Off and Approach Condition)

relays mounted in the bottom of the right side of the main junction box. Each relay serves to disconnect its respective generator from the bus when the output voltage of the generator becomes abnormally high. The reset mechanism is manually operated and can be reset by actuating the push button on the top of the relay in the main junction box.

Unless the safety of the airplane is at stake, neither the air circuit breakers nor the overvoltage relays should be reset without first determining the reason for malfunctioning.

Four ammeters, one for each generator, are located on the ammeter-voltmeter panel, and indicate the current output of the four generators. A single voltmeter is mounted on the same panel, with a five-position switch which connects the voltmeter either to “BUS” (the normal position for the switch) or to one of the four generators.

9.2. D-C POWER SUPPLY - BATTERIES — Two 12- volt, 88-ampere-hour storage batteries, wired in series and located in the battery compartment just aft of the nose gear well, are an auxiliary source of direct current. The length of time the batteries will deliver power to the electrical system depends upon the state of charge of the batteries, the operating temperature, and the rate of amperage drain. The battery system is considered as an auxiliary source of power, as it is incapable of supplying the electrical load of the airplane for more than a short period of time. In flight, the batteries will act as a stand-by source of power, with the generators supplying the primary power and charging the batteries. The batteries serve as a source of emergency during starting without an external power source and, under normal operating conditions, serve to aid the generators in maintaining normal voltages during heavy current surges. A hot-air tube may be inserted through an access hole aft of the nose gear well to raise the temperature of the battery compartment for cold weather use. Fumes from the batteries are vented overboard.

A battery transfer relay in the main junction box connects the batteries to the main bus until the external power source is supplying sufficient power to close the relay. An amber warning light, connected across the external power source, is mounted above the battery selector switch and illuminates when an external power source is connected and the battery switch is on. While the batteries are in the airplane, it is impossible to charge them from the ground power supply.

9.2.1. Battery Master Switch — The batteries are connected to the bus system by an on-off switch mounted on the forward overhead panel. The "ON" position is designated "BATT & GND PWR" (aft position), and, in this position, the switch closes the power circuit from the batteries or the ground power receptacle to the bus.

For emergency use, a gang bar is installed over the battery master switch and the four generator switches to move them to the "OFF" positions simultaneously, cutting off all power sources from the bus.

9.2.2. Battery Selector Switch — The battery selector switch, mounted immediately aft of the battery master switch on the forward overhead panel, is a make-before-break switch, which momentarily energizes both the ground power supply and battery relays as it passes from one position to the other. The switch has two positions: "PLANE BATTERY" (aft position) and "GROUND POWER" (forward position). During the engine start, the switch should be positioned to the desired power source.

However, the battery selector switch must be positioned to "GROUND POWER" at all times when the battery master switch is "ON" and a ground power supply is connected to the airplane. This is necessary to prevent a reversal of the battery cart from severely damaging the airplane's electrical system.

9.3. A-C POWER SUPPLY — Two rotary inverters, housed in the soundproofed inverter compartment outboard of the radio rack, supply alternating current for the instruments and electronic equipment. Either inverter is capable of supplying the entire a-c load of the airplane—both single and 3-phase—at 115 volts for operation of the electrical instruments, the automatic pilot, and the communication and navigation equipment.

Single and 3-phase, 115-volt, 400-cycle a-c power is supplied to the automatic pilot and radio equipment; single and 3-phase 26-volt, 400-cycle a-c power is supplied through step-down transformers for operation of the engine instruments, the turn-and-bank inclinometers, and the gyro horizon indicators.

The inverters operate directly from the main bus, and each circuit is protected by a 125-ampere circuit breaker on the main circuit breaker panel.

9.3.1. Inverter Controls and Warning System. — The three inverter switches are mounted on the forward overhead panel and have the following positions:

Inverter 1: “No.1” / “OFF” / “STAND BY.”
Inverter 2: “No.2” / “OFF” / “STAND BY.”
Inverter 3: (Engine Instruments): “NORMAL” / “OFF” / “STAND BY.”

During cruising operations, it is normal to operate all a-c equipment from one inverter. For take-offs, landings, and instrument flying, it is advisable to operate both inverters; thus, in the event of inverter failure during critical operations, all a-c fed equipment will not be affected. The left switch selects a-c power for the captain’s flight instruments; the center switch selects power for the first officers’ flight instruments and the automatic pilot; the right switch selects a-c power for the engine instruments.

Dual red warning lights, mounted on both the captain’s and first officer’s flight instrument panels, illuminate when a-c power is lost. When there is an actual inverter failure (any inverter) *both* lights will illuminate until such time that you select the opposite inverter. The only time that a *single* light will illuminate is when A-C power is lost to that particular side, due to either an Inverter CB or Bus CB which has tripped.

Two warning horn switches on the No. 1 and No. 3 throttles will close when the throttles are advanced for take-off if the inverter supplying flight instrument power is inoperative.

9.4. EMERGENCY INVERTER — In some airplanes an emergency inverter, installed in a small case located just outboard of the captain at floor level, supplies a-c current to a limited number of electrically actuated flight instruments in the event of total inverter failure.

The emergency inverter switch, mounted on the forward overhead panel, is actually three switches ganged together to an emergency bar. Moving the ganged emergency switches to the “ON” position will automatically disconnect the normal inverters and turn on the emergency inverter. At the same time, a battery relay circuit is completed to supply 28-volt d-c battery power to the emergency inverter and also to the instrument panel white lights.

All a-c engine instruments are inoperative when operating on the emergency inverter.

The voltage regulator auxiliary blower should be turned “ON” when operating on the emergency inverter, as the normal blower is shut off when the normal inverters are inoperative.

9.5. LANDING LIGHTS — The two electrically operated, vapor proof, 1000-candle-power landing light assemblies, mounted on the bottom of the wing, betweenthe nacelles, are controlled by four switches on the upper instrument panel. Two of the switches are placarded “OFF” and ‘’ON,” and open and close the circuit of their respective lights. The remaining two switches control the actuating motors of the landing light assemblies and are placarded “EXTEND” and “RETRACT.” Two adjustable motor limit switches automatically stop the motor of each light at both extremes of travel. The landing lights are held in intermediate positions by an automatic brake system. The maximum extension arc of each landing light is 84¼ degrees.

Ground operation of the landing lights should be limited to as short a period as possible, as the absence of a cooling windstream will result in their overheating. Always make certain that the on-off switch is in the “OFF” position following retraction.

Maximum airspeed for landing light extension is 147 KIAS.

9.6. WING ILLUMINATION LIGHTS — A wing illumination light is installed on each side of the fuselage, between the second and third forward windows of the main cabin. The lights are adjusted to illuminate the leading edges of the wing for observation during icing conditions and as an aid during night fueling operations. The lights are controlled by a momentary contact, impulse relay type on-off switch, on the forward overhead panel. A warning light, mounted adjacent to the switch will illuminate when the leading edge lights are turned on. A similar on-off switch is installed in the nose gear well for ground crew operation of the wing lights. Either of these switches will alternately turn the lights on and off.

No restriction is placed on the operation of the wing leading edge lights.

9.7. POSITION LIGHTS — The position lights, which are controlled by a switch on the forward overhead panel, consist of a red light on the left wing tip, a green light on the right wing tip and a red and white light on the tail cone tip.

The double-throw light switch has three positions: “FLASH,” “OFF,” and “STEADY.”

With the double-throw switch in the “FLASH” position, the white tail light and the wing tip lights flash on and off together, and the red tail light and the beacon light flash together.

With the switch in the “STEADY” position, only the wing tip lights and the white tail light are continuously illuminated. The remaining lights cannot operate on the “STEADY” position.

If the position light flasher motor fails during operation, a micro switch closes to complete a circuit to the wing lights and to the white tail light for continuous light operation.

No limitations are placed on operation of the position lights.

9.8. COCKPIT AND FLIGHT COMPARTMENT LIGHTING — The cockpit and flight compartment lighting system consists of lights for illumination of both compartments and for the instruments and controls. The intensity of illumination is controlled by adjusting the rheostat switches.

The red lights on the captain’s and first officers’ flight instrument panels are controlled by switches on the cold-air orifice panels. The red lights for the engine instrument panel, the forward top face of the control pedestal, the fuel dump valve control handles, the overhead panels, and the white overhead flood light over the flight compartment door are controlled by rheostat switches on the forward overhead panel.

Twelve white lights on the main instrument panel, a white overhead flood light on the left side of the flight compartment aft of the radio rack, the white light for the overhead panels, and the observer’s map light are controlled by rheostat switches on the forward overhead panel.

Brief-case lights with built-in switches are located outboard of the captain and first officer, below the side windows. One red light on the hydraulic instrument panel, one on the oxygen panel, and one on the remote flap control position indicator are operated by a push button on the inboard horn of each aileron control wheel.

9.9. LANDING GEAR WELL LIGHTS — A switch on the forward overhead panel operates lights in the main gear wells and the nose gear well for checking the landing gear downlatches during night operation and for aid in ground servicing. An amber warning light adjacent to the switches illuminates to indicate that the downlatch lights are on.

9.10. TAKE-OFF WARNING SWITCHES — Two takeoff warning switches are operated by the positioning of the No. 1 and No. 3 throttles. The switches are energized as the throttles are advanced for take-off and will close the circuit of the take-off warning horn if the wing flaps, flight instrument inverter, and propeller pitch control switches are not set for take-off. In this airplane, which is approved for a zero wing flap take-off setting, the wing flaps are not part of the take-off warning system. The take-off warning horn blows intermittently so that it can be distinguished from the landing gear warning horn.

9.11. WARNING LIGHTS AND SWITCHES — Various switch-actuated warning lights and horns have been installed in the DC-6 airplane to reduce to a minimum the necessity for the crew to constantly watch each set of instruments, and to provide a visual or aural warning at the instant a condition becomes critical enough to demand attention. The following is a list of the warning systems, together with a brief description of each; a complete description of each is given in the respective paragraphs in this section dealing with the particular systems.

9.11.1. Landing Gear Control Lever Safety Solenoid — A solenoid-actuated pin projects across the landing gear lever when the solenoid is de-energized, which occurs when the weight of the airplane is on the landing gear. A finger hole on the aft face of the control pedestal permits the pin to be released manually.

9.11.2. Landing Gear Warning Lights — Three green dual indicator lights and one red dual indicator light are mounted to the right of the first officer's flight instrument panel. The green lights indicate that the gear is down and latched; the red light indicates that the gear is in an intermediate position between full down and full up. The red light will also illuminate if a throttle is retarded past one-quarter open and the gear is up and latched.

9.11.3. Landing Gear Warning Horn — A warning horn will sound when one or more throttles are retarded past the one-quarter open position and the gear is not down and latched. A horn silencing button is mounted on the aft face of the control pedestal to silence the horn (desirable when an engine is shut down, for example). If two throttles have been retarded, the horn will again sound (after silencing) if one throttle is advanced while the other is retarded.

9.11.4. Cabin Pressure Warning Horn — A bellows-operated alitude warning switch closes the circuit to the intermittent take-off warning horn when the cabin pressure exceeds an altitude of 10,000 (±500) feet. The circuit opens when the cabin, altitude again drops below 10,000 feet. A cabin pressure warning silencing button on the forward overhead panel is provided to silence the horn if continuous operation in excess of this altitude is necessary. When the cabin drops below 10,000 feet again, the warning horn cut-off relay resets itself for future operation.

9.11.5. Door Warning Lights — The flight compartment door, main cabin door, both lower baggage compartment doors, and the hydraulic accessories compartment and heater accessories compartment doors are each equipped with latch-actuated door warning switches, which close circuits to dual red warning lights on the cabin supercharger panel. One light indicates for the cabin doors and one for the belly compartment doors; the lights illuminate if any door is not closed and latched.

In addition, the flight compartment and main cabin doors are each equipped with a. warning light circuit that illuminates dual warning lights which shine through Lucite rods for visibility both from within and without the airplane. The lights illuminate ‘when the airplane is on the ground and the cabin pressure control valve has not opened sufficiently to depressurize the cabin, indicating it is unsafe to open the doors.

9.11.6. Landing Gear Well and Wing Illumination Light Indicator Lights. — Dual, amber warning lights, mounted adjacent to the gear well light switches and the wing illumination light switch, indicate when these lights are in operation.

9.11.7. External Power Supply Indicator Light — An amber light, mounted adjacent to the battery selector switch on the forward overhead panel, indicates when external power is plugged in and the battery selector switch is in the “GROUND POWER” position. The light goes out when the switch is positioned to the airplane batteries.

9.11.8. Oil Pressure Warning Light — An amber oil pressure warning light, mounted adjacent to the oil pressure indicators on the engine instrument panel, indicates when the oil pressure for any engine drops below 50 (±5) psi. The four Engine Fuel & Oil Pressure Warning Isolation Switches are required to be switched on in order for this light to work. The light will go out when the pressure again rises above this value or if the Engine Fuel & Oil Pressure Warning Isolation Switches are switched off.

9.11.9. Fuel Pressure Warning Light — A red fuel pressure warning light, mounted adjacent to the fuel pressure indicators on the engine instrument panel, indicates when the fuel pressure for any engine drops below 1.8 (±½) psi. The light will go out when the pressure rises above this value again. The four Engine Fuel & Oil Pressure Warning Isolation Switches are required to be switched on in order for this light to work.

9.11.10. Inverter Warning Lights — Red inverter warning lights, one on the captain's and one on the first officer's flight instrument panels, illuminates when the a-c voltage drops below a safe value for reliable operation of the electrically actuated flight instruments. When this happens, switch to the opposite inverter.

9.11.11. Voltage Regulator Compartment Warning Light — An amber thermoswitch-controlled warning light, mounted on the forward overhead panel, illuminates when the normal compartment blower is failing to maintain an adequate temperature in the voltage regulator compartment. When this happens, turn on the auxiliary blower; the light will go out when the temperature drops to a safe level.

9.11.12. Cabin Supercharger Oil Pressure Warning Light — A dual red warning light, mounted on the upper instrument panel, illuminates when the oil pressure of either cabin supercharger drops below 35 (±5) psi.

9.11.13. DELETED.

9.11.14. Fire Warning Lights — Dual red thermal lights, mounted on or adjacent to the fire extinguisher selector valve handles and on the heater fire control panel, illuminate when high temperatures exist in the designated areas. The fire warning lights will go out when the fire is extinguished.

9.11.15. DELETED.

9.11.16. Water/Alcohol Flow Lights — Four green lights, mounted beneath the captain's flight instrument panel, indicate normal W/A flow when the system is in operation.

9.11.17. DELETED.

9.12. DELETED.

9.13. CIRCUIT PROTECTORS — Protective devices are inserted into all electric circuits to protect the wiring and the equipment when the current load exceeds the circuit wiring capacity. The circuit protectors are generally located where the circuit joins the main distribution bus in the main junction box. Circuit breakers have replaced fuses in most of the circuits in the DC-6 airplane, with the exception of some of the radio equipment and certain a-c circuits in some airplanes. Circuit breakers provide thermal delay and will not open the circuit on slight momentary overloads. All circuit breakers, except those for the cabin ground blower (located in the heater accessories compartment) are readily accessible in flight.

If any circuit protector trips or burns out after resetting or replacement, a serious short is indicated and the use of that circuit should be discontinued. However, if the safety of the airplane depends on the continued operation of the affected equipment, the non-trip-free circuit breakers of the emergency circuits (fuel booster pumps and propeller circuits) may be held manually in the closed position for a short period. If the circuit breaker is held in the closed position too long and the overload is sufficient, overheating of the wire will occur, with a resultant fire hazard.

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10. COMMUNICATION AND RADIO NAVIGATIONAL EQUIPMENT

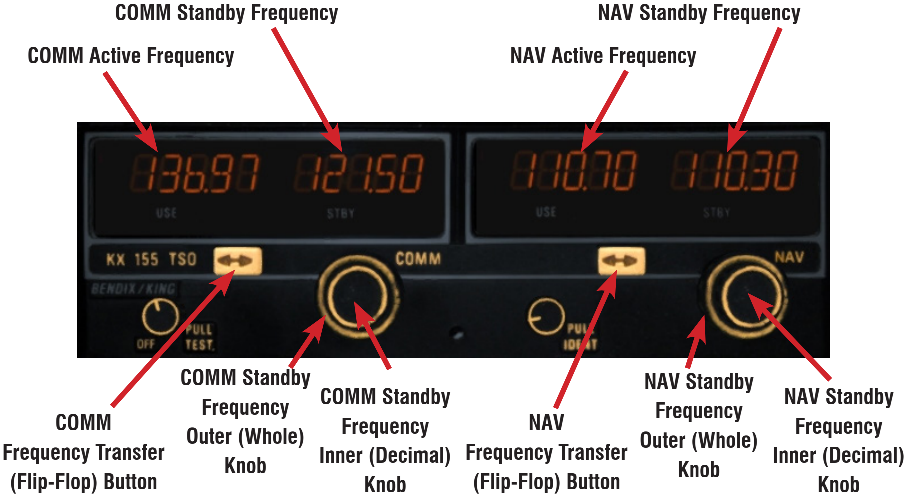
The radio equipment, as installed in the DC-6 airplane, provides communication, navigation and instrument landing facilities. The installations described in this section are the following:

Bendix King KX 155 NAV/COMM Transceiver
Bendix King KR 87 ADF Receiver
Bendix King KI-227 ADF Indicator
Garmin GI-106A GPS/VOR/LOC/Glideslope Indicator
Bendix MN- 61A Marker Beacon System

The communication and navigation radio units as well as the ADF unit are mounted underneath the upper instrument panel, within easy reach of the captain and first officer.

10.1. BENDIX KING KX 155 NAV/COMM TRANSCEIVER — This unit has been installed to bring the DC-6 up to date, as the old radios on the pedestal have become obsolete. This unit, together with the installed GPS, makes "stay ahead" frequency pre-planning effortless.

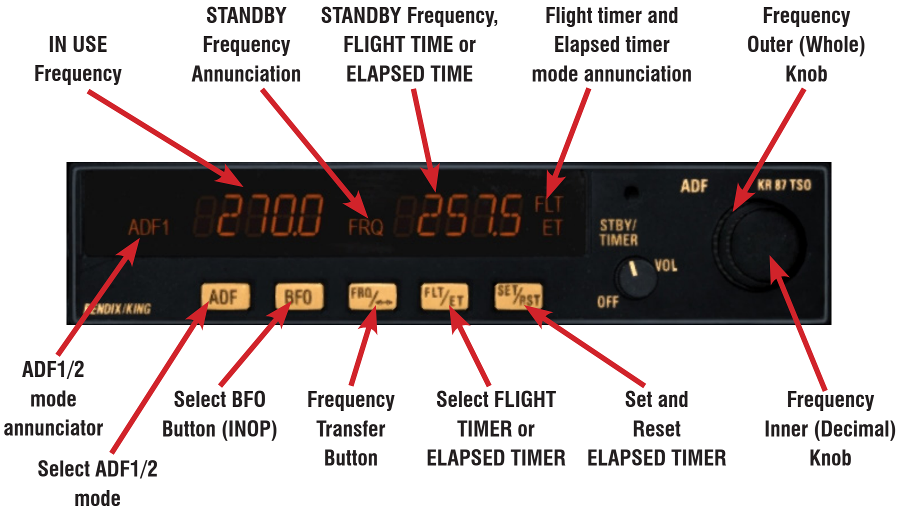
Both the NAV and COMM frequency displays incorporate the popular "flip-flop" preselect feature. This function allows pilots to set up en route or approach frequency changeovers well in advance of the actual transition point of ATC handoff sequence, for true "stay ahead" flight management.



By selecting the NAV and COMM frequency in the "Standby" (STBY) display, pilots can "flip-flop" it into "active" status at the press of a button.

Large, self-dimming, microprocessor controlled readouts and solid-state electronic tuning provide fast, accurate selection of all 200 NAV and 760 COMM frequencies. The KX 155 features a built-in glideslope receiver which is connected to the Garmin GI-106A GPS/VOR/LOC/Glideslope Indicator on the captain's instrument panel and the Bendix KI-209 VOR/LOC/Glideslope Indicator on the first officer's instrument panel.

10.2. BENDING KING KR 87 ADF RECEIVER — This compact Autmatic Direction Finding (ADF) unit gives you accurate bearing-to-station in the 200kHz to 1799kHz frequency range, complete with ADF, ANT and BFO tuning modes, plus audio output for station identification and monitoring AM broadcasts.



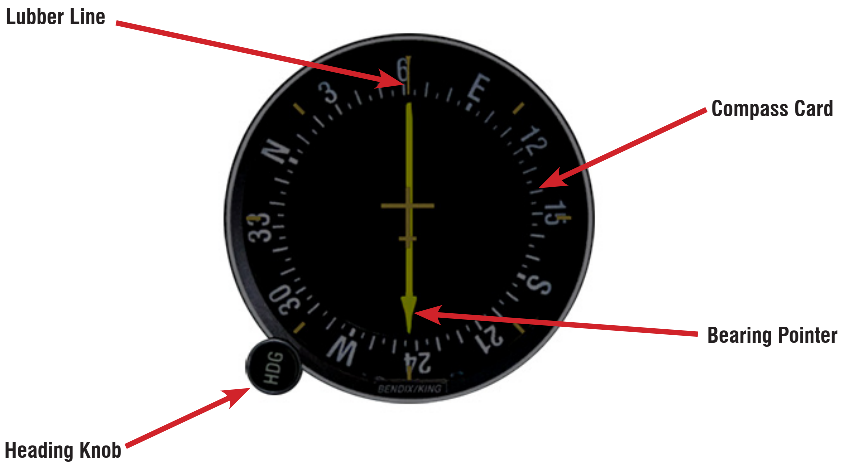
The KR 87's advanced coherent detection design rejects unwanted frequency noise and achieves much greater range while remaining less susceptible to engine noise, static and atmospheric interference. Its flip-flop frequency display allows you to switch between pre-selected standby and active frequencies with the touch of a button.

10.3. BENDIX KING KI-227 ADF INDICATOR — The Bendix King KI 227 automatic direction finder (ADF) indicator works in conjunction with the KR 87 ADF Receiver.

When the KR 87 is tuned to an in-range and active station, the needle should move without hesitation to the station bearing. Excessive sluggishness, wavering or reversals indicate a signal that is weak or intermittent, or a system malfunction.

When the KR 87 is not tuned to an in-range and active station, the needle will turn to the 90° relative position and remain there.

Use the heading (HDG) knob to manually rotate the compass card to match your current direction. Frequently check the indication of the ADF compass card and compare it with that of your compass and direction indicator from time to time, ensuring that the ADF compass card matches the aircraft heading.



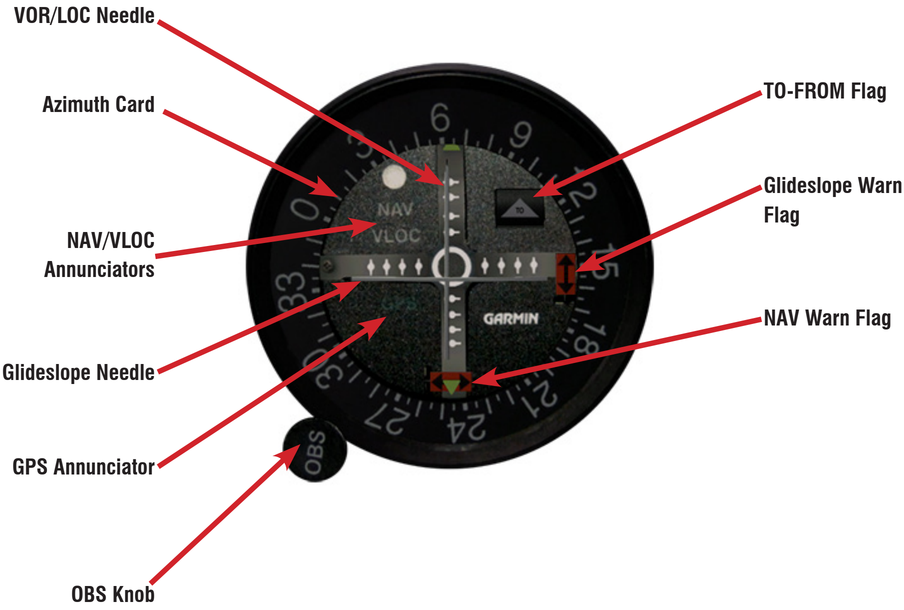
Bendix King KI-227 ADF Indicator

10.4. GARMIN GI-106A GPS/VOR/LOC/GLIDESLOPE INDICATOR — The Garmin GI 106A is a high-quality course deviation indicator that displays rectilinear needle movements and contains integral GPS, NAV and VLOC mode annunciators.

The GI 106A features a glideslope needle and flag, which include a VOR/LOC/GPS needle, TO/FROM indicator and NAV warning flag.

The Course Deviation Indicator (CDI) is designed to operate with VHF and GPS navigational equipment, providing VOR, Localizer (LOC), GPS, and Glideslope (GS) information.

To aid the pilot in determining the source of displayed navigation data, the GI 106A includes three annunciators on its face: GPS, VLOC (VOR/Localizer/Glideslope), and NAV.



Garmin GI-106A GPS/VOR/LOC/Glideslope Indicator

10.4.1. GARMIN GI-106A VOR OPERATION

Channel the NAV receiver to the desired VOR frequency and positively identify the station by listening to received audio. Determine the NAV warning flag is out of view.

Flying inbound to a VOR station is accomplished by first rotating the OBS knob to center the deviation indicator, and determining the TO-FROM meter is in the TO condition. The aircraft is then turned to a magnetic heading, which is the same as the selected course with proper allowance for wind correction. When the aircraft is on course, the vertical pointer will be centered. If the aircraft moves off course, the deviation indicator will move away from the center position and flying in the direction of pointer deflection (left or right) is required to re-intercept the course. The procedure for flying outbound from a VOR station is the same as flying inbound, except the OBS knob is first rotated to cause a “FROM” indication to appear with the pointer centered.

To intercept a selected VOR radial (from the station) and fly outbound, turn the OBS control to set the desired radial under the top indicator index. Maneuver the aircraft to fly the selected radial magnetic heading plus 45° intercept angle which will provide a sufficient intercept angle. The intercept angle should be reduced as the deviation needle approaches an on course condition (center) to prevent excessive course bracketing.

10.4.2. GARMIN GI-106A LOCALIZER OPERATION

Select the desired localizer frequency and observe that the localizer warning flag is concealed. The TO-FROM flag is not functional for localizer operation. When flying on the front course or outbound on the back course make corrections toward the localizer (vertical) needle deflection.

The localizer path narrows as the approach end of the runway becomes closer. When flying inbound on the back-course or outbound on the front course, the corrections are made away from the direction of needle deflection. A helpful hint when flying the localizer is to set the localizer heading on the OBS dial under the lubber line for quick reference.

10.4.3. GARMIN GI-106A GLIDESLOPE OPERATION

The glideslope (horizontal) needle provides the pilot with vertical steering information during ILS approaches. The glideslope circuitry is energized when the associated localizer frequency is selected on the navigation receiver. Observe that the glideslope warning flag is concealed. The glideslope needle deflects towards the direction the pilot must fly to remain on the glide path.

If the glideslope needle deflects upward the aircraft is below the glide path and the pilot must climb to again intercept the glide path and center the needle. If the needle deflects downward the aircraft is above the glide path and the pilot must descend to again intercept the glide path and center the needle. When the needle is centered the aircraft is on the glide path.

10.5. MARKER BEACON — The Bendix Type MN- 61A marker-beacon receiver is designed to provide visual and aural reception of pretuned inner, middle and outer (instrument approach system) marker signals.

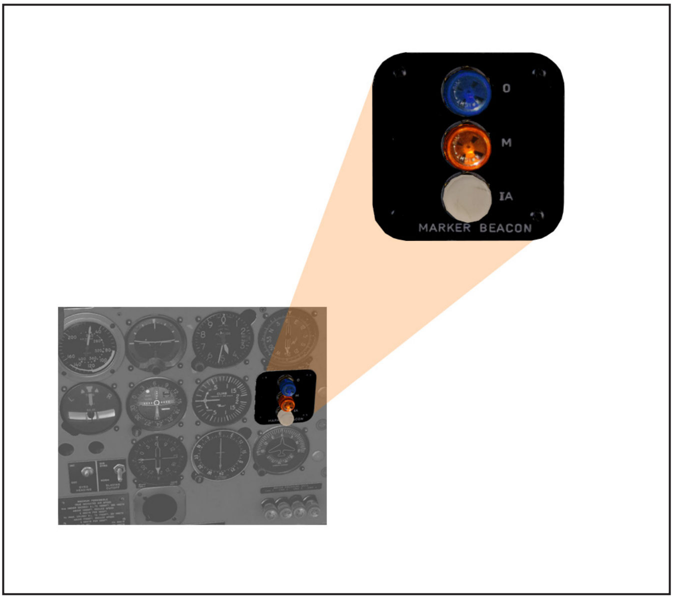
Visual indication of the marker signals is provided by two three-light indicators mounted on the captain's and first officer's flight instrument panels. Aural monitoring is controlled by the marker beacon monitoring switch on each audio control panel. The receiver is in continuous operation when the radio master circuit breaker switch is closed.

10.5.1. Marker Beacon Controls — The marker beacon controls are as follows:

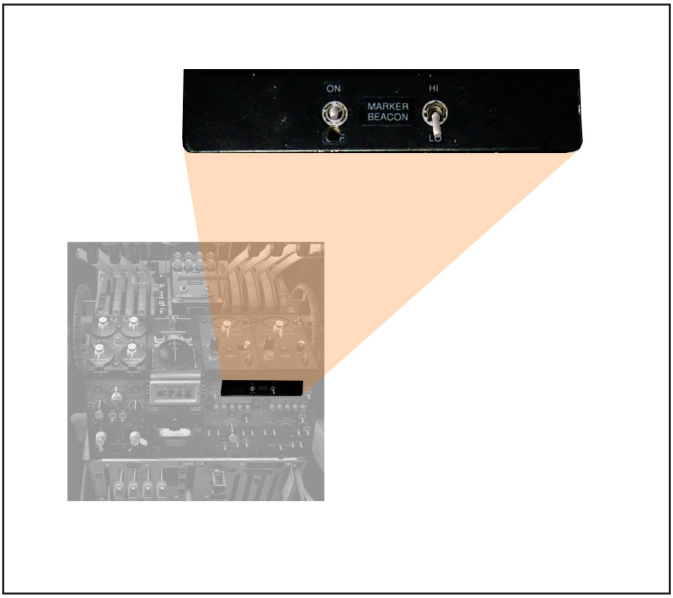
(1) The marker beacon sensitivity control on the pedestal radio control panel controls the sensitivity of reception. The " HI " or "LO" setting of this switch determines the duration of the indication received when passing over a marker.

(2) The marker beacon monitoring switch on each audio control panel permits monitoring of the signals to each individual station when the switch is in the "ON" position.

(3) The marker beacon indicators consist of two groups of three lights each. The blue (top) light is marked "O" and gives visual indication of the reception of the outer marker. The amber light, marked "M," gives dot signal indication of the reception of middle-marker signals. The white light, marked "IA," gives dash signals when receiving the inner-marker signals.



Marker Beacon Lights



Marker Beacon Controls

10.6. STATIC DISCHARGERS — Twelve static dischargers are installed on the trailing edges of the control surfaces to reduce the electro-static potential on the airplane. Each discharger consists of a wick protruding from a plastic tube.

11. ANTI-ICING AND DE-ICING SYSTEMS

The various anti-icing systems installed, in the DC-6 airplane, with the exception of the carburetor alcohol system and the propeller de-icing system are best utilized in the prevention of ice accretion rather than in the disposal of ice after it has accumulated. These anti-icing systems should be put into operation at any time that icing conditions are anticipated (before they are encountered) and should be turned off after the condition no longer exists. Care must be taken in the operation of the alcohol anti-icing system, since the time available for its use is governed, wholly by the supply of alcohol available. Upon landing (at the completion of the landing roll) all anti-icing and de-icing systems should be turned off.

The leading edges of the wing and tail surfaces are protected against ice accretion during flight by the airfoil thermal anti-icing system. This system consists of three combustion heaters and their accessory equipment— one in each outboard nacelle area and the third located in the tail section—which supply heated air to the wings and stabilizers. The double-paned windshield is normally protected from, ice accretion by means of heated air taken from the cabin, heater through a duct. The corner windows of the cockpit are defrosted by windshield air discharge.

Isopropyl alcohol is delivered under pressure to a spray manifold in each carburetor for the elimination of ice in the carburetor air intake throat. Isopropyl alcohol is also delivered under pressure to perforated tubing along the lower and inboard exterior edges of the windshield for supplementary anti-icing when the cabin heater is not functioning.

The propellers are protected from ice accretion by an electric de-icing system consisting of heating elements installed externally or internally on the blades.

11.1. CARBURETOR DE-ICING AND ANTI-ICING SYSTEMS — The major carburetor anti-icing system is the carburetor preheat system, which uses engine heat to preheat the air entering the carburetor. Under most conditions the preheat system, when applied correctly and in advance of a known moisture-laden air condition, will be sufficient to prevent ice accretion in the carburetor throat. For a complete description and operation of the carburetor preheat system, refer to Section III, paragraph 7.5.

If carburetor preheat is unable to prevent ice accretion, or if inadvertent engine cutting occurs before sufficient preheat can be applied, isopropyl alcohol from the 16-gallon tank, located in the right wing-tofuselage fillet, is routed through a pump and filter to each carburetor air intake throat. The system is controlled by four momentary-contact switches on the heater control panel, which act both as system energizer switches and as selector switches. The alcohol de-icing system pump is energized when any one of the carburetor de-icer switches is closed.

The flow of alcohol, which is preset and cannot be changed during flight, is 100 pounds per hour per engine, or a total of approximately 17 minutes supply for four engines in continuous operation provided no alcohol is used for the windshield. A Liquidometer remote- indicating quantity transmitter registers fluid level on an indicator mounted on the upper instrument panel.

While no functional limitations are placed on the use of the system, it is recommended that the system be shut off as soon as deemed advisable, to conserve alcohol.

11.2. PROPELLER DE-ICING SYSTEM — The Hamilton Standard propellers are protected from ice formations by an electric de-icing system, which consists of heating elements mounted internally in the Hamilton Standard propeller. The heating elements create sufficient intermittent heat to raise the blade surface temperature above the freezing point so that existing ice is loosened, and is thrown off periodically by centrifugal force.

The propeller installation is equipped with a timing device, mounted in the hydraulic accessories compartment, that controls the flow of current to the heating elements through a protective relay, which protects against overheating or underheating. A relay is mounted in each nacelle firewall junction box.

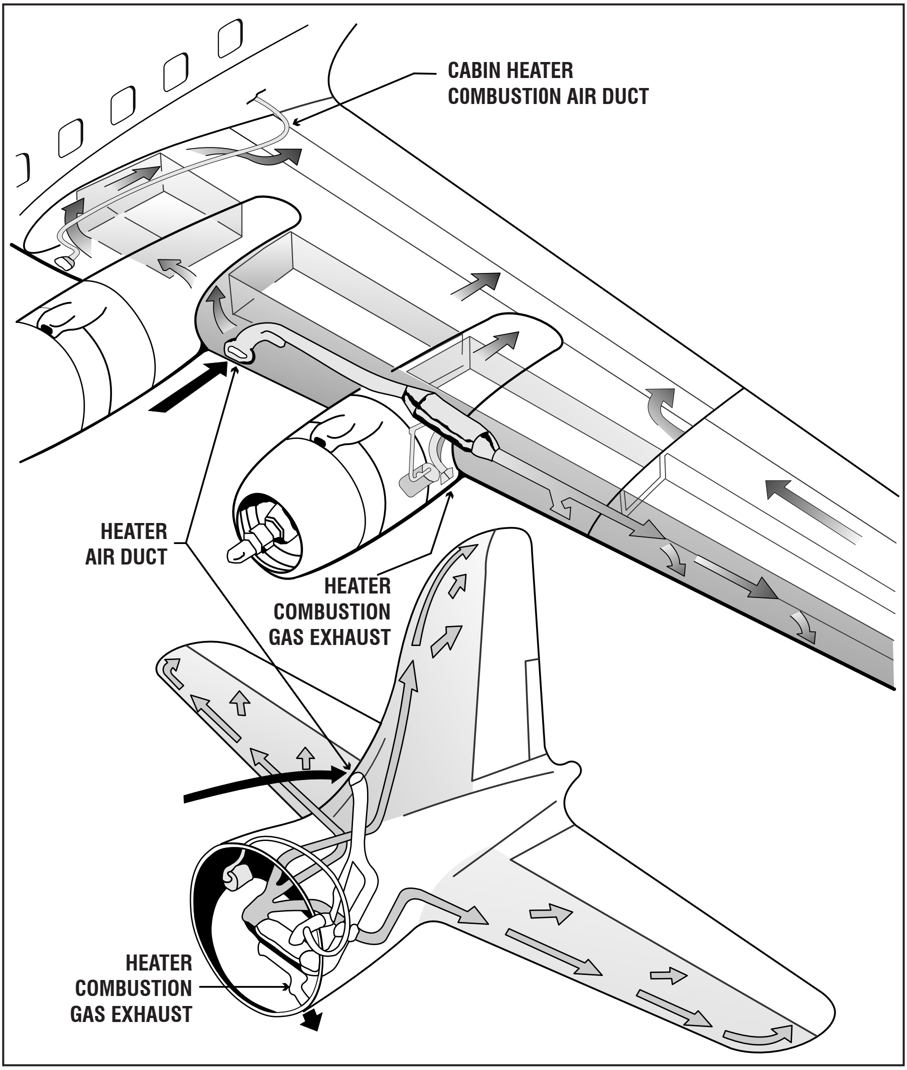


Figure 54 — Airfoil Anti-Icing System

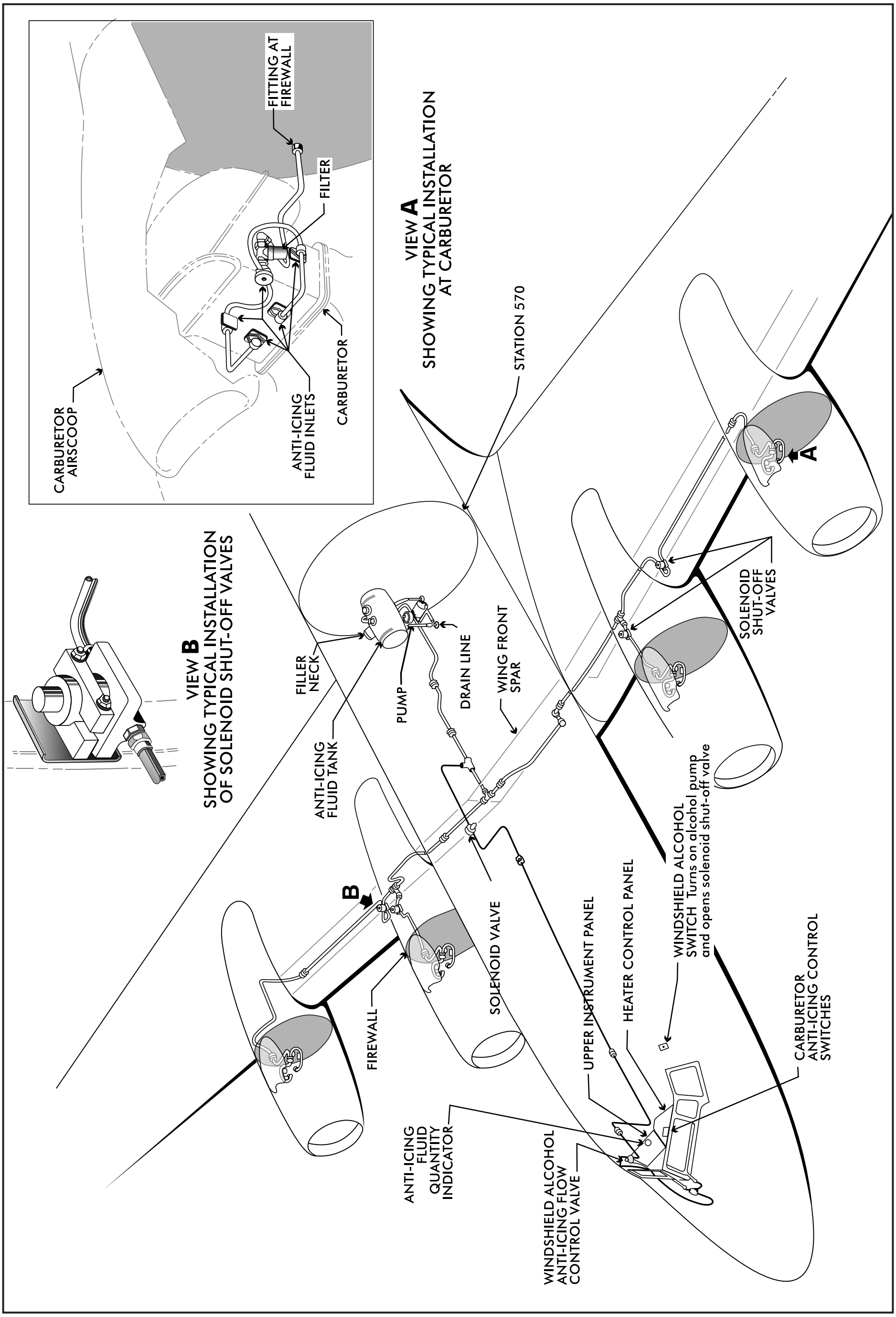


Figure 55 — Carburetor and Windshield Alcohol Anti-Icing Systems

The protective relay automatically opens the circuit to its respective propeller anti-icing circuit if one or more blade heating elements malfunction during operation, and thereby prevents damage resulting from unbalanced propeller de-icing. On airplanes with Hamilton Standard propeller installations, such as this one, the protective relay resets automatically.

The Hamilton Standard propeller timer installation varies with airplanes. On some airplanes, the timer is set to energize the protective relay for a period of 20 seconds on and 60 seconds off and is controlled by an on-off switch on the heater control panel. On other airplanes, the timer, depending on the degree of icing conditions, may be positioned to either of two cycles of operation as controlled by a three-position switch, on the heater control panel, marked “LONG,” “SHORT,,” and “OFF,” The “SHORT” cycle operates for 20 seconds on and 60 seconds off; the “LONG” cycle operates for 60 seconds on and 180 seconds off.

An ammeter selector switch and four individual selector switches are installed on the aft overhead panel to provide a manual means of propeller de-icing. In the event of timer failure, or if it is desired not to de-ice one propeller, all or any one of the four switches can be thrown to the “MANUAL” position. Then, when the ammeter selector switch is turned to the selected propeller, the ammeter reading will be indicated and the propeller selected will de-ice.

The propeller de-icing system must not be left on longer than one minute when the engines are inoperative and the propeller blades do not have the protection of a cooling airflow. Allow a minimum of five minutes between operations so that the heating elements can cool sufficiently. Unlimited ground operation of the propeller de-icing system is permissible when the propellers are in operation, and landings and take-offs can be made with the system in operation.

Hamilton Standard propeller de-icer system circuits are opened and the systems inoperative during propeller feathering or reverse-pitch operation.

11.3. WINDSHIELD ANTI-ICING SYSTEM — Hot air, supplied to the windshield from the cabin heater through an insulated duct system, is routed up the center post of the windshield and forced between the inner and outer windshield panes. Part of the heated air is exhausted through the corner posts of the windshield and part is ducted to the curved corner windows. From the corner windows and posts the air is ducted down the cockpit sidewalls and may be exhausted either into the cockpit or beneath the floor by two 2-position control valves, one at floor level, just aft of the captain's left rudder pedal, and one on the lower forward corner of the first officer's side window. Positions are "COCKPIT" and "NORMAL" (beneath the floor).

Actually, the windshield thermal anti-icing system serves a dual purpose; besides supplying heat in sufficient quantity and temperature for preventing ice accretion it also supplies varying degrees of heat to maintain the vinyl layer of the windshield in a sufficiently plastic state to retain its impact-resistance quality. (When too warm, vinyl becomes soft; when too cold, it becomes brittle. The optimum temperature range for strength is from 80°F to 120°F.) The four position windshield vinyl warming and thermal antiicing switch, on the heater fire control panel, is marked (in a clockwise direction) with the following positions; "OFF - ABOVE 10°," "10° TO 0°," "0° TO —40°," and "ANTI-ICING." The degrees are in centigrade. Before choosing a setting for vinyl-warming purposes, the O.A.T. reading must be taken first and the setting made accordingly.

In the "10 TO 0 ° " position, heated air is supplied to the windshield from the cabin superchargers only, through the windshield anti-icing control valve, which, at the same time, reduces the volume of heated air being discharged into the flight compartment area for warming purposes.

However, if the cockpit is hot, it is not necessary to move the vinyl warming switch in accordance with the name plate. Since the vinyl pane is in the inner windshield panel, its temperature is influenced considerably by cockpit temperature. In many cases it is possible for an airplane to climb to an altitude where the outside air temperature drops to a level where, under ordinary conditions, the vinyl would require heat. However, the interior of the cockpit and the vinyl pome will still be quite warm, due to heat storage in the fuselage by a hot ground condition. Moving the windshield switch to the "10° TO 0°" setting will cause a decrease in volume of airflow through the turbine with loss in cooling. The next three positions will stop the turbine. Therefore, if the cabin is hot, keep the windshield heat switch in the " OFF " position.

In the “0° TO -40°” position, the cabin heater cycles to a maximum heat output of approximately 120° to 135°C. In the “ANTI-ICING” position, the cabin heater cycles at maximum, the windshield anti-icing control valve opens fully, and the mixed air duct damper in the cabin mixing valve creates a back pressure to increase the airflow to the windshield. For maximum windshield anti-icing, not more than 20 individual cold-air outlets should be open in the main cabin. The amount of windshield heat available increases in volume as individual main cabin cold-air outlets are closed. When the windshield heat control switch is in the “ANTI-ICING” position, no additional hot air is available to the cockpit. The cockpit heat control must therefore be placed in the “NORMAL” position.

In addition to thermal anti-icing for the windshield, isopropyl alcohol can be sprayed over its exterior surfaces. One supply tank and pump furnish alcohol for both the windshield and the carburetor alcohol antiicing systems. The rate of alcohol flow is controlled by a needle valve mounted on the cockpit sidewall, outboard of the first officer.

Either the thermal or the alcohol anti-icing system can be operated without functional restrictions; however it must be remembered that the alcohol system is limited in the quantity of alcohol available (a total supply to the windshield amounting to 48 minutes of continuous operation with the needle flow valve full open, provided no alcohol is used for the carburetor). Consequently the windshield alcohol anti-icing system should only be used for emergency conditions in order to make certain that alcohol is available for carburetor anti-icing.

For emergency operation of the windshield antiicing system, refer to Section VI, Emergency Procedures and Trouble Shooting.

