

DESCRIPTION AND
IV OPERATION OF
AUXILIARY EQUIPMENT

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SECTION IV
DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT
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HEATING AND VENTILATING SYSTEM

This heating and ventilating system (*figure 4-1*) is the exhaust-heated type and consists of two heat exchangers, one mounted on each engine exhaust tailpipe, two mixing chambers, two nacelle spill valves, a 28-volt d-c emergency defrosting blower for windshield and astrodome defrosting, four 28-volt d-c critical temperature warning lights, two critical temperature thermostats, the necessary insulated ducting, airscoops, outlet valves, and controls. Ram air entering the heat exchanger is heated by the exhaust tailpipe, then routed through the nacelle spill valve to the mixing chamber. Here the heated air is mixed with ram air from a scoop in the proportions necessary for regulating the temperature, and routed to the various outlets. The left heat exchanger supplies heated air to the main cabin outlets, the windshield and astrodome defroster outlets, the pilots' handwarmer outlets, and the navigator's station outlets. The right heat exchanger supplies heated air to the radio operator's station outlets, the pilots' footwarmer outlets, and the autopilot servo unit housing. The hot air flow from the heat exchangers is continuously supplied to the heating system when the engines are operating. Heating system operation is discontinued by positioning the nacelle spill valve controls to spill the hot air flow, from the left and/or right heat exchanger, overboard. Ventilation for hot weather operation is obtained by spilling the heated air overboard and permitting only the ram air flow from the mixing chamber airscoops to be routed through the system. In addition, each outlet location is provided with a control valve to regulate the flow of heated or ventilated air, as desired. Two control boxes, one located in the cockpit and one located at the radio operator's station, contain the necessary controls for regulating the temperature in the fuselage compartments. The two spill valves, one in each nacelle, are controlled from the radio operator's control box. A defrosting control valve at the navigator's station controls the flow of air to the main cabin and defrosting outlets, and turns on the emergency defrosting blower.

MIXING CHAMBER CONTROL KNOBS

Two push-pull mixing chamber control knobs placarded **HOT-COLD**, one located on the control box (*figure 4-1*) at the radio operator's station, and the other located on the control box (*figure 4-1*) behind the co-pilot's seat, are used to mechanically position the butterfly valves in the left and right mixing chambers respectively. When the knob on the co-pilot's control box is in the **HOT** position, the valves in the right mixing chamber are positioned to shut off the ram air flow from the airscoop and open the hot air flow from the right heat exchanger to supply the

respective outlets with heated air. When the knob is in the **COLD** position, the valves are positioned to shut off the hot air flow from the right heat exchanger and open the ram air flow from the airscoop to supply the respective outlets with ventilating air. Any intermediate position of the control knob will provide a mixture of ram and heated air in proportion to the control knob setting. The left mixing chamber control knob at the radio operator's station controls the ram and hot air flow from the left mixing chamber, and functions in the same manner as the right mixing chamber control knob at the co-pilot's station.

NACELLE SPILL VALVE CONTROL KNOBS

Two nacelle spill valve control knobs, placarded **HEAT-SPILL**, are located on the control box (*figure 4-1*) at the radio operator's station. These push-pull knobs are used to spill the heated air overboard when heating system operation is not desired, or during hot weather operation when cold air flow is desired or when a critical temperature warning light illuminates. When either control knob is in the **SPILL** position, the corresponding spill valve is opened mechanically to exhaust the heated air overboard. When the knob is in the **HEAT** position, the spill valve is closed, and the heated air is routed to the mixing chamber and distribution ducts. No intermediate positions are provided for the spill valves.

DEFROSTING CONTROL VALVE HANDLE

A mechanically operated defrosting control valve handle (*figure 4-1*), located at the navigator's station, controls the flow of heated air from the left heat exchanger to the windshield, astrodome, and the main cabin compartment, and also turns **ON** the emergency defroster blower. The control handle has the following placarded positions: **NORMAL DEFROST-BLOWER OFF**, **CABIN HEAT**, and **EMER DEFROST-BLOWER ON**. When the control handle is placed in **NORMAL DEFROST-BLOWER OFF** position, the control valve is positioned to shut off the heated air flow to the main cabin and route heated air to the pilots' handwarmer outlets and to the windshields and astrodome for defrosting. When the handle is positioned to **CABIN HEAT**, the control valve shuts off the heated air flow to the defroster outlets and routes heated air to the main cabin compartment. When the control handle is moved to the **EMER DEFROST-BLOWER ON** position, the emergency defrosting control valve shuts off the cabin heat, routes the heated air flow to the emergency defrosting blower, and automatically positions a 28-volt d-c spring-loaded switch to turn **ON** the emergency defrosting blower motor to supply an increased quantity of heated air to the pilots' handwarmer outlets and to the windshields and astrodome for defrost-

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ing. When the control is moved from this position, the switch automatically returns to OFF position, shutting off the blower motor.

AIR OUTLET CONTROL HANDLES

The air outlet control handles, one located at each air outlet at the crew stations, mechanically control the amount of air released through the outlets.

CRITICAL TEMPERATURE WARNING LIGHTS

Four 28-volt d-c critical temperature warning lights are provided, two on the main instrument panel (17, figure 1-11, and 19, figure 1-12), and two above the control box at the radio operator's station. The two warning lights at each station, one for the RIGHT spill valve and one for the LEFT spill valve, are illuminated by thermostats located on the right and left spill valve assemblies (figure 4-1) when temperatures exceed approximately 232°C (450°F). The respective warning light or lights will go out when the temperature falls below these limits.

DEFROSTER FANS AND SWITCHES

Two 28-volt d-c defrosting fans are installed, one above and aft of the pilot's seat, and the other above and aft of the co-pilot's seat. A defroster fan switch is located on top of each fan. When the switch is positioned ON, a 28-volt d-c circuit is closed to start the fan motor. When the switch is positioned OFF, the fan circuit is opened.

HEATING AND VENTILATING SYSTEM OPERATION

Heating (Flight or Ground).

1. Individual air outlet control handles — Open (as required).
2. Mixing chamber control knobs — HOT (or as required for desired temperature).
3. Nacelle spill valve control knobs — HEAT.
4. Defrosting control valve handle — CABIN HEAT (if required).



If a critical temperature warning light illuminates, it is imperative that the respective nacelle spill valve be opened immediately to spill the heated air overboard. When the light goes out, the spill valve may be closed again.

If an engine is feathered, the respective spill valve should be opened to spill the air overboard, and the respective mixing chamber control knob should be placed in HOT position, to eliminate air flow through the system.

Ventilating.

1. Individual air outlet controls — OPEN (as required).
2. Nacelle spill valve control knobs — SPILL.
3. Mixing chamber control knobs — COLD (or as required for desired ventilation).
4. Defrosting control valve handle — CABIN HEAT (if main cabin ventilation is required).

Windshield and Astrodome Defrosting (Normal Operation).

1. Navigator's station heat outlet — CLOSED.
2. Mixing chamber control knob at radio operator's station — HOT.
3. Left nacelle spill valve control knob — HEAT.
4. Defrosting control valve handle — NORMAL DEFROST-BLOWER OFF.

Note

Cabin heat is not available during defrosting operation. The mixing chamber control knob at the co-pilot's station may be positioned to HOT to furnish heat to the cockpit and the radio operator's station, as desired, during defrosting operation.

HEATING AND VENTILATING SYSTEM - TYPICAL

C47 AND R4D SERIES AIRCRAFT

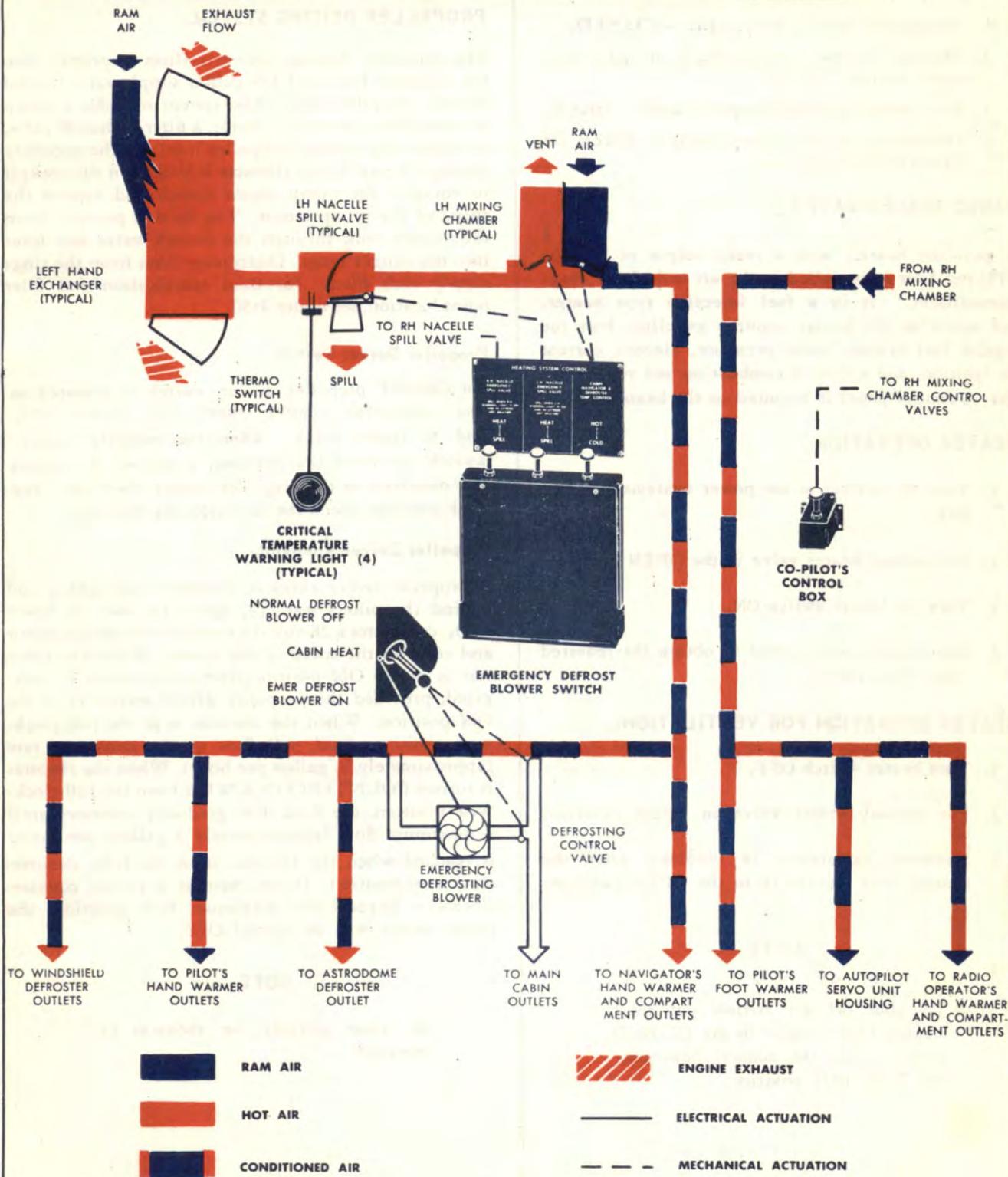


Figure 4-1

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**Windshield and Astrodome Defrosting
(Emergency Operation).**

1. Navigator's station heat outlet - CLOSED.
2. Mixing chamber control knob at radio operator's station - HOT.
3. Left nacelle spill valve control knob - HEAT.
4. Defrosting control valve handle - EMER DEFROST-BLOWER ON.

CARGO SPACE HEATER.

A gasoline heater, with a rated output of 200,000 BTU per hour is installed in the aft end of the cargo compartment. It is a fuel injection type heater. For operation the heater requires gasoline, from the regular fuel system, under pressure, electric current for ignition, and a flow of combustion and ventilating air. A control panel is mounted on the heater.

HEATER OPERATION:

1. Turn on inverter at the power systems junction box.
2. Put manual heater valve in the OPEN position.
3. Turn the heater switch ON.
4. Use manual heat control to obtain the required cabin temperature.

HEATER OPERATION FOR VENTILATION:

1. Turn heater switch OFF.
2. Put manual heater valve in OPEN position.
3. Maximum ventilation is obtained when the manual heat control is in the OPEN position.

NOTE

To shut off all airflow put the manual heater valve in the CLOSED position and the manual heat control in the HOT position.

ANTI-ICING AND DEICING SYSTEMS.

PROPELLER DEICING SYSTEM.

The propeller deicing system utilizes isopropyl alcohol supplied from a 4 US gallon supply tank located behind the pilot's seat. The system includes a pump mounted on a 28-volt d-c motor, a filter, a shutoff valve, a slinger ring on each propeller hub, and the necessary piping. A switch and rheostat is located in the cockpit to energize the pump motor circuit and control the speed of the pump motor. The fluid is pumped from the supply tank through the shutoff valve and filter into the slinger rings. Distributor lines from the rings supply each blade. For fluid specification and filler point location, see figure 1-30.

Propeller Deicer Switch.

An ON-OFF propeller deicer switch is mounted on the electrical control panel (12, figure 1-13, and 5, figure 1-14). When the propeller deicer switch is in the ON position, a 28-volt d-c circuit is completed to the propeller deicer rheostat. The OFF position opens the circuit to the rheostat.

Propeller Deicer Rheostat.

A propeller deicer rheostat, located to the right of and behind the pilot's seat (13, figure 1-6 and 14, figure 1-8), completes a 28-volt d-c circuit to the pump motor and controls the speed of the motor. When the rheostat is in the ON position, the pump motor is energized, provided the propeller deicer switch is in the ON position. When the rheostat is in the full clockwise position, fluid will flow at the minimum rate (approximately $\frac{1}{2}$ gallon per hour). When the rheostat is turned COUNTERCLOCKWISE from the full clockwise position, the fluid flow gradually increases until a maximum flow (approximately 3 gallons per hour) is reached when the rheostat is in the fully counterclockwise position. If the rheostat is turned counterclockwise beyond the maximum flow position, the pump motor will be turned OFF.

NOTE

On some aircraft the rheostat is reversed.

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Propeller Deicer Valve Handle.

A propeller de-icer valve handle, located behind the pilot's seat and below the deicing fluid supply tank, mechanically positions the shutoff valve that controls deicing fluid flow to the propellers. The handle has unmarked OPEN and CLOSE positions. When the deicer valve is moved to the OPEN position (aligned with supply line), the shutoff valve is mechanically opened to supply deicing fluid to the propellers. Moving the deicer valve handle to the CLOSE position (at right angle to the supply line), closes the shutoff valve, stopping fluid flow through the system.

Propeller Deicer System Operation

1. To start, propeller deicer valve handle—OPEN (aligned with supply line).
2. Propeller deicer switch—ON.
3. Propeller deicer rheostat—ON (regulate as required).
4. To stop, propeller deicer rheostat—OFF.
5. Propeller deicer, switch—OFF.
6. Propeller deicer valve handle—CLOSE (right angle with supply line).

CARBURETOR DEICING SYSTEM

The carburetor deicing system furnishes alcohol to the carburetor air intake throat for the removal of ice. The carburetor deicing system and the windshield de-icing system utilize a common supply tank with a capacity of 11.5 US gallons. The supply tank is located under the right wing fillet, with the filler neck extending through the fillet. On some aircraft, a filler neck is also located behind the co-pilot's seat to replenish the carburetor and windshield alcohol supply during flight, if required. The system includes a pump mounted on a 28-volt d-c motor, a filter, and a relief valve to allow excess fluid to flow back into the tank in the event of excessive pressure. Operation of the pump motor is controlled by a switch located in the cockpit. A control valve is also provided in the cockpit to shut off the alcohol supply when carburetor de-icing is not required. With continuous operation, the fluid output of the pump is approximately 8 gallons per hour. For fluid specification and filler points, see figure 1-30.

Carburetor and Windshield Deicer Switch

The carburetor deicer switch, located on the electrical control panel (13, figure 1-13 and 8, figure 1-14), has ON and OFF positions. When the switch is placed ON, a 28-volt d-c circuit is closed to energize the pump motor to supply alcohol to the carburetors under pressure for continuous operation, provided the control valve handle is ON. In the OFF position, the circuit is opened to discontinue system operation. On some aircraft a 3-position 28-volt d-c windshield deicing switch (13, figure 1-13 and 23, figure 1-14) is located on the electrical control panel. When the switch is placed ON, the circuit is closed to energize the pump motor to supply alcohol to the windshield under pressure for continuous operation, provided the control valve handle is turned ON. When the switch is placed in the MOM (spring-loaded) position, momentary operation of the system is provided for occasions when it is desired to operate the system only during short intervals. In the OFF position, the circuit is opened to discontinue system operation.

Carburetor Deicing Control Valve Handle

The carburetor deicing control valve handle, located to the right of and above the co-pilot's seat (6, figure 1-7), controls the supply of alcohol from the supply tank to the carburetors. The handle is turned ON to supply alcohol for operation of the carburetor deicing system, provided the carburetor deicer switch is ON. The handle is turned OFF to shut off the fluid supply to the carburetors.

CARBURETOR DEICER SYSTEM (R4D SERIES AIRCRAFT).

The carburetor deicing system utilizes a 28-volt d-c pump motor to supply alcohol to the carburetor air intake throat for the removal of ice. The 11 US. gallon supply tank is located in the right forward baggage compartment. A shutoff valve is located immediately below the supply tank. Operation of the pump motor is controlled by a switch located in the cockpit. The fluid output of the pump for continuous operation is approximately 8 gallons per hour. For fluid specification and filler points, see figure 1-30.

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Carburetor Deicer Switch (R4D Series Aircraft).

The carburetor deicer switch, located on the electrical control panel (8, *figure 1-14*), has ON, MOM, and OFF positions. When the switch is placed ON, a 28-volt d-c circuit is closed to energize the pump motor and supply alcohol to the carburetors under pressure for continuous operation, provided the shutoff valve below the supply tank is opened. When the switch is placed in the MOM (spring-loaded) position, momentary operation for short intervals is provided. In the OFF position, the circuit is opened to shut off the pump motor.

WINDSHIELD DEICING SYSTEM

The windshield deicing system is designed to furnish alcohol to the outside of the windshields to remove ice. The system utilizes the same supply tank and pump motor as the carburetor deicing system (see the paragraph on Carburetor Deicing System, this section). The alcohol sprayed on the front windshields can be used in conjunction with the windshield wipers. The pump is controlled by a switch in the cockpit, and the rate of alcohol flow to the windshields is controlled by a needle valve control located in the cockpit. A control valve is also provided to shut off the fluid supply when system operation is not necessary. For fluid specification and filler point location, see *figure 1-30*.

Windshield Deicing Control Valve Handles

Two windshield deicing control valve handles, one located to the left of the pilot's seat and one located to the right of the co-pilot's seat (10, *figure 1-6 and 12, figure 1-7*), control the supply of alcohol from the supply tank to the windshields. The handle is turned ON to supply alcohol for operation of the windshield deicing system, provided the windshield deicer switch is ON. The handle is turned OFF to shut off the fluid supply to the windshields.

Windshield Alcohol Speed Control Knob

The windshield alcohol speed control knob, located in the vee of the windshield above the main instrument panel, controls the quantity of fluid flow to the windshields. When the knob is turned counterclockwise, the opening becomes wider for the passage of more fluid in proportion to the knob setting and, when the knob is turned clockwise, the opening becomes smaller to reduce the fluid flow.

Windshield Deicing Hand Pump Handle (Some Aircraft).

A windshield deicing hand pump handle is located forward and to the right of the co-pilot's station. Operation of the pump handle forces alcohol through the perforated tubing that outlines the frames on the side windshields and the sliding window panels.

WINDSHIELD DEICING SYSTEM (R4D SERIES AIRCRAFT).

The windshield deicing system furnishes alcohol to the outside of the windshields from a 6.5 US. gallon supply tank, located in the right forward baggage compartment (11, *figure 1-30*). This system contains two units with the same source of supply. The first unit sprays alcohol by means of a hand pump onto the right and left windshields and both sliding window panels; the second unit sprays alcohol by means of a 28-volt d-c motor driven pump onto the front windshields, and can be used in conjunction with the windshield wipers. The pump motor is controlled by a switch, and the alcohol rate of flow is controlled by a needle valve, both located in the cockpit. A control valve is also provided to shut off the fluid when system operation is not necessary. For fluid specification and filler point location, see *figure 1-30*.

Windshield Deicing Hand Pump Handle (R4D Series Aircraft).

The windshield deicing hand pump handle is located forward and to the right of the co-pilot's station (29, *figure 1-9*). Operation of the pump handle forces alcohol through the perforated tubing that outlines the frames on the side windshields and the sliding window panels.

Windshield Deicing Switch (R4D Series Aircraft).

The 3-position, 28-volt d-c windshield deicing switch is located on the electrical control panel (23, *figure 1-14*). When the switch is placed ON, the circuit is closed to energize the 28-volt d-c pump motor and spray alcohol on the front windshields. When the switch is placed in the MOM (spring-loaded) position, momentary operation of the system for short intervals is provided. In the OFF position, the circuit is opened to discontinue system operation.

Windshield Deicing Control Valve Handles (R4D Series Aircraft).

Two windshield deicing control valve handles, one located to the left of the pilot's seat and one located to the right of the co-pilot's seat (15, *figure 1-8 and*

22, figure 1-9), control the supply of alcohol from the hand pump to the right and left windshields and both sliding window panels. When the handle is turned on, the supply line is opened; when the handle is turned OFF, the supply to the side windshields is shut off.

Windshield Alcohol Speed Control Knob (R4D Series Aircraft).

The windshield alcohol speed control knob, located in the vee of the windshield above the main instrument panel, controls the quantity of fluid flow to the front windshields. When the knob is turned clockwise, the opening becomes wider for the passage of more fluid in proportion to the knob setting, and, when the knob is turned counterclockwise, the opening becomes smaller to reduce the fluid flow.

WING AND EMPENNAGE DEICING SYSTEM.

A wing and empennage deicing system is installed on the aircraft for the purpose of removing ice after it has formed. Rubber deicing boots are installed on the leading edge of each wing, each horizontal stabilizer, and on the vertical stabilizer. Air pressure, supplied from the pressure ports of the two engine-driven vacuum pumps (one on each engine), flows through two oil separators (to separate the oil from the air), two check valves, an air filter, and through a distributor valve to alternately expand and contract the tubes in the de-icing boots (figure 4-3). One complete de-icing cycle is completed every 40 seconds. Each cycle consists of five 8-second pressurizing periods. The first period: air inflates the center tubes on the right and left outboard de-icer boots. Second period: the upper and lower tubes on the right and left outboard boots are inflated. Third period: the center tubes in the right and left inboard boots are inflated. Fourth period: the upper and lower tubes in the right and left inboard boots are inflated. Fifth period: both tubes in each of the three stabilizer boots are inflated. This pulsing action cracks ice formations on the boots, and the air-stream blows the ice off. The distributor valve is controlled by a 28-volt d-c motor which opens or closes the port in the distributor valve unit. Operation of the electric motor is controlled from the cockpit. A pressure relief valve in the air filter regulates the pressure in the system. A gage located in the cockpit is connected to a line from the air filter and indicates the system air pressure.

Wing and Empennage Deicing System Control Handle

A wing and empennage deicing system control handle (17, figure 1-9), located on the bulkhead aft of the co-pilot's station, has ON and OFF placarded positions. The control handle mechanically turns an arm, connected at either end to a cable, to start or stop the distributor valve motor, and positions the overboard ports in the distributor valve as required.

Wing and Empennage Deicing System Pressure Gage.

A direct-reading wing and empennage deicing system pressure gage mounted on the main instrument panel (23, figure 1-11, and 26, figure 1-12) indicates system operating pressure.

WING AND EMPENNAGE DEICING SYSTEM OPERATION.

NOTE

For best results, wait until at least $\frac{1}{4}$ inch of ice has formed before starting the deicing system. If ice is too thin, it will crack in small patterns and will not have enough weight and body to be blown off by the slipstream.

Start the system by turning the deicing control handle to the ON position.

1. Observe the pulsation of the deicer boots for proper operation.
2. Deicer system pressure - Check.

NOTE

When the system is operating, the gage will not give a constant recording of 8 psi because of the fluctuation of air pressure; however, it should reach 8 psi at the peak of each inflation in order to properly inflate the individual tubes in each boot.

PITOT STATIC TUBE HEATERS.

The two pitot static tubes (21, figure 1-1) are each equipped with a 28-volt d-c integral heater which prevents ice from forming on the tubes. The heaters are operated by means of switches located in the cockpit.

Pitot Heater Switches.

The pitot heater units are controlled by two switches, located on the electrical control panel, one for the FWD. pitot tube and one for the AFT pitot tube (10, 11, figure 1-13, and 21, 22, figure 1-14). When either switch is positioned ON, the 28-volt d-c circuit is closed to operate the electrical heaters in the pitot tubes. In the OFF position, the circuit is opened to discontinue heater operation.

