T.O. 1C-133A-1

Flight Manual

USAF SERIES
C-133A
AND
C-133B
AIRCRAFT

THIS PUBLICATION IS INCOMPLETE WITHOUT T.O. 1C-133A-1-1.

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS PUBLICATION TO THE ATTENTION OF ALL AIR FORCE PERSONNEL CLEARED FOR OPERATION OF SUBJECT AIRCRAFT.

THIS PUBLICATION INCLUDES SAFETY OF FLIGHT AND SAFETY SUPPLEMENTS 1C-133A-SF-1-36, 38, 39 AND 41, AND SS-1-44, [redacted] AND 47. SEE WEEKLY INDEX, T.O. 0-1-1A FOR CURRENT STATUS OF SAFETY SUPPLEMENTS.

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14 Blank	Original

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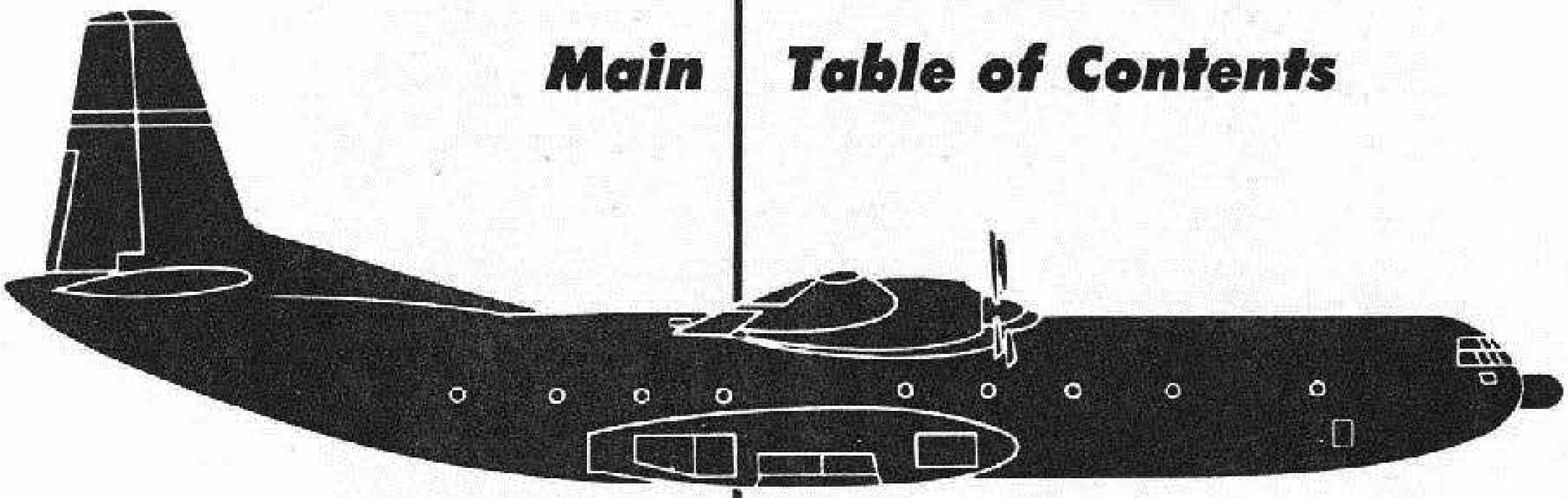

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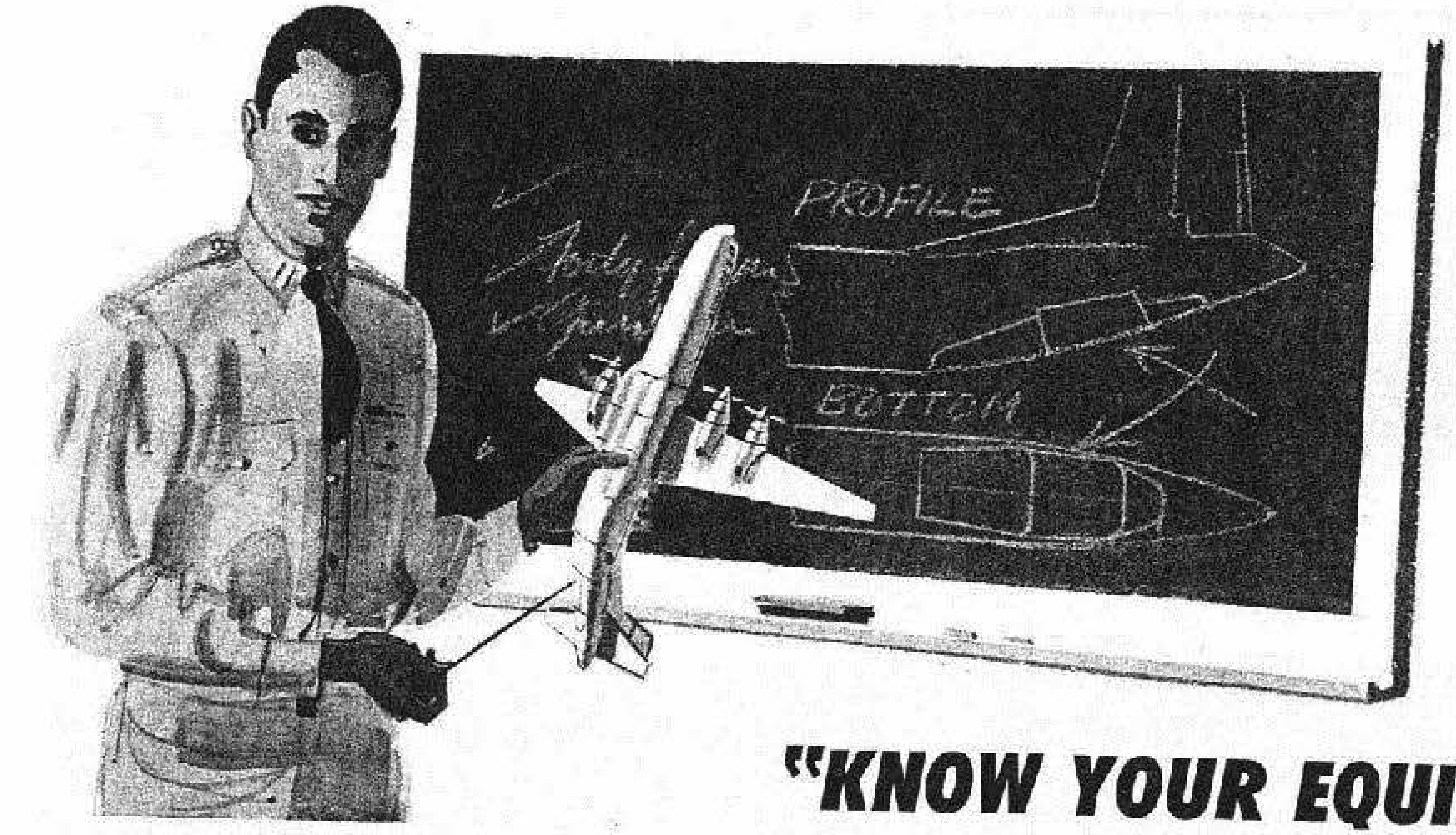


"KNOW YOUR EQUIPMENT"

UAB1-3

SCOPE. This manual contains all the information necessary for safe and efficient operation of the C-133A and C-133B. These instructions provide you with a general knowledge of the aircraft, its characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and therefore, basic flight principles are avoided.

SOUND JUDGEMENT. Instructions in this manual are for a crew (pilot) inexperienced in the operation of this aircraft. This manual provides the best possible operating instructions under most circumstances, but it is a poor substitute for sound judgment. Multiple emergencies, adverse weather, terrain, etc, may require modification of the procedures.

PERMISSIBLE OPERATIONS. The Flight Manual takes a "positive approach" and normally states only what you can do. Unusual operations or configurations (such as asymmetrical loading) are prohibited unless specifically covered herein. Clearance must be obtained from WADD before any questionable operation is attempted which is not specifically permitted in this manual.

STANDARDIZATION AND ARRANGEMENT. Standardization assures that the scope and arrangement of all Flight Manuals are identical. The manual is divided into nine fairly independent sections to simplify reading it straight through or using it as a reference manual. The first three sections must be read thoroughly and fully understood before attempting to fly the airplane. The remaining sections provide important information for safe and efficient mission accomplishment. Performance data is contained in *T.O. 1C-133A-1-1.*

SAFETY OF FLIGHT SUPPLEMENTS. Information involving safety will be promptly forwarded to you by

Safety of Flight Supplements. Supplements covering loss of life will get to you in 48 hours by TWX, and those concerning serious damage to equipment within 10 days by mail. The current status of each Safety of Flight Supplement affecting your airplane can be determined by referring to the Weekly Index of Safety of Flight Supplements *(T.O. 0-1-1A)*. The title page of the Flight Manual and the title block of each Safety of Flight Supplement should also be checked to determine the effects they may have on existing supplements. You must remain constantly aware of the status of all supplements — current supplements must be complied with but there is no point in restricting your operation by complying with a replaced or rescinded supplement.

CHECKLISTS. The Flight Manual contains only amplified checklists. Condensed (abbreviated) checklists have been issued as separate technical orders — see the back of the title page for T.O. number and date of your latest checklist. Line items in the Flight Manual and checklists are identical with respect to arrangement and item number. Whenever a Safety of Flight Supplement affects the condensed (abbreviated) checklist, write in the applicable change on the affected checklist page. As soon as possible, a new checklist page, incorporating the supplement will be issued. This will keep handwritten entries of Safety of Flight Supplement information in your checklist to a minimum.

HOW TO GET PERSONAL COPIES. Each flight crew member is entitled to personal copies of the Flight Manual, Flight Manual Appendix (Performance Data), Safety of Flight Supplements, and Checklists. The required quantities should be ordered before you need them to assure their prompt receipt. Check with your supply personnel — it is their job to fulfill your Technical Order request. Basically, you must order the required quantities on the Publication Requirements Table *(T.O. 0-3-1)*. Technical Orders 00-5-1 and 00-5-2 give detailed information for properly ordering these publications. Make sure a system is established at your base to deliver these publications to the flight crews immediately upon receipt.

FLIGHT MANUAL AND CHECKLIST BINDERS. Loose leaf binders and sectionalized tabs are available for use with your manual. These are obtained through local purchase procedures and are listed in the Federal Supply Schedule (FSC Group 75, Office Supplies, Part 1). Binders are also available for carrying your condensed (abbreviated) checklist. These binders contain plastic envelopes into which individual checklist pages are inserted. They are available in three capacities and are obtained through normal Air Force supply under the following stock list numbers: 7510-766-4268, -4269, and -4270 for 15, 25, and 40 envelope binders respectively. Check with your supply personnel for assistance in securing these items.

WARNINGS, CAUTIONS, AND NOTES. The following definitions apply to "Warnings," "Cautions," and "Notes" found throughout the manual.

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

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

Note — An operating procedure, technique etc., which is considered essential to emphasize.

EFFECTIVITY. This publication contains information for both the C-133A and C-133B aircraft. Many of the changes in configuration between the two models are apparent to the flight crew by visual inspection and are adequately covered by text or illustrations. In some cases it is necessary to point out the difference in the text. Where information is pertinent to only one model, that information is designated as being applicable to the C-133A or the C-133B. In cases where information is applicable to a part of the series, or overlaps between the two series, effectivity is noted by AF serial number. The following table is a list of AF serial numbers by model with the manufacturer's corresponding fuselage number.