11.4. ACCESSORY ANTI-ICING SYSTEM — The pitot heads, the cabin aftercooler airscoop and splitter (belly scoop), the airfoil heater airscoop splitters, and the cabin heater combustion airscoop are kept free of ice accretion by electric heating elements controlled by a single on-off pitot and scoop heater switch on the upper instrument panel. A selector switch, adjacent to the pitot heater switch, and a single ammeter permit a check on the operation of the various heating elements.

With the selector switch turned to the respective units, and the pitot and scoop heaters switch "ON," the following amperages should be read on the ammeter as an indication of correct operation:

"CAPT PITOT & STATIC"	6-10
"1st OFF PITOT & STATIC"	6-10
"BELLY SCOOP LEADING EDGE"	15-21
"WING SCOOPS"	19-28
"CABIN HEATER COMBUSTION AIR SCOOP"	11-15

11.5. AIRFOIL THERMAL ANTI-ICING SYSTEM — The leading edges of the wing and stabilizers are kept ice-free by internal combustion heaters, which receive their normal fuel supply from the No. 3 main fuel tank, or their emergency fuel supply from the No. 2 main fuel tank. The system is controlled by a group of switches on the heater control panel. In flight, the heaters are supplied with ventilating air and combustion air from the airscoops. During heater ground operation, the wing heaters are supplied by a combination of ram air for ventilation from the No. 2 and No. 4 engine propeller blasts and air for combustion from the ground blowers (both necessary for heater operation). In the tail anti-icing system, both ventilating air and combustion air are supplied by a ground 3 blower. The ground blowers are automatically put into operation when the landing gear safety switch is closed as the gear assumes the weight of the airplane during landing, and the airfoil anti-icing switch is closed. The wing heaters exhaust through an outlet outboard of each outboard nacelle; the tail heater exhausts through an outlet near the bottom of the tail section.

A group of cycling and overheat thermoswitches in the heated-air ducts regulates the temperature of the air leaving the airfoil heaters between 182°C (360°F) to 190°C (376°F) for normal operation, and 210°C (410°F) for a maximum limit of operation.

The circuits for the airfoil anti-icing heaters and ground blowers are automatically opened, shutting off heaters and blowers, when the throttles for the No. 2 and/or No. 4 engine are in reverse-pitch position. In addition, the generator voltage controlled heater relay will close only when the generator on engine No. 2 and/or No. 4 is turning over at a rate sufficient to generate enough power to close the heater relay. This also ensures sufficient ram air pressure from the propellers to supply the heaters.

11.5.1. Airfoil Anti-Icing System Controls — The airfoil anti-icing system control switches and instruments are located on the heater control panel. A single on-off switch controls the airfoil anti-icing heaters. This switch is mounted adjacent to the cabin heater master switch. A gang bar is mounted above both switches for simultaneously shutting off both systems. Adjacent to these switches are toggle switches for the selection of either the "SYSTEM NO. 1" or "SYSTEM NO. 2" ignition system, for each heater. An additional set of switches selects the "SYSTEM NO. 1" or "SYSTEM NO. 2" fuel system for each heater. A heater fuel system switch, located at the extreme left of the heater control panel, operates a cross-feed valve and turns on the cabin heater fuel pump to furnish an additional fuel source if the heater pump cannot maintain pressures given in the following table (unless the pump is already operating, in which case, it merely diverts some fuel into the anti-icing heater systems).

OPERATION	ALTITUDE	IAS	WING AND TAIL HEATER FUEL PRESSURE (psi)
Ground	Sea Level	0	3 to 7
Flight	Sea Level to 20,000 feet	230	20 to 26

For normal operation of the heater fuel system, the heater fuel system switch should be in the "NORMAL" position.

Two dual thermocouple-actuated indicators, one for the tail anti-icing system and one for the left and right wing systems, are mounted on the heater control panel.

Temperatures are indicated as structure temperature, not heater, discharge temperature. Two dual Magnesyntype heater fuel pressure indicators, one for the tail anti-icing heaters and one for the left and right wing heaters, are also mounted on the heater control panel. Fuel pressures indicated are heater nozzle pressures.

Operate the airfoil thermal anti-icing system whenever necessary. Take-offs and landings may be made with the system in operation. However, it is recommended that the thermal anti-icing system be put into operation at least five minutes before entering a known icing condition, or immediately after encountering an unexpected icing condition. Do not operate the thermal anti-icing system in flight if O.A.T. exceeds 10°C (50°F), except for short test periods.

12. AIR CONDITIONING

The DC-6 cabin area, which extends from the bulkhead at station 64 to the pressure dome forming the aft bulkhead of the aft lounge, is maintained within comfortable temperature and pressure limits by the air conditioning system. While air temperature and pressure can be controlled in flight, the system is so designed that preflight setting of the system can be made from a flight plan, with no further adjustments necessary.

Air temperature can be maintained within a range of 65°F to 85°F, with an outside air temperature range of —40°F to 100°F. The cabin pressure can be maintained at sea level with the airplane at altitudes up to 9000 feet, and the same pressure differential can be held at varying altitudes up to 25,000 feet. In excess of this altitude, the differential pressure becomes progressively less. Examples of the differential altitudes obtainable at various pressure altitudes are given in the following table:

AIRPLANE PRESSURE ALTITUDE	CABIN PRESSURE ALTITUDE
9000 feet	Sea Level
10,000 feet	800 feet
15,000 feet	4500 feet
20,000 feet	8000 feet
25,000 feet	11,300 feet

Figure 56 — Cabin Supercharger Control Panel

The ventilating rate of the system is sufficient to accomplish a complete change of air in the cabin every three minutes.

A small, circular door, or negative pressure relief valve, in the pressure dome automatically opens whenever outside air pressure exceeds cabin pressure.

12.1. CABIN PRESSURE SYSTEM — Cabin pressurizing is accomplished by supplying the cabin with ventilating air under pressure from two engine-driven superchargers, one located in each outboard nacelle. The air is ducted from the superchargers through a cooling or heating system, depending on requirements, and then through distributing ducts to the cabin and cockpit. The air pressure in the cabin is maintained and controlled by metering the discharge of air from the cabin through a pressure control valve that is controlled automatically by the pressure control instruments. The air pressure can also be controlled manually.

The automatic pressure control instruments can be pre-set before flight and, on many flight schedules, require no adjustments in flight. For example, it is possible to start cabin pressurizing on take-off and then gradually build up cabin pressure — relative to outside air pressure — during the ascent of the airplane, so that full cabin pressure is obtained at the same time that the airplane reaches the maximum flight altitude. As the airplane descends, the automatic controls decrease cabin pressure gradually, so that the cabin is depressurized at the moment the airplane lands.

12.2. CABIN PRESSURE AUTOMATIC CONTROLS AND INDICATING INSTRUMENTS — The automatic controls and indicating instruments for the cabin pressurizing system consist of the following instruments mounted on the cabin supercharger panel.

- Cabin pressure regulator
- Cabin pressure limit control (mounted behind panel)
- Cabin supercharger airflow indicators (2)
- Cabin differential pressure indicator
- Cabin altimeter
- Cabin rate-of-climb indicator

12.2.1. Cabin Pressure Regulator — The cabin pressure regulator is an instrument for controlling cabin pressure in accordance with a predetermined flight plan. The regulator is equipped with an indicating dial calibrated in increments of 1000 feet, a rotatable marker with the controlling knob located at the lower left corner of the indicator and marked “START MARKER,” and two indicating pointers, rigidly attached to each other, marked “CABIN” and “FLIGHT,” with a controlling knob, marked “HAND,” at the lower right corner of the indicator.

Before flight, rotate the “start marker” knob until the marker on the face of the indicator is set at the altitude of the take-off field. This is the altitude at which the cabin will start pressurizing. The “hand” knob should then be rotated until the “flight” pointer is set at the maximum anticipated flight altitude. The “cabin” pointer will then indicate the maximum altitude the cabin will reach when the airplane attains the flight plan altitude. As the airplane takes off and climbs to the flight plan altitude, the cabin altitude climbs at a slower rate and the cabin pressure builds up — relative to outside air pressure — until it reaches the maximum differential pressure of 4.16 psi as the airplane reaches its flight plan altitude. The rate of climb of the cabin depends upon the setting of the cabin pressure regulator and the rate of climb of the airplane, but no rate calculations are necessary, as the pressurization takes place automatically.

If the landing field altitude is the same as that of the take-off field, no adjustment of the instrument in flight is necessary. As the airplane descends, the cabin will descend at a slower rate. As the cabin does not have as far to descend as the airplane, the cabin pressure will be zero at the same time that the airplane lands at the altitude previously pre-set on the “start marker.” However, if the altitude of the landing field is different from that of the take-off field, then, at any time after the airplane reaches the flight plan altitude and before starting the descent, set the “start marker” to the altitude of the landing field. Thus, as the airplane descends to the landing altitude, the cabin will also descend, but more slowly, to the same altitude as that set on the “start marker.”

The “start marker” cannot be rotated around the dial past the “cabin” pointer. If this is attempted, the marker will merely push the pointer around ahead of it.

12.2.2. Deleted.

12.2.3. Cabin Pressure Limit Control — A cabin pressure limit control located behind the cabin supercharger control panel, functions as an override on the cabin pressure regulator. The pressure limit control prevents cabin pressure from exceeding the maximum differential pressure allowable. The operation of this controlling unit is entirely automatic, no manual control being supplied.

Above a 25,000-foot density altitude, the cabin superchargers are unable to maintain a 4.16 differential on the cabin. Consequently, the cabin pressure limit control replaces the cabin pressure regulator as the controlling instrument to maintain a ratio of pressure between the cabin and the outside air pressures.

12.2.4. Cabin Supercharger Airflow Indicators — Two cabin supercharger airflow indicators, mounted on the cabin supercharger panel, give indication of the airflow rate of the superchargers. The airflow instruments should indicate normally within the green arc.

12.2.4A. Cabin Supercharger Duct Pressure Indicator — A supercharger duct pressure indicator is installed on some airplanes and is located on the ammeter-voltmeter panel in the flight compartment. With the indicator installed, excessive duct leakage can be readily detected by checking the duct pressure reading against the Supercharger Duct Maximum Pressure Chart, Figure 57.100. Duct pressure leakage is checked by manually running the cabin temperature mixing valve toward “COLD” to open port A of the mixing valve until it stops and then noting the reading of the duct pressure gauge. The gauge reading should then be checked against the chart.

12.2.5. CABIN ALTIMETER — The cabin altimeter, on the cabin supercharger panel, is a standard altimeter instrument. The cabin altimeter should be set to 29.92 at all times.

12.2.6. Cabin Rate-of-Climb Indicator — The cabin rate-of-climb indicator, mounted on the cabin supercharger panel, indicates the rate in feet per minute at which the cabin is ascending or descending. During manual control of the pressurizing system, it is necessary to watch this instrument closely to stay within a safe rate of cabin pressure change.

12.2.7. Cabin Altitude Warning Switch and Pressure Control Valve Warning Switch — The cabin altitude warning switch is connected to a warning horn that will sound when the cabin altitude exceeds 10,000 feet, to indicate that an altitude has been reached where oxygen should be used by the crew. The horn can be silenced by means of a cut-out switch on the aft overhead panel. The horn will reset itself automatically when the cabin altitude drops below 9600 feet. The horn and warning switch are located in a box behind the captain's seat.

The cabin pressure control valve is equipped with a warning switch that is series-connected to the cabin pressure warning light adjacent to both the flight compartment and the main cabin doors. The switch is set to trip whenever the cabin pressure control valve is closed more than 15 degrees and to illuminate the warning lights if the airplane is on the ground. This warning switch serves two purposes: It gives visual indication to the ground crew that the valve door has been closed in flight by means of the CO_2 fire protection system, and, prior to take-off or after landing when doors and windows are closed, it also indicates to both the flight crew and the ground crew that the pressure control valve is closed.

12.2.8. Cabin Differential Pressure Indicator — The cabin differential pressure indicator, mounted on the cabin supercharger panel, indicates the variance of pressure between the cabin and the outside air pressure in pounds per square inch. The instrument obtains air pressure from the cabin and the main static source. The maximum differential pressure for landing is 1.8 psi and the maximum differential for flight is 4.16 psi, as determined by structural limitations.

12.2.9. Cooling turbine Switch — The cooling turbine switch, on the left side of the forward overhead panel, acts as a manual electrically actuated override switch on the cooling turbine. The switch is only used under emergency conditions and during engine operation below 1200 rpm. The switch has two positions: "NORMAL" (aft) and "OFF" (forward). When the switch is in the "NORMAL" position, the electrical circuits function normally under the influences of the controlling units. When the switch is in the "OFF" position, a relay circuit is energized directly from the main power distribution bus, which, in turn, energizes the motor actuator on the temperature control mixing valve and closes the cold-air port. This results in an immediate reduction of the supercharger work loads, as operation of the cooling turbine ceases with the closing of the cold-air port.

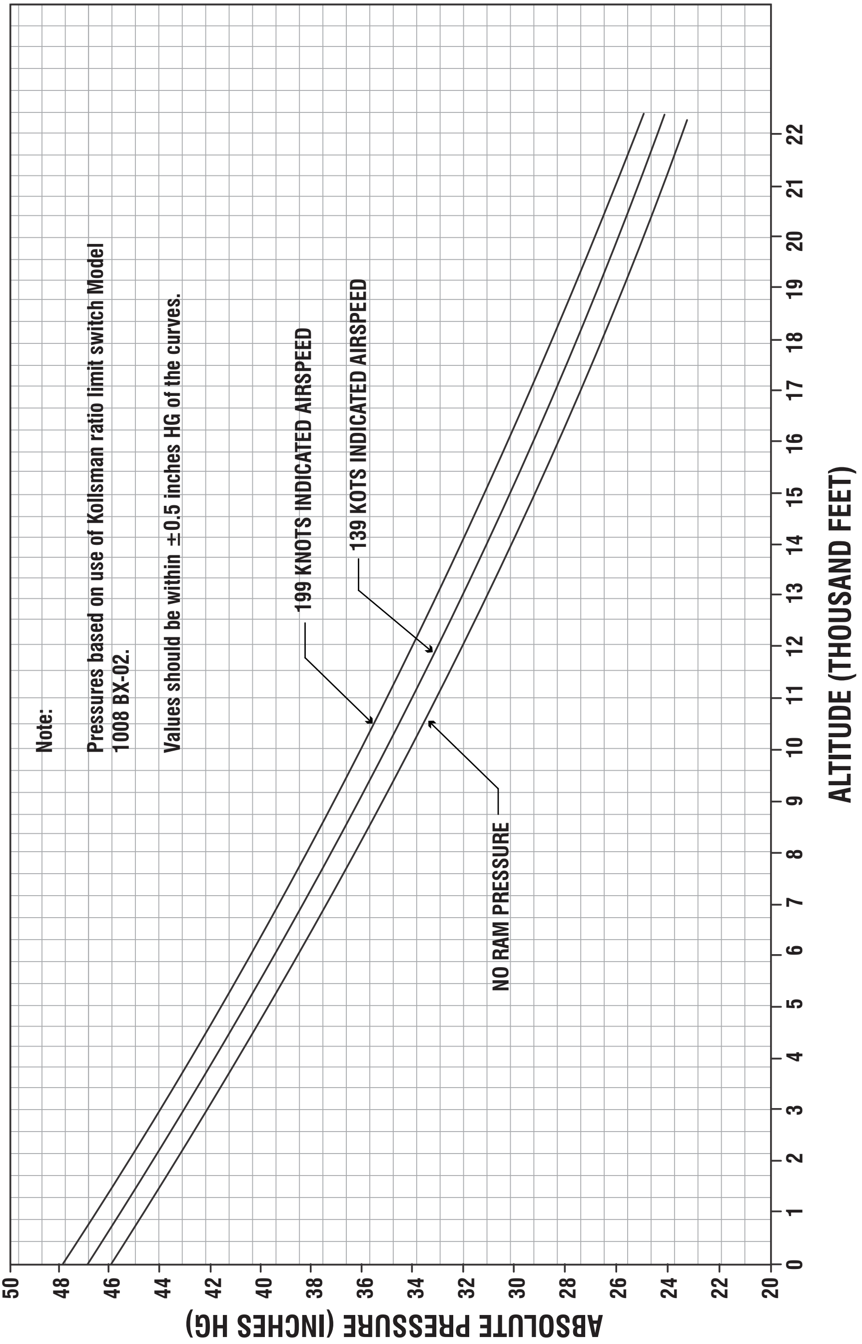
The cooling turbine switch must be in the "NORMAL" position for normal operation unless the following conditions exist:

(1) If both superchargers are inoperative.

(2) If an airflow indicator fluctuates severely over a period of time or continuously shows a high flow rate which does not reduce with a reduction of engine rpm.

(3) If the cabin supercharger gear box oil pressure drops below 50 psi and is accompanied by a rise in gear box oil temperature. This condition is sometimes a result of an excessive work load on the supercharger and can be corrected by placing the cooling turbine switch in the "OFF" position.

The switch should be in the " OFF " position during engine start ground operation, and after landing, when the engine rpm will normally be below 1200.



Note:

Pressures based on use of Kollsman ratio limit switch Model 1008 BX-02.

Values should be within ±0.5 inches HG of the curves.

Figure 57.100 — Supercharger Maximum Discharge Pressure Chart

12.3. DELETED.

12.4. EMERGENCY CABIN ALTITUDE CONTROL — The emergency cabin altitude crank, located to the right of the first officer, is used in the event of electric power or actuator failure. The crank is cable rigged to the cabin pressure emergency relief valves, located aft of the lower aft baggage compartment.

Rotating the crank in a counterclockwise direction opens the relief valves and discharges cabin air, decreasing cabin pressure; rotating it clockwise closes the valve and allows the cabin pressure to increase. The crank can be positioned on its circular base to give the desired degree of pressure change as indicated by the cabin altimeter and the cabin rate-of-climb indicator.

The relief valves will automatically open at a differential pressure of 4.2 psi, and will not allow the differential pressure to exceed 4.67 psi.

12.5. CABIN SUPERCHARGER CLUTCH DISCONNECT — The cabin superchargers can be made inoperative in the event of supercharger malfunctioning by means of the two control levers on the cockpit floor, outboard of the first officer. Rapidly pulling up on the designated latched lever will disengage the respective supercharger clutch without affecting the operation of the engine.

The superchargers can again be made operative by first feathering the propeller and then squeezing the latch on the respective clutch disconnect lever and slowly lowering it to the full down, or “ENGAGED” position. This will permit the cabin supercharger clutches to re-engage.

Unfeather the propeller after the clutches are engaged. If the cabin supercharger has been disengaged as a result of abnormal oil pressure or temperature, do not re-engage the supercharger clutches.

12.6. OPERATION OF CABIN PRESSURE SYSTEM — During normal operation, the cabin supercharger system requires no adjustments other than preflight and pre-landing adjustments, with the exception of frequent checks for correct operation of the system. For emergency operation or trouble shooting of a malfunctioning system, refer to Section VI.

All the instruments and altimatic controls necessary for automatic operation of the cabin pressurizing system are located on the supercharger panel to the right of the upper instrument panel (see Figure 56). For graphic examples of operation, refer to Figures 60 through 63.

12.6.1. Before Starting Engines — Make certain before starting engines that:

(1) All system circuit breakers are SET.

(2) Cabin pressure warning light is OFF.

(3) Cabin supercharger clutch disconnect levers are "ENGAGED."

(4) Emergency cabin altitude control is in NORMAL position.

(5) Manual control door is CLOSED.

(6) Cabin heater fuel system switch is in "NORMAL" position.

(7) Cabin, heater automatic control by-pass switch is "OFF,"

(8) O.A.T. exceeds —23°C (—10°F). A lower temperature requires super charger preheating.

(9) "Start marker" is set to take-off field altitude.

(10) "Flight" hand on cabin pressure regulator is set to maximum anticipated flight altitude.

(11) Up hand on pressure change limit control is set to 600 fpm.

(12) Down hand on pressure change limit control is set to 300 fpm.

(13) Cooling turbine switch is in "OFF" position.

12.6.2. On Starting Outboard Engines

(1) Cabin supercharger oil pressure should read a minimum of 35 psi within 30 seconds after starting.

(2) Airlow indicators should register an airflow that is stabilized within the green arc within two minutes after starting.

(3) During engine run-up, check frequently to make certain that the following cabin supercharger pressure and temperature ranges are indicated:

CABIN SUPERCHARGER OIL PRESSURE

Desired	60 to 90 psi
Minimum	35 psi
Maximum	120 psi

CABIN SUPERCHARGER OIL TEMPERATURE

Desired	60° to 80°C
Minimum	15°C
Maximum	100°C

12.6.3. Take-Off, Climb, and Cruise

(1) Cooling turbine switch in “NORMAL” position.

(2) All door warning lights must be OFF for take-off.

(3) Cockpit side windows must he closed.

(4) Set cabin altimeter to 29.92.

(5) The cabin supercharger oil pressure, oil temperature, and airflow indicators should indicate normally. The airflow indicators may indicate above the green band during take-off as a result of high engine rpm.

(6) No change will normally be required on the “flight” hand. If it is necessary to change the cabin pressure regulator setting during flight, reset only during level flight and wait until the cabin rate-of-climb becomes zero before climbing or descending the airplane.

(7) With single supercharger operation, the cooling turbine should not be used (cooling turbine switch “OFF”), as its effectivity is greatly reduced with only half the airflow. It may also be desirable to fly unpressurized to some altitude above the take-off field, this altitude to be judged by cabin temperature. Flying unpressurized with only one supercharger will

permit ram air to by-pass the disconnected supercharger and aid in cooling the cabin. When the cabin reaches a comfortable temperature, pressurized operation may be started with no discomfort to the passengers. To establish this operating schedule, initially set the “start marker” to some arbitrary altitude above the start-pressurizing altitude— for example, 8,000 feet—and set the “flight” hand to the maximum anticipated flight altitude (approximately 20,000 feet). Then, if the cabin is within comfortable temperature limits before reaching 8000 feet—for example, 7000 feet—reset the “start marker” to that altitude and continue flying the airplane on the predetermined flight plan.

(8) When flying with both superchargers inoperative, it is necessary that the pressure control valve be fully open to provide cabin ventilation. This is accomplished by opening the manual control door and depressing the “decrease” button; *do not close the manual control door after depressing the button*, as the automatic controls will attempt to pressurize the cabin by preventing ventilation. This operation will provide a maximum ventilating flow to the cabin through the supercharger by-pass ducts. During this type of operation, the cooling turbine Switch must be in the “OFF” position.

12.6.4. Descent and Landing

(1) If the destination field altitude is different from the take-off field, the “start marker” must be reset to the landing field altitude after reaching the cruising altitude and before descending for the approach. This is done to eliminate any sudden change of cabin pressure altitude during the final stages of the approach. *When the cabin is pressurized, do not change the “start marker” during climb or descent.*

(2) Do not land with a differential pressure exceeding 1.8 psi. If the system has been set correctly and is functioning properly, this exceedance in differential pressure will not exist.

(3) *Do not open windows or doors after landing until the cabin pressure warning lights are OUT and/or the differential pressure gauge indicates zero pressure.*

(4) If it becomes necessary to hold at altitude (not to exceed 8000 feet) for clearance after a let down from cruising altitude, it is possible, if desirable, to descend the cabin at a slow and uniform rate of descent by setting the “start marker” and the “cabin” hand to the landing field altitude. If the airplane remains at altitude long enough for the cabin to reach the landing field altitude, the descent can then be made at the highest rate possible without changing the cabin pressure. However, as a result of the added load thrown onto the cabin superchargers, the cabin may heat up to an uncomfortable degree, particularly if ambient air temperatures exceed 85 °F, as a result of the inability of the cooling turbine to remove sufficient heat from the compressed air.

(5) After landing, and while taxiing up to the loading ramp, place the cooling turbine switch in the “ OFF “ position.

12.7. CABIN HEATING AND TEMPERATURE CONDITIONING SYSTEM — Conduction and radiation principles of air heating are employed in DC-6 airplanes. Conditioned air is routed beneath the floor and up the walls for radiant heating before it enters the cabin through wall outlets for direct heating. Adjustable cold-air orifices are located adjacent to each seat for individual requirements of air that is cooler than that supplied by the conditioning system. All the temperature controls are located on the cabin attendant’s temperature control panel and on the heater control panel in the cockpit.

During a large percentage of flight operations, the 300,000-Btu combustion heater for the cabin may not be required to operate, since the air from the cabin superchargers will be heated sufficiently, as it is compressed, to maintain the cabin temperature within comfortable limits. When both superchargers are operating and the cabin is fully pressurized, the cabin heater is not required to supply heat when O.A.T. is approximately 10°F or above. When the cabin superchargers are operative, all air is delivered to the cabin from the superchargers. When the superchargers are inoperative, a by-pass check valve in each outboard nacelle will allow ram air to enter the cabin for ventilating purposes if the cabin is depressurized and the pressure control valves are open.

The basic unit of the cabin temperature conditioning system is the three-port mixing valve, which receives cold air from the cooling turbine, cool air from the aftercooler, warm air from the engine-driven cabin superchargers, and/or hot air from the cabin heater. Depending on O.A.T. and cabin temperature requirements, the mixing valve mixes the air from any two adjacent ports in the proper proportion to provide tempered air, as required, to maintain cabin temperature within the limits of 65°F to 85°F. The cooling turbine has a limited capacity, but is capable of holding cabin temperature approximately 15°F below O.A.T., provided excessive humidity is not encountered.

However, in cases of high relative humidity, a portion of the cooling capacity of the turbine may be taken up in removing moisture from the air and therefore the temperature of the air may not be noticeably lowered. In fact, there may be instances in which moisture condensation might be visible as a fog or vapor emitting from the air outlets in the cabin or cockpit (needless to say, this condensate should not be confused with smoke).

The cabin heater receives its fuel supply from the No. 2 main fuel tank, and has a normal fuel consumption of approximately two gallons per hour, with a maximum consumption of approximately four gallons per hour. The maximum ground and en route cabin heater temperature is 150°C (302°F).

12.7.1. Temperature Controls — Operation of the temperature control system is made possible by means of the cabin temperature rheostat on the cabin temperature control panel, located above the electrical overhead panel. Once the heater is in operation, the system will position the mixing valve to give the preselected temperature in the main cabin.

The cockpit temperature is normally consistent with the main cabin temperature.

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EXAMPLE CONDITION: Take-off and landing altitudes, both at sea level. Maximum flight altitude, 20,000 feet.

INSTRUMENT SETTINGS AND OPERATION

STEP 1. Set cabin altimeter to 29.92.

STEP 2. Set the "START MARKER" on cabin pressure regulator to 0 feet (take-off altitude A).

STEP 3. Set the "FLIGHT" pointer ("HAND" knob) on cabin pressure regulator for an anticipated flight altitude of 20,000 feet.

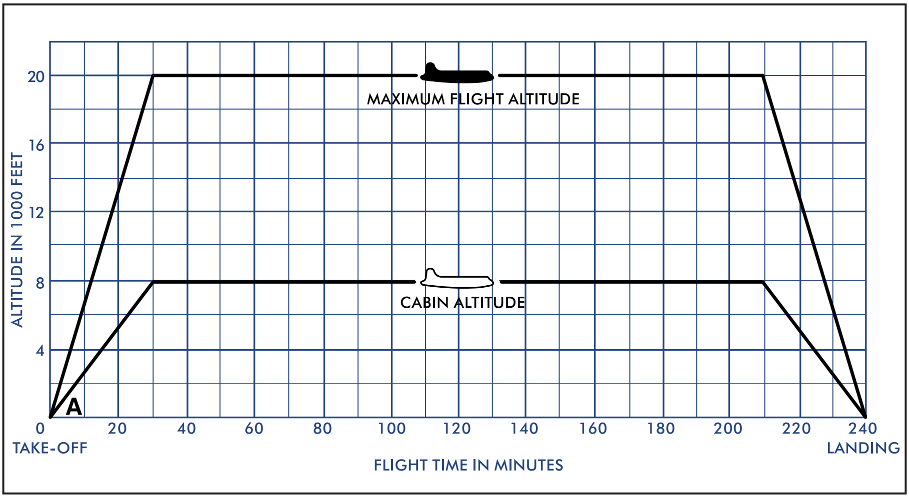

Figure 60 — Example No. 1

EXAMPLE CONDITION: Take-off altitude, 0 feet; landing altitude, 4000 feet. Maximum flight altitude, 20,000 feet.

INSTRUMENT SETTINGS AND OPERATION

STEP 1. Set cabin altimeter to 29.92.

STEP 2. Set the "START MARKER" on cabin pressure regulator to 0 feet (take-off altitude A).

STEP 3. Set the "FLIGHT" pointer ("HAND" knob) on cabin pressure regulator for an anticipated flight altitude of 20,000 feet.

STEP 4. After reaching maximum flight altitude B and before descending to landing field D , set "START MARKER" on cabin pressure regulator to landing field altitude of 4.000 feet.

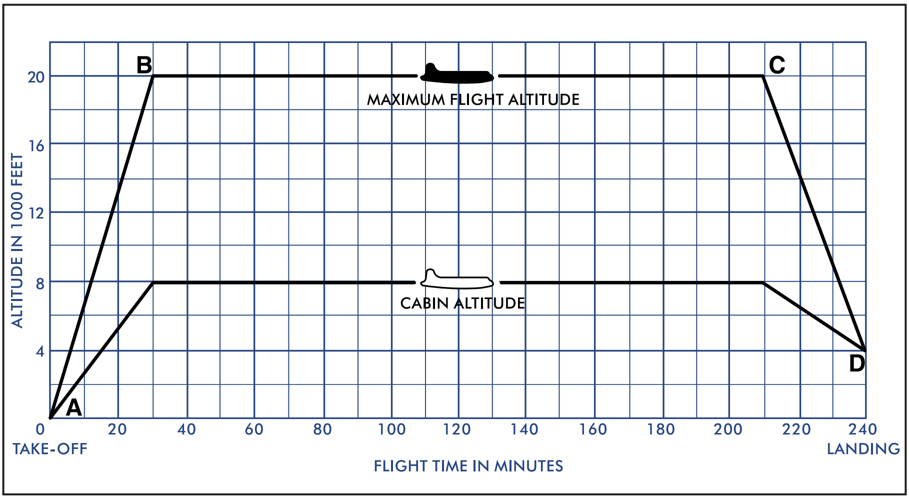

Figure 61 — Example No. 2

EXAMPLE CONDITION: Take-off and landing, at sea level (or same altitude). Maximum flight altitude, 8,500 feet.

INSTRUMENT SETTINGS AND OPERATION

STEP 1. Set cabin altimeter to 29.92.

STEP 2. Set the "START MARKER" on cabin pressure regulator to 0 feet (take-off altitude A).

STEP 3. Set the "FLIGHT" pointer ("HAND" knob) on cabin pressure regulator for an anticipated flight altitude of 8,500 feet.

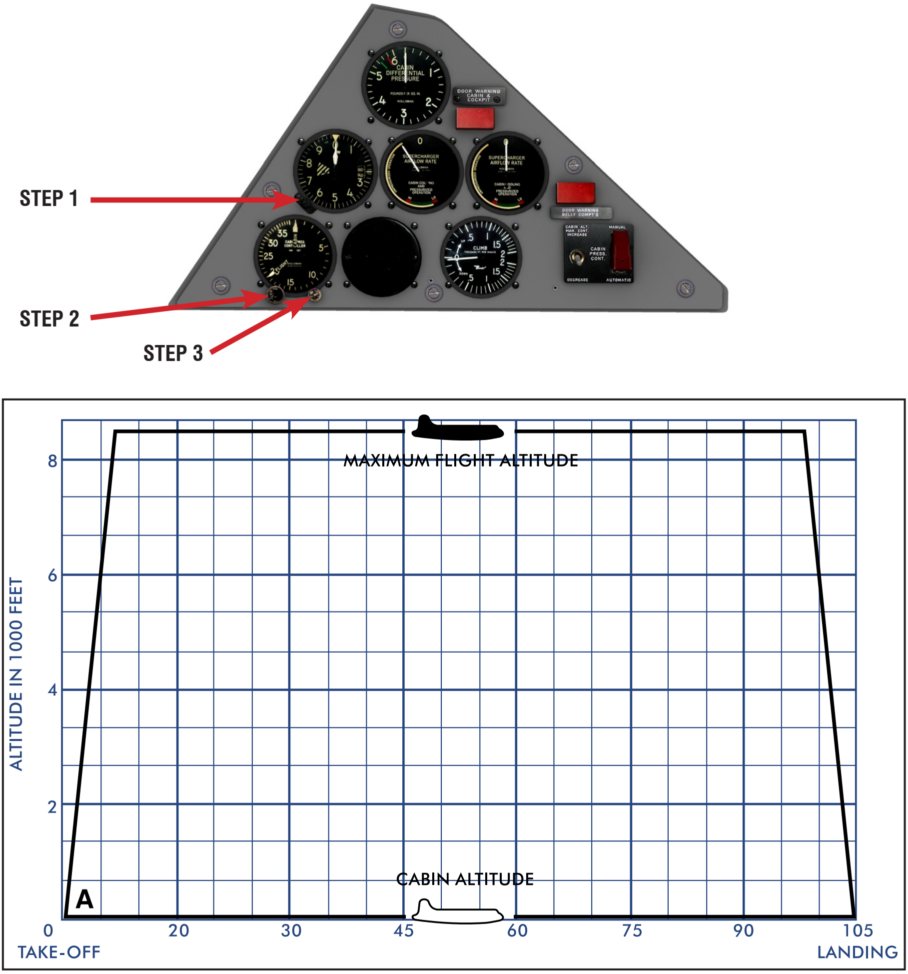

Figure 62 — Example No. 3

EXAMPLE CONDITION: Cabin at full pressure at 20,000 feet flight altitude. Rapid descent from 20,000 feet to 8,000 feet, followed by a period of level flight and then a rapid descent to sea level.

INSTRUMENT SETTINGS AND OPERATION

STEP 1. Set "START MARKER" on cabin pressure regulator to 0.

STEP 2. Set "CABIN" pointer ("HAND" knob) on cabin pressure regulator to 0.

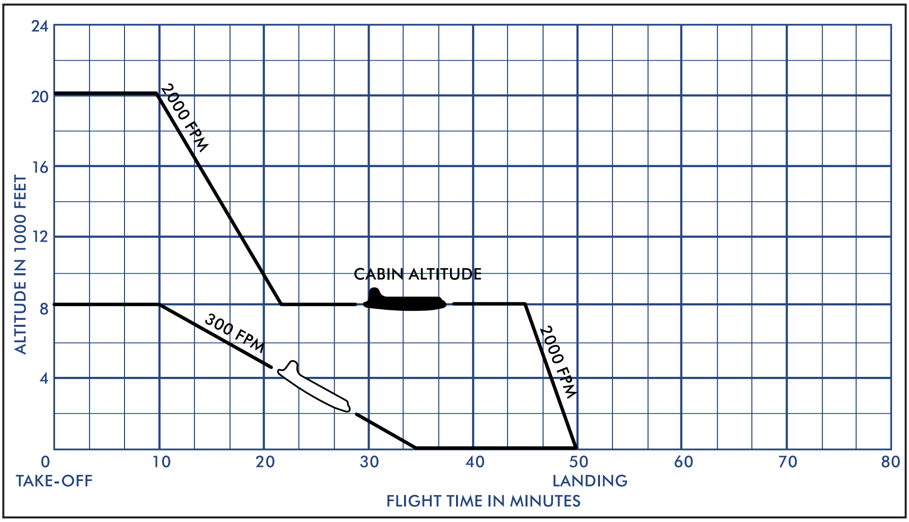

Figure 63 — Example No. 4

As mentioned, a control rheostat on the electrical control panel permits manual temperature variation within the cockpit. Heat is delivered through the distributing duct when the cockpit temperature control rheostat is placed in the "WARMER" position and when the windshield heat switch is "OFF" or in any of the vinyl warming positions. No heat will be delivered through the cockpit heat distributing duct when the windshield heat switch is in the "ANTI-ICING" position, although the hot-air exhaust from the windshield may be diverted into the cockpit or beneath the floor as desired. With the windshield anti-icing heat being applied, the cockpit temperature control should be in the "NORMAL" position. The cockpit mixing valve movement is controlled directly by the cockpit temperature control rheostat. Approximately 40-degree clockwise rotation of the rheostat is required to turn on the heater, which will subsequently cycle at approximately 95°C to 140°C (35°F to 60°F). For cooling turbine operation, the cockpit temperature control should be in "NORMAL" and the windshield heat control should be "OFF."

12.7.2. Heater Switches — Heater electrical ignition and fuel system selector switches, controlling duplicate ignition and fuel systems, are mounted on the heater control panel. Each switch has two positions: "SYSTEM NO. 1" (down) and "SYSTEM NO. 2" (up). In either position, the operation of the heater is automatic. The switches should normally be in the "SYSTEM NO. 1" position; however, if one system fails, the duplicate system can be switched into operation.

The on-off cabin heater master control switch is mounted adjacent to the heater ignition selector switches. In the "OFF" position, this master switch shuts off the cabin heater ignition, fuel supply, and the cabin heater fuel pump, regardless of the positions of the switch only when the heater must be turned off as a result of erratic heater operation or to maintain a consistent temperature during manual control of the heater.

A two-position cabin heater automatic control bypass switch is mounted on the heater fire control panel to provide a means of "last resort" operation of the cabin heater when all possible combinations of fuel and ignition have failed to obtain cabin heater operation. In the "ON" position the heater cycles at its maximum heat output of approximately 95°F to 140°C (35° to 60°F). When operating in this manner, watch the cabin heater temperature indicator to make certain that the temperature does not exceed 150°C (65.6°F). If this temperature is reached, turn the cabin heater master control switch alternately "ON" and "OFF" to control the heater. A cabin heater drop-out safety switch is incorporated in the heater system to prevent the heater combustion chamber from exceeding a safe temperature.

A two-position cross-feed switch is provided, adjacent to the heater fuel selector switches, for the heater fuel pump. The switch should be left in "NORMAL" (down) unless failure of either the cabin or airfoil anti-icing heater fuel pump is indicated. In that event, placing the switch in the "CROSS-FEED" position energizes both the airfoil and cabin heater fuel pumps and interconnects them to permit the cross-feeding of fuel.

The windshield heat control switch should be positioned to the correct O.A.T. reading en route in order to maintain correct vinyl temperatures and correct cabin heater operation.

12.7.3. Cabin Ground Blower — A cabin ground blower provides ventilating air for the cabin and/or combustion air for the cabin heater (depending on temperature demands) when the airplane is on the ground. Blower operation is automatic when an external power source is connected to the airplane with the engines inoperative or when the No. 2 and No. 4 engines are operating above the generator cut-in speed.

12.8. CABIN HUMIDIFIER — On some airplanes a means of varying the moisture content of the air entering the cabin is provided by a humidifier unit consisting of an electrically heated water boiler. The humidifier receives its water supply from the aft lounge water supply tank in the sleeper airplane and from the forward water tank in the dayplane. The unit is controlled by a four-position selector switch, "OFF" — "LOW" — "MEDIUM" — "HIGH," on the cabin attendant's temperature control panel. The switch controls three Calrod heating elements in the boiler; the "LOW" position energizes one of the elements, the "MEDIUM" position energizes two elements, and the "HIGH" position applies power to all three elements. The humidifier unit cannot be ground operated, as the control circuit is broken by means of a landing gear actuated relay.

No cabin instrumentation is provided for determining the moisture content of the air, therefore the cabin attendant must judge the need of increased moisture and determine whether the unit should be turned "OFF" or "ON."

12.9. DELETED.

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13. FIRE PROTECTION EQUIPMENT

The main fire protection system consists of fire warning lights, a fire warning bell, thermal detectors, a detector circuit test system, two banks of three CO2 cylinders each, and a selector system which permits discharge of either or both banks to the nacelle areas and the lower fuselage compartments individually (in some airplanes, the two wing airfoil heaters are also connected to the two banks). The selector valve controls, the manual discharge valve controls, and the warning lights for the nacelle areas and the fuselage are mounted in a row immediately below the glareshield. In those airplanes in which the airfoil heaters are connected into the main CO2 system, the electric CO2 discharge and selector controls and warning lights for the wing airfoil anti-icing heaters, as well as all the fire detector circuit test switches, are located on the heater fire control, panel above the left side window.

The CO2 cylinders are located in the nose gear well; each one contains a winterized charge of 11.66 pounds of C02 and nitrogen gas. The nitrogen is added to aid in rapidity of discharge at extreme temperatures. Oneinch flood valves are installed on the top of each cylinder. The valves on the two aft cylinders in each bank are operated by a series-cable control to discharge the system manually while each forward cylinder flood valve is operated by released CO2 pressure from either of the other cylinders. Each flood valve is equipped with a safety disc set to rupture at a pressure between 2650 and 3000 psi, discharging the gas overboard through a common red discharge indicator disc set into the right and left sides of the fuselage nose skin. If the two wing heaters are connected into the main CO2 system, the forward cylinders are each equipped with a 1 solenoid valve, electrically controlled, which releases CO2 gas to actuate the flood valves on the two aft cylinders. A yellow system-discharge indicator disc, adjacent to the red discharge indicator disc, indicates CO2 system manual discharge.

The CO2 gas is released into the system and is directed to the four nacelles, the lower forward baggage compartment, the lower aft baggage compartment, the hydraulic accessories compartment, and the cabin heater accessories compartment (and to the wing airfoil anti-icing heaters in some airplanes), as previously selected by operation of the appropriate selector valve handle or electric switch. The selector valve must be operated prior to the discharge of the CO2. The discharge of CO2, once started, cannot be stopped by pushing in either the discharge handle or the selector handle. The discharge handle should be left in the OUT position after pulling to indicate which bank of cylinders has been released. A check valve automatically isolates the used bank in the event that a second CO2 discharge is necessary.

Two electrically released CO2 cylinders, each containing a 1.03-pound winterized charge for the tail airfoil anti-icing heater and the cabin heater, provide fire protection, one cylinder for each heater. The controlling push buttons are located on the heater fire control panel. Dual warning lights are also mounted on the panel. In addition, the cabin heater is teed into the main CO2 system through the CO2 distribution lines in the heater accessories compartment. In some airplanes, the two wing airfoil anti-icing heaters are protected and individually operated by the main CO2 system controls, while other installations consist of a separate small cylinder similar to those on the cabin and tail heaters and similarly mounted and controlled.

For operation of both the main and electrically controlled systems, refer to Section VI.

13.1. MAIN FIRE DETECTOR SYSTEM — Dual warning lights, mounted in each fire extinguisher selector valve handle and CO2 discharge handle, are illuminated by action of thermal fire detectors installed in the critical areas. Dual lights are installed to ensure indication in the event of failure of either bulb. Thermocouple-type fire detectors are mounted in each nacelle area, fore and aft of the firewall, and thermal-switch-type fire detectors are located in the lower fuselage compartments.

The nacelle area is divided into three fire zones: Zone 1 is the power section forward of the inner ring (forward of the trailing edges of the cowl flaps). Zone 2 (accessory section) is the nacelle area between the inner ring and the firewall. Zone 3 is the nacelle area aft of the firewall. Zone 1 has fire detection, but no CO2 discharge, while Zones 2 and 3 are equipped with both fire detection and CO2 discharge.

The fire detection circuit is so arranged that in Zone 1, where there is no CO2 discharge, only the warning lights on the selector valve handle will illuminate. If a fire is detected in an area served by CO2 (Zones 2 and 3 of the nacelle areas and all the lower fuselage compartments) the lights on both the appropriate selector valve handle and on both discharge handles will be illuminated.

13.1.1. Main Fire Extinguisher System Manual Controls — Eight fire extinguisher selector valve handles and two CO2 discharge handles are mounted in a row immediately beneath the glareshield and are identified from left to right as follows: CO2 discharge handle (“L.H. CYL.”), lower forward baggage compartment (“FWD BAG”), hydraulic accessories compartment (“HYD. ACC. COMPT,”), No. 1, 2, 3, and 4 engines (“ 1 , “ “2,” “ 3 , “ and “4”), cabin heater accessories compartment (“HEATER COMPT.”), lower aft baggage compartment (“AFT BAG”), and CO2 discharge handle (“R.H. CYL.”).

The operation of the four engine handles not only controls the flow of CO2 to the individual nacelles but also closes the emergency shut-off valve, that cuts off the flow of fuel, oil, and hydraulic fluid (in inboard engines) to the affected engine and also shuts off the generator blast tube, which cuts off the flow of cooling air to the generator.

Operation of the lower fuselage compartment handles controls the flow of CO2 to the selected area. In addition, the discharge of CO2 into any of these lower compartments actuates a cable, which closes the cabin pressure control valve; when closed in this manner, the valve cannot be reopened in flight. The CO2 discharge also actuates a switch, which automatically shuts off the auxiliary vent blower that supplies the circulating air for the operation of the smoke detectors and the cabin thermister and for the ventilation of the toilets.

After the CO2 cylinders have been discharged, the direction valve and the pilot valve for the nacelles will automatically close, causing the selector valve handle to move about ¼ inch toward the closed position (forward). This leaves the emergency shut-off valves in the closed positions; therefore, if it is necessary to discharge the remaining bank of cylinders into the same area, the selector valve handle must first be pulled completely out again. Should it become necessary to direct CO2 to another area, pull the handle for that area and discharge the remaining CO2. Do not, however, push in any other selector valve handle that may have been, pulled for another area.

After operating one of the engine selector valve handles, if a propeller fails to feather completely and continues to windmill, the selector valve handle for the affected engine may be pushed in until a spring stop is felt, provided there is a reasonable assurance that the fire is out.

This action will partially open the oil supply line emergency shut-off valve, allowing oil to circulate and prevent engine seizure, and also will partially open the generator blast tube. The fuel and hydraulic fluid emergency shut-off valves will remain closed.

The bank selector switch provides a means of determining which CO2 installation is installed for the wing heaters; that is, if the bank selector switch is not installed, the wing heaters are equipped with individual CO2 cylinders. In those airplanes in which the two wing airfoil anti-icing heaters are connected into the main CO2 system, it will be necessary to check the CO2, cylinder bank selector switch on the heater fire control panel, after a wing heater fire, to determine which bank remains before pulling one of the two CO2 discharge handles. This must be done if it becomes necessary to combat a fire in any other part of the airplane, as, in such a. case, both handles will be in the forward position and will, not give any indication as to which bank has been released.

It is worthy of note that, as groups, the two CO2 discharge handles, the four lower fuselage compartment selector handles, and the four engine selector handles, will not pull out equidistantly. Consequently, when pulling a handle out for more than one group, pull firmly until the handle stops. Do not attempt to pull the CO2 discharge handle, for example, out as far as the engine selector handles, as the travel is less than a third that of the engine selector handle.

13.2. HEATER FIRE EXTINGUISHER SYSTEM — Two small cylinders, containing a winterized charge of 1.03 pounds of CO2 are attached, one each, to the cabin heater and the tail airfoil anti-icing heater. The cylinders are equipped with ½-inch flood valves and are electrically discharged by means of controls on the heater fire control panel. A yellow discharge disc, to indicate a normal discharge, and a red blowout disc, to indicate a thermal expansion discharge, are installed in the tail and. fuselage skin in close proximity to each heater. Dual warning lights, two for each heater, two selector switches (guarded), one for each heater, and a discharge switch are mounted on the heater fire control panel.