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WING AND EMPENNAGE DE-ICING SYSTEM

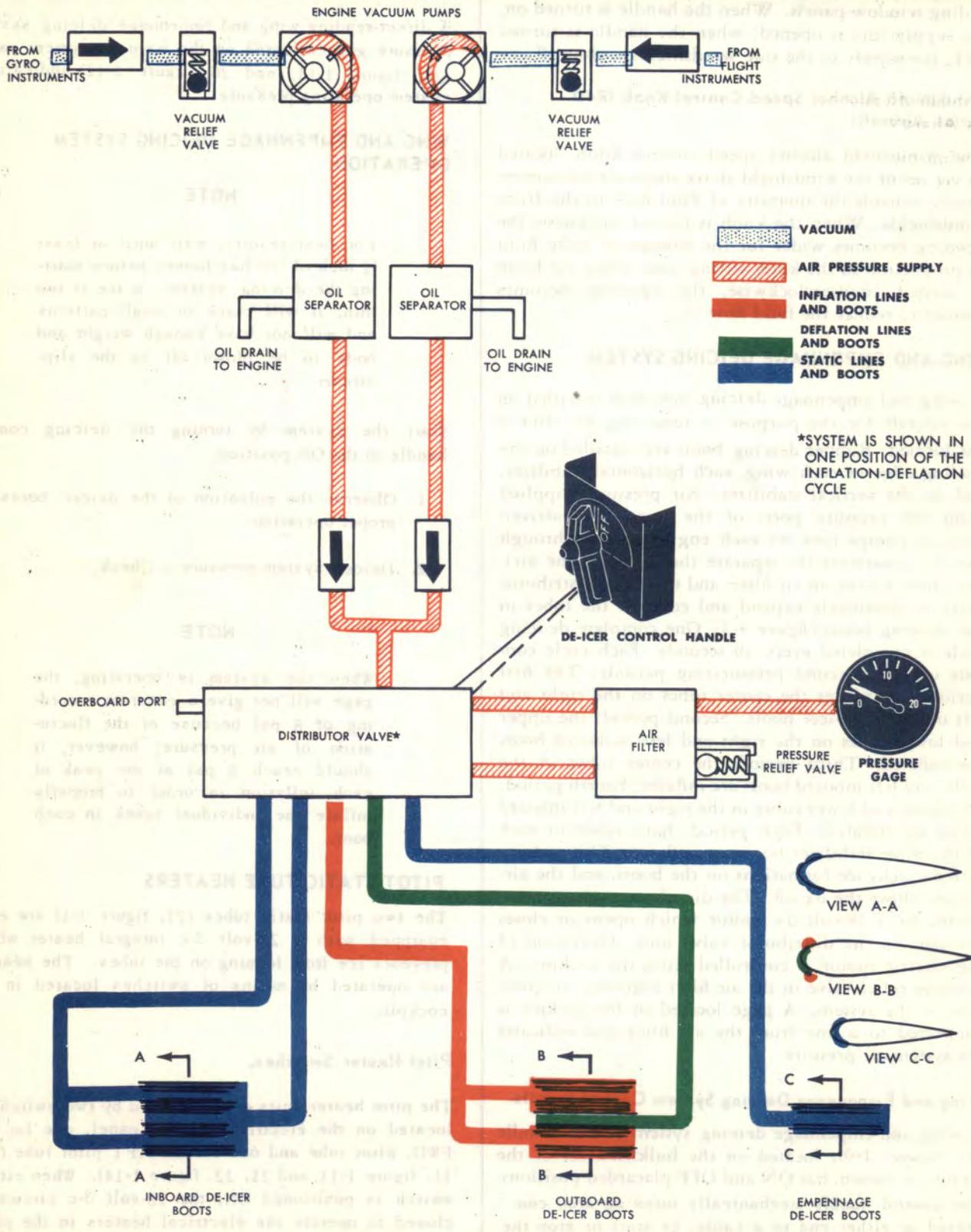


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**COMMUNICATION AND ASSOCIATED
ELECTRONIC EQUIPMENT.**

(See figure 4-4.)

The following equipment is typical for all C-47, C-117 and R4D series aircraft. Each aircraft must be checked to determine the exact radio equipment installed.

RADIO SELECTOR SWITCH.

A radio power selector switch (2, figure 1-7), is mounted on the pilot's radio control panel, and selects the VHF, the UHF, or the HF liaison transmitter. Only one transmitter operates at a time.

**VHF COMMAND TRANSMITTER RECEIVER
(AN/ARC-3).**

The VHF transmitter-receiver is controlled from the pilot's control panel and receives its power from the 28-volt d-c Radio Junction Box Bus No. 1. The equipment is line-of-sight VHF and is used for 2-way voice communication, air-to-air or air-to-ground. The set is turned on by placing the VHF 2-position ON-OFF switch in the ON position. To turn the equipment off, place the switch in the OFF position.

**UHF COMMAND TRANSMITTER-RECEIVER
(AN/ARC-27).**

The UHF transmitter-receiver is controlled from the pilot's radio panel, and receives its power from the 28-volt d-c Radio Junction Box Bus No. 2. The transmitter-receiver has been designed to provide radio telephone communication in the frequency range of 225.0 to 399.9 megacycles between aircraft and ground or between aircraft. The transmitter may be tone modulated (A2) at 1020 cycles per second for emergency or direction-finding purposes. The transmitter-receiver provides 1750 frequency channels in this range and provision has been made for the pilot's remote selection of any of the 18 or 20 preset frequencies or operation of a guard frequency. On some installations, a quick manual tuner is installed on the radio panel. On these airplanes, the pilot is able to select any one of the available 1750 frequency channels which include 18 or 20 preset ones and guard. Transmission and reception are line-of-sight on the same frequency and antenna. To turn the equipment on, rotate the function switch clockwise from the off position. To turn the equipment OFF, rotate the function switch counterclockwise to OFF.

CAUTION

- To preclude damage to the equipment, allow at least one minute for the set to warm up before operating.
- Do not rotate the channel selector while the tuning cycle is in progress.

**HF LIAISON TRANSMITTER AND RECEIVER.
(AN/ARC-8 or SCR-287).**

The HF liaison transmitter and receiver are controlled from the radio operator's station (1, and 5, figure 4-7) and are operated by power from the 28-volt d-c Radio Junction Box Bus No. 1. The HF liaison set provides long-range 2-way code and voice communication. A key for the operation of CW (3, figure 4-7) is mounted on the radio operator's table. To turn on the transmitter, place the radio power selector switch in the LIAISON position and rotate the emission selector switch clockwise to VOICE, CW, or MCW as required. To turn off the transmitter, place the emission selector switch in the OFF position. To turn on the receiver, place the radio power selector switch in the LIAISON position and move the function selector switch either to MVC or AVC, as desired. To turn off the receiver, place the function selector switch in the OFF position.

INTERPHONE SYSTEM.

Multiple interphone control panels are located in the flight compartment, adjacent to each crew member's station; headsets and hand microphones are also provided. These are operated from the interphone control panels (figure 4-6) at each crew member's station. The interphone equipment provides communication facilities between all crew members and enables the flight compartment crew members to use the VHF command set, VHF navigation set, the liaison set, the automatic radio compass, and the marker beacon. The power source is the 28-volt d-c Radio Junction Box Bus No. 2. To turn on the interphone equipment, turn on the aircraft power supply and see that the radio power circuit breaker in the main junction box and the three circuit breakers on the radio circuit breaker panel (figure 1-20) are in the ON position. To turn off the interphone equipment on the ground, turn off the aircraft power supply. In an emergency, to turn off the interphone in flight, open the circuit breakers.

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COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT

The following list is typical for all C-47, C-117, and R-4D series aircraft. Each aircraft must be checked to determine the exact radio equipment installed.

TYPE	DESIGNATION	FUNCTION	PRIMARY OPERATOR	RANGE	LOCATION OF CONTROLS
VHF COMMAND	AN/ARC-3 WILCOX 807	SHORT-RANGE, TWO-WAY VOICE AND CODE COMMUNICATION	PILOT AND CO-PILOT	LINE OF SIGHT	PILOT'S RADIO CONTROL PANEL
UHF COMMAND	AN/ARC-27	SHORT-RANGE, TWO-WAY VOICE COMMUNICATION	PILOT, CO-PILOT AND RADIO OPERATOR	LINE OF SIGHT	PILOTS' RADIO CONTROL PANEL AND RADIO OPERATOR'S CONTROL PANEL
HF LIAISON	AN/ARC-8	LONG-RANGE, TWO-WAY VOICE AND CODE COMMUNICATION	RADIO OPERATOR	200 TO 2500 MILES	RADIO OPERATOR'S STATION
OMNI-RANGE AND INSTRUMENT APPROACH	AN/ARN-14 AND AN/ARN-18	OMNI-RANGE LOCALIZER AND GLIDE PATH INDICATION	PILOT AND CO-PILOT	LINE OF SIGHT TERMINAL AREA	PILOTS' RADIO CONTROL PANEL
LOCALIZER AND GLIDE PATH	AN/ARN-18	INDICATES GLIDE ANGLE FOR LANDING AND LATERAL ALIGNMENT WITH RUNWAY	PILOT AND CO-PILOT	TERMINAL AREA	ABOVE THE LEFT ELECTRIC CONTROL PANEL
INTERPHONE	AN/A1C-3 OR AN/A1C-10	INTERCREW COMMUNICATION	ALL CREW MEMBERS	WITHIN THE AIRCRAFT	CONTROL PANEL IN EACH CREW MEMBER'S STATION
AUTOMATIC RADIO COMPASS	AN/ARN-6 (DUAL) AN/ARN-7	RECEPTION OF VOICE OR CODE COMMUNICATION; POSITION FINDING, HOMING	PILOT, CO-PILOT NAVIGATOR	20 TO 200 MILES	PILOT'S RADIO CONTROL PANEL AND NAVIGATOR'S STATION
RADIO LOW ALTIMETER	AN/APN-22	10,000 FT. OVERLAND, 20,000 FT. OVER WATER	PILOT	AIRCRAFT TO TERRAIN OR WATER	MAIN INSTRUMENT PANEL
MARKER BEACON	RC-193A OR BC-1333-B	RECEIVES LOCATION MARKER SIGNAL ON NAVIGATIONAL BEAM	PILOT AND CO-PILOT	OVER STATION	INDICATOR LIGHT IN COCKPIT VISIBLE TO PILOT AND CO-PILOT
TACAN	AN/ARN-21	AID TO NAVIGATION	PILOT AND CO-PILOT	LINE OF SIGHT 195 MILES MAXIMUM	PILOT'S RADIO CONTROL PANEL
IFF OR SIF	AN/APX-25 AN/APX-6	PROVISIONS ONLY IDENTIFICATION	PILOT OR CO-PILOT	LINE OF SIGHT	PILOT'S RADIO CONTROL PANEL
EMERGENCY TRANSMITTER	AN/CRT-3	EMERGENCY SEA RESCUE		LINE OF SIGHT	STRAPPED ON AFT MAIN CABIN DOOR OR NAVIGATOR'S STATION
RADAR ALTIMETER	SCR718	50,000 FT	PILOT	AIRCRAFT TO TERRAIN OR WATER	MAIN INSTRUMENT PANEL
DIRECTION FINDER	AN/ARA-25	UHF DIRECTION FINDER	PILOT CO-PILOT		RADIO OPERATOR'S STATION
"LORAN" NAVIGATION	AN/APN-9	"LORAN" NAVIGATIONAL EQUIPMENT	NAVIGATOR		PILOT'S OVERHEAD RADIO CONTROL PANEL

Figure 4-4

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INTERPHONE SYSTEM (SOME AIRCRAFT).

The interphone system provides a means of communication between crew members and also permit crew participation in radio operations. Five interphone control panels are provided, one for each crew member and one at the rear of the main cabin compartment. The pilot and co-pilot are each provided with a mixer control box and a filter control, which make it possible to monitor all radio sets, or isolate as desired. Selection at the navigator's station interphone control panel and radio operator's station interphone panel differs in that the radio operator cannot select the VHF navigation radio and the navigator cannot select the liaison radio. Selection at the rear cabin compartment interphone control panel is the same as at the radio operator's station with the exception that, in the LIAISON position, only reception is possible.

The MIXED SIGNALS COMM position, on the pilot's and co-pilot's interphone control panels, permits HF, VHF, or UHF transmission and reception, depending on the position of the microphone selector switch and the audio switches on the interphone control panel.

The radio power switch must be set to correspond. The power source is the 28-volt d-c Radio Junction Box Bus No. 2. To turn on the interphone equipment, turn on the aircraft power supply and see that the radio power circuit breaker in the main junction box and the three circuit breakers on the radio circuit breaker panel (figure 1-20) are in the ON position. To turn off the interphone equipment on the ground, turn off the aircraft power supply. In an emergency, to turn off the interphone equipment in flight, pull the circuit breakers.

RADAR ALTIMETER (SCR 718) (HIGH RANGE)

Radar set SCR 718 is a high-altitude altimeter that operates in the UHF band on a frequency of 440 megacycles. The altimeter is a pulse type, and is capable of indicating accurate terrain clearance up to 50,000 feet. The altitude reading displayed on the indicator is accurate to within 50 feet on the 5,000-foot scale, and to within 500 feet on the 50,000-foot scale. Basically, the equipment transmits pulses of radar energy earthward from the aircraft, and then receives the same signal as it is reflected from the earth. The length of time required for the signal to follow its path is measured, and presented as a lobe on the circle on the face of the indicator tube. The circle is calibrated to read directly in feet. When the toggle switch on the indicator is in the TIMES ONE position, the altimeter reads up to 5,000 feet; when the toggle switch is in the TIMES TEN position, the altimeter reads up to 50,000 feet.

RADAR ALTIMETER SYSTEM (LOW-RANGE, AN/APN-22).

CAUTION

The SCR-718 radio altimeter operating in the band 420/460 mc/s is a source of interference to the radio astronomy receivers and other authorized electronic radiation equipment operating in 406/450 mc/s. To prevent interference, SCR-718 radio altimeter equipment will be used only over broad ocean area starting not less than 50 miles offshore.

The AN/APN-22 radar altimeter system is a microwave altimeter, and receives power from the 28-volt DC No. 1 radio bus and 115 volt AC power from No. 1 radio bus. The system measures the terrain clearance of the aircraft through a transmitted and received frequency - modulated microwave carrier. The system is reliable from 0 to 10,000 feet over land and from 0 to 20,000 feet over water. The indication accuracy is ± 2 feet from 0 to 40 feet, and ± 5 percent of the indicated altitude from 40 to 20,000 feet. The system ON-LIMIT control switch is located on the height indicator. ON turns on the power for the system. LIMIT sets the bug pointer at the desired altitude. Indication that the aircraft is above the set altitude is obtained by comparing the indicator pointer with the bug pointer, or by observing illumination of a red light on the face of the indicator. The indicator pointer will go behind a mask on the indicator if the system is inoperative or a dropout altitude is reached. The dropout altitude is the altitude when the return signal is too weak to operate the system. The signal will be too weak above 10,000 feet over land and above 20,000 feet over water, or in banks of 60 degrees or more, and climbs and dives of 70 degrees or more.

WARNING

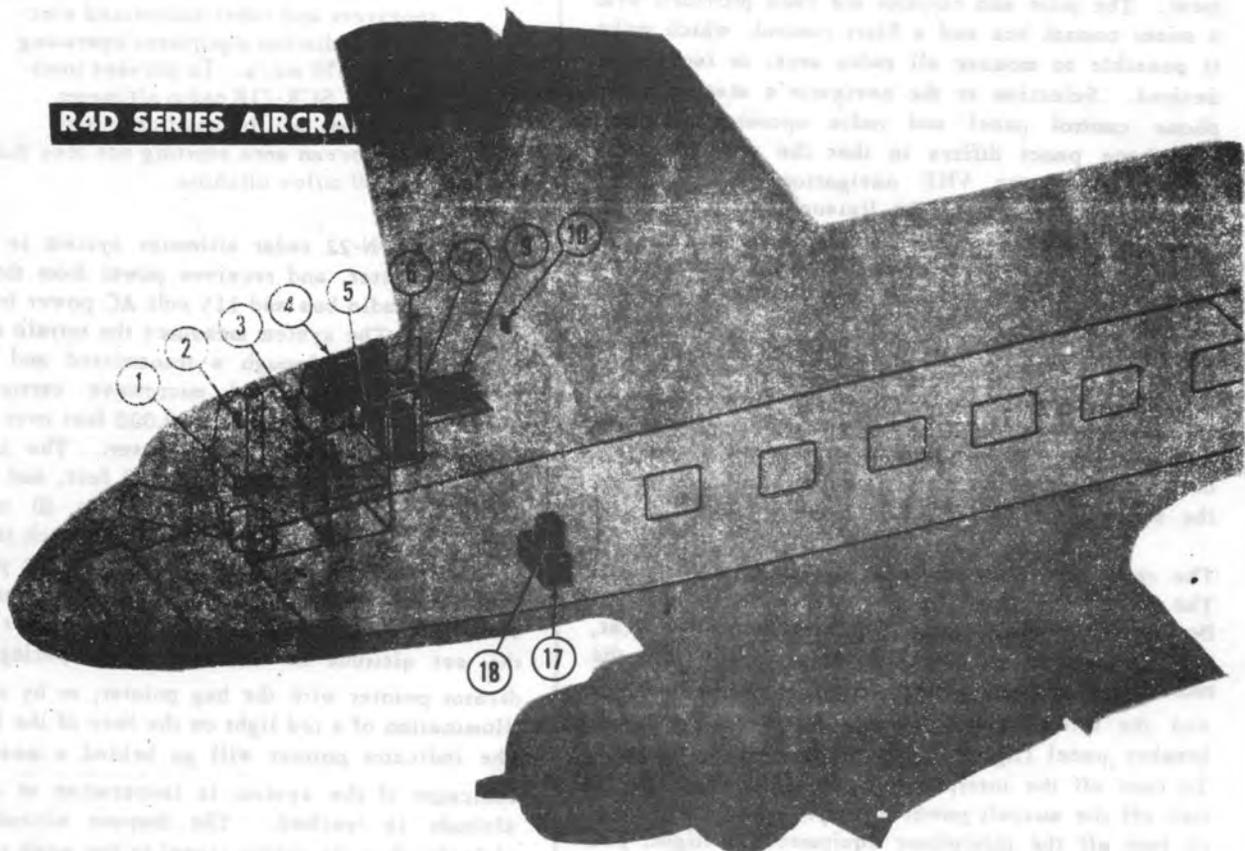
Do not rely on your AN/APN-22 equipment to provide terrain clearance when flying over areas covered by a large depth of snow and ice.

IFF/SIF EQUIPMENT.

Power for the identification radio equipment is provided by the 28-volt d-c Radio Bus No. 2 and the 115 volt a-c Radio Bus No. 1. Refer to appropriate manual for operating instructions.

COMMUNICATION AND ASSOCIATED ELECTRONIC

R4D SERIES AIRCRAFT



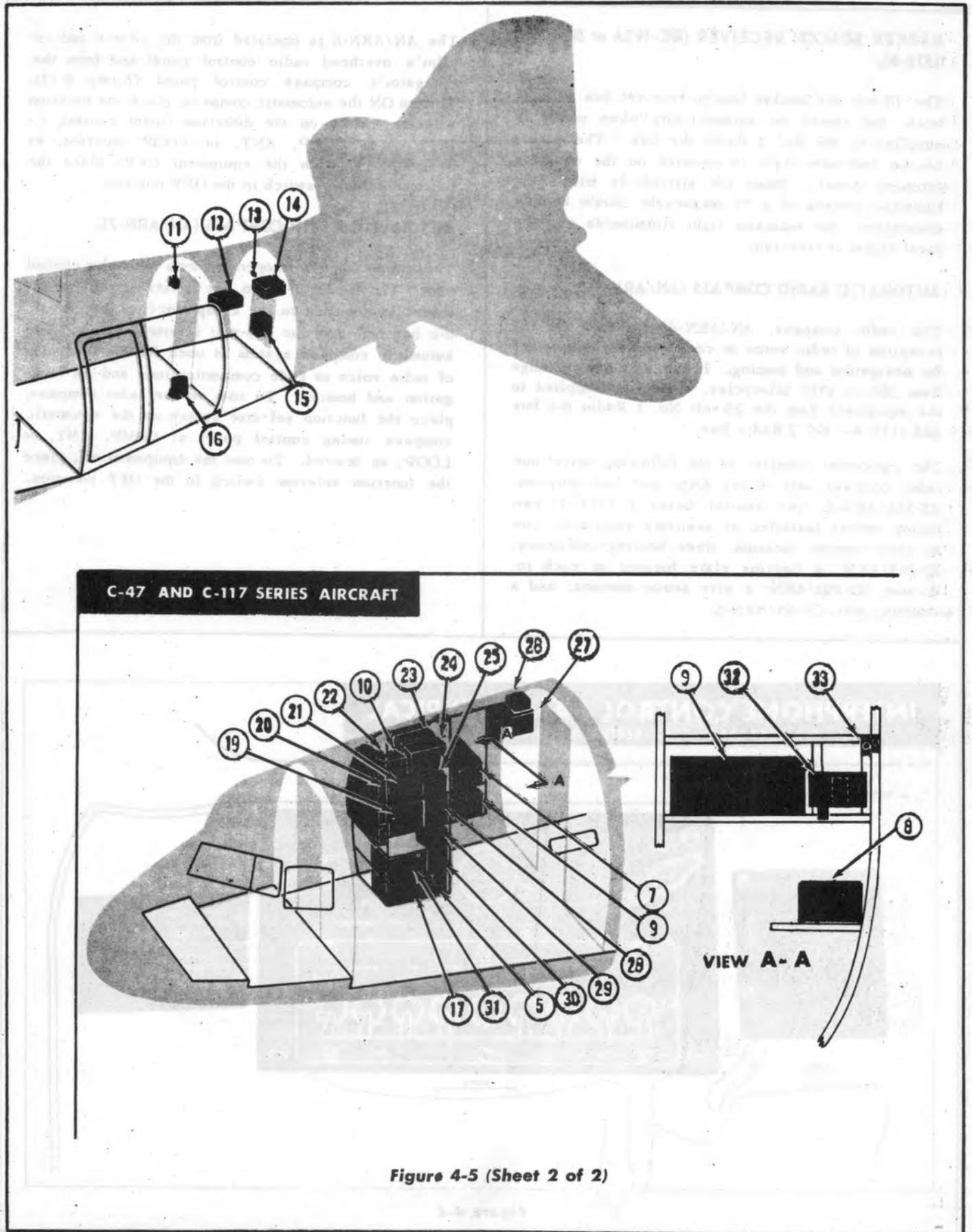
- | | |
|--|--|
| <ol style="list-style-type: none"> 1. LF CONTROL PANEL 2. VHF COMMAND RADIO CONTROL PANEL 3. LOCALIZER AND GLIDE PATH RECEIVER 4. LIAISON TRANSMITTER SPARE TUNING UNITS 5. MARKER BEACON RECEIVER 6. LF RECEIVER 7. LIAISON RADIO TRANSMITTER 8. VHF COMMAND FM 9. LIAISON RADIO RECEIVER 10. INTERPHONE AMPLIFIER 11. CARGO COMPARTMENT INTERPHONE CONTROL PANEL 12. RADIO LOW ALTIMETER TRANSMITTER-RECEIVER 13. MICROPHONE JACK BOX 14. VHF COMMAND RADIO TRANSMITTER-RECEIVER 15. IFF RADIO TRANSMITTER-RECEIVER 16. EMERGENCY TRANSMITTER (GIBSON GIRL)—
MOUNTED ON INSIDE OF CARGO DOOR 17. AUTOMATIC RADIO COMPASS RECEIVER | <ol style="list-style-type: none"> 18. FREQUENCY METER 19. VHF RADIO RECEIVER 20. RADIO CIRCUIT BREAKER PANEL 21. VHF RADIO TRANSMITTER 22. OMNI BEARING INDICATOR 23. COMPASS REPEATER AMPLIFIER 24. FLUXGATE COMPASS AMPLIFIER 25. GLIDE PATH RECEIVER 26. RADIO BEARING INDICATOR 27. TACAN RADIO TRANSMITTER — RECEIVER 28. OMNI LOCALIZER RECEIVER 29. LIAISON RADIO DYNAMOTOR 30. OMNI LOCALIZER RECEIVER DYNAMOTOR 31. UHF TRANSMITTER-RECEIVER 32. INTERPHONE CONTROL PANEL 33. LIAISON MONITOR SWITCH |
|--|--|

Figure 4-5 (Sheet 1 of 2)

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C-47 AND C-117 SERIES AIRCRAFT

Figure 4-5 (Sheet 2 of 2)

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MARKER BEACON RECEIVER (RC-193A or BC-1333-B).

The 28-volt d-c marker beacon receiver has no controls, but comes on automatically when power is supplied to the No. 2 Radio d-c bus. The marker beacon indicator light is mounted on the main instrument panel. When the aircraft is within the radiation pattern of a 75 megacycle marker beacon transmitter, the indicator light illuminates and the aural signal is received.

AUTOMATIC RADIO COMPASS (AN/ARN-6).

The radio compass, AN/ARN-6, is used for the reception of radio voice or code communication, and for navigation and homing. It has a frequency range from 100 to 1750 kilocycles. Power is supplied to the equipment from the 28-volt No. 1 Radio d-c bus and 115V a-c No. 2 Radio Bus.

The equipment consists of the following units: one radio compass unit, R-101/ARN; one loop antenna, AS-313/ARN-6; two control boxes C-1514/A; two tuning meters installed as auxiliary equipment, one at each control location; three bearing indicators, ID-250/ARN; a lighting plate located at each indicator, ID-250/ARN; a wire sense antenna; and a coupling unit, CU-65/ARN-6.

The AN/ARN-6 is operated from the pilot's and co-pilot's overhead radio control panel and from the navigator's compass control panel (figure 4-12). To turn ON the automatic compass, place the function selector switch on the direction finder control, C-1514/A, to COMP, ANT, or LOOP position, as desired. To turn the equipment OFF, place the function selector switch in the OFF position.

AUTOMATIC RADIO COMPASS (AN/ARN-7).