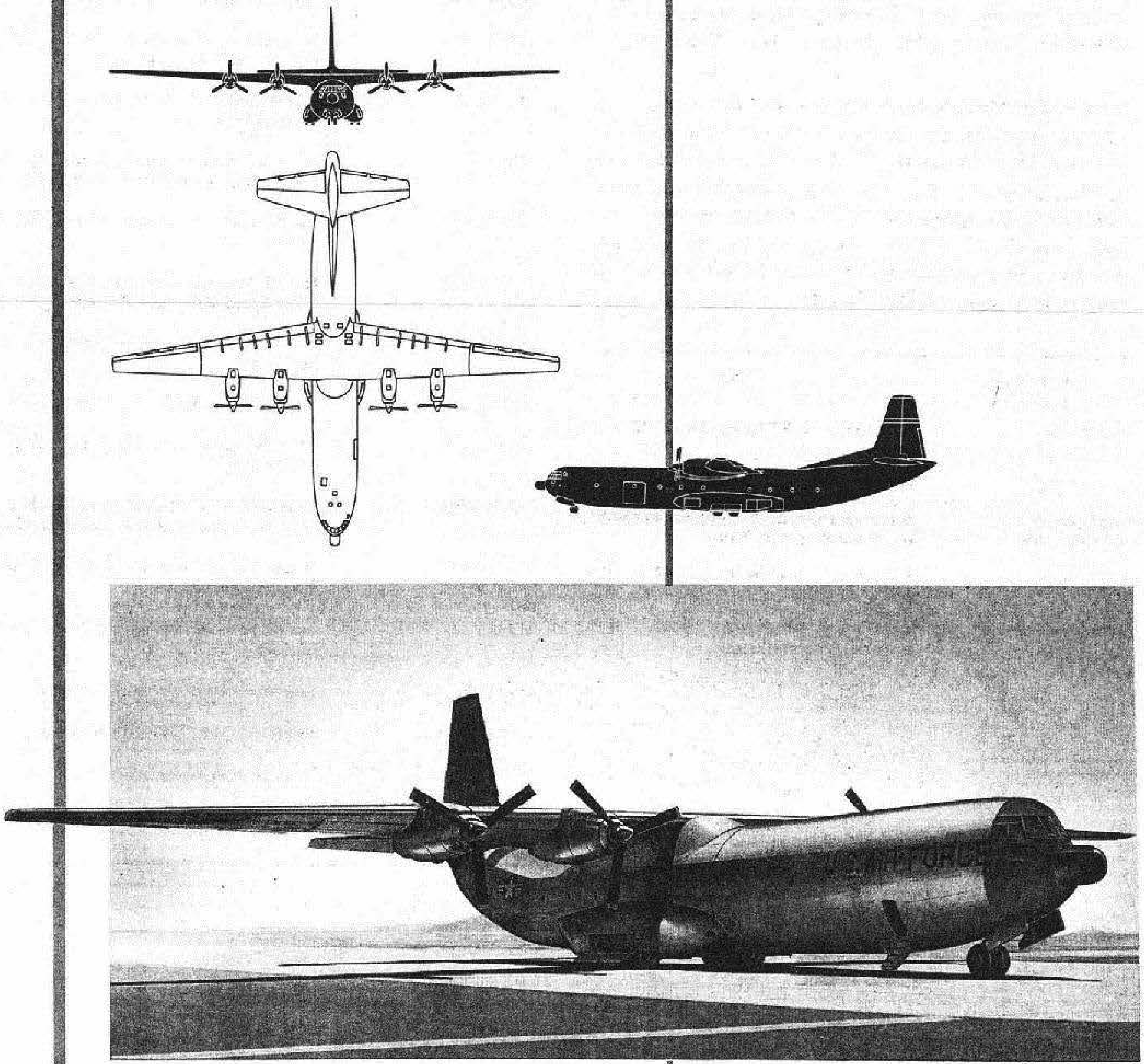
Fuselage Number	*AF Serial Number*
C-133A:	
1	54-135
2	54-136
3	54-137
4	54-138
5	54-139
6	54-140
7	54-141
8	54-142
9	54-143
10	54-144
11	54-145
13	56-1998
14	56-1999
15	56-2000
16	56-2001
17	56-2002
18	56-2003
19	56-2004
20	56-2005
21	56-2006
22	56-2007
23	56-2008
24	56-2009
25	56-2010
26	56-2011
27	56-2012
28	56-2013
29	56-2014
30	57-1610
31	57-1611
32	57-1612
C-133B:	
33	57-1613
35	57-1615
36	59-522
37	59-523
38	59-524
39	59-525
40	59-526
41	59-527
42	59-528
43	59-529
44	59-530
45	59-531
46	59-532
47	59-533
48	59-534
49	59-535
50	59-536

YOUR RESPONSIBILITY — TO LET US KNOW. Every effort is made to keep the Flight Manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusion of the latest data in the manual. However, we cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual or any phase of the Flight Manual program are welcomed. These should be forwarded through your Command Headquarters to Hq WRAMA, Robins AFB, Georgia, Attn: WRNEO.

TIME COMPLIANCE TECHNICAL ORDERS. Time Compliance Technical Orders are identified by the T.C.T.O. number. Thus, **(T.C.T.O. 502)** would indicate that the portion of text in the paragraph following the number would be applicable to all aircraft modified by T.O. 1C-133-502. The following listing contains applicable Time Compliance Technical Orders affecting both C-133A and C-133B aircraft.

T.O. Number	*Title*
1C-133-502	Installation of Engine Fuel Heating System
1C-133-506	Replacement of Engine Inlet Struts
1C-133-509 1C-133-509A	Incorporation of Inspection Capabilities for Side Cargo Door
1C-133-510	Revision of Auxiliary Alternator Out Light Circuitry
1C-133-515	Installation of Engine Bleed Valve Override System
1C-133-517	Revision to Radio Magnetic Indicator Wiring
1C-133-518	Autopilot Improvements
1C-133-533	Replacement of Door and Ramp Control Valves, Part No. 40400-303
1C-133-534	Revision to Turn and Slip Indicator Installation
1C-133-549	Revision to Fire Overheat Warning System
1C-133-568	Removal of Fuel Oil Heat Exchanger Assembly Part No. 7454152-9 and Installation of C-2 Strainer
1C-133-569	Installation of Stall Warning System
1C-133-571	Installation of Propeller Power Unit Oil Monitoring System
1C-133-578	Installation of Nose Gear Steering Warning System
1C-133-579	Installation of Pressure Barrier Panels for Sliding Clear View Windows
1C-133-583	Installation of Second Anti-Collision Light
1C-133-589	Installation of Alternate Windshield Heat Sense Selection Switch
1C-133-592	Revision to Fire and Overheat Warning System
1C-133-594	Installation of Lock—Side Cargo Door
1C-133-596	Installation of AC Generator Drive Disconnect
1C-133-606	Removal of Propeller Low Oil Pressure Warning System Indicator Lights
1C-133-612	Installation of Engine Vibration Monitoring Equipment
1C-133-614	Installation of Emergency Nose Gear Unlock
1C-133A-719	Revision to Fire Detector System
1C-133A-756	Installation of VHF-101 Equipment
1C-133B-505	Modification of Stall Warning System
3E3-2-558	Deactivation of Centrifugal Switch Assembly, Part No. 152821

the C-133



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DESCRIPTION SECTION I

UAB1-5

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THE AIRCRAFT.

The aircraft is manufactured by the Douglas Aircraft Company, Inc. It is a long-range, high-wing monoplane, designed for use as a logistic transport. The aircraft is equipped with a fully retractable tricycle landing gear. There are four main gear units, one nose gear unit, and one auxiliary tail wheel unit. The aircraft is powered by four Pratt & Whitney turbo-prop engines. Each engine is equipped with an 18-foot Curtiss turboelectric propeller with full feathering, reverse pitch, and negative torque control features. The aircraft has two gas turbine units (GTU's) that provide power for the two hydraulic pumps and the auxiliary generator. The GTU's also supply bleed air for starting, air conditioning, and pressurization of the flight deck and cabin.

MAIN DIFFERENCES.

Main differences in design and operation between different series of this aircraft model at time of delivery are listed in figure 1-1.

AIRCRAFT DIMENSIONS.

The principal dimensions of the aircraft are:

Span	179 feet 8 inches
Length (overall, including radome)	157 feet 6 inches
Height (including anticollision light)	48 feet 9 inches
Stabilizer span	60 feet
Main Gear Tread (from outboard wheel rim to outboard wheel rim)	21 feet 8 inches

See figure 2-7 for ground clearance and turning radius, and figure 4-22 for internal dimensions.

AIRCRAFT GROSS WEIGHT.

The aircraft design gross weight is 275,000 pounds for C-133A aircraft, and 286,000 pounds for C-133B aircraft. For complete weight information, see Section V.

INTERIOR ARRANGEMENT.

The aircraft is designed to carry various types of cargo as well as fully assembled missiles in the cabin and may be loaded through the aft and clamshell cargo doors *(28 and 29, figure 1-2)* and ramp *(30, figure 1-2)*, or the side cargo door *(38, figure 1-2)*. The aircraft is fitted with a complete rapid cargo loading and tiedown system. The rapid cargo loading system utilizes roller conveyor sections running forward and aft in the cargo compartment. The conveyor sections are held in position by quick-disconnect holddown fittings which attach to seat studs located on the cargo floor. A transfer dolly is provided to permit lateral movement of cargo pallets. The cargo tiedown system consists essentially of six overhead nets which can be dropped and secured to provide vertical and lateral restraint of cargo movement, and six barrier nets to restrain forward and aft cargo movement. For the location of the various compartments of the aircraft, see figure 1-3.

FLIGHT CREW.

Accommodations are provided for a crew of four members: pilot, copilot, flight engineer, and navigator. Provision is also made for a relief crew.

ENGINES.

The aircraft is powered by four Pratt & Whitney turbo-prop engines *(figure 1-4)*. The T34-P-7WA type engines installed on C-133A aircraft are each capable of developing a static maximum power of 6500 shaft horsepower. The T34-P-9W engines installed on C-133B aircraft are each capable of developing a static

Main Differences

Item	*C-133A*	*C-133B*
Design Gross Weight	275,000 Pounds	286,000 Pounds
Engines	T34-P-7WA	T34-P-9W
VHF Communications	AN/ARC-49	*VHF-101
Engine Temperature Indicating System	Exhaust Gas Temperature	Turbine Inlet Temperature
Emergency Flap Extension	Electric Motor	Electrically Driven Auxiliary Hydraulic Pump
Stall Warning System	Not Installed	*Control Column Shaker
Rear Cargo Loading Doors	Cargo Door & Ramp	Ramp & Clamshell Doors

*Some C-133A aircraft

Figure 1-1

maximum power of 6950 shaft horsepower. Each engine is a multi-stage, axial-flow, single compressor gas turbine which produces thrust by driving a propeller at the front of the engine and discharging high-velocity gases through a tailpipe nozzle at the turbine exhaust or rear of the engine. The power of either type engine may be augmented during takeoff, by the use of the water-alcohol injection system which injects a water-alcohol mixture into the combustion chamber. The engines are housed in conventional, semi-monocoque nacelles, and are accessible through quick opening, orange-peel type cowling.

The major sections of the engine are the nose section, the air inlet section, the compressor section, the accessory section, the combustion section, and the turbine section.

The nose section contains the propeller shaft, which is driven by a 2-stage planetary reduction gear system, the torque pressure indicating system, and the negative torque control system.