In addition to the electrically controlled system, the cabin heater is also teed into the main CO2 system, installed in the heater accessories compartment. Thus, when the main CO2 system is operated for that area, some CO2 is injected directly into the cabin heater. Consequently, three separate injections of CO2 into the cabin heater are possible (rather than a single discharge, as in the tail airfoil heater); one discharge front the small cylinder on the heater and one from each bank of CO2 cylinders of the main system.

In those airplanes that have the wing heaters connected into the main CO2 system, the direction valves are electrically operated by solenoids. Two dual warning lights, one for each wing heater, two guarded heater selector switches, a switch for selecting either the left or right bank of CO2 supply cylinders, and a discharge button are mounted on the heater fire control pane. In other airplanes, small cylinders containing a winterized charge of 1.03 pounds of CO2, like those installed on the cabin and tail heaters, are installed, one each, at each wing heater. Red and yellow indicators are installed on the bottom of each outboard nacelle. In this installation, the same dual warning lights and heater selector switches on the heater fire control panel are used, and the CO2 discharge button at the bottom of the panel is used to discharge all four cylinders.

13.2.1. Heater Fire Extinguisher Controls — When the warning lights illuminate for any heater, the plastic cover on the heater fire control panel must be raised and the selector switch for the heater indicated depressed first. The selector switch will shut off the fuel supply to all three airfoil heaters from both fuel System No. 1 and System No. 2, and will also prevent any fuel from being delivered to the airfoil heaters from the cabin heater fuel pump (however this does not affect the operation of the cabin heater unless the cross-feed fuel system is being used). In the same way, depressing the selector switch for the cabin heater cuts off all fuel (both System No. 1 and System. No. 2) and also prevents the cross-feeding of fuel from the airfoil, heater fuel pump to the cabin heaters (unless they are operating on the cross-feed fuel system, the operation of the airfoil anti-icing heaters is not affected).

Approximately ten seconds must be allowed to elapse after the selector switch is pushed, before depressing the discharge button to permit fuel to dissipate from inside the heater.

In some airplanes, if either of the wing airfoil anti-icing heaters is affected, a second discharge of CO2 into the same heater can be made, if it becomes necessary, by positioning the CO2 bank selector switch to the opposite bank and again depressing the discharge button.

Once the heater selector switches have been depressed, there is no means of resetting them during flight. Care should be exercised to make certain that the desired heater selector switch is depressed the first time; if the wrong switch is depressed first, or two adjacent switches are depressed simultaneously, the CO2 cylinders on both heaters will automatically discharge when the discharge button is depressed. In the same way, in those airplanes where the two wing heaters are connected into the main CO2 system, if the discharge is made to one heater, followed later by a discharge to the other heater, the solenoid-operated direction valve for the first heater will be re-energized and the discharge of CO2 will be split between the two heaters.

13.3. FIRE WARNING CIRCUIT TEST SWITCHES — All smoke and thermal detector circuits can be electrically tested for normal circuit continuity prior to flight by means of the momentary contact circuit test switches mounted on the heater fire control panel. When the “ZONE 1” test switch is depressed, the warning lights in all four selector valve handles for the nacelles will illuminate and the fire bell will sound, but the warning lights in the two CO2 discharge handles will not illuminate. Depressing the “ZONE 2 AND 3” test switch will illuminate both the selector valve handles and the discharge handles, as well as sound the fire bell. Depressing the “FWD BAG,” “HYD. ACC,” “HEATER COMPT.,” and the “AFT BAG” switches will sound the fire warning bell and illuminate both the respective selector valve handle and both discharge handles. The warning lights may not illuminate immediately when a switch is closed; from two to ten seconds may elapse before all the lights are illuminated because of the time required to heat the test element.

When the “BAG SMOKE” test switch is depressed, only the smoke detector warning lights adjacent to the “FWD BAG” and the “AFT BAG” (and in some airplanes, the heater accessories compartment handle) selector valve handles will illuminate (but not the handles themselves, nor will the fire warning bell sound).

After testing the smoke detector circuits, the "SMOKE RESET" switch must be depressed to reset the smoke detectors to an operative condition; this will also cause the smoke warning lights to go out. However, following a fire in an area equipped with a smoke detector, it may not be possible to reset the smoke detectors, as smoke in the compartments will automatically maintain, the detectors in a tripped condition. No reset switch is required for the thermal detector systems, as the lights will go out when the test switches are released.

13.4. PORTABLE FIRE EXTINGUISHER — Four portable fire extinguishers, carbon tetrachloride and/or CO_2 are located in accessible positions in the interior of the airplane. Complete instructions for the use of this equipment are attached to each extinguisher.

When sprayed on a fire, carbon tetrachloride produces phosgene gas, which can be harmful even if breathed in small quantities. DO NOT stand near fire when spraying with carbon tetrachloride. The odor of phosgene strongly resembles that of moldy hay.

13.5. LOUNGE FIRE EXTINGUISHING SYSTEM — A carbon tetrachloride fire extinguisher system is installed in the soiled-linen containers in the lounge. Automatic in operation, the system consists of a temperaure-released valve nozzle and a CO_2 pressurized carbon tetrachloride supply. There are no warning devices to give indication of a fire in the soiled-linen containers.

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Section III
POWER PLANT

1. GENERAL ARRANGEMENT

The DC-6 airplane is powered by four eighteen-cylinder, two-row, radial, air-cooled, Pratt & Whitney Aircraft Double Wasp CB-16 engines with propeller reduction gearing of 0,4375:1. Each engine is equipped with a single-stage, two-speed, integral engine-driven supercharger, which is controlled by a selector switch. Hamilton Standard propellers are installed on this airplane. A water/alcohol injection system is also installed as an optional extra.

2. ENGINE SPECIFICATIONS

Number of cylinders	18
Cylinder diameter (bore)	5.75 inches
Length of piston stroke	6.00 inches
Piston displacement	2804 cubic inches
Compression ratio	675:1
Blower gear ratio	
Low	7.29:1
High (CB-16)	8.58:1
Blower diameter (CB-16)	12.5 inches
Propeller reduction gear ratio (CB-16)	0.4375:1
Propeller shaft spline size	SAE No. 60A
Fuel required	Grade 100/130
Oil recommended	120 S.U.S. at 210°F, grade 1120, winter; 100 S.U.S. at 210°F, grade 11.00, summer

3. ENGINE RATINGS

Engine ratings are the limits of operation within which the accepted degree of reliability and efficiency can be obtained. Outside of these limits, the pilot is relying on safety margins that have not been proved. In the rating chart for this engine, Normal Rated Power, or METO, is the maximum power permissible for continuous operation under any normal flight condition. Normal rated rpm is the maximum engine speed that may be used for continuous operation, regardless of power. Take-off and Maximum Continuous ratings are listed on the CAA Certificate.

Double Wasp CB16 Engine Ratings

CONDITION	BHP	RPM	ALTITUDE IN FEET	MANIFOLD PRESSURE (Inches Hg)
Low blower 7.29:1				
Take-off (2 minutes, "dry")	2050	2700	6900	55.0
Take-off (2 minutes, "wet")	2400	2800	5000	59.5
METO LOW	1800	2600	9700	46.5
				(47.5-S.L.)
METO HIGH	1700	2600	16,700	47.5
8.58:1				(49.0-10,000 ft.)
Normal Rated Power				
Low	1800	2600	9700	46.5
				(47.5-S.L.)
High	1600	2600	18,700	44.5

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4. FUEL SPECIFICATIONS

The engine should not be operated on fuel of lower rating than grade 100/130 octane. The use of a fuel of higher than the required antiknock rating is preferable if the specified fuel is not available.

5. IGNITION SYSTEM

Each engine is equipped with dual, eighteen-cylinder, Bendix-Scintilla Type DF18LN magnetos and special type radio-shielded harness, which is integral with the magneto distributor blocks. Dual Bendix-Scintilla pressurized distributor assemblies work in conjunction with the magnetos. Each distributor housing incorporates a rotary air pump to furnish and maintain adequate air pressure in the magnetos and distributors at high-altitude operation.

The ignition switches on the forward overhead panel are connected to the magnetos through grounding circuits that are completely isolated from all other electric circuits by conduit and shielding. A starter induction vibrator supplies an interrupted current to the primary winding of the magneto to boost the secondary high voltage for starting. The vibrator operates through the boost switch on the forward overhead panel.

Engine performance furnishes the only clue to the functioning of the ignition system. The ignition switches have four positions: “BOTH,” “L,” “R,” and “OFF.” During engine run-up, it is advisable to check the ignition system out by turning the switches from “BOTH” to “R” to “BOTH” to “L,” stopping at each position long enough to note rpm drop-off. Switch momentarily to “OFF” and note whether the system cuts out; then return the switches to “BOTH.”

When reversing powers are used, higher temperatures and the absence of a cooling airstream around the ignition harness may lead to damage of the harness. Therefore, do not use reversing powers for any protracted period of time.

On some airplanes, a low-tension ignition system is installed. This system differs from the normal ignition system in that a high-tension induction coil is located on each engine cylinder instead of a high-tension current being supplied directly from the distributor.

Figure 77 — Power Plant Switches

6. STARTING SYSTEM

A direct-cranking electric starter is mounted on each engine. The starter controls, located on the forward overhead panel, consist of a selector switch for choosing the engine to be started and primed, a start switch for energizing the starter, a boost switch to provide sufficient electric boost to the magnetos, and a starter safety switch. A prime switch is mounted to the left of the start switch for aid in starting the engines. The boost switch is mounted to the right of the start switch. Except for the selector switch, the remaining switches are momentary-contact type.

The engine starter selector switch must be out of the “OFF” position and set to the engine to be started before the start switch or the prime switch will function. The safety switch must be held in the ON (aft) position and the boost switch must be depressed before the start switch will function.

Because of the extremely high amperage drain on the battery during starting operations, an external power source should be used for starting if possible. After starting the first engine, if an external power source is low or is not available, the engine can be run up to approximately 1200 rpm (after it is sufficiently warm) and the generator switch turned “ON” to supply current for starting the remaining engines. During this kind of engine start, all power in the cockpit should be off, except to the inverter that is supplying engine instruments and to the necessary flight compartment lighting.

If an engine fails to start within 45 seconds, shut down and allow the starter motor to cool for approximately one minute. If the engine does not start on the *second try, a five-minute shut-down is necessary* to allow the starter motor to cool. Start the next engine in the interim.

7. CARBURETORS

The Bendix-Stromberg pressure-injection, automatic type carburetor used on the Pratt & Whitney engines is composed of four basic units. These four units are coordinated to measure the air and fuel delivered to the engine to maintain a controlled fuel-air ratio throughout the entire operating range, from idling to take-off power. The carburetor, as a unit, controls fuel flow; the throttle unit controls airflow.

Manifold pressure gauge line purge valves, one for each pressure line, are mounted immediately below the panel for the purpose of purging the lines of condensate and foreign material. The valves are operated by depressing the valve knobs. The lines should be purged only when manifold pressure settings are less than that of the existing barometric pressure reading for the airplane's actual altitude. If the purging operation is not performed in this manner, the lines will fill instead of purging.

The pressure of the fuel delivered at the entrance of the carburetor is important to the fuel-air ratio. If it does not fall within the lower specified limit, the carburetor will not meter fuel correctly in response to airflow.

The carburetor air temperature indicators, mounted on the engine instrument panel, measure the temperature of the air entering the carburetors. A red line at 38°C warns of approach to the low blower detonation range. The two banks of four throttles on the top face of the control pedestal are marked "OPEN" (forward), "CLOSE" (center), and "REV" (aft).

A throttle-locking solenoid is installed as a safety precaution to prevent inadvertent operation of the propeller reverse-pitch mechanism during flight. A switch on the right main gear and/or the nose gear energizes the solenoid to release the lock as the weight of the airplane is assumed by the gear.

A take-off warning circuit is connected with the throttles. If the inverters are not operating, or the wing flaps are not positioned for take-off, or all propellers are not in take-off position, the take-off warning horn in the horn box will sound when the throttles are advanced.

A friction lock is installed to the right of the left bank of throttles. The locking position is forward. On some airplanes, a drop-leaf bar prevents two of the throttles from being advanced whenever the gust lock is engaged. The bar, actuated by the gust lock lever linkage, automatically drops down onto the top of the control pedestal when the gust lock is disengaged.

7.1. CARBURETOR AUTOMATIC-MIXTURE CONTROL UNIT — The carburetor automatic-mixture control unit consists of a sealed metallic bellows operating a contoured needle valve. The sealed bellows is filled with nitrogen and an inert oil to make it sensitive. The control compensates for en route changes in temperature and pressure by metering fuel in such a way as to conform to the basic fuel-air ratio curve throughout all flight conditions.

7.2. CARBURETOR PRESSURE REGULATOR UNIT — The carburetor pressure regulator unit automatically adjusts the fuel pressure across the metering jets in direct proportion to the mass airflow through the throttle body. The unit is made up of an air diaphragm, a fuel diaphragm, a sealing diaphragm, a balancing diaphragm, and a balanced fuel valve. Fuel enters through a strainer, passes through the balanced fuel poppet valve to one side of the fuel diaphragm chamber, and then flows to the jets in the throttle control unit. Vapor separators are provided in the fuel strainer chamber and the unmetered fuel chamber to prevent vapor from entering the metered fuel chamber.

7.3. CARBURETOR FUEL CONTROL UNIT — The carburetor fuel control unit, attached directly to the regulator unit, consists of a series of metering jets, a manual mixture control valve, an idle valve, a power enrichment valve, and a regulator fill valve. During the idling range of speeds, the idle valve meters the fuel, opening fully at higher rpm to offer no restriction. The manual mixture control valve is equipped with a mixture control lever. When the valve is placed in the closed—”IDLE CUT-OFF”—position, the fill valve is closed and prevents flow of fuel from the metered fuel chamber in the regulator, thereby stopping all fuel flow to the engine.

It is important that the mixture control be returned to “IDLE CUT-OFF” and that the booster pump be turned “OFF” immediately following a false start, as, with the primer switch “OFF” and the booster pump in “LOW,” between 2 and 4 pints of fuel per minute will discharge into the engine. Even with the booster pump in “LOW” and the mixture control in “IDLE CUT-OFF,” it is possible for some fuel to be forced past the carburetor poppet and primer valves. It requires less than one pint of fuel to hydraulically lock a cylinder.

7.4. CARBURETOR MANUAL MIXTURE CONTROL — The manual mixture control valve in each carburetor is equipped with a control lever on the aft right face of the control pedestal. Each lever has the following positions: “AUTO RICH,” “AUTO LEAN,” and “IDLE CUTOFF.”

7.4.1. Auto Rich — The “AUTO RICH” position is the normal position to be used for all operations, except when a leaner mixture is desired for cruising. The “AUTO RICH” setting automatically maintains a pre-set fuel-air ratio for high-power output.

7.4.2. Auto Lean — The “AUTO LEAN” position is a leaner setting than “AUTO RICH” and is suitable for cruise operation. It may be too lean for rapid engine

Figure 82 — Mixture Controls

Figure 83 — Carburetor Preheat Controls

acceleration. The “AUTO LEAN” position also provides automatic fuel-air ratio operation.

7.4.3. Idle Cut-Off — The “IDLE CUT-OFF” position stops all fuel flow to the fuel discharge nozzle, regardless of throttle position. The mixture control must be left in “IDLE CUT-OFF” when the engine is inoperative.

7.5. CARBURETOR AIR TEMPERATURE AND PRE-HEAT — The metering of fuel in the carburetor may be seriously affected by the formation of ice in the main air passages of the induction system or in the air passages of the carburetor itself. Ice forms principally as a result of low temperature, or because of a combination of low temperature and high-moisture content of the air, or as a result of the expansion of air through the carburetor. Carburetor air temperature leaving the system will be 10C to 26C lower than induction temperature as a result of fuel vaporization and mass flow acceleration. The heat reduction will depend upon mixture setting, with richer mixtures resulting in greater heat loss. The most evident indication of carburetor ice accretion on the airplane is changing fuel flow (usually leaning) followed by a related drop in BMEP. A drop in manifold pressure may also occur if the icing is severe enough.

The four grip-type carburetor air temperature controls, located on the right aft face of the control pedestal, are used to regulate the temperature of the air entering the carburetors. Temperature indication is given by two dual carburetor air temperature indicators on the engine instrument panel. The control quadrants are marked “HOT” (full up) and “COLD” (full down), with intermediate settings available. Moving a control toward the “HOT” position operates a door in the airscoop, which, in turn, allows air heated by the engine to enter the induction system. The engines should never be started with the carburetor air temperature controls in the “HOT” positions, as severe backfiring may damage the preheat system. During icing conditions, start each engine in the “COLD” position and then move the carburetor air temperature control to “HOT” after the engine starts.

It is not recommended that take-off’s be made using carburetor preheat, as a power loss of 1 per cent per 10 degrees of carburetor air temperature rise above 60 degrees can be expected.

Carburetor preheat should be used as a preventive measure against an icing condition, rather than as a cure, and should be selected prior to entering known moisture-laden air. Preheat should be used whenever necessary to hold the carburetor air temperature to a maximum of 15°C (59°F) in “HIGH” blower, and to a maximum of 38°C (100°F) in “LOW” blower.

During let-down operation while low power settings are being used and so that spark plug fouling will be minimized, it is advisable to use varying amounts of carburetor preheat. Hold CAT. maximums as given above.

It must be remembered that carburetor heat is engine heat, and that, if the engine has lost power due to carburetor icing, the amount of engine heat available may be insufficient to remove the ice, in which case the carburetor alcohol anti-icing system must also be used.

7.6. PRIMING SYSTEM — The priming system functions as an aid in starting the engines by injecting straight charges of fuel into either the top eight cylinders of each engine or into the blower throat on later manufactured or modified engines. When used properly, the priming system greatly reduces the hazards of flooding. During priming, it is necessary to operate the fuel booster pumps in “LOW” boost to create sufficient fuel pressure, and, in extreme cold weather starts, it may be necessary to use “HIGH” boost. The engines should be started using the priming system only, the mixture controls being moved out of “IDLE CUT-OFF” after the engines start firing. To avoid overloading a warm engine, it is advisable to flick the primer switch intermittently while cranking, although the actual amount of priming necessary will depend on weather conditions and air temperatures.

Excessive priming will load the cylinders with raw fuel, causing starting difficulty and tending to wash the oil film off the cylinder walls, with consequent danger of scoring or piston seizure. Excessive priming may also cause fuel to drain back through the intake pipes of the primed cylinders and collect in the intake pipes of’the bottom cylinders, making hydraulicking possible.

The engines should not be started with the mixture controls out of “IDLE CUT-OFF.”

Insufficient priming or too much throttle opening is usually indicated by backfiring of the engine through the intake system, in which case cranking and priming should continue until the engine commences to fire. The priming solenoid on each carburetor is actuated by the momentary contact switch on the forward overhead panel, adjacent to the starter switch. It is necessary to position the engine selector switch before operating the priming switch.

8. ENGINE SUPERCHARGING

The rear crankcase section of the engine accommodates drive gears and clutches for the single-stage, two speed, integral, engine-driven supercharger.

The blower ratio clutches incorporate creeper gears that aid in preventing sludge accumulation. The creeper gears cause intermittent bleeding of pressure oil from the clutches to carry off sludge formations that tend to cause sticking of the clutches. However, formation and accumulation of sludge will vary with operating conditions and types of oil used, and it is advisable to shift the clutches prior to each take-off and at periodic intervals during flight (approximately every two hours) to ensure proper clutch operation. Allow the clutch to operate for approximately 10 minutes before returning to the desired blower speed. Oil dilution procedures tend to aggravate the accumulation of sludge. The engine superchargers are controlled electrically by two-position switches on the upper instrument panel. The use of the “LOW” blower should be maintained as long as possible, shifting to “HIGH” blower when the critical blower altitude is reached. The critical blower altitude is calculated on the Take-Off, Climb, and Landing Charts in Section VIII. Since, as a general rule, BMEP readings will be lower in “HIGH” blower than in “LOW,” operation may be continued in “LOW” blower until BMEP drops to the “HIGH” blower value before shifting blower ratios. When shifting blower speeds from “LOW” to “HIGH,” reduce throttle setting to avoid excessive manifold pressure. It is not necessary to reduce manifold pressure when shifting from “HIGH” to “LOW.” Reset throttles after shifting to obtain desired manifold pressure. All take-offs should be made in “LOW” blower. All engine ground operation, except during blower clutch check, should be made with the supercharger in the low blower gear ratio. High blower is only used at an altitude when the power output is insufficient in low blower. However, it must be remembered that the increase of horse power required to drive the high blower creates increased fuel consumption of approximately 16 gallons per hour per engine.

The lack of a change of BMEP and fuel flow when shifting from “LOW” blower to “HIGH” or vice-versa indicates a fixed-position blower, caused by failure of the blower shifting mechanism. To determine whether the blower is in “HIGH” or “LOW,” compare the BMEP and fuel flow readings obtained with those of a properly operating engine at the same manifold pressure reading. There is no way of shifting a locked blower. If “HIGH” blower operation becomes necessary at low altitudes, due to a locked blower, care must be taken to operate the engine within power and C.A.T. limits to avoid detonation, as the higher temperature rise through the supercharger in the high ratio makes it imperative that the C.A.T. be held to lower limits than in low ratio. If an engine should stick in high blower, an emergency approach power of a maximum of 2400 rpm and 46.5 inches Hg manifold pressure may be used. This is not to be construed as an emergency highblower take-off rating.

9. COWL FLAPS

The cowl flap actuating system serves to control the amount of cooling airflow over the engine. During all ground operation of the engine, it is essential that cowl flaps be fully open, regardless of O.A.T. The ignition harness and other power plant items require all possible cooling.

The cowl flap potentiometer controls (cowl flap positioning switches) on the upper instrument panel are used to set the cowl flaps to their desired positions. The switches are calibrated in increments of two degrees, from -4° to +22°.

Recommended cowl flap positions are:

For take-off and climb	+4°; maximum cylinder-head temperature 260°C (500°F)
For normal cruise and descent	"CLOSE"; maximum cylinder head temperature 232°C (450°F) ; desired, 200°C (400°F)
For approach	+4°; maximum cylinder-head temperature 260°C (500°F)

The cowl flaps are designed to operate throughout their full travel at DC-6 design dive speed.

10. BMEP INDICATION

A basic limitation placed on engine operation is imposed by the pressures developed in the cylinders during combustion. Within limits, as these pressures become greater, an increase in power results. However, when pressures become too great, they impose dangerous loads on engine structures, leading to excessive temperature and resulting in possible engine failure. Cylinder pressures are not directly recorded on any cockpit instrument. However, a number of factors can be taken into account and the resulting interpretation, indicative of cylinder pressures, is recorded as BMEP (brake mean effective pressure) on the four BMEP indicators mounted on the engine instrument panel. Although BMEP limits will not necessarily be the same throughout the operating range of the engine, BMEP values do set a series of limits for preventing detonation and protecting the cylinders against excessive pressures. The most efficient results will therefore be obtained by operating at or near the recommended BMEP limits. The BMEP indicating instrument gives a reading in pounds per square inch. The power calculated from the indicated values of BMEP and rpm is the power delivered to the propeller by the engine and does not include the power delivered to accessory equipment. No other variable need be considered. Engine power (below METO) may be set by BMEP and rpm values, as charted in the performance data given in Section VIII. No one engine should be set on a BMEP basis at higher than two inches Hg manifold pressure above the average manifold pressure of the other three engines. The BMEP indicator is a valuable instrument of power output measurement but should always be used in conjunction with other engine instruments. Do not attempt to maintain a constant BMEP reading during engine malfunctioning or during applications of carburetor heat in excess of established limits.

11. HAMILTON STANDARD PROPELLERS

The Hamilton Standard propeller is a full-feathering, reversible-pitch, constant-speed-type, governor-controlled, electrically controlled, and hydraulically positioned propeller. The installation in the DC-6 airplane provides limited-range automatic synchronization as well as a manual synchronizer override. Ice formation is removed from the blades of each propeller by electrical heating elements installed on or in the leading edges of the blade. For complete operating instructions and a description of the propeller de-icing system, refer to Section II.

Each propeller installation has its own circuit breaker for feathering and reversing circuits, mounted on the main circuit breaker panel. In addition, one circuit breaker for the manual governor control and one for the synchronizing control are mounted on the same panel. Each propeller has its own manual selector control switch, mounted on a control box on the top face of the control pedestal.

A master synchronizing control is mounted adjacent to the individual selector controls.

The two-chambered hub of the propeller assembly incorporates oil-actuated servo units for controlling propeller blade angle or pitch. A bevel gear at the root of each blade is in constant mesh with a power gear driven by a movable helically-slotted cam, which, in turn, is joined to a helically-slotted fixed-position cam through a roller assembly. As the roller assembly travels back and forth in the cam slots, the power (or movable) gear cam is forced to rotate back and forth also, thus driving the blade gears and changing the angle of the blades. The roller assembly is moved by a hydraulically actuated piston, which moves forward to decrease blade pitch and aft (toward the engine) to increase blade pitch. Normally, the piston is limited in travel at the low-pitch setting by stop levers. However, when the propeller-reversing feature is used, the low-pitch stops are released, allowing the piston to move forward to the reverse-pitch stop. The stop levers reseat themselves again when the propeller has completed the unreversing cycle.

11.1. HAMILTON STANDARD PROPELLER GOVERNORS — Constant-speed operation is controlled by an engine-driven flyweight-type double-acting governor, mounted directly on the front accessory section case of each engine. The governor directs engine system oil to and from the two chambers of the propeller hub. The oil, boosted in pressure by a pump incorporated in the governor, is controlled by a pilot valve that is moved toward the increase rpm (low-pitch) position by a speeder spring against which the flyweight governor itself operates. In an underspeed condition, for example, the flyweights permit the pilot valve to be pushed by the speeder spring, while in an overspeed condition, the pilot valve is moved by the flyweights against the speeder spring tension. During the on-speed condition, the governor maintains an equilibrium in pressure. The tension of the speeder spring is variable and is regulated by a rack-and-pinion arrangement, the pinion of which is driven through a gear reduction system by a stepmotor consisting of a small three-phase-wound magnet. An rpm limit indicator switch is built into each stepmotor to give visual indication that a maximum rpm limit has been reached; it also supplies signals to the synchronizer for calibration operation.

The governor is equipped with an auxiliary oil supply, the oil is supplied by an electrically operated, auxiliary, high-pressure, gear-type pump through a check valve, to permit the introduction of higher-than-normal oil pressure for rapid blade-angle variation during the feathering or reversing cycles. For feathering and unfeathering, the auxiliary pump is controlled by means of the feathering buttons on the forward overhead panel and receives its power from the engine starter bus through the starter limiter fuses. During reversing and unreversing, the pump is energized by relays in the reversing circuit.

The propeller rpm limit for minimum governor control (full high pitch) is 1200. For the Hamilton Standard propeller governor check, refer to Section V.

11.2. HAMILTON STANDARD PROPELLER TACHOMETER GENERATORS — On most airplanes, a heavyduty tachometer generator, mounted on each engine, provides voltages for the tachometer indicating system as well as a means for the synchronizer to compare the speeds of the engines. On some airplanes, separate generators are installed for the tachometer indicating system. While the voltage output will vary with engine rpm, the synchronizer control units are sensitive to frequency only.

11.3. HAMILTON STANDARD PROPELLER CONTROLS — All the propeller controls are located on the top face of the control pedestal, with the exception of the circuit breakers and the feathering switches.

11.3.1. Individual Selector Switches — Four toggle-type, momentary-contact selector switches, one for each propeller, are mounted on the top face of the control pedestal. These switches provide speed variation for any one engine independently of the others and can be used with the system in either manual or automatic. The switches are two-position switches and are placarded “DECREASE RPM” and “INCREASE RPM.”

While the switches can be used to vary the rpm of one or more engines, the engine being used as a master engine should be controlled by means of the master control lever adjacent to the selector switches. In automatic, if a toggle switch is used to change the speed of a slave engine more than 3 per cent of the master engine rpm, the master engine will not pull the slave back into synchronization. This is known as limited band control.

An indicator light is mounted adjacent to each selector switch and illuminates when the corresponding propeller governor has reached its high- or low-rpm limit. However, whether low-rpm light indication is received or not is relatively unimportant, as it is the high-rpm indication that is critical.

Figure 85 — Propeller Controls (Hamilton Standard)

11.3.2. Master Control Lever — The propeller master control lever, mounted between the throttle locking lever and the propeller selector switches, is connected to the synchronizer unit, which, in turn, operates through a follow-up system to vary the rpm of all four engines simultaneously. The master lever is placarded "DECREASE RPM" (aft position) and "INCREASE RPM" (forward position); the take-off position is full forward. At the full-forward position (high rpm), the lever actuates a switch that, through relays, disconnects the synchronizing system when the engines are set for take-off rpm, thus allowing each engine to seek its maximum rpm for maximum power output, irrespective of its speed relative to the other engines. With the lever full forward, the system is non-automatic, and the individual selector switches can be used to synchronize engine rpm. The position.of the lever is not necessarily an indication of synchronized speed unless the system has been calibrated either by placing the lever in the full "INCREASE RPM" position after any manual operation, or by manual adjustment of the individual toggle switch.

11.3.3. Master Engine Selector Switch — The master engine selector switch, mounted adjacent to the individual propeller selector switches, is a three-position toggle switch—"ENGINE 2," "MANUAL," and "ENGINE 3"—which provides a means of selecting either inboard engine to act as the master engine to which the remaining engines are slaved, or permits manual control of the propeller system. With the switch in the "MANUAL" position the master control lever is rendered inoperative and the individual selector switches can be used to vary the propeller rpm to attain synchronous rpm. In the "MANUAL" position, it is possible for the propellers to be placed in full high pitch by means of the selector switches, even though the master lever is in the full-forward position. With this-selector switch in "MANUAL," movement of the master control lever will have no effect and may require recalibration when selecting No. 2 or No. 3 engine again.

11.3.4. Resynchronizing Switch — A resynchronizing push-switch is mounted adjacent to the master engine selector switch to permit synchronizing the system without overshooting when one or more engines are out of synchronization with the master engine. Depressing the switch allows each engine to progress three per cent toward the master engine speed each time the switch is depressed and released. For operating procedures in the event of malfunctioning propellers, refer to Section VI.

11.3.5. Synchronizer Unit — In the Hamilton Standard propeller installation, three engines are designated as slave engines, and the blade settings of the respective propellers are controlled to synchronize the rpm of the slave engines with the fourth, or master, engine. The heart of the synchronizer system is the synchronizer unit located in the inverter compartment.

11.4. FEATHERING AND UNFEATHERING HAMILTON STANDARD PROPELLER — Four feathering buttons are mounted on the forward overhead panel. The buttons are push-pull type with three positions: fully depressed is the feathering position; pulled full out is the unfeathering position; and the detent, approximately halfway between these two positions, is the neutral, or normal inoperative position. Before feathering the master engine, the master engine selector switch should be placed in the opposite engine position, otherwise the propellers of the slave engines will decrease approximately three per cent of the master engine rpm before being stopped by the synchronizer system as they attempt to follow the master engine down in rpm.

For feathering, the buttons are depressed and will automatically hold in this position until the feathering operation has been completed, when they should return to the normal position.

For unfeathering, the buttons should be pulled full out and held for not more than two seconds, then released. Wait ten seconds for indication of propeller rotation. Under extremely low OAT conditions, hold the propeller to a speed of 200 to 300 rpm. Allow the Hamilton Standard propeller to windmill at this speed to circulate cold or congealed propeller oil before unfeathering to the governing range (1200 rpm) and starting the engine.

When feathering and unfeathering in flight, the same considerations must be given to the temperature condition of the engine that apply when shutting down or starting up on the ground. In other words, during practice feathering, it is essential that the engine be cooled as gradually in flight as on the ground; even more so, in fact, as the continued airflow results in a greatly increased rate of cooling, which, in turn, magnifies the detrimental effects of uneven contraction of engine parts. Similarly, it is equally important that the engine be given a warm-up period during the unfeathering operation before applying full power.

For complete feathering-unfeathering operation and check-out procedures of the Hamilton Standard propeller, refer to Section V.

12. PROPELLER REVERSING

Reverse thrust is obtained by rotating the blades through low pitch to a negative angle, thus reversing the direction of thrust.

Reversing the propeller on the ground is accomplished by pulling the throttles aft past the center, or closed, position, which can be felt as a definite stop. At this point, a cam-actuated switch on the forward face of the control pedestal closes to energize the propeller reversing circuit. A continuing aft movement of the throttles applies engine power under the same variable degrees of power application as during conventional thrust. A throttle reverse lock assembly, actuated by a landing-gear-controlled solenoid, prevents the propellers from being reversed during flight. When the landing gear assumes the weight of the airplane on the ground, the lock is released, permitting the use of reverse pitch. The propeller blades are returned to the normal operating range simply by pushing the throttles forward, again past the closed position. A second throttle lock, individual for each engine, prevents power from being applied to the engine for reversing operation should the reversing circuits fail to become energized. A fast rate of pitch change is provided for reversing and return from reverse.

Reverse pitch, when properly used, can increase the safety and utility of the airplane on the ground by making available an additional positive braking system and simplifying landings on ice-covered runways. However, engine cooling must be considered in another light during reverse-pitch operation. The engine creates as much heat during reverse-pitch operation as during positive thrust, but a cooling airstream is no longer circulated, to the same degree, around the engine and its accessories to dissipate the heat. It is even possible for the reversed airflow to draw some of the engine exhaust directly into the engine section. The effects of this accumulation of non-dissipated heat may not show up immediately and are not indicated on any cockpit instrument.

It is well worth noting that the cylinder temperatures which are measured on the downstream side under normal airflow conditions become the cylinder temperatures on the upstream side when the airflow is reversed. The upstream temperature is about 55°C (131°F) lower than the downstream temperature and cannot be used as an indication of true cylinder condition unless this difference is taken into account.

Cylinder head temperatures will not rise materially, as the reserve of heat capacity allows the bulk of the engine to absorb heat without appreciable temperature rise.

The damage that may result from heat will be to those engine accessories made of rubber components and may not become apparent from one application of heat. Therefore, do not prolong reversing operations.

Protracted periods of reverse operation should be avoided. Caution should be used when reversing the propellers on runways covered with dust or light snow to prevent loss of visibility. High rolling speeds of the airplane are not recommended in reverse.

NOTE: We suggest you use the following key assingment in MSFS under Options -> Controls ->Keyboard->Flight Control Surfaces->Primary Control Surfaces: **Toggle Water Rudder**.

13. WATER/ALCOHOL INJECTION

A water/alcohol (W/A) injection system is an optional installation to permit the safe increase of takeoff powers according to the requirements of the operator. These added performance requirements may be to increase payloads or to permit operations from airports with otherwise restricted runway lengths.

Contrary to common assumption, the injection of a water/alcohol mixture does not, in itself, increase the power output of an engine. Neither does it produce the same reaction as atmospheric humidity, which actually results in a loss of brake horsepower output—a loss which will be experienced by either a “wet” or “dry” engine, although the “dry” engine will lose power more rapidly.

The injection of W/A merely acts as a detonation suppressant, allowing engine operation with “Best Power” mixture in the high-power range.

“Best Power” mixture in the high-power range (“dry” operation) will result in a combination of temperature and pressure of the fuel/air charge, leading to detonation. This tendency to detonate is suppressed normally by enriching the mixture beyond “Best Power” to supply excess fuel to cool the combustion; however, this will, in turn, result in a power reduction of approximately six to eight per cent. This enrichment can be increased until the excess fuel being used as a cooling agent will literally flood the engine.

The W/A injection mixture replaces the excess fuel used for cooling with a volume of W/A, which serves even better the purpose of cooling the charge and consequently suppresses the tendency toward detonation. During W/A injection, the fuel/air mixture strength is automatically reduced to "Best Power" by the derichment valve in the carburetor, and, if no change is made in manifold pressure, a power increase of approximately 160 brake horsepower at sea level is immediately obtained. This increase is due entirely to derichment to "Best Power" mixture.

The anti-detonant qualities of water/alcohol are such that, in addition to the increased power obtainable at the normal take-off manifold pressure, the throttle may be further advanced to obtain an additional power output of approximately 140 bhp by increasing the manifold pressure. This added throttle movement applies only to engines such as those used on the DC-6, which do not require full-throttle travel for normal take-off powers at sea level.

A typical example of the power increase resulting from the injection of W/A during a take-off at 2100 bhp is the immediate advance to approximately 2260 bhp obtained as a result of derichment. At sea level and at a standard day temperature, the throttles can be further advanced to obtain an additional 3 inches Hg manifold pressure to gain a further increase of 140 bhp, making a total possible take-off bhp of approximately 2400.

It is a CAA requirement that all W/A supply tanks must be filled to capacity prior to each wet take-off.

The tanks hold sufficient fluid for 2 minutes of operation at take-off powers, with 150 per cent reserve supply remaining. The W/A will flow into the engine at a rate of approximately one gallon per minute at sea level. For W/A formulas, see Section I, paragraph 3-3.

The W/A injection system, when installed, consists of four similar systems, one for each engine. Each system, consists essentially of a vented, a 5- or a 10-usable-U.S.-gallon capacity W/A tank, located on the aft face of the firewall for the inboard engines and in the leading edge of the wing for the outboard engines, a pump, a combination water regulator, a derichment valve in the carburetor, and controls for operating the system. Four "ON-OFF" switches, one for each injection system, are mounted on the aft overhead, panel; two dual quantity indicators are mounted on the upper instrument panel; two dual, system pressure indicators are mounted on the engine instrument panel;

and four green W/A flow indicating lights (in some airplanes, these lights indicate that water pressure is available to the water regulator), which indicate normal W/A flow, are mounted on the captain's flight instrument panel.

13.1. W/A INJECTION PUMPS — A positive-displacement, vane-type pump, electrically driven, is mounted in the vicinity of each W/A supply tank. Each pump incorporates a pressure relief valve set to return excess W/A to the inlet port of the pump when the W /A injection system pressure at the pressure regulator exceeds 22 (±1) psi at rated flow at 59.5 inches Hg on CB-16 engines, and 2800 rpm, or full throttle. These pressures will be approximately 27 to 32 psi on the 30-inch Hg engine run-up check due to the absence of system pressure drop at zero flow.

13.2. WATER REGULATORS — The non-hesitating variable water/air ratio regulator, one mounted on the right side of the intermediate rear section of each engine, is the controlling unit that regulates the quantity flow of the water/alcohol mixture at a rate dependent upon the fuel flow through the carburetor. As the W/A flow increases, the derichment valve in the carburetor closes, reducing the fuel flow through the carburetor and finally arriving at a "Best Power" mixture setting.
If the W/A supply is depleted or fails, indicated by a green light going out, the derichment valve opens to enrich the fuel/air mixture, and check valves in the regulator and water feed line and a solenoid valve in the vapor vent line close to prevent reverse fuel flow through the regulator. *In this event, a return to "dry" powers for that system should be made immediately*. The regulator is fitted with a vapor vent return line to the top of the W/A supply tank.

13.3. W/A INJECTION SYSTEM CONTROLLING SWITCHES — Each engine W/A injection system is controlled by two switches; the manual control switch on the aft overhead panel and an oil-pressure-operated switch, which tees off the oil pressure line supplying the engine oil pressure warning switch. The oil-pressure- operated switch, set to close when engine oil pressures exceed 25 (±5) psi, is connected in series with the on-off switch, thus preventing the W/A injection system pump from operating when the engines are not running. Turning the manual switch "ON " with engines inoperative will not energize the W/A injection system.

13.4. W/A PRESSURE AND QUANTITY INDICATING SYSTEMS — A Magnesyn-type pressure transmitter in each system measures unmetered W/A pressure and transmits the indication to two dual indicators on the engine instrument panel. The transmitters are identical to the fuel pressure transmitters.

As the water injection system is completely closed off by the pressure and solenoid check valves during the "dry" engine operation, it is normal for the W/A pressure indicators to indicate between 10 and 20 psi when the pressure is inoperative.

A Liquidometer-type transmitter is installed in the bottom of each W/A tank; the two dual W/A quantity indicators are mounted on the upper instrument panel.

13.5. DELETED

13.6. OPERATION OF THE W/A INJECTION SYSTEM

13.6.1. Ground Check — During engine run-up with throttles set at 30 inches Hg, mixture controls in "AUTO RICH," superchargers "LOW" and propellers in full increase rpm, place W/A injector switches "ON" to bleed the system of air, and check W/A pressures. The green W/A flow indicating lights will not come on at 30 inches Hg. On those airplanes in which the lights indicate pressure and not flow, the lights will be "ON." The W/A pressures will be approximately 27 to 32 psi, the outboard systems being approximately 2 psi higher than the inboard systems. This will ensure immediate delivery of W/A during take-off.

13.6.2. Take-Off — Turn the W/A injection control switches "ON" before increasing engine power for takeoff. Always turn the W/A system "ON" before increasing the manifold pressure. As power is increased through "Normal Rated" and at least by the time 50 inches Hg at sea level (decreasing with altitude) is reached the green W/A flow lights should come "ON" indicating proper W/A flow into the engine. As W/A cuts in, the BMEP indicators will fluctuate, finally steadying down to show an appreciable increase (a minimum of 10 BMEP) over the equivalent "dry" setting.

If the green lights do not come on, *do not increase power above the "dry" take-off horsepower rating.*

Note

> Do not attempt wet operation at low water levels, as the W/A pump may pump sufficient air through the regulator to maintain the minimum pressure required for derichment with air as well, as water. The resultant lean fuel-air ratio may produce detonation. A constant check of the water quantity gauge should be made.

While it may not be possible, on high-altitude fields, to obtain W/A injection manifold pressures greater than the maximum "dry," sea-level manifold pressure of 55 inches Hg on CB-16 engines, W/A injection powers will still be higher than the equivalent "dry" powers at that altitude due to the use of "Best Power" mixtures. On those airplanes equipped with a low-blower water regulator setting, take-off with the water injection system in operation is limited to 12,000 feet density altitude. On those airplanes with both high- and lowblower water regulator settings, take-off with water injection system in operation is limited to 20,000 feet density altitude.

13.6.3. After Take-Off — After the first power reduction is made below the take-off value, turn the W/A injection control switches "OFF". The green flow lights will go "OFF" and the W/A pressure indicators will indicate nozzle pressures.

INDEX

Section IV

OPERATING RESTRICTIONS AND LIMITATIONS

Section IV
OPERATING RESTRICTIONS AND LIMITATIONS

1. GENERAL ARRANGEMENT

The restrictions and limitations in this section are based on the manufacturer's recommendations, CAA directives, and the results of thorough flight testing.

2. GROSS WEIGHT LIMITATIONS VS. SPEED LIMITATIONS

See flight performance charts in Flight Operation Data, Section VIII.

3. CENTER OF GRAVITY LIMITS

Maximum forward CG limit — gear up position .... 12 percent MAC
Maximum aft CG limit — gear up position .... 34 percent MAC
Maximum forward CG limit — gear down position
to 90,200 pounds gross take-off weight .... 14 percent MAC
with a straight line variation between
1.4.0 per cent and 18.0 percent MAC
at 102,800 pounds gross take-off weight.
(This is a nose gear structural
limitation for ground operation—
flight stability is 14.0 percent to
102,800 pounds.)
Maximum aft CG limit — gear down position .... 34 percent MAC

4. WING AND POWER LOADING

(1) Wing loading — based on 1,463 square feet:

102,800 pounds maximum gross take-off .... 66.4 pounds per square foot

80,000 pounds maximum
gross zero fuel weight .... 54.6 pounds per square foot

74,000 pounds maximum
gross zero fuel weight .... 50.6 pounds per square foot

(2) Power loading — based on 2,400 blip per engine and 100/130 octane fuel:

102,800 pounds maximum gross take-off ....10.1 pounds per bph

80,000 pounds maximum
gross landing weight .... 8.3 pounds per bph

5. WET TAKE-OFF RESTRICTIONS

(1) Quantity—For “wet” take-off, do not take off without full W/A tanks.

(2) On those airplanes equipped with a low-blower water regulator setting, “wet” take-offs are limited to 12,000 feet density altitude. On those airplanes with both high- and low-blower water regulator settings, “wet” take-offs are limited to 20,000 feet density altitude.

6. SPEED LIMITATIONS

	KNOTS	
	IAS	TIAS
(1) Maximum speed at which fuel may be dumped *Do not dump fuel with gear or flaps down.*	185	191
(2) Minimum speed at which airplane is controllable in flight with one engine failure (propeller idling, other three engines at take-off power, flaps at take-off position, landing gear up), except at weight wheel stalling speed is higher:		
Wing flaps 20°	83	83
Wing flaps 0°	86	86
(3) Recommended maximum airspeed in severe turbulence with landing gear and wing flaps up, or with landing gear extended and flaps up:		
Below 80,000 pounds gross weight	147 to 155	152 to 160
Above 80,000 pounds gross weight	155 to 164	160 to 169

(4) Minimum take-off climb speed (V2) ...... See Performance Charts, Section VIII

(5) Critical engine failure speed (V1) .... See Performance Charts, Section VIII

		KNOTS	
		IAS	TIAS
(6)	Minimum cooling climb speed (4° cowl flaps)	135	139
(7)	Maximum airspeed for wing flap extension to 30° down	168	173
(8)	Maximum airspeed for wing flap extension over 30° down at airplane gross weight of:		
	73,000 pounds	135	139
	75,000 pounds	135	139
	78,000 pounds	139	143
	80,000 pounds	147	152
(9)	Maximum airspeed for landing gear extension	168	173
(10)	Maximum airspeed for landing light extension	173	179
(11)	Maximum airspeed for propeller unfeathering (Hamilton Standard)	135	139
(12)	Design maneuvering speed (fullcontrol deflection) :		
	68,000 pounds	139	143
	73,000 pounds	144	147
	84,000 pounds	154	159
	93,200 pounds	163	167
	102,800 pounds	172	178

7. PROPELLER RPM LIMITS

Idling:
Forward .... 600 (±50) rpm
Reverse ....900 (±100) rpm

Minimum governing speed .... 1200 (±25) rpm
Maximum governing speed .... 2800 (+50, -0) rpm
Magneto check loss, maximum 100 rpm, BMEP 12 psi

RPM at 30 inches Hg at sea level, all blades................... 2250 (±50) rpm
Engine tachometer difference .... 50 rpm maximum
Feathered, no rotation, all blades to 217 KIAS.

8. PROPELLER VIBRATION LIMITS

(1) Avoid continuous operation between 1200 and 1500 rpm while on the ground.

(2) The following limitations apply to the 43D60 propellers with 6841A-0,6851A-0, or 6825 AO blades on all R-2800 engines of the CA series, and the 6841A-0 or 6825A-0 blades with engines of the C series.

a. Avoid continuous operation above 2450 engine rpm for gross weights above 80,000 pounds, except for take-off and emergency.

b. For each hub barrel, a maximum of 500 take-offs are permissible when zerodegree flaps and gross weights of 90,000 pounds and above are employed, after which time the barrel must be retired. No take-off restrictions are made when 20° flap is used with any gross weight.