The radio compass is operated from the radio control panel (2, figure 1-7) in the pilots' compartment. Power is supplied to the equipment from the 28-volt d-c bus and from the 115-volt inverter system. The automatic compass system is used for the reception of radio voice or code communications and for navigation and homing. To turn on the radio compass, place the function selector switch on the automatic compass tuning control panel at COMP, ANT, or LOOP, as desired. To turn the equipment off, place the function selector switch in the OFF position.

INTERPHONE CONTROL PANEL—TYPICAL

C47 AND C117 SERIES AIRCRAFT

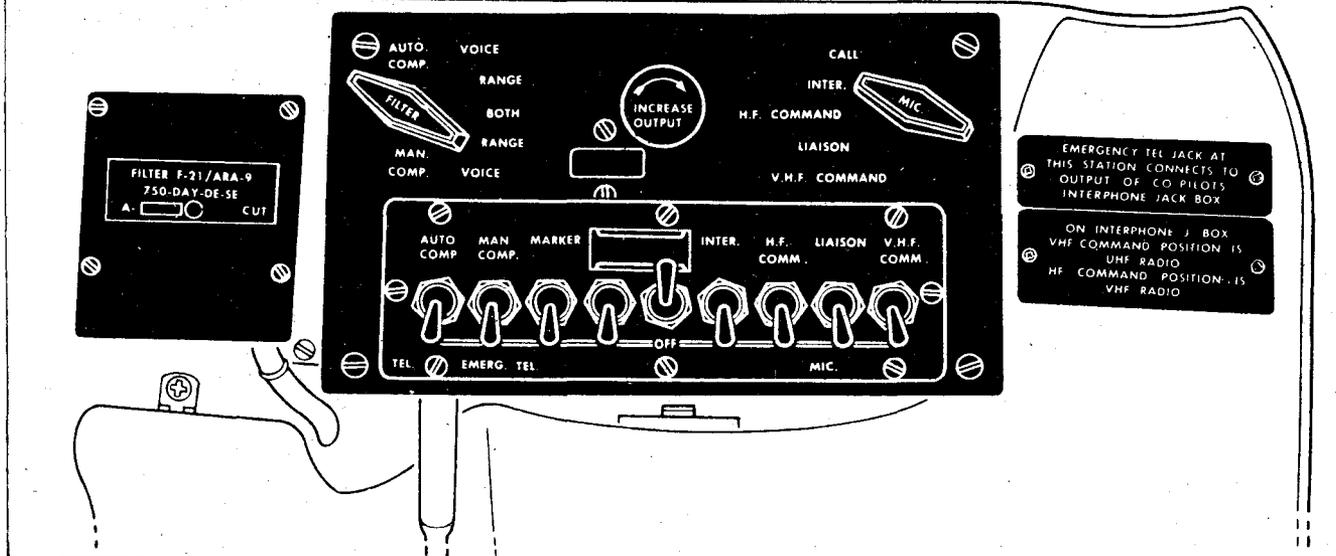


Figure 4-6

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LOCALIZER RECEIVER AND GLIDE PATH RECEIVER (RC/101 and AN/ARN-18).

This equipment is controlled from the LOCALIZER control panel located above the electrical control panel in the pilots' compartment. Its power sources are the 28-volt d-c bus localizer and the 115-volt a-c bus glide slope. Instrument landing approach system localizer channels are selected on the control panel. Channels U, V, W, X, Y, and Z may be selected by placing the selector switch handle in the position required. Glide path frequencies are automatically paired with their respective localizer channels. Localizer and glide path course deflection is indicated on the glide path indicator installed on the pilot's instrument panel. To turn on the receivers, place the ON-OFF toggle switch on the localizer control panel in the ON position. To turn the equipment off, place the ON-OFF toggle switch in the OFF position.

OMNI-RANGE AND LOCALIZER RECEIVER AND GLIDE PATH RECEIVER (AN/ARN-14 and AN/ARN-18).

This equipment is controlled from the VHF NAV radio control panel in the pilot's compartment (2, figure 1-7). Its power sources are the 28-volt d-c No. 1 Radio Bus for the course indicator (ID 249) except the heading pointer. 115V AC power from the No. 2 a-c radio bus is required for the heading pointer, and the radio magnetic indicator (ID 250). Omni-range and instrument landing system approach localizer frequencies are selected on the frequency control unit. Glide path frequencies are automatically paired with their respective localizer frequencies. Omni-range courses are selected with reference to the head or tail of the (VOR No. 2) bearing indicator and set in the course selector window located on the main instrument panel. The function of the equipment is radio navigation and instrument landing. To turn on the equipment, place the VHF NAV POWER switch in the ON position. To turn off the equipment, turn the VHF NAV POWER switch OFF.

WARNING

- Power source for glide indication will vary from aircraft to aircraft. Determine power source prior to flight.

- During a VOR instrument approach, turn the Tacan set off at the Tacan control panel. This will prevent an automatic switchover to Tacan in the event of a VOR power failure during a VOR approach.

NOTE

In case of complete inverter failure power is still available to operate the CDI of the ID 249 when used with the ARN-14.

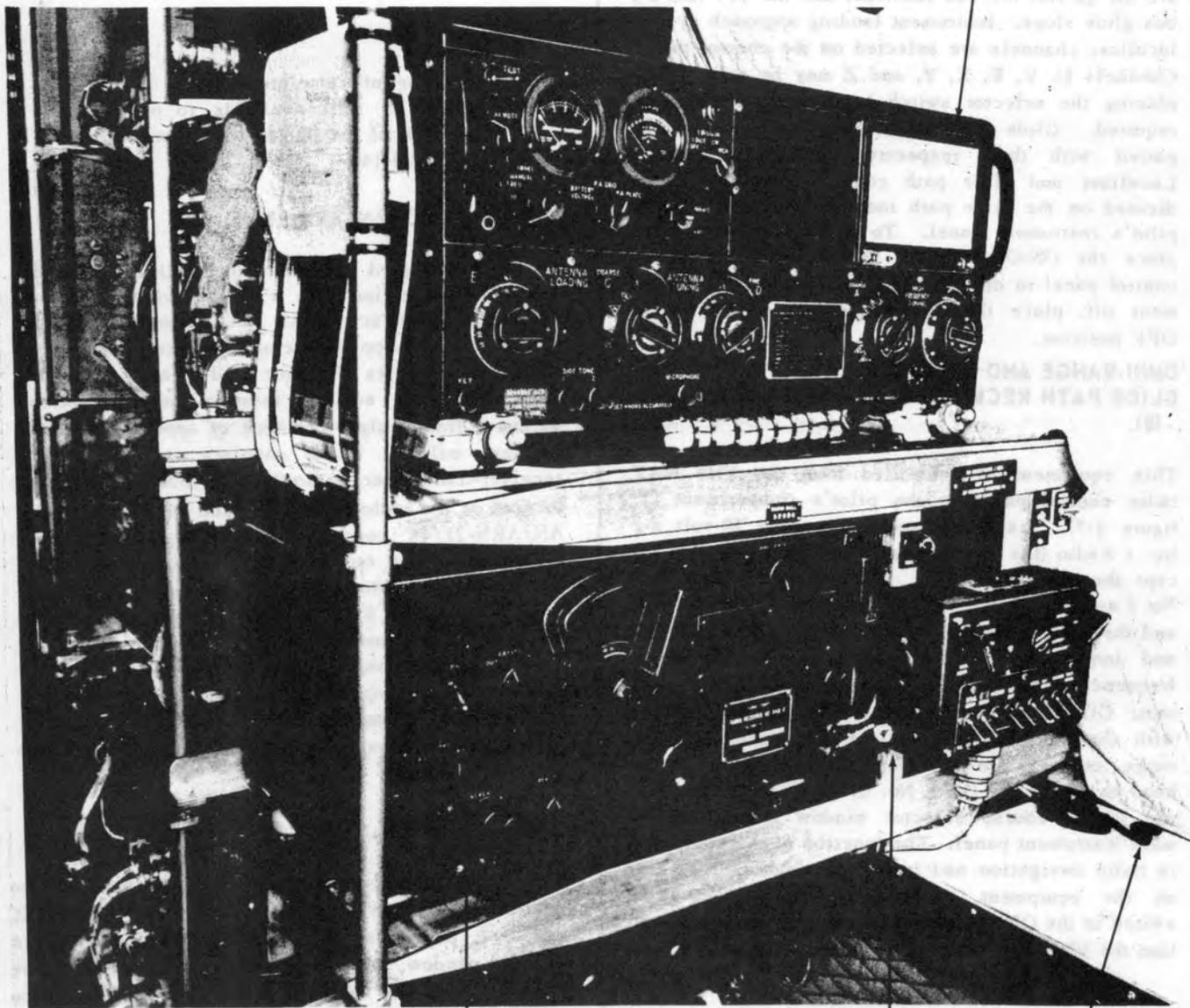
TACAN RADIO (AN/ARN-21/45).

Tacan is designed to operate in the UHF frequency band in conjunction with a radio navigation system called TACAN (Tactical Air Navigation). The system enables an equipped aircraft to obtain continuous indications of its distance and bearing from any selected tacan surface (station beacon) located within a line-of-sight distance of approximately 195 nautical miles. Tacan consists essentially of a receiver-transmitter, radio bearing indicator (ID 307) located at the radio equipment rack and a DME. The AN/ARN-21/45 components available to the pilot in flight are the radio magnetic indicator (ID 250), the course indicator (ID 249), the Tacan Range indicator DME (ID 310), Tacan Control Panel, and a Navigation instrument selector switch. There are 126 frequency channels any one of which may be selected by setting the proper controls on the control panel. Tacan is powered by both 28-volt d-c Radio Junction Box Bus No. 2 and 115-volt a-c Radio Bus No. 1.

TACAN CONTROL PANEL.

The Tacan control panel located on the pilot's radio control panel, has a power switch with OFF, REC and T/R positions, two channel selector knobs, a channel window, and a volume-control knob. With the power switch in the REC position, the distance function of the set is disabled, and only bearing information is available. With the power switch in the T/R position, both bearing and distance information is displayed on the indicators. The left or outside on the concentric channel selector knob selects the first two figures of the Tacan beacon channel number, and the right or inside channel selector knob selects the third number. The volume control knob is used to adjust the volume of aural identification signals received from the Tacan surface beacon.

RADIO OPERATOR'S STATION
TYPICAL

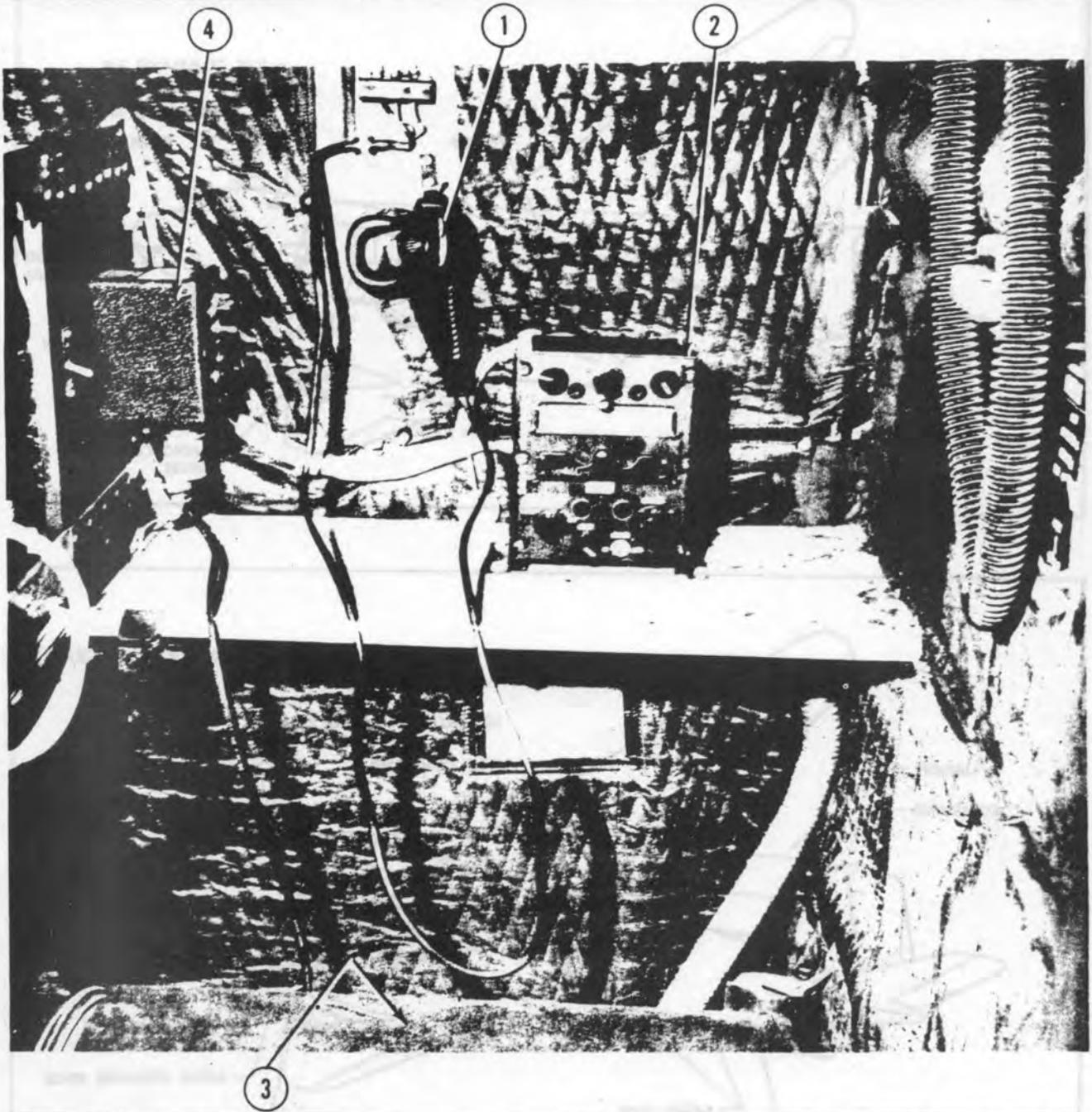


- 1. HF LIAISON TRANSMITTER
- 2. KEYER

- 3. INTERPHONE CONTROL PANEL
- 4. HF LIAISON RECEIVER

Figure 4-7 (Sheet 1 of 2)

RADIO OPERATOR'S STATION SOME SC-47 AIRCRAFT



1. MICROPHONE
2. CONTROL BOX

3. HF LIAISON TRANSMITTER-RECEIVER
4. SPEAKER CONTROL BOX

Figure 4-7 (Sheet 2 of 2)

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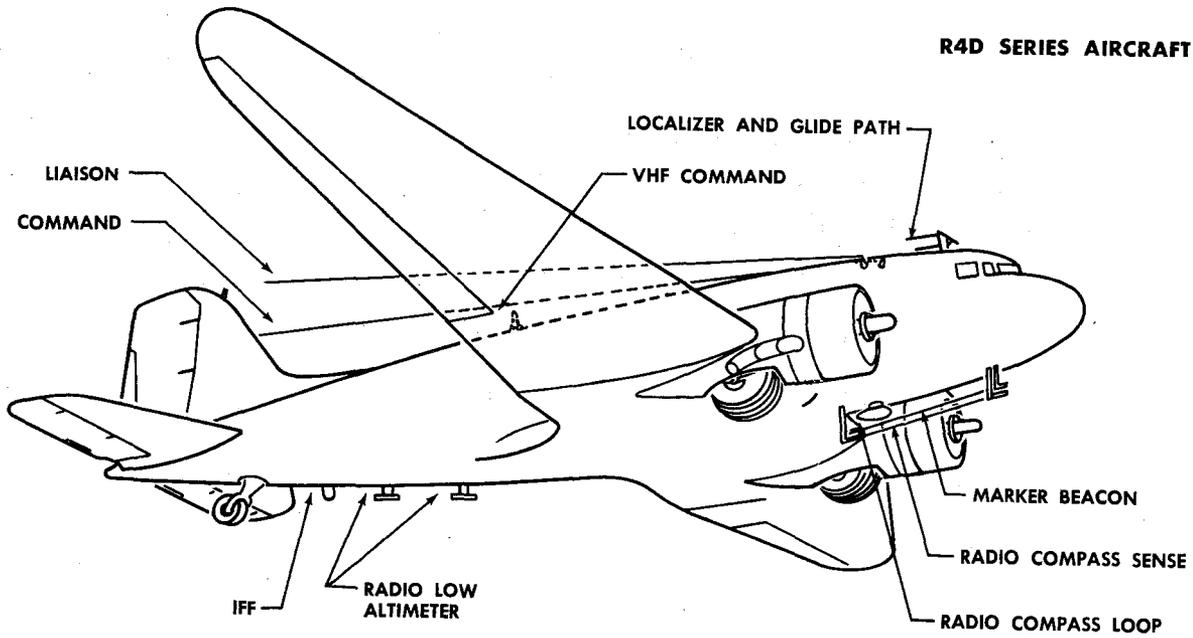
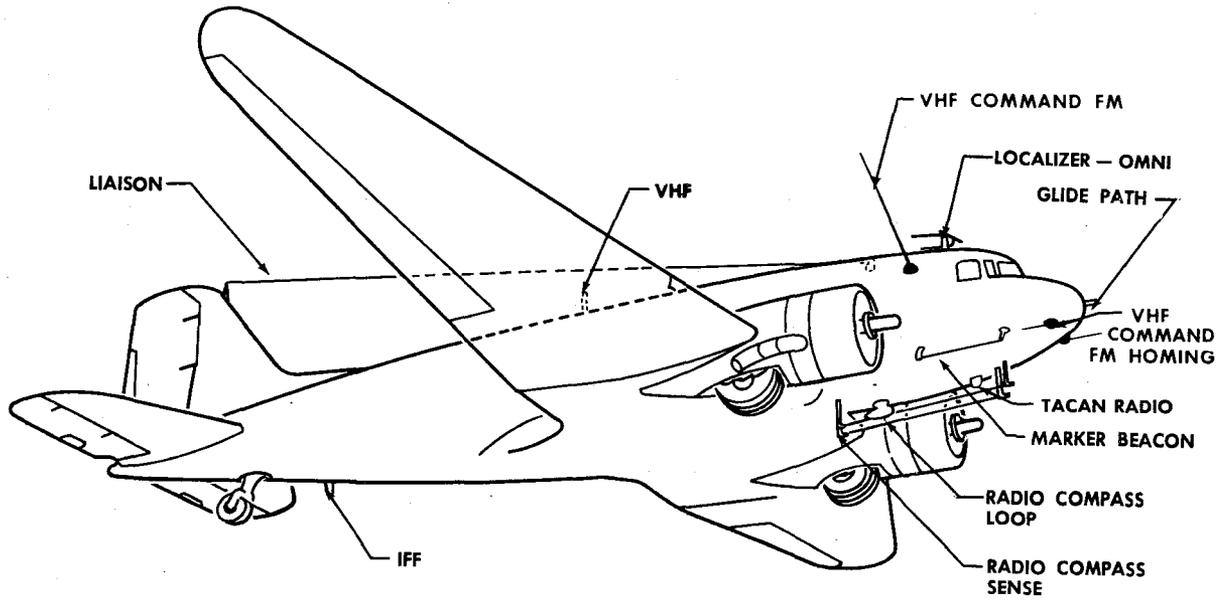


Figure 4-8

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Navigation Instrument Selector Switch.

A navigation instrument selector switch with TACAN and VOR positions, is located on the pilots' radio control panel. When the switch is positioned to VOR, the omni-range receiver controls the course indicator and the No. 2 needle of the radio magnetic indicator (RMI). When the switch is positioned to TACAN, the Tacan radio controls the course indicator and the No. 2 needle of the radio magnetic indicator. The switch receives power from the 28-volt d-c system through a circuit breaker on the radio circuit breaker panel (figure 1-20).

COURSE INDICATOR (ID 249/ARN).

The course indicator ID 249 (8, figure 1-12) is used in conjunction with both the VOR and Tacan. Signals received from either radio are relayed to the course deviation indicator of the course indicator. Deviation of the aircraft course either left or right of the selected course will be indicated by displacement of the course deviation indicator, regardless of position of aircraft in relation to the station.

RADIO MAGNETIC INDICATOR ID 250.

The radio magnetic indicator (1, figure 1-12) is also used with AN/ARN-21 (Tacan) as well as with the AN/Radio Compass. It consists of a rotating compass card, actuated by the directional indicator (slaved) system, and two bearing indicators. The bearing indicators are connected to function as a single unit and are actuated by the receiver portion of the AN/ARN-21 when Tacan is selected. Azimuth signals from the Tacan surface beacon are then received by the AN/ARN-21 and relayed to the radio magnetic indicator, causing the bearing indicators to indicate the magnetic bearing of the Tacan surface beacon. With the control switch in the REC position bearing information may be received even though the transmitter portion of the set is not energized.

TACAN RANGE INDICATOR.

A Tacan range indicator is installed on the pilot's instrument panel. The indicator displays the slant range distance in nautical miles between the airplane and the Tacan surface beacon. The numerals in the window are controlled by the range circuits of the AN/ARN-21 Tacan. While the indicator is "searching" for the correct range or when the switch is in the REC position, the rotating numbers are partially covered by a red flag, which warns the pilot against reading incorrect distance indications.

TACAN RADIO OPERATION.

1. Navigation instrument selector switch - TACAN.
2. Function switch - T/R or REC.
3. Channel selector knobs - Desired Channel.
4. Volume control knobs - As Required.
5. Bearing selector knob (course indicator) - Desired Bearing.
6. To Stop, function switch - OFF.

WARNING

The course indicator (localizer and glide path needles) is unreliable for instrument approaches (ILS) when the navigation instrument selector switch is in the TACAN position.

TACAN FALSE LOCK-ON.

Occasionally TACAN equipment will "lock-on" to a false bearing which will be 40° or a multiple of 40° in error. These errors can be on either side of the correct bearing. When the TACAN "locks-on" a false bearing, switching to another channel and then back to the desired channel, or turning the set off and then back on will recycle the search mode. This will most probably result in a correct "lock-on."

NOTE

This deficiency does not affect the DME display provided by the TACAN equipment.

- a. When using TACAN, cross check for false "lock-on" with ground radar, airborne radar, VOR, dead reckoning or other available means. These cross checks are especially important when switching channels or when tuning set on.
- b. If a false "lock-on" is suspected, switch to another channel, check it for correct bearing and then switch back to the desired channel.
- c. Check for correct "lock-on".
- d. If false "lock-on" is still suspected, turn set off and then ON.
- e. Recheck for correct "lock-on."
- f. If false "lock-on" persists, utilize the other equipment or aids available.

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NOTE

If, during an emergency the size and direction of error can be determined, TACAN can be utilized if compensation is made for the error in TACAN bearing.

"LORAN" NAVIGATIONAL EQUIPMENT (AN/APN-9).

The "Loran" navigational equipment is located at the navigator's station and receives, amplifies, and detects "Loran" signals and provides a method of navigation. The equipment is controlled by switches located on the receiver.

UHF DIRECTION FINDER (AN/ARA-25).

A UHF direction finder device is installed in the aircraft to indicate the relative bearing of and to home on radio signal sources in the 225.0 to 400 megacycle range. The relative bearing of the signal source is indicated on the course indicators located on the main instrument panel and navigator's station. To turn on the equipment, turn the selector switch on UHF control unit to the ADF position. To turn equipment off, turn the selector switch on the UHF control unit to the OFF position.

RADIO SET CONTROL C-451A/ARC-21

This unit, located at the Radio Operator's station (figure 4-7), provides facilities for presetting 20 of the 44,000 available frequencies, and for permitting complete control and operation of the equipment. The settings on the switch that selects the mode of operation are: Amplitude Modulation Equivalent (AME), Single Sideband (SSB), Continuous Wave (CW) and Frequency Shift Keying (FSK). The number of the channel in use is visible through an illuminated window, together with the numbers of the preceding and succeeding channels. In the center of the panel are two covers, held closed by thumb screws, which enclose the drums on which the desired frequencies are preset. A matte-surfaced plastic sheet for recording the preset channels is mounted on the top cover. Illumination is provided by installing four panel lights through a brilliance control.

There are no provisions for manual tuning. CW operation is possible when a keying adapter is available. Audio input or output for the equipment is obtained through the interphone system, utilizing the same headphones and microphone for reception and transmission as used for intercommunication in the aircraft.

LIGHTING EQUIPMENT.

All lights are wired to the 28-volt d-c power supply system through their respective circuit breakers and switches, except that, on some aircraft, the fluorescent lights use 26-volts a-c, supplied through a transformer, for power (figure 1-19).

EXTERIOR LIGHTING.

Navigation (Position) Lights and Switches

Navigation (position) lights are installed on the aircraft as follows: a green light on the right wing tip, a red light on the left wing tip, and a clear lens on the tail cone. Two navigation light switches are mounted on the electrical control panel (1, figure 1-13 and 24, figure 1-14). These are 3-position toggle switches, one with BRIGHT and DIM positions, the other with STEADY and FLASH positions. The center position of the switches is the OFF position. When the STEADY FLASH switch is placed on FLASH, the wing tip lights and tail cone light flash on and off. When the switch is in the STEADY position, the lights remain illuminated continuously. The BRIGHT-DIM switch controls the intensity of the lights when the FLASH-STEADY switch is in either position.

Formation Lights and Switch (R4D Series Aircraft).

Nine formation lights are installed on R4D series aircraft, three on top of the center fuselage and three on the top of each wing. The lights are controlled by a rheostat located on the electrical panel (10, figure 1-14). The switch has OFF and ON positions. It is OFF when rotated to the left, and the intensity increases as the switch is rotated 180 degrees to the right to the full ON position.