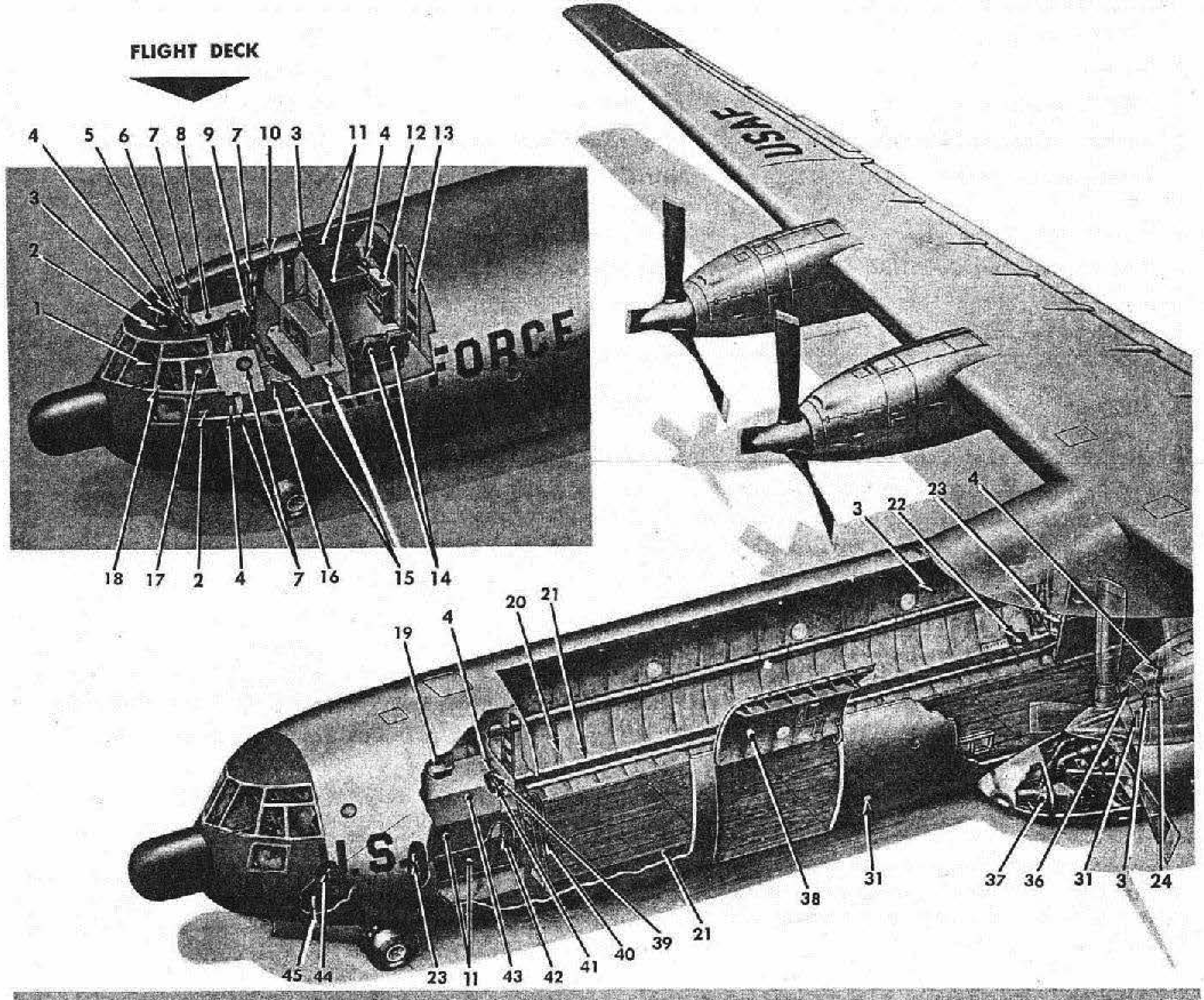
The air inlet section consists of an annular air inlet around the nose section. Six hollow struts project radially across the air inlet passageway between the nose section and the case of the air inlet section. Compressor discharge air is circulated through the four upper struts to prevent engine air inlet icing. The struts located at the 11 o'clock and 3 o'clock positions each contain breather passages. Pressurized oil flowing to the nose section passes through the strut located at the 5 o'clock position. Scavenged oil being returned from the nose section passes through the strut located at the 7 o'clock position.

Note

Engine locations, such as right, left, and o'clock positions, are as viewed from rear of engine.

The compressor section, which has a constant inside diameter, contains a 13-stage axial-flow compressor which develops a compression ratio of approximately 6.7 to 1. The compressor drives the propeller shaft reduction gears through splined couplings. To facilitate starting, and to prevent compressor stall and instability during low rpm ground operation, overboard air bleed valves are provided at the sixth and seventh stages of compression. Although the overboard air bleed valves are spring loaded to the open position during starting and low rpm ground operation, they are automatically closed by the bleed valve governor at all engine speeds used during flight operation. A manually-controlled engine bleed valve governor override system is provided which will close the bleed valves to prevent loss of power during flight in the event the bleed valve governor should fail. Normally, the bleed valve governor override switches are left in the OFF position, and should be placed in the OVERRIDE position only in the event a bleed valve governor failure occurs during flight. Just aft of the thirteenth stage of compression, at the compressor discharge point, are located four ports from which high

General



1. GLARE SHIELD
2. MAP CASE (2 PLACES)
3. UTILITY POWER OUTLET — 28 VOLTS AC (6 PLACES)
4. PORTABLE OXYGEN BOTTLE (5 PLACES)
5. COPILOT'S SEAT
6. FLIGHT ENGINEER'S DATA CASE
7. BLACKOUT CURTAINS (6 PLACES)
8. FLIGHT ENGINEER'S STATION
9. LOAD ADJUSTER
10. PERISCOPIC SEXTANT
11. RELIEF CREW BUNKS
12. BUFFET
13. FLIGHT DECK ENTRANCE DOOR
14. RELIEF CREW SEATS (RECLINING)
15. NAVIGATOR'S STATION
16. NAVIGATOR'S MAP CASE
17. PILOT'S SEAT
18. FLIP HOLDER
19. CREW ENTRANCE DOOR
20. CARGO NET STOWAGE (19 PLACES)
21. WALKWAYS
22. SINGLE-POINT REFUELING ADAPTER
23. LANDING GEAR EMERGENCY RELEASE HANDLES (5 PLACES)

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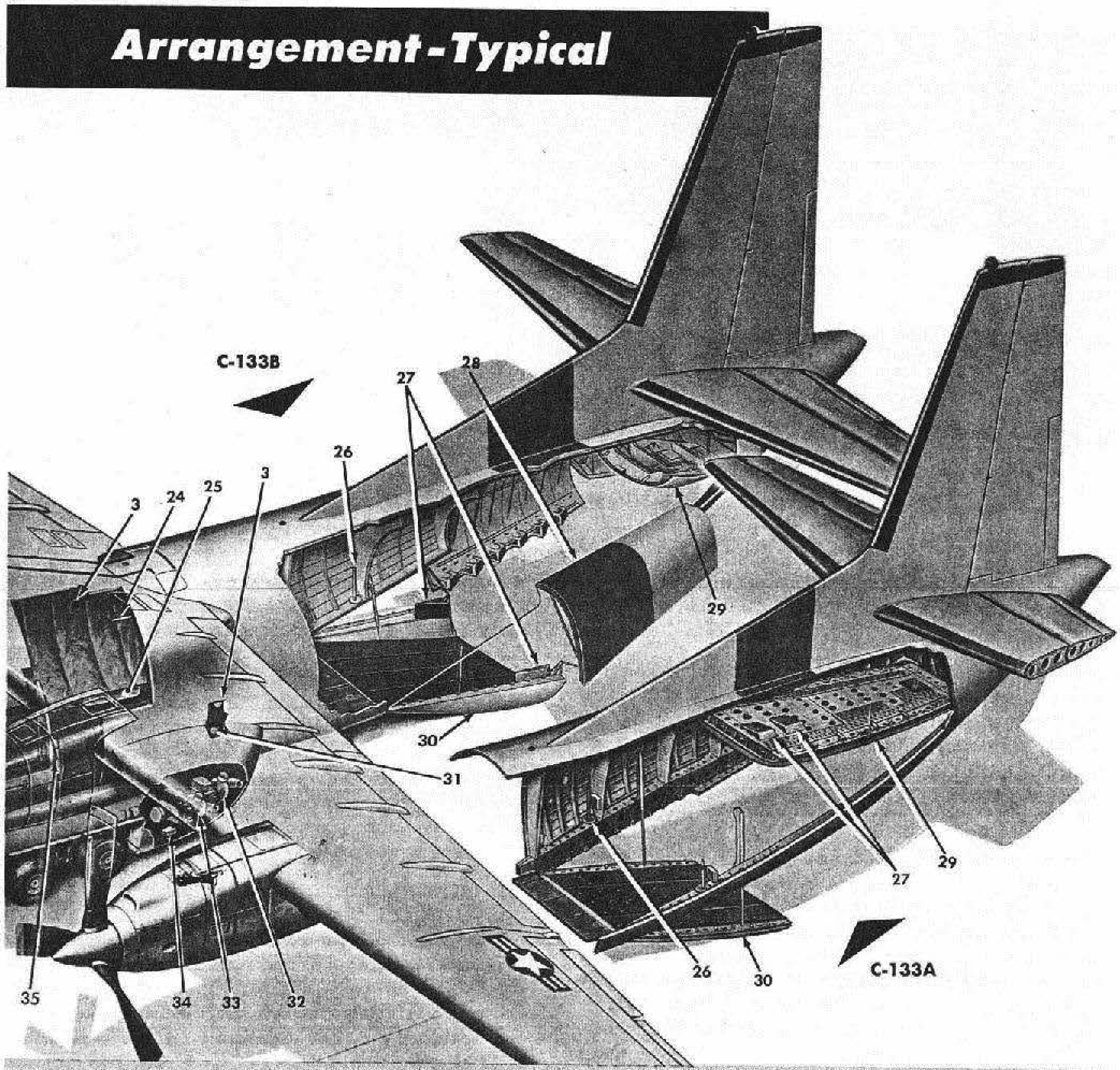
Figure 1-2 (Sheet 1 of 2)

Arrangement - Typical



24. AILERON SURFACE LOCK ACCUMULATOR
25. WATER-ALCOHOL INJECTION TANK
26. TIP-OVER STRUTS (FUSELAGE GROUND LOADING SUPPORT STRUTS) — STOWED POSITION (ONE EACH SIDE)
27. RAMP TOES — STOWED POSITION
28. CLAMSHELL DOORS
29. AFT DOOR
30. RAMP
31. UTILITY POWER OUTLET — 200 VOLTS AC (3 PLACES)
32. GTU NO. 2
33. GTU NO. 1
34. BATTERY
35. HYDRAULIC RESERVOIR AND QUANTITY GAGE
36. HYDRAULIC HAND PUMP
37. HEAT EXCHANGER (LEFT SIDE SHOWN, RIGHT SIDE OPPOSITE)
38. SIDE CARGO DOOR
39. STOWAGE RACK-LANDING GEAR SAFETY PINS
40. FLIGHT DECK LADDER
41. FUEL DIPSTICK (AFT SIDE OF LAVATORY)
42. SHEAVE STOWAGE
43. LAVATORY
44. EXTERNAL POWER RECEPTACLE
45. PARKING BRAKE ACCUMULATOR

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Compartment Diagram

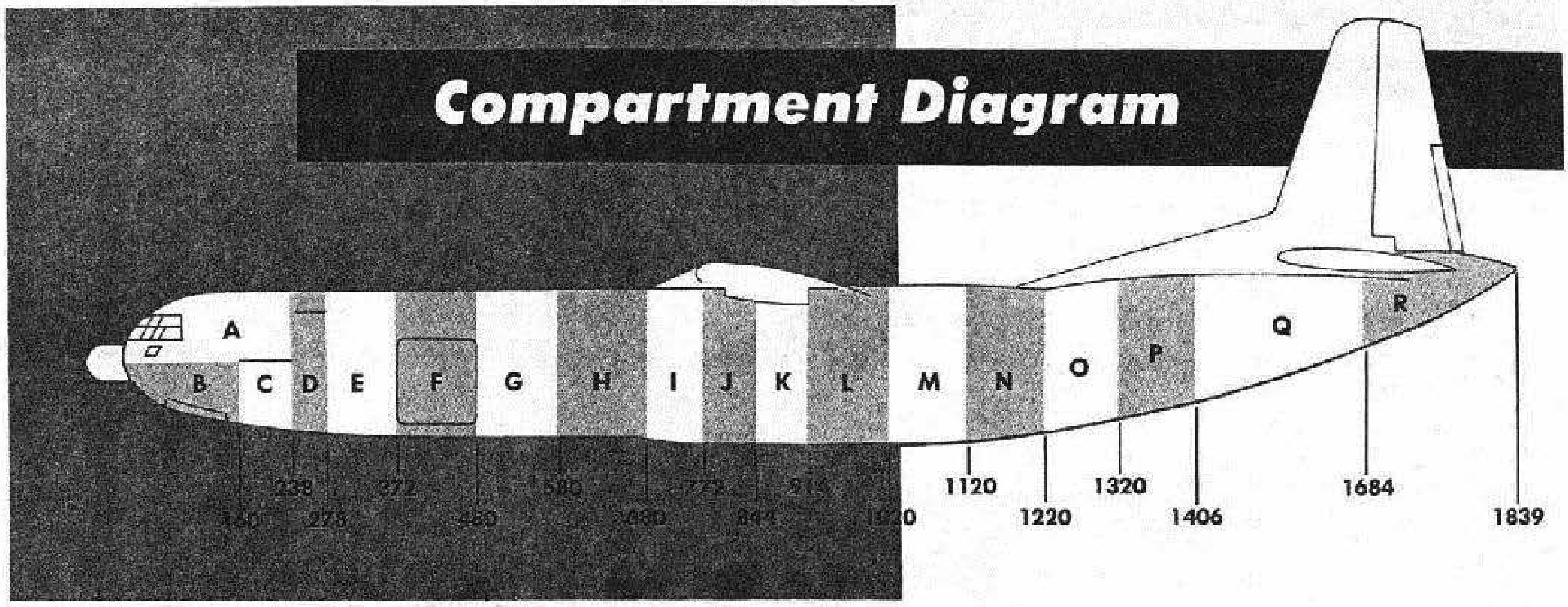

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Figure 1-3

pressure air can be bled for the operation of various pneumatic units.