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9. FLIGHT LOAD ACCELERATION LIMITS

Flaps up — limit maneuver load factor .... 2.67, up to 86,680 pounds
Flaps up — limit maneuver load factor .... 2.5, above 86,680 pounds
Flaps down — limit maneuver factor 2.0 .... up to all weights

10. DELETED

11. OPERATING PRESSURE LIMITS

(1) Manifold pressure, RPM, power:

Take-off, 2050 hp dry (2700 (±50) rpm)
CB-16engines .... 55.0 inches Hg (2 minutes maximum)

BMEP .... 212 psi (Desired)

Take-off, 2400 hp wet (2800 (±50) rpm)
CB-16engines .... 59.5 inches Hg (2 minutes maximum)

BMEP .... 242 psi (Desired)

BMEP check at 30 inchesHg (sea level) ....120 (± 4) psi

Emergency approach power for engine stuck in high blower,at 10,000 feet and below, 2400 rpm maximum, for standard temperature conditions .... 46.5 inches Hg maximum

For hot weather conditions .... 31.0 inches Hg maximum

(2) Engine fuel pressures:

Idling rpm (minimum) .... 16 psi

Minimum cruise .... 22 psi

Maximum cruise .... 24 psi

Desired cruise .... 23 psi

High boost (engines off) * .... 21 to 30 psi

Low boost (engines off) * .... 12 to 1.4 psi

Fuel flow check at 30 inches Hg (sea level) CB-16 engines (Auto Rich) .... 480 (±50) pounds per hour

Warning light (red) .... 18 (±0.5) psi

* At 28 (±0.1) volts (bus).

(3) W/A injection pressures:

At 2400 blip (maximum flow)	22 (±1) psi
Idling rpm and 30 inches Hg magneto check	27 to 32 psi

(4) Engine oil pressures:

Idling rpm (minimum) full low pitch	25 psi
Ground run-up at 30 inches Hg (sea level)'* (full low pitch)	85 (±5) psi
Minimum*	60 psi
Maximum*	90 psi
Desired*	85 psi
Warning light (amber)	50 (±5) psi

* At 2200 rpm at 60 °C (140°F)

(5) Hydraulic and air system pressure:

Hydraulic, minimum	2600 psi
Hydraulic, maximum	3050 psi
Air brake	1500 (±50) psi

(6) Cabin pressure differential:

Absolute maximum	4.67 psi
Normal maximum	4.16 psi
Maximum relief	4.67 psi
Maximum for landing	1.80 psi
Maximum negative relief	-0.5 psi
Rate flow, normal	Green band
Rate flow, not supercharged	White band

(7) Cabin supercharger oil pressures:

Minimum .... 30 psi

Maximum .... 120 psi

Desired .... 65 to 90 psi

Warning light (red) .... 35 (±5) psi

(8) Heater fuel pressures (cabin and airfoil):
Ground, engines off, cabin 3 to 7 psi
Ground, engines running:

Cabin .... 7 to 16 psi

Airfoil .... 3 to 7 psi

Flight at 230 IAS .... 20 to 26 psi

(9) Oxygen system:

Low-pressure system .... 400 (± 25) psi

High-pressure system .... 1800 (±25) psi

(10) Oxygen system:

Low-pressure system .... 400 (± 25) psi

High-pressure system .... 1800 (±25) psi

12. OPERATING TEMPERATURE LIMITS

(1) Engine cylinder head temperatures:

Minimum for magneto check .... 120°C (248°F)

Maximum before take-off .... 232°C (450°F)

Maximum during takeoff (2 minutes) .... 260°C (500°F)

Maximum rated power, (1 hour climb) ..... 260°C (500°F)

Maximum cruising .... 232°C (450°F)

Maximum before stopping engines .... 150°C (302°F)

(2) Engine oil inlet temperatures:

Maximum at take-off and climb powers:

R-2800-34,-83 engine .... 98°C (208°F)

Desired at climb and cruise powers
(thermostat setting) .... 74° to 80°C
(1.65° to 176°F)

Maximum at rated powers:

R-2800-34, -83 .... 93°C (200°F)

Minimum cruise .... 40°C (104°F)

Minimum ground run-up
(1000 rpm maximum until
40°C is reached) .... 40°C (104°F)

(3) DELETED

(4) Cabin supercharger oil temperatures:

Minimum before starting .... -23°C (-10°F)

Maximum .... 100°C (212°F)

Desired .... 60° to 80°C
(140° to 176°F)

(5) Cabin and airfoil heater temperatures:

Ground Operation:

Cabin (windshield heat
control set at “10 TO 0°“) .... 180° to 200°C
(356° to 392 °F)

Cabin (windshield heat
control set at “ANTI-ICING“) .... 120° to 135°C
(248° to 275 °F)

Wing and Tail Thermocouples:

Structure — maximum .... 150°C (302°F)
Hairpin — maximum .... 185°C (365°F)
Tubular — maximum .... 210°C (410°F)

Flight Operation:

Cabin .... 135°C (275°F)

Wing and Tail Thermocouples:

Structure — maximum .... 150 °C (302°F)
Hairpin — maximum ....185 °C (365°F)
Tubular — maximum .... 210 °C (41.0°F)

Maximum OAT, for airfoil operation .... 10°C (50°F)

(6) Carburetor air temperature maximums:

No preheat:

Low blower .... None
High blower* .... 15 °C (59°F)

Prolonged preheat:

Low blower* .... 40°C (104°F)
High blower* .... 15°C (59°F)

Momentary preheat for de-icing:

Low blower (AUTO RICH) .... 60°C (140°F)
High blower (AUTO RICH) .... 40°C (104°F)

* Avoid exceeding 40°C (104°F) in low blower and 15°C (59”F) in high blower to prevent detonation and power loss.

13. ELECTRICAL SYSTEM LIMITS

Bus or ground power source .... 28 (± 0 . 5) volts
Generators (each) .... 28 (± 0 . 5) volts
Generators, all within .... 30 amps
Inverters (each) .... 115 (± 3) volts
Flight and engine instruments 26 .... (± 3) volts

14. INSTRUMENT LIMIT MARKINGS

(See Figure 41, Section II, pg 86-89)

15. TAXIING

Turns at high speed should be avoided as directional stability of the airplane resists turning, and sidewise skipping of the nose wheel will result. Use the brakes for decreasing speed and stopping, not for steering.

16. STALLS

Normal stalling characteristics of this airplane are good, with buffeting occurring several miles per hour above the speed for complete stall.

17. SPINS

Do not intentionally spin the airplane. Spins have not been demonstrated on this airplane.

18. CRITICAL CROSS-WIND OPERATION

The airplane is considered to be satisfactory for landings and take-offs in direct cross-winds up to 26 knots, where wind speeds are measured at the control tower at a height of 50 feet above the field level.

This 26 knot cross-wind component is not the limiting value for cross-wind handling, but was the highest value available during the type certification tests.

19. USE OF FUEL BOOSTER PUMPS

Use “LOW” boost whenever fuel pressure drops below 22 psi for engine start, during take-off above 2500 feet, for take-off at any time ground temperature is above 24°C (75°F), and before selecting a new fuel supply. In the event of engine-driven fuel pump failure or of an extreme cold weather start, where “LOW” boost does not supply sufficient pressure, “HIGH” boost may be used, provided “LOW” boost is used first to pressurize the system up to the carburetor. When shifting from “LOW” to “HIGH” boost, make the shift as fast as possible.

20. FUEL TRANSFER

Transfer of fuel from one tank to another is prohibited. When operating the fuel system on cross-feed, the tank or tanks not being used must be turned “OFF.”

21. OIL TRANSFER

Engine section oil tanks must not be filled above the 20-gallon level by use of the oil transfer system.

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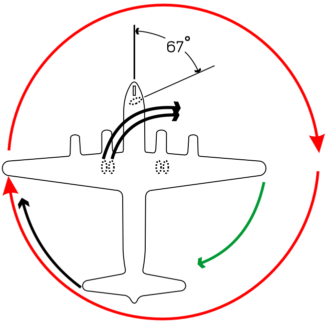
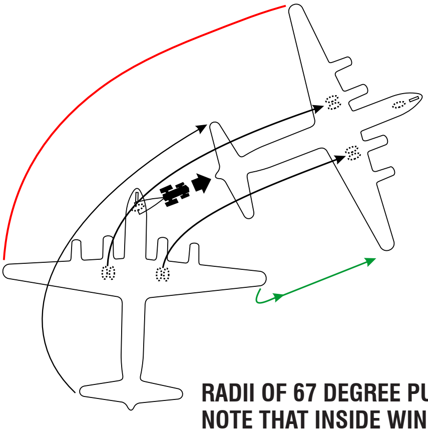
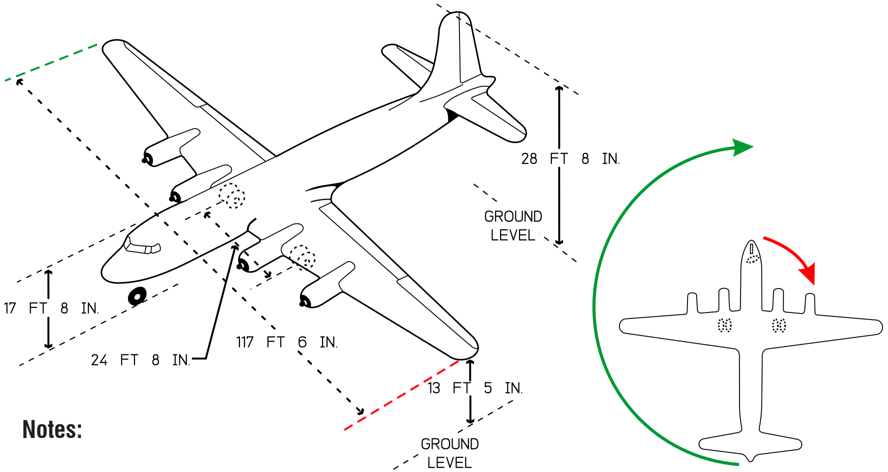


RADII OF MINIMUM TURN OF AIRPLANE UNDER OWN POWER FULL RIGHT STEERING WHEEL PIVOTING ON ONE MAIN GEAR
(DIAMETER OF TURNING AREA = 142 FT. 2 IN.)



RADII OF 67 DEGREE PULL TURN NOTE THAT INSIDE WING HAS A REVERSING MOTION BEFORE FORWARD MOVEMENT OCCURS.



DIAMETER OF CIRCLE WITH AIRPLANE ROTATING ON THREE-POINT TURNTABLE = 148 FT.

Notes:

1. **Disconnect nose wheel torque links before towing airplane.**
2. **Before moving airplane make certain there is sufficient lateral and vertical clearance from ground and overhead obstructions for maneuvering.**

Figure 88 — Turning Radii of Airplane

INDEX

Section V

RECOMMENDED OPERATING PROCEDURES

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Section V
RECOMMENDED OPERATING PROCEDURES

1. GENERAL ARRANGEMENT

It is standard airline practice to assign to the captain the full responsibility for his airplane and its load during flight. The operating procedures that follow begin with the prestarting check and continue through all normal flight operations. These operating procedures represent the safest and most efficient methods known of operating the airplane, being based on factory tests and the experience gained in the original CAA certification of the DC-6.

It is recommended that these procedures be established as fixed habits. Although the order of items in each list may (and probably will) be modified to suit the desires of the operator, it is of the utmost importance that all the steps included be accomplished. Only by the use of a check list can the operator be certain that some item contributing to flight safety and proper operation of the airplane is not overlooked.

These procedures are designed for a three-man crew —pilot, co-pilot, and flight engineer—for normal airline operation. The procedures are listed in direct sequence for the first flight of a series of operations, and are so arranged that checks and adjustments can be made with a minimum of cross-movements.

The following operating procedures are divided into two check lists: the first is a concise, standard type flight compartment check list; the second is an expanded check list wherein more detailed instructions on specific operations are given. A “Before Entering Flight Compartment” check is not included in either check list, since it is assumed that a thorough external check has been made by the ground crew and that the airplane is ready for flight.

No emergency or abnormal operations are given in this section, which is based entirely on a normal sequence of operating steps. Refer to Section VI for emergency procedures, and Section IV for operating restrictions and limitations.

2. CHECK-OUT LIST

2.1. FLIGHT COMPARTMENT CHECK — PRESTARTING

(1) Cabin attendant's temperature control panel—SET.
(2) Emergency equipment—stowed.
(3) Hand fire extinguishers—installed.
(4) Main, and radio circuit breaker panels — all circuit breakers SET.
(5) Inverter circuit breaker panel (aft of captain's seat)—all circuit breakers SET.
(6) Deleted.
(7) "BATT. & GND. PWR." Switch "ON."
(8) Battery selector switch—"GROUND POWER." (amber light ON).
(9) Position, fuselage, cockpit, and flight compartment lights—as required.
(10) Seats, safety belts, and rudder pedals—adjusted.
(11) "NO SMOKING" and "SEAT BELT" signs—"ON."
(12) Water injection pump switches—"OFF."
(13) Propeller emergency de-icing controls—"OFF."
(14) Deleted.
(15) Cowl flap selector switches—"OPEN."
(16) Fuel booster pump circuit breakers—SET.
(17) Fuel booster pump switches—"OFF."
(18) Cooling turbine switch—as desired.
(19) Inverter switches—all. three "ON."
(20) Auxiliary blower—"OFF."
(21) Voltage Regulator Overheat Warning Light—"OFF."
(22) Deleted.
(23) Emergency instrument switch (if installed) —"OFF."
(24) Generators—"ON."
(25) All ignition switches—"OFF."
(26) Heater fuel switch—"NORMAL" (down).
(27) Heater, fuel, and ignition selector switches—"SYSTEM NO. 1" (down).

(28) Deleted.
(29) Cabin heater master switch—“ON” (up).
(30) Airfoil de-icer heaters master switch—“OFF.”
(31) Propeller de-icer switch—“OFF.”
(32) Carburetor de-icer switches—“OFF.”
(33) Anti-icing fluid quantity—check.
(34) Hydraulic fluid quantity—check.
(35) W/A quantity — check (must be full for “wet” take-off).
(36) Fuel quantity—check.
(37) Oil quantity—check.
(38) Landing light switches—“RETRACT” and “OFF.”
(39) Deleted.
(40) Engine supercharger switches—“LOW,”
(41) Cabin pressure regulator — start marker and flight hand—SET.
(42) Deleted.
(43) Cabin altimeter—set to 29.92.
(44) Cabin pressure manual control door—“CLOSED.”
(45) Door warning lights—“OFF.”
(46) A-c voltmeter selector—set to “ENG. INST.”
(47) D-c voltmeter selector—set to “BUS.”
(48) Bus voltage—normal.
(49) Deleted.
(50) Fire extinguisher selector valve and discharge handles—IN (forward).
(51) Fire detector system warning lights—TEST.
(52) Cockpit heat control—as desired.
(53) Windshield heat control—as desired.
(54) Deleted.
(55) Clocks and altimeters—SET.
(56) Deleted.

(57) Hydraulic system by-pass control lever—“ON” (down).

(58) Auxiliary hydraulic pump selector valve control lever—“BRAKE SYSTEM” (forward).

(59) Hydraulic system pressure—2600 to 3050 psi (with auxiliary hydraulic pump).

(60) Deleted.

(61) Emergency air brake pressure—1500 (±50) psi.

(62) Deleted.

(63) Fuel tank selector valve controls — “MAIN” (forward) (Check targets.)

(64) Cross feed and auxiliary tank valve controls—“OFF” (forward).

(65) Propeller master RPM control lever—FORWARD (take-off position).

(66) Engine master controls;

- Hamilton Standard propeller selector switch “NO. 2 AUTO” or “NO. 3 AUTO.”

(67) Throttles—1/10 to 1/4 open (maximum).

(68) Auto-pilot—“OFF.”

(69) Parking brake—“ON.”

(70) Mixture controls—“IDLE CUT-OFF.”

(71) Fuel/Oil Pressure Warning Isolation Switches—ON

(72) Auto-pilot servos—“DISENGAGED.”

(73) Landing gear control lever—“DOWN”; green indicator lights—ON.

(74) Trim tabs—SET.

(75) Carburetor air temperature controls — “COLD” (down).

(76) Wing flap control lever—“UP.”

(77) Radio-check.

(78) Mechanic’s interphone—“STANDBY.”

2.2. STARTING ENGINES

(1) Start engines in following order—3-4-2-1.

(2) Engine selector switch — position to engine being started.

(3) Safety switch—"ON" first; then start switches "ON."

(4) Turn engine over with starter. Watch propeller motion. If any sign of hesitation or stoppage occurs, disengage starter and investigate. After engine has turned freely 9 to 12 blades, turn ignition switch "ON."

(5) Fuel booster pump for engine being started—"LOW."

(6) Primer switch—"ON" as required.

(7) Mixture control—"AUTO RICH" after engine fires.

(8) Throttle—adjust to 800 to 1000 engine rpm, watching for engine and cabin supercharger oil pressure rise. If pressure does not show within 30 seconds after starting, stop engine and investigate.

(9) Fuel booster pump—"OFF."

(10) Hydraulic system pressure — check (2600 to 3050 psi).

(11) If external power source was used to start engines, turn battery selector switch to "PLANE BATTERY" and disconnect external power supply after all engines are started.

2.3. ENGINE WARM-UP

Throttles—adjust to 1000 engine rpm until engine and cabin supercharger oil temperatures are up to the minimum.

2.4. ENGINE RUN-UP — On dry runways, all four engines can be run up simultaneously. (Gust lock must be disengaged.)

(1) Propeller reverse pitch—check.

(2) All engines-1500 rpm.

(3) Propellers—test; return to take-off position after testing.

(4) Propeller feathering—check.

(5) Engines—manifold pressure equivalent to field barometric pressure.

(6) Fuel and oil pressures—check.

(7) Cylinder and oil temperatures—check.

(8) Generator amperage and voltage—check.

(9) Inverters—check voltage.

(10) Blowers—”HIGH” then “LOW.”
(11) Magnetos—check.
(12) W/A injection, system — switches “ON” to bleed system, and check.
(13) BMEP indicators-check.
(14) Cabin supercharger oil pressure and temperature—check.
(15) Engines—1000 rpm.
(16) Pitot and airscoop heater amperage—check.
(17) Propeller de-icing system—check.

2.5. PRE TAKE-OFF

(1) Flight instruments—check.
(2) Wing flaps-“20°” down.
(3) Cowl flaps—“4°” open.
(4) Fuel booster pumps as required.
(5) Air conditioning controls—SET.
(6) Captain’s instrument and radio inverter opposite to first officer’s.
(7) Controls—gust lock disengaged and controls FREE.
(8) Mixture controls—“AUTO RICH.”

2.6. TAKE-OFF

(1) W/A injection switches—“ON” for wet takeoff.
(2) Throttles—SET to manifold pressure.
(3) Landing gear (on signal)—“UP.”
(4) Power (on signal)—reduce to rated.
(5) Wing flaps (on signal) —“UP.”
(6) Landing gear control lever (lights out) —“NEUTRAL.”

2.7. CLIMB

(1) Power—as required, not to exceed rated power.
(2) W/A injection switches—“OFF.”
(3) Cylinder head temperature—check.
(4) Landing light switches—“RETRACT” and “OFF.”
(5) “SEAT BELT” and “NO SMOKING” signs—“OFF.”

(6) Windshield heat control—SET.
(7) Cabin supercharger oil pressure and temperature—check.
(8) Cabin supercharger airflow indicators—check.
(9) Cabin rate of climb and cabin altitude—check.
(10) Shift to "HIGH" blower above critical altitude.

2.8. CRUISE

(1) Mixture controls—"AUTO LEAN."
(2) Hydraulic system by-pass control lever—"OFF" (up).
(3) Cowl flaps-SET.
(4) Windshield heat control—SET.
(5) Fuel system selection—as required.
(6) Captain's instrument and radio inverter switch and engine instrument inverter switch same as first officer's.
(7) Cabin pressure regulator—set "start marker" to destination altitude.
(8) Engine superchargers — shift blowers every two hours.

2.9. DESCENT

(1) Engine superchargers (below 12,000 feet) —"LOW."
(2) Windshield heat control—SET.
(3) Altimeters—SET.
(4) Fuel tank selector controls—"MAIN."
(5) Auxiliary fuel tank selector controls—"OFF."
(6) Cross-feed controls—"OFF."
(7) Carburetor air temperature controls — as required.
(8) Hydraulic system by-pass control—"ON" (down.)
(9) Wing flaps (for holding below 168 knots)—to 30°.
(10) Captain's instrument and radio inverter switch—opposite to first officer's.
(11) Landing lights (below 147 knots)—"EXTEND" and "ON."

2.10. APPROACH

(1) "SEAT BELT" and "NO SMOKING" signs—"ON."
(2) Landing gear—"DOWN."

(3) Brake action—check

(4) Hydraulic pressures—check.

(5) Brake air pressure—check.

(6) Landing gear warning lights—check (green).

(7) Mixture controls—“AUTO RICH.”

(8) Carburetor air temperature controls—“COLD.”

(9) Propeller governor controls— 2400 rpm.

(10) Cowl flaps—4° open.

(11) Wing flaps-full down (below 136 knots).

2.11. LANDING ROLL

(1) Brakes and propeller reversing—as required.

(2) Cowl flaps—“OPEN.”

(3) Wing flaps—“UP.”

(4) Propeller governor control—take-off rpm (full forward).

(5) Cabin—depressurized.

(6) Propeller de-icer switch—“OFF.”

2.12. PARKING

(1) Parking brakes—“ON.”

(2) Mixture controls—“IDLE CUT-OFF,”

(3) Fuel tank selector controls—“OFF.”

(4) Ignition switches—“OFF.”

(5) Inverter switches—“OFF.”

(6) Generator switches—“OFF,”

(7) Gust lock—ENGAGED.

(8) Electrical switches and equipment controls—as required.

3. EXPANDED CHECK LIST

3.1. TAXIING

(1) Remove and stow landing gear safety ground locks.

(2) All doors—CLOSED; door warning lights—OFF.

(3) Release parking brakes by depressing brake pedals.

(4) If it is necessary to use propeller reverse pitch to back the airplane into position for taxiing, hold the control surfaces in a neutral position, provided that the gust lock is not engaged. When high reversing powers are used, considerable control lashing may be experienced. Brakes should be applied carefully, particularly with aft CG conditions, to avoid pitching back on the tail. Avoid ruts, soft ground, etc., which cause sudden deceleration or require high power. A maximum of one minute of reversing power is recommended.

(5) Only use brakes for decreasing speed and for stopping the airplane, not for steering. However, if the nose wheel steering system fails, the airplane can be maneuvered by differential engine power or by use of the brakes.

(6) To change direction of roll, apply a steady pressure on the nose wheel steering wheel.

(7) Sharp turns at high speeds and excessive movement of the nose wheel should be avoided, as directional stability of the airplane resists turning and sidewise skipping of the nose wheel will result.

3.2. ENGINE RUN-UP

(1) Parking brakes—“ON.”

(2) Hydraulic pressure—2600 to 3050 psi.

(3) Deleted.

(4) Deleted.

(5) Propeller governor check (Hamilton Standard):

a. Increase engine speed to 1700 rpm and lock throttles.
b. Move individual propeller switches to “DECREASE RPM” positions and hold until 1200 rpm is reached. Then move propeller switches to “INCREASE RPM” positions until lights come on.
c. Repeat the above operation, using the master control lever for each master engine (engines 2 and 3). Return the master control lever to the take-off position (full forward) following each check.

(6) Propeller check for one or more propellers inadvertently in reverse pitch (Hamilton Standard only):

a. Set all engines to 1500 rpm, with governor controls in full increase rpm.
b. With master governor selector on No. 2 or No. 3 engine, move master lever to high pitch. (If any propeller is in reverse, governor should unreverse it at 1200 rpm.) Return governors to low pitch (high rpm).
c. Push feathering button on each engine momentarily. If rpm increases, blade was in reverse, but will return to positive pitch.
d. With selector switch on No. 3 engine, move master rpm lever towards “DECREASE RPM” until 1600 rpm is reached, all propellers should be governing. Toggle each slave engine (1, 2, 4) 100 rpm. above or below No. 3 engine. Push and release resynchronizing button; each slave engine should decrease or increase by 3%.

Repeated actuation of resynchronizing button should bring slave engines to rpm of master engine; master engine should not change. Repeat this procedure with selector in No. 2 engine position. Turn selector switch to manual. Toggle each engine to “DECREASE RPM’” until each engine rpm is reduced. 200 rpm. Move master lever to full “INCREASE RPM,” there should be no increase in engine rpm. Turn the selector switch to either No. 2 or No. 3 master; after a few seconds, all four limit lights should be on and the rpm on all engines should have increased to approximately 1700 rpm.

(7) Propeller feathering check (Hamilton Standard):

a. Push feathering button and wait until the propeller rpm has dropped 200 to 300.

b. Pull feathering button out to the full-out position and allow governor to return rpm to run-up values.

(8) Generators—check for correct output of each generator.

(9) Inverters—check for correct output of each inverter.

(10) Engine supercharger check:

a. Open throttle to obtain field barometric pressure. The rpm obtained will be approximately 2100 to 2200.

b. Switch from “LOW” to “HIGH” blower. Proper operation of the selector valve and clutch is indicated by a rise of approximately ten inches manifold pressure.

c. Switch from, “HIGH” blower back to “LOW.” A drop in manifold pressure indicates proper clutch shifting.

(11) Magneto check:

a. Switch ignition from “BOTH” to “RIGHT” and back to “BOTH.”

b. Switch ignition from “BOTH” to “LEFT” and back to “BOTH.”

c. Normal drop-off in either “RIGHT” or “LEFT” should not exceed 100 rpm, BMEP drop-off on one magneto should be approximately 7 psi and not exceed 12 psi.

Operation on a single magneto should be limited to the shortest possible time, and high power should be avoided.

(12) Turn “ON” W/A injection system switches until pressure stabilizes to bleed the systems. W/A pressure should be between 27 and 32 psi. Green lights will be out. Turn switch off until ready for take-off.

(13) Return throttles to 1000 rpm.

(14) Propeller de-icing check:
   a. Turn propeller de-icer switch “ON.”
   b. An increase in amperage reading will, indicate the start of the de-icing cycle. Approximately 1½ minutes will be required to complete the de-icing cycle.

(15) Check all engine instruments for correct indications.

(16) Check cabin supercharger instruments for correct indications.

3.3. TAKE-OFF AND CLIMB

(1) W/A injection switches “ON” (if installed) before selecting manifold pressure or rpm. Green, flow lights will come on below 50 inches Hg manifold pressure at sea level to indicate normal operation. At this point, as the power is increased to full take-off power, the W/A pressure will reduce to 22 (±1) psi.

(2) Use nose wheel, steering to maintain direction of roll until rudder becomes effective at approximately 43 knots.

(3) Establish recommended climbing airspeed according to the Take-Off, Climb, and Landing Charts in Section VIII.

(4) For power reduction after take-off”, reduce manifold pressure and rpm to rated powers. Then turn “OFF” the W/A injection switches (if installed).

(5) High-blower climbing powers should be in accordance with the Take-Off, Climb, and Landing Charts in Section VIII.

3.4. CRUISE

(1) When climb has been completed, level off and reduce power to that desired for cruising, depending on the flight plan.

(2) Adjust cowl flaps to maintain cylinder-head temperatures not exceeding a maximum continuous temperature of 232°C (450°F).

(3) Hydraulic system by-pass valve control lever— "OFF" (up). During cruising, when it is not necessary to adjust hydraulically operated units, the hydraulic system by-pass valve should be in the open (by-pass) position to relieve the system.

(4) When critical altitudes for low blower have been reached, close throttles to approximately ½ open to avoid excessive manifold pressure, and switch superchargers to "HIGH." Reset throttles to obtain desired manifold pressure.

(5) After cruise is established, switch to alternate or auxiliary fuel tanks.

3.5. DESCENT

(1) The maximum permissible gliding and diving speeds of the airplane are dependent upon maximum gross weight and altitude. The maximum permissible gliding and diving speeds can be determined by reference to charts in Section VIII, Flight Operation Data.

(2) Do not exceed the maximu.ni "AUTO LEAN" powers.

3.6. LANDING

(1) The landing speed and distance recjuired may be obtained from the Take-Off, Climb, and Landing Charts in Section VIII. In general, make a conventional landing, contacting the ground with the main gear first and then contacting the nose wheel as speed is lost. The airplane is equipped with a tail skid to guard against structure damage in the event of a tail-down landing. Do not raise the nose wheel once it has grounded.

(2) After landing, the nose wheel, steering wheel should be used to maintain the direction of roil. However, if the nose gear shock strut is fully extended (little or no weight on the nose gear), the nose wheel will be centered mechanically, and steering will be inoperative. Apply the brakes lightly or push the control column forward slightly to force the nose down.

(3) Braking may be applied together with propeller reversing. To reverse propellers, move the throttles from normal idling to idling reverse, hesitate slightly to prevent high rpm when blades pass through zero pitch, pull back the red reverse pitch lever, and then smoothly apply necessary reverse thrust. During reversing, the first officer should hold flight controls in neutral. Return propellers to normal thrust at completion of the landing roll and push the red reverse pitch lever forward.

3.7. STOPPING ENGINES

(1) Stop the engines by moving the mixture controls to "IDLE CUT-OFF" and gradually opening the throttles to give a clean cut-off with no backfiring.

(2) When a cold-weather start is anticipated, perform oil-dilution operation (see Section VII).

(3) Do not open the main cabin door or the flight compartment door if the door warning lights are ON. Wait until the lights go OUT, indicating that the cabin pressure is equal to atmospheric pressure.

4. BASIC DC-6 AIRPLANE STRENGTH AND OPERATION

The following information, designed to provide guiding data regarding basic DC-6 airplane design, supplements information supplied in other sections of this manual. Large transport airplanes have become highly complex mechanisms, and the level of piloting ability required for their safe and efficient operation is necessarily high, requiring the experience and skillful handling resulting from a thorough understanding of the operating conditions and structural design of the airplane.

4.1. IMPORTANCE OF FUEL WEIGHT DISTRIBUTION— On the DC-6 airplane, it is imperative, for reasons explained in the following paragraphs, that the recommended sequence of fuel loading and consumption (see Fuel System, Section II) be adhered to if the structural integrity of the airplane is to be protected at all times. DC-6 airplanes are designed in accordance with conditions established by CAA and with make-good limit (applied) load factors of 2.50 or more upward and 1.25 or more downward. The purpose of the data given in the following paragraphs is to aid flight personnel in handling the airplane by providing them with a reasonable knowledge of what airplanes in general, and the DC-6 in particular, will take.

The gross weights at which these load factors are made good depend on fuel distribution along the span of the wing. All weight above the zero fuel and oil weight must consist of fuel. See Paragraph 2, Section IV, for applicable zero fuel and oil weights.

The correlation between fuel load and strength is best exemplified at the joint between the inner and outer wing. The area of the outer wing and tip is approximately 30 per cent of the total wing area. This means that for a gross weight of 90,000 pounds, for example, there is an airload of 30 per cent of that weight, or 27,000 pounds, lifting up on the outer wings. Thus, on each side of the airplane, there is a 13,500- pound airload lifting upward on each outer wing. (The figures used in this example are approximate, as, for the sake of clarity, no cognizance is taken of wing twist, tip shape, and other factors which affect the true span-wise distribution of the airload. Also, any load carried by the tail is ignored. However, for the purpose of this example, the approximations are sufficiently accurate.)

If the outer wing were completely weightless (a strictly theoretical condition), the load to be transmitted across the inner-to-outer wing joint would be the full 13,500 pounds. However, actually the outer wing does have finite weight—the complete outer wing panel, tip, and ailerons on the DC-6 weigh a little more than 1000 pounds. Also, with the airplane fueled in accordance with the manufacturer's recommended procedure (as given in Section. II, paragraph 3), the outer wing would be full of fuel, the weight of which must be added to the actual structural weight (at the gross weight used in this example). Consequently, the total weight of an outer wing panel and the fuel it contains would be the weight of the outer wing structure: 1000 pounds, plus the weight of the fuel in the outer wing, or 2160 pounds—a total weight of 3160 pounds. As all this dead weight acts downward as a result of gravitational pull, the net load to be transmitted across the inner-to-outer wing joint is 13,500 pounds (airload upwards) minus 3160 pounds (dead weight downward), or a total of 10,340 pounds.

If the airplane were operated at the same gross weight as above, without any fuel in the outer wing tank, then the net load would be 13,500 pounds minus 1000 pounds—the structural weight of the outer wing panel only—or a load of 12,500 pounds net load at the joint. Thus, the load at this important joint would be increased by 21 per cent over what it would be when fuel is properly distributed.

Although the foregoing example is based on the wing joint, similar examples can be set up for any section of the wing or at the joint between the wing and fuselage. The margins of safety in the wing joint and other structure will not permit load increases that could result from, violations of the recommended fuel loading schedule. The design of the structure was based upon the airplane's being operated in accordance with the manufacturer's recommendations.

4.2. IMPORTANCE OF SPEED REDUCTION IN TURBULENT AIR— When operating in severely turbulent air, it is recommended that the flying speed of DC-6 series airplanes be reduced to 152 to 160 knots TIAS for those airplanes equipped with a six- or eighttank fuel system and to 160 to 169 knots TIAS for those having a ten-tank system. This reduction should be observed when actually in the turbulent area; when an encounter with a sharply denned front is anticipated while on instruments; or at night when the moment of contact cannot be precisely anticipated. Severe turbulence in this case refers to conditions of sufficient disturbance that the pilot's primary concern is the safety of the airplane and the passengers.

Typical VG diagrams for three conditions of loading have been prepared for the DC-6 airplane. The diagrams show airplane velocities plotted against load factor made good at three representative gross weights: Figure 89 applies to an airplane loaded to a gross weight of 68,000 pounds, with zero or very little fuel weight in the wings; Figure 90 applies to an airplane loaded to a gross weight of 84,000 pounds, with 16,000 pounds of fuel weight in the wings; and Figure 91 applies to an airplane loaded to a gross weight of 102,800 pounds, with 23,200 pounds of fuel in the wing. (In all cases fuel is distributed in accordance with recommended fuel scheduling.) The VG diagrams illustrate the importance of limiting flight speed in turbulent air in that, flying at a given weight, the severity of the acceleration produced by a gust is a function of the flying speed at which the gust is encountered.

In selecting a speed for operation in severe turbulence, a compromise must be made between the following two limitations: It is desirable to keep the speed low to permit the structure to withstand the greatest possible gust velocities, and, at the same time, it is equally desirable to maintain sufficiently high airspeed to prevent the airplane from closely approaching the stalling point, caused by the gusts associated with the turbulent condition. For each gross weight and fuel load combination there is a theoretical airspeed at which some specific degree of turbulence will simultaneously cause both permanent set of the structure and a stall condition. For example, Figure 89 shows that for the 68,000-pound gross weight condition, the maximum airspeed is 154 knots TIAS. At this speed, a 51- foot-per-second gust line would pass through the intersection of the stall boundary and the structural limitation line. The recommended airspeed of 152 to 160 knots for operation in severely turbulent air brackets the 154 knots maximum conditions of simultaneous stall and structural yielding for this particular weight. The critical speed varies for each gross weight. However, from the three VG diagrams, it can be seen that the airplane, when flying within the recommended rough airspeed range, can encounter sharp-edged gusts, approximating 50-foot-per-second velocity, without exceeding the limit load factor for which the structure is designed. In turbulence less severe than that described above, the pilot should reduce speed in accordance with his own judgment of the situation. When slowing to reduce the effects of turbulence, it is advisable to reduce power and wait for the speed to drop without simultaneously pulling up the airplane, to avoid combining the acceleration due to the pull-up with those accelerations resulting from the turbulence. The DC-6 airplane is designed for level flight operation with flaps and landing gear retracted at 260 knots TIAS with a gust intensity of 30 feet per second, and for approach with 30 degree flaps and extended landing gear at an airspeed of 173 knots with a gust intensity of 15 feet per second assumed, in accordance with CAA regulations. A lesser gust intensity is assumed for approach and flap extension because the airplane is operated for a relatively short time under these conditions and the probability is that the airplane is less likely to encounter a severe gust during these periods. If it is deemed advantageous to operate at higher powers in turbulent air under increased drag conditions, it is permissible to extend the landing gear within placarded landing gear extension speed limits. In view of the fact that the airplane is more capable of withstanding a severe gust with the flaps and gear retracted, it is recommended that the airplane be operated in turbulent air conditions with the flaps and gear retracted at the recommended turbulent air speed. The danger of a momentary stall is less remote and less serious than the possibility of overloading the wing flaps and other parts of the airplane.

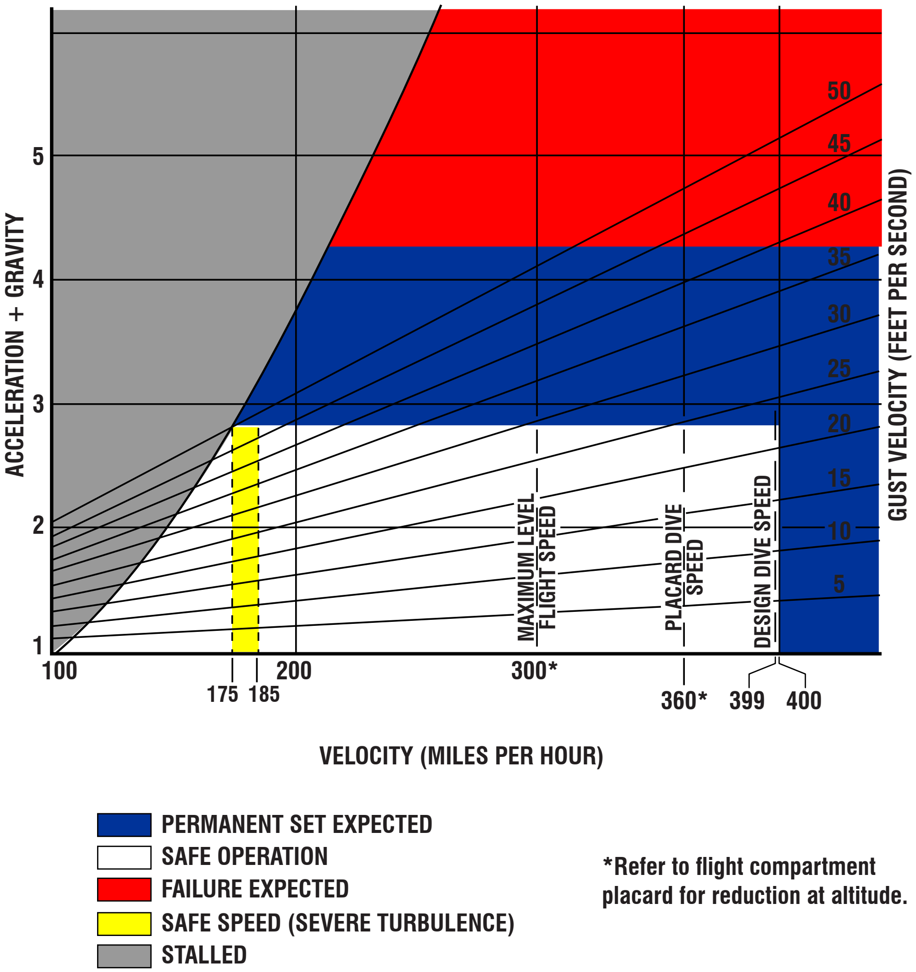
4.3. EXPLANATION OF LOAD FACTOR— The load factor can be defined as the ratio between the total air load on the wing and the weight of the airplane. More technically, the load factor can be defined as the multiplying factor by which the steady flight forces are multiplied to obtain the equivalent static effect of dynamic forces acting during acceleration of the airplane. The load factor used in designing an airplane is based on previous experience and known data. The wing is designed to support a total load equal to the total weight of the airplane multiplied by this load factor.

It is common to refer to a load factor as G where G denotes the pull of gravity. Strictly speaking, however, G refers to the acceleration of gravity and should not be used interchangeably with load factor. It might be well to point out that a person is accustomed to forces equal to one load factor, as these are the forces experienced when standing or sitting quietly. Thus, the forces of which a person is conscious under higher load factor conditions are the result of an increment above one G.

4.4. DETERMINATION OF WING DESIGN LOADS— In an airplane, the total gross weight is supported by the air load on the wings. If the air load is suddenly increased, as by a gust, to more than that necessary to just support the weight of the airplane, the additional air load tends to accelerate the airplane, while the inertia of the airplane tends to resist this acceleration.

Should the upward accelerating force acting on the airplane be too great, some part of the airplane structure may be overstressed and permanent distortion occur, if the magnitude of the overload is carried too far beyond this point (1½ times the load that causes the permanent set), actual failure may occur. As an example of this principle, a parallel may be made of lifting an object with a string. The object corresponds to the airplane fuselage and its contents, and the string corresponds to the airplane wing. The string may be of sufficient strength to support a weight several times that of the weight attached to it, but, if an attempt is made to lift the object by jerking upward on the string, it is quite possible to jerk hard enough to break the string. This jerk is an accelerating force identical in effect with the suddenly applied air load on the wing. The ratio of the total load on the string, including the accelerating force, tp the weight of the attached object (or similarly, the ratio of the total air load on the wing, including the accelerating force, to the gross weight of the airplane) is called the load factor. The ultimate load factor made good—of the string or the wing—is the maximum value that this ratio can attain before failure occurs.

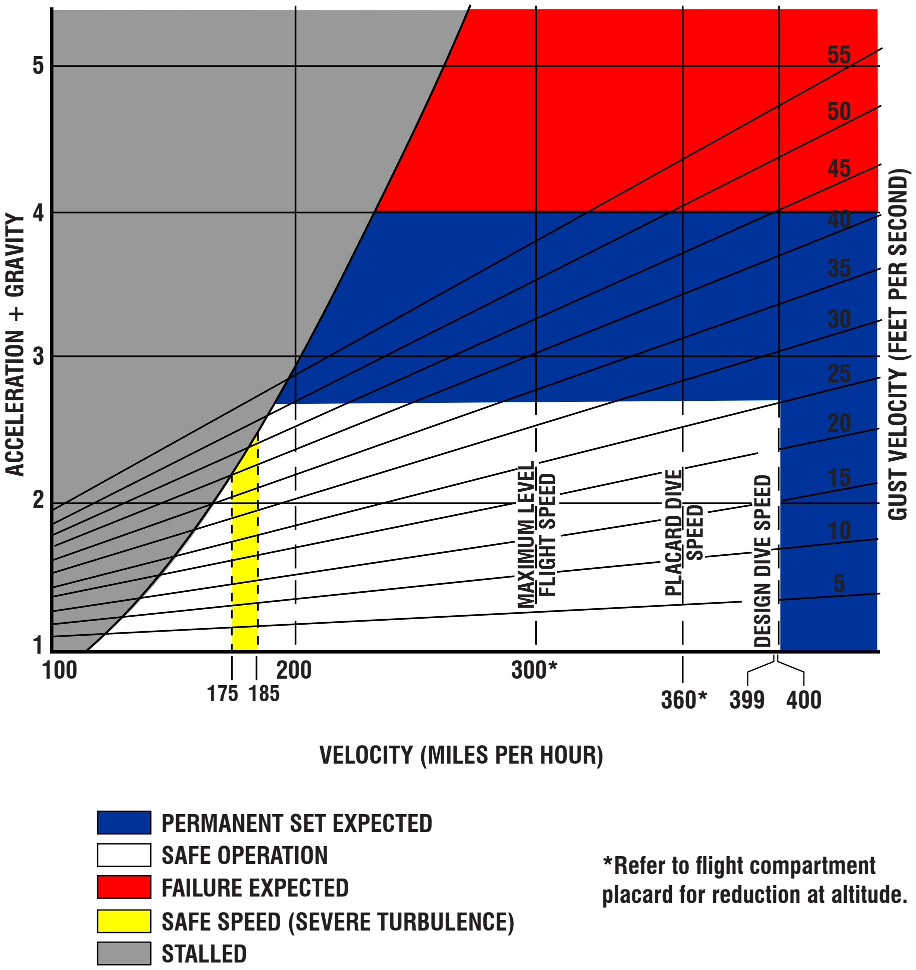
Airplane weight and speed limitations are intended to restrict operation, so that the load factors applied to the airplane by normally encountered accelerations (produced by either gust or deliberate maneuver) will be no greater than the load factor that will cause permanent distortion.



*Refer to flight compartment placard for reduction at altitude.

68,000 POUNDS GROSS WEIGHT
ZERO POUNDS WING FUEL

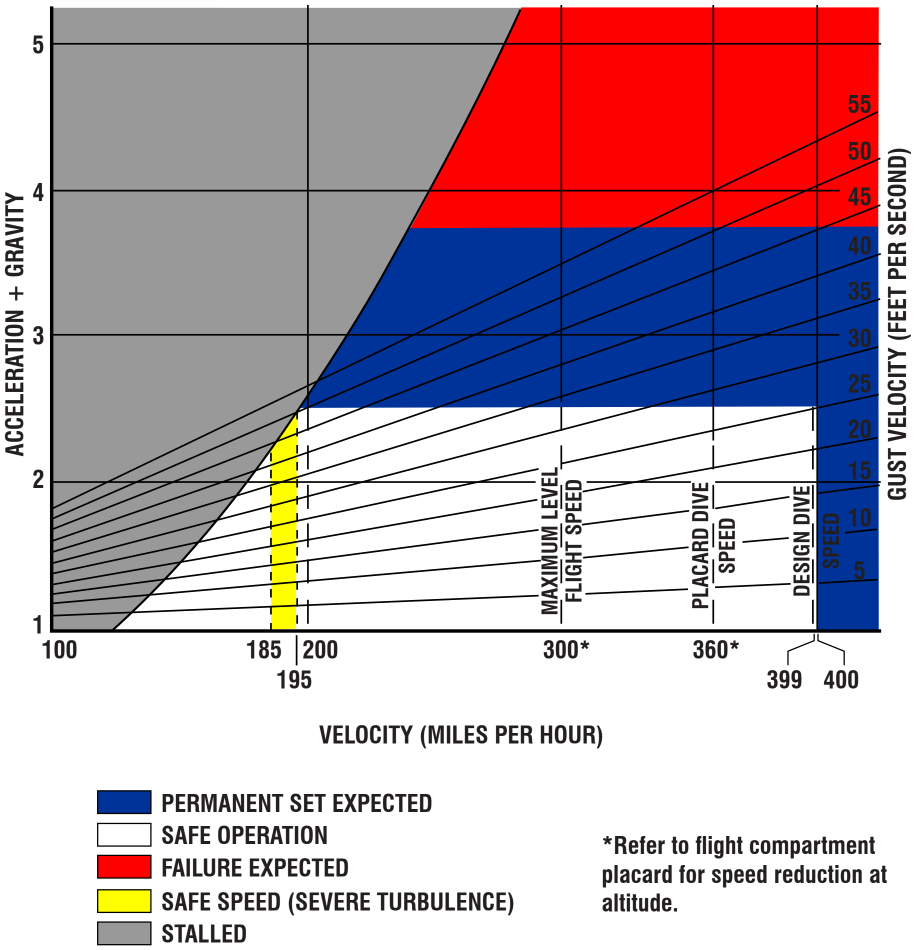
Figure 89 — V-G Diagram - I



*Refer to flight compartment placard for reduction at altitude.