Anticollision Light and Switch

A red rotating beacon anticollision light is installed on top of the vertical stabilizer to minimize the possibility of inflight collision. The light is controlled by an ON-OFF switch located on the pilot's electrical control panel.

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NOTE

The rotating anticollision light should be turned OFF during flight through conditions of reduced visibility where the pilot could experience vertigo as a result of the rotating reflections of the light against the clouds. In addition, the light would be ineffective as an anticollision light during these conditions since it could not be observed by pilots of other aircraft.

Landing Lights and Switches.

One landing light is permanently installed in the leading edge of each outer wing panel. Two ON-OFF landing light switches (27, figure 1-13 and 25, 1-14) are installed on the electrical control panel for individual operation of the lights. The left landing light is adjusted to project a beam of approximately 430 feet, and the right landing light to project one of about 380 feet, when the aircraft is in 3-point ground position.

NOTE

There is no restriction on the use of the landing lights.

Aldis Lamp (Some Aircraft).

On some aircraft, an aldis lamp is provided in a holder located on the bulkhead behind the co-pilot's seat. The lamp may be plugged into the receptacle at the co-pilot's station when the light is required. The aldis lamp may be used to advantage during taxiing at night and during night flying to check for wing icing.

INTERIOR LIGHTING.

Instrument Lights and Switches.

The instrument lights consist of three dashlights controlled by the ON-OFF cockpit lights switch located on the electrical control panel (21, figure 1-13 and 6, figure 1-14). On some aircraft, Grimes instrument lights are installed. Illumination of the electrical control panels is controlled by the light rheostat (4, figure 1-13 and 4, figure 1-14) on the left electrical control panel. The compass light is controlled by the compass light rheostat (2, figures 1-13, and 1-14) located on the electrical control panel left of the instrument lights rheostat.

INSTRUMENT LIGHTS AND SWITCHES (Some Aircraft).

On some aircraft, a Grimes red lighting system is installed on the main instrument panel. The panel lights in the main instrument panel are controlled by three rheostats, one for the pilot's instrument panel, one for the center instrument panel and one for the co-pilot's instrument panel. The lights on the overhead radio panel are controlled by a rheostat on the command selector box and the lights in the electrical panel are controlled by a rheostat on the pilots overhead panel. The compass light is controlled by a rheostat in the electrical panel.

Fluorescent Lights and Switches.

On some aircraft, four fluorescent ultraviolet lights are installed, one on each side of the pilots' compartment and two on the control pedestal (6, figure 1-6 and 17, figure 1-7), and are used for the illumination of the instrument panel. Four rheostat-type switches (one for each light) are located immediately above the main instrument panel, two on the pilot's side and two on the co-pilot's side, and are used to turn the lights ON and adjust the brilliancy. The rheostats are placarded OFF, DIM, ON, and START. The switch must be positioned to START in order to put the lights in operation. The ON position provides the brightest illumination and, as the knob is turned past DIM toward OFF, the brilliancy is decreased. The OFF position turns the light OFF.

EXTENSION LIGHT AND SWITCH.

An extension light is installed on the bulkhead behind the co-pilot's seat. The light is operated and adjusted by a red knurled rheostat at the bottom of the light and a red momentary switch button on top and at the end of the light.

Navigator's Table Light and Switch.

The navigator's table light (3, figure 4-11 and 7, figure 4-12) is controlled by a switch mounted on a wooden support plate directly over the table. The switch is a toggle-type placarded WORK LIGHT.

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Dome Lights and Switches.

Nine dome lights are installed in the following locations; one in the forward passageway, one in the radio operator's compartment, one in the navigator's compartment, four in the main cabin, one in the lavatory, one in the tail compartment, and, on C-117 series aircraft, one at the steward's station. Except for the main cabin lights, each light is controlled by a switch mounted beside it. On C-47 and R4D series aircraft, the main cabin compartment dome lights are controlled by either of two switches located at each end of the main cabin compartment ceiling. On C-117 series aircraft, the main cabin dome lights are controlled by a switch at the steward's station. The navigator's dome light is controlled by a switch mounted on the navigator's dome light panel (1, figure 4-11 and 8, figure 4-12).

Passenger Warning Sign and Switches (Some Aircraft).

A passenger warning sign, located on the upper center of the main cabin forward bulkhead, when illuminated will read NO SMOKING - FASTEN SAFETY BELT. The control switches for operation of the warning sign are located on the electrical control panel in the cockpit.

AUTOPILOT.

The type A-3 or A-3A-1 autopilot is a gyroscopically controlled, hydraulically actuated system which automatically operates the flight control cable systems to maintain a desired magnetic heading and a normal stabilized attitude. An autopilot control panel (figure 4-10), installed in the center of the main instrument panel, contains controls necessary for actuation of the autopilot in maneuvering and trimming the aircraft. Bypass valves in the servo units are operated by the autopilot control valve handle on the control pedestal. Relief valves in each servo unit permit overpowering of the autopilot control in the event of an emergency by limiting the oil pressure in each servo cylinder.

CAUTION

The autopilot shall be engaged or disengaged with the flight control systems only when the aircraft is in a level flight attitude:

AUTOPILOT CONTROL VALVE HANDLE.

A manually operated autopilot control valve handle (10, figure 1-10), mounted on the aft lower face of the control pedestal, has ON and OFF positions. When the handle is placed in the ON position, a bypass valve in each servo unit is mechanically closed, and hydraulic

fluid pressure enters the servo cylinders to actuate the autopilot system. Placing the handle in the OFF position opens the bypass valve in the servo unit and permits the hydraulic fluid to bypass the servo cylinders and return to the hydraulic reservoir.

CAUTION

Trimming the aircraft shall not be accomplished with the autopilot engaged since undue loads will be imposed on the autopilot system.

AUTOPILOT EMERGENCY SHUTOFF VALVE HANDLE.

A manually operated autopilot emergency shutoff valve handle (5, figure 1-24) mounted on the hydraulic control panel has ON and OFF positions. The handle is safetywired in the ON position for normal autopilot operation. When the handle is placed in the OFF position, a shutoff valve installed in the hydraulic fluid pressure line is mechanically closed to divert the flow of oil from the autopilot system in case of damage to the oil lines resulting in fluid loss.

ELEVATOR CONTROL KNOB.

The elevator control knob, located on the autopilot control panel (figure 4-10), controls the aircraft in pitch attitude. Rotating the knob counterclockwise results in a nose-up attitude; rotating the knob clockwise produces a nose-down attitude.

RUDDER CONTROL KNOB.

The rudder control knob, located on the autopilot control panel (figure 4-10), controls the aircraft about the vertical axis. Rotating the knob clockwise produces a right turn; rotating the knob counterclockwise results in a left turn.

AILERON CONTROL KNOB.

The aileron control knob, located on the autopilot control panel (figure 4-10), controls the aircraft about the roll axis. Turning the control knob toward the high wing will bring the aircraft to a level attitude.

AUTOPILOT INDICATORS.

A vacuum-operated gyro turn indicator and gyro bank-climb indicator is incorporated in the autopilot control panel (figure 4-10) to provide visual indication of the autopilot signal in each axis. If the needles diverge more than one pointer width from the respective index, an excessive out-of-trim condition exists and should be corrected.

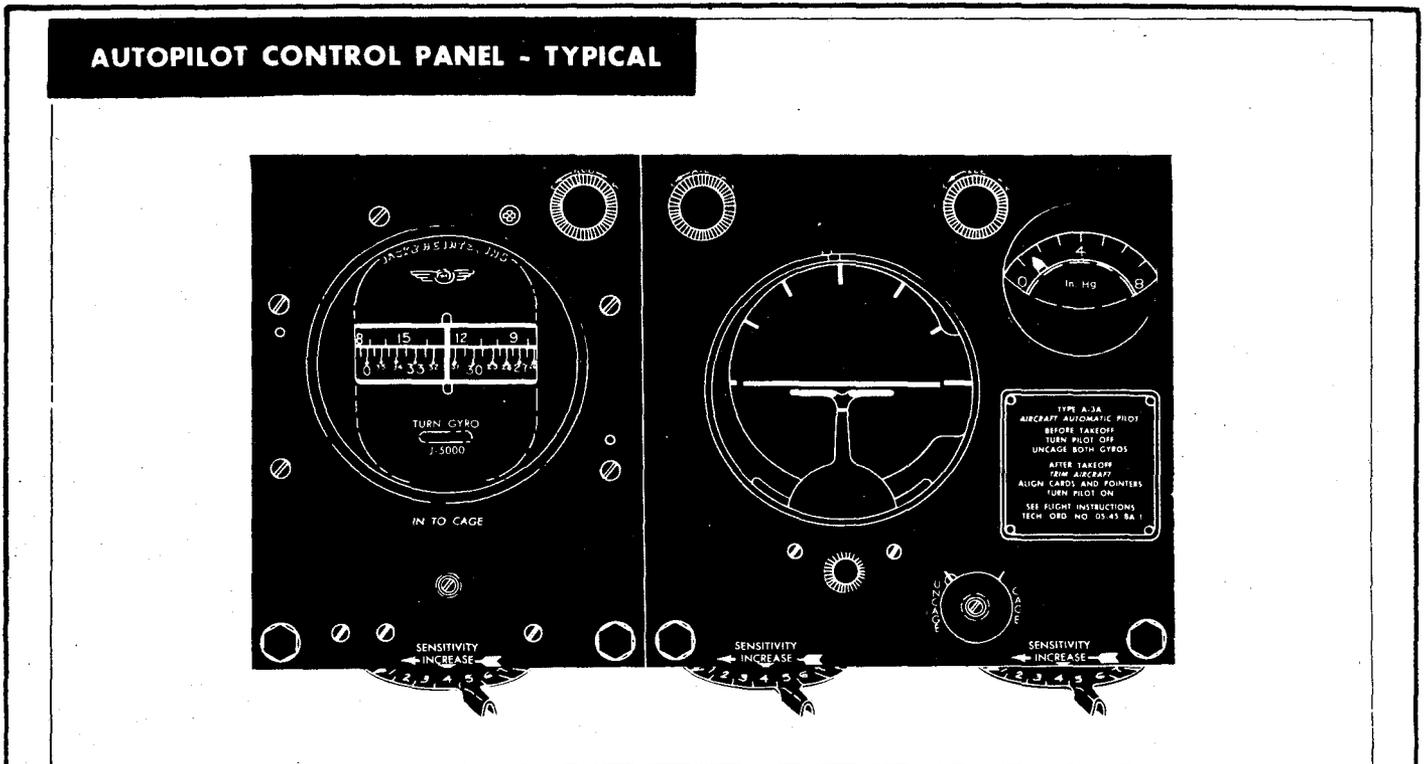


Figure 4-10

Vacuum Gage.

A direct-pressure-operated vacuum gage, installed on the autopilot control panel (figure 4-10), indicates the vacuum pressure of the vacuum system in inches of Hg. Vacuum pressure indication is taken directly from the vacuum manifold.

Autopilot Oil Pressure Gage.

A direct-pressure-operated autopilot oil pressure gage mounted on the right side of the main instrument panel (22, figure 1-11 and 24, figure 1-12), indicates the autopilot system oil pressure.

Caging Knobs.

Caging knobs for the autopilot gyro instruments are installed on the autopilot control panel (figure 4-10). The limit of the gyro turn unit is 55° from vertical in bank, glide, or climb. The limit of the bank-climb gyro unit is 50° from vertical in bank, climb, or glide. Any maneuver that exceeds these limits will result in gyro spill or tumble causing the instruments to give incorrect indications. Pushing the gyro turn caging knob to the IN position, and turning the bank-climb caging knob clockwise to the CAGE position will mechanically set the gyro gimbal rings of each unit in their proper positions. After resetting the gyro units

for proper heading and indication, the gyro turn caging knob may be pulled to full OUT, and the bank-climb caging knob may be turned counterclockwise to the UNCAGE position for gyro operation of both units.

NOTE

Instruments should be uncaged at all times, except during maneuvers that exceed their operational limits.

Sensitivity Dials.

On aircraft with the A-3A-1 autopilot installed, three manually operated sensitivity dials, one for each flight control, are installed on the autopilot control panel (figure 4-10). Each dial has seven settings: 0 through 6. Moving the dials toward higher numbers stimulates quicker flight control response. The sensitivity dials mechanically control the amount of air flow through an air relay valve diaphragm chamber connected to a balanced oil valve that controls the flow of oil in each servo unit.

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Speed Control Valve Knobs.

On aircraft with the A-3 autopilot installed, three manually operated speed control valve knobs (32, figure 1-12), one for each flight control, are installed on the main instrument panel directly in front of the pilot's station. Each control knob has an indicator dial with seven settings: 0 through 6. Rotating the dials toward higher numbers stimulates quicker flight control response. The speed control valve knobs mechanically control the flow of oil from the servo cylinders to the hydraulic reservoir.

AUTOPILOT OPERATION.

Preflight Ground Test.

To perform an autopilot preflight ground test, proceed as follows:

1. Autopilot emergency shutoff valve handle - Safetied ON.
2. Fluid level in hydraulic reservoir - Check sight gage.
3. Autopilot control valve handle - OFF.
4. Operate engines at approximately 1000 rpm.
5. Autopilot vacuum gage - Within limits.
6. Autopilot oil pressure gage - Within limits.
7. Uncage the bank-climb gyro unit.
8. Set the gyro turn unit to desired heading and uncage.
9. Flight controls - Neutral.
10. Set the rudder followup card to match the gyro turn card, set the aileron followup index to match the bank index, and set the elevator followup index to match the elevator alignment index.
11. On the type A-3A-1 autopilot, set each sensitivity dial to position 3. On the type A-3 autopilot, open each speed control valve knob to position 6.
12. Autopilot control valve handle - ON.
13. Check autopilot operation by turning each trimmer control knob.
14. Check the manual override by operating the flight controls against the autopilot.

NOTE

If the flight controls are moved too far from the automatic control position when overpowering the A-3A-1 autopilot, they will not return automatically when released, because the indexes of the autopilot gyro instruments will be moved out of alignment, and the signal response from the flight control surfaces to the autopilot followup cable system will be disrupted. Disengage the autopilot, align the indexes, and reengage the autopilot.

15. Auto - pilot emergency shutoff handle - OFF.

During Flight.

To operate the autopilot during flight, proceed as follows:

1. Trim the aircraft to fly "hands off."
2. Auto-pilot emergency shutoff handle - ON.
3. Select the desired aircraft heading and align the followup cards and indexes on the control panel.
4. Sensitivity dials or speed control valve knobs - Set (as desired).
5. Autopilot control valve handle - ON.
6. Trim the aircraft in the axis indicated by the gyro indexes with the autopilot in operation.

To turn off the autopilot, place the autopilot control valve handle in the OFF position and the autopilot emergency shutoff handle - OFF.

NAVIGATION EQUIPMENT.

For instrument approach equipment, see Communication and Associated Electronic Equipment, this section.

For instrument approach procedures, see Section IX.

DRIFTMETER.

A type B-5 driftmeter (8, figure 4-11), installed on a wooden shelf located aft of the navigator's table, is used by the navigator to measure the angle of drift while in flight. On some aircraft, a type B-3 driftmeter is located aft of the navigator's table.

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ASTROCOMPASS.

Some aircraft, facilities for mounting an astrocompass are located directly under the astrodome.

FLUX GATE COMPASS.

The flux gate compass system consists of a flux gate transmitter and gyro caging motor, both installed in the right outer wing panel, a flux gate compass master indicator installed at the navigator's station (5, figure 4-11 and 4, figure 4-12), a repeater indicator in the main instrument panel (1, figure 1-11), and a C-1 compass signal amplifier installed in the radio rack. The compass system receives its a-c power from the a-c inverter that is installed on the floor at the radio operator's station. The master indicator provides compensated compass readings by means of a direct-reading, 360-degree dial. The dial shows the four cardinal headings as well as intermediary headings which are marked every 5 degrees and numbered every 30 degrees. The small window on the upper face of the instrument shows the magnetic heading uncorrected for variation. The master indicator actuates the repeater indicator on the main instrument panel.

CARGO LOADING EQUIPMENT (C-47 AND R4D SERIES AIRCRAFT).

The aircraft is equipped to handle diversified types of cargo in the main cabin (*figure 4-14*). Fittings are provided for carrying external load items. Loading of the aircraft is accomplished through the double cargo loading doors, with a snatch block and idler pulley, a small and large platform, and a set of loading ramps.

WARNING

If possible, all personnel carried in the main cabin shall be located aft of the cargo.

For detailed information concerning cargo loading and dimensional limitations, refer to the applicable handbook of maintenance instructions.

TIE-DOWN FITTINGS AND RINGS.

Tie-down rings, installed along the sides of the main cabin compartment, are used for securing cargo, with fittings stowed in the miscellaneous stowage bag (8, *figure 1-1*) on the main cabin compartment aft bulkhead.

CARGO DOORS.

Double cargo doors, divided in the center, are mounted on hinges that swing outward. The doors may be secured against the side of the fuselage, in the open position, to permit unobstructed cargo loading operations. The main cargo door incorporates a smaller door that is used as a paratroop exit in flight, and for personnel entrance and exit when the aircraft is on the ground. The cargo door is also equipped with an emergency release mechanism that pulls the hinge pins if it becomes necessary to jettison the door while the aircraft is in flight. The two cargo doors may be removed from their hinges, if necessary, when loading heavy equipment. On some aircraft, the rear cargo door hinges have been redesigned to permit the door to swing farther aft and make removal for cargo loading unnecessary.

Main Cargo Door Latch Handles.

Two external and two internal door handles are located at the aft end of the forward cargo door. The lower handle controls the upper and lower latches of the forward cargo door, and the upper handle controls the center latching mechanism between the forward and aft cargo doors.

Main Cargo Door Emergency Release Handle.

The main cargo door is equipped with an internal emergency release handle should it become necessary to remove the door. The emergency release handle, located just above the lower hinge of the forward door and attached to the forward door jamb, is painted yellow and must be pushed down to remove the door. The handle operates as a direct lever in pulling the hinge pins.

Main Cargo Door Paratroop Door Handles.

The main cargo door incorporates a paratroop exit door which may be opened for the exit of paratroops by turning the two handles located near the top of the forward cargo door and pulling inboard.

Aft Cargo Door Latch Handles.

The aft cargo door can be opened only from the interior of the aircraft by means of two latch handles, one located on top and one located on the lower forward end of the aft cargo door.

LOADING RAMPS.

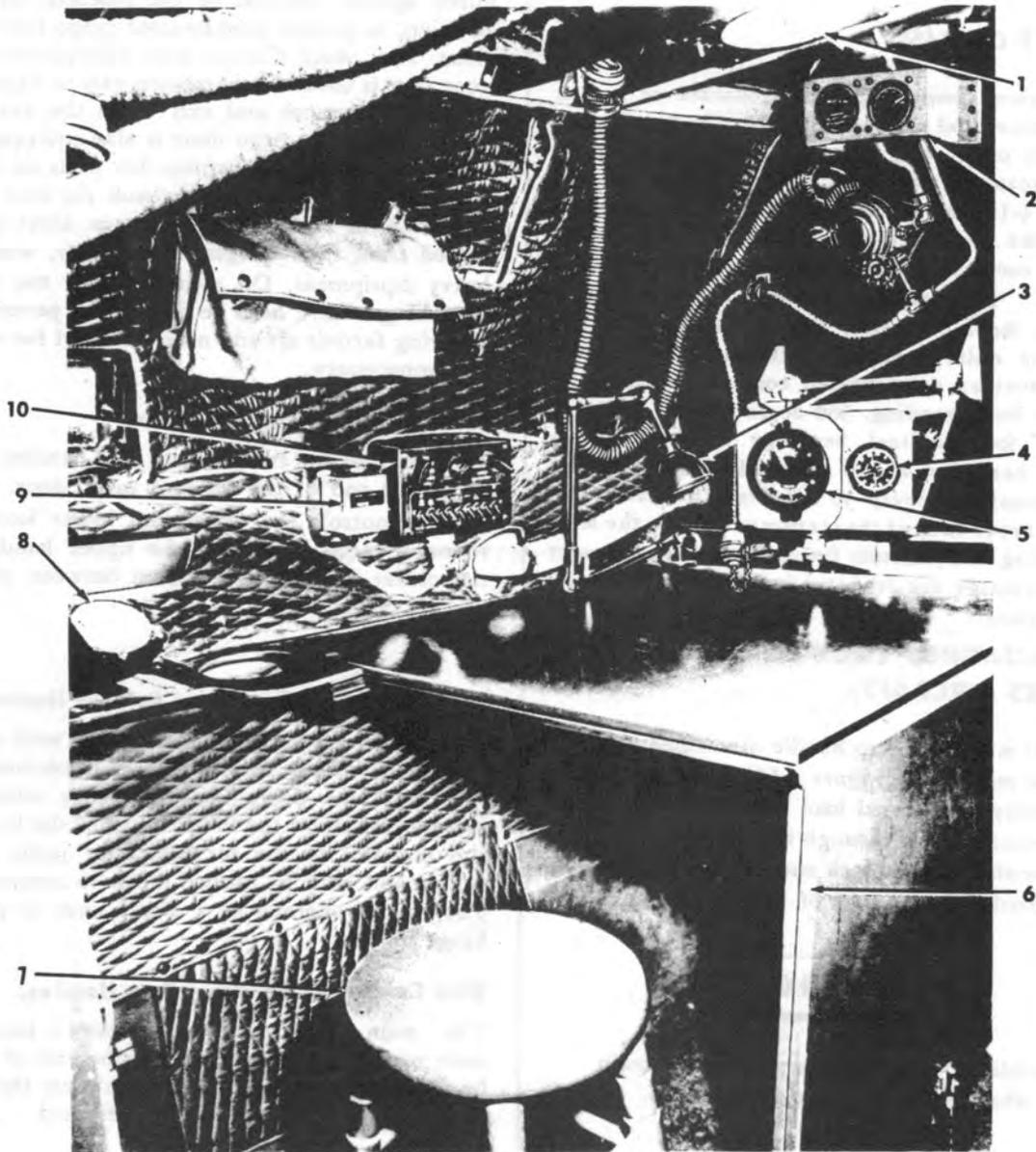
Holes for the attachment of loading ramps are provided in the sill of the main cargo loading doors.

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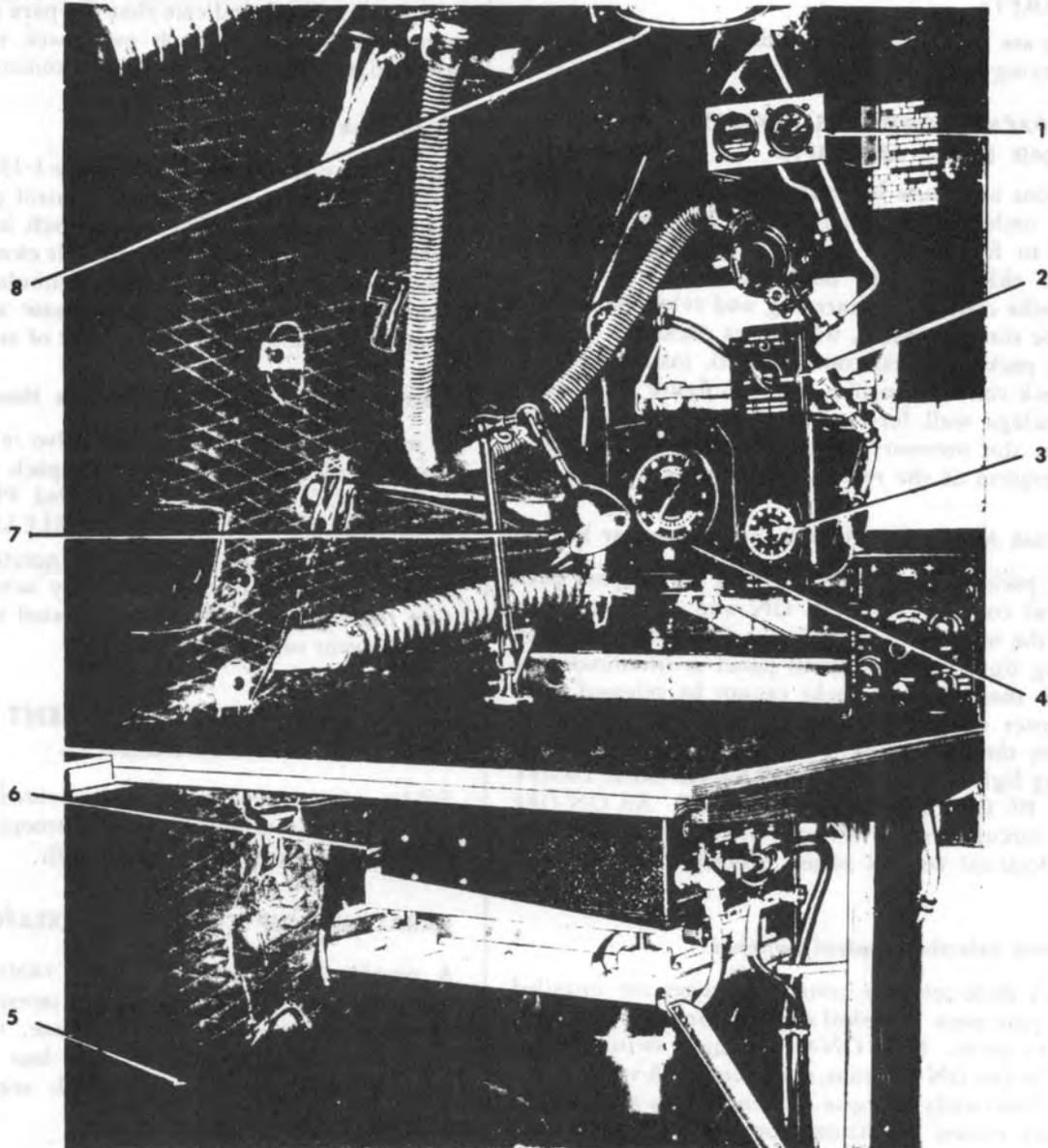
NAVIGATOR'S STATION—TYPICAL
C-47 SERIES AIRCRAFT



- | | |
|--|---------------------------------|
| 1. DOME LIGHT | 6. DROP LEAF TABLE |
| 2. OXYGEN FLOW PANEL | 7. NAVIGATOR'S STOOL |
| 3. TABLE WORK LAMP | 8. DRIFTMETER |
| 4. RADIO MAGNETIC INDICATOR | 9. RADIO FILTER |
| 5. FLUX GATE COMPASS
MASTER INDICATOR | 10. INTERPHONE CONTROL
PANEL |

Figure 4-11

NAVIGATOR'S STATION - TYPICAL
C-47 SERIES AIRCRAFT WITH AN/ARN-6 INSTALLED



1. OXYGEN FLOW PANEL

2. RADIO COMPASS SWITCH

3. RADIO MAGNETIC INDICATOR

4. FLUX GATE COMPASS MASTER INDICATOR

5. NAVIGATOR'S STOOL

6. R-101/ARN-6 COMPASS RECEIVER

7. TABLE WORK LAMP

8. DOME LIGHT

Figure 4-12

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CARGO CARRYING EQUIPMENT — EXTERIOR (C-47 AND R4D SERIES AIRCRAFT).