The accessory section, in addition to providing the drives for the various engine accessories, also contains the four engine mounting pads. The four engine mount supports, which accommodate vibration isolators, are equally spaced at 45 degree increments to the vertical plane.

The combustion section contains eight burner cones which open into an annular combustion chamber. Each burner cone is equipped with a dual-orifice fuel nozzle. The No. 2 and No. 7 burner cones are each equipped with a spark igniter for starting purposes. Hot gases from the combustion chamber are discharged into the three-expansion stage turbine section where they provide the power to drive the compressor and propeller. A fuel drain is provided at the bottom of the outer case of the combustion chamber.

The turbine section consists of the turbine case and a turbine rotor, and provides three stages of expansion for the hot gases from the combustion chamber. A fuel drain is provided at the bottom of the turbine case.

The engine has two ranges of control; the flight range, and the ground, or Beta range. Engine power is controlled by a single lever, the throttle, which coordinates fuel flow with the propeller governor setting by directing signals to both the fuel control unit and the propeller, according to the power setting desired. In scheduling the flow of fuel to the engine, the fuel control unit automatically compensates for compressor inlet temperature, burner pressure, throttle position, and engine speed.

A self-contained engine brake is incorporated on the starter drive shaft. The engine brake may be used to prevent an inoperative engine from windmilling while the aircraft is parked, or to stop propeller rotation under certain emergency conditions that may occur during flight. The engine brake may also be used to reduce the time required to shut down an engine, during ground operations, providing the speed of the engine is below 45 percent rpm; however, it is recommended that the engine be allowed to coast to a stop, in order to provide better cooling.

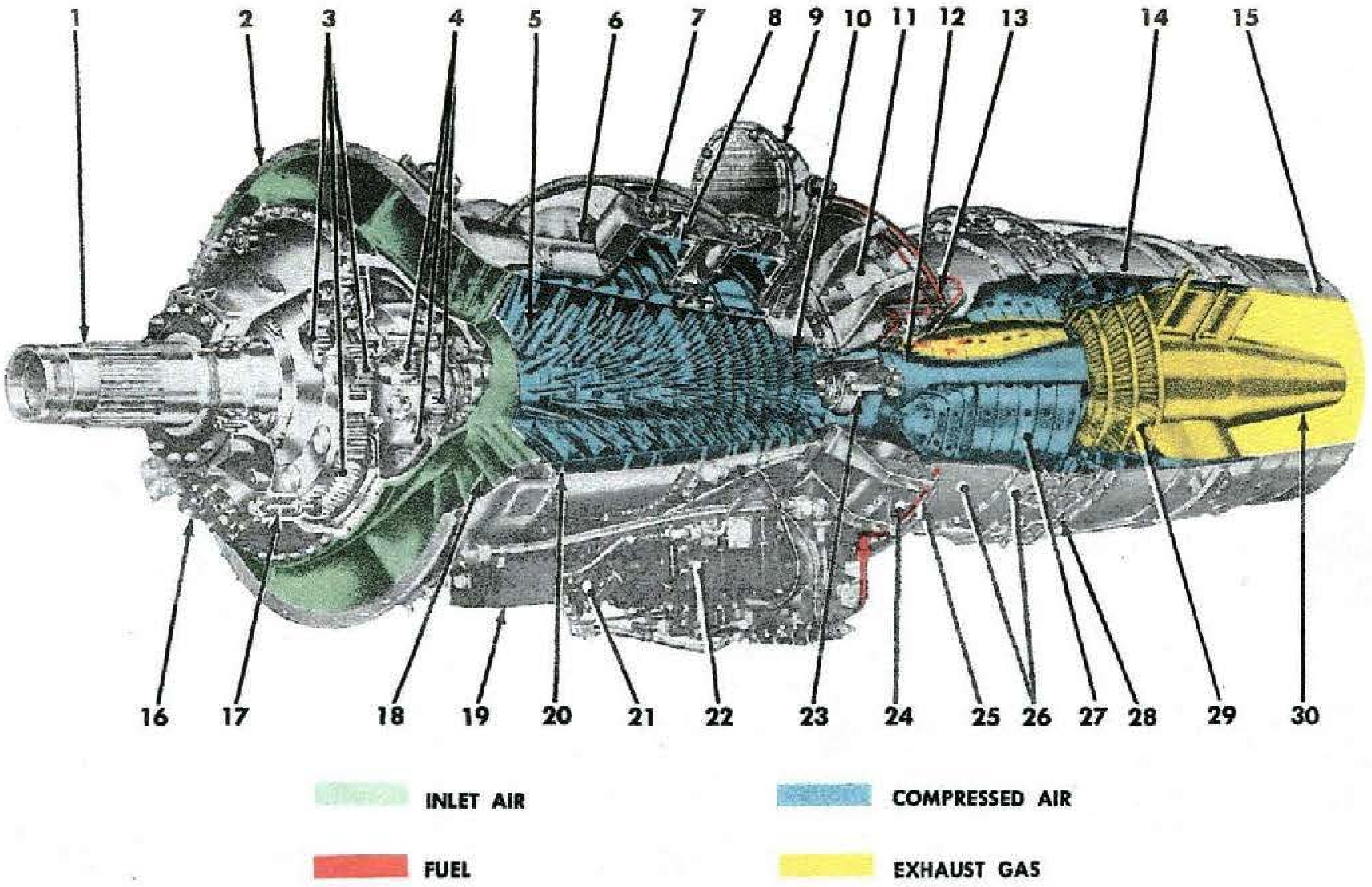
The engine is provided with a dual, negative torque control (NTC) system which automatically senses a negative torque condition, where the propeller is driving the turbine. When such a condition is sensed, the NTC system provides a signal to the propeller increase pitch circut, which starts the propeller toward the feathered position. (See figure 1-44 for engine servicing specifications.)

ENGINE FUEL SYSTEM.

The engine fuel system components are mounted on the main accessory drive section, at the bottom of the engine. The components of the system include a fuel pump, a fuel pump transfer valve, a fuel control unit, and a pressurizing and dump valve. A fuel flow transmitter is mounted forward of the firewall, on the right side of the engine. A primary and a secondary manifold are mounted on the engine fireseal ring which is secured to the aft end of the accessory section.

In addition to these units, those **aircraft with T.C.T.O. 502** are equipped with fuel heaters, mounted on the left side of the engine forward of the firewall. The fuel

Pratt and Whitney T34-P Engine — Typical

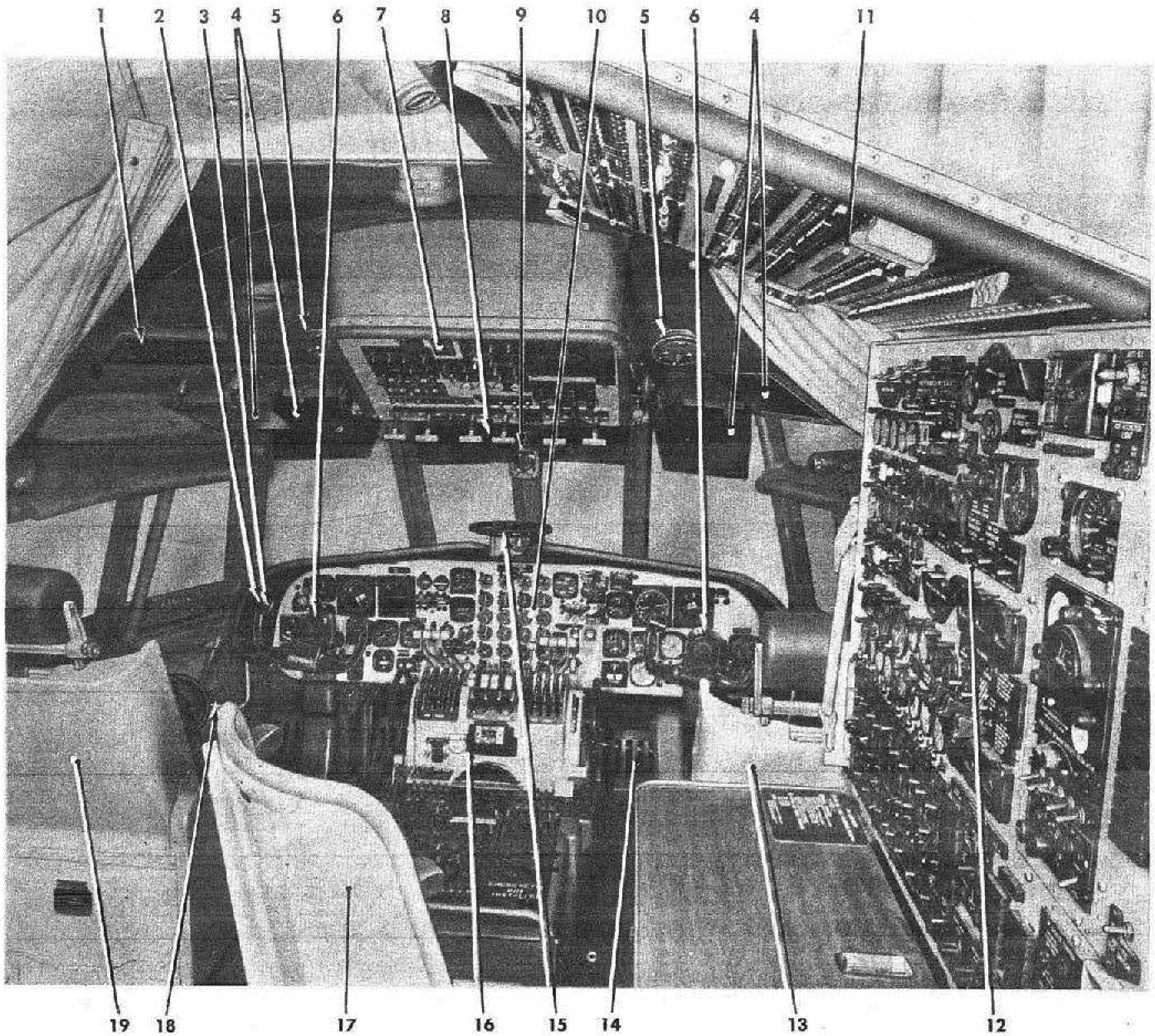


1 PROPELLER SHAFT
2 COMPRESSOR AIR INLET CASE
3 LOW-SPEED REDUCTION GEARING
4 HIGH-SPEED REDUCTION GEARING
5 FIRST STAGE COMPRESSOR ROTOR
6 COMPRESSOR FRONT CASE
7 AIR BLEED VALVE MANIFOLD
8 AIR BLEED VALVE ASSEMBLY
9 GENERATOR DRIVE ADAPTER ELBOW
10 THIRTEENTH STAGE COMPRESSOR ROTOR
11 ACCESSORY DRIVE CASE
12 FUEL NOZZLE AND SUPPORT
13 FIRE SEAL
14 TURBINE OUTER CASE
15 TURBINE EXHAUST EXTENSION CASE
16 REDUCTION GEARING SCAVENGE OIL PUMP
17 NEGATIVE TORQUE CONTROL ASSEMBLY
18 COMPRESSOR INLET GUIDE VANE
19 IGNITION EXCITER
20 COMPRESSOR STATOR VANE AND SHROUD ASSEMBLY
21 FUEL CONTROL UNIT
22 ENGINE FUEL PUMP
23 DUAL FLUID PUMP DRIVE GEAR TRAIN
24 PRIMARY FUEL MANIFOLD
25 SECONDARY FUEL MANIFOLD
26 TELESCOPING COMBUSTION CHAMBER CASES
27 COMBUSTION CHAMBER BURNER CONE
28 THERMOCOUPLE HARNESS
29 THIRD STAGE TURBINE DISC AND BLADE ASSEMBLY
30 TURBINE EXHAUST CONE

UAB1-89

Figure 1-4

Flight Deck Arrangement – Typical



1.	PILOT'S OVERHEAD SIDE PANEL
2.	MICROPHONE SWITCH
3.	AUTOPILOT RELEASE SWITCH
4.	SUN VISORS
5.	CONDITIONED AIR OUTLET
6.	CONTROL COLUMN
7.	PILOTS' OVERHEAD PANEL
8.	PILOTS' APN-59 INDICATOR (STOWED)
9.	STANDBY COMPASS
10.	PILOTS' INSTRUMENT PANEL
11.	FLIGHT ENGINEER'S OVERHEAD PANEL
12.	FLIGHT ENGINEER'S INSTRUMENT PANEL
13.	COPILOT'S SEAT
14.	RUDDER PEDALS
15.	RUDDER TRIM WHEEL AND INDICATOR
16.	CONTROL PEDESTAL
17.	FLIGHT ENGINEER'S SEAT (HEADREST REMOVED FOR CLARITY)
18.	PILOT'S FOOT REST
19.	PILOT'S SEAT

UAB1-111

Figure 1-5

heaters are installed in the fuel system ahead of the engine-driven fuel pump and are designed to utilize scavenged engine oil to heat the fuel, thereby minimizing the formation of ice crystals in the fuel and preventing the accumulation of ice in the fuel strainer and fuel control unit. The fuel heating unit incorporates a fuel strainer, a core assembly, pressure-operated bypass valves, and a temperature control valve. The pressure-operated bypass valves are installed in both the core and in the fuel strainer to assure unobstructed fuel flow, in the event clogging occurs. The temperature control valve maintains the temperature of the fuel between 2°C and 27°C, by varying the flow of oil through the core of the heater. When the temperature of the oil is below 32°C, all of the oil is bypassed around the core. The fuel heater is fully automatic in operation.