84,000 POUNDS GROSS WEIGHT
16,000 POUNDS WING FUEL

Figure 90 — V-G Diagram - II



*Refer to flight compartment placard for speed reduction at altitude.

102,800 POUNDS GROSS WEIGHT
23,200 POUNDS WING FUEL AND NACELLE OIL

Figure 91 — V-G Diagram - III

4.5. WING WEIGHT EFFECT ON DESIGN LOADS — In the foregoing example of lifting an object with a string, some of the total load must go into lifting the string itself, even though that weight is negligible compared to the weight of the object.

Similarly, some of the total air load on an airplane wing must go into lifting the wing itself. However, unlike the string, the weight of the airplane wing and its contents represents an appreciable part of the total gross weight. But that part of the total load which is required to lift the string or the wing and its contents does not contribute toward breaking either. It is that part of the total load trying to accelerate the object or the fuselage which attempts to break either the string or wing.

Therefore, the dead weight of the wing—including wing structure, nacelles, landing gear, and wing contents— which is supported by air loads is actually subtracted from the total load that the wing structure must carry, since it opposes the air load at approximately the same location as that at which the air load is applied.

The distribution of weight affecting stresses within the lifting object may be compared to a board supported at each end and bearing four blocks. If all four blocks are grouped in the middle of the board, the concentration of weight causes the board to bend and, if the board is small, might even result in its failure. If the blocks are evenly distributed over the length of the board, more of the board's structure is utilized as support and the board will not bend as much. If the blocks are grouped at each end, over the supports, the total load is still the same, but the stress on the board has changed to the point where the board will not bend any more than as if no blocks were on it. Thus, the net load the board must carry is contingent on the manner in which the blocks are distributed. Similarly, the net load that the wing structure must carry is dependent upon the proportion of the total airplane weight contained in the wings themselves and is equal to the total air load minus the total wing weight load (or the gross weight of the complete airplane minus the weight of the wing and its contents). The air load diagrams in Figures 92 through 94 explain this graphically. In level flight an airplane having a gross weight of 80,000 pounds is supported by 40,000 pounds air load on each wing. The wing joint at the fuselage must, therefore, withstand 40,000 pounds, presuming that the wing has no weight (see Figure 92).

However, the weight of wing structure, nacelles, engines, and wing contents reduces this load at the wing-to-fuselage joint because the total weight is not all contained in the i fuselage. Thus, as shown in Figure 92, though, the total airplane gross weight is still 80,000 pounds, the fuselage weight is reduced to 53,800 pounds and the load at the wing joint is reduced to 26,900 pounds—the difference between 40,000 and 26,900 pounds being the weight of the engines, wing, etc., on each side. Therefore less structure is actually required to attach the wing, even though the airplaoe still has the same gross weight.

The distribution of the weight of wing structure and contents along the wing span is fixed once the design is complete. However, the addition of fuel tanks distributed over the span of the wing makes it possible to actually control an appreciable part of the total dead weight of the wing and its contents. By adding fuel weight to the wing weight, the loads carried by the wing structure can be improved.

Thus, using Figure 93, with a gross weight of 80,000 pounds, the addition of fuel in the wing tanks will reduce the fuselage weight to 37,800 pounds, and the structure at the wing-to-fuselage joint now only needs to carry 18,900 pounds on each side—the load which the wing structure must carry having been reduced from 40,000 pounds to 18,900 pounds. This reduction in structural loading was accomplished by considering the weight as being removed from the fuselage and placed along the wing, where it acts against the air loads and reduces the effect of these loads on the structure. Since the total net load, or the total load in the fuselage that the wing can safely withstand, is known, it is possible to compute the amount of fuel, necessary to prevent the net load on the wing, for any combination of gross weight and load factor, from exceeding the maximum allowable.

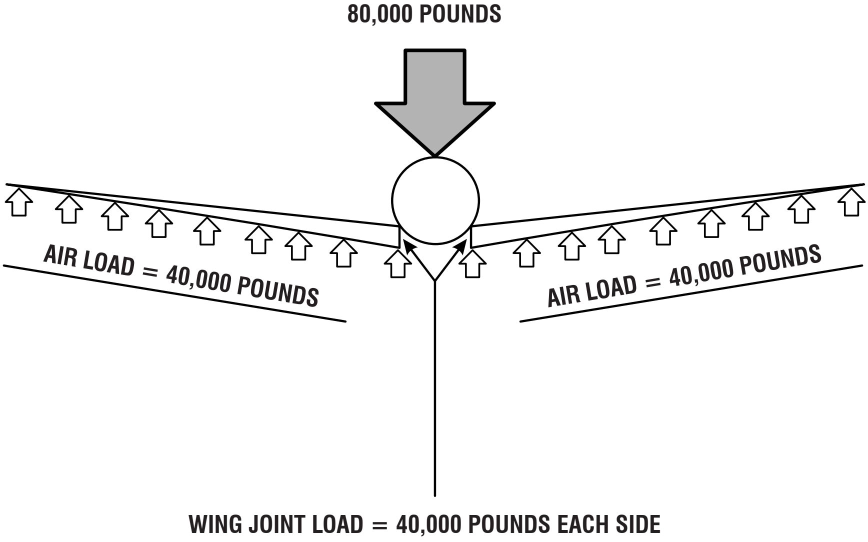


Figure 92 — Air Load Diagram - I

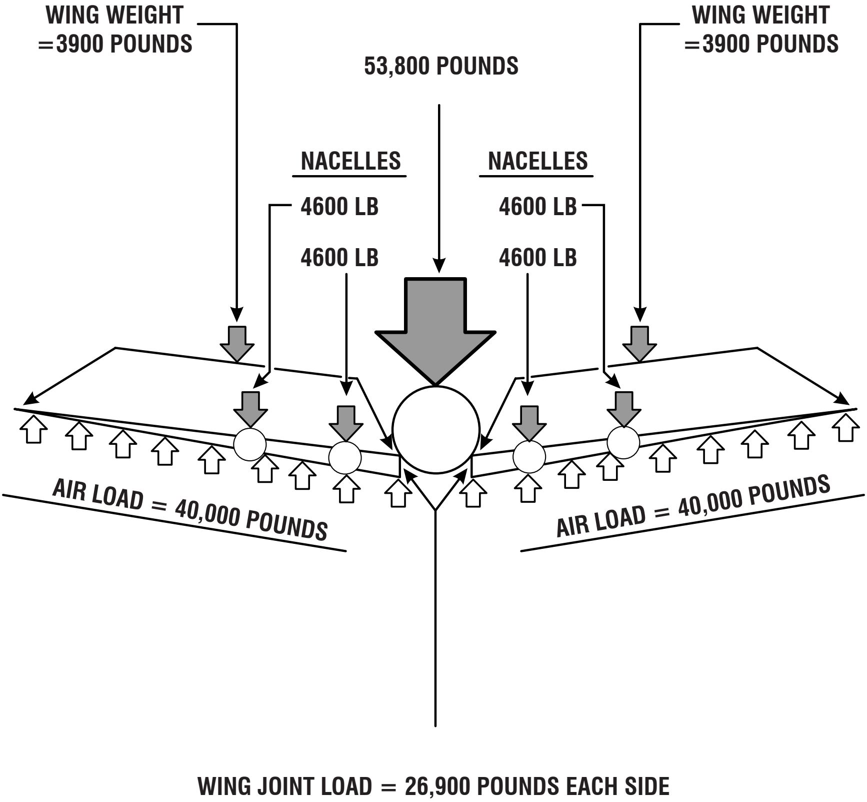


Figure 93 — Air Load Diagram - II

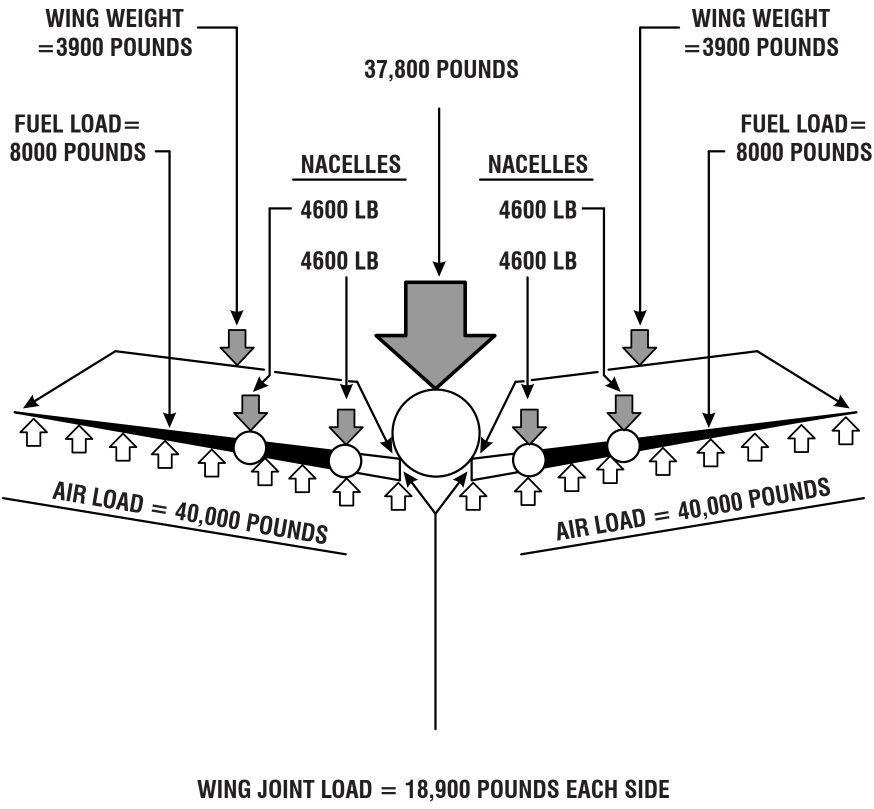


Figure 94 — Air Load Diagram - III

5. WEIGHT AND BALANCE

The importance of correct loading practices cannot be overemphasized. However, the belief that the airplane should be loaded to some "optimum" CG (somewhere near the middle of the CG range) to obtain maximum performance is erroneous. If loaded aft of the aft limit, the airplane will be unstable, but not uncontrollable. Loading forward of the forward limit will result in excessive elevator control forces, and, if too far forward of the forward limit, the amount of elevator control available will be insufficient to properly flare the airplane during a landing.

The weight and balance of an airplane can be compared to the principle of the steelyard scale, which is in equilibrium or balance when it rests on the fulcrum in a level position. It is apparent that the influence of weight is directly dependent on its distance from the fulcrum, and that for balance, the weight must be so distributed that the rocking effect is the same on either side of the fulcrum. It follows that a heavy weight near the fulcrum has the same balancing effect as a lighter weight farther out on the bar. Thus, the scale is in balance only when the horizontal center of gravity (CG) is at one location; that is, at the fulcrum. An airplane, however, can be balanced in flight by operation of the trim tabs or elevators, as long as the CG is anywhere within the specified forward and aft limits.

This allowable variation in the location of CG is called the CG range, the exact location of which is always near the forward part of the wing. Obtaining this balance is simply a matter of distributing the load so that the CG of the loaded airplane falls within the allowable range. Heavy loads near the CG location can be balanced by much lighter loads at the nose or tail of the airplane. The moments, or index units, of the loads determine this exactly.

It has been found desirable in practice to measure all distances from an arbitrary reference datum at or near | the nose of the airplane (see Figure 94). By measuring all arms in the same direction, all moments become positive, thus eliminating errors in adding plus and minus moments that might result from a reference datum located within the limits of the airplane.

When the total moment about this reference datum is divided by the total weight, the resulting arm is the distance to the center of balance position, or CG, from the reference datum. If the CG does not fall within specified limits, the load must be shifted until the CG does fall within the limits. The allowable CG range is determined by calculations and flight tests. Limits are usually expressed as a percentage of the mean aerodynamic chord of the wing (per cent MAC), or in inches from the reference datum (called the "arm").

To obtain the gross weight and corresponding CG location of the loaded airplane, it is necessary to first know the basic weight and CG location of the airplane itself, which has been determined by weighing the basic airplane as described in the Loading Chart. When the weight, arms, and moment of the basic airplane are known, the effect of fuel, crew, cargo, passengers, and other disposable weight is computed as they are added to the airplane. This is accomplished by adding all the moments of these additional items to the total moment of the basic airplane and dividing the resulting moment by the sum of the basic weight and the weight of the items. This establishes the CG for the loaded airplane in inches from the reference datum. These calculations may be performed by using the Loading Chart furnished with the airplane.

5.1. LOADING CHART— The index-unit type of loading chart has been devised for the purpose of proper airplane loading. In the loading chart itself, the moments have all been divided by a constant of 1000, thus moving the decimal point to the left to make the process of adding up moments less tedious and to obtain a sufficiently accurate answer. The terms "moment" and "index unit" are used interchangeably.

The Loading Chart is nothing more than an orderly system of adding up the total airplane-and-contents weight to obtain the gross weight, which, in turn, is compared against the sum of the moments of the airplane and its contents. If, when plotted on the graph, the intersection of these two quantities falls within the indicated limits, the loading is satisfactory. If the intersection does not fall within the limits, weight must be shifted. Thus, if the plotted point falls outside on the tail-heavy side, weight must be shifted forward to balance. The weight and moment for an empty airplane are given in the first pages of the Loading Chart. The succeeding pages give various tables showing the resulting moment for different weights. It is necessary only to select the appropriate moments of the quantities in question and add to the empty airplane moment.

Supplementary pages in the Loading Chart list restrictions, instructions, report of actual weighing, diagrams, and locations of various load items.

5.2. EQUIPMENT ITEM LIST— It would be futile to give the balance and weight-empty of an airplane without supplementing it with a record of the equipment included or excluded in that weight. Such a record should be well detailed, giving the weight and location of each item mentioned, definite part numbers, and a description of the items.

The Equipment Item List has been made up in the form of a check-off list, wherein only those items present are checked. There is no set rule regarding the items to be included in an equipment list. Ordinarily, only items which are CAA-required equipment or modifications are listed, as well as readily detachable parts, such as radio units, cabin seats, rugs, etc.

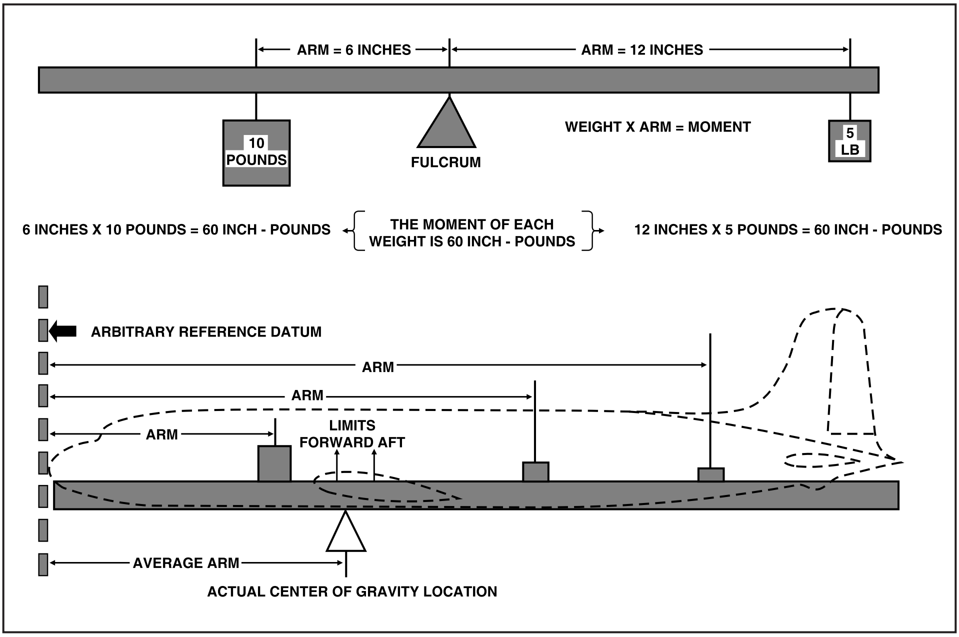


Figure 94 — Weight and Balance Diagram

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INDEX

Section VI

EMERGENCY PROCEDURES AND TROUBLE SHOOTING

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Section VI
EMERGENCY PROCEDURES AND TROUBLE SHOOTING

1. GENERAL

All emergency operating instructions and trouble shooting procedures have been assembled in this section for ready reference. The operator should become thoroughly familiar with these instructions before his first flight in the DC-6 airplane. In those emergency procedures which have been grouped into Phases, the individual operations (where more than one occur) within each Phase may be arranged in the order that suits the operator; all operations in Phase I, however, must be accomplished prior to any operation in Phase II, etc.

2. PROPELLER FEATHERING PROCEDURE (ENGINE ISOLATION)

2.1. FEATHERING (HAMILTON STANDARD PROPELLERS)

Phase I: Propeller master control — “MANUAL”

Propeller selector control—”FEATHER.” (Push IN feathering button on the forward overhead panel.)

Mixture control—”IDLE CUT-OFF.”

Fire extinguisher selector valve handle—FULL OUT (this closes the firewall shut-off valves and the handle should not be pulled until after the propeller is feathered).

Phase II: Cowl flaps — CLOSED.
Gear and wing flaps— CHECK.
Fuel booster pump—“OFF.”
Generator—“OFF.”
Ignition—”OFF.”
Fuel tank selector valve—”OFF.”
Cross-feed valves—”OFF.”

If the propeller continues to windmill and will not feather, the fire extinguisher selector valve handle may be pushed half-way in to detent ("oil-on") position.

2.2. UNFEATHERING (HAMILTON STANDARD PROPELLER)

Phase I: Booster pumps — "LOW."

Generator switch—"ON."

Ignition switch—"BOTH."

Cowl flaps—as desired to maintain adequate temperature.

Fire extinguisher selector valve handle—full forward.

Fuel tank selector valve handle—as desired.

Cross-feed valve handle—as desired.

Reduce airspeed to 135 KIAS (dial) maximum.

Throttle—closed.

Phase II: To avoid unfeathering into reverse, use the following procedures.

Run propeller governor to full high pitch (low rpm). Indicator light will come on when high pitch position is reached. Pull feathering button OUT for not more than two seconds; then release it. Never hold the button OUT for more than two seconds. Wait at least 10 seconds and watch for indication of propeller rotation. With rpm as low as possible, allow governor to take over.

Phase III: Mixture control — "AUTO RICH."

Phase IV: Warm up engine gradually to ensure complete circulation of oil.

Phase V: Advance throttle and propeller controls to the desired operating settings.

3. FUEL DUMPING PROCEDURE

Emergency jettisoning of fuel during flight is accomplished by means of four extendible-retractable dump chutes, one in the lower aft section of each nacelle, and a dump valve on each tank. The chutes are operated by control levers located beneath the floor plate aft of the control pedestal. Dumping all the tanks simultaneously gives the most rapid rate of load reduction and the best distribution of the remaining fuel load. With all the dump valves open, the amounts of fuel given in the Total Disposable Fuel and Dumping Rates Table, below, can be dumped in the stated time for the 8-tank fuel system:

Standpipes within each main fuel tank ensure that sufficient fuel will remain in the main tanks for 45 minutes of flight at 75% of rated power (METO) after all fuel possible has been dumped in level flight.

It is recommended that fuel be dumped as follows:

(1) Assume a level flight attitude.

(2) Reduce airspeed to 191 KIAS maximum.

(3) Gear and flaps full “UP.”

(4) Check fuel quantity indication.

(5) Pull fuel dump control handles completely aft to the “OPEN” positions and, simultaneously, take a time reading. (The first twothirds of the control handle travel—to the detent— extends the chute; the final one-third of travel opens the fuel dump valve.)

(6) When the necessary weight of fuel has been dumped, push each control handle forward to the detent, or “DRAIN” position; this closes the dump valves but leaves the chutes extended. (There may be a tendency for the levers to creep out of the “DRAIN” position; in which case, the levers must be manually held in that position.) Leave the control handles in the “DRAIN” positions for five minutes to permit all residual fuel to drain from the dumping system.

(7) It is suggested that a crew member visually check the chutes during the drain period to make certain the valves have closed and no fuel is running out. These chutes can be checked from the aft cabin area.

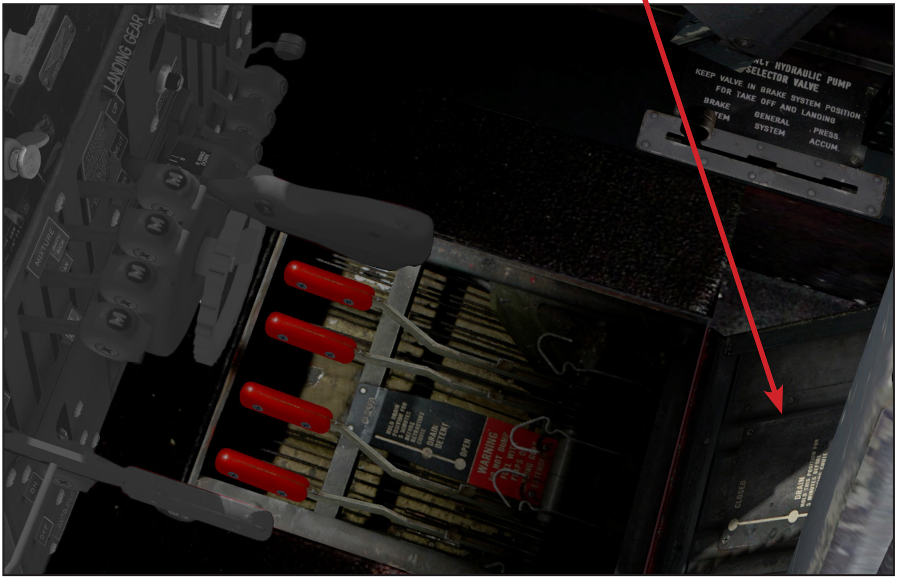
(8) Place the control handles in the “CLOSED” (full down, forward) positions to retract the dump chutes.

TOTAL DISPOSABLE FUEL AND DUMPING RATES TABLE

FUEL SYSTEM	TOTAL USABLE FUEL		TOTAL DUMPABLE FUEL		DUMPING RATES PER MINUTE		TOTAL DUMPING TIME (APPROX.)	TOTAL USABLE FUEL AFTER DUMPING	
	Gallons	Pounds	Gallons	Pounds	Gallons	Pounds	Minutes	Gallons	Pounds
8-TANK FUEL SYSTEM									
Combined Outboard Tanks (No. 1 and No. 4 main; No. 1 and No. 4 alternate)	1,582	9,492	1,250	7,500	232	1,392	5.5	332	1,992
Combined Inboard Tanks (No. 2 and No. 3 main; No. 2 and No. 3 alternate)	1,740	10,440	1,342	8,052	190	1,140	7	398	2,388

DC-6 Fuel Dump Control Levers

NOTE: To access the fuel dump control levers, click on the floor plate aft of the center pedestal. It is labeled “FUEL DUMP CONTROLS.” To close the floor plate, click on the inside of the plate when it is open.



4. ENGINE FAILURE ON TAKE-OFF

If an engine should fail when the take-off speed is below the critical engine failure speed (see Speed Power Table, Section VIII), the remaining engines should be cut and the airplane be stopped. If the speed is above the critical engine failure speed, the take-off should be carried through as follows:

(1) Raise the landing gear after being safely airborne.

(2) Feather the propeller of the failed engine immediately.

(3) Close the cowl flaps on the failed engine.

(4) Continue straight climb at take-off power to a safe altitude before raising the wing flaps.

(5) Reduce power to rated on the remaining engines.

5. GO-AROUND FROM MISSED APPROACH

5.1. FOUR ENGINE GO-AROUND — If it becomes necessary to pull up and go around from a normal approach (gear down, flaps 50°, and all engines operating), operate as follows:

(1) Apply full take-off power and pull up to best climbing speed. If necessary, W/A (if installed) take-off power may be used.

(2) Raise the landing gear.

(3) Retract the wing flaps to the 20° take-off flap position.

(4) Increase to climb airspeed of 139 KIAS.

(5) Proceed as during a normal take-off.

5.2. THREE-ENGINE GO-AROUND — One dead engine— either inboard or outboard—does not greatly affect the flight characteristics of the airplane. If it becomes necessary to pull up and go around on a threeengine approach (gear down, flaps 30°, three engines operating, inoperative propeller feathered), proceed as follows:

(1) Apply full take-off power and pull up to best climbing speed. If necessary, W/A (if installed) take-off power may be used.

(2) Raise the landing gear and simultaneously retract the wing flaps to the 20° take-off flap position.

(3) Increase to climb airspeed of 139 KIAS.

Three-engine operation in take-off, climb, cruise, approach, and landing configurations is safe (even with full flaps) provided airspeeds above minimum engineout control speeds are maintained. In approach and landing, reduce trim tab settings so that abrupt changes in control forces will not be necessary when power is reduced.

6. LANDING GEAR FAILURE

6.1. LANDING GEAR LATCH FAILURE

(1) If a main gear downlatch fails to engage (target not visible, but gear down) retract the landgear lever locking solenoid pin and return the lever to the "NEUTRAL" position for a moment. Turn "ON" the auxiliary hydraulic pump and place the landing gear lever again in the "DOWN" position, which should lock the gear. However, if the gear does not lock, make a normal landing, but get the nose wheel down as quickly as possible so that the main gear will not have to support the entire weight of the airplane.

(2) If the nose gear downlatch fails (bungee link not on center, but wheel down), hold the nose wheel off the ground as long as possible after ground contact is made. Use the brakes sparingly, taking advantage of the entire available runway length to lose landing speed.

(3) The belief that a pull-out of any number of G's will shear the uplatches without the assistance of some hydraulic pressure is erroneous. (The landing gear can be extended normally without hydraulic pressure by moving the landing gear control lever down to the "DOWN" position. This releases the uplatches, opens the gear-up hydraulic lines to return, and allows the gear to extend and lock by its own weight.)

If the uplatches fail to release after the landing gear control lever has been placed in the "DOWN" position (no hydraulic pressure), full down-line hydraulic pressure from the auxiliary hydraulic pump will shear the uplatch shear bolts, permitting the gear to extend.

6.2. LANDING GEAR TIRE FAILURE

(1) If the nose wheel tire is flat at the time of landing, keep this wheel off the ground as long as possible, with aft CG at 33 per cent. (Moving two passengers from the center cabin area to the rear cabin area will shift the CG approximately 1 per cent.) Use a minimum of braking.

(2) If one or both tires are flat on one main gear, drop the nose gear as quickly as possible. There is very little actual danger in landing with one flat tire on one main gear. The landing should be made smoothly and taxiing should be done slowly.

If both tires are out on one main gear as a result of striking some object on the runway, there may be more damage than just flat tires. For example, a hydraulic hose may also have torn loose, a wheel may have broken, or the landing gear itself may have been sprung. The airplane tends to swerve to the side of the flat tire; this tendency may be counteracted by using braking on the good tire side and by nose wheel steering, with forward pressure on the control column to give good steering characteristics. The outboard engine on the flat tire side may also be used to assist in holding the airplane straight, but the engine should be used cautiously as the added power will increase the landing roll.

6.3. NOSE WHEEL SHIMMY—Nose wheel shimmy is an indication of an unbalanced condition of the nose wheel or failure of the steering system. If this occurs during take-off, decreasing the load on the nose wheel will decrease the shimmy tendency; therefore, pull the nose wheel off the ground as soon as possible. If shimmy occurs during the landing roll, decelerate gradually, since loading the nose wheel will increase the shimmy tendency. In landing with a known shimmy condition, keep the nose wheel off the ground as long as possible.

6.4. GEAR-UP LANDING—If it is necessary to land with the main and nose gear fully retracted, do so with full flaps. If only one main gear fails to extend, retract the gear and make a belly landing.

Landing with the nose gear up and the main gear extended is much the same as landing in deep mud or snow, when the nose is held up as long as possible. Use the following procedure:

(1) Shift the passengers in the cabin to give a CG of approximately 33 per cent and fasten seat belts. (Two people moving from the center of the cabin to the rear will move the CG aft approximately one per cent.)

(2) Make a normal landing on the runway in a slightly tail down attitude.

(3) Immediately upon ground contact, apply sufficient up-elevator to keep the aircraft in a level attitude.

(4) Maintain this level attitude until full up-elevator position is reached and the nose pitches over. If the tail is too low just before elevator effectiveness is lost, nose contact with the ground will be severe.

(5) Apply as little braking as possible.

(6) During initial rolling contact on the main gear, the fuel tank selector valve controls should be placed in the "OFF" positions, the mixture controls in the "IDLE CUT-OFF" positions, ignition switches "OFF," and the battery master switch "OFF." After the airplane has stopped, personnel with hand fire fighting equipment should stand by as the battery compartment is subject to damage in a nose down landing which may result in possible electrical shorts.

With the CG at 33 per cent, the nose will contact the ground at approximately 60 miles per hour at zero wind. When the nose finally contacts the ground, less structural damage will result from this type of landing than if a belly landing was made. Adjusting the load by moving passengers aft to attain a CG of 33 per cent should not be overdone, as exceeding an aft CG of 35 per cent can result in bringing the airplane to a stop with the tail resting on the ground.

If the airplane does come to rest with the tail on the ground, however, do not allow any movement of passengers within the cabin, as this may result in upsetting the balance of the airplane. Wait until the ground crew can either install jacking equipment under the nose or tie the tail to a ground securing point.

7. HYDRAULIC SYSTEM FAILURE

If a failure in the hydraulic system is evidenced bythe loss of hydraulic fluid (as indicated on the quantity gauge), return all control levers for hydraulically operated units to the OFF positions, and isolate the leak, as follows:

(1) Landing gear control lever—"NEUTRAL."

(2) Wing flap control lever—5° (valve closed position).

(3) Windshield wipers-"OFF."

(4) Brakes-OFF.

(5) With the by-pass valve closed, build up system pressure. If the pressure falls from 3000 psi I to 2700 psi in less than one minute, the drop is excessive. If the drop in pressure is not excessive, move the landing gear control lever to the "UP" position and check for an excessive

drop in pressure. If the drop in pressure is not excessive, move the flap control lever to the full "UP" position and again check for an excessive drop in pressure.

(6) If the trouble still has not been isolated, extend the landing gear (below 168 KIAS) then check for excessive drop in pressure. Then hold the brakes in the ON position and check for adequate pedal back-pressure and excessive drop in pressure. If the failure is in the gear-down line, immediately return the landing gear control lever to "NEUTRAL" to prevent the loss of hydraulic fluid. Extend the wing flaps for the approach and landing before placing the landing gear control lever in the "DOWN" position (which is mandatory).

(7) If the main hydraulic fluid supply is lost, nose wheel steering will be inoperative. For brake operation from the auxiliary supply, place the auxiliary hydraulic pump selector valve in the "BRAKE SYSTEM" (forward) position and operate the auxiliary hydraulic pump for hydraulic brake pressure (the auxiliary hydraulic pump control switch is a momentary contact type, and must be held in the "ON" position for continued operation).

(8) The emergency hydraulic fluid supply is adequate for a full extension of the wing flaps and for operation of the brakes in a normal landing roll. Start the auxiliary pump just prior to contact.

(9) In the event of excessive pressure or overheating of the hydraulic system, open the by-pass valve. Do not close the by-pass valve until it becomes necessary to operate one of the hydraulic units.

8. AIR BRAKE OPERATION

If no hydraulic pressure is available to the brakes, stop the airplane with the air brake system. Do not use the air brakes before the nose wheel has touched the ground. Apply the brakes slowly and intermittently after ground speed has been reduced by an extendedroll, gradually increasing the braking power rather than applying it suddenly.

9. MALFUNCTIONING ELECTRICALSYSTEM

9.1. CIRCUIT PROTECTORS

(1) If a circuit breaker opens, disconnecting power to any circuit, it indicates an overload or short in that circuit.

(2) If the circuit breaker reopens after being reset, do not use that circuit unless the safety of the airplane depends on its continued operation.

(3) In an emergency (the emergency circuits are the fuel booster pump circuit and the propeller feathering circuit), when the safety of the airplane depends on the continued operation of the affected equipment, the circuit breaker may be held closed at the expense of the affected equipment or wiring (holding the circuit breaker closed, however, is a potential fire hazard). Refer to paragraph 19-5-3 in this section, for use of the circuit breakers in locating and controlling an electrical fire.

9.2. GENERATORS—If there is no indication on one ammeter but the others have normal readings, make the following check:

(1) Check the generator voltage, which should be the same as that of the other generators (about 28).

(2) Check the generator switch, which should be "ON"; if so, turn it "OFF" and note if the readings of the other ammeters increase. If they do, the trouble is in the ammeter. Turn the generator switch back "ON" and leave it on.

(3) If the generator voltage reads zero, check the field circuit breaker on the main circuit breaker panel. If it has tripped, reset it. If it immediately trips again, leave it off and turn the generator switch "OFF."

(4) Check the reverse-current circuit breaker, located in the ceiling of the main junction box. If it has tripped (orange target showing in the small peep hole), turn the generator switch "OFF" and proceed on three generators.

9.3. GENERATOR OVERVOLTAGE—The d-c system voltage is normally held to about 28 volts by the regulators. Short circuits in the wiring or regulator failure may cause the voltage to rise considerably. High voltage is indicated by:

One generator ammeter indicating full scale, others zero.

Voltmeter reading off scale.

Lights brighter than normal.

If high voltage exists, perform the following corrective steps:

(1) Open the generator switch for the generator having high amperage reading.

(2) Open the field circuit breaker for the malfunctioning generator (it may trip automatically).

(3) There is no en route means of correcting a generator overvoltage condition.

9.4. INVERTERS

(1) If an inverter fails in flight, as indicated by the inverter warning light, switch to the other inverter.

(2) In the event of a take-off or landing with one generator inoperative, it is suggested that operation be made with one inverter only (either the upper or the lower).

9.5. ERRATIC ELECTRICAL SYSTEM—For ground operation, an external source of electric power must be used to provide correct voltage. Check this voltage on the d-c voltmeter, with the selector switch set to the "BUS" position. If the ground power source is not within the allowable electrical limits (24 to 28 volts), turn the battery master switch "OFF" and request replacement of the external power source. If a replacement unit is not available, start the first engine on the airplane battery (see Section III, paragraph 6).

Probably the most common cause of irregular engine operation is faulty spark plugs. The plugs may run hot and result in preignition or run cold and foul up from the accumulation of carbon deposits. If one or more spark plugs fail, resulting in loss of power, it is inadvisable to attempt to recover the lost power by increasing manifold pressure, since this practice may lead to detonation, especially when operating in the high-power range.

9.6. VOLTAGE REGULATORS—Do not tamper with the regulator adjustment to obtain close paralleling in flight. An approximately equal division of load is desirable but not essential.

Cooling of the voltage regulator compartment is essential. The normal blower is automatically turned on by starting either inverter. The auxiliary blower is turned on by a switch on the forward overhead panel. The red warning light on the panel indicates excessive temperature in the voltage regulator compartment. If the warning light comes on, the auxiliary blower should be turned on at once. If the warning light does not go out within a few minutes after turning on the auxiliary blower, unlatch the voltage regulator compartment door and investigate. In extreme cases, where airflow appears to be inadequate, cooling may be obtained by allowing the door to hang open.

10. MALFUNCTIONING HAMILTON STANDARD PROPELLER

The circuit breakers in the propeller circuits are located at the top of the center panel of the main circuit breaker panel, and *must be set at all times*.

10.1. INDIVIDUAL PROPELLER OUT OF SYNCHRONIZATION

(1) Push the resynchronizing button.

(2) If this does not correct the condition, actuate the respective propeller control switch to bring the propeller back into synchronization.

(3) If the propeller does not stay in synchronization after being brought back, place the propeller synchronizer selector switch in the opposite inboard engine position and push the resynchronizing button.

(4) If the propeller still will not stay in synchronization, place the propeller synchronizer selector switch in the “MANUAL” position and operate individual propeller control switches for synchronizing and change of rpm.

10.2. ALL ENGINES HUNTING OR SURGING

(1) Place the propeller synchronizer selector switch in the opposite inboard engine position.

(2) If this does not correct the condition, place the propeller synchronizer selector switch in the “MANUAL” position.

(3) If either inboard engine must be feathered, *make certain that the propeller synchronizer selector switch is placed in the opposite inboard engine position before starting to feather.*

10.3. PROPELLER OVERSPEEDING—Immediately perform the following steps:

(1) Close all throttles and decrease speed below 139 KIAS as rapidly as possible.

(2) Place mixture control of runaway engine in "IDLE CUT-OFF."

(3) Feather runaway propeller.

(4) Speed may be resumed after propeller becomes stationary.

(5) In a high rpm windmilling condition, passengers should be moved aft of the plane of propeller rotation. A high rpm windmilling condition may be partially restored to normal by descending to a lower altitude, inasmuch as the propeller windmilling characteristics are a function of true airspeed.

10.4. ENGINE SURGING AS A RESULT OF MALFUNCTIONING FUEL SYSTEM—It should be remembered that vapor locking of the fuel system, either in the fuel lines or in the carburetor chamber itself, can result in alternating slugs of fuel and vapor entering the engine, resulting in intermittent power loss and subsequent surging. See paragraph 21.2, Vapor Lock, in this section, for corrective steps.

10.5. ENGINE SURGING RESULTING FROM EXCESSIVELY LEAN MIXTURE—If after correcting the preceding conditions, engine surging is still evident, the trouble is probably originating in the engine itself. Place the mixture control in the "AUTO RICH" position and apply carburetor heat for several minutes. This will usually correct the trouble and the carburetor temperature may then be returned to the desired range.

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11. MALFUNCTIONING OF CABIN TEMPERATURE CONTROL SYSTEM

11.1. EXCESSIVE CABIN HEATER OUTPUT — The temperature indicator on the heater control panel should not exceed 150°C (302°F). If it should exceed this limit, perform the following corrective steps:

(1) Turn the cabin heater master switch "OFF." The temperature should drop immediately after this step.

(2) If, after the temperature drops, it is desired to resume operation of the cabin heater, position the cabin heater fuel control selector switch to the other system ("SYSTEM NO. 2" if "SYSTEM NO. 1" was being used), return the cabin heater master switch to the "ON" position, and select the "35° TO 0°" (1.67° TO -17.8°C) vinyl warming position on the windshield heat control.

(3) After the cabin heater is back in operation, watch the heater temperature to make certain that it does not rise excessively again.

(4) If the cabin heater temperature indicator is within limits, but the cabin temperature is too hot, adjust the temperature control switch to a lower value. Considerable time may be required for the temperature indicator and rheostat reading to agree, therefore if the cabin temperature approaches the temperature setting, the system is probably functioning properly. If this still does not control the temperature, open the manual control door on the cabin attendant's temperature control panel, located over the main cabin door, and push the "DECREASE" button. The cabin temperature may be manually controlled by depressing either the "INCREASE" or "DECREASE" button as required. Wait at least 10 minutes for the cabin temperature to stabilize before depressing a button again.

11.2. LOSS OF CABIN HEATER OUTPUT — If the cabin heater temperature indicator shows no heater output, check for the following tripped circuit breakers on the main circuit breaker panel:

Cabin heater power

Cabin heater control

Cabin heater fuel pump and heater fuel pump master

Auxiliary vent blower

If these circuit breakers are not tripped, the trouble may be caused by any of the following:

Failure of the fuel system control.

Failure of the heater ignition system.

Failure of the cabin heater fuel pump.

Failure of the automatic control system.

The drop-out switch may have opened the circuit as a result of an excessive heater temperature rise.

Perform the following steps to determine the cause of trouble and to attempt resumption of heater operation.

(The cabin heater fuel pressure indication should rise and fall with heater cycling and indicate between 8 and 25 psi, depending on altitude and speed.)

(1) If fuel pressure is indicated, but heat is neither indicated nor felt at the outlets, proceed as follows:

- a. Turn the heater “OFF”; wait 30 seconds, and then turn the heater back “ON.”
- b. If the heater fails to operate, again turn the heater “OFF”; wait another 30 seconds, then turn to the other cabin heater ignition system (“SYSTEM NO. 2” if “SYSTEM NO. 1” was being used) and turn the heater back “ON.”
- c. If the heater still fails to operate, again turn the heater “OFF” and wait 30 seconds; then switch to the other fuel system (“SYSTEM NO. 2” if “SYSTEM NO. 1” was being used) and turn the heater back “ON.”

(2) If neither cabin heater fuel pressure nor heat output is indicated, proceed as follows:

- a. Check for fuel in the No. 2 main fuel tank.
- b. If fuel is available, switch to the other fuel system (“SYSTEM NO. 2” if “SYSTEM NO. 1” was being used). If heater comes on, the drop-out switch in the original system may have operated as a result of excessive temperature increase.
- c. If the heater still does not function, switch the heater fuel system control to “CROSSFEED.” If the heater comes on, the heater fuel pump has failed and fuel is now being supplied by the airfoil anti - icing heater fuel pump.
- d. If the heater is still inoperative, switch the cabin heater automatic control by-pass switch “ON.” If the heater functions, the automatic control system has failed and the heater is now operating under the control of the limit switches.
- e. Deleted.

11.3. CABIN TEMPERATURE INDICATION — The temperature of the main cabin, as indicated by the main cabin temperature indicator, should agree with the setting on the control knob within a few degrees (under stabilized conditions). If it does not, proceed as follows:

(1) If the cabin temperature is below the setting of the control knob, check to make certain that the cabin heater master switch is "ON" and the windshield heat position has been selected. If the correct position for heat application has been selected and sufficient heat is not available, try the next higher windshield heat position (clockwise).

(2) If the cabin temperature reading is above the setting of the control knob, check the cooling turbine switch on the forward overhead panel to make certain that it is in the "NORMAL" position.

(3) If, after performing one of the above steps, the temperature control setting and the temperature indicator still do not agree, the system is either out of calibration or the automatic control system is malfunctioning. If the cabin temperature is still not within comfortable limits, open the manual control door on the cabin attendant's temperature control panel and push the "DECREASE" button to decrease the temperature or the "INCREASE" button to increase the temperature.

(4) Approximately 2 to 2½ minutes of continuous pressing of a button are required to move the mixing valve through its complete travel in one direction—five minutes for both trips. It is advisable to intermittently depress the buttons in order to obtain smaller variations of temperature change. Wait at least 10 minutes for the temperature to stabilize before depressing a button again. The manual control door must be left open during manual operation of the system.

12. MALFUNCTIONING OF AIRFOIL ANTI-ICING SYSTEM

12.1. AIRFOIL ANTI-ICING HEATER TEMPERATURE — The maximum airfoil anti-icing heater temperature is: 150°C (302°F) with structure-type thermostats, 185°C (365°F) with hairpin-type thermostats, and 210°C (4l0°F) with tubular-type thermostats. If a temperature indicator for the three airfoil anti-icing heaters exceeds the above temperatures, proceed as follows:

(1) Turn the airfoil anti-icing heater master switch "OFF." The temperature should drop immediately.

(2) If airfoil anti-icing heater operation is required, position the respective anti-icing heater fuel control selector switch to the other system ("SYSTEM NO. 2" if "SYSTEM NO. 1" was being used) and then turn the airfoil anti-icing heater master switch back "ON."

(3) Watch the airfoil anti-icing heater temperature indicator to make certain that it does not rise excessively again.

(4) If the temperature continues to rise, turn the airfoil anti-icing heater master switch "OFF." If it is necessary to operate the anti-icing . heaters, airfoil anti-icing can be maintained by manually turning the airfoil de-icer switch "ON" and "OFF" as required to maintain the temperature below the structure limit.

(5) In flight, anti-icing heater output in relation to ram airflow through the heater and ducting or to O.A.T. is such that, at some airspeeds, the airfoil anti-icing heaters may not cycle. Therefore, continuous fuel pressure with normal temperature indication does not indicate malfunctioning of the system.

12.2. AIRFOIL ANTI-ICING HEATER FUEL SYSTEM

(1) If there is temperature indication but not fuel pressure indication for any one airfoil antiicing heater, the fuel pressure indicator has probably failed; no action is necessary as fuel pressure indication is not necessary to the operation of the heaters. With the airfoil deicer switch "ON," the three airfoil anti-icing heater fuel pressure indicators on the heater control panel should indicate between the limits shown in the normal anti-icing fuel pressure table, depending on altitude and airspeed.

NORMAL ANTI-ICING FUEL PRESSURE TABLE

OPERATION	IAS	WING AND TAIL HEATER FUEL PRESSURE (PSI)
Ground	0	3 to 7
Flight	230	20 to 26

(2) If there is fuel pressure but heat output is not indicated, proceed as follows:

a. Turn the heater “OFF”; wait 30 seconds, and then turn the heater back “ON.”

b. If the heater fails to operate, again turn the heater “OFF”; wait another 30 seconds, then turn to the other airfoil heater ignition system (“SYSTEM NO. 2” if “SYSTEM NO. 1” was being used) and turn the heater back “ON.”

c. If the heater still fails to operate, again turn the heater “OFF” and wait 30 seconds; then switch to the other fuel system (“SYSTEM NO. 2” if “SYSTEM NO. 1” was being used) and turn the heater back “ON.”

(3) If no pressure or temperature is indicated on any one of the airfoil indicators, switch to the other system. If fuel is available, position the respective anti-icing heater fuel control selector switch to the other system (“SYSTEM NO. 2” if “SYSTEM NO. 1” was being used).

(4) If no pressure or temperature is indicated on any of the indicators, perform the following steps:

a. Check the following circuit breakers on the main circuit breaker panel to make certain that they are SET:

Main and airfoil healer
Airfoil heater fuel pump
Cabin heater fuel pump
L & R wing airfoil heater
Heater fuel pressure indicator

   b. Check for inverter power, which should be 26 volts.
   c. Check for fuel in No. 3 main fuel tank.

(5) If adequate pressure or temperature is still not available for any of the airfoil heaters, position the airfoil anti-icing heater fuel system Switch to “CROSSFEED.”

(6) If there is neither fuel pressure nor temperature indication on any of the airfoil anti-icing heater indicators, the lack of fuel pressure may indicate a failure of the fuel system. Throw the airfoil de-icer heater master switch to the “OFF” position. TURN AIRFOIL MASTER SWITCH “OFF” AND HEATER FUEL SYSTEM SWITCH BACK TO “NORMAL.”

(7) If malfunctioning of either the left or the right wing anti-icing heater or both is indicated by their respective fuel pressure and temperature indicators, the left and right wing airfoil anti-icing heaters circuit breaker on the main circuit breaker panel may be tripped. This will turn off both wing heaters, leaving the tail heater in operation.