Fittings are installed on the underside of the fuselage for carrying two propellers.

PARA PACK PROVISIONS — EXTERIOR (C-47 AND R4D SERIES AIRCRAFT).

Provisions are made for carrying six para pack racks on the underside of the fuselage. The racks are attached to fittings that are installed flush with the fuselage skin. Standard bomb shackles in the para pack racks contain the carrying and releasing mechanism for the para packs, when para packs are carried. A para pack electrical control panel, installed on the para pack control junction box (13, *figure 1-1*) on the left fuselage wall forward of the main cargo doors, contains the necessary switches and indicator lights for operation of the release mechanisms.

Para Pack Master Switch and Circuit Breaker Switch.

A para pack master switch mounted on the para pack electrical control panel has ON and OFF positions. When the master switch is in the OFF position, a red warning light on the control panel is illuminated to indicate that the para packs cannot be released until the master switch is placed in the ON position to energize the 28-volt d-c para pack circuit. The red warning light is placarded **WARNING—RED LIGHT MUST BE OFF TO RELEASE PACKS**. An ON-OFF toggle circuit breaker switch, mounted on the para pack electrical control panel, protects the para pack circuit.

Para Pack Selective Control Switches.

Six para pack selective control switches are installed on the para pack electrical control panel for releasing the para packs. Each ON-OFF toggle switch, when placed in the ON position, completes a 28-volt d-c circuit to electrically energize a solenoid that actuates the electrical release mechanism on the respective para pack rack. Any para pack or combination of para packs may be released by actuating the selected toggle switch.

Para Pack Series Release Switch.

A para pack button-type release switch is connected to the para pack electrical control panel by a 2-foot length of flexible cable. Each time the switch button is depressed, a 28-volt d-c circuit is closed and the para pack release mechanisms are electrically actuated through individual solenoids to drop the para packs in the following sequence: (1) right aft, (2) left aft, (3) right center, (4) left center, (5) right forward, and (6) left forward.

Indicator Lights.

Six green 28-volt d-c indicator lights, installed above the selective control switches on the para pack electrical control panel, indicate that the para pack electrical circuit is armed. As each para pack is released, its respective indicator light will automatically go out.

Para Pack Salvo Switch.

A para pack salvo switch (23, *figure 1-13* and 29, *figure 1-14*), located on the electrical control panel, has ON and OFF positions. When the switch is placed in the ON position, a 28-volt d-c circuit is closed and the six para pack electrical solenoids are simultaneously energized, allowing the electrical release mechanisms to drop all six para packs in the event of an emergency.

Para Pack Manual Salvo Release Handle.

A manually operated para pack salvo release handle is installed directly below the para pack electrical control panel. The handle is placarded **PULL UP FOR PARACHUTE PACK SALVO RELEASE**. When the handle is pulled to the full out position, a manual release mechanism is mechanically actuated, permitting the six para packs to be released simultaneously in the event of electrical failure.

TROOP CARRYING EQUIPMENT (C-47 AND R4D SERIES AIRCRAFT).

Folding bench-type seats are provided in the main cabin for the seating of 27 or 28 troops (*figure 4-14*). Each seat is fitted with a safety belt.

PARACHUTE RIP CORD CABLE (STATIC LINE).

A parachute rip cord anchorage cable is installed along the top of the main cabin interior to the left of the centerline. When not in use, the cable may be stowed by snapping it into four spring clips, located directly above it, which are provided for that purpose.

PARACHUTE TROOP EXIT PANEL.

On some aircraft, the inside panel of the forward half of the main cargo door is removable inward by turning the handles near the top of the door and lifting it out. This is used as the exit for parachute troops. Four hooks and bungee rings, installed on the right side of the fuselage opposite the main cargo loading door, are provided for stowing the panel while using the exit. The door is stowed by holding it against the side of the fuselage and hooking the bungees over it to secure it to the side.

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WINDSHIELD WIPERS.

A windshield wiper system is provided for the two forward windshields. The windshield wipers are hydraulically operated and controlled by two needle-type control valve knobs, one for each windshield (1, figure 1-7), located in the vee of the windshield above the main instrument panel. To operate either wiper, slowly open the control valve until the desired speed of the wiper blade is obtained. During heavy rain, or if ice forms on the windshield, the windshield wipers may be operated in conjunction with the windshield de-icing system. See the paragraph on Windshield De-icing System, this section.

CAUTION

Do not operate the windshield wipers on dry windshields.

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SECTION V
OPERATING LIMITATIONS

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INTRODUCTION.

This section includes the engine and aircraft limitations that must be observed during normal operation. The instrument markings (figure 5-1), which form a part of these limitations, must be referred to, as they are not necessarily repeated in the text.

Company policy for C-47 operation has been determined to be in accordance with the Air Force TO-1C47-1 with certain exceptions. Where noted below the following items to Air Force T.O. are the company accepted exceptions. In all cases the Company Flight Manual of Operations may, or may not, reflect the figures given below. Action is being taken to correct the Flight Manual where discrepancies occur.

MINIMUM CREW REQUIREMENT.

The minimum crew for a flight is a pilot and a copilot. Additional crew members, as required, will be added.

INSTRUMENT LIMIT MARKINGS.

The limits marked on the aircraft instruments are shown in figure 5-1.

NOTE

The limitations marked on the instruments apply to flight conditions and are not intended to indicate ground operating limits.

ENGINE LIMITATIONS.

Refer to figure 5-1 for normal operating limits. Overspeed limitations on the engine are 2900 rpm for complete inspection and above 3050 rpm for replacement. Note all conditions of overspeed on aircraft log book.

ENGINE POWER TIME LIMITATIONS.

The engines are approved for 2 minutes of operation at maximum power during takeoff and climb at takeoff speed. There is no limitation in the use of METO power.

ENGINE (OVERBOOST OR) EXCESSIVE MANIFOLD PRESSURE.

Use of manifold pressures in excess of those specified under normal and alternate fuel grade operating limits, this section, is not permitted. If excessive manifold pressure is experienced, the following limits apply:

1. At or above METO power an excessive manifold pressure over 15 seconds duration requires engine removal.
2. At any power setting 10 or more inches Hg excessive manifold pressure required engine removal.
3. Below METO power 5 to 10 inches Hg excessive manifold pressure from 5 to 15 seconds duration required engine inspection.

ALTERNATE FUEL GRADE OPERATING LIMITS.

The alternate fuel grade is 115/145. Operating limits for 115/145 grade fuel are the same as those specified for 100/130 grade fuel.

ENGINE OIL PRESSURE LIMITS (GROUND OPERATION ONLY).

Oil pressures that are not within the following limits during ground operation should be noted on the aircraft log book.

Desired 80-90 psi at 2200 rpm 60°C oil inlet temperature.

Normal Operating Range:

RPM	MIN.	MAX.
2550-2700	80	110 psi
2000-2200	65	100 psi
1600-	55	90 psi
1400-	45	85 psi
Idle	15	psi min

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AIRSPED LIMITATIONS.

Item	26,000 Lb Gross Wt	29,000 Lb Gross Wt	31,000 Lb Gross Wt	33,000 Lb Gross Wt
Max level flight (indicated)	177 Knots (204 mph)	169 Knots (195 mph)	148 Knots (171 mph)	129 Knots (149 mph)
Max allowable	221 Knots (255 mph)	202 Knots (233 mph)	170 Knots (196 mph)	140 Knots (160 mph)
Max for extending landing gear (indicated)	140 Knots *(160 mph)			
Max for extending full wing flaps (indicated)	97 Knots *(112 mph)			
Max for extending ½ wing flaps (indicated)	100 Knots *(115 mph)			
Max for extending ¼ wing flaps (indicated)	104 Knots *(120 mph)			

*Not Affected By Gross Wt.

PROHIBITED MANEUVERS.

All acrobatic flight maneuvers are prohibited.

CENTER OF GRAVITY LIMITATIONS.

Gear down	Forward 11% MAC	Aft 28% MAC
Gear up	Forward 11% MAC	Aft 28% MAC

OPERATIONAL WEIGHT LIMITATIONS.

Weight, more than any other single factor, will determine the capability and performance of your aircraft. In designing an aircraft, weight has always been a primary restrictive factor as it has a direct effect on aircraft configuration, power, and range. Aircraft are designed with sufficient strength to accomplish a certain basic mission without undue allowance for overloading or improper weight distribution. Every effort is made to eliminate unnecessary weight; however, the weight penalty for making an aircraft foolproof is prohibitive. Weight limitations, therefore, are necessarily involved in the operation of the aircraft. If these limitations are exceeded, a loss in the performance of the aircraft is inevitable and structural failure is quite probable. When an aircraft is loaded beyond the established limits, ceiling and range are decreased, control forces and stalling speeds become higher, and the rate of climb falls off rapidly as the maximum gross weight is exceeded. The take-off and landing rolls increase appreciably with an increase in gross weight. Likewise, the braking power is insufficient for check-

ing the forward momentum of the aircraft and the wings are more vulnerable to airloads during maneuvers or flight through turbulent air. These effects can reach serious proportions when the weight limitations of a specific aircraft are disregarded. In cargo aircraft, particular attention must be paid to the weight problem. In order that cargo of various sizes may be accommodated, the cargo compartment is of such proportions that space is not usually a restrictive factor; consequently, overloading is entirely possible and weight limitations must be complied with if the aircraft is to be operated efficiently, economically, and safely. A consideration of the weight factors involved, particularly as they apply to this aircraft, appears in the succeeding paragraphs.

WEIGHT AND LOADS.

Due to the effect of gravity on the mass of your aircraft, the aircraft possesses weight. More exactly, this weight is a force which gravity exerts on the material used in the fabrication of the aircraft and which pulls the aircraft toward the earth. In any condition of static equilibrium during straight and level flight or at rest on the ground, the aircraft is subjected to this pull of gravity, the strength of which is spoken of as 1G. As fuel, cargo, passengers, crew members, and additional equipment are added in order that the aircraft may accomplish a specific mission, the additional weight constitutes a force acting on the aircraft structure. The weight of the aircraft, or the force that gravity imposes on the aircraft, may also be considered as a load. On the ground, this load must be sustained by the landing gear; in flight, by the wings. There is a limit to the load which the landing gear is capable of supporting during taxi, take-off, and landing operations; there is likewise a limit to the load which the wings can sustain in flight. During maneuvering and flight through turbulent air, additional loads are imposed on the aircraft. These loads, caused by the acceleration of the aircraft, are the result of forces which, in addition to that of gravity, act upon the total mass of the loaded aircraft. Both types of force tend to produce undesirable and potentially dangerous loads on the aircraft structure and its members. This is particularly true of the wings, which must sustain the aircraft in flight. When the weight of the aircraft is increased, the wings become more and more vulnerable to the loads imposed by sudden changes in air currents or manipulation of the controls. The ultimate strength of the aircraft structure is eventually exceeded by the combined forces of weight and airloads. When this condition occurs, structural failure results. Since the maximum weight which the aircraft can safely carry is dependent upon distribution of the weight throughout the aircraft and its capacity to sustain airloads in accelerated flight, an understanding of weight limitations is required to accomplish a mission successfully.

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LOAD FACTORS.

A load factor is the ratio of the load imposed on the aircraft when accelerated in any direction, as compared with the load imposed on the aircraft by gravity in any condition of static equilibrium. The load factor denotes the strength of the forces acting on the aircraft as a result of sudden changes in air currents and manipulation of the controls, and is expressed by the term G, which is the gravitational force. By definition, then, all aircraft at rest on the ground or in straight and level flight possess a load factor of 1G because the force acting upon the aircraft under either of these conditions is merely that of gravity. When the aircraft enters a region of turbulent air or the pilot elects to maneuver the aircraft, additional forces are imposed on the structure. The additional load on the wings resulting from these forces is expressed in relation to the gravitational force and is referred to as 0.5G, 2.0G, 3.0G, etc, which mean that the forces exerted on the wing structure and its members are .5, 2, or 3 times the force exerted by gravity. For example, if the normal weight of the aircraft is 25,000 pounds and the load factor at some given moment of accelerated flight is 3.0G, the total force which the wings must sustain is 75,000 pounds, or three times the normal weight of the aircraft in straight and level flight.

MARGIN OF SAFETY.

The margin of safety is the range of forces which exist between the load factor the aircraft is sustaining at any given moment and the load factor at which structural damage will occur. If, for example, the aircraft is incapable of sustaining a load factor greater than 3.0G, and during flight through turbulent air is subjected to a force of 1.5G, the margin of safety at this particular moment is 1.5G. When fuel and cargo loads are increased, the margin of safety decreases. This increase in weight actually becomes a component of the forces acting on the aircraft, and, as such, lessens the capacity of the aircraft to sustain further loads due to accelerated flight. For this reason, it is advisable in loading an aircraft to maintain a margin of safety that will never be exceeded during any period of flight.

WARNING

If the combined weight of cargo and fuel is such that the aircraft is incapable of sustaining a force of 3.0G, turns and pull-outs should be made with caution to minimize the resulting airloads.

EXPLANATION OF CHART.

The weight limitations chart (*figure 5-2*) is intended to present graphically the weight-carrying capabilities of the aircraft as defined by the various criteria which provide limits for safe and efficient operation. The chart will help the flight planner to recognize the weight limitations that will restrict operation in a specific mission and to determine what margin of safety may be established.

NOTE

Although the chart indicates the limitations involved in the loading of the aircraft, the authority for operating the aircraft at a given gross weight remains the responsibility of the local authority.

GROSS WEIGHTS.

The data in this chart is based on an initial operating weight of the aircraft exclusive of fuel and cargo. The zero point of the chart at the junction of the fuel and cargo load axes represents an operating weight of 20,000 pounds. Because individual operating weights may vary, it will be necessary to adjust the chart for the specific aircraft involved. The operating weight plus the fuel and cargo required in a mission can be shown by gross weight lines that slope at a 45-degree angle to the axis of the chart. These diagonal lines also indicate various structural and performance limitations. However, any gross weight line may be plotted to obtain a graphic representation of the limitations involved in the fuel-weight combination that a mission may require.

NOTE

The gross weight of the aircraft should never exceed that required for the mission, since unnecessary risk and wear of the equipment will otherwise result. Take-off gross weights must also be considered in the light of available runways, surrounding terrain, altitude, atmospheric conditions, and the requirements and urgency of the mission.

WING FUEL LOAD.

At the base of the chart along the horizontal axis, the weight of the fuel normally carried in the wing tanks is indicated in thousands of pounds.

INSTRUMENT MARKINGS



OIL TEMPERATURE

- █ 40°C Minimum
- █ 60°C To 80°C Normal
- █ 100°C Maximum



OIL PRESSURE

- █ 55 psi Minimum for flight (1700-2000 rpm)
- █ 65 to 110 psi Normal
- █ 110 psi Maximum
- 15 psi Minimum for idle
- 80 psi Minimum above 2500 rpm

**** NOTE:** An increase of up to 1.5 in. hg. is permitted for horsepower loss due to humidity.



MANIFOLD PRESSURE

- * █ 30.2 In. Hg 2050 RPM 600 BHP-AL Permitted
- █ 32.8 In. Hg 1900 RPM 600 BHP-AL Permitted
- █ 32.8-42.5 In. Hg-A.R. Reqd. 42.5 In. Hg or above A.R. Reqd. (5 Min Limit).
- █ 42.5 In. Hg-Meto Power
- ** █ 48 In. Hg-Maximum

* **NOTE:** For complete range of MP limits at various PRM settings, see Appendix, Part II.



TACHOMETER

- █ 1300 To 1700 RPM - Dangerous Empennage Vibration
- █ 1700 To 2050 Rpm - A.L. Permitted
- █ 2050 To 2550 Rpm - A.R. Reqd
- █ Above 2550 Rpm - 2 Min Limit A.R. Reqd
- █ 2550-Meto Power
- █ 2700 Rpm - Maximum



CARB AIR TEMPERATURE

- █ 10°C To 15°C - Possible Icing
- █ 15°C To 38°C - Normal
- █ 50°C - Detonation

NOTE: 38°C maximum with carb. heat.



CYL-HEAD TEMPERATURE

- █ 150°C - 232°C - A.L. Permitted
- █ 232°C To 270°C - A.R. Reqd
- █ 270°C - Maximum

NOTE: 232°C maximum for ground oper.

Figure 5-1 (Sheet 1 of 2)

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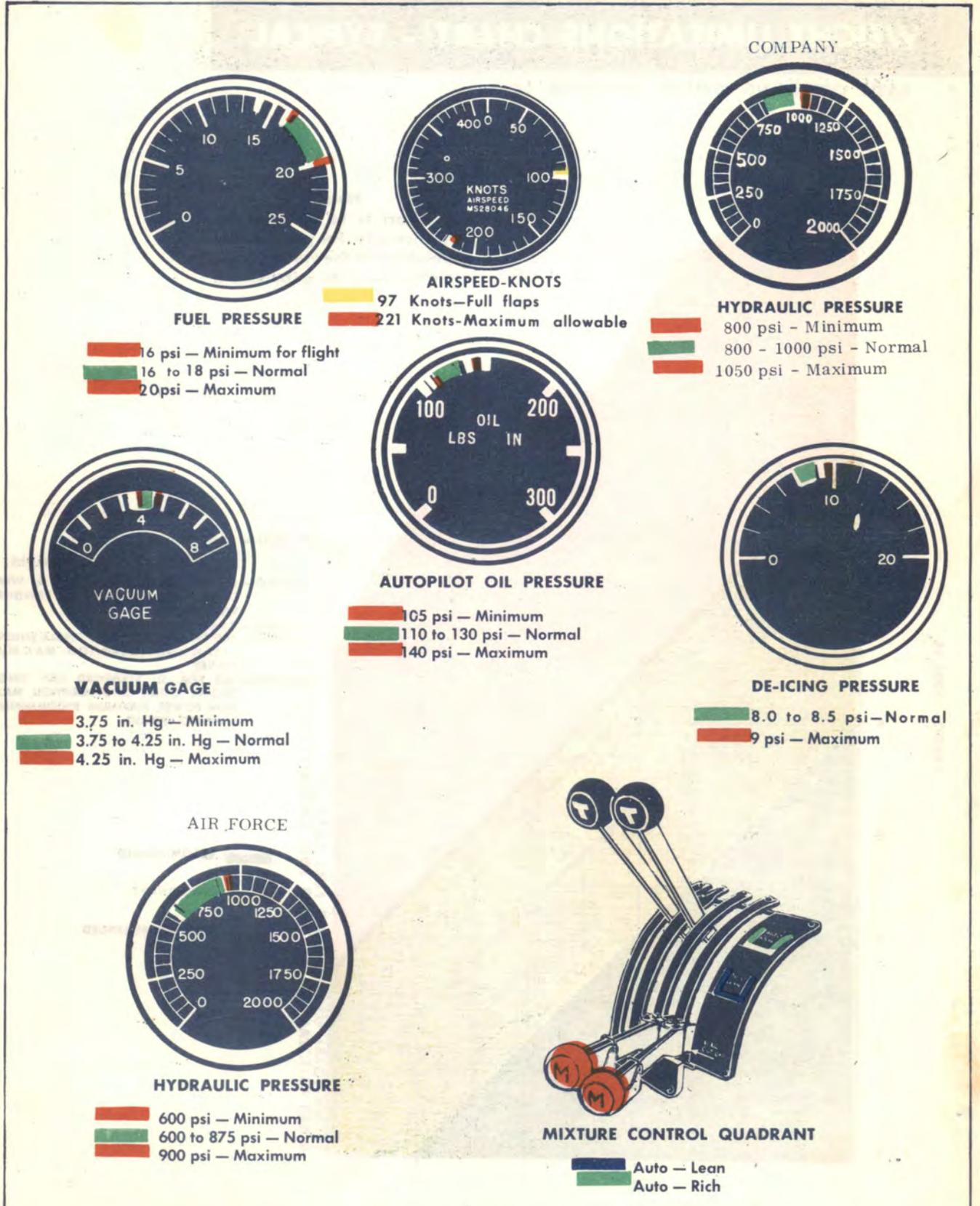


Figure 5-1 (Sheet 2 of 2)

WEIGHT LIMITATIONS CHART - TYPICAL

BASIC OPERATING WEIGHT OF 20,000 LB

Note
 This chart is to be used for reference only. For performance capabilities at the various gross weights, refer to appendix I.

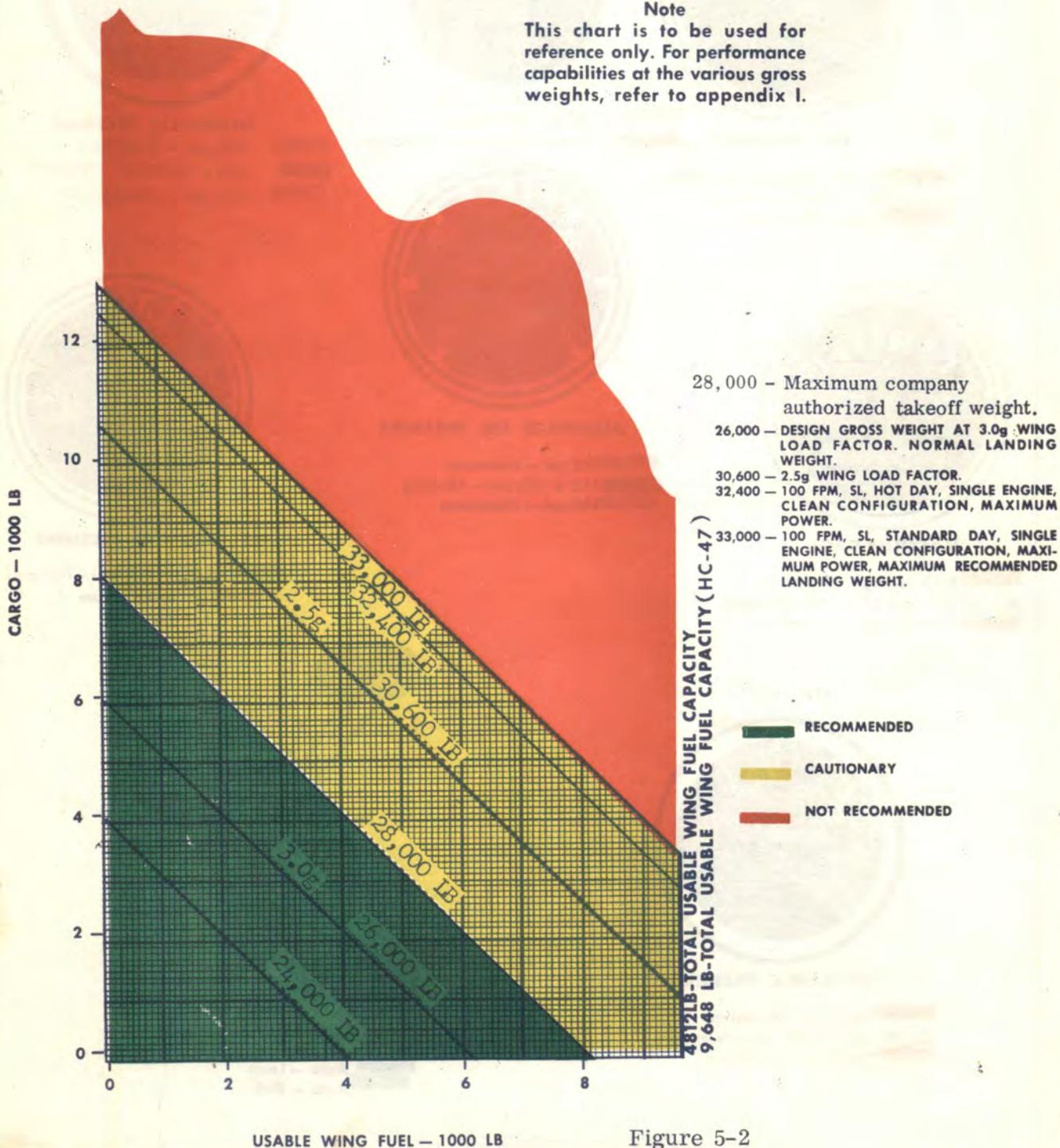


Figure 5-2

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LONG-RANGE FUEL LOAD.