The engine fuel system receives fuel under boost pump pressure from the main fuel supply system, through strainers, to the engine-driven fuel pump *(22, figure 1-4)*. From the fuel pump, fuel is routed to the fuel control unit *(21, figure 1-4)* through a filter which forms an integral part of the fuel control unit. The fuel control unit meters the fuel, which is then directed through the fuel flow transmitter to the pressurizing and dump valve. From the pressurizing and dump valve, the fuel is routed to the primary and secondary manifolds and then to the fuel nozzles in the burner cones.

The engine fuel pump is a two-stage, positive displacement, gear-type pump. During normal operation, the first stage acts as an engine-driven boost pump and increases fuel pressure to the inlet of the second stage by approximately 25 psi above the fuel supply pressure. The second stage increases the pressure of the fuel to approximately 500 psi. Either stage has adequate capacity to maintain sufficient fuel pressure for engine operation, in the event of failure of the other pumping stage.

The fuel pump transfer valve consists of an automatic valve assembly which transfers fuel pump operation from parallel to series operation, as required. During engine starting, when the speed of the engine is below approximately 25 percent rpm, both stages of the pump operate in parallel for increased volume output; at higher engine speeds, both stages operate in series. In the event of failure of one of the stages of the fuel pump, the fuel pump transfer valve will direct the flow of fuel from the operative stage to the fuel control unit.

The fuel control unit meters fuel to the engine as a function of throttle angle, compressor inlet temperature, engine speed, and combustion chamber pressure. An integral shutoff valve, actuated by the condition lever, turns on or shuts off the flow of fuel to the engine. Power output of the engine is controlled by regulating the flow of fuel through the fuel control unit with the throttle. Fuel is metered to the engine according to a prescribed schedule for all operating conditions so that the flow of fuel is neither too much, which may cause excessive turbine temperatures, nor less than the minimum required to sustain combustion.

A 2-step ground idle speed control provides two idle speeds in the ground operating range. Whenever the throttle is retarded below the FLIGHT IDLE position, a stop in the fuel control unit maintains a high ground idle speed at a relatively high fuel flow and engine rpm. This feature keeps the engine in readiness to supply power for full reverse thrust during landing, and maintains sufficient engine rpm for operation of the main a-c generators. To obtain low ground idle rpm, the stop must be actuated by placing the ground speed control switches, located on the control pedestal, in the LO-IDLE position. With the switches in this position, fuel flow will be reduced to allow low rpm operation with the throttle at or near the ground idle detent. To obtain high ground idle rpm from low ground idle, the throttle must be moved either to approximately the FLIGHT IDLE or REVERSE position. This action will mechanically reposition the high ground idle stop, and will prevent engine speed from returning to low ground idle rpm until the ground speed control switches are again actuated to the LO-IDLE position. During GROUND range operation of the throttle, engine rpm is controlled by the fuel control unit, and is in no way effected by the propeller governor.

From the fuel control unit, metered fuel passes through the fuel flow transmitter to the pressurizing and dump valve. The pressurizing and dump valve directs all fuel from the fuel control unit to the primary fuel manifold *(24, figure 1-4)*, and then to the inner passages of the dual-orifice fuel nozzles *(12, figure 1-4)* during low fuel pressure operation. As fuel pressure and flow are increased, fuel is also directed to the secondary fuel manifold *(25, figure 1-4)* and to the outer passages of the dual-orifice fuel nozzles. When the engine is shut down by movement of the condition lever to the FUEL OFF position, the dump portion of the pressurizing and dump valve is actuated to the open position to permit fuel to drain from the fuel manifolds.

Throttles.

Two banks of four throttles each *(1 and 6, figure 1-11)*, located on the control pedestal, are mechanically linked to the engine fuel control units and to the propeller circuits to control power output. The throttles also control propeller reversing. Each throttle actuates a water-alcohol injection switch during advancement to the MAX power (takeoff) position, and actuates the landing gear warning switch when retarded toward FLIGHT IDLE. The takeoff warning horn switch is actuated by the No. 1 or No. 3 throttle when advanced above FLIGHT IDLE. The throttle, through mechanical linkage, also drives the synchronizer to set the desired synchronization speed of the propellers throughout the FLIGHT range. In the GROUND range, engine rpm is controlled by fuel control governing. See figure 1-9 for throttle settings and ranges of control.

Throttle Lock Lever.

A throttle lock lever, placarded POWER LOCK *(2, figure 1-11)*, is located between the pilot's throttles and the condition levers and is used to adjust the friction on the throttles by fore or aft movement. Friction is increased by moving the throttle lock lever forward.

Ground Speed Control Switches.

Two ground speed control switches *(9, figure 1-11)*, one for No. 1 and 4 engines, and one for No. 2 and 3 engines, are installed on the control pedestal. The switches provide two ranges of idle speed for ground operation, HI-IDLE and LO-IDLE. The switches are spring loaded to the HI-IDLE position. When a throttle is retarded to the GROUND IDLE detent and the respective ground speed control switch is momentarily actuated to the LO-IDLE position, a 28-volt d-c circuit is completed to energize a solenoid on the fuel control unit to change the ground idle stop to the LO-IDLE position; engine speed then drops to approximately 55.5 percent rpm. When the throttle is advanced above the FLIGHT IDLE position, or is moved to REVERSE, a cam mechanically actuates a mechanism on the fuel control unit to change the ground idle stop to the HI-IDLE position. When the throttle is again retarded to the GROUND IDLE position or taken out of REVERSE, engine speed will be maintained at 90.9 percent rpm until the ground speed control switch is again actuated to the LO-IDLE position.

WATER-ALCOHOL INJECTION SYSTEM.

A water-alcohol injection system is installed to deliver a metered flow of water-alcohol mixture to the fuel nozzles in each engine. The supply of water-alcohol is contained in a 100 gallon supply tank *(25, figure 1-2)*, located in the aft section of the right pod. Four gravity fed, electrically driven pumps, located below the supply tank, deliver the mixture to each engine. The supply of water-alcohol mixture is adequate for approximately 1¾ minutes of operation, with all four engines operating. This allows use of water-alcohol injection during the MAX power check, while still providing 1½ minutes of water-alcohol injection after brake release. In the event of an engine malfunction, which requires retarding of the throttle below MAX power, the operating time on water-alcohol injection will be increased on the remaining engines, since all pumps are gravity fed from a common manifold.

The use of water-alcohol injection increases the power output of the engine by increasing the mass flow through the turbine. Since the water-alcohol mixture is a coolant, this increase is accomplished without increasing EGT/TIT above operating limits. At approximately 50°C, the use of water-alcohol injection will provide engine performance approximately equivalent to ICAO Standard Day performance. This will amount to an increase in torque pressure of approximately 7.2 psi, or 1000 shaft horsepower per engine. Water-alcohol injection may be used whenever the ambient temperature is above 0°C. For operation at other temperatures, and restrictions on the use of water-alcohol injection, see Engine Operating Limitations, Section V and Part 2 of *T.O. 1C-133A-1-1*.

Water-Alcohol Injection Switch.

A 3-position water-alcohol injection switch *(figure 1-8)*, placarded ON, OFF, and DRAIN, is located on the pilots' overhead panel. Placing the switch in the ON position completes circuits from the flight deck 28-volt d-c nonessential bus which supplies power to energize four relays. The relays, when energized, complete circuits from the center fuselage 200-volt, 3-phase, a-c nonessential bus which suplies power to operate the four water-alcohol injection pumps. Placing the switch in the ON position also establishes the circuits for four, throttle-actuated, water-alcohol shutoff valve switches. Advancing the throttles to the MAX power position actuates these switches, which complete circuits from the flight deck 28-volt d-c nonessential bus which supplies power to actuate the shutoff valves to the open position. The four shutoff valves, one of which is located in each engine nacelle, then direct a metered flow of the water-alcohol mixture to the engines. As the throttles are retarded from the MAX power position, the switches are actuated and complete circuits from the same bus which supplies power to actuate the shutoff valves to the closed position. When the switch is placed in the OFF position the water-alcohol injection system circuits are deenergized. Placing the switch in the DRAIN position completes a circuit from the center fuselage 28-volt d-c nonessential bus which supplies power to open the tank drain valve, the shutoff valves, and the solenoid-operated drain valve in each nacelle, for complete draining of the system. Circuit protection is provided by circuit breakers located on the flight engineer's overhead circuit breaker panel, the center fuselage d-c circuit breaker panel, and the center fuselage a-c circuit breaker panel.

Water-Alcohol Injection Pressure Indicators.

Four 2-position, 28-volt d-c, water-alcohol injection pressure indicators *(47, figure 1-7)* are mounted on the pilots' instrument panel. The ON position indicates that pressure is available in the nacelle, and the OUT position indicates that inadequate pressure is available or that the supply has been depleted. Power for operation of the pressure indicators is obtained from the flight deck 28-volt d-c nonessential bus. Circuit protection is provided by a circuit breaker located on the flight engineer's overhead panel.

NACELLE PREHEAT SYSTEM.

The nacelle preheat system is installed to permit preheating the fuel control units of the engines during ground starting or to supply heat to the fuel control units during flight, when extremely cold temperature conditions exist. Heated air, obtained from either the compressor bleed air supply of the GTU's or the thirteenth compressor stage bleed air duct of any operating engine, is used to preheat the fuel control units. When the pneumatic manifold shutoff valves are open, heated air from either source is routed through the main pneumatic manifold and branch ducts to an electrically operated nacelle preheat shutoff valve located in each engine nacelle. Actuating the nacelle preheat shutoff valve to the open position then permits the heated air to be directed upon the respective fuel control unit. In this manner, all four fuel control units may be preheated from a single source of heated air.

When the pneumatic manifold shutoff valve of an operating engine is closed and the nacelle preheat shutoff valve for that engine is open, heated air for nacelle preheat purposes is supplied, independently of other sources, directly from that engine to its own fuel control unit.

Note

> Maximum nacelle preheat airflow will be obtained with the air conditioning system shut off.

Nacelle Preheat Switches.

Four ON-OFF nacelle preheat switches *(1, figure 1-13)* are mounted on the flight engineer's instrument panel. The ON position of each switch completes a 28-volt d-c circuit to open the preheat shutoff valve in each engine nacelle to direct hot air on the respective fuel control units. The OFF position deenergizes the circuit to close the shutoff valve. These switches are normally left in the OFF positions. The pneumatic manifold switches must be in the OPEN position to provide nacelle preheat, unless the engines are operating.

ENGINE BLEED VALVE GOVERNOR OVERRIDE SYSTEM (AIRCRAFT AF-59-530 AND SUBSEQUENT AND AIRCRAFT WITH T.C.T.O. 515).

To prevent loss of power during flight in event of a bleed valve governor failure, a manual bleed valve governor override system has been provided which allows the pilot to close the bleed valve to prevent dumping compressor bleed air overboard.

Engine Bleed Valve Governor Override Switches.

Four engine bleed valve governor override switches are mounted on the pilots' overhead panel *(figure 1-8)*. The switches are placarded OFF — OVERRIDE, and control a 3-way solenoid at each engine. When the switches are placed in the OVERRIDE position, the solenoid valves are actuated, causing the engine bleed valve governor to be bypassed and completing the circuit to the bleed control to close the overboard bleed valve. Power for operation of the engine bleed valve governor system is obtained from the flight deck 28-volt d-c essential bus and the center fuselage 28-volt d-c essential bus.