(8) If malfunctioning of the tail anti-icing heater is indicated by its fuel pressure or temperature indicator, the tail airfoil anti-icing heater circuit breaker on the main circuit breaker panel may be tripped, leaving the two wing anti-icing heaters in operation.

12.3. DELETED.

12.4. MALFUNCTIONING WINDSHIELD ANTI-ICING SYSTEM — If the windshield anti-icing system fails to remove ice after being in operation approximately 10 to 15 minutes, instruct the cabin attendant to close as many of the passenger cold-air orifices as possible. If ice is to be most effectively removed from the windshield, there should not be more than 20 coldair orifices open. If passengers do not require cold air, it is preferable to have all orifices closed.

13. MALFUNCTIONING OF CABIN SUPERCHARGER AND PRESSURIZING SYSTEM

13.1. CABIN SUPERCHARGER GEAR BOX PRESSURE

(1) The cabin supercharger lubrication system is equipped with an oil pressure switch that operates a warning light on the upper instrument panel when the oil pressure falls to 35 psi.

(2) If the cabin supercharger gear box oil pressure drops suddenly below 35 psi, with little resultant rise in temperature, declutch the supercharger.

(3) If the cabin supercharger gear box oil pressure drops slowly to 35 psi while the oil temperature rises, proceed as follows:

   a. Place the cooling turbine switch in the “OFF” position.
   b. If this does not cause the pressure to rise, declutch the supercharger.

(3) If the cabin supercharger gear box oil pressure drops slowly to 35 psi while the oil temperature rises, proceed as follows:

   a. Place the cooling turbine switch in the "OFF" position.
   b. If this does not cause the pressure to rise, declutch the supercharger.

13.2. CABIN SUPERCHARGER AIRFLOW

(1) If there is no indication of airflow on the indicator and pressure and temperature are normal, declutch the supercharger.

(2) If the airflow indicator fluctuates wildly, place the cooling turbine switch in the "OFF" position.

(3) If placing the cooling turbine switch in the "OFF" position does not correct the condition, increase the engine rpm substantially and then decrease it to the previous setting.

(4) If this does not correct the condition, declutch the supercharger.

(5) If the airflow indicator shows a regular fluctuation, place the cooling turbine switch in the "OFF" position. However, it is not necessary to declutch the cabin supercharger unless gear box oil temperatures are excessive and/or pressures are below the limit.

(6) If the airflow indicator continuously shows a high flow rate and the reading does not drop with a reduction in engine rpm, place the cooling turbine switch in the "OFF" position.

(7) If the airflow rate varies directly with the rpm and does not return to normal after a change in rpm, declutch the supercharger.

13.3. MALFUNCTIONING WINDSHIELD ANTI-ICING SYSTEM — If the automatic cabin pressure control system malfunctions in any way, the cabin altitude may be controlled by opening the manual control door on the cabin supercharging panel and depressing the required button. During manual control of the cabin pressurizing system, however, the manual control door on the altinuttic control panel must be left open: closing the door returns the system to automatic control. Should this fail to provide the desired control, the cabin pressure may be controlled by the use of the emergency pressure relief valve control lever at the right of the first officer's seat.

Failure of the propeller reversing switch (on the landing gear) in the closed position during flight will also cause the automatic cabin pressure control system to be inoperative. It will then be necessary to operate the cabin pressure system manually.

13.4. EXCESSIVE CABIN DIFFERENTIAL PRESSURE — If the cabin differential pressure exceeds 4.2 psi (the cabin emergency relief valve should start to open at this pressure), open the manual control door and push the altitude increase button (decrease the cabin pressure). If this does not correct the condition, proceed as follows:

(1) Decrease the cabin pressure by operating the cabin pressure emergency relief valve at the right of the first officer's seat.

(2) Check the following circuit breakers on the main circuit breaker panel to see that they are SET.

Cabin manual pressure control warning lights.

Cabin automatic pressure control.

Cabin pressure control amplifier (on the a-c section of the main circuit breaker panel).

14. IMPROPER CABIN HEATER GROUND BLOWER OPERATION

When the airplane is on the ground, combustion air for the cabin heater and for the cabin is supplied by the cabin heater ground blower, located in the left wing-to-fuselage fillet. Cabin heater operation provides hot air for the cabin and for the windshield. Faulty operation of the ground blower may be indicated by the lack of airflow from either the conditioned air or cold air orifices.

(1) A cold cabin and/or no heat at the windshield when the windshield heat switch is on, and no indication of fuel pressure or heater temperature.

(2) A cold cabin and/or no heat at the windshield when the windshield heat switch is on, with erratic fuel pressure and heater backfiring.

In the event of faulty ground blower operation, check for the following conditions, with all engines inoperative:

(1) Ground power supply, with proper voltage, connected to airplane.

(2) Battery master switch—"BATT & GND POWER."

(3) Battery selector switch—"GROUND POWER."

(4) Humidifier and ground blower circuit breaker on main circuit breaker panel—SET.

(5) Cabin ground blower circuit breaker in heater junction box in heater accessories compartment—SET.

(6) Cabin and airfoil anti-icing heater ground relay circuit breaker on the main circuit breaker panel—SET.

The ground blower will normally operate at any time a ground power supply is connected to the airplane. The blower will also function when both inboard engines are operating above 1000 rpm, or, in some airplanes, when No. 2 and No. 4 engines are operating above 1000 rpm, and the respective generator switches are "ON."

15. IMPROPER AIRFOIL ANTI-ICING HEATER GROUND BLOWER OPERATION

If the airplane is on the ground, erratic and low fuel pressure may be caused by malfunctioning of the airfoil anti-icing heater blowers. For correct operation of the airfoil anti-icing heater ground blowers, engines No. 2 and No. 4 must be operating above 1000 rpm and their respective generator switches must be "ON."

The airfoil anti-icing system is automatically turned off whenever reversing powers are used on No. 2 and No. 4 engines.

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16. MALFUNCTIONING OF SPERRY A-12 AUTOMATIC PILOT

(1) If the pilot switch cannot be turned "ON," check for the following conditions:

a. The turn knob is out of the detent.

b. The servo engaging levers are iu the "ON" (up) positions. Disengage the levers by pushing down to the "OFF" positions.

c. The airplane's a-c power supply is not on or is below the automatic pilot operating limits. Check the a-c voltmeter. If the voltage is low, switch to the other inverter.

d. The airplane's a-c power supply has not been on for at least two minutes.

e. The electrical release buttons in the aileron control wheel horns are sticking and are not in the normal (out) position.

f. One of the four automatic pilot d-c circuit breakers on the main circuit breaker panel is tripped or the single a-c fuse on the right-hand annex fuse panel is blown.

(2) If the pilot switch automatically moves to the "OFF" position, check for the following conditions:

a. The airplane's d-c or a-c power supply is either off or was momentarily off, or the a-c power supply has dropped to a low value.

b. The electrical release button on either aileron control wheel horn has been pressed.

c. The turn knob was out of the detent when the servo engaging levers were engaged.

d. One of the automatic pilot circuit breakers or the single a-c fuse has tripped or blown.

(3) If the altitude control switch cannot be turned "ON," the servo engaging levers are "OFF" and the pilot switch is "OFF."

(4) If the altitude control switch automatically returns to the "OFF" position, the servo engaging levers have been moved to the "OFF" positions or the pilot switch has been inadvertently moved to the "OFF" position.

(5) If the pitch knob spins freely, introducing no signal (no elevator motion), the altitude control swtich is "ON." The pitch knob is declutched by placing the altitude control switch "ON." The pitch potentiometer is centered automatically (signal wiped out) whenever the altitude control switch is moved to the "OFF" position.

(6) If the automatic pilot will not electrically disengage, push the servo engaging levers full down ("OFF").

17. FIRE CONTROL

17.1. ENGINE SECTION FIRE

If it is determined that an engine section or nacelle fire exists in flight, perform the following steps immediately.

Phase I: Propeller master control — "MANUAL"

Propeller selector control—"FEATHER"

Mixture control — "IDLE CUT-OFF."

Fire extinguisher selector valve handle (illuminated)— FULL OUT.

Phase II: Crew's oxygen system — 100 per cent flow; full-face, demand-type oxygen masks — ON.

Either C02 discharge handle — full OUT.

All cockpit crew members should put on oxygen masks before or simultaneously with the discharge of CO_2*. The crew member delegated to discharge* CO_2 *to the fire zone, however, may delay putting on his mask until after this operation is accomplished.*

Phase III: Cowl flaps — “OPEN.” (The cowl flaps may be closed after the fire is out to reduce drag.)

Gear and wing flaps — CHECK
Fuel booster pump — “OFF.”
Generator — “OFF.”
Ignition — “OFF.”
Fuel tank selector valve—”OFF.”
Cross-feed valves—”OFF.”
Cowl flaps—”OFF.”
Carburetor heat—”COLD.”

DO NOT RESTART ENGINE IN WHICH FIRE HAS OCCURRED. Land as soon as practicable.

GENERAL NOTES

The engine and nacelle area is divided into three zones: Zone I is the power section (forward of the inner ring); Zone II is the accessory section (between the inner ring and the firewall); Zone III is the area aft of the firewall. While there is no CO_2 protection in Zone I, a fire may burn through this zone into Zone II or III; therefore CO_2 should be discharged regardless of zone indication. With the cowl flaps open, some CO_2 will be drawn forward into Zone I to aid in preventing the fire from spreading; the CO_2 discharged into Zone II and III will also serve to cool the heated surfaces in those areas and will help prevent the ignition of fuel and oil.

Zones II and III, both equipped with thermal detectors and CO_2 discharge systems, are to be considered as one zone since the thermal detectors are interconnected to a common warning light system and CO_2 discharges simultaneously into both zones. The thermal detectors for both Zones II and III will illuminate the respective engine selector handle and both CO_2 discharge handles.

DO NOT EXTEND THE LANDING GEAR OR FLAPS UNTIL THE LAST POSSIBLE MOMENT BEFORE LANDING, thus preventing extensive fire damage to the landing gear system or flaps.

Leave the CO_2 selector valve handle in the OUT position. Approximately 2 seconds after CO_2 is discharged, the pilot valve will return the selector valve handle ¾-inch towards the off position to close the selector valve. This automatic closing eliminates the necessity of manually closing the selector valve before CO_2 is released into another area.

CAUTION

If a nacelle selector valve handle is pulled completely out, and CO_2, is not discharged to the area, the system will remain open until the selector handle is manually returned to the FULL IN position. Pushing the handle into the detent position will not close the system, thus permitting a split shot of CO_2 if another selector valve handle is pulled out and CO_2 is discharged. If the fire shut-off handle for an engine has been pulled to the FULL OUT position with no fire present and subsequently a fire develops in another area protected by the main airplane system, it is necessary to momentarily return the previously selected handle to the FULL IN position prior to the discharge of CO_2 to the new area. Approximately five seconds after the system has been discharged, the handle selected may be returned to the FULL OUT position in order to again close the fuel and oil shut-off valves.

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If a second fire occurs in the same area, or, if the first fire is not extinguished with one discharge of CO_2, PULL THE SELECTOR VALVE HANDLE COMPLETELY OUT AGAIN and then pull the other CO_2 discharge handle. However, do not release the second CO_2 discharge until the first discharge has proved ineffective, to avoid wasting CO_2.

If the propeller of the dead engine cannot be feathered, and no fire is present, the fire extinguisher selector valve handle may be pushed in approximately half-way to the spring stop. This will partially open the oil shut-off valve and permit oil flow to reach the engine, relieving the possibility of an engine seizure. The fuel and hydraulic fluid valves will remain closed when the handle is returned to the detent from the FULL OUT position.

17.2. INDUCTION SYSTEM FIRE— If a fire occurs in the induction system during starting, keep the engine turning until the burning gasoline is drawn into the engine or until the fire is extinguished.

17.3. AIRFOIL ANTI-ICING HEATER FIRE— On some airplanes, the airfoil anti-icing heaters are individually equipped with small CO_2. fire extinguishers. On other airplanes, the tail anti-icing heater is equipped with an individual CO_2 cylinder, while the wing anti-icing heaters are protected by CO_2 discharged from the two banks of large CO_2 cylinders in the main system. On other airplanes, the tail anti-icing heater and the wing anti-icing heaters are connected to the main CO_2 system. In the event of an airfoil heater fire, proceed as follows (according to the system installed):

(1) If all airfoil heaters are equipped with individual cylinders:

   a. When an airfoil heater warning light comes on, use the gang bar to turn “OFF” both the airfoil and the cabin heater master switches to shut off heater fuel pumps, fuel cycling valves, and heater ignition systems.
   b. Turn back the hinged plastic cover and depress the heater selector switch opposite the light.
   c. Wait 5 to 10 seconds and then push the CO_2 discharge button at the bottom of the panel.

(2) If all airfoil heaters are protected by the main CO_2 system:

All cockpit crew members should put on oxygen masks before or simultaneously with the discharge of CO_2. However, the crew member delegated to *discharge CO2 to the fire zone may delay putting on his mask until after accomplishing this operation.*

a. When either wing heater warning light, or tail heater warning light, comes on, use the gang bar to turn "OFF" both the airfoil and the cabin heater master switches.
b. Turn back the hinged plastic cover and depress the heater selector switch opposite the light.
c. Wait 5 to 10 seconds, then push the CO2 discharge button adjacent to the wing heater or tail heater selector switches. The button must be held in the depressed position for approximately two seconds.
d. If a second discharge of CO2 into the same heater becomes necessary, position the CO2 the cylinder selector switch on the heater fire control panel to the opposite bank and again depress the discharge button.
e. After firing a bank of CO2 cylinders into any heater, pull out the CO2 discharge handle on the main CO2 control panel for the exhausted bank as an indication of which bank remains. *The selector valve will not close after one bank of CO2 is discharged to any airfoil heater. If the second bank of CO2 is discharged to any other anti-icing heater, the discharge will be divided between the two heaters, thus reducing the total amount of CO2 discharged into the subsequently selected heaters.*

(3) If wing airfoil heaters are protected by the main CO2 system, and the tail airfoil heater is equipped with an individual CO2, cylinder, accomplish steps a, b, and c in (1), above, when a tail heater warning light illuminates.
(4) In case of a tail heater fire, inspect the compartment after discharging CO2.
(5) If the fire is not under control, land as soon as possible. If the fire is out, it is advisable to land as soon as practicable.
(6) Do not use any of the airfoil heaters following an airfoil heater fire. If necessary, however, the cabin heater may be restarted, provided the heater fuel system cross-feed is not used.

17.4. EMERGENCY DESCENT PROCEDURE— Descend from altitude at the highest possible speed as follows:

(1) Descend at Vne or a maximum of 260 KIAS, gear and flaps up.

(2) If this procedure cannot be used, descend as rapidly as possible, observing flap and geardown speed restrictions, but no less than 135 KIAS (dial).

17.5. FUSELAGE SMOKE OR FIRE PROCEDURE— In the event of smoke or fire in any fuselage compartment or in the cabin, as indicated visually or by means of smoke or fire warning lights, THE FOLLOWING STEPS ARE TO BE TAKEN IMMEDIATELY BEFORE TAKING ANY FIRE CONTROL ACTION:

Phase I: Crew oxygen system, 100 per cent flow—oxygen masks, full-face, demand-type—ON.
All combustion heaters—”OFF.”

Phase II: Cockpit temperature control—”NORMAL.”
Windshield heat control—”OFF.”
Cooling turbine switch—”OFF.”
Cabin temperature control—to the full counterclockwise position.
Fuel booster pumps—”OFF.”
Alcohol system—”OFF.”
Fuel cross-feed system—”OFF.”
Hydraulic system control — “OFF” (system bypassed).
Passenger oxygen system—”OFF.”

In those airplanes equipped with the standard lowpressure oxygen system, in which cylinders are mounted aft of the lower aft baggage compartment and below the floor, the oxygen should be turned OFF. Portable oxygen bottles, each having a capacity of at least 15 minutes for an active person at 20,000 feet altitude, and full-face masks and demand regulators, are conveniently installed in the flight compartment for each crew member.

In those airplanes equipped with an independent crew oxygen supply, with the cylinders, lines, etc., in the cockpit, the crew’s system should be ON, and the separate passenger system be turned OFF in the event of a fuselage fire. A portable oxygen bottle having a capacity of at least 15 minutes for each active person at 20,000 feet altitude, and a full-face mask and a demand regulator, should be installed conveniently in the flight compartment.

After the preceding preliminary steps have been accomplished, subsequent operations should be initiated depending upon the various conditions of fire and/ or smoke noted in the following paragraphs.

17.5.1. Underfloor Fire— If a fire is indicated in any of the lower fuselage compartments (evidenced by both an illuminated fire extinguisher selector valve handle and both CO_2 discharge handles), complete the steps in paragraph 19.5, and proceed as follows:

(1) Close throttles and descend at Vne or a maximum of 260 KIAS, gear and flaps up. Or if this procedure cannot be used, descend as rapidly as possible, observing flap and gear down speed restrictions but not less than 135 KIAS (dial). If level flight is necessary, maintain maximum cruise speed.

(2) Cabin superchargers—DECLUTCH.

(3) Cabin pressure emergency relief valve — FULL OPEN, failure to open this valve will result in dangerous amounts of CO_2 in the cockpit and cabin.

(4) Fire extinguisher selector valve handle (illuminated)—PULL OUT.

(5) Either CO_2 discharge handle—PULL OUT.

In order to more nearly approach compliance with Aviation Safety Release #295, dated 7/22/48, the following warnings are included as an interim measure.

WHEN CO_2 IS DISCHARGED INTO ANY OF THE LOWER FUSELAGE COMPARTMENTS, RECLINING PASSENGERS MUST BE REQUIRED TO SIT UPRIGHT AND ALL PASSENGERS IN THE j FIRST THREE ROWS OF SEATS MUST BE MOVED AFT.

DO NOT DISCHARGE THE SECOND BANK OF CO_2 INTO THE FUSELAGE BECAUSE DISCHARGE OF BOTH BANKS OF CO_2 CYLINDERS CAN CAUSE CONCENTRATIONS DANGEROUSLY HIGH AT SEA LEVEL.

The use of one bank of CO_2 on fuselage fires will provide protective concentrations in excess of those required in the fuselage underfloor fire zones. Use of the second bank of CO_2 can result in dangerous concentrations in the habitable portions of the aircraft and *it should not be discharged by the crew unless it is determined by visual inspection of the compartment affected that the fire is still uncontrolled after the use of the first bank of CO_2.*

(6) Inspect compartment. Under most discharge conditions CO_2 vapor may be mistaken for smoke; therefore, extreme caution should be employed in inspection of the compartment affected.

(7) If fire is not under control, land as soon as possible. If fire is out, it is advisable to land as soon as practicable.

GENERAL NOTES

Following a fire in any of the lower fuselage compartments, DO NOT re-engage the cabin superchargers. When CO_2 is discharged into any lower fuselage compartment, the cabin automatic pressure control valve is automatically closed and will remain closed until reset by a ground crew.

17.5.2. Cabin Heater Fire— The cabin heater is protected by a small CO_2 cylinder that discharges directly into the combustion air intake duct and the ventilating air duct; also by the main CO_2 system which protects the cabin heater accessories compartment. If the cabin heater fire warning light illuminates, complete the steps in paragraph 19.5, and proceed as follows:

(1) Close throttles and descend at Vne or a maximum of 260 KIAS, gear and flaps up. Or, if this procedure cannot be used, descend as rapidly as possible, observing flap and gear down speed restrictions, but not less than 135 KIAS (dial). If level flight is necessary, maintain maximum cruise speed.

(2) De-clutch cabin superchargers.

(3) Open fully cabin pressure emergency relief valve.
Failure to open this valve will result in dangerous amounts of CO_2 in the cockpit and cabin.

(4) Turn back the hinged plastic cover and depress the cabin heater selector switch (opposite the warning light).

(5) Wait five to ten seconds and then push the CO_2 discharge button.

(6) Inspect compartment to make certain that fire is out.

(7) If a second discharge of CO_2 into the cabin heater becomes necessary, a portion of either main bank of CO_2 cylinders may be discharged into the cabin heater as follows:

   a. Pull full out the heater compartment fire extinguisher selector valve handle.

   b. Pull either CO_2 discharge handle.

(8) Inspect compartment to make certain that fire is out.

(9) If fire is not under control, land as soon as possible. If fire is out, it is advisable to land as soon as practicable.

(10) Do not operate the cabin heater following a fire and do not re-engage the cabin superchargers. However, if it becomes necessary to use the airfoil heaters, they may be re-started, provided the heater fuel system crossfeed is not used. *If the fire warning light for the cabin heater illuminates, as well as the main CO_2 selector valve handle for the heater compartment and CO_2 discharge handles, the main CO_2 system should be operated rather than the control on the heater fire control panel.*

17.5.3. Electrical Fire— If the smoke or fire is definitely identified as being of electrical origin, and the source has been found, proceed as follows, after performing the preliminary steps in paragraph 19.5.

(1) Emergency instrument and/or lights—ON.

(2) Battery and generator switches—OFF.

(3) Use hand fire extinguisher to combat fire.
When sprayed on a fire or heated surfaces, carbon tetrachloride produces phosgene, a very toxic gas, which is harmful even in small amounts and can prove fatal if inhaled in sufficient quantities.

(4) Make certain that the circuit breaker for the involved electrical circuit has tripped before restoring power.

If the source of the electrical fire is not determined, proceed as follows:

(1) All circuit breakers — TRIPPED.

(2) Generators and field circuit breakers (one circuit at a time) — SET.

(3) Battery switch — ON.

(4) Either inverter circuit — ON.

(5) Voltage regulator blower circuit — ON.

(6) Circuit breakers (one at a time) — SET.

When the source of smoke has been found in this manner, leave the involved circuit inoperative and restore power to the remaining circuits.

17.5.4. Miscellaneous Cabin or Flight Compartment Fire— Hand fire extinguishers are located in the cabin and flight compartment (see Figure 7) to be used at the crew's discretion on localized fires. Operating instructions for the extinguishers are attached to each extinguisher. If fire or smoke is severe enough, follow smoke evacuation and/or emergency descent procedure (see paragraph 19.6).

17.5.5. Underfloor Smoke and/or Fire— If a smoke warning only is received for any lower fuselage compartment, and after the preliminary steps in paragraph 19.5, preceding, have been performed, proceed as follows:

(1) Inspect the indicated compartment through the floor holes provided, using the viewer. Inspect adjacent compartments if necessary.
(2) If fire exists, remove viewer; close and latch the cover over the viewer hole and proceed with underfloor fire procedure, as given in paragraph 19.5.1.
(3) If no fire exists, proceed with the smoke evacuation procedure given in paragraph 19-6.

GENERAL NOTES

If only a smoke detector warning light comes on, push the RESET button on the heater control panel. If the light goes out and remains out, faulty indication is probable. If the light remains on, a possible fire is indicated, but in either case the compartment having smoke warning should be visually checked through the inspection hole provided in the fuselage floor. If fire exists, proceed with “UNDERFLOOR FIRE” procedures.

If the fire is out, the thermal detector warning light in the selector valve handle should go out, but the smoke detector warning light will, in all probability, remain on, as smoke and/or fog from the discharge of CO_2 will maintain the detector in a tripped condition.

17.5.6. Ventilation System Smoke or Vapor— If smoke or vapor appears in the ventilating system, perform the preliminary steps in paragraph 19.5, which will shut off the heaters and the cooling turbine. If smoke or vapor persists, proceed as follows:

(1) Close throttles and descend at Vne or a maximum of 260 KIAS, gear and flaps up. Or, if this procedure cannot be used, descend as rapidly as possible, observing flap and gear down restrictions but not less than 135 KIAS (dial). If level flight is necessary or desirable, maintain maximum cruise speed.
(2) Both cabin superchargers — DECLUTCH.
(3) Cabin pressure emergency relief valve — FULL OPEN.

(4) If all steps in paragraphs 19.5 and 19.5.6 are performed, the cabin temperature mixing valve will automatically go to Port B, provided the cabin temperature is in “AUTOMATIC.”

(5) Accomplish underfloor inspection procedure.

(6) Land as soon as practicable.

17.6. SMOKE EVACUATION— In the event of heavy smoke concentrations in the cabin or cockpit, perform the following steps immediately:

(1) Close throttles and descend at Vne or a maximum of 260 KIAS, gear and flaps up. Or, if this procedure cannot be used, descend as rapidly as possible, observing flap and gear down restrictions, but not less than 135 KIAS (dial). If level flight is necessary, maintain cruise speed.

(2) Cabin superchargers — DECLUTCH

(3) Cabin pressure emergency relief valve — FULL OPEN.

(4) Door between cabin and flight compartment—CLOSED.

(5) Cockpit side windows and clear view panels— CLOSED. (The clear view panel may be opened momentarily to aid in depressurization if it is considered necessary to open the flight compartment door beyond the detents.)

Heavy smoke concentrations may be reduced in the cabin or flight compartment by opening the main cabin door or an emergency escape harch nearest the smoke source or the flight compartment door to the detent. As this procedure will produce an increased airflow through the ventilating system, caution and judgment must be used in this operation, *which may be done only after depressurizing. Extreme caution must be used when opening an external door beyond the detents during flight, as the door may surge open two or three feet when initially opened before returning to a trail position.*

18. DITCHING

It is recommended in the interests of both structural integrity and rapid disembarkation that the airplane be ditched depressurized. Prior to ditching, the air conditioning system should be operated as follows:

(1) Turn off all cabin and airfoil heaters.

(2) Declutch both cabin superchargers.

(3) Open cabin pressure emergency relief valve.

(4) When depressurized, close cabin emergency pressure control valve.

Prior to ditching, make certain thai small items are adequately secured and that all doors and windows which may take in water are closed and latched. Remove stowed life rafts and ditching equipment and place them in a handy but crashproof place where they cannot fly forward and injure passengers or crew. Make certain that all passengers and crew have assumed ditching stations and that they are adequately braced against sudden deceleration.

Dump all excess fuel to lighten the airplane and to reduce the stalling speed; then close the dump valves and retract the chutes. limpty tanks are an aid to buoyancy. Ditching should take place while power is still available.

Ditch at the lowest possible rate of descent and at a very flat angle. Always use full flaps and land with the gear retracted. Approach the surface with power on and make contact with the water at a speed slightly above the stalling speed. At the moment of contact the nose should be 5° to 10° high to give the best planing action and distribution of the landing shock over the bottom of the fuselage. Contacting the surface tail first results in a tendency for the tail to be sucked down, causing the airplane to remain in a nose high attitude on the surface, and to plane on the fuselage and wing undersurfaces, gradually settling until the nose drops below the surface. This type of contact will reduce the deceleration encountered when the nose drops and the airplane pitches forward, and will damage the fuselage belly and the nose section far less than a contact made from a steep approach angle. Under no circumstances should the airplane be stalled in from a steep angle of approach, as this will result in a severe impact which may stove in the bottom, and be followed by an abrupt deceleration as the nose buries itself in the sea.

Land into the wind in calm water or light seas. If heavy seas are running, approach parallel to the line of wave swells and land on the back side of a swell.

When ditching with both engines inoperative on one side, land with the operating inboard engine only supplying power. On a let-down with any engine inoperative, it is advisable to hold the airspeed considerably above the stalling speed until the flare-out.

When landing at night, use landing flares and landing lights as desired. After landing, leave all lights on to aid in disembarkation.

A double impact is always encountered during ditching. The first impact is on contact with the surface and the second when the nose drops below the surface. With proper ditching technique, the first impact will be light, followed by a uniform deceleration to the second impact (which will be approximately one to two G's). To avoid injury, all personnel should be cautioned to remain braced until after the second impact.

The best position for crew members when ditching is a sitting position, facing aft, with the back, shoulders, and head firmly braced against a bulkhead- This position should be assumed by all crew members who are not at the controls. All passengers should have their seat belts securely fastened and should assume a position with the head down and securely braced against the knees. Coats, light luggage, blankets, or pillows should be used for padding under the face.

It is important that the airplane be evacuated as rapidly as possible after ditching. This requires that the crew be carefully rehearsed in emergency procedures, which can best be accomplished by the operating organization concerned.

The airplane may float for a considerable time if not damaged excessively by the landing impact. However, safety dictates that all aboard be debarked in life rafts as quickly as possible.

19. FUEL SYSTEM FAILURE

19.1. FUEL STOPPAGE IN FLIGHT— If an engine fails in flight because of loss of fuel pressure, immediately check for adequate fuel in the tank supplying the failing engine. If fuel in sufficient quantities is present, retard the throttle and switch on the electric fuel booster pump for that tank to the "LOW" position. If this does not immediately bring up the pressure, a failure other than that of the engine-driven pump is indicated, and the failing engine should be isolated. If cross-feed is being used, immediately switch the operating engine on the side affected to its respective tank system, and do not use fuel from the system in which the failure has occurred.

If, while the engine is being operated, the fuel pressure indication suddenly drops to zero and the warning light comes on, but the engine continues to run smoothly, shut it down immediately. The fuel line to the pressure transmitter may have broken, in which case continued operation will pump fuel into the nacelle area, which will create a dangerous fire hazard. The fuel pressure warning switch is set at 18 (±½) psi. If the fuel pressure indication fails, but the warning light does not come on, and the fuel flowmeter shows normal flow rate, the fuel pressure transmitter has probably failed.

19.2. VAPOR LOCK— The fuel system can malfunction as a result of vapor lock, a condition which occurs when the fuel boils or when the fuel is supersaturated with air in degrees varying from mild to critical, which leads to the release of air vapor in the fuel lines as the supersaturated fuel is agitated. A vapor lock can occur in the main fuel line between the tank and the engine-driven fuel pump, as a result of fuel air vapors trapping in the fuel line, and it can also occur in the metered and unmetered fuel chambers of the carburetor.

The usual indications of vapor lock start with a regular and rapid engine surging of high frequency, coupled with rapid fuel pressure and fuel flow fluctuations. This is usually followed by an irregular surge of greater magnitude in phase, with extreme fuel pressure and flow fluctuations. In the final stage, the surging can become great enough to lead to complete power failure.

Any type of vapor lock can be rapidly and completely broken by placing the electric fuel booster pump switch for the submerged booster pumps in the “LOW” position, which ppressurizes the main fuel line system up to the engine-driven fuel pump, forcing air and fuel vapor back into solution with the fuel, and de-aerating the fuel in the tank.

The carburetor vapor vent return system is capable of handling a normal amount of air coming out of solution; it is only when the amount of air exceeds the capacity of the vapor vent return system to handle it that erratic engine operation occurs. A plugged vapor vent line will produce the same effect.

20. HYDRAULICKING

Hydraulicking of the pistons is caused by the accumulation of liquid fuel or oil in the lower cylinders, either as a result of a slow drainback during an inoperative period or as a result of excessive priming, which may cause fuel to drain back from the primed cylinders to the lower cylinder intake pipes.

Because of the incompressibility of liquids, the piston is unable to travel through its entire compression stroke, resulting in broken pistons, bent rods, or damaged cylinders or master rod assemblies. On a coldengine start, it is advisable to pull the propeller through by hand, in the direction of normal rotation. 8 to 10 blades. If the propeller stops and cannot be rotated, liquid is present in the lower cylinders and must be drained out before the start can be resumed.

21. CARBURETOR ICING

If manifold pressure and fuel flow unaccountably drops, carburetor icing may be the cause. Apply preheat to the carburetor for a short period. This will result in further manifold pressure reduction, but if a subsequent slow rise is noted in manifold pressure, ice is present and is melting. In this event, leave the carburetor heat on continuously until icing conditions no longer prevail. Manifold pressure and engine temperatures should be watched closely during this period. Return the carburetor temperature to desired limits when the ice has been cleared.

Use preheat before carburetor icing becomes critical, as, if the ice accretion is allowed to progress to a critical extent, the loss of engine power may make it impossible to generate sufficient heat to clear the engine. If the preheat capacity is sufficient and if remedial action is not delayed, the elimination of ice will only be a matter of seconds.

If carburetor heat fails to remove ice formation, use the carburetor alcohol anti-icing system until the malfunctioning engine is operating properly.

22. DELETED

23. DETONATION AND PREIGNITION

During normal combustion, the fuel-air charge burns smoothly and evenly, increasing rapidly in rate as combustion advances and slowing down as combustion reaches completion. In contrast, detonation is the sudden self-ignition and uncontrolled burning of the unburned fuel-air due to the temperature being above the ignition temperature. The result is a sudden and violent explosion instead of a smooth expansion of gases. Detonation is accompanied by severe pressure fluctuations of extreme rapidity and extremely high temperatures, which, in severe or prolonged cases, may result in burned pistons or cracked cylinder heads. Detonation may occur in all cylinders simultaneously or in only one cylinder, and may vary between cylinders in degree of intensity. It is important to stay safely below the detonation range, since recognition of the condition is extremely difficult because of the high engine-noise level. Failure of the W/A injection system during high ambient air temperature or high carburetor air temperature may also cause detonation.

Similar to detonation, and frequently accompanied by it, is preignition, or the uncontrolled ignition of the charge ahead of the normal ignition time. Preignition is caused by the charge contacting some "hot spot" in the combustion chamber, such as an incandescent spark plug.

Detonation-free operation is normal and possible over the full range of rated engine performance, even under the most adverse conditions. Some of the conditions most likely to lead to detonation are given in the following paragraphs. However, if detonation is suspected, appropriate action should be taken.

23.1. EXCESSIVE MANIFOLD PRESSURE— The pressure of the charge entering the cylinders increases as manifold pressures increase. The charge pressure is multiplied during compression and combustion, and it may increase to a critical value and result in detonation.

23.2. EXCESSIVE CARBURETOR AIR TEMPERATURE— As high initial-charge air temperature enters the engine, it may also, during compression and combustion, increase the temperature of the fuel-air charge to the point where detonation may occur. Excessive carburetor air temperature may result from too much carburetor preheat or from hot air entering the induction system. Carburetor air heated above 15°C (59°F) is likely to result in detonation when the engine is operating close to maximum cruise power in high blower. In low blower the limit is 40°C (104°F).

23.3. EXCESSIVE CYLINDER-HEAD TEMPERATURE— Detonation may occur when the temperature of the fuel-air charge is raised to critical values by high cylinder- head temperatures. High cylinder-head temperatures may be caused by inadequate cooling of the engine or by exceeding the specified maximum allowable manifold pressure during take-off or emergency operation. Opening the cowl flaps will increase the engine cooling.

23.4. IMPROPER GRADE OF FUEL— Detonation will inevitably follow any attempt to operate in the high power range if the fuel used has an anti-knock rating lower than that called for by the engine rating. The anti-knock rating is the degree of resistance a fuel possesses toward the tendency to detonate.

23.5. MALFUNCTIONING IGNITION SYSTEM— Detonation is likely to occur during operation in the high power range when the spark timing is too far advanced or when only one of the two spark plugs in a cylinder is functioning.

23.6. EXCESSIVELY LEAN MIXTURE— The tendency to detonate varies with the fuel-air ratio, and mixtures at or near best power output are the ones most apt to detonate. An excessively lean mixture will cause severe detonation during high power output with high BMEP—too low an rpm and too high a manifold pressure. Combustion chamber temperatures can be lowered most effectively by enriching the mixture beyond the best power setting and by increasing rpm, which results in lowering the BMEP.

24. ERRATIC ENGINE OPERATION

Probably the most common cause of irregular engine operation is faulty spark plugs. The plugs may run hot and result in preignition or run cold and foul up from the accumulation of carbon deposits. If one or more spark plugs fail, resulting in loss of power, it is inadvisable to attempt to recover the lost power by increasing manifold pressure, since this practice may lead to detonation, especially when operating in the high-power range.

25. MALFUNCTIONING ENGINE OIL SYSTEM

The indications of oil system failure that may lead to engine failure are loss of oil pressure, oil temperature increase, and/or loss of oil quantity indication.

If the oil pressure indications fail, but the oil temperature remains normal and the oil pressure warning light does not come on, the trouble probably lies in the oil pressure indicating system. However, if the oil pressure indication drops and the oil pressure warning light does come on but the oil temperature remains normal, it is probable that the oil line to the pressure transmitter has broken, in which case continued operation of the affected engine will pump oil into the nacelle area with a consequent fire hazard.

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Section VII

EXTREME WEATHER OPERATION

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Section VII
EXTREME WEATHER OPERATION

1. GENERAL

The following instructions for the cold-weather operation of the DC-6 airplane, its anti-icing equipment, and its oil dilution system supplement the information in other sections of this manual.

2. STARTING A COLD ENGINE

When a cold engine is started, ice may form on the spark plugs and on other parts of the combustion chamber after one or more unsuccessful starts. This ice is a combination of fuel, oil, and water and will prevent the spark plugs from firing. Every effort must be made to "catch" the engine on the first starting' attempt, since condensate will form within a few seconds after the engine has fixed and quit. After two or three ineffective starting attempts have been made, time can be saved and abuse to the batteries and starter avoided by removing the spark plugs and inspecting them for ice. If icing has occurred, the front plugs should be changed.

When a stiff engine is started, it is very easy to get the mixture too rich for running, and the engine will not pick up speed. Therefore, it may be necessary to move the mixture control to the "IDLE CUT-OFF" position for brief periods until engine speed increases enough so that airflow is sufficient to match fuel flow. The priming system supplies fuel to the top cylinders only. At cranking speed, fuel discharged from the carburetor' nozzle or spinner goes principally to the lower cylinders. A small discharge of fuel from the supercharger drain during a cold-engine start is normal.

In cold weather, engine operation immediately after starting is frequently rough, with backfiring and afterfiring. This is clue principally to a lean carburetor idling mixture and to reduced vaporization of the fuel. Iced plugs will also produce the same effects. As a corrective measure, turn on the carburetor heat as soon as the engine is free of backfiring. After the engine has warmed up, adjust the carburetor heat as required.

After a cold start do not attempt to heat the engine up more quickly by closing the cowl flaps. The cowl flaps must be full "OPEN" for all ground operations. The cowl flaps only control, cylinder head temperatures, not oil temperature which is the primary concern. Oil temperature represents the temperature of the internal engine parts.

Oil congealing in a radiator produces unusual and often misleading indications. The usual indication is extremely high oil temperatures together with a reduction in pressure, often followed by a sudden drop in oil temperatures accompanied by an extremely high pressure as the congealed oil is forced into the system. After a cold-weather start, it is advisable to check oil temperatures and pressures carefully during the warmup and run-up to prevent a take-off with congealed oil in the radiator.

3. CARBURETOR HEAT

Carburetor icing is apt to occur when the ambient air is highly humid, or when the carburetor air temperature is between-5°C (23°F) and 15°C (59°F). To prevent the formation of ice, carburetor air temperature should be kept above 15°C (59°F) and below 40°C (104°F) (detonation limit). A drop in manifold pressure is an indication of carburetor icing.

During icing conditions, where carburetor heat is used, apply only enough heat to prevent the formation of ice, and apply it continuously rather than in short applications. The amount of heat available is proportional to the power output of the engine; reduction of power in a descent is at the expense of available carburetor heat.

Under extremely cold ambient air conditions, applications of carburetor heat may cause the formation of ice in the induction system as a result of bringing the carburetor intake temperature upward within the icing range.

Do not take-off or land with carburetor heat applied.

4. WINDSHIELD ANTI-ICING

The windshield is kept free of ice and frost by hot air diverted from the cabin heating system and circulated between the panes. The system should be operated without limitations aoy time conditions require its use.

5. PROPELLER ANTI-ICING

The propeller anti-icing system removes ice already formed on the propellers and repels the formation of ice by electrically heating the propeller blades. Operate the system continuously when necessary. Under heavy icing conditions it is recommended that the propeller rpm be increased periodically to maximum.

6. AIRFOIL ANTI-ICING

The leading edges of the wings and the horizontal and vertical surfaces of the empennage are maintained in an ice-free condition by means of hot-air ducts beneath the skin surfaces. The airfoil anti-icing heaters are to be used continuously whenever icing conditions exist. Ground operation is possible and there are no limitations on the use of the system during take-offs and landings. Use the wing illumination lights frequently during icing and when icing conditions are anticipated.

7. PITOT TUBE AND AIRSCOOP ANTI-ICING

The pitot tubes and airscoops are provided with electric heating elements to prevent ice formation. These elements may be put into operation whenever icing conditions prevail. If one of the pitot tubes fails, and heat does not correct the trouble, turn the static selector switch to “ALTERNATE.”

8. LANDING GEAR

During cold-weather operation, when take-offs are made from slushy fields, leave the gear down after the take-off until it is dry or until the slush has frozen. This will prevent the gear from freezing in the retracted position.

9. OIL DILUTION

The airplane is equipped with a system of oil dilution to facilitate cold weather starting. When a cold weather start is anticipated, the engine oil should be diluted with fuel before stopping the engines, provided that the engine oil temperature is maintained below 50°C (122°F). Above that temperature dilution is not effective, as the fuel introduced into the system will vaporize.

When the oil temperature of any engine exceeds 50°C during the dilution period, stop the engine and wait until oil temperatures have fallen below 40°C (104°F) before again starting the engine and resuming the dilution operation. During conditions of extremely low O.A.T. it may be necessary to break the dilution period up into two or more short periods, which will be neither detrimental nor beneficial to the general dilution procedure.

If it becomes necessary to service the nacelle oil tanks, the oil dilution procedure must be divided so that part of the dilution is accomplished before servicing the tanks and the remainder after the oil tanks are serviced.

Insufficient oil dilution will result not only in difficult starts but also in broken oil lines and possible engine failures as a result of poor lubrication.

Following an engine oil dilution operation, it is necessary to operate the engine at normal operating temperatures for approximately half an hour to permit the fuel in the oil supply to evaporate and allow the oil to resume its normal viscosity.

Perform the oil dilution operation as follows (operation of the dilution system is indicated by a drop in fuel pressure):

(1) Turn the fuel booster pumps on “LOW” to supply fuel pressure.

(2) Operate each engine at 1000 to 1200 rpm.

(3) Maintain oil temperature below 50°C (122°F), stopping any engine for a short period if the temperature exceeds this limit.

(4) Operate the oil dilution solenoid switches for the following periods and temperatures:

4° to -12°C (40° to 10°F)	3 minutes
-12° to -29°C (10° to -20°F)	6 minutes
-29° to -46°C (-20° to -50°F)	9 minutes

Add one minute of dilution for each additional 5°C (9°F) below - 46 ° C (-50°F).

(5) A short acceleration period of approximately 10 seconds at the end of the dilution run will usually clear the spark plugs from any fouling condition resulting from prolonged idling.

(6) When dilution is complete, shut the engine down in a normal manner, continuing To hold the oil dilution switch "ON" until the engine has stopped.

(7) When warming up an engine after an oil dilution operation, it is preferable to allow the oil temperature to rise above 60°C (140°F) and to increase the engine speed during the run-up to dissipate as much of the dilutant fuel as possible (below this temperature and at low engine speeds very little gasoline will be driven out of the oil). It is also desirable to vary the propeller blade pitch during warm-up to aid in removing congealed oil from the propeller dome.

10. TAKE-OFF AND LANDING

During extremely cold weather, condensation may permit droplets of water to freeze in the fuel tank vent lines which may, through stoppage, cause the tanks to collapse from suction and the resultant vacuum, as the fuel level drops. During snow, the captain and first officer should check the upper wing surfaces for an accumulation of snow and make certain the controls are completely free through their full travel prior to take-off. At night use the wing illumination lights to check the wing surfaces.

When landing or taking-off on an icy runway, crosswinds can become particularly dangerous, because of the loss of maneuverability resulting from a decreased coefficient of friction. The airplane may, if the wind is gusty, be moved sideways before control can be regained. Brakes should be used sparingly during the landing roll, taking full advantage of the runway length to slow down the roll. Reverse pitch should be used to slow the airplane; however, if the runway is covered with loose snow the reversed propellers might throw up a cloud of snow and obscure vision.

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Section VIII

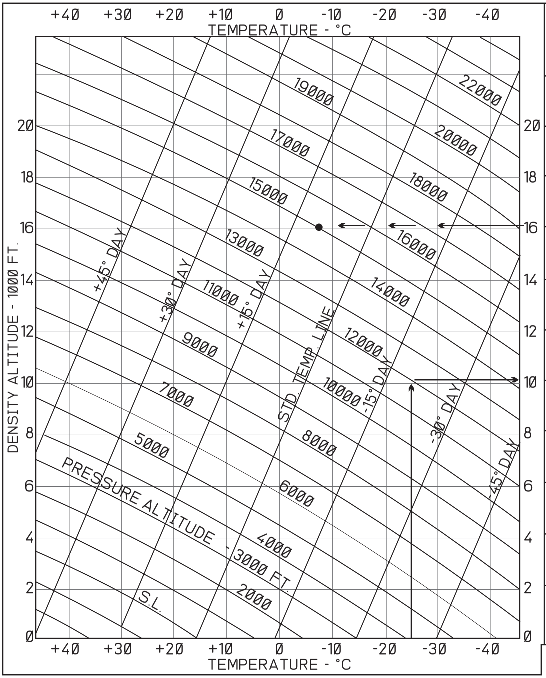
FLIGHT OPERATION DATA

All normal flight operation data are given on the following pages. As the basic data from which the operating charts that follow were reduced has in no way changed, the original dates of compilation are retained for this section of the DC-6 Operation Manual, except for Figure 112.110, which has alternate static source calibration data added.

SPEED POWER TABLE

DC-6 AIRSPEED (KNOTS) & GROSS WEIGHT

DENSITY ALTITUDE	POWER BHP	103,000 #		100,000 #		95,000 #		90,000 #		85,000 #		80,000 #		75,000 #	
		IAS	TAS	IAS	TAS	IAS	TAS	IAS	TAS	IAS	TAS	IAS	TAS	IAS	TAS
20,000	1200 1150 1100			171	243	177	250	181 176	257 251	182 177	257 251	182	257	187	263
18,000	1200 1150 1100			177	242	183	248	186 181	253 247	185 180	252 245	185	252	189	256
16,000	1200 1150 1100	173	229	180	238	185 181	246 239	190 185	250 244	188 184	248 242	188	247	191	252
14,000	1150 1125	171	220	177	227	183 180	235 230	188 185	240 236	188	240	193	245	195	247
12,000	1150 1125	177	217	183	225	187 184	232 227	192 189	237 233	192	236	196	241	198	244
10,000	1150 1125	181	218	186	223	191 189	229 225	195 193	233 230	196	234	198	238	200	240
8000	1150 1125	185	216	189	221	195 192	226 222	198 195	230 226	198	229	200	232	202	234
6000	1150 1125	189	213	194	218	198 195	223 218	201 198	226 222	201	226	203	229	205	232
4000	1150 1125	193	210	198	215	200 198	219 216	204 201	222 219	204	222	206	224	207	226
2000	1150 1125	196	208	200	213	203 201	215 213	206 204	218 216	207	219	208	221	209	222
SEA LEVEL	1150 1125	199	205	203	211	206 204	212 210	209 207	215 213	209	215	211	216	213	218



DC-6 AIRSPEED (KNOTS) & GROSS WEIGHT

NOTES:

(1) Airspeeds are based upon cruising with -1° cowl flaps on all engines. A change of 1° in cowl flap opening for all engines makes approximately 3 Kts. change in airspeed.