When long-range fuel tanks are installed in the main cabin to increase the range of the aircraft or to transport fuel, the total weight of this fuel and the tanks should be computed as cargo load. By computing the fuel in the long-range tanks as cargo load, detailed chart work is eliminated, as are the individual calculations involved in adding the weight of the long-range fuel to the fuel load and the weight of the long-range tanks to the cargo load. Whenever long-range fuel is carried, a reduction in the cargo load is necessary to compensate for the weight of the long-range fuel and tanks.

CARGO LOAD.

In any mission, range and fuel consumption directly determine the fuel that must be carried, and indirectly the cargo that can be transported. With the necessary fuel for the mission established, cargo loading is variable within the limits established by the strength and performance of the aircraft. The payload, as carried in the cargo compartment, appears in thousands of pounds along the vertical axis of the chart. When long-range fuel is utilized to increase the range of the aircraft, the combined weight of the fuel and tanks should be computed as cargo load.

WING LOAD FACTORS.

The loads which the wing will sustain under different weight conditions are represented by the wing load factor lines on the chart. Under most loading conditions, which are normally limited by single-engine performance, the margin of safety provided by the wing load factors is very small. However, when flight through turbulent air is anticipated, the highest practical wing load factor is desirable.

SPEED.

The loads on the wing increase as the gross weight increases. This effect may be largely nullified by a reduction in speed. Refer to the paragraph on Airspeed Limitations, this section, for recommended speeds at various gross weights.

LANDING GEAR LIMITATIONS.

The landing gear structure is designed for landing during routine operation at a gross weight of 26,000 pounds at a maximum contact sinking speed of 9 fps limit. This is the maximum recommended landing weight for normal operation. The maximum recommended landing weight under emergency conditions is 33,000 pounds. This weight is based on the fact that the landing gear fittings become critical at this weight

when landing in the tail down attitude. Therefore, when landing at weights in excess of 26,000 pounds, the tail down attitude should be avoided if at all possible. At a landing weight of 33,000 pounds, the brakes are good for 100 stops. The main wheels and tail wheel and tire become critical for strength at 33,000 pounds gross weight.

PERFORMANCE LIMITATIONS.

In the case of 2-engine aircraft, it is generally inherent that performance rather than structural limitations restricts the weight which the aircraft can carry. Obviously, the gross weight must necessarily be limited by the ability of the aircraft to take off within available runway length and clear any obstacles. But the primary consideration is the ability of the aircraft to fly with partial power. Single-engine performance, then, is the major restrictive factor in the loading of the aircraft. Note the gross weight lines on the chart, particularly those which separate the loading areas. Each of these lines defines a specific limitation and several of the lines are wholly performance limitations. These performance limitations are based on the gross weight at which an adequate rate of climb can be maintained under various conditions of power, temperature, and configuration.

POWER LOSS AND PERFORMANCE.

On this aircraft, the effect of an engine failure on performance is immediate. The loss of half the total thrust normally developed by both power plants and the asymmetric power condition that results produce a marked decrease in the rate of climb. The significance of gross weight and configuration immediately becomes apparent, for the aircraft with partial power is unable to maintain an adequate rate of climb at gross weights above 33,000 pounds, or in a configuration where the landing gear and wing flaps are extended. Power losses due to temperature, humidity, and engine deficiency exert a considerable influence on the rate of climb, even when both engines are operating. It is not difficult to visualize the effect which engine failure will produce on the rate of climb, but it is interesting to note the remarkable difference in aircraft performance resulting from a rise in temperature and a corresponding fall in air density. As the weight limitations chart illustrates, the difference between a standard day and a hot day requires a cargo adjustment of approximately 600 pounds. For purposes of standardization, the temperature of a standard day is 15°C (59°F) and that of a hot day, 38°C (100.4°F) at sea level. Naturally, variations of temperature and altitude within this range will give similarly graduated values in brake horsepower and rate of climb. The effect of humidity and engine deficiency on brake horsepower and, ulti-

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mately, on the gross weight at which the aircraft may be operated, has not been included in the weight limitations chart because there are so many variable conditions involved.

CONFIGURATION AND PERFORMANCE.

The configuration of the aircraft also imposes a penalty on performance. In other than clean configurations, the increase in drag produces a decrease in the rate-of-climb and requires a readjustment of the gross weight at which the aircraft may be operated. As with power losses, this condition is most critical at take-off when, of necessity, the landing gear is extended and the cowl flaps and oil cooler flaps are open. The drag created by a windmilling propeller and the extended landing gear during the take-off roll is such that no attempt to take off should be made unless the safe single-engine airspeed for the aircraft gross weight has been achieved.

RECOMMENDED LOADING AREA.

The green area on the chart represents the loading conditions that present no particular problem in regard to the strength or performance of the aircraft. Operation of the aircraft at weights outside this recommended loading area should be avoided unless the dictates of the mission require it. The green area is bounded by the 2.5G wing load factor line. No aircraft will be operated outside of green area without prior approval of DFD.

CAUTIONARY LOADING AREA.

The yellow area on the chart represents loadings of progressively increasing risk as the red area is approached. Caution must be exercised because single-engine performance at these gross weights is marginal, depending upon configuration, altitude, and ambient air temperature. This area is defined by the gross weight diagonal which indicates a rate of climb of 100 feet per minute at sea level on a standard day with one propeller feathered, gear and flaps up, and maximum power on the operative engine.

LOADING NOT RECOMMENDED.

The red area represents loadings which are not recommended because the margin of safety, from the standpoint of both performance and structural limitations, is something less than the most desirable or practical. Under conditions of extreme emergency when safety of flight is of secondary importance, DFD will determine whether the degree of risk warrants operation of the aircraft at gross weights appearing in the red zone.

USE OF CHART.

A sample problem is presented to illustrate the application of the chart.

1. Assume that a C-47 aircraft calls for a 10,500-pound payload and 3000 pounds of fuel. Starting with the operating weight of 20,000 pounds at "0," proceed along the vertical axis to 10,500 pounds; this increases the gross weight to 30,500 pounds. Next proceed along the horizontal axis to 3000 pounds and project a line vertically to intersect the horizontal projection of the 10,500 pound line. By interpolation, the intersection will indicate a gross weight of 33,500 pounds. This value is above the maximum recommended gross weight, and in order to keep within the cautionary envelope, the cargo or fuel must be reduced by 500 pounds.

2. Another example to demonstrate a problem where the operating weight of the aircraft is greater than that shown on the chart: assume an operating weight of 22,000 pounds instead of 20,000 pounds, or a difference of 2000 pounds. Using the same requirements as in the previous example and proceeding as before, the gross weight will be found to be 33,500 pounds by interpolation; but, to this value, 2000 pounds must be added to the cargo scale to correct the chart for the heavier aircraft. This increases the total gross weight to 35,500 pounds. This value is above the maximum recommended gross weight, and in order to keep within the cautionary envelope, the cargo or fuel must be reduced by 2500 pounds.

MANIFOLD PRESSURE CORRECTION FOR HUMIDITY.

Maximum manifold pressure under part throttle conditions may be increased up to 1.5 in. hg. to correct for reduction in air displaced by humidity. This has no harmful effect on the engine since the increased manifold pressure only returns mass air flow to the amount expected in dry air at standard temperature. Horsepower developed does not exceed engine rating as a result of this correction. Reference Psychometric Chart (Figure A1-8) Appendix Page A1-14.

NOTE

Overboosting is more serious than underboosting. The psychometric chart must be utilized to obtain an accurate correction, therefore, if accurate temperature and dew point information is not available, 48 in. hg. should not be exceeded for takeoff.

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C-47 MINIMUM EQUIPMENT GO NO-GO LIST

A. General

The following list contains listings of certain instruments and accessories which may be inoperative and still not reduce the safety of operation of the aircraft below minimum limits. This list should eliminate last minute delays if items may be "held over" to a station where both time and equipment will be more readily available.

B. Continuation of Flight With Inoperative and/or Defective Equipment

1. Main Maintenance Base

An aircraft will not be dispatched from the main or Sub-Base with inoperative or defective equipment or with any uncorrected Flight Log report that affects the air worthiness of any system required to meet the basic operating specifications approved by the Company. However, a flight may be dispatched for ferry or non-revenue flight from either base provided the defective or inoperative unit is repaired or replaced prior to origination of schedule or revenue flights.

2. Line Stations

An aircraft may be dispatched with inoperative or defective equipment provided that the units are within the limits prescribed in the appropriate Minimum Equipment List.

3. Minimum Requirements

a. The appropriate list will be used as a guide in determining the items of

serviceable flight equipment required under circumstances where all the normal complement of flight equipment is not operative. The final decision of whether to proceed with an unserviceable unit within the minimums as listed must be left to the discretion of the Captain of the flight.

b. After investigation of the Flight Log report, if a decision is made to continue the flight with a unit inoperative, it must be determined that the unit is rendered free from the possibility that further extension of the damage or defect could cause a fire hazard or a mechanical failure, either internally or to its drive, mounting connections, allied assembly or system which could endanger the safety of the aircraft in flight.

c. The inoperative or malfunctioning system must be adequately placarded at the appropriate control or gauge, and the control of an inoperative system must be saftied in the OFF or NEUTRAL position to prevent inadvertant operation. A log book entry, relative to the inoperative unit or system, must be made.

C. Minimum Operative Instruments, Communications, Navigation & Equipment.

1. The items listed are only those which may be defective at the departure of aircraft from an outlying station. Replacement or repair must be effected at the next base having the facilities to perform the work.

2. Any instrument, communication unit, navigational unit or any other equipment which is not listed below and is required by FAR or CCAR, as appropriate, must be complete and operational for continuation of flight.

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<u>ITEM</u>	<u>EQUIPMENT</u>	1. EQUIPMENT INSTALLED	2. MINIMUM EQUIPMENT REQUIRED FOR ALL FLIGHT CONDITIONS:
<u>I AIR CONDITIONING</u>			
1	Cockpit heater	1	Not required when inflight ambient temperature is + 10°C or above.
2	Cabin heater	1	Same as for cockpit heater above.
<u>II COMMUNICATION EQUIPMENT</u>			
1	HF transmitter/receiver	2	1 One HF may be inoperative if two are installed for flight outside local area.
2	VHF transmitter/receiver	2	1 One VHF may be inoperative if two are installed or one HF and UHF is operative.
3	UHF transmitter/receive (If installed)	1	Not required if one HF and one VHF is operative.
4	Interphone jack box	3	2 One may be inoperative.
5	Headset	3	2 One may be inoperative.
6	Microphone	3	2 One may be inoperative.
<u>III ELECTRICAL POWER</u>			
1	Inverter	2	1 One may be inoperative for day VFR operations.
2	AC voltmeter	1	1
3	Generator	2	1 One may be inoperative if it is removed and a pad installed.
NOTE: Monitor electrical load as necessary to prevent overloading the remaining operative generator.			
4	Battery	2	1

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C-47 GO NO-GO LIST

<u>ITEM</u>	<u>EQUIPMENT</u>	1. EQUIPMENT INSTALLED	
			2. MINIMUM EQUIPMENT REQUIRED FOR ALL FLIGHT CONDITIONS:
5	Ammeter (If Installed)	2	2 If no voltmeters
6	Voltmeter	2	2 If no ammeters
7	Generator warning lights	2	2 Not required if ammeters or voltmeters are operative.
	<u>IV EQUIPMENT FURNISHINGS</u>		
1	Safety belts		One for each person aboard.
2	First aid kit	1	1
3	Fire axe	1	1
	<u>V FIRE PROTECTION</u>		
1	Fire detection system including lights and bell		
	Engine	2	2
	Heater (If installed)	1	May be inoperative if heaters are not to be used.
2	Engine fire extinguisher system	2	2
3	Portable fire extinguisher	2	2
	<u>VI FLIGHT CONTROLS</u>		
1	Flap position indicator	1	May be inoperative if V_{fe} (97 KIAS) is observed for any flap operation.
	<u>VII FUEL SYSTEM</u>		
1	Booster pumps	2	2
2	Engine driven fuel pump	2	2
3	Cross-feed system (If installed)	1	1

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ITEM	<u>EQUIPMENT</u>	1. EQUIPMENT INSTALLED	
			2. MINIMUM EQUIPMENT REQUIRED FOR ALL FLIGHT CONDITIONS:
4	Firewall shut-off valves	2	2
5	Fuel quantity gauges	4	4 If at point of origin or no dip-stick available if all tanks are to be used. Gauges are only required on tanks to be used. Not required if away from point of origin and dip-stick is available for flight back to point of origin.
7	Fuel tanks	4	2 One required for each engine.
	<u>VIII HYDRAULIC POWER</u>		
1	Main accumulator	1	1
2	Hydraulic pumps		
	Engine driven	2	1 For one time flight to point of origin only. Any other flight, two are required.
	Hand pump	1	1
3	Hydraulic system pressure gauge	1	1
4	Landing gear down pressure gauge	1	1
5	Sight gauge	1	1
	<u>IX ICE AND RAIN PROTECTION</u>		
1	Surface de-icing system	1	Only required for flight in geographical icing regions.
2	Carburetor alcohol anti-icing system	1	Same as above.
3	Carburetor heat controls	2	2
4	Pitot heat	2	2 One may be inoperative in VFR. Required on the operative airspeed indicator.

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ITEM	<u>EQUIPMENT</u>	1. EQUIPMENT INSTALLED
5	Windshield wipers	2
6	Windshield anti-icing system	1
	<u>X INSTRUMENTS</u>	
1	Clock with sweep second hand	2
2	Free air temperature gauge	1
	<u>XI LANDING GEAR</u>	
1	Landing gear warning system	1
	<u>XII LIGHTS</u>	
1	Instrument lights	1
2	Position light system	1
3	Landing lights	2
4	Anti-collision light	1
5	Flasher unit	1
6	Passenger warning lights	2
	<u>XIII NAVIGATION</u>	
1	Altimeter	2

2. MINIMUM EQUIPMENT REQUIRED FOR ALL FLIGHT CONDITIONS:

- 2 Required for flight in precipitation in terminal areas.
- May be inoperative if icing conditions will not exist along the route of flight.
- 1 Not required for VFR if one crew member has a sweep second hand watch.
- Required for flight in geographical icing regions.
- 1
- For all night operations red and white lighting must be provided to clearly illuminate all instruments and controls.
- 1 May be inoperative for day operation.
- 1 One may be inoperative at night if returning to point of origin. Both may be inoperative for day operation.
- May be inoperative to next station where repairs can be made if all three position lights are operative in "flash" position.
- May be inoperative if anti-collision light is operative.
- May be inoperative if public address system and stewardess call box are working during passenger operations.
- 1 One may be inoperative for day VFR.

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ITEM	<u>EQUIPMENT</u>	1. EQUIPMENT INSTALLED	
			2. MINIMUM EQUIPMENT REQUIRED FOR ALL FLIGHT CONDITIONS:
2	Vertical velocity indicator	1	1
3	Airspeed indicator	2	1 One may be inoperative for day VFR.
4	Attitude indicator	2	1 One may be inoperative for day VFR.
5	Directional indicator	2	1 One may be inoperative for day VFR.
6	Magnetic compass with correction card.	1	1
7	Turn and bank indicator	1	1 One may be inoperative for day VFR.
8	ADF receivers	2	1 One may be inoperative if VOR system is operative. Only one required for day VFR.
9	VOR receiver (If Installed)	1	1 Not required if both ADF receivers are operative or for day VFR.
10	Flux gate compass	1	1 Not required if both directional indicators are operative.
	<u>XIV OXYGEN</u>		
1	Flight crew oxygen	0	0 Not installed in SEA.
2	Flight crew oxygen masks	0	0 Not installed in SEA.
	<u>XV VACUUM</u>		
1	Vacuum pumps	2	1 One may be inoperative for day VFR.
2	Vacuum gauge	2	1
	<u>XVI PROPELLER</u>		
1	Propeller governor and control	2	2
2	Propeller feathering pumps and motors	2	2
	<u>XVII POWER PLANT</u>		
1	Cowl flaps (If installed)		

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ITEM	<u>EQUIPMENT</u>	1. EQUIPMENT INSTALLED	
	<u>XVIII ENGINE FUEL AND CONTROL</u>		
1	Fuel pressure indicators	2	2
2	Fuel tank selector valves	2	2
	<u>XIX ENGINE INDICATING</u>		
1	Tachometer indicating systems	2	1 One may be inoperative provided the manifold pressure gauge is operating on affected engine.
2	Manifold pressure gauges	2	1 One may be inoperative provided the tachometer is operating on affected engine.
3	Cylinder head temperature gauges	2	1 One may be inoperative provided the oil temperature gauge is operating on affected engine.
4	Carburetor air temperature gauges	2	1 One may be inoperative. Use operative instruments for reference during carburetor icing conditions.
	<u>XX OIL</u>		
1	Oil temperature gauges	2	1 One may be inoperative provided oil pressure and cylinder head temperature gauges are operative on affected engine.
2	Oil pressure gauges	2	2
3	Oil temperature controls (If installed)	2	2
	<u>XXI STARTING</u>		
1	Starters		
	Direct drive	2	2
	Energize/engage type	2	Engaging mechanism can be inoperative if starters can be engaged manually for flight to point of mechanical repair.

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SECTION VI
FLIGHT CHARACTERISTICS

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GENERAL.

The flight characteristics are normal for a twin-engine transport aircraft. The aircraft is very stable around all axes and is easily trimmed to fly *hands off*. Very minor trim changes are required to maintain the desired aircraft attitude. Control forces required for maneuvering throughout the speed range are normal. Rudder and aileron control is excellent and elevator forces are normal at high and low airspeeds.

STALLS.

The power-off stalling characteristics for this aircraft are normal. Stall warning comes in the form of a comparatively mild buffeting of the horizontal stabilizer. Stalling speed increases with the degree of bank and increase in gross weight, as shown in figure 6-1. The ailerons are effective up to the point of stall. No violent rolling action either precedes or accompanies the power-off stall under any flap setting. However, as in the case of most multi-engine aircraft, stall encountered with power on will probably cause violent rolling movements. The extended landing gear has no appreciable effect on the stalling characteristics. Recovery from a stall is normal and should be made by nosing the aircraft down and applying power. Apply power smoothly and avoid an abrupt pull-out.

PRACTICE APPROACH TO STALLS.

Practice approach to stalls at a safe altitude, applying the principles discussed in the above paragraph. Minimum altitude for practicing approach to stalls is 5000 feet above the terrain.

SPINS.

Intentional spins are prohibited. However, in case a spin is entered into accidentally, use normal spin recovery procedure to regain level flight. If the normal spin recovery procedure does not stop the spin, a *blast of power* on the inside engine may expedite the recovery. This is not a normal procedure, however, since the thrust from the blast of power may increase airspeed beyond the maximum design structure limits.

DIVING.

Placarded airspeed should not be exceeded in a dive. Recovery from a dive should be accomplished smoothly, and abrupt pull-outs avoided.

APPROXIMATE STALLING SPEEDS - POWER OFF

MPH AND KNOTS IAS

Note: The extended landing gear has no appreciable effect on the stalling characteristics.

GROSS WEIGHT (POUNDS)	0 FLAP						1/4 FLAPS					
	LEVEL KNOTS	FLIGHT MPH	30 DEG KNOTS	BANK MPH	45 DEG KNOTS	BANK MPH	LEVEL KNOTS	FLIGHT MPH	30 DEG KNOTS	BANK MPH	45 DEG KNOTS	BANK MPH
33,000	76	88	82	95	91	105	71	82	77	89	86	99
31,000	73	85	79	91	88	101	69	79	75	86	83	96
29,000	71	81	76	88	85	98	67	77	72	83	80	92
27,000	68	78	73	84	82	94	64	74	69	80	77	89
25,000	65	75	70	81	78	90	62	71	66	77	74	85
23,000	62	72	67	77	75	86	59	68	63	73	71	82
21,000	59	68	64	74	71	82	56	64	60	70	68	78

GROSS WEIGHT (POUNDS)	1/2 FLAPS						FULL FLAPS					
	LEVEL KNOTS	FLIGHT MPH	30 DEG KNOTS	BANK MPH	45 DEG KNOTS	BANK MPH	LEVEL KNOTS	FLIGHT MPH	30 DEG KNOTS	BANK MPH	45 DEG KNOTS	BANK MPH
33,000	68	78	73	83	81	92	65	75	70	81	79	90
31,000	65	75	70	81	78	89	63	72	68	78	76	87
29,000	63	72	68	78	75	86	61	70	66	76	73	84
27,000	61	70	65	75	72	83	59	67	63	73	70	81
25,000	58	67	62	72	69	79	56	65	60	70	68	78
23,000	55	64	60	69	66	76	53	62	58	69	64	74
21,000	53	61	57	65	63	72	51	59	55	63	61	71

Figure 6-1

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SECTION VII
SYSTEMS OPERATION

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CARBURETOR ICING.

Immediately prior to beginning the take-off roll, advance the throttles sufficiently to make carburetor heat available. Hold the control column full back to prevent nose over. Set the carburetor air controls to FULL HOT to obtain temperatures within the continuous operating range as indicated by the instrument markings. Maintain this temperature for the time required to insure complete removal of any ice previously formed in the induction systems. The increase in CAT. will be accompanied by a drop in MP of an inch or two. If an appreciable quantity of ice has formed in the vicinity of the throttle valve, the MP will increase an inch or so as the ice is removed. If no rise in MP is observed, either no throttle icing existed or the ice has not yet melted. The pilot will have to decide which circumstance exists. Turn the carburetor alcohol deicer switch ON (the carburetor deicing control valve handle must also be ON). Observe that a drop in CAT. occurs. When satisfied that no ice remains in the induction system, move the carburetor air controls to the full cold (RAM) position.

NOTE

Allow two minutes for carburetor stabilization prior to applying power for the take-off roll.

When the aircraft is airborne and power is reduced to climb settings, adjust the CAT as required to operate outside the probable carburetor icing range, as indicated by the instrument markings, and turn the carburetor deicing system OFF. A gradual loss of manifold pressure greater than that expected due to increase in altitude, without the throttles being moved, is an indication of carburetor icing. Apply carburetor deicing fluid as required until the ice has been eliminated, as indicated by recovery of the manifold pressure. Readjust the CAT to avoid further carburetor icing.

CAUTION

Conserve the carburetor alcohol supply for momentary use during flight, for use during landing, or for an emergency.

BACKFIRING.

To prevent backfiring during starting, movement of the mixture control from IDLE CUT-OFF to AUTO-RICH should occur slightly before ceasing to prime, in order to allow the carburetor to come up to operating pressures and start functioning in a normal manner. The transition should be smooth.

SPARK PLUG ANTI-FOULING PROCEDURES GENERAL.

Spark plug fouling is a principal cause of ignition trouble, which in turn is one of the most common engine maintenance and operating problems with aircraft engines using 100/130 or 115/145 grade fuel. These grades of fuel may contain a relatively high lead content, up to 4.6 cc per gallon. Such fouling might be defined as an accumulation of deposits which cause misfiring or prevent firing across the spark plug electrodes. The most common types of fouling are lead fouling and carbon fouling, with lead fouling the main trouble-maker. Cause, prevention, and cure of spark plug fouling are all linked to the chemistry and physics of the combustion cycle, which in turn are subject to wide variation under different ground and flight engine operating conditions. A logical treatment of the problem involves a separate discussion of each aspect of typical engine operation including ground running, takeoff, cruise, and descent. Prevention is the most profitable line of attack to the problem.

IMPORTANT FACTS.

Tetraethyl lead is the most important basic cause of lead fouling. Scavenger agents such as bromine in the tetraethyl lead are provided to combine with the lead during combustion, removing it with the exhaust gases. However, under certain conditions of temperature and pressure, the lead will condense out on the spark plug insulator as lead oxide or lead bromide. In the presence of excess carbon as a reducing agent, these may form metallic lead particles. All such deposits can prevent ignition or firing. Other pertinent factors which influence plug misfiring include the condition of the ignition system, spark plug characteristics and age, general engine conditioning including the care and handling of spark plugs, the operating requirements and characteristics of the particular engine installation, and the specific engine operation conditions. In general, spark plug fouling involves a buildup of deposits through prolonged operation under a fixed set of conditions. Prevention and remedy for plug fouling, therefore,

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depend on taking action to vary these conditions, upsets the chemistry of the fouling cycle, and restore good ignition.

IDLE MIXTURE CHECK.

Idle mixture adjustment is one of the most important factors to be considered in providing protection against fouled spark plugs. When performing a post-flight check, the pilot must check the idle mixture at minimum idle rpm and for a rise not to exceed 10 rpm. Too much emphasis cannot be placed on slow movement of the manual mixture lever during the check.