IGNITION SYSTEM.

An ignition system utilizing 28-volt d-c power is installed on each engine with spark igniters in combustion chambers No. 2 and 7 for starting purposes only. High tension voltage is delivered to the spark igniters from the ignition exciter *(19, figure 1-4)* and compositor units when the ignition circuit is energized. The ignition switches are actuated by the condition levers when they are moved from the FUEL OFF to the RUN-FUEL ON position. Actuation of the ignition switches energizes the ignition timer, which begins a 3-minute ignition cycle. The ignition circuit is automatically deenergized at the completion of this cycle. The timer can be reset at any time the corresponding condition lever is returned to the FUEL OFF position for a minimum of 1 second, and then returned to the RUN-FUEL ON position. See Condition Levers, this section.

Note

> The engine ignition circuit breakers should be open whenever the engine is not in use. This procedure increases the service life of the ignition timer and the spark igniters by preventing them from operating during static checks of propellers and rigging.

ENGINE STARTING SYSTEMS.

Each engine is equipped with a pneumatic starting system which uses bleed air. The starter unit is a pneumatically driven turbine, geared to the engine through an accessory drive pad. Air for engine starting may be obtained from the GTU compressor bleed air supply which is routed through a pneumatic manifold and starter valve to each engine starter, from an operating engine which supplies bleed air to the same pneumatic manifold, or from an external pneumatic ground power source. Four engine starter switches are located at the pilot's station to control engine starting. A solenoid-controlled, pneumatically actuated starter shutoff valve is installed to control each engine starter. Normally, the shutoff valve is opened by the starter switch, to permit engine starting, and closed by a centrifugally actuated overspeed switch in the starter, when the engine reaches low ground idle rpm. In the event a malfunction occurs and the overspeed switch does not close the shutoff valve, the valve may be closed by the starter switch to prevent the starter from overspeeding. Since overspeeding of the starter could result in serious damage, both to the starter and to adjacent equipment, a starter disengage warning system is provided which indicates whenever the shutoff valve is open and the air inlet duct of the starter is being supplied with pneumatic pressure. When the GTU's are used for engine starting, the air conditioning system should be off so that air supply will not be diverted to the air conditioning system.

Engine Starter Switches.

Four engine starter switches *(figure 1-8),* located on the pilots' overhead panel, are placarded PUSH TO START — PULL TO RESET. When the switch is pushed to the PUSH TO START position for engine starting, a 28-volt d-c holding coil in the switch is energized to hold the switch in and complete the circuit to open the starter valve and admit bleed air to the air turbine starter. Before the engine reaches 55 or 63 percent rpm, depending on the type of starter installed, a centrifugal switch opens the circuit and the engine starter switch should pop out to the RESET position. When the engine starter switch is pulled to the RESET position, the switch is released from the holding coil and the circuit to the starter valve is deenergized to close the valve. After an engine lights-off, it may be necessary to manually pull the engine starter switch to the RESET position. The switch may be pulled out manually at any time to disconnect the starting system. When the engine brake switch is in the ON position, the engine starter circuits (ground and air) are inoperative.

ENGINE STARTER DISENGAGE WARNING SYSTEM.

An engine starter disengage warning system is installed which provides a visual warning when the starter is engaged. The warning system includes four starter disengage warning lights, four pressure-actuated switches, and a test switch. When the starter shutoff valve opens, during normal engine starting, the pressure of the air being supplied to the starter will close the pressure-actuated switch, causing the respective starter disengage warning light to come on. When the starter shutoff valve closes, stopping the flow of air to the starter, the pressure-actuated switch will open, and the light will go out. In the event the light remains on after the engine has reached a speed of either 55 or 63 percent rpm, depending on the type of starter installed, it will warn that a malfunction has occurred, causing the shutoff valve to remain open, and that air pressure is still being supplied to the starter. This condition could cause a starter overspeed to occur, resulting in damage to the starter and adjacent equipment.

Engine Starter Disengage Warning Lights.

Four amber, 28-volt d-c, engine starter disengage warning lights, one for each engine, are installed in the knobs of the engine starter switches *(figure 1-8).* Each warning light is controlled by a normally open, pressure-actuated switch. When a starter shutoff valve is open and air is being supplied to that starter, the pressure of the air in the starter air inlet duct will close the pressure-actuated switch. When the pressure-actuated switch closes, a circuit is completed between the flight deck 28 volt d-c essential bus and the warning light, causing the light to come on regardless of the position of its respective starter switch. When the starter shutoff valve is closed, the reduction in air

Pilots' Overhead Panel–Typical

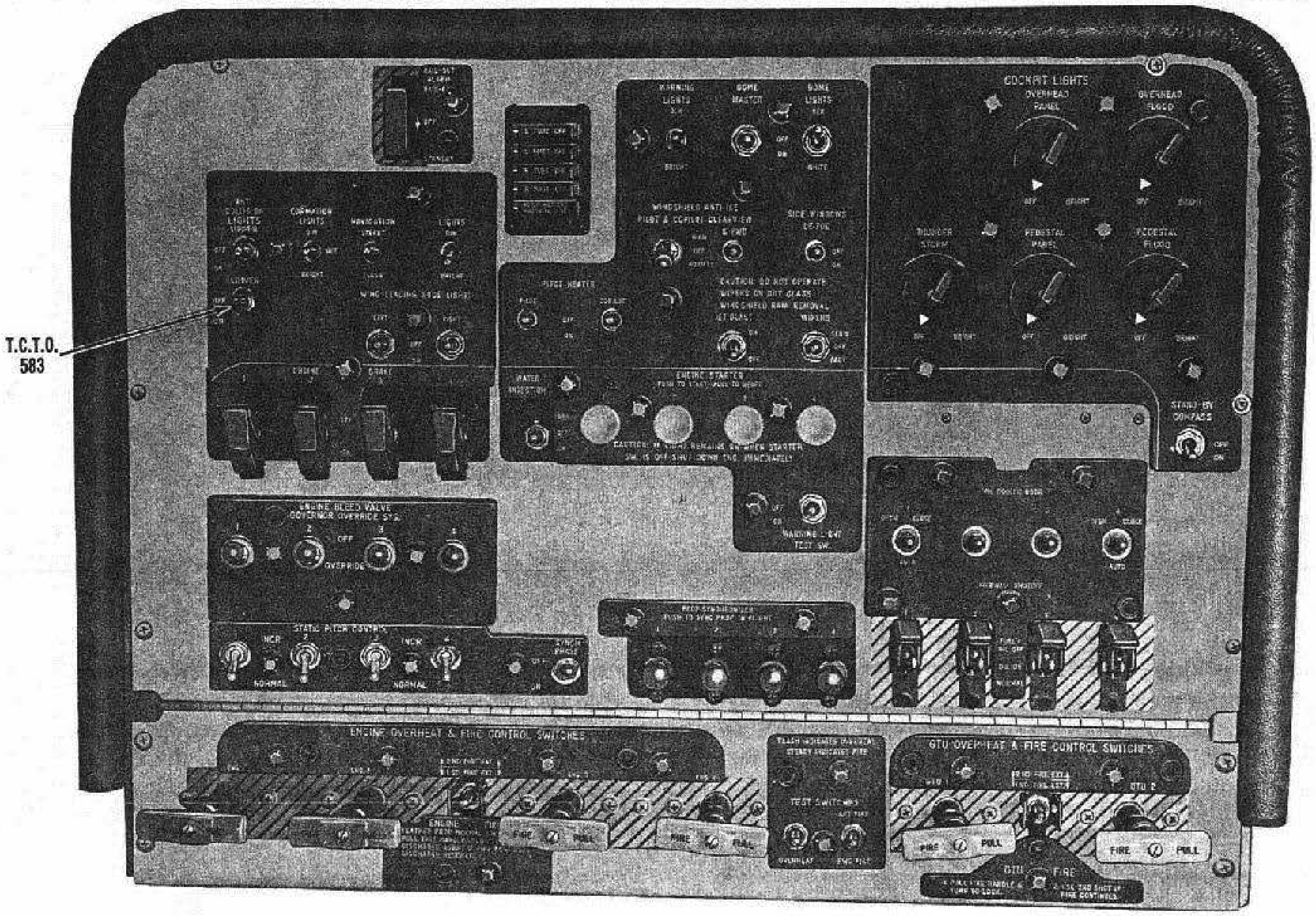


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Figure 1-6

pressure in the starter air inlet duct permits the pressure-actuated switch to open, deenergizing the circuit, and the warning light will go out. The engine starter disengage warning light circuits are protected by a circuit breaker located on the flight deck left hand auxiliary circuit breaker panel.

Engine Starter Disengage Warning Light Test Switch.

A 2-position, engine starter disengage warning light test switch *(figure 1-8)* is located on the pilots' overhead panel. The switch, placarded WARNING LIGHT TEST SW., has the placarded positions OFF and ON. Placing the switch in the ON position completes a circuit from the flight deck 28-volt d-c essential bus causing the warning lights in all four starter switch knobs to come on. When the test switch is placed in the OFF position, the warning light test circuit is deenergized, and the lights will go out.

ENGINE BRAKE SYSTEM.

Each engine is equipped with a self-contained, electrically actuated hydraulic brake, which may be used to prevent rotation of an inoperative engine while the aircraft is on the ground. When the brake is energized, the brake actuator drives a plunger in a cylinder to provide the hydraulic pressure that applies the brake. When the pressure reaches the required value, an automatic pressure switch opens the electrical circuit to the actuator. When the brake is disengaged, the circuit is energized to reverse the brake actuator action and the circuit is opened by a limit switch at the end

Pilots'

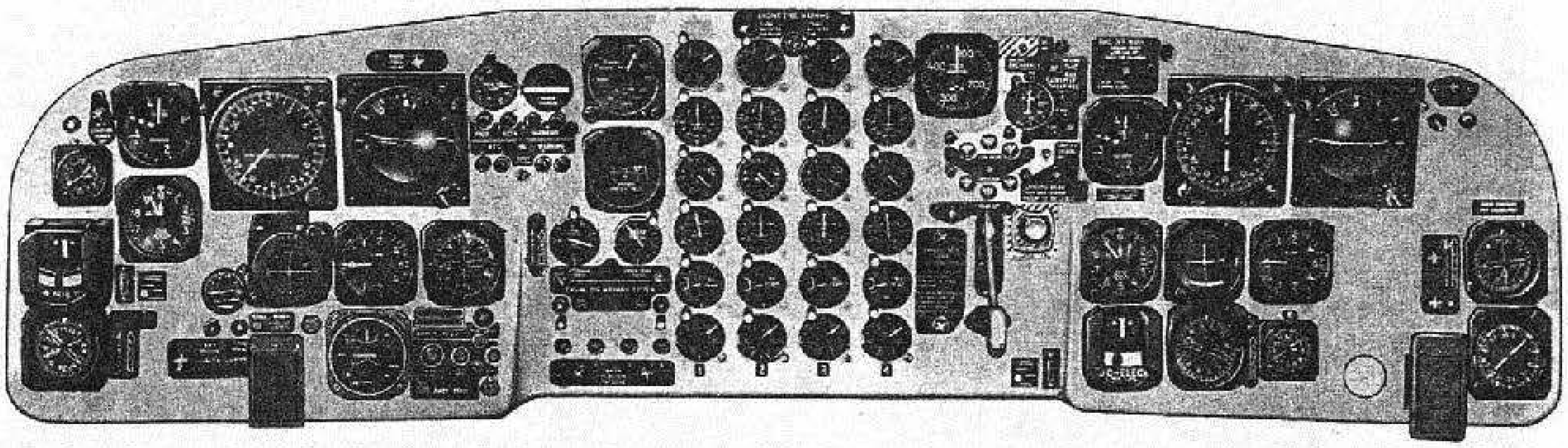


Figure 1-7 (Sheet 1 of 2)

of the plunger travel. To reduce the time required to shut down an engine on the ground, the brake may be applied at any engine speed below 45 percent rpm. However, it is recommended that the engine be allowed to coast to a stop to provide better cooling.

Engine Brake Switches.