(2) Normal operation for any area should be at the highest power shown. For any weight between one shown and the next lower, use the power for the lower weight. For example, at 88,000 lbs. at 16,000 ft., use 1150 HP. DO NOT ATTEMPT TO OPERATE WHERE AIRSPEEDS ARE NOT SHOWN. Operation in the shaded areas is inefficient and should always be avoided unless weather, ATC, or some other unusual operating condition makes operation in one of these areas necessary. When necessary to operate in one of these areas, use the cruise power indicated.

Example: Determine max. cruise density altitude desirable for a gross weight of 100,200 lbs. and determine the pressure altitude that will result in the required density altitude if the expected temperature is approximately 10°C above standard.

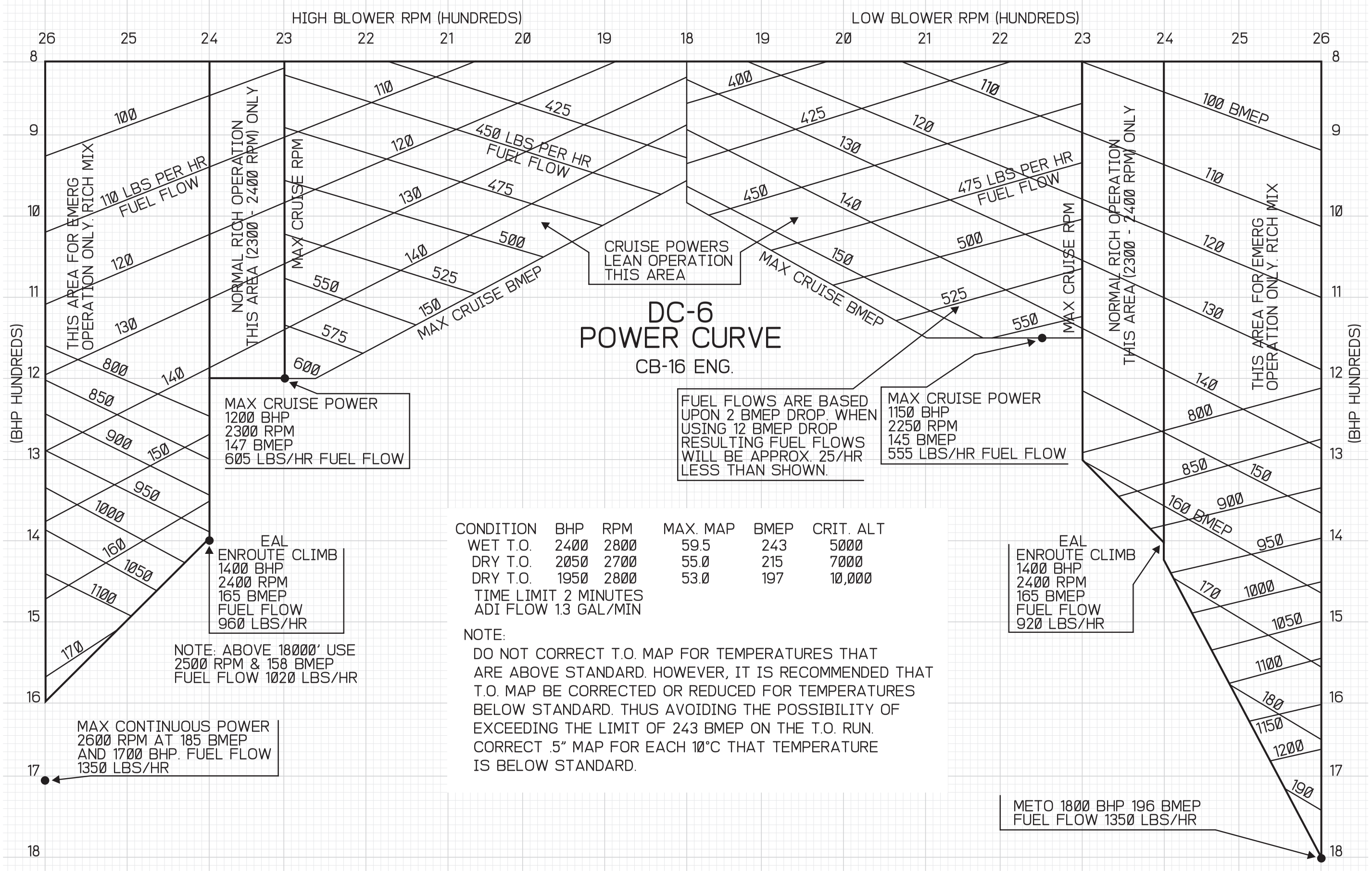
Answer: Enter chart in the 100,000 lbs. column and proceed vertically down finding the max. desirable altitude to be 16,000 ft which gives an IAS of approximately 180 Kts. at 1200 BHP. Proceed horizontally accross to a point that is 10°C above standard, which results in a pressure altitude of 15,000 ft.

Example: Find IAS and TAS for 1150 BHP in cruise at 12,000 ft. pressure alt. and with OAT of -25°. Cr.Wt. 90,000 Lbs.

Answer: a) Enter temp. scale at -25°C. b) Proceed vertically to intersect 12,000 ft. pressure alt. curve (which gives corrected or density alt. of 10,000 ft.). c) Follow accross horizontally to 1150 BHP at 90,000 lbs. box. Obtain answer which is: Expected IAS=195 Kts. and 223 TAS.

(3) GROSS WEIGHTS SHOWN ARE WEIGHTS EXISTING AT TIME IN QUESTION AND ARE NOT TAKE-OFF WEIGHTS. As the take-off weight is reduced by fuel consumption, power used is to be reduced accordingly.

Example: Start of cruise at 18,000 ft. the gross weight is 92,000 lbs. This requires 1200 HP for normal cruise. When 2,000 lbs. of fuel is burned off, the cruise power is to be reduced to 1150.



DC-6
POWER CURVE
CB-16 ENG.

MAX CRUISE POWER
1200 BHP
2300 RPM
147 BMEP
605 LBS/HR FUEL FLOW

MAX CRUISE POWER
1150 BHP
2250 RPM
145 BMEP
555 LBS/HR FUEL FLOW

FUEL FLOWS ARE BASED UPON 2 BMEP DROP. WHEN USING 12 BMEP DROP RESULTING FUEL FLOWS WILL BE APPROX. 25/HR LESS THAN SHOWN.

EAL
ENROUTE CLIMB
1400 BHP
2400 RPM
165 BMEP
FUEL FLOW
960 LBS/HR

EAL
ENROUTE CLIMB
1400 BHP
2400 RPM
165 BMEP
FUEL FLOW
920 LBS/HR

NOTE: ABOVE 18000' USE 2500 RPM & 158 BMEP FUEL FLOW 1020 LBS/HR

MAX CONTINUOUS POWER 2600 RPM AT 185 BMEP AND 1700 BHP. FUEL FLOW 1350 LBS/HR

METO 1800 BHP 196 BMEP
FUEL FLOW 1350 LBS/HR

CONDITION	BHP	RPM	MAX. MAP	BMEP	CRIT. ALT
WET T.O.	2400	2800	59.5	243	5000
DRY T.O.	2050	2700	55.0	215	7000
DRY T.O.	1950	2800	53.0	197	10,000

TIME LIMIT 2 MINUTES
ADI FLOW 1.3 GAL/MIN

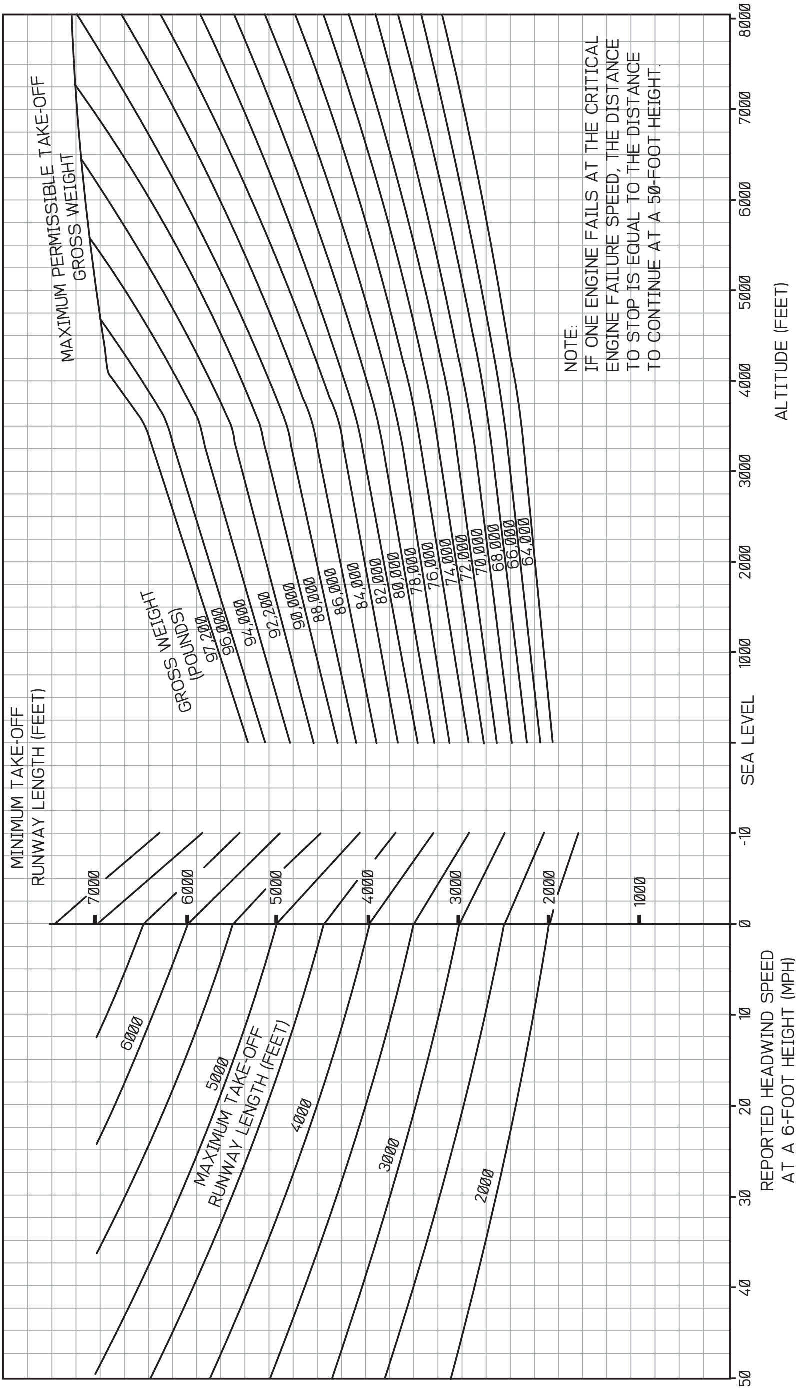
NOTE:

DO NOT CORRECT T.O. MAP FOR TEMPERATURES THAT ARE ABOVE STANDARD. HOWEVER, IT IS RECOMMENDED THAT T.O. MAP BE CORRECTED OR REDUCED FOR TEMPERATURES BELOW STANDARD. THUS AVOIDING THE POSSIBILITY OF EXCEEDING THE LIMIT OF 243 BMEP ON THE T.O. RUN. CORRECT .5" MAP FOR EACH 10°C THAT TEMPERATURE IS BELOW STANDARD.

DC-6 TAKE-OFF PERFORMANCE
MINIMUM TAKE-OFF RUNWAY LENGTH

PRATT & WHITNEY R-2800-CB16 ENGINES WITH A/W INJECTION
HAMILTON STANDARD PROPELLER NO. 23260 - BLADE NO. 2H17U3-48R
HARD SURFACE RUNWAY NO RUNWAY SLOPE
NO OBSTACLE AT END OF RUNWAY STANDARD ATMOSPHERIC CONDITIONS
WING FLAP SETTINGS 20 DEGREES

150% REPORTED TAILWIND AND 50% REPORTED HEADWIND SPEED USED IN CONSTRUCTION OF THIS CHART.



NOTE:
IF ONE ENGINE FAILS AT THE CRITICAL ENGINE FAILURE SPEED, THE DISTANCE TO STOP IS EQUAL TO THE DISTANCE TO CONTINUE AT A 50-FOOT HEIGHT.

FIGURE 112.100 - TAKE-OFF PERFORMANCE (WET) - CB16 ENGINES

DC-6 TAKE-OFF PERFORMANCE
MINIMUM TAKE-OFF RUNWAY LENGTH

PRATT & WHITNEY R-2800-CB16 ENGINE (DRY)

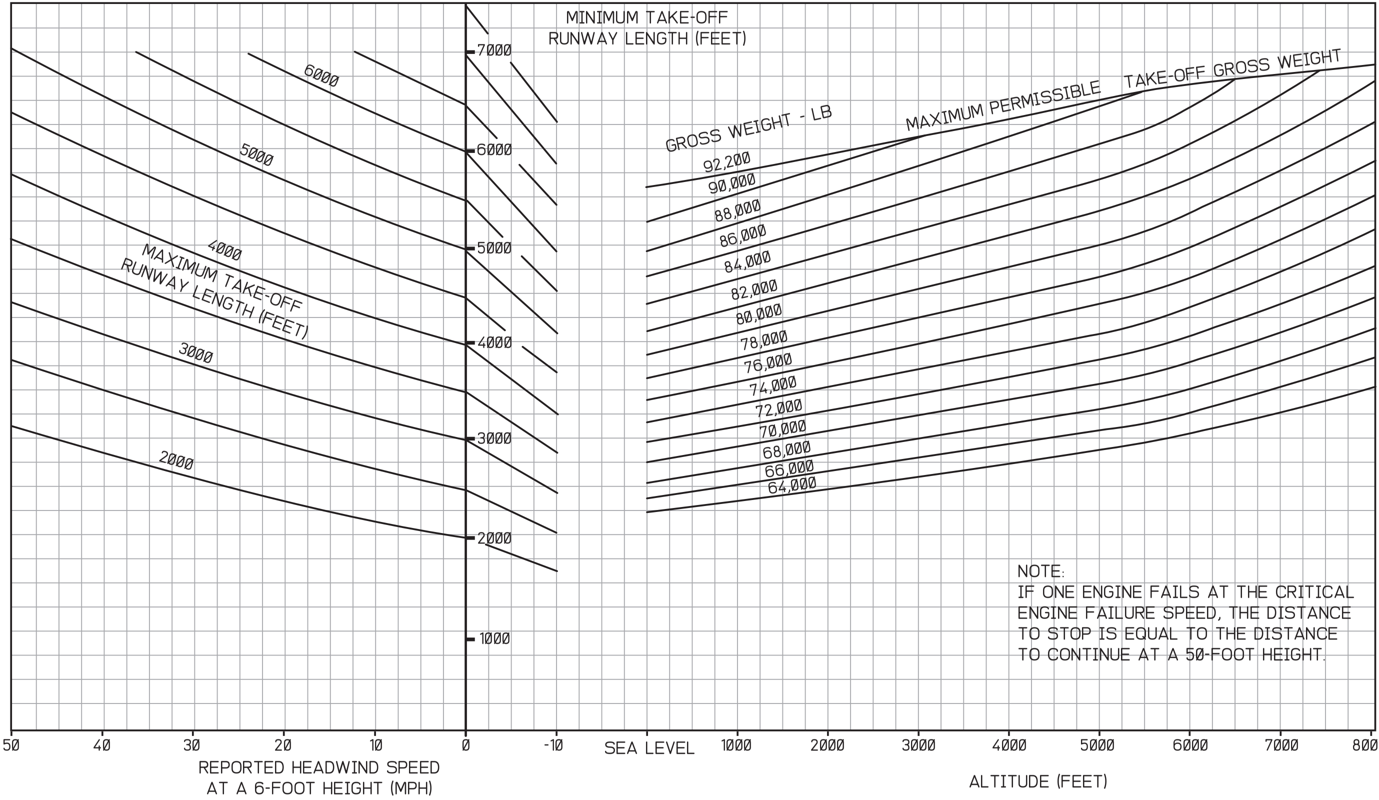
HAMILTON STANDARD PROPELLER NO. 23260 - BLADE NO. 2H17U3-48R

HARD SURFACE RUNWAY
NO OBSTACLE AT END OF RUNWAY

NO RUNWAY SLOPE
STANDARD ATMOSPHERIC CONDITIONS

WING FLAP SETTINGS 20 DEGREES

150% REPORTED TAILWIND AND 50% REPORTED HEADWIND SPEED USED IN CONSTRUCTION OF THIS CHART.



NOTE:
IF ONE ENGINE FAILS AT THE CRITICAL ENGINE FAILURE SPEED, THE DISTANCE TO STOP IS EQUAL TO THE DISTANCE TO CONTINUE AT A 50-FOOT HEIGHT.

FIGURE 112.110 - TAKE-OFF PERFORMANCE (DRY) - CB16 ENGINES

DC-6 WITH P&W R2800-CB16 ENGINES

LEVEL FLIGHT CRUISE CHART
FOUR ENGINES OPERATING
1000 TORQUEMETER HORSEPOWER

	ENGINE DATA								AIRPLANE DATA										
	ALL GROSS WEIGHTS					GROSS WEIGHT (LB) 97,200 TO 92,500			GROSS WEIGHT (LB) 92,500 TO 87,500		GROSS WEIGHT (LB) 87,500 TO 82,500		GROSS WEIGHT (LB) 82,500 TO 77,500		GROSS WEIGHT (LB) 77,500 TO 72,500		GROSS WEIGHT (LB) 72,500 TO 67,500	
	ALTITUDE	RPM	BMEP	LB/HR	TIME‡	DIAS	TAS	TIME**	DIAS	TAS	DIAS	TAS	DIAS	TAS	DIAS	TAS	DIAS	TAS
	24	2300	123	524	2.38						165	247	172	259	179	268	182	274
	23	2270	124	518	2.41						168	247	176	258	180	266	185	272
	22	2220	127	512	2.44				163	235*	171	246	179	257	183	265	187	270
HIGH BLOWER ↑	21	2170	130	506	2.47				166	236	173 LIV L/D	246	181	255	185	262	189	267
	20	2120	133	500	2.50				170	236	176	245	183	253	187	260	191	265
	19	2070	137	495	2.53				172	235	179	245	185	252	189	258	192	263
LOW BLOWER ↓	18	2260	125	487	2.56				174	234	180	243	186	250	191	256	193	260
	17	2220	127	481	2.60				177	233	183	242	188	248	192	254	195	258
	16	2170	130	475	2.63				179 LIV L/D	232	185	241	190	246	193	252	196	256
	15	2130	133	470	2.65				181	232	186	239	192	245	195	250	198	253
	14	2090	135	464	2.69	174	221	2.53	184	231	188	238	193	243	196	248	198	252
	13	2050	138	460	2.71	177	221	2.56	185	230	191	237	194	242	198	246	200	249
	12	2020	140	455	2.75	179	221	2.58	187	229	192	235	196	239	198	244	201	246
	11	1980	143	451	2.77	185 LIV L/D	221	2.60	189	227	193	233	198	238	200	242	203	245
	10	1940	145	447	2.79	184	220	2.63	191	226	195	232	198	236	202	240	204	242
	9	1910	148	443	2.82	185	218	2.65	192	225	197	231	200	234	203	238	205	240
	8	1870	151	439	2.85	187	218	2.68	194	224	198	229	202	232	204	236	206	238
	7	1820	155	434	2.88	189	216	2.71	196	222	199	227	203	231	205	234	207	236
	6	1820	155	434	2.88	191	215	2.71	198	220	201	225	205	229	206	232	208	233
	5	1820	155	434	2.88	193	214	2.71	199	219	203	224	205	227	208	230	209	232
	4	1820	155	434	2.88	195	213	2.71	200	218	204	222	207	225	209	228	211	229
	3	1820	155	434	2.88	197	212	2.71	202	216	205	220	208	223	211	225	212	227
	2	1820	155	434	2.88	200	212	2.71	203	215	206	218	210	221	212	224	212	225
	1	1820	155	434	2.88	201	210	2.71	205	213	208	217	211	219	212	222	214	223
	0	1820	155	434	2.88	203	209	2.71	205	212	209	215	212	218	213	219	215	221

D.I.A.S.—Dial Indicator Airspeed corrected for installation and compressibility effects, but assuming zero instrument error.

Altitude—Density Altitude (1,000 feet)

B.M.E.P.—Torquemeter Brake Mean Effective Pressure (lbs. per square inch)

LB/HR—Fuel Flow per Engine using the specific fuel consumptions as quoted in P & W eng. spec. No. 8138, rev. 1-4-50 (lbs. of fuel per hour).

R.P.M.—Engine Speed (revolutions per minute).

T.A.S.—True Airspeed (statute miles per hour).

* —Speeds are not quoted below V_1 speed.

‡Time—Time to burn 5,000 lbs. of fuel (hrs.).

**Time—Time to burn 4,700 lbs. of fuel (hrs.).

Figure 112.120—Level Flight Cruise Chart—Four Engines Operating—1000 Torquemeter Horsepower—CB16 Engines

DC-6 WITH P&W R2800-CB16 ENGINES
LEVEL FLIGHT CRUISE CHART
FOUR ENGINES OPERATING
1100 TORQUEMETER HORSEPOWER

	ENGINE DATA								AIRPLANE DATA									
	ALL GROSS WEIGHTS					GROSS WEIGHT (LB) 97,200 TO 92,500			GROSS WEIGHT (LB) 92,500 TO 87,500		GROSS WEIGHT (LB) 87,500 TO 82,500		GROSS WEIGHT (LB) 82,500 TO 77,500		GROSS WEIGHT (LB) 77,500 TO 72,500		GROSS WEIGHT (LB) 72,500 TO 67,500	
	ALTITUDE	RPM	BMEP	LB/HR	TIME‡	DIAS	TAS	TIME**	DIAS	TAS	DIAS	TAS	DIAS	TAS	DIAS	TAS	DIAS	TAS
	21	2280	136	557	2.24	170	242	2.11	179	256	186	264	192	270	195	276	198	280
	20	2220	140	554	2.26	173	242	2.12	182	254	189	262	193	268	197	274	199	278
	19	2170	143	550	2.27	176	242	2.14	185	253	191	260	195	265	198	271	200	274
HIGH BLOWER ↑	18	2120	147	547	2.28	179	241	2.15	186	252	192	258	197	264	199	269	202	271
	17	2070	150	543	2.30	181 ^{LIV}	$_{L/D}$241	2.16	189	250	194	257	198	262	201	266	203	269
	16	2260	137	537	2.32	185	240	2.18	191	249	196	255	199	259	202	264	205	266
	15	2230	139	532	2.35	186	240	2.20	192	247	198	253	201	258	204	262	205	264
LOW BLOWER ↓	14	2190	142	526	2.37	189	240	2.23	194	245	198	252	202	255	205	259	207	261
	13	2150	145	520	2.40	191	239	2.26	196	244	200	250	204	253	206	257	208	258
	12	2110	147	515	2.43	192	238	2.28	198	243	202	248	205	252	207	255	209	257
	11	2070	150	509	2.46	194	236	2.31	199	241	204	246	206	249	209	252	211	254
	10	2030	153	503	2.48	196	234	2.34	201	239	205	244	208	247	210	250	212	252
	9	2010	155	500	2.50	198	232	2.35	203	238	206	242	209	245	211	248	212	250
	8	2010	155	500	2.50	199	231	2.35	205	236	207	239	211	243	212	245	214	247
	7	2010	155	500	2.50	202	230	2.35	206	234	209	238	212	241	213	243	215	245
	6	2010	155	500	2.50	204	229	2.35	207	232	210	236	212	239	215	241	217	243
	5	2010	155	500	2.50	206	228	2.35	209	231	212	234	214	237	216	238	218	241
	4	2010	155	500	2.50	208	227	2.35	211	229	212	232	215	234	217	237	218	238
	3	2010	155	500	2.50	210	226	2.35	212	227	214	231	217	232	218	234	220	236
	2	2010	155	500	2.50	212	225	2.35	213	225	215	229	218	231	219	232	221	233
	1	2010	155	500	2.50	214	224	2.35	215	224	217	226	219	229	221	230	222	232
	0	2010	155	500	2.50	216	222	2.35	216	222	218	225	220	226	222	228	224	229

D.I.A.S.—Dial Indicator Airspeed corrected for installation and compressibility effects, but assuming zero instrument error.

Altitude—Density Altitude (1,000 feet)

B.M.E.P.—Torquemeter Brake Mean Effective Pressure (lbs. per square inch)

LB/HR—Fuel Flow per Engine using the specific fuel consumptions as quoted in P & W eng. spec. No. 8138, rev. 1-4-50 (lbs. of fuel per hour).

R.P.M.—Engine Speed (revolutions per minute).

T.A.S.—True Airspeed (statute miles per hour).

‡Time—Time to burn 5,000 lbs. of fuel (hrs.).

**Time—Time to burn 4,700 lbs. of fuel (hrs.).

Figure 112.130—Level Flight Cruise Chart—Four Engines Operating—1100 Torquemeter Horsepower—CB16 Engines

DC-6 WITH P&W R2800-CB16 ENGINES
LEVEL FLIGHT CRUISE CHART
FOUR ENGINES OPERATING
1200 TORQUEMETER HORSEPOWER

	ENGINE DATA								AIRPLANE DATA									
	ALL GROSS WEIGHTS					GROSS WEIGHT (LB) 97,200 TO 92,500			GROSS WEIGHT (LB) 92,500 TO 87,500		GROSS WEIGHT (LB) 87,500 TO 82,500		GROSS WEIGHT (LB) 82,500 TO 77,500		GROSS WEIGHT (LB) 77,500 TO 72,500		GROSS WEIGHT (LB) 72,500 TO 67,500	
	ALTITUDE	RPM	BMEP	LB/HR	TIME‡	DIAS	TAS	TIME**	DIAS	TAS	DIAS	TAS	DIAS	TAS	DIAS	TAS	DIAS	TAS
	20	2300	147	633	1.97	189	262	1.86	194	270	198	275	201	279	203	284	205	286
	19	2260	150	623	2.00	191	261	1.89	196	268	199	273	203	278	205	282	207	285
	18	2260	150	623	2.00	193	260	1.89	198	265	201	271	204	275	206	279	208	281
HIGH BLOWER ↑	17	2260	150	623	2.00	195	258	1.89	198	264	202	269	205	273	207	276	210	278
	16	2260	150	623	2.00	197	257	1.89	200	262	204	266	207	271	209	273	211	276
LOW BLOWER ↓	15	2300	147	608	2.05	198	256	1.94	202	260	205	265	208	268	210	271	212	273
	14	2270	150	599	2.09	200	254	1.97	204	258	206	262	210	265	212	268	213	271
	13	2220	153	590	2.14	202	252	1.99	205	256	208	260	211	264	212	265	214	268
	12	2190	155	584	2.14	205	251	2.01	207	254	210	258	212	261	214	264	216	265
	11	2190	155	584	2.14	205	249	2.01	209	252	212	256	213	258	215	261	217	263
	10	2190	155	584	2.14	207	247	2.01	210	251	212	254	214	257	216	258	218	260
	9	2190	155	584	2.14	208	245	2.01	211	248	213	252	215	254	217	256	218	258
	8	2190	155	584	2.14	210	243	2.01	212	246	215	249	217	252	218	253	220	255
	7	2190	155	584	2.14	212	241	2.01	214	245	217	247	218	250	219	252	221	252
	6	2190	155	584	2.14	212	239	2.01	216	243	218	245	219	247	221	249	223	251
	5	2190	155	584	2.14	214	238	2.01	218	241	219	243	221	245	222	246	224	248
	4	2190	155	584	2.14	216	236	2.01	218	238	220	241	222	243	224	245	225	245
	3	2190	155	584	2.14	218	234	2.01	220	237	222	238	224	241	225	242	226	244
	2	2190	155	584	2.14	219	232	2.01	222	235	224	237	225	238	226	240	228	241
	1	2190	155	584	2.14	220	230	2.01	223	232	225	234	226	237	227	238	229	239
	0	2190	155	584	2.14	221	228	2.01	225	231	226	232	227	234	229	236	231	237

D.I.A.S.—Dial Indicator Airspeed corrected for installation and compressibility effects, but assuming zero instrument error.

Altitude—Density Altitude (1,000 feet)

B.M.E.P.—Torquemeter Brake Mean Effective Pressure (lbs. per square inch)

LB/HR—Fuel Flow per Engine using the specific fuel consumptions as quoted in P & W eng. spec. No. 8138, rev. 1-4-50 (lbs. of fuel per hour).

R.P.M.—Engine Speed (revolutions per minute).

T.A.S.—True Airspeed (statute miles per hour).

‡Time—Time to burn 5,000 lbs. of fuel (hrs.).

**Time—Time to burn 4,700 lbs. of fuel (hrs.).

Figure 112.140—Level Flight Cruise Chart—Four Engines Operating—1200 Torquemeter Horsepower—CB16 Engines

DC-6 WITH P&W R2800-CB16 ENGINES
LEVEL FLIGHT CRUISE CHART
FOUR ENGINES OPERATING
1240 TORQUEMETER HORSEPOWER

ENGINE DATA								AIRPLANE DATA									
ALL GROSS WEIGHTS					GROSS WEIGHT (LB) 97,200 TO 92,500			GROSS WEIGHT (LB) 92,500 TO 87,500		GROSS WEIGHT (LB) 87,500 TO 82,500		GROSS WEIGHT (LB) 82,500 TO 77,500		GROSS WEIGHT (LB) 77,500 TO 72,500		GROSS WEIGHT (LB) 72,500 TO 67,500	
ALTITUDE	RPM	BMEP	LB/HR	TIME‡	DIAS	TAS	TIME**	DIAS	TAS	DIAS	TAS	DIAS	TAS	DIAS	TAS	DIAS	TAS
14	2300	152	631	1.98	205	259	1.86	208	264	211	267	213	270	215	272	217	274
13	2260	155	623	2.01	206	258	1.89	210	261	212	265	215	267	217	270	218	271
12	2260	155	623	2.01	207	255	1.89	211	258	213	262	216	265	218	267	218	269
11	2260	155	623	2.01	209	253	1.89	212	257	215	260	217	262	218	265	220	266
10	2260	155	623	2.01	211	252	1.89	213	254	216	258	218	259	219	262	221	264
9	2260	155	623	2.01	212	250	1.89	214	252	217	255	218	257	220	259	223	261
8	2260	155	623	2.01	213	247	1.89	215	250	218	252	219	254	221	257	224	258
7	2260	155	623	2.01	215	245	1.89	217	248	219	251	221	252	223	254	225	256
6	2260	155	623	2.01	216	244	1.89	218	245	220	248	223	251	225	252	225	253
5	2260	155	623	2.01	218	242	1.89	219	244	221	245	224	248	225	250	227	252
4	2260	155	623	2.01	218	239	1.89	220	241	223	244	225	245	226	247	228	249
3	2260	155	623	2.01	220	238	1.89	222	239	225	242	225	244	228	245	229	246
2	2260	155	623	2.01	222	236	1.89	224	238	225	239	227	241	229	243	230	244
1	2260	155	623	2.01	224	234	1.89	225	236	227	238	229	239	231	241	232	242
0	2260	155	623	2.01	225	232	1.89	227	234	229	236	222	238	232	238	232	239

D.I.A.S.—Dial Indicator Airspeed corrected for installation and compressibility effects, but assuming zero instrument error.

Altitude—Density Altitude (1,000 feet)

B.M.E.P.—Torquemeter Brake Mean Effective Pressure (lbs. per square inch)

LB/HR—Fuel Flow per Engine using the specific fuel consumptions as quoted in P & W eng. spec. No. 8138, rev. 1-4-50 (lbs. of fuel per hour).

R.P.M.—Engine Speed (revolutions per minute).

T.A.S.—True Airspeed (statute miles per hour).

‡Time—Time to burn 5,000 lbs. of fuel (hrs.).

**Time—Time to burn 4,700 lbs. of fuel (hrs.).

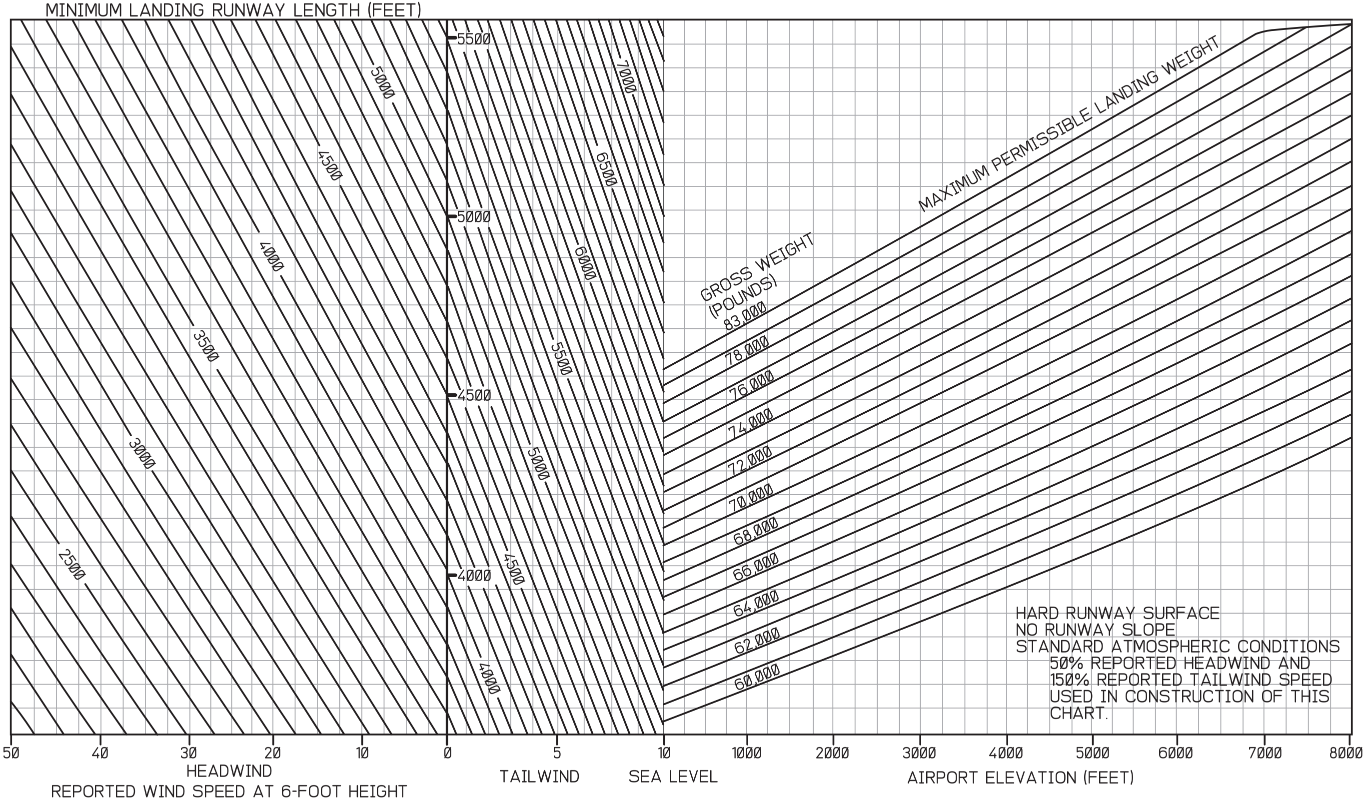
Figure 112.145—Level Flight Cruise Chart—Four Engines Operating—1240 Torquemeter Horsepower—CB16 Engines

DC-6 LANDING PERFORMANCE
MINIMUM EFFECTIVE LANDING RUNWAY LENGTH FOR ALTERNATE DESTINATION

(LANDING DISTANCE EQUALS 70% OF RUNWAY LENGTH)

PRATT & WHITNEY R-2800-CB16 ENGINE (DRY) HAMILTON STANDARD PROPELLER NO. 23260 - BLADE NO. 2H17U3-48R

FLAPS IN 40 DEGREE LANDING POSITION



HARD RUNWAY SURFACE
NO RUNWAY SLOPE
STANDARD ATMOSPHERIC CONDITIONS
50% REPORTED HEADWIND AND
150% REPORTED TAILWIND SPEED
USED IN CONSTRUCTION OF THIS
CHART.

FIGURE 112.150 - LANDING PERFORMANCE - CB16 ENGINES
(ALTERNATE DESTINATION, FLAPS 40 DEGREES)

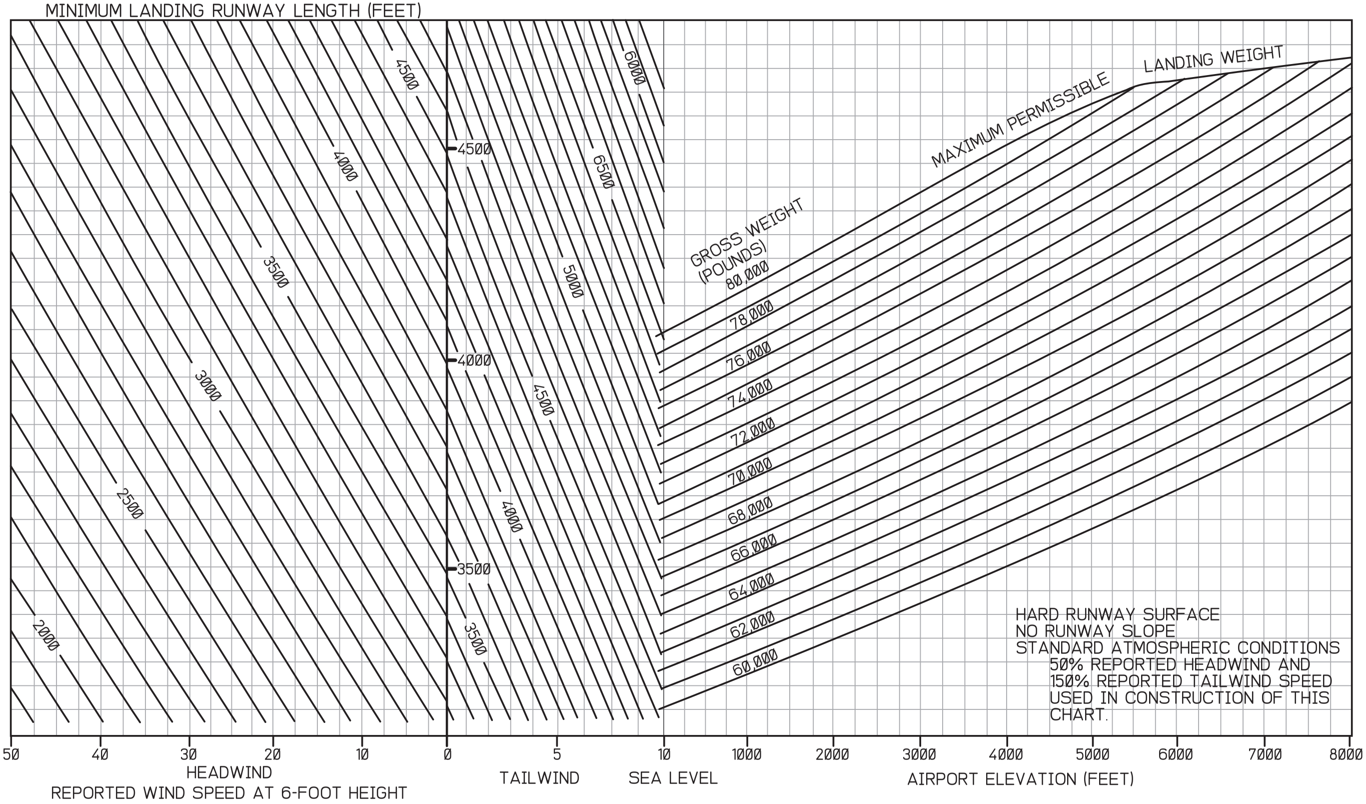
DC-6 LANDING PERFORMANCE

MINIMUM EFFECTIVE LANDING RUNWAY LENGTH FOR ALTERNATE DESTINATION

(LANDING DISTANCE EQUALS 70% OF RUNWAY LENGTH)

PRATT & WHITNEY R-2800-CB16 ENGINE – HAMILTON STANDARD PROPELLER NO. 23260 – BLADE NO. 2H17U3-48R

FLAPS IN FULL DOWN LANDING POSITION



HARD RUNWAY SURFACE
NO RUNWAY SLOPE
STANDARD ATMOSPHERIC CONDITIONS
50% REPORTED HEADWIND AND
150% REPORTED TAILWIND SPEED
USED IN CONSTRUCTION OF THIS
CHART.

FIGURE 112.160 - LANDING PERFORMANCE - CB16 ENGINES
(ALTERNATE DESTINATION, FLAPS FULL DOWN)

DC-6 LANDING PERFORMANCE
MINIMUM EFFECTIVE LANDING RUNWAY LENGTH FOR INTENDED DESTINATION

(LANDING DISTANCE EQUALS 60% OF RUNWAY LENGTH)

PRATT & WHITNEY R-2800-CB16 ENGINE – HAMILTON STANDARD PROPELLER NO. 23260 – BLADE NO. 2H17U3-48R

FLAPS IN 40 DEGREE LANDING POSITION

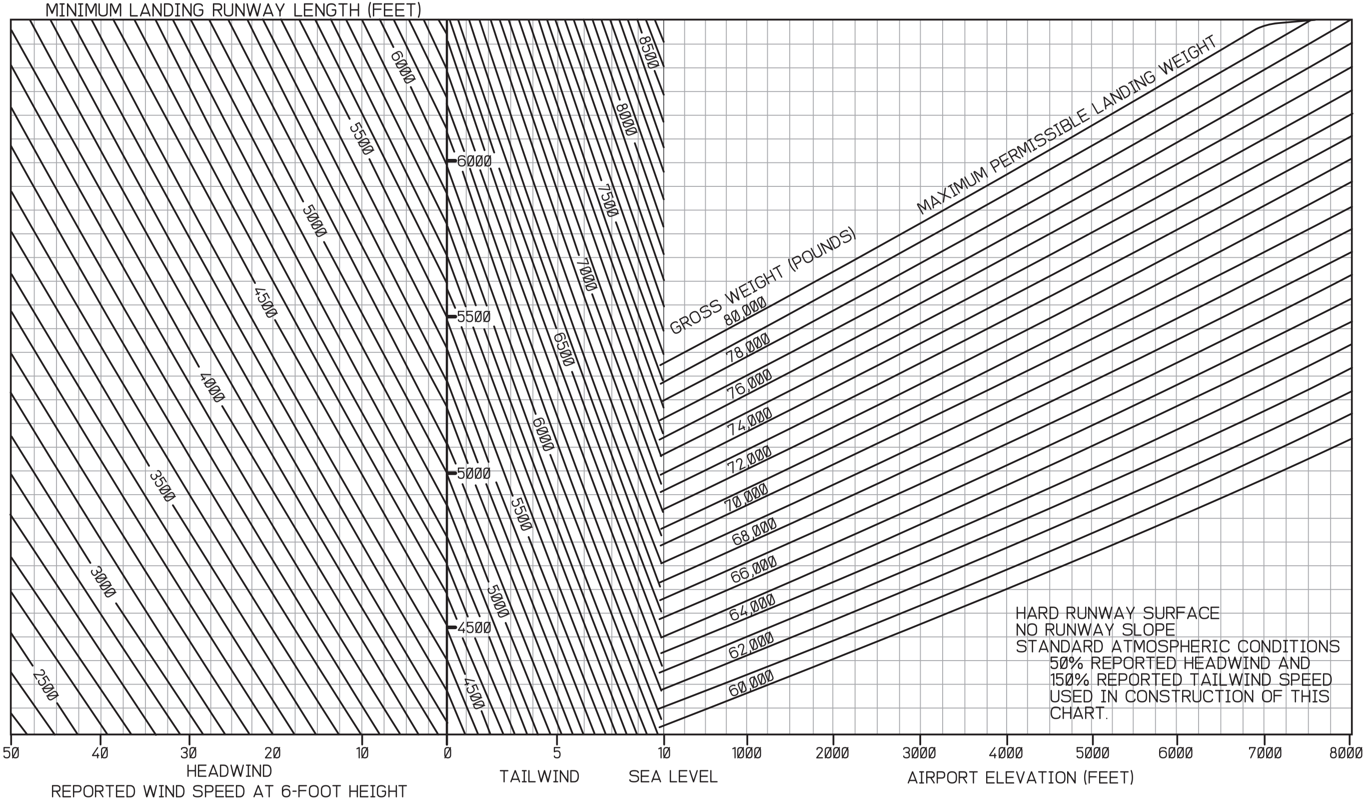


FIGURE 112.170 - LANDING PERFORMANCE - CB16 ENGINES
(INTENDED DESTINATION, FLAPS 40 DEGREES)

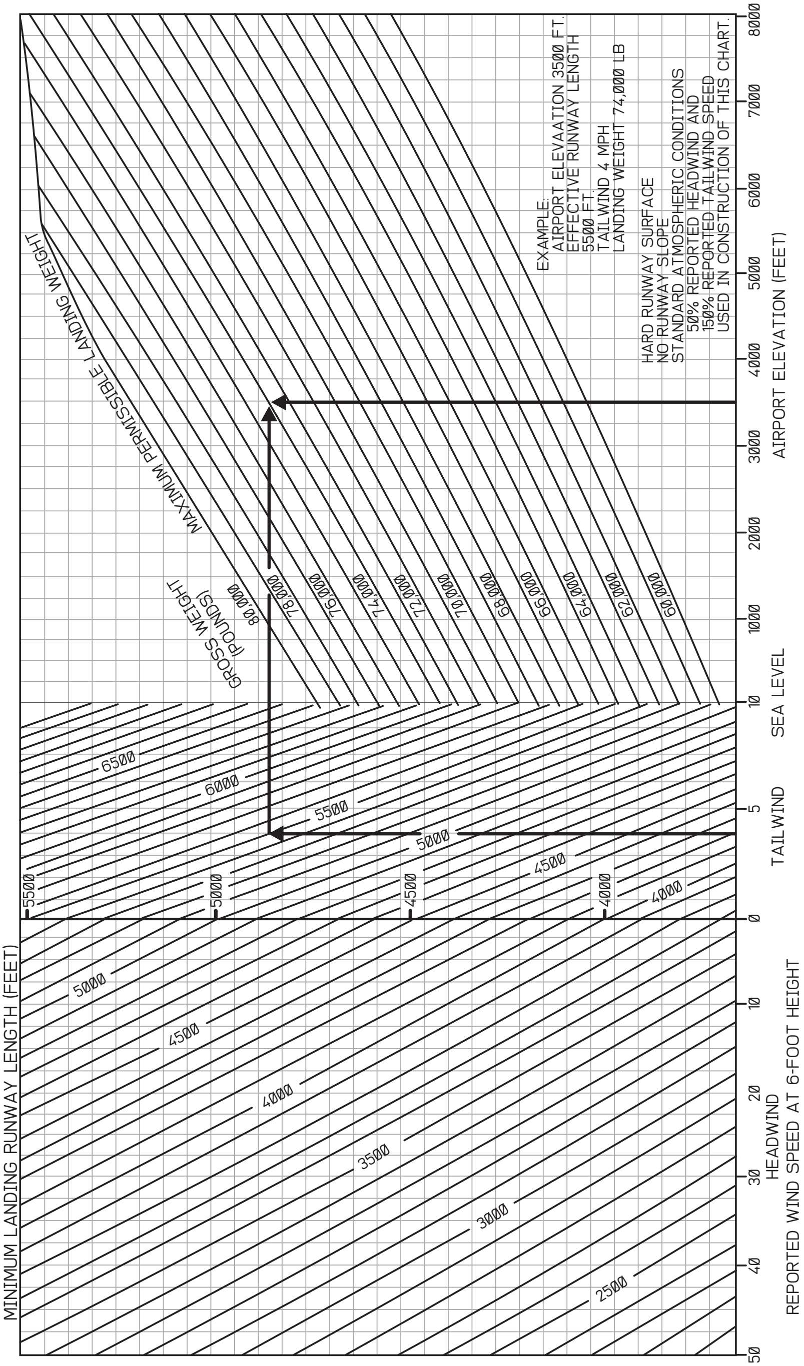
DC-6 LANDING PERFORMANCE

MINIMUM EFFECTIVE LANDING RUNWAY LENGTH FOR INTENDED DESTINATION

(LANDING DISTANCE EQUALS 60% OF RUNWAY LENGTH)

PRATT & WHITNEY R-2800-CB16 ENGINE – HAMILTON STANDARD PROPELLER NO. 23260 – BLADE NO. 2H17U3-48R

FLAPS IN FULL DOWN LANDING POSITION



EXAMPLE:
AIRPORT ELEVAATION 3500 FT.
EFFECTIVE RUNWAY LENGTH
5500 FT.
TAILWIND 4 MPH
LANDING WEIGHT 74,000 LB

HARD RUNWAY SURFACE
NO RUNWAY SLOPE
STANDARD ATMOSPHERIC CONDITIONS
50% REPORTED HEADWIND AND
150% REPORTED TAILWIND SPEED
USED IN CONSTRUCTION OF THIS CHART.