Best power mixture must be obtained and held for at least five seconds. Best power is when a maximum rise in rpm is noted. Any further movement past this point will cause a drop in rpm; therefore, the pilot should move the mixture lever slowly until he has obtained maximum rpm and the rpm has started to decrease. The mixture lever should then be moved very slowly back to the point where the maximum rpm rise was obtained. After ascertaining that the best power mixture has been obtained and maximum rpm rise has been noted, return the mixture control to the appropriate setting. If no rpm rise was noted when slowly moving the mixture lever toward IDLE CUT-OFF, the mixture is too lean. If a rise of more than 10 RPM or a drop in manifold pressure exceeding 1/4 inch Hg. is noted, the idle RPM fuel-air ratio is too rich and the mixture should be manually leaned to obtain best power or maximum RPM. This condition will be noted in Form 781. If the rpm rise was less than 10RPM the mixture control may be placed in either the AUTO LEAN or AUTO RICH position. This condition will be noted on log book. It must be remembered that cylinder head temperature has a direct bearing upon the results obtained; therefore, the pilot must have a cylinder head temperature between 160°C and 180°C when performing an idle mixture check. When the aircraft is at the home station and the idle mixture is found to be out of adjustment, it is recommended that corrective maintenance be performed prior to releasing the aircraft for flight. Idle mixture strength does change with altitude changes. Therefore, when an aircraft is operating away from its home station, the idle mixture could be too rich and cause fouling of the spark plugs. Naturally, this will be noted by the pilot when he performs the idle mixture check. This will not be cause for rejection of the aircraft, as the mixture will be correct when the aircraft is returned to the home station. In these cases, the pilot will manually lean the mixture for any extended periods of ground operation. The mixture will be manually leaned to obtain maximum rpm, which will be best power mixture. Further, a minimum of 150°C

cylinder head temperature should be maintained. The most critical fouling range for the R-1830 engine is between 900 and 1100 rpm.

SPARKPLUG CLEANOUT FOR GROUND OPERATION.

Whenever excessive rpm drop is noted during power and ignition check proceed as follows:

1. Propellers - FULL INCREASE.
2. Mixture - RICH.
3. Operate engine at Field Barometric Manifold Pressure until CHT reaches 180-200°C.
4. Advance power slowly to 5 inches above field barometric and hold for one minute.
5. Recheck ignition.
6. If spark plugs are not cleared after this procedure has been tried twice, corrective maintenance must be performed. During extended periods of ground idling it is recommended that mixtures be manually leaned to obtain maximum rpm. After each 10 minutes of ground operation at low rpm, the throttles shall be advanced slowly (3 to 5 seconds per 100 rpm) to a manifold pressure 5 inches above field barometric pressure. This power shall be held for one minute; however, maximum ground operating cylinder head temperature will not be exceeded.

NOTE

Another ignition check will be performed just prior to takeoff, when time since the last engine runup ignition check exceeds 10 minutes.

INFLIGHT PREVENTION.

A periodic change in engine conditions will usually prevent lead fouling during cruise. After each hour at cruise settings, one for the following procedures should be used to prevent fouling:

1. The use of auto-rich mixture for a two-minute period.
2. A change in power of 3 to 5 inches of manifold pressure or a change of 100 rpm. A reduction in the power level followed by an increase in the power level appears to the most effective approach to prevention of fouled spark plugs.

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INFLIGHT DEFOULING.

If spark plug fouling occurs in flight the rich-mixture method of prevention should be tried first. If this is not effective reduce manifold pressure slowly until plugs resume firing and maintain this power for approximately one minute. Slowly increase power, and repeat the previous process until all plugs have resumed firing and manifold pressure has been increased to the desired cruise setting.

CAUTION

Whenever appreciable power changes are made it is important to cushion the high inertia loads on the master rod bearings which occur under these conditions. As a rule of thumb, each 100 rpm requires at least 1 inch Hg manifold pressure (for example, 23 inches Hg at 2300 rpm). Operation at high rpm and low manifold pressure should be kept at a minimum.

CHANGING POWER CONDITIONS DURING FLIGHT.

The most economical engine operation at low power can be obtained by operating at low engine rpm and high manifold pressure up to the maximum bmep limit (see Appendix).

To prevent excessive cylinder pressures when changing power conditions, use the following procedure:

INCREASING POWER.

1. Mixture controls — At the proper setting for the desired power condition.
2. Propeller controls — Adjust to obtain the desired engine rpm.
3. Throttles — Adjust to obtain the desired manifold pressure.

REDUCING POWER.

1. Throttles — Adjust to obtain the desired manifold pressure.
2. Propeller controls — Adjust to obtain the desired engine rpm.
3. Throttles — Readjust as necessary.
4. Mixture controls — Adjust to the proper setting for the desired cruising condition.

CAUTION

When maneuvering with low power or during descent with low power, it is important to cushion the high inertia loads on the master rod bearings which occur at high rpm and low manifold pressure. As a rule of thumb, each 100 rpm requires at least 1 inch Hg manifold pressure. Use high rpm and low manifold pressure only when necessary.

FUEL SYSTEM MANAGEMENT.

FUEL TANK SELECTION.

When the engines are operated, the main fuel tanks or the auxiliary fuel tanks can be selected to supply fuel to a single engine or to both engines. During flight, the long-range fuel tanks (if installed) can be selected, through the shutoff valves at the front tanks, to supply fuel to either or both engines. The fuel tank selectors, used with fuel booster pumps, make selection from all tanks possible (figure 7-1).

NORMAL FUEL TANK PROCEDURE.

When running fuel tanks empty in flight, keep a close check on the fuel pressure gage. It is advisable to switch to another tank as soon as the fuel pressure begins to drop. If a tank is allowed to run dry to the extent that the engine slows down, the throttle should be moved toward the CLOSE position before the fuel tank selector is moved, in order to prevent the engine from overspeeding. All take-offs and landings should be made with the fuel tank selector set to the fullest (main or auxiliary) tanks.

CAUTION

Unless the fuel is required to complete the mission, it is advisable to select a new fuel supply before running a tank empty (approximately 20 gallons remaining) in order to prevent engine failure because of fuel starvation.

NOTE

It is very important upon reaching a cruising altitude that fuel be consumed from main tanks first and auxiliary tanks last. This procedure is necessary, since the majority of the return flow will be routed to the main tanks. This procedure will also permit using a minimum amount of elevator tab to trim the aircraft.

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SWITCHING FUEL TANKS

1. Place booster pump ON for desired engine.
2. Select desired fuel tank.
3. Turn booster pump OFF after assuring proper engine operation.

LONG-RANGE FUEL TANK OPERATION.

To prevent drawing air into the fuel supply lines, which will result in a fuel system air lock, take-off is not permitted with less than 25 gallons of fuel in each long-range tank.



Take-off is not permitted using fuel from the long-range fuel supply. The long-range shutoff valves must be turned OFF prior to take-off.

The long-range fuel tank shutoff valves (*figure 1-20*) will be turned to the OFF position in sufficient time to maintain a minimum of 25 gallons of fuel in each tank. Since the fuel booster pumps are installed downstream from the main, auxiliary, and long-range tanks, they have a tendency to pump air from the empty tanks or leaking valves; therefore, the fuselage tanks should not be permitted to run dry in flight unless the fuel is needed for emergency purposes.

NOTE

If the long-range fuel tanks run dry and the engines are allowed to slow down, move the throttles toward the CLOSE position before moving the right and the left fuel tank selectors from the OFF positions. This will prevent the engines from overspeeding. Turn ON the booster pumps until the engine runs smoothly.

In the event that air locks occur with the fuel boost pumps operating, the condition will in all probability be aggravated; however, a new fuel supply should be selected immediately. For long-range fuel tank operation, proceed as follows:

1. When cruising altitude has been reached, turn the long-range fuel shutoff valves ON.
2. Turn the right and left engine fuel tank selectors OFF.
3. When the fuel supply in the long-range fuel tanks becomes low, turn the left and right fuel tank selectors to the LEFT MAIN and the RIGHT MAIN positions respectively.
4. Turn the long-range fuel shutoff valves OFF.

CAUTION

Do not operate with both normal and long-range fuel systems on at the same time; turn OFF the long-range fuel system shutoff valves when operating on main or auxiliary tanks to prevent air locks. Do not climb at a steep angle when operating on the long-range fuel system and the fuel level is low in the tanks, since air locks will occur from fuel being trapped in the tanks.

FUEL SYSTEM MANAGEMENT.(HC-47 SERIES A/C)

FUEL TANK SELECTION.

Each engine is supplied independently by the tanks in the corresponding wing. The fuel may be supplied from the main tank, auxiliary tank or the outer wing tank but cannot be used from any tank to the opposite engine without using the cross-feed. It is advisable that both engines be operated from their respective wing tanks to maintain proper balance. Fuel management will vary with the mission to be flown, aircraft gross weight and distribution of the fuel load. When the normal fuel load is carried (204 gallons in each main tank, 50 in each auxiliary tank, and 200 gallons in each outer wing tank), the main tanks will be used for take-off, climb, and circumstances permitting, in cruise until 100 gallons remain in each main tank (*figure 7-1*).

CAUTION

Whenever possible maintain sufficient fuel in the main and auxiliary tanks to permit flight to an emergency landing field should the necessity arise to dump outer wing tank fuel.

When a mission requires more fuel than the normal fuel load, the outer wing tanks will be serviced to capacity before servicing the auxiliary wing tanks.

NORMAL FUEL TANK PROCEDURE.

Should it be necessary to completely exhaust fuel in the outer wing and auxiliary tanks in order to consolidate fuel available in the main tanks, use fuel from the outer wing and auxiliary tanks until 50 gallons remain in each tank. Next, use fuel from the outer wing tank until 20 gallons remain in each outer wing tank. At this time place one selector on the main tank and continue using fuel from the outer

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wing tank for one engine. Note the time and monitor the fuel pressure on the engine using fuel from the outer wing tank. When a drop in pressure is noted switch the selector to the main tank position. When fuel pressure is again normal note the time and place the other selector to outer wing tank position. Monitor the fuel pressure on the engine on the outer wing tank and when a drop in fuel pressure is noted turn the selector to the auxiliary tank position again noting the time. When fuel pressure is again normal place the other fuel tank selector to the auxiliary position and repeat this procedure with the main and auxiliary tanks, when the fuel level reaches 20 gallons in the auxiliary tanks. By checking time to run tanks dry an accurate fuel consumption rate can be determined.

CAUTION

Do not completely exhaust fuel in any tank at less than 1000 feet above the terrain except when necessary.

NOTE

If a tank is allowed to run dry to the extent the engine slows down, the throttle should be closed before the tank selector is moved in order to prevent the engine from overspeeding. Operate fuel booster pump until the engine runs smoothly.

SWITCHING FUEL TANKS

1. Place booster pump ON for desired engine.
2. Select desired fuel tank.
3. Turn booster pump OFF after assuring proper engine operation.

CROSSFEED SYSTEM.

The cross-feed system can be used to equalize the fuel load in each wing and in case of fuel system failure or damage. To use the cross-feed:

1. Select the tank from which fuel is to be used by both engines.
2. Turn the booster pump ON for the engine which is to receive fuel from the opposite side of the aircraft.
3. Turn the cross-feed valve ON, then return to NEUTRAL when the indicator light goes out.

NOTE

The cross-feed indicating light indicates when valve motor is energized in both opening and closing operation. The time lapse for either is one second.

4. Turn the fuel selector OFF for the engine which is to receive fuel from the opposite side of the aircraft.
5. Turn the booster pump OFF. When fuel has been consumed to the desired level:
 - a. Turn the booster pump ON for the engine which is receiving fuel from the opposite side of the aircraft.
 - b. Turn the fuel selector for the engine receiving fuel from the opposite side of the aircraft to the desired tank.
 - c. Turn the cross-feed valve OFF then return switch to NEUTRAL when the indicator light has gone out.
 - d. Turn the booster pump OFF.

FUEL DUMP.

The following procedure will be used to dump fuel from the outer wing tanks;

NOTE

Fuel dumping should be considered as an emergency procedure only, since the aircraft can be landed at weights up to 33,000 pounds if proper precautions are taken.

1. Select tanks other than outer wing tanks for engine operation.
2. Check the wing flaps UP.

CAUTION

Never dump fuel with flaps in DOWN position.

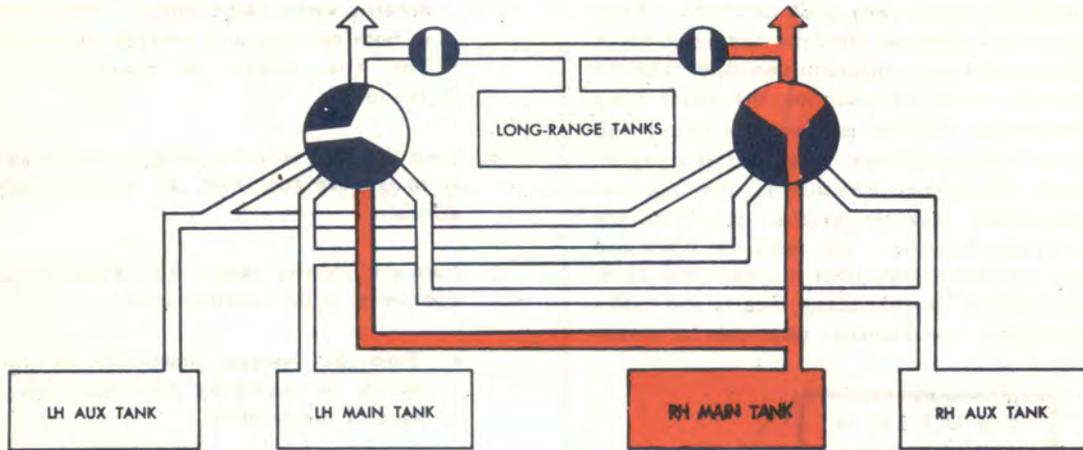
3. Reduce airspeed to 100 knots (115 mph).

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FUEL SYSTEM MANAGEMENT



BOOSTER PUMPS

LH

ON



OFF

RH

ON



OFF

LH ENGINE FUEL TANK SELECTOR



RH ENGINE FUEL TANK SELECTOR



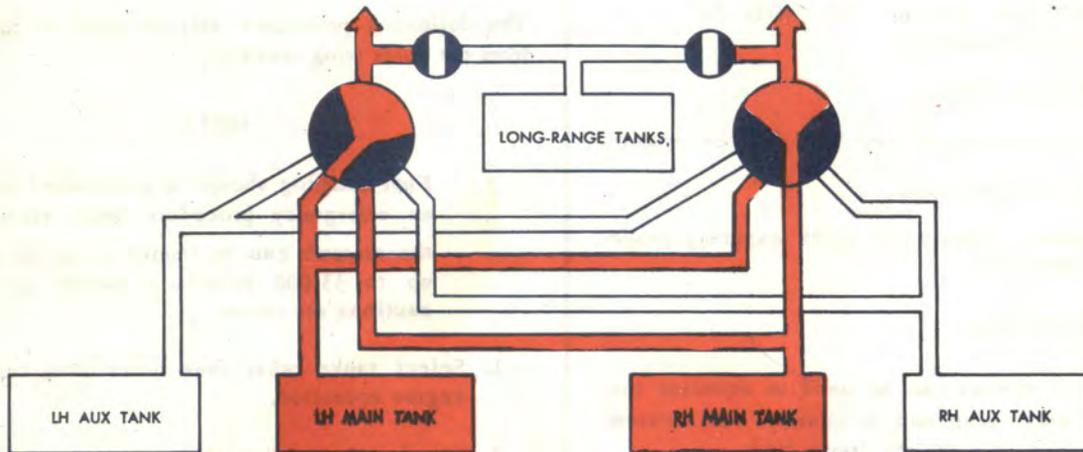
LONG-RANGE FUEL SHUTOFF HANDLE

ON



OFF

**NORMAL ENGINE STARTING OPERATION.
BOOSTER PUMP ON TO ENGINE BEING STARTED.**



BOOSTER PUMPS

LH

ON



OFF

RH

ON



OFF

LH ENGINE FUEL TANK SELECTOR



RH ENGINE FUEL TANK SELECTOR



LONG-RANGE FUEL SHUTOFF HANDLE

ON



OFF

Note:
OFF during
ground opera-
tion.

**TAKE-OFF, LANDING, AND GROUND OPERATION.
FULLEST TANKS TO RESPECTIVE ENGINES.**

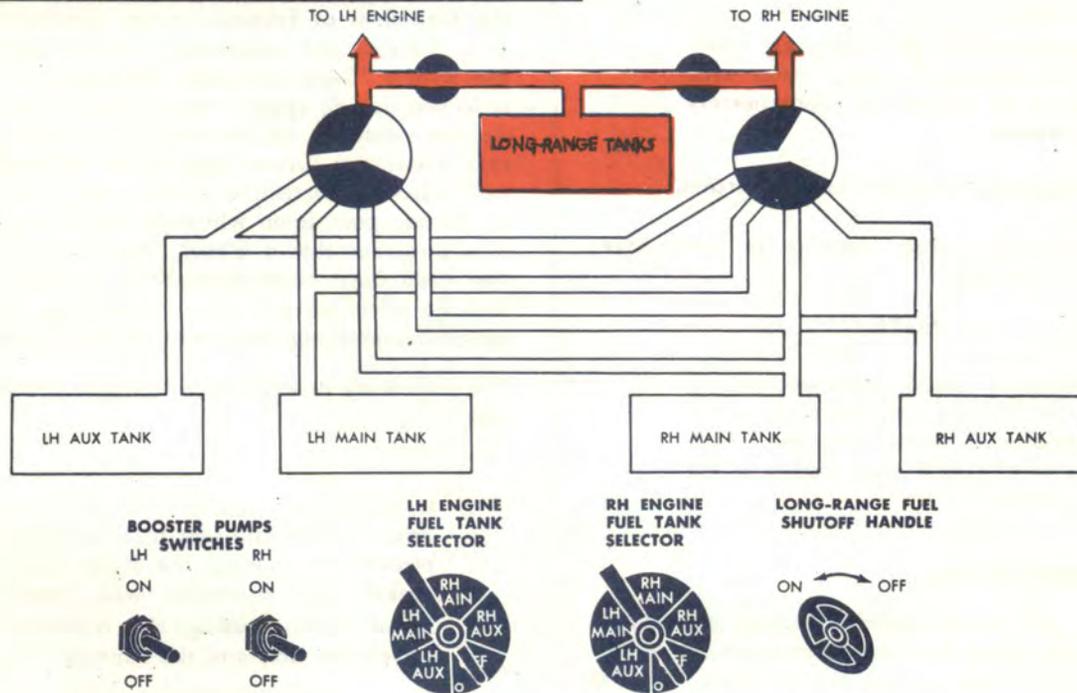
Note: If all tanks are full, use main tanks first.

Figure 7-1 (Sheet 1 of 2)

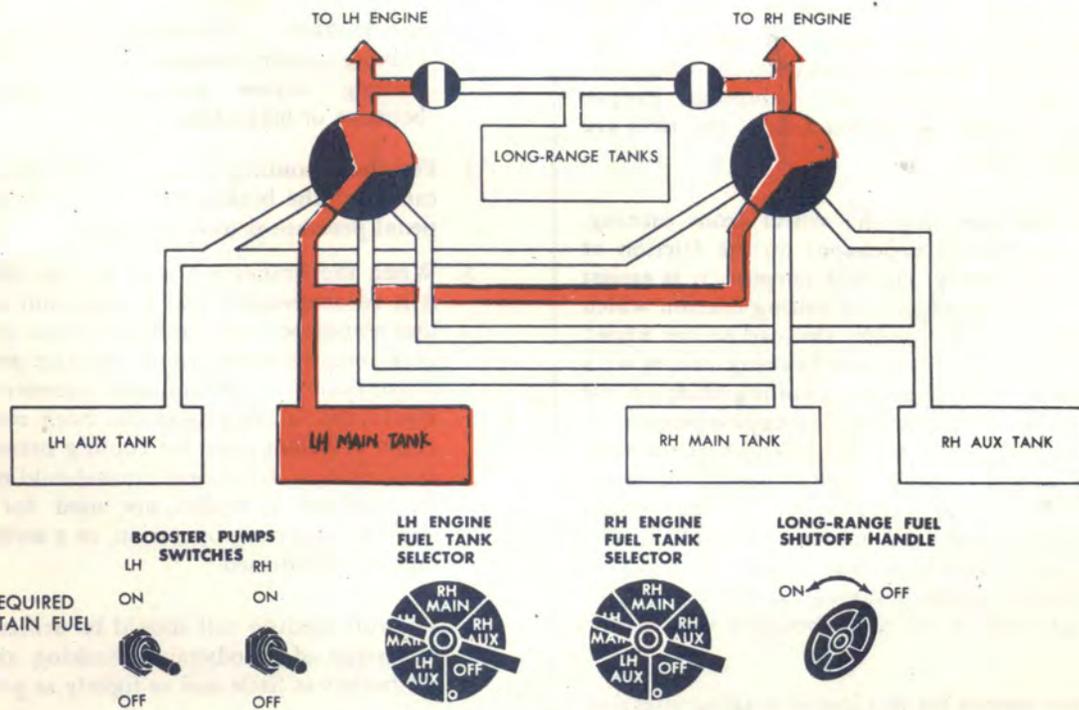
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FUEL SYSTEM MANAGEMENT



CRUISE — LONG-RANGE TANK OPERATION.
LONG-RANGE TANKS SUPPLYING FUEL TO BOTH ENGINES.



NOTE:
ON AS REQUIRED
TO MAINTAIN FUEL
PRESSURE.

ONE-TANK OPERATION.
LH MAIN TANK SUPPLYING FUEL TO BOTH ENGINES.

Figure 7-1 (Sheet 2 of 2)

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NOTE

Best dumping rate is realized at an air speed below 100 knots (115 mph). At this air speed, entire outer wing fuel can be dumped in approximately 3½ minutes.

4. Place both dump switches in ON position.
5. Visually check dump opening to make sure valve is operating.

NOTE

Dumping can be discontinued at any time by placing the switches in the CLOSED (full down) position. After valve is CLOSED, turn switch to the OFF position.

BRAKE OPERATION.

Use extreme care when applying brakes immediately after touchdown, or at any time when there is considerable lift on the wings, to prevent skidding the tires and causing flat spots. Heavy brake pressure can result in locking the wheel more easily immediately after touchdown, than when the same pressure is applied after the full weight of the aircraft is on the wheels. A wheel, once locked in this manner immediately after touchdown, will not become unlocked as the load is increased, as long as brake pressure is maintained. Proper braking action cannot be expected until the tires are carrying heavy loads.

Although brakes can stop the wheel from turning, stopping the aircraft is dependent on the friction of the tires on the runway. For this purpose, it is easiest to think in terms of coefficient of rolling friction which is the frictional force divided by the load on the wheel. It has been found that optimum braking occurs with approximately a 15 to 20 per cent rolling skid; i.e. the wheel continues to rotate, but has approximately 15 to 20 per cent slippage on the surface, so that the rotational speed is 80 to 85 per cent of the speed which the wheel would have were it in free roll. As the amount of skid increases beyond this amount, the coefficient of friction decreases rapidly so that, with a 75 per cent skid, the friction is approximately 60 per cent of the optimum and, with a full skid, becomes even lower.

There are two reasons for this loss in braking effectiveness with skidding. First, the immediate result of the skid is to scuff the rubber, tearing off little pieces which act almost like rollers under the tire. Second, the heat generated by the skid friction starts to melt the rubber, and the molten rubber acts as a lubricant.

NACA figures have shown that, for an incipient skid with an approximate load of 10,000 lbs per wheel, the coefficient of friction on dry concrete is as high as .8, whereas the coefficient is of the order of .5 or less with a 75 per cent skid. Therefore, if one wheel is locked during application of brakes there is a very definite tendency for the aircraft to turn away from that wheel and further application of brake pressure will offer no corrective action. Since the coefficient of friction goes down when the wheel begins to skid, it is apparent that a wheel, once locked, will never free itself until brake pressure is reduced so that the braking effect on the wheel is less than the turning moment remaining with the reduced frictional force.

The following procedures will apply for brake operation:

1. If maximum braking is required after touchdown, lift should first be decreased as much as possible by raising the flaps before applying brakes. This procedure will improve braking action by increasing the frictional force between the tires and the runway.

CAUTION

Immediately following maximum braking while landing, little or no braking action may be available because of brake fade.