Four 2-position, guarded, engine brake switches *(figure 1-8)*, one for each engine, are located on the pilots' overhead panel. The switches have the placarded positions ON and OFF. When a brake switch is placed in the ON position, a circuit is completed from the flight deck 28-volt d-c essential bus which energizes the respective engine brake control relay. The relay, when energized, completes a circuit from the center fuselage 28-volt d-c essential bus which provides power to the respective engine brake actuator, causing it to engage the brake. In addition, the ON position opens the circuits to the respective starter switch and to the air start position of the respective condition lever, in order to prevent starting the engine with the brake ON. The OFF position completes a 28-volt d-c circuit to reverse the brake actuator action and to disengage the brake. The circuit is opened by means of a limit switch at the end of the actuator travel. In addition, the OFF position closes the circuits to the starter switch and to the air start position of the condition lever. The circuits between the engine brake switches and the engine brake control relays are protected by a circuit breaker placarded ENGINE DRAG BRAKE CONTROL, located on the flight engineer's overhead circuit breaker panel. The circuits between each relay and its respective engine brake actuator are individually protected by circuit breakers, placarded ENGINE BRAKE POWER, located on the center fuselage right hand circuit breaker panel.

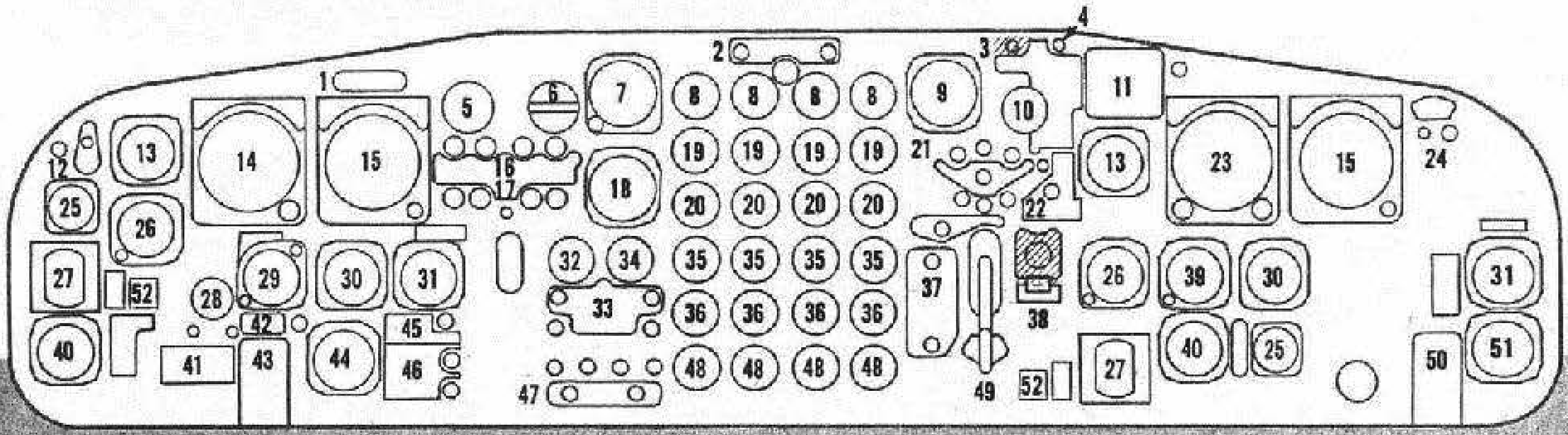
WARNING

The engine brake switch should not normally be turned ON in flight. Under certain emergency conditions, such as a propeller rotating slowly either forward or backward, propeller rotation may be stopped by use of the engine brake. If propeller rotation continues after applying the brake, immediately return the engine brake switch to OFF to prevent damage from overheating or secondary fire. Under no circumstances should the engine brake be used if propeller rotation exceeds 1 blade per second, as determined by visual check.

ENGINE INSTRUMENTS.

All engine instruments are single indicating and are mounted in the center section of the pilots' instrument panel *(figure 1-7)*, with the exception of the total fuel flow indicator *(34, figure 1-13, and 4, figure*

Instrument Panel — Typical



1. RADIO CALL PLACARD
2. MASTER ENGINE FIRE WARNING LIGHT
3. EMERGENCY FLAP SWITCH
4. EMERGENCY WING FLAP HYDRAULIC PRESSURE INDICATING LIGHT
5. FREE AIR TEMPERATURE INDICATOR
6. PITOT HEATER MASTER CAUTION INDICATOR
7. RADAR ALTIMETER
8. TORQUE PRESSURE INDICATOR (4)
9. TRUE AIRSPEED INDICATOR
10. WING FLAP POSITION INDICATOR
11. TAKEOFF WARNING LIGHT
12. N-1 COMPASS POWER-OFF LIGHT
13. AIRSPEED INDICATOR (2)
14. N-1 COMPASS REPEATER (V-7A)
15. ATTITUDE INDICATOR (2)
16. PROPELLER BETA WARNING LIGHTS
17. NTC INDICATOR LIGHTS
18. ID-307/ARN RANGE INDICATOR
19. TACHOMETER (4)
20. TURBINE INLET TEMPERATURE/EXHAUST GAS TEMPERATURE INDICATOR (4)
21. LANDING GEAR POSITION INDICATORS
22. LANDING GEAR WARNING LIGHT TEST AND HORN CUTOFF SWITCH
23. DIRECTIONAL INDICATOR
24. INTERCALL SWITCH AND LIGHT
25. CLOCK (2)
26. ALTIMETER (2)
27. TURN AND SLIP INDICATOR (2)
28. LIQUID OXYGEN QUANTITY INDICATOR
29. ID-351/ARN OR ID-387/ARN COURSE INDICATOR (VOR/ILS)
30. VERTICAL VELOCITY INDICATOR (2)
31. ID-250/ARN RADIO MAGNETIC (ADF-1 & ADF-2) INDICATOR (2)
32. HYDRAULIC SYSTEM PRESSURE INDICATOR
33. OIL LOW-LEVEL AND OIL LOW-PRESSURE WARNING LIGHTS
34. EMERGENCY AIRBRAKE PRESSURE INDICATOR
35. FUEL FLOW INDICATOR (4)
36. OIL TEMPERATURE INDICATOR (4)
37. EMERGENCY GEAR EXTENSION PLACARD
38. LANDING GEAR DOWNLOCK OVERRIDE BUTTON
39. ID-525/ARN COURSE INDICATOR (VOR/ILS)
40. RADIO MAGNETIC (TAC OR VOR) AND (UHF-D/F) INDICATOR (2)
41. LIQUID OXYGEN QUANTITY INDICATOR TEST SWITCH AND LOW-LEVEL WARNING LIGHT
42. STALL WARNING SYSTEM TEST SWITCH
43. PILOT'S COMPASS DEVIATION CARD HOLDER
44. THREE AXIS TRIM INDICATOR
45. TWO-POSITION RUDDER STOP CAUTION INDICATOR AND TEST SWITCH
46. ANTISKID SWITCH AND WARNING LIGHT
47. WATER-ALCOHOL INJECTION PRESSURE INDICATOR (4)
48. OIL PRESSURE INDICATOR (4)
49. LANDING GEAR LEVER
50. COPILOT'S COMPASS DEVIATION CARD HOLDER
51. N-1 COMPASS REPEATER (V-8)
52. TURN AND SLIP EMERGENCY POWER SWITCHES (2) (T.C.T.O. 534)

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Figure 1-7 (Sheet 2 of 2)

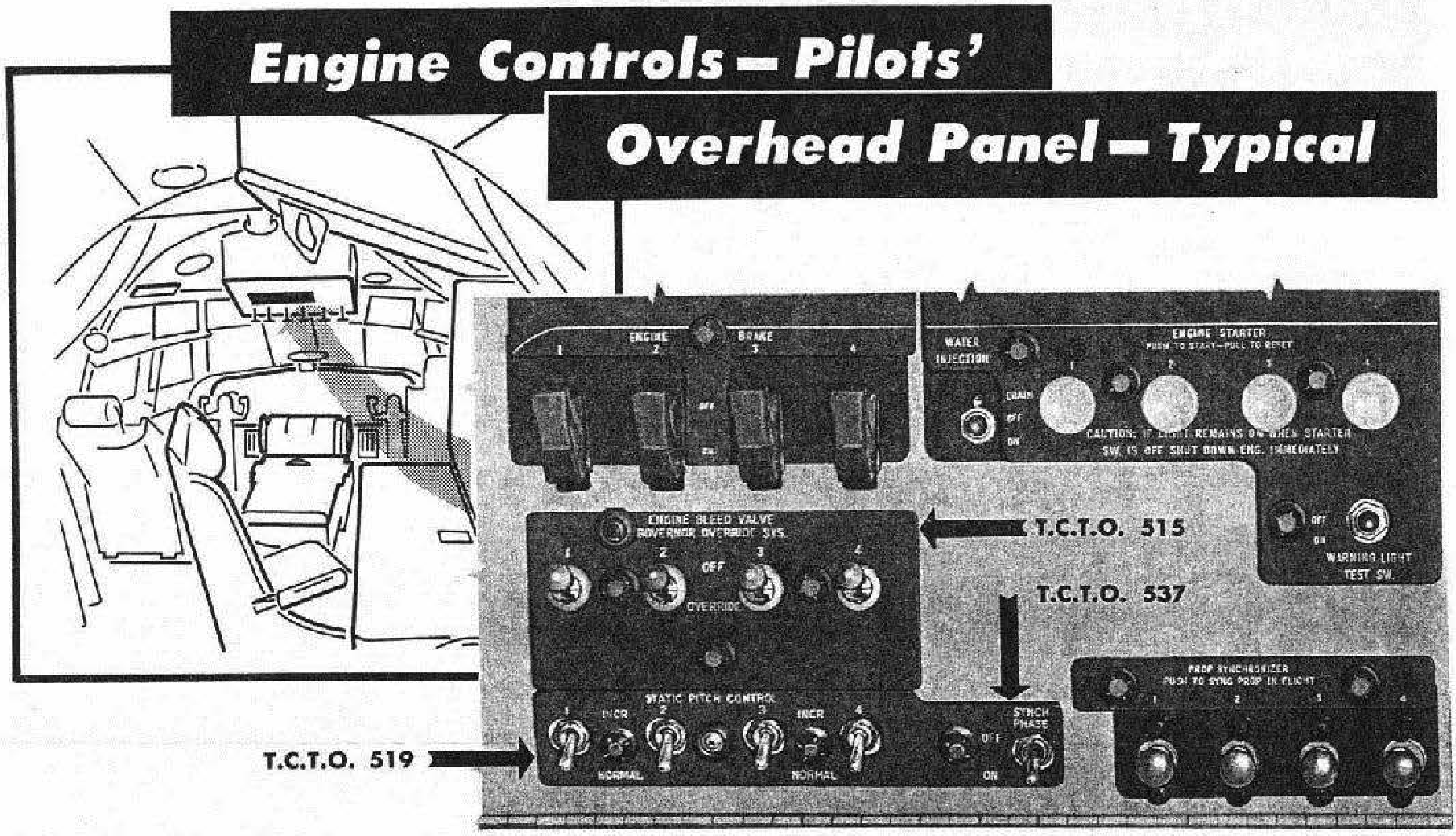

Engine Controls — Pilots' Overhead Panel — Typical

Figure 1-8

1-19), which is located on the flight engineer's instrument panel. For ease of reading, all the instruments are mounted so that on takeoff the pointers will point in the same direction when indicating normal readings.

Tachometers.

Four engine tachometers *(19, figure 1-7),* calibrated in percent rpm, are mounted on the pilots' instrument panel. Engine-driven tachometer generators supply power and signals for these instruments.

Turbine Inlet Temperature (TIT) Indicators — C-133B Aircraft.

Four 115-volt a-c turbine inlet temperature (TIT) indicators *(20, figure 1-7),* calibrated in degrees centigrade, are mounted on the pilot's instrument panel. The indicator system receives signals from 17 TIT probes located just forward of the turbine inlet nozzle in each engine. Power for operation of the TIT indicating systems is obtained from the flight deck 115-volt a-c essential bus. Circuit protection for each of the four TIT indicating systems is individually provided by circuit breakers located on the flight deck left hand auxiliary circuit breaker panel.

Exhaust Gas Temperature (EGT) Indicators — C-133A Aircraft.

Four exhaust gas temperature indicators *(20, figure 1-7),* calibrated in degrees centigrade, are mounted on the pilots' instrument panel. The exhaust gas temperature indicators are energized from the flight deck 115-volt a-c essential bus. The exhaust gas temperature indicator circuits for each engine are individually protected by a circuit breaker located on the flight deck left hand auxiliary circuit breaker panel.

Torque Pressure Indicators.