FIGURE 112.180 - LANDING PERFORMANCE - CB16 ENGINES
(INTENDED DESTINATION, FLAPS FULL DOWN)

DC-6 LANDING PERFORMANCE
LANDING DISTANCE FROM A 50-FOOT HEIGHT

PRATT & WHITNEY R-2800-CB16 ENGINE
HAMILTON STANDARD PROPELLER NO. 23260 – BLADE NO. 2H17U3-48R

FLAPS IN 40 DEGREE LANDING POSITION

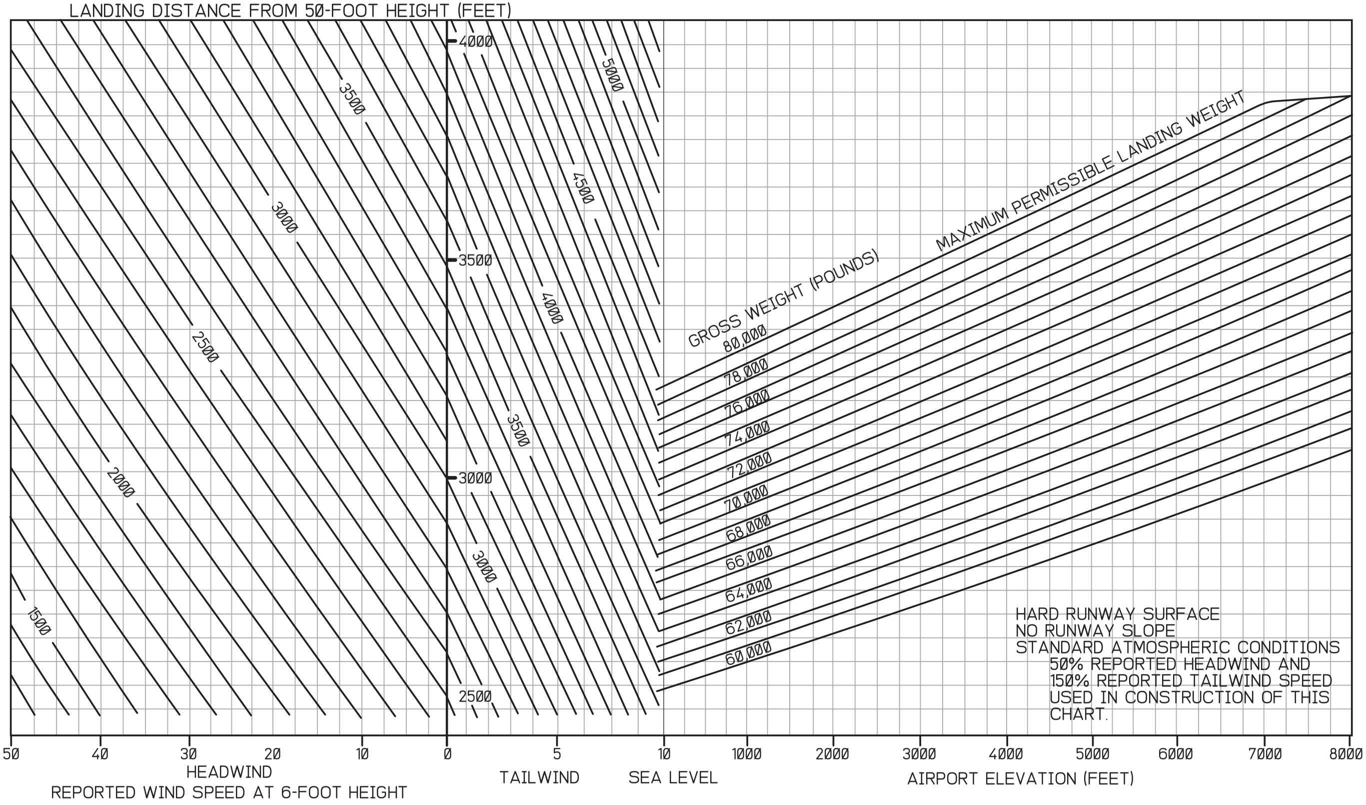


FIGURE 112.190 - LANDING PERFORMANCE - CB16 ENGINES
(LANDING DISTANCE FROM A 50-FOOT HEIGHT, FLAPS DOWN 40 DEGREES)

DC-6 LANDING PERFORMANCE
LANDING DISTANCE FROM A 50-FOOT HEIGHT

PRATT & WHITNEY R-2800-CB16 ENGINE
HAMILTON STANDARD PROPELLER NO. 23260 – BLADE NO. 2H17U3-48R

FLAPS IN FULL DOWN LANDING POSITION

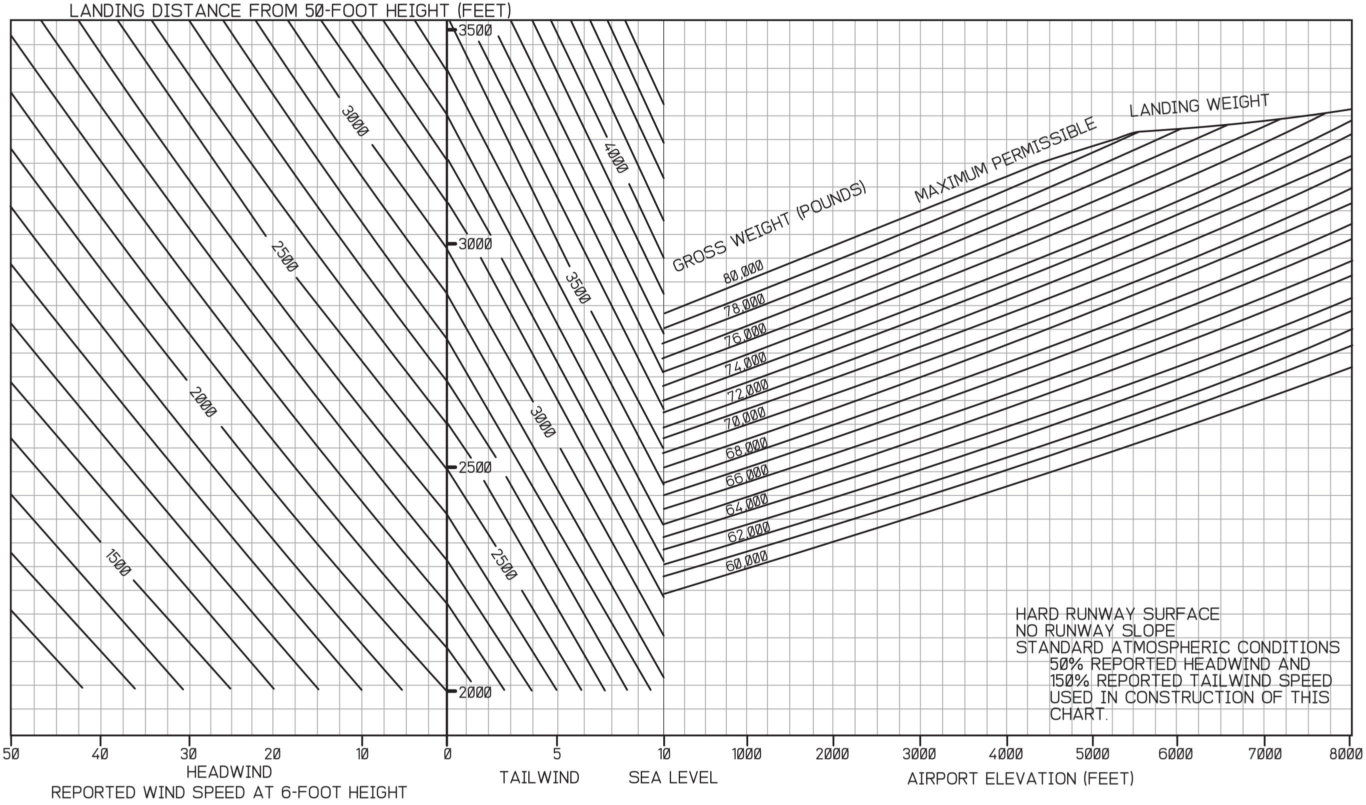


FIGURE 112.200 - LANDING PERFORMANCE - CB16 ENGINES
(LANDING DISTANCE FROM A 50-FOOT HEIGHT, FLAPS FULL DOWN)

METO

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							Blower and RPM	BMEP PSI	Fuel Flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+15°	+30°			
18000	-21	46.4	47.2						HIGH 2600	185	1385
16000	-17	46.5	47.5								
14000	-13	46.5	47.5	48.0							
12000	-9	46.7	47.6	48.5							
10000	-5	46.8	47.8	48.5							
8000	-1	44.4	45.4	46.2	46.8				LOW 2600	196	1385
6000	+3	44.4	45.4	46.2	47.0	47.2					
4000	+7	44.4	45.4	46.3	47.0	47.6					
2000	+11	44.5	45.5	46.4	47.2	48.0	48.1				
SL	+15	44.5	45.5	46.5	47.2	48.0	48.5				

HIGH BLOWER POWER CHART - METO

1500 CLIMB

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							Blower and RPM	BMEP PSI	Fuel Flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+20°	+30°			
20000	-25	40.2	FT						HIGH 2500	170	1100
18000	-21	39.6	41.0								
16000	-17	39.7	40.4	41.0							
14000	-13	36.3	40.5	41.0					HIGH 2400	177	1075
12000	-9	36.5	37.2	37.9							
10000	-5	36.7	37.4	38.1	38.8	39.5					
8000	-1	36.9	37.7	38.4	39.0	39.8	40.5	41.2	LOW 2400	177	1040
6000	+3	37.3	38.0	38.7	39.5	40.2	40.9	41.6			
4000	+7	37.5	38.3	39.1	39.8	40.5	41.3	41.8			
2000	+11	37.9	38.7	39.5	40.2	40.9	41.6	41.8			
S.L.	+15	38.4	39.2	39.9	40.6	41.4	41.8	41.8			

HIGH BLOWER POWER CHART - 1500 CLIMB

1400 CLIMB

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C -30°	-20°	-10°	0°	+10°	+20°	+30°	Blower and RPM	BMEP PSI	Fuel Flow Lb/HR
20000	-25	37.3	37.5						HIGH 2500	158	1025
18000	-21	36.7	37.5								
16000	-17	36.8	37.5						H 2400	165	965
14000	-13	34.2	37.5						HIGH 2300	172	920
12000	-9	34.5	35.2	36.0							
10000	-5	34.7	35.4	36.2	36.8	37.4					
8000	-1	35.0	35.7	36.4	37.0	37.6	38.2	39.0	LOW 2400	166	940
6000	+3	35.3	36.0	36.6	37.3	37.9	38.5	39.2			
4000	+7	35.6	36.3	36.9	37.6	38.2	38.8	39.5			
2000	+11	36.0	36.7	37.3	37.9	38.5	39.1	39.5			
S.L.	+15	36.3	37.0	37.6	38.2	39.0	39.4	39.5			

HIGH BLOWER POWER CHART - 1400 CLIMB

1200 CRUISE

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C -30°	-20°	-10°	0°	+10°	+20°	+30°	Blower and RPM	BMEP DROP	Fuel Flow Lb/HR
19000	-23	33.9	FT						HIGH 2300	12	576
18000	-21	33.9	34.6	FT							
17000	-19	33.9	34.6	35.3	35.9	FT					
16000	-17	31.3	34.5	35.2	35.8	36.5	FT				
15000	-15	31.3	31.9	35.2	35.8	36.4	37.1	37.7			
14000	-13	31.7	32.1	32.7	33.3	36.4	37.0	37.6			
13000	-11	31.8	32.4	32.8	33.4	34.0	37.0	37.6			
12000	-9	31.9	32.5	33.1	33.7	34.0	34.6	37.6			
11000	-7	32.0	32.7	33.3	34.0	34.6	34.8	35.4	LOW 2300	12	554
10000	-5	32.2	32.8	33.5	34.1	34.7	35.3	35.4			
9000	-3	32.3	33.0	33.7	34.3	34.9	35.5	36.1	LOW 2200	12	543
8000	-1	32.6	33.2	33.8	34.4	35.1	35.7	36.3			
7000	+1	32.7	33.3	34.0	34.6	35.2	35.9	36.5			
6000	+3	32.8	33.5	34.2	34.8	35.5	36.1	36.6			
5000	+5	33.0	33.7	34.4	35.0	35.6	36.3	36.9			
4000	+7	33.2	33.9	34.6	35.3	35.9	36.5	37.1			
3000	+9	33.4	34.0	34.7	35.4	36.0	36.6	37.2			
2000	+11	33.6	34.3	35.0	35.6	36.2	36.8	37.5			
1000	+13	33.8	34.5	35.2	35.8	36.4	37.0	37.7			

HIGH BLOWER POWER CHART - 1200 CRUISE

1100 CRUISE

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							Blower And RPM	BMEP DROP	Fuel Flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+20°	+30°			
20000	-25	28.7	29.3						LOW 2300	12	517
19000	-23	28.8	29.4	29.9							
18000	-21	29.2	29.8	30.0	30.6						
17000	-19	29.9	30.5	30.4	30.7	31.2					
16000	-17	30.0	30.6	30.5	31.1	31.3	31.9				
15000	-15	30.7	30.7	31.2	30.8	31.3	32.1	32.7			
14000	-13	30.9	31.5	31.4	32.0	31.4	32.5	32.8			
13000	-11	31.0	31.7	32.2	32.1	32.6	32.6	33.2	LOW 2200	12	504
12000	-9	31.1	31.8	32.4	33.0	32.8	33.3	33.3			
11000	-7	31.3	31.9	32.5	33.1	33.6	33.5	34.1	LOW 2100	12	496
10000	-5	31.4	32.1	32.7	33.3	33.8	34.4	34.2			
9000	-3	31.6	32.2	32.8	33.5	34.0	34.6	35.2	LOW 2000	12	490
8000	-1	31.7	32.4	33.0	33.6	34.1	34.7	35.3			
7000	+1	31.9	32.5	33.2	33.8	34.3	34.9	35.5			
6000	+3	32.1	32.7	33.4	34.0	34.5	35.1	35.7			
5000	+5	32.3	32.9	33.5	34.1	34.7	35.3	35.9			
4000	+7	32.4	33.1	33.7	34.3	34.9	35.5	36.1			
3000	+9	33.5	33.2	33.9	34.5	35.1	35.7	36.3			
2000	+11	32.7	33.4	34.1	34.6	35.3	36.0	36.5			
S.L	+15	33.0	33.8	34.6	35.0	36.6	37.4	36.9			

HIGH BLOWER POWER CHART - 1100 CRUISE

WET TAKE-OFF

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							RPM	BMEP PSI	Fuel flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+15°	+30°			
4000	+7	54.7	55.9	57.0	57.9	58.7			LOW 2800	242	
2000	+11	54.7	55.9	57.0	57.9	59.0	59.1				
SL	+15	54.7	55.9	57.0	57.9	59.0	59.5				

DRY TAKE-OFF

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							RPM	BMEP PSI	Fuel flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+15°	+30°			
4000	+7	48.8	49.8	50.7	51.5	52.2			LOW 2800	197	
2000	+11	48.8	49.8	50.7	51.5	52.5	52.6				
SL	+15	48.8	49.8	50.7	51.5	52.5	53.0				

LOW BLOWER POWER CHART - WET AND DRY TAKE-OFF

METO

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							RPM	BMEP PSI	Fuel flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+15°	+30°			
8000	-1	44.4	45.4	46.2	46.8				LOW 2600	196	1385
6000	+3	44.4	45.4	46.2	47.0	47.2					
4000	+7	44.4	45.4	46.3	47.0	47.6					
2000	+11	44.5	45.5	46.4	47.2	48.0	48.1				
SL	+15	44.5	45.5	46.5	47.2	48.0	48.5				

LOW BLOWER POWER CHART - METO

1500 CLIMB

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							RPM	BMEP PSI	Fuel flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+20°	+30°			
14000	-13	36.3									
12000	-9	36.5	37.2	37.9							
10000	-5	36.7	37.4	38.1	38.8	39.5					
8000	-1	36.9	37.7	38.4	39.0	39.8	40.5	41.2	LOW 2400	177	1040
6000	+3	37.3	38.0	38.7	39.5	40.2	40.9	41.6			
4000	+7	37.5	38.3	39.1	39.8	40.5	41.3	41.8			
2000	+11	37.9	38.7	39.5	40.2	40.9	41.6	41.8			
S.L.	+15	38.4	39.2	39.9	40.6	41.4	41.8	41.8			

LOW BLOWER POWER CHART - 1500 CLIMB

1200 CRUISE

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C -30°	-20°	-10°	0°	+10°	+20°	+30°	RPM	BMEP PSI	Fuel flow Lb/HR
16000	-17	31.3									
15000	-15	31.3	31.9								
14000	-13	31.7	32.1	32.7	33.3						
13000	-11	31.8	32.4	32.8	33.4	34.0					
12000	-9	31.9	32.5	33.1	33.7	34.0	34.6				
11000	-7	32.0	32.7	33.3	34.0	34.6	34.8	35.4	2300	12	554
10000	-5	32.2	32.8	33.5	34.1	34.7	35.3	35.4			
9000	-3	32.3	33.0	33.7	34.3	34.9	35.5	36.1	2200	12	543
8000	-1	32.6	33.2	33.8	34.4	35.1	35.7	36.3			
7000	+1	32.7	33.3	34.0	34.6	35.2	35.9	36.5			
6000	+3	32.8	33.5	34.2	34.8	35.5	36.1	36.6			
5000	+5	33.0	33.7	34.4	35.0	35.6	36.3	36.9			
4000	+7	33.2	33.9	34.6	35.3	35.9	36.5	37.1			
3000	+9	33.4	34.0	34.7	35.4	36.0	36.6	37.2			
2000	+11	33.6	34.3	35.0	35.6	36.2	36.8	37.5			
1000	+13	33.8	34.5	35.2	35.8	36.4	37.0	37.7			

LOW BLOWER POWER CHART - 1200 CRUISE

1100 CRUISE

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C -30°	-20°	-10°	0°	+10°	+20°	+30°	RPM	BMEP PSI	Fuel flow Lb/HR
20000	-25	28.7	29.3						2300	12	517
19000	-23	28.8	29.4	29.9							
18000	-21	29.2	29.8	30.0	30.6						
17000	-19	29.9	30.5	30.4	30.7	31.2					
16000	-17	30.0	30.6	30.5	31.1	31.3	31.9				
15000	-15	30.7	30.7	31.2	30.8	31.3	32.1	32.7			
14000	-13	30.9	31.5	31.4	32.0	31.4	32.5	32.8			
13000	-11	31.0	31.7	32.2	32.1	32.6	32.6	33.2	2200	12	504
12000	-9	31.1	31.8	32.4	33.0	32.8	33.3	33.3			
11000	-7	31.3	31.9	32.5	33.1	33.6	33.5	34.1	2100	12	496
10000	-5	31.4	32.1	32.7	33.3	33.8	34.4	34.2			
9000	-3	31.6	32.2	32.8	33.5	34.0	34.6	35.2	2000	12	490
8000	-1	31.7	32.4	33.0	33.6	34.1	34.7	35.3			
7000	+1	31.9	32.5	33.2	33.8	34.3	34.9	35.5			
6000	+3	32.1	32.7	33.4	34.0	34.5	35.1	35.7			
5000	+5	32.3	32.9	33.5	34.1	34.7	35.3	35.9			
4000	+7	32.4	33.1	33.7	34.3	34.9	35.5	36.1			
3000	+9	33.5	33.2	33.9	34.5	35.2	35.8	36.3			
2000	+11	32.7	33.4	34.1	34.6	35.3	35.9	36.5			
1000	+13	32.8	33.5	34.2	34.8	35.4	36.0	36.6			

LOW BLOWER POWER CHART - 1100 CRUISE

1000 CRUISE

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							RPM	BMEP PSI	Fuel flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+20°	+30°			
18000	-21	27.0	27.5								
17000	-19	27.2	27.7	28.3							
16000	-17	27.8	28.3	28.4	28.9						
15000	-15	27.9	28.5	29.1	29.0	29.6					
14000	-13	28.8	29.4	29.2	29.7	29.7	30.1				
13000	-11	28.9	29.5	30.1	29.8	30.4	30.2	30.8	2200	129	463
12000	-9	29.8	30.3	30.2	30.7	30.5	31.1	31.7	2100	135	454
11000	-7	30.4	30.6	31.2	30.9	31.4	31.3	31.9			
10000	-5	30.5	31.1	31.3	31.9	31.5	32.1	32.7	2000	141	447
9000	-3	30.7	31.3	32.0	32.1	32.6	32.2	32.8			
8000	-1	30.9	31.5	32.1	32.6	32.8	33.4	34.0	1900	149	441
7000	+1	31.1	31.7	32.3	32.9	33.5	34.2	34.2			
6000	+3	31.3	31.9	32.5	33.1	33.7	34.3	34.9	1850	153	436
5000	+5	31.4	32.1	32.7	33.3	33.9	34.5	35.1			
4000	+7	31.6	32.3	32.9	33.6	34.2	34.8	35.4			
3000	+9	31.9	32.5	33.1	33.8	34.3	35.0	35.6			
2000	+11	32.0	32.7	33.3	33.9	34.5	35.1	35.7			
1000	+13	32.3	32.9	33.6	34.2	34.8	35.4	36.0			

LOW BLOWER POWER CHART - 1000 CRUISE

900 CRUISE

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C							RPM	BMEP PSI	Fuel flow Lb/HR
		-30°	-20°	-10°	0°	+10°	+20°	+30°			
20000	-25	25.0									
19000	-23	25.0	25.5	26.1							
18000	-21	25.5	26.0	26.2	26.7	27.1					
17000	-19	25.6	26.1	26.7	27.2	27.2	27.7				
16000	-17	26.3	26.8	26.8	27.3	27.7	27.8	28.3	2200	116	426
15000	-15	26.4	26.9	27.5	27.4	27.9	28.3	28.5			
14000	-13	27.3	27.8	27.6	28.2	28.7	28.5	29.0	2100	121	418
13000	-11	27.4	28.0	28.5	28.3	28.8	29.3	29.2			
12000	-9	28.5	28.2	28.7	29.3	28.9	29.5	30.0	2000	127	409
11000	-7	28.7	29.3	29.8	29.6	30.1	29.7	30.2			
10000	-5	28.9	29.5	30.0	30.6	30.2	30.7	30.3			
9000	-3	29.9	30.5	31.1	30.7	31.3	30.9	31.5	1900	134	403
8000	-1	30.4	31.1	31.3	31.8	31.5	32.0	31.6			
7000	+1	30.6	31.2	31.9	32.1	32.7	32.3	32.9	1800	142	395
6000	+3	31.0	31.6	32.2	32.9	32.9	33.5	34.1	1700	150	388
5000	+5	31.1	31.8	32.4	33.0	33.6	34.2	34.3			
4000	+7	31.3	31.9	32.5	33.2	33.8	34.4	35.0	1650	154	385
3000	+9	31.5	32.1	32.7	33.4	34.0	34.6	35.2			
2000	+11	31.7	32.4	33.0	33.7	34.2	34.8	35.4			
1000	+13	32.0	32.6	33.3	33.9	34.5	35.1	35.7			

LOW BLOWER POWER CHART - 900 CRUISE

800 CRUISE

PRESS ALT/ft	STD temp/°C	Manifold Pressure at Carb Temp in °C -30°	-20°	-10°	0°	+10°	+20°	+30°	RPM	BMEP PSI	Fuel flow Lb/HR
22000	-29	22.6	23.1								
21000	-27	23.2	23.3	23.7							
20000	-25	23.3	23.6	23.8	24.3	24.7					
19000	-23	23.9	23.7	24.1	24.6	24.9	25.3				
18000	-21	24.0	24.4	24.3	24.8	25.2	25.5	26.0	2200	103	391
17000	-19	24.7	24.5	25.0	25.5	25.3	25.8	26.2			
16000	-17	24.8	25.3	25.2	25.6	26.1	26.0	26.5	2100	108	383
15000	-15	25.0	25.5	26.0	26.5	26.3	26.7	26.7			
14000	-13	26.1	25.6	26.1	26.7	27.1	26.9	27.4	2000	113	373
13000	-11	26.3	26.8	27.3	26.9	27.4	27.8	27.5			
12000	-9	27.2	27.0	27.5	28.0	28.6	28.0	28.5	1900	119	366
11000	-7	27.4	28.0	28.5	28.2	28.8	29.2	28.7			
10000	-5	28.1	28.2	28.7	29.2	29.0	29.5	30.0	1800	126	357
9000	-3	28.3	28.8	29.4	29.4	30.0	30.5	30.0			
8000	-1	28.7	29.2	29.8	30.3	30.2	30.7	31.2	1700	133	351
7000	+1	29.6	30.2	30.1	30.6	31.2	30.9	31.5			
6000	+3	29.9	30.5	31.1	31.0	31.5	32.0	32.6	1600	142	344
5000	+5	30.1	30.7	31.3	31.9	31.7	32.2	32.8			
4000	+7	30.4	31.0	31.6	32.2	32.8	33.4	32.9			
3000	+9	30.7	31.2	31.9	32.5	33.1	33.7	34.3	1500	151	339
2000	+11	31.0	31.6	32.3	32.9	33.5	34.0	34.6			
1000	+13	31.4	32.0	32.7	33.3	33.9	34.4	35.0			

LOW BLOWER POWER CHART - 800 CRUISE

CENTIGRADE-FAHRENHEIT CONVERSION TABLE

°F=9/5°C+32=1.8(°C+17.8)
°C=5/9(°F-32)

C	⬅F C➡	F	C	⬅F C➡	F
–62.2	–80	–112.0	79.4	175	347.0
–56.7	–70	–94.0	82.2	180	356.0
–51.1	–60	–76.0	85.0	185	365.0
–45.6	–50	–58.0	87.8	190	374.0
–40.0	–40	–40.0	90.6	195	383.0
–34.4	–30	–22.0	93.3	200	392.0
–31.7	–25	–13.0	96.1	205	401.0
–28.9	–20	–4.0	98.9	210	410.0
–26.1	–15	+5.0	101.7	215	419.0
–23.3	–10	14.0	104.4	220	428.8
–20.6	–5	23.0	107.2	225	437.0
–17.8	0	32.0	110.0	230	446.0
–15.0	5	41.0	112.8	235	455.0
–12.2	10	50.0	115.6	240	464.0
–9.4	15	59.0	121.1	250	482.0
–6.7	20	68.0	126.7	260	500.0
–3.9	25	77.0	132.2	270	518.0
–1.1	30	86.0	137.8	280	536.0
1.7	35	95.0	143.3	290	554.0
4.4	40	104.0	148.9	300	572.0
7.2	45	113.0	154.4	310	590.0
10.2	50	122.0	160.0	320	608.0
12.8	55	131.0	165.6	330	626.0
15.6	60	140.0	171.1	340	644.0
18.3	65	149.0	176.7	350	662.0
21.1	70	158.0	182.2	360	680.0
23.9	75	167.0	187.8	370	698.0
26.7	80	176.0	193.3	380	716.0
29.4	85	185.0	198.9	390	734.0
32.2	90	194.0	204.4	400	752.0
35.0	95	203.0	210.0	410	770.0
37.8	100	212.0	215.6	420	788.0
40.6	105	221.0	221.1	430	806.0
43.3	110	230.0	226.7	440	824.0
46.1	115	239.0	232.2	450	842.0
48.9	120	248.0	237.8	460	860.0
51.7	125	257.0	243.3	470	878.0
54.4	130	266.0	248.9	480	896.0
57.2	135	275.0	254.4	490	914.0
60.0	140	284.0	260.0	500	932.0
62.8	145	293.0	256.6	510	950.0
65.6	150	302.0	271.1	520	968.0
68.3	155	311.0	276.7	530	986.0
71.1	160	320.0	282.2	540	1004.0
73.9	165	329.0	287.8	550	1022.0
76.7	170	338.0			

U.S. GALLONS—IMPERIAL GALLONS—LITERS CONVERSION TABLE

Multiply	By	To Obtain
U.S. gallons	0.8326	Imperial gallons
Imperial gallons	1.201	U.S. gallons
U.S. gallons	3.785	Liters
Liters	0.2642	U.S. gallons
Imperial gallons	4.546	Liters

Imperial Gallons⬅	U.S. Gallons ➡	Liters
4.16	5	18.93
8.33	10	37.85
12.48	15	56.77
16.65	20	75.70
20.81	25	94.62
24.97	30	113.55
29.14	35	132.47
33.30	40	151.40
37.46	45	170.32
41.63	50	189.25
49.95	60	227.10
58.28	70	264.95
66.60	80	302.80
74.93	90	340.65
83.26	100	378.50
91.58	110	416.35
99.91	120	454.20
108.23	130	492.05
116.56	140	529.90
124.89	150	567.75
133.21	160	605.60
141.54	170	643.45
149.86	180	681.30
158.19	190	719.15
166.52	200	757.0
174.84	210	794.85
183.17	220	832.70
191.14	230	870.55
199.82	240	908.40
208.15	250	946.25
228.96	275	1040.87
249.78	300	1135.50

Imperial Gallons⬅	U.S. Gallons ➡	Liters
270.59	325	1230.12
291.41	350	1324.75
312.22	375	1419.37
333.04	400	1514.0
353.85	425	1608.62
374.67	450	1703.25
395.48	475	1797.87
416.30	500	1892.50
437.11	525	1987.12
457.93	550	2081.75
478.74	575	2176.37
499.56	600	2271.0
520.37	625	2365.62
541.19	650	2460.25
562.0	675	2554.87
582.82	700	2649.50
624.45	750	2838.75
666.08	800	3028.0
707.71	850	3217.25
749.34	900	3406.50
790.97	950	3595.75
832.60	1000	3785.0
1665.20	2000	7570.0
2497.80	3000	11355.0
3330.40	4000	15140.0
4163.0	5000	18925.0
4595.60	6000	22710.0
5828.20	7000	26495.0
6660.80	8000	30280.0
7493.40	9000	34065.0
8326.0	10000	37850.0

FUEL WEIGHT CONVERSION TABLE

Multiply	By	To Obtain
Pounds	0.4536	Kilograms
Kilograms	2.205	Pounds
Gallons of fuel	6.0	Pounds

U.S. Pounds	⬅ U.S. Gallons ➡	Kilograms	U.S. Pounds	⬅ U.S. Gallons ➡	Kilograms
6	1	2.72	1050	175	476.28
12	2	5.44	1200	200	544.32
18	3	8.16	1350	225	612.36
24	4	10.88	1500	250	680.40
30	5	13.60	1650	275	748.44
36	6	16.32	1800	300	816.48
42	7	19.05	2100	350	952.56
48	8	21.77	2400	400	1088.64
54	9	24.49	2700	450	1224.72
60	10	27.21	3000	500	1360.80
90	15	40.82	3600	600	1632.96
120	20	54.43	4200	700	1905.12
150	25	68.04	4800	800	2177.28
180	30	81.64	5400	900	2449.44
210	35	95.25	6000	1000	2721.60
240	40	108.86	12000	2000	5443.20
270	45	122.47	18000	3000	8164.80
300	50	136.08	24000	4000	10886.40
360	60	163.29	30000	5000	13608.0
420	70	190.51	36000	6000	16329.60
480	80	217.72	42000	7000	19051.20
540	90	244.94	48000	8000	21772.80
600	100	272.16	54000	9000	24494.40
750	125	340.20	60000	10000	27216.0
900	150	408.24			

POUNDS–KILOGRAMS CONVERSION TABLE

Multiply	By	To Obtain
Pounds	0.4536	Kilograms
Kilograms	2.205	Pounds

Kilograms	⬅ Pounds-Kilograms ➡	Pounds	Kilograms	⬅ Pounds-Kilograms ➡	Pounds
0.454	1	2.21	3.63	8	17.64
0.908	2	4.41	4.08	9	19.84
1.36	3	6.61	4.54	10	22.05
1.82	4	8.82	6.81	15	33.07
2.27	5	11.02	9.08	20	44.10
2.72	6	13.23	11.35	25	55.12
3.18	7	15.43	13.62	30	66.15

POUNDS–KILOGRAMS CONVERSION TABLE–Continued

Multiply	By	To Obtain
Pounds	0.4536	Kilograms
Kilograms	2.205	Pounds

Kilograms	⬅ Pounds-Kilograms ➡	Pounds
15.89	35	77.17
18.16	40	88.20
20.23	45	99.22
22.70	50	110.25
24.97	55	121.27
27.24	60	132.30
29.51	65	143.32
31.78	70	154.35
34.05	75	165.37
36.32	80	176.40
38.59	85	187.42
40.86	90	198.45
43.13	95	209.47
45.40	100	220.50
47.67	105	231.52
49.94	110	242.55
52.21	115	253.57
54.48	120	264.60
56.75	125	275.62
59.02	130	286.65
61.29	135	297.67
63.56	140	308.70
65.83	145	319.72
68.10	150	330.75
72.64	160	352.80
77.18	170	374.85
81.72	180	396.90
86.26	190	418.95
90.80	200	441.0
95.34	210	463.50
99.80	220	485.10
104.42	230	507.15
108.96	240	529.20
113.50	250	551.25
124.85	275	606.37
136.20	300	661.50
147.55	325	716.62
158.90	350	771.75
170.25	375	826.87
181.60	400	882.0
192.95	425	937.12
204.30	450	992.25
215.65	475	1047.37
227.0	500	1102.50
249.70	550	1212.75
272.40	600	1323.0
295.10	650	1433.25
317.80	700	1543.50
340.50	750	1653.75
363.20	800	1764.0
385.90	850	1874.25
408.60	900	1984.50
431.30	950	2094.75
454.0	1000	2205.0
681.0	1500	3307.50
908.0	2000	4410.0
1135.0	2500	5512.50
1362.0	3000	6615.0
1589.0	3500	7717.50
1816.0	4000	8820.0
2043.0	4500	9922.50
2270.0	5000	11025.0
2497.0	5500	12127.50
2724.0	6000	13230.0
2951.0	6500	14332.50
3178.0	7000	15435.0
3405.0	7500	16537.50
3632.0	8000	17640.0
3859.0	8500	18742.50
4086.0	9000	19845.0
4313.0	9500	20947.50
4540.0	10000	22050.0
4994.0	11000	24255.0
5448.0	12000	26460.0
5902.0	13000	28665.0
6356.0	14000	30870.0
6810.0	15000	33075.0
9080.0	20000	44100.0
11305.0	25000	55125.0
13620.0	30000	66150.0
15890.0	35000	77175.0
18160.0	40000	88200.0
20430.0	45000	99225.0
22700.0	50000	110250.0
24970.0	55000	121275.0
27240.0	60000	132300.0
29510.0	65000	143325.0
31780.0	70000	154350.0
34050.0	75000	165375.0
36320.0	80000	176400.0
38590.0	85000	187425.0
40860.0	90000	198450.0
43130.0	95000	209475.0
45400.0	100000	220500.0

KNOTS–MPH–KILOMETERS CONVERSION TABLE

Multiply	By	To Obtain
MPH	0.8684	Nautical MPH
MPH	1.609	Kilometers
Kilometers-per-hour	0.6214	MPH
Knots-per-hour	1.152	MPH

Knots	⬅ MPH ➡	Kilometers	Knots	⬅ MPH ➡	Kilometers
43.42	50	80.45	156.31	180	289.62
47.76	55	88.49	160.65	185	297.66
52.10	60	96.54	164.99	190	305.71
56.44	65	104.58	169.33	195	313.75
60.78	70	112.63	173.68	200	321.80
65.13	75	120.67	178.02	205	329.84
69.47	80	128.72	182.36	210	337.89
73.81	85	136.76	186.70	215	345.93
78.15	90	144.81	191.04	220	353.98
82.49	95	152.85	195.39	225	362.02
86.84	100	160.90	199.73	230	370.07
91.18	105	168.94	208.41	240	386.16
95.52	110	176.99	217.10	250	402.25
99.86	115	185.03	225.78	260	418.34
104.20	120	193.08	234.46	270	434.43
108.55	125	201.12	243.15	280	450.52
112.89	130	209.17	251.83	290	466.61
117.23	135	217.21	260.52	300	482.70
121.57	140	225.26	269.20	310	498.79
125.91	145	233.30	277.88	320	514.88
130.26	150	241.35	286.57	330	530.97
134.60	155	249.39	295.25	340	547.06
138.94	160	257.44	303.94	350	563.15
143.28	165	265.48	312.62	360	579.24
147.62	170	273.53			
151.97	175	281.57			

MISCELLANEOUS CONVERSION FACTORS

Multiply	By	To Obtain
Feet	0.3034	Meters
Meters	3.281	Feet
Miles	1.609	Kilometers
Kilometers	0.6214	Miles
Miles	0.8684	Knots
Knots	1.152	Miles
Horse Power	1.014	Metric Horse Power
Metric Horse Power	0.9863	Horse Power

WEIGHTS OF LIQUIDS

Fuel = 6 pounds per U.S. gallon
Avgas = 7.2 pounds per imperial gallon
Water = 8.35 pounds per U.S. gallon
Alcohol (methyl) = 6.8 pounds per U.S. gallon
Engine Oil = 7.5 pounds per U.S. gallon

TAKE-OFF SPEEDS

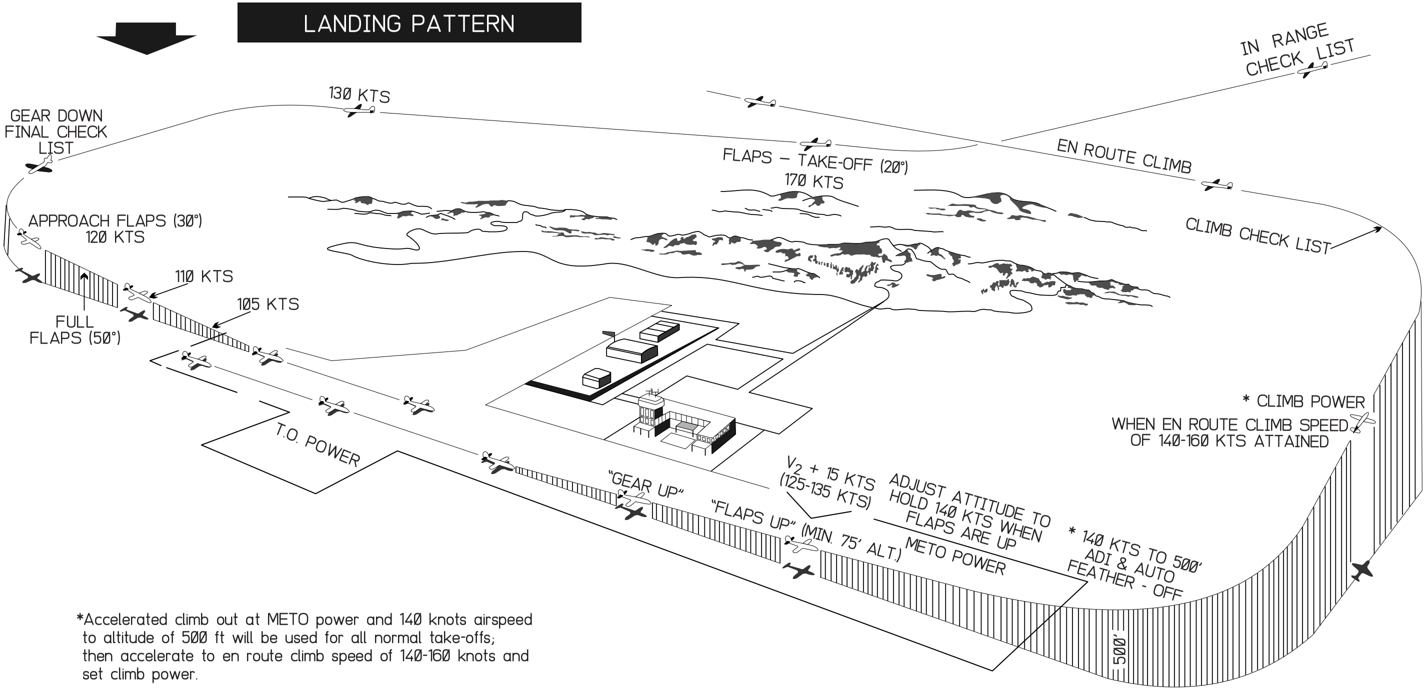
WET, AUTOFEATHER OPERATIVE												
TOW/1000 Lbs	80	82	84	86	88	90	92	94	96	98	100	103
V1 (KIAS)	80	83	85	88	90	93	95	97	99	102	105	107
V2 (KIAS)	101	103	104	106	107	108	109	110	111	112	114	115
DRY, AUTOFEATHER OPERATIVE												
V1 (KIAS)	85	88	90	93	96	99	101					
Contaminated runway, use minimum V1 = 85 Kts												
Corrections to V1	Airport elevation Uphill slope Downhill slope Headwind Tailwind	+1 Kt / 1000 feet +4 Kts / 1% -4 Kts / 1 % +1 Kt / 15 Kts H/W -2 Kts / 5 Kts T/W										
Vr = V2 - 5 Kts. Vf = V2 + 15 Kts. Vmcg = 78 Kts												

LANDING SPEEDS

Weight /1000 Lbs	V_{AT} -TARGET THRESHOLD SPEED (KIAS)			
	FLAP FULL	FLAP 40°	FLAP 30°/20°	FLAP ZERO
70	94	101	108	118
72	95	103	110	120
74	97	104	111	121
76	98	105	112	122
78	99	106	113	123
80	100	107	114	124
82	102	108	115	125
84	103	109	116	126
86	104	110	117	127
88	106	111	118	128

DC-6 PERFORMANCE

TAKE-OFF & LANDING PATTERN



*Accelerated climb out at METO power and 140 knots airspeed to altitude of 500 ft will be used for all normal take-offs; then accelerate to en route climb speed of 140-160 knots and set climb power.

WHEN NOISE ABATEMENT PROCEDURES REQUIRED, continue 140 knots airspeed at METO power to altitude of 1500 feet before accelerating to en route climb speed and setting climb power. METO power is not to be used any longer than necessary during climb.

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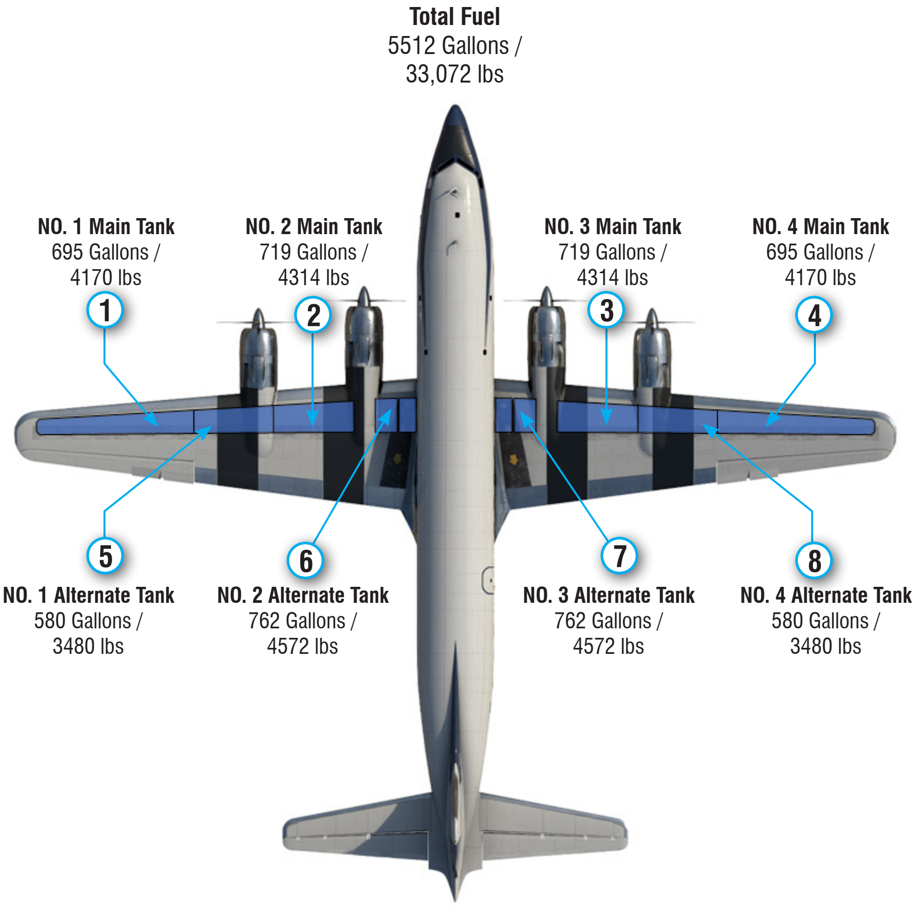

Figure A1 — DC-6 8-Tank Fuel System Layout

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