2. For short landing rolls, a single, smooth application of the brakes with constantly increasing pedal pressure is most desirable.
3. When the brakes are used to stop the aircraft, it is recommended that a minimum of 15 minutes elapse between landings where the landing gear remains extended in the slip stream, and a minimum of 30 minutes between landings where the landing gear has been retracted, to allow sufficient time for cooling between brake applications. Additional time should be allowed for cooling if brakes are used for steering, cross-wind taxiing operation, or a series of landings are performed.
4. The full landing roll should be utilized to take advantage of aerodynamic braking and to use the brakes as little and as lightly as possible.
5. After the brakes have been used excessively for an emergency stop, and are in the heated condition, the aircraft should not be taxied into a crowded parking area or the parking brakes set. Peak temperatures occur in the wheel and brake

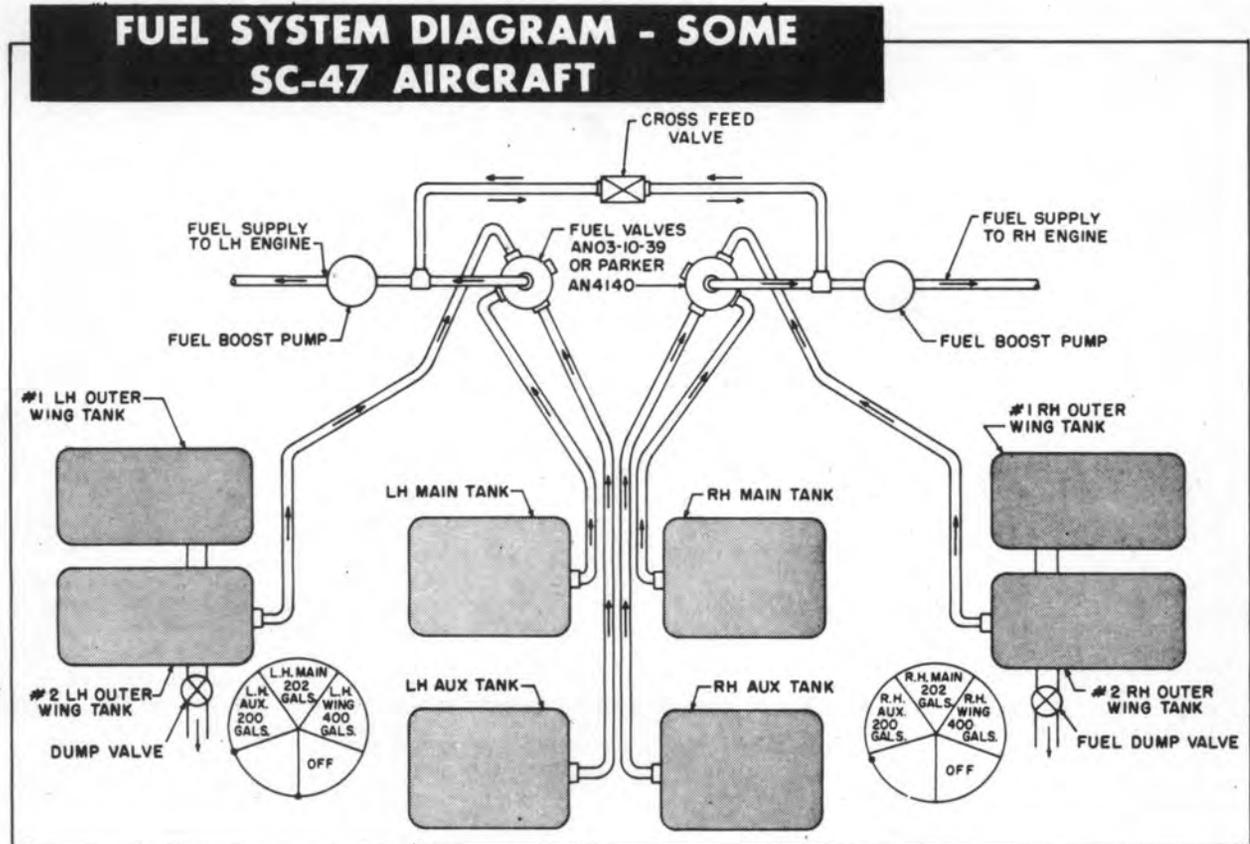


Figure 7-2

assembly from 5 to 15 minutes after a maximum braking operation. To prevent brake fire and possible wheel assembly explosion, the specified procedures for cooling brakes should be followed.

6. The brakes should not be dragged when taxiing, and should be used as little as possible for turning the aircraft on the ground.

NOTE

Taxiing with one engine inoperative is not recommended.

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SECTION VIII
CREW DUTIES
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INTRODUCTION.

This section lists duties, other than primary functions, performed by crew members.

NOTE

During all critical phases of flight, the flight instruments will be cross checked for proper indications. The pilot not flying the aircraft will closely monitor the instruments and will advise the pilot at the controls of any malfunction of instruments or deviation from published procedures. Both pilots will be thoroughly familiar with the departure, holding, letdown, low approach, and missed approached phases of the flight.

PILOT.

It will be the duty of the pilot to insure that a thorough inspection of the aircraft and all equipment is conducted before departure. The pilot will personally inspect all items of bail-out, ditching, and survival equipment. The check lists for the pilot are covered in detail in Section II and III.

CO-PILOT.

The co-pilot will aid the pilot, as directed, to accomplish the assigned mission.

PASSENGER BRIEFING CHECKLIST.

Passenger information and an emergency diagram are provided at the end of this section as a reproducible page. This page will be reproduced by the operating commands and prepared as plastic covered cards to be located at passenger stations within the aircraft.

PREDEPARTURE BRIEFING.

1. Crew Introduction
2. Destination
3. Estimated time enroute
4. Flight altitude
5. Weather (enroute and destination)
6. Demonstrate use of oxygen equipment
7. Demonstrate use of parachutes
8. Demonstrate use of seat belt
9. Indicate location of emergency equipment

10. Describe procedures to be used during an inflight emergency
11. Advise passengers of information cards and describe warning signals
12. Instruct passengers in smoking restrictions and use of seat belts
13. Caution passengers against use of electronic equipment

OVERWATER BRIEFING.

1. Describe applicable emergency equipment
2. Describe ditching procedures

ARRIVAL BRIEFING.

1. Announce arrival time
2. Instruct passengers in smoking restrictions and use of seat belt
3. Provide additional information as applicable.

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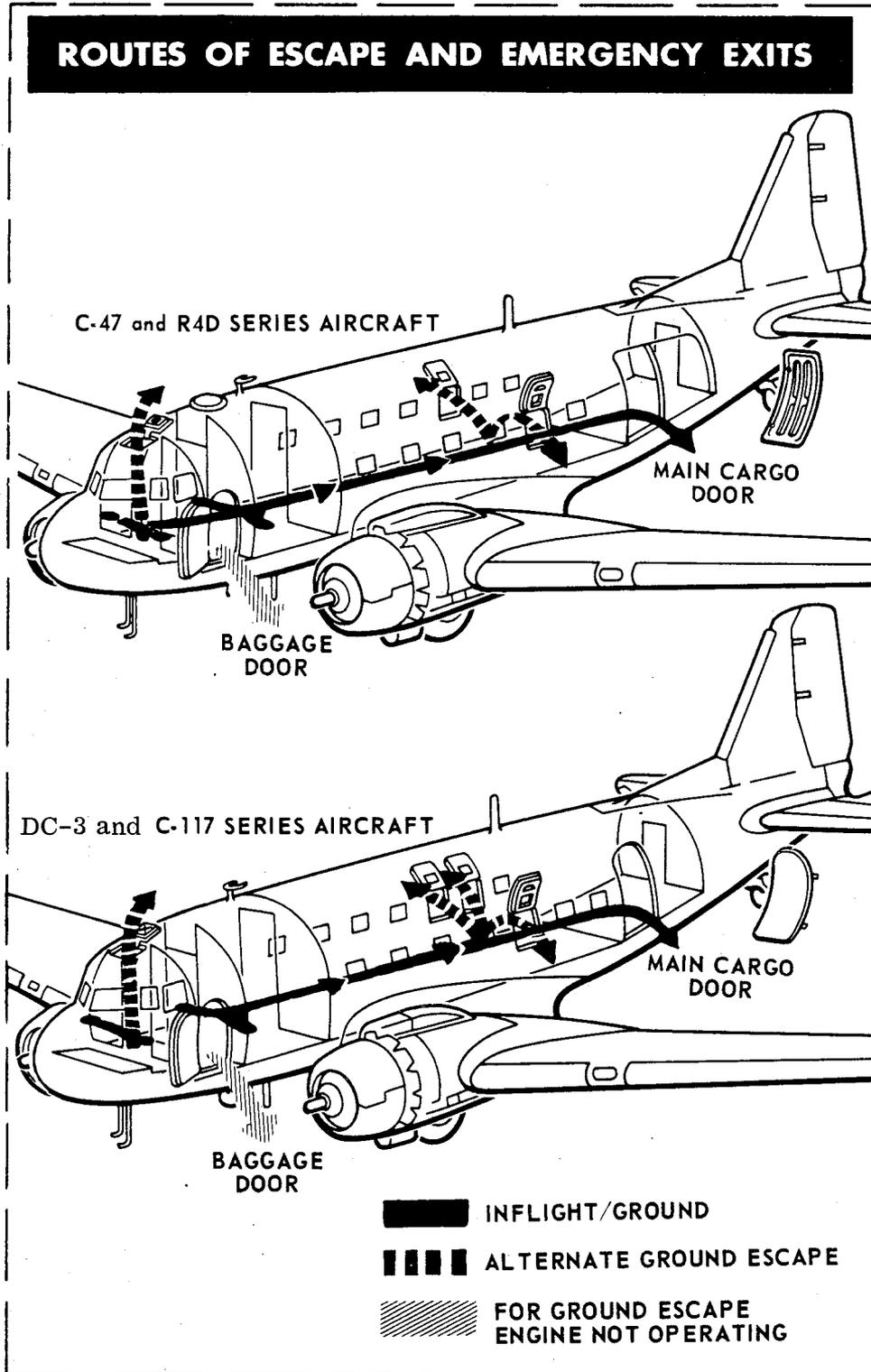


Figure 8-1.

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PASSENGER INFORMATION

1. Seat belts will be fastened during takeoff and landing and as instructed by the pilot. Smoking is prohibited during all ground operations, during and immediately after takeoff and before landings, and at any time during flight as instructed by the pilot.
2. In the event of an inflight emergency, remain seated with the seat belt fastened and follow the pilot's or crew members instructions.
3. Emergency exits and escape routes are shown in Figure 8-1.

BAIL OUT

1. If the pilot decides that Bail Out is necessary, he will alert the crew and passengers with three short rings on the alarm bell.
2. A crew member will instruct the passengers on bail out procedures, and help adjust the parachutes.
3. The pilot will give the bail out signal; one sustained ring of the alarm bell, and the crew will supervise bail out proceedings.

CRASH LANDING OR DITCHING

1. If a crash landing or ditching situation has developed, the pilot will alert the crew and passengers with six short rings of the alarm bell.
2. Fasten seat belt securely.
3. Remove cords, ties, straps; loosen collar, and parachute harness, don life vest (if applicable) but do not inflate.
4. If blankets or pillows are available, use to protect face.
5. Just prior to impact, the pilot will alert the crew and passengers with one sustained ring of the alarm bell.
6. Brace for impact.
7. Hold crash landing positions until after the airplane has stopped moving.
8. Remove seat belt and follow the crews instructions.

IX ALL-WEATHER
OPERATION

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SECTION IX
ALL-WEATHER OPERATION

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INTRODUCTION.

Except for some repetition necessary for emphasis, clarity, or continuity of thought, this section contains only those procedures that differ from, or are in addition to, the normal operating instructions covered in Section II. Discussions relative to systems operation are covered in Section VII.

Instrument Flight Procedures

The aircraft has excellent maneuverability characteristics for instrument flying. Stability in all axes is excellent. Maneuverability on Ground Control Approach and Instrument Landing System is very good. Before attempting any instrument flight, check that all radios, radio aids, and flight instruments are operating properly.

INSTRUMENT TAKE-OFF.

CAUTION

Take-off should be avoided when both temperature and dew point are within the area of 31° to 33°F and the runway is wet or rain or snow is falling. When the above conditions exist, ice may accumulate on the empennage during runup and take-off, and wing and carburetor icing may occur immediately after take-off.

Planning for instrument take-off should include the possibility of return to the field, and suitable precautions should be taken, including the monitoring of the take-off by GCA or other instrument facilities.

INSTRUMENT CLIMB.

Climbing airspeed and attitude are easily maintained. Banks in excess of 30° are not recommended.

CRUISING.

Cruising under instrument conditions does not differ from cruising under VFR conditions; however, the following checks should be made:

1. Check the directional indicators periodically with the standby compass.

2. Before entering known or suspected icing or visible moisture, turn on the pitot heat and be alert for propeller, wing, and carburetor ice. If ice starts to form on unheated parts of the windshield, it is an indication that ice is forming on the propeller. Turn on the propeller deicing system.

CAUTION

If deicer boots are used, do not operate them continuously, since this may result in ballooning the ice immediately over the boots and render them ineffective. Allow the ice to build up to approximately ¼ inch thickness, then turn the boots on to remove it. After the ice is removed, turn the boots off until the ice builds up again.

SPEED RANGE.

Stability and flight characteristics are good throughout the full range of speed, and instrument flight should be conducted in accordance with the power charts (see Appendix).

DESCENT.

To descend from altitude, use the same procedure as during VFR flight to the minimum instrument altitude for the range being used and in accordance with instructions received from Air Traffic Control.

HOLDING.

Hold with the landing gear and wing flaps up, and use enough power to maintain an IAS of 105 knots (121 mph).

INSTRUMENT APPROACHES.

The general qualities and capabilities of the aircraft are excellent for instrument approaches. A study of all approach procedures must be made before starting the initial approach. Complete the prelanding checks before final approach, so that full attention can be given to flying during the approach.

RADIO RANGE APPROACH.

See Section 9.60D

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GROUND CONTROLLED APPROACH (GCA).

There is very little difference between a GCA and range approach. The approach is accomplished by reference to basic instruments and execution of instructions issued by a ground controller.

See Section 9.60D

INSTRUMENT LANDING SYSTEM (ILS).

An ILS differs from a GCA only in that the required procedures must be interpreted from instrument presentation. See Section 9.60D

AUTOMATIC DIRECTION FINDER (ADF) APPROACH.

See Section 9.60D

OMNI-RANGE (VOR) APPROACH.

See Section 9.60D

TACAN APPROACH.

See Section 9.60D

Ice and Rain

Rain without icing conditions presents no particular problems other than restricted visibility. When icing conditions are encountered, the following procedure will apply:

1. Known regions of moderate icing will be avoided.
2. Before entering an icing region, turn on the pitot heaters and check deicer system pressure.

NOTE

Climb or cruise at 10 to 15 knots above normal during icing conditions; reducing the angle of attack minimizes the accumulation of ice on under surfaces.

3. Regulate carburetor heat to maintain CAT within limits and adjust the cowl flaps as required to maintain proper CHT during flight through the icing region.
4. Operate the wing and empennage deicer system as required (see the paragraph on Wing and Empennage Deicing System Operation, Section IV).

5. If ice forms on the wing area aft of the deicer boots, change the flight path and leave icing region.

WARNING

Ice accumulation on the aircraft will result in higher stall speeds due to the change in aerodynamic characteristics and increased weight of the aircraft due to ice build-up. Approach and landing speeds must be increased accordingly.

Flight in Turbulence and Thunderstorms

WARNING

Flight through a thunderstorm or clear air turbulence should be avoided if at all possible. However, should circumstances force a flight into a zone of severe turbulence, the desired penetration airspeed of the aircraft, which is 52 Kts (60 mph) above the stalling speed for its gross weight, should be established before entering the storm. The following recommended techniques aid in reducing structural strain to the aircraft.

Power settings and propeller pitch are the keys to proper flight technique in turbulent air. (Severe turbulence is defined as a condition of sufficient disturbance to make the safety of the aircraft and its occupants the pilot's primary concern.) In selecting a speed for operation in severe turbulence, a compromise must be made between the desire to keep the speed low enough to permit the structure to withstand the greatest possible gusts and the desire to keep the speed high enough to prevent closely approaching the stalling point.

APPROACHING STORM.

It is imperative that the aircraft be prepared as follows before entering the zone of turbulence (if the storm cannot be seen, its proximity may be detected by radio crash static).

1. Disengage the autopilot.

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450-80K
CLEAN
+52
#132

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2. Reduce airspeed as required.
3. Mixture controls - AUTO-RICH.
4. Propeller controls - 2350 rpm.
5. Pitot heater switch - ON.
6. Carburetor heat - As required.
7. Throttles - As required.
8. Check the power source and gyro stabilized instruments settings.
9. Safety belt (and shoulder harness if installed)- Tightened. (Check with crew members.)
10. Turn off any radio equipment rendered useless by static.
11. Turn the cockpit lights full bright to minimize the blinding effect of lighting.

CAUTION

Do not lower the flaps or gear, since structural damage may occur.

PENETRATING STORM.

Penetrate the storm as follows:

1. Maintain the power and pitch settings established before entering the storm to hold the airspeed constant, regardless of an erratic airspeed indication caused by heavy rain partially blocking the pitot heads.
2. Devote full attention to flying the aircraft. Concentrate principally on holding a level attitude by reference to the attitude indicator and maintaining as constant an altitude as possible.

CAUTION

Do not chase the airspeed indicator or altimeter since undue stress might be imposed on the aircraft.

3. The altimeter is unreliable in severe turbulence because of differential barometric pressures. A gain or loss of several thousand feet may be expected, and allowance for this error must be made in determining minimum safe altitude.

NOTE

Altitudes nearest the freezing level are usually the most turbulent.

4. Do not attempt to keep up with the airspeed indicator, which may be off as much as 60 knots as a result of heavy rain partially blocking the pitot heads.
5. Use as little elevator control as possible in maintaining attitude in order to minimize the stresses imposed on the aircraft.

Night Flying

On aircraft not equipped with landing light shields, a glare from the landing lights will be noticed in the cockpit.

Cold-Weather Procedures

The following operating instructions are written to supplement the instructions in Section II and should be complied with when cold weather conditions are encountered. The success of extreme weather operation depends greatly on the preparation made during engine shutdown as outlined in this section; upon this depends the success of the next day's starting operation. Most cold weather operating difficulties are encountered on the ground. The most critical periods in the operation of the aircraft are the postflight and preflight periods. Proper diligence on the part of crew members concerning ground operation is the most important factor in successful cold weather operation.

WARNING

To prevent engine oil starvation due to congealed oil in the engine oil tanks, the procedures for oil preheat and oil dilution must be strictly adhered to. Oil in the tank must be heated to -12°C ($+10^{\circ}\text{F}$) or above before starting engines.

BEFORE ENTERING AIRCRAFT.

WARNING

All ice, frost, and snow must be removed before flight is attempted.

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Apply external heat to the engines and accessory sections. Preheat the engine nacelle until cylinder head temperatures reach 4°C. The time requirements on the following list are rough estimates for engine heating at various temperatures. These requirements will vary with wind velocities and percentage of engine oil dilution. The tabulation below is based on an oil dilution of approximately 25 per cent and no wind.

-6.7° to -18°C (20° to 0°F)..... 1/2 hour (approx)

-18° to -32°C (0° to -25°F)..... 1/2 to 1 hour

-32° to -40°C (-25° to -40°F)..... 1 1/2 to 2 1/2 hours

Check the oil drains for oil flow. If no oil flow is obtainable, continue preheat until oil flow is readily obtained. In addition to external heating, oil immersion heaters may be used; however, no special fittings are provided in the oil tanks for immersion heaters on some aircraft. If the immersion heaters are to be effective in keeping the oil warm during the night, they should be placed in the oil tanks immediately after landing. Use a portable heater to heat the flight instruments, defrost the windshields, and warm the radios, the dynamotors, the inverter, and other equipment within the aircraft. Remove all external coverings, pitot head covers, wing covers, etc. Clean the shock struts and landing gear actuating cylinders of ice and dirt, and check the struts for proper inflation. The hydraulic system is limited to -40°C (-40°F) and will not operate below this temperature. Check for engine stiffness periodically to determine when sufficient heat has been applied. Generally, if an engine is stiff enough to require more than three men to move a propeller, it is considered too stiff to start.

ON ENTERING AIRCRAFT.

1. Operate all the flight control surfaces and tabs through full travel three or four times to check ease of operation. When lowering flaps during normal preflight, the flaps should be lowered in approximately 10-degree increments to check ease of operation.
2. Check functioning of those instruments that can be checked without engine operation.

WARNING

In cold weather, make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

3. Exert light pressure on the brake pedals several times before setting parking brakes to assure adequate pressure for parking brake operation.

BEFORE STARTING ENGINES.

Before starting the engines, perform the following:

1. Remove the oil immersion heaters.
2. Remove the ground heater ducts.
3. Remove the engine nacelle shields (or covers, if installed).
4. Pull the propellers through 15 blades by hand.

STARTING ENGINES.

1. If the oil pressure is not within limits after 30 seconds running, or if the pressure drops below limits after a few minutes of ground operation, shut down and check for blown lines or coolers and recheck for congealed oil or ice at the drains.

NOTE

Oil congealing in a radiator produces unusual and often misleading indications. The usual indication is high oil temperature together with a reduction in pressure, often followed by a sudden drop in oil temperature accompanied by high pressure as the congealed oil is forced into the system.

2. Carburetor air preheat (not to exceed carburetor air temperature limits), should be applied immediately after starting in order to assist vaporization and combustion.
3. Check all instruments for proper operation.
4. Operate the wing flaps at least once.
5. 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 runup to dissipate as much of the fuel as possible to allow the oil to return to its normal viscosity. Below this temperature and at low engine speeds, very little fuel will be dissipated from the oil.

WARM-UP AND GROUND TESTS.

Use the procedure under Engine Runup, Section II.

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TAKE-OFF.

Carburetor heat may be required so that the fuel will vaporize properly at extremely low temperature. Monitor and regulate the carburetor heat to maintain carburetor air temperature within the proper limits during engine runup, climb and cruise (see the paragraph on Carburetor Icing, Section VII).

The heating system should be operating so that the windshield defrosting can be utilized during take-off, if necessary, and so that the flight instruments will not cool and give erroneous indications. Pitot heaters should be ON if precipitation is encountered or if icing conditions are anticipated immediately after take-off. Remember that the flight indicators are not very reliable at temperatures below -43°C (-45°F) and that all flight instruments should be cross-checked.

CAUTION

Do not use surface de-icers during take-off because of resultant disturbance of air flow spoiling the lift of the wing.

AFTER TAKE-OFF.

After take-off, cycle the gear several times to remove slush and snow and to prevent the gear from freezing in the retracted position.

DURING FLIGHT.

Periodically exercise prop controls to provide a supply of warm oil in the prop dome.

APPROACH AND LANDING.

Follow normal prelanding procedures. Apply carburetor heat as required, to prevent carburetor icing and to keep engine running smoothly. At extremely low temperatures it would be wise to use a power-on approach, thus helping keep the cylinder head temperature from becoming critically low. Whenever carburetor heat is used, allowance must be made for the power reduction associated with application of heat. Drain the water supply systems.

ENGINE SHUTDOWN.

Oil dilution is preferred, if the expected minimum temperature is below 4°C (40°F), in order to minimize the requirement for preheat prior to the next engine start.

OIL DILUTION PROCEDURE.

The aircraft is equipped with an engine oil dilution system to facilitate cold weather starting. When a cold weather start is anticipated, the engine oil should be diluted with fuel before the engines are stopped, provided that the engine oil temperature is maintained below 50°C (122°F). Above this temperature, dilution is not effective, since the fuel introduced into the system will vaporize.

When the oil temperature exceeds 50°C (122°F) 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 OAT, it may be necessary to break the dilution period up into two or more short periods because of oil temperature limits for dilution.

If it is necessary to service the engine section oil tanks, the oil dilution period must be divided so that part of the dilution is accomplished before the oil tanks are serviced and the remainder after the tanks are serviced.

If the oil tank is full and more than 3 minutes dilution time is required, some oil should be drained from the tank to prevent overflowing during the dilution period of subsequent engine run.

Perform the oil dilution operation as follows (operation of the oil dilution system is indicated by a drop in fuel pressure, followed later by a drop in oil pressure):

1. Operate each engine at 1100 to 1200 rpm.
2. Maintain oil temperatures below 50°C (122°F), stopping an engine for a short period if the temperature exceeds this limit.
3. Turn booster pumps ON.
4. Operate the oil dilution solenoid switches for the following periods for indicated anticipated temperatures:

4° to -12°C (40° to 10°F)	2 minutes
-12° to -29°C (10° to -20°F)	4 minutes
-29° to -46°C (20° to -50°F)	7 minutes
5. Move the propeller controls from INCREASE to DECREASE three times to dilute oil in the propeller domes. The time required to actuate the propeller controls from INCREASE RPM to DECREASE RPM three times should not exceed 1 minute total time. This 1 minute will be dilution time in addition to the time required to dilute for each anticipated ambient temperature.

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6. To dilute oil in the propeller feathering system, push right feathering button and allow for 200 RPM drop, then pull out feathering button. Dilute oil in left propeller feathering system using same procedures.
7. A short acceleration period of approximately 10 seconds at the end of the dilution run will usually clear the spark plugs of any fouling condition resulting from the prolonged idling.

After the oil has been diluted as specified above, and the propeller feathering system checked out during dilution, position the carburetor mixture controls to IDLE CUT-OFF, and continue to hold the oil dilution switch ON until the propeller stops turning.

Desert Procedures

Wind-blown sand is the main concern of operation in the desert. Many of the malfunctions which occur will be found to originate from improper care on the ground. Since most of the procedures given in Section II apply as well to Desert Procedures, only specific information for care of the aircraft during ground and flight operation will be given in this section. Carburetor air filters may be required for all operations.

Unless absolutely necessary do not take off during sand or dust storms.

HIGH ALTITUDE PROCEDURES.

The following procedures are recommended when operating from fields with an elevation that results in density altitudes of approximately 6000 to 16,000 feet.

STARTING.

The engine is more prone to flooding upon starting at density altitudes above 6000 feet, due primarily to reduction in density of the air flowing through the carburetor. The following techniques should be employed when starting at these altitudes.

1. Use larger throttle openings when starting.
2. Start in low blower.
3. When bringing in the mixture, move it to the AUTO-LEAN position.

TAXIING.

Above 6000 feet density altitude, taxiing should be done at 1200 rpm in AUTO-LEAN. If necessary, manually lean mixtures to achieve a smooth idle.

ENGINE RUNUP.

Normal runup procedures will be used at altitudes below 10,000 feet density altitude. At altitudes above 10,000 feet, where high blower will be used for takeoff, eliminate normal sequence of high blower check. Shift to high blower at 1700 rpm, just prior to advancing throttles for takeoff.

TAKEOFF.

At altitudes below 10,000 feet, use low blower and normal takeoff procedures. Above 10,000 feet altitude, high blower should be used.

APPROACH AND LANDING.

Normal low altitude traffic pattern approach and threshold-indicated airspeeds are recommended; however, bear in mind that true airspeed increases with altitude for the same indicated airspeed and consequently, the landing ground roll will be appreciably extended at high elevations. Another factor to consider is the decrease in ground cushioning effect during the flare out. Close adherence to the recommended approach speeds and flap settings are mandatory for the successful completion of either a landing or go-around. After touchdown place mixture in AUTO-LEAN and blowers in LOW.