Four 28-volt a-c torque pressure indicators *(8, figure 1-7),* calibrated in pounds per square inch (psi), are installed on the pilots' instrument panel. Indications of actual engine power output are provided by the torque pressure indicators. The indicators receive signals from a variable reluctance transmitter mounted on the nose case of each engine. Power for operation of the torque pressure indicating systems is obtained from the flight deck 28-volt a-c essential bus. Circuit protection for each of the four torque pressure indicating systems is individually provided by circuit breakers located on the flight deck right hand auxiliary circuit breaker panel.

Oil Pressure Indicators.

Four oil pressure indicators *(48, figure 1-7)*, calibrated in pounds per square inch (psi), are installed on the pilots' instrument panel. Oil pressure is taken from the pressure side of each engine-driven pump, by a 28-volt a-c variable-reluctance transmitter which receives power from the flight deck 28-volt a-c essential bus. Circuit protection for each of the four oil pressure indicating systems is individually provided by circuit breakers located on the flight deck right hand auxiliary circuit breaker panel.

Oil Low-Pressure Warning Light.

A red, 28-volt a-c, oil low-pressure warning light *(33, figure 1-7)* is installed on the pilots' instrument panel. The light is controlled by pressure switches located in each engine oil system. The warning light, when on, indicates an oil pressure condition below 42 psi. The circuit to the warning light is opened when the condition levers are placed in the FUEL OFF or FEATHER position. Power for operation of the oil low-pressure warning light is obtained from the flight deck 28-volt a-c essential bus. Circuit protection is provided by a circuit breaker located on the flight deck right hand auxiliary circuit breaker panel. For minimum oil pressure operating limits, see Section V.

Oil Temperature Indicators.

Four 28-volt d-c oil temperature indicators *(36, figure 1-7)*, calibrated in degrees centigrade, are installed on the pilots' instrument panel. The indicators are controlled by four oil temperature sensing bulbs located in the respective oil tank sumps. Power for operation of the oil temperature indicating systems is obtained from the flight deck 28-volt d-c essential bus. Circuit protection is provided by a circuit breaker located on the flight engineer's overhead circuit breaker panel.

Oil Volume Indicators.

Four oil volume indicators *(36, figure 1-13)*, calibrated in gallons, are installed on the flight engineer's instrument panel. The indicators are actuated by float units mounted in their respective tanks. Power for operation of the oil volume indicating systems is obtained from the flight deck 28-volt d-c essential bus. Circuit protection for each of the four oil volume indicating systems is individually provided by circuit breakers located on the flight deck left hand auxiliary circuit breaker panel.

Oil Low-Level Warning Lights.

Two amber, 28-volt a-c, oil low-level warning lights *(33, figure 1-7; and 37, figure 1-13)* are installed; one on the pilots' instrument panel and one on the flight engineer's instrument panel. The lights are controlled by a float-actuated oil low-level warning light switch installed in each oil tank. Both lights will come on, to warn of low oil level, when the quantity of oil in any tank becomes less than 3.8 gallons. The oil low-level warning light circuit for each engine is opened when the condition lever for that engine is in either the FUEL OFF or FEATHER position, to prevent the warning light from remaining on in the event an engine has been shutdown due to low oil quantity. Power for operation of the oil low-level warning lights is obtained from the flight deck 28-volt a-c essential bus. Circuit protection is provided by a circuit breaker located on the flight deck right hand auxiliary circuit breaker panel.

Fuel Flow Indicators.

Four fuel flow indicators *(35, figure 1-7)*, calibrated in pounds per hour, are mounted on the pilots' instrument panel. Power for operation of the fuel flow indicators is obtained from both the flight deck 28-volt d-c essential bus and the flight deck 115-volt a-c essential bus. The 28-volt d-c power is converted to 15-volt, 4-cycle, 3-phase a-c power by the fuel flow indicating system power supply unit. The 15-volt, 4-cycle, 3-phase a-c and 115-volt, 400-cycle single-phase a-c power is then supplied to the transmitters and indicators of the system for their operation. The power supply unit is located on the right side of the forward equipment rack, at station 160. Circuit protection for both the 28-volt d-c and 115-volt a-c circuits of the fuel flow indicating system is provided by circuit breakers located on the flight deck left hand auxiliary circuit breaker panel.

Total Fuel Flow Indicator.

The total fuel flow indicator *(4, figure 1-19)*, mounted on the flight engineer's instrument panel, indicates total fuel flow in pounds per hour. Power for operation of the total fuel flow indicator is obtained from the flight deck 115-volt a-c auxiliary bus. Circuit protection for the total fuel flow indicator circuits is provided by a circuit breaker located on the flight deck left-hand auxiliary circuit breaker panel.

Fuel Low-Pressure Warning Lights.

Four red, press-to-test, 28-volt a-c fuel low-pressure warning lights *(1, figure 1-19)*, one for each engine, are mounted on the flight engineer's instrument panel. The warning lights are wired through the flight engineer's dimming relay to fuel pressure switches in each engine fuel system. When the fuel pressure drops below 9 psi, the switch completes the circuit and the respective warning light will come on to indicate inadequate fuel boost pump discharge pressure. Power for operation of the fuel low-pressure warning lights is obtained from the flight deck 28-volt a-c essential bus. Circuit protection for each of the four fuel low-pressure warning lights is individually provided by circuit breakers located on the flight deck right-hand auxiliary circuit breaker panel.

ENGINE VIBRATION MONITORING SYSTEM (AIRCRAFT WITH T.C.T.O. 612).

The engine vibration monitoring system is installed to enable the flight engineer to monitor vibration levels at the inlet, accessory case, and turbine case of each engine. The system consists of a vibration indicator, a-c and d-c power switches, a vibration pickup selector switch, a test switch, engine vibration amplifier, and three vibration pickups mounted on the engine. Power for operation of the system is supplied from the 28-volt d-c essential bus and the 115-volt, single-phase a-c essential bus on the flight deck left-hand auxiliary circuit breaker panel.

Engine Vibration Indicator.

The engine vibration indicator *(55, figure 1-13)* is mounted on a panel at the upper left corner of the flight engineer's instrument panel. The indicator consists of four vertical reading scales and pointers, one for each engine. The scales are graduated in numbers which can be converted to mils or read directly as velocity. The indicator pointer shows the relative output of the vibration pickup selected for reading by the vibration pickup selector switch.

Vibration Pickup Selector Switch.

A 4-position vibration pickup selector switch placarded LOCATION SELECTOR is mounted on the panel directly below the vibration indicator. The switch has the positions INLET, ACCESSORY, TURBINE, and PROP. When placed in any of the four positions, the signals from the vibration pickups at the selected location on all four engines are selected for display on the indicator scales.

Engine Vibration Monitoring System Power Switches.

Two 2-position engine vibration system power switches, placarded A.C. PWR. D.C., are installed on the vibration indicator panel *(55, figure 1-13)*. Each switch has the positions ON and OFF, when placed in the ON position, power is supplied to the vibration amplifiers from the applicable bus.

Engine Vibration Indicator Test Switch.

A press-to-test engine vibration test switch is installed on the vibration indicator panel to enable the operator to test the continuity of the circuit through the indicator, amplifier and pickups. The system can be tested at any time power is available to the system whether engines are operating or not. When the switch is depressed, and power to the system is ON, a 400 cycle signal of known voltage is inserted in series with the pickup cables. This signal is read as a deflection of the pointer of the indicator. To test all pickups and cabling the vibration pickup selector switch must be positioned to each of the four positions while performing the check. Refer to Section VII for Engine Vibration Monitoring System checks and operational procedure.

PROPELLERS.

Each engine is equipped with a Curtiss turboelectric, three-blade, full-feathering, reversible-pitch propeller. Each propeller is controlled by its respective throttle and condition lever, and is provided with both synchronized and mechanical reference governing, automatic negative torque control (NTC), coordinated blade angle control, synchrophasing, overspeed pitch lock and static pitch control.

When a throttle is in the FLIGHT range, the propeller for that engine controls the rpm of its respective engine either electrically, through the synchronizer, or mechanically, through mechanical reference governing. The negative torque control system provides a visual warning in the event a loss of power causes the engine to be driven by the propeller.

Note

> The negative torque control system is effective during operation on either synchronized or mechanical reference governing.

When a throttle is in the GROUND range, it controls the blade angle of its respective propeller through a coordinator-potentiometer which is mounted on, and actuated by, the fuel control unit. Propeller control is proportional to throttle setting throughout the GROUND range until the full reverse blade angle of minus 9.2 degrees is reached.

The propeller synchrophasing system, operating through the synchronizer, causes the blades of each propeller to rotate in a preset position relative to the position of the blades of the other propellers. By controlling the position of the propeller blades so that the tips of the blades of adjoining propellers do not pass the same relative points at the same time, harmonic vibration, noise, and structural fatigue are reduced.

The propeller overspeed pitch lock system mechanically prevents the blade angle of the propellers from a coordinator-potentiometer which is mounted on, and actuated by, the fuel control unit. Propeller control is proportional to throttle setting throughout the GROUND range until the full reverse blade angle of minus 9.2 degrees is reached.

(Aircraft With T.C.T.O. 519):

Each engine is equipped with a Curtiss turbo-electric, three-blade, full-feathering, reversible-pitch propeller. Each propeller is controlled by its respective throttle and condition lever, and is provided with both synchronized and mechanical reference governing, automatic negative torque control (NTC), coordinated blade angle control, synchrophasing, overspeed pitch lock and static pitch control.

When a throttle is in the FLIGHT range, the propeller for that engine controls the rpm of its respective engine either electrically, through the synchronizer, or mechanically, through mechanical reference governing. The negative torque control system provides a visual warning in the event a loss of power causes the engine to be driven by the propeller.

Note

> The negative torque control (NTC) system is effective during operation on either synchronized or mechanical reference governing.

When a throttle is in the GROUND range, it controls the blade angle of its respective propeller through a coordinator-potentiometer which is mounted on, and actuated by, the fuel control unit. Propeller control is proportional to throttle setting throughout the GROUND range until the full reverse blade angle of minus 9.2 degrees is reached.

The propeller synchrophasing system, operating through the synchronizer, causes the blades of each propeller to rotate in a preset position relative to the position of the blades of the other propellers. By controlling the position of the propeller blades so that the tips of the blades of adjoining propellers do not pass the same relative points at the same time, harmonic vibration, noise, and structural fatigue are reduced.

The propeller overspeed pitch lock system mechanically prevents the blade angle of the propellers from decreasing, in the event certain malfunctions occur during flight. An engine overspeed condition, a propeller blade attaining a blade angle of less than 8-degrees, or a loss of d-c power will cause the overspeed pitch lock to become engaged. When the overspeed pitch lock of a specific propeller is engaged, the blade angle of that propeller can be increased, but cannot be decreased below 60 degrees.

The hunt-to-feather feature of the auxiliary feathering circuit utilizes propeller rotational forces to affect a change of blade angle.

The static pitch controls are provided to permit the propellers to be feathered, on the ground, when the engines are not operating.

CONDITION LEVERS.

Four condition levers *(4, figure 1-11),* located on the control pedestal, are mechanically linked to respective engine fuel control units. The levers have the placarded positions FEATHER, FUEL OFF, RUN-FUEL ON, and AIR START. Through mechanical linkage, the lever turns the fuel on in the RUN-FUEL ON and AIR START positions and shuts the fuel off and deactivates the circuits to the oil low-level and low-pressure warning lights in the FUEL OFF and FEATHER positions. Movement of a lever from the FUEL OFF position toward the RUN-FUEL ON position actuates a switch which energizes a timer, allowing engine ignition to be on for 3 minutes. The ignition cycle can be reset at any time by returning the lever to the FUEL OFF position for a minimum of 1 second, then moving it back toward the RUN-FUEL ON position. Return of the lever to the FUEL OFF position at any time will terminate the ignition cycle. When the lever is positioned to FEATHER, a switch is actuated which opens the propeller control circuit and completes a 28-volt d-c circuit to the normal propeller feathering system, moving the propeller blades to the feathered position. When the lever is placed in the AIR START position, it actuates a switch which opens the normal propeller circuit, and completes a 28-volt d-c circuit to the decrease pitch change mechanism. This mechanism moves the propeller blades from the feathered position to a preset (74-degree) air start blade angle. The levers are spring loaded to return to the RUN-FUEL ON position when released from the AIR START position. The levers may be returned to FUEL OFF whenever fuel for the engine is not required. When a condition lever is placed in either the FUEL OFF or FEATHER position, the engine anti-icing system circuits for that engine are de-energized.

WARNING

The normal NTC and the normal propeller operating circuits are inoperative when the condition lever is in the AIR START position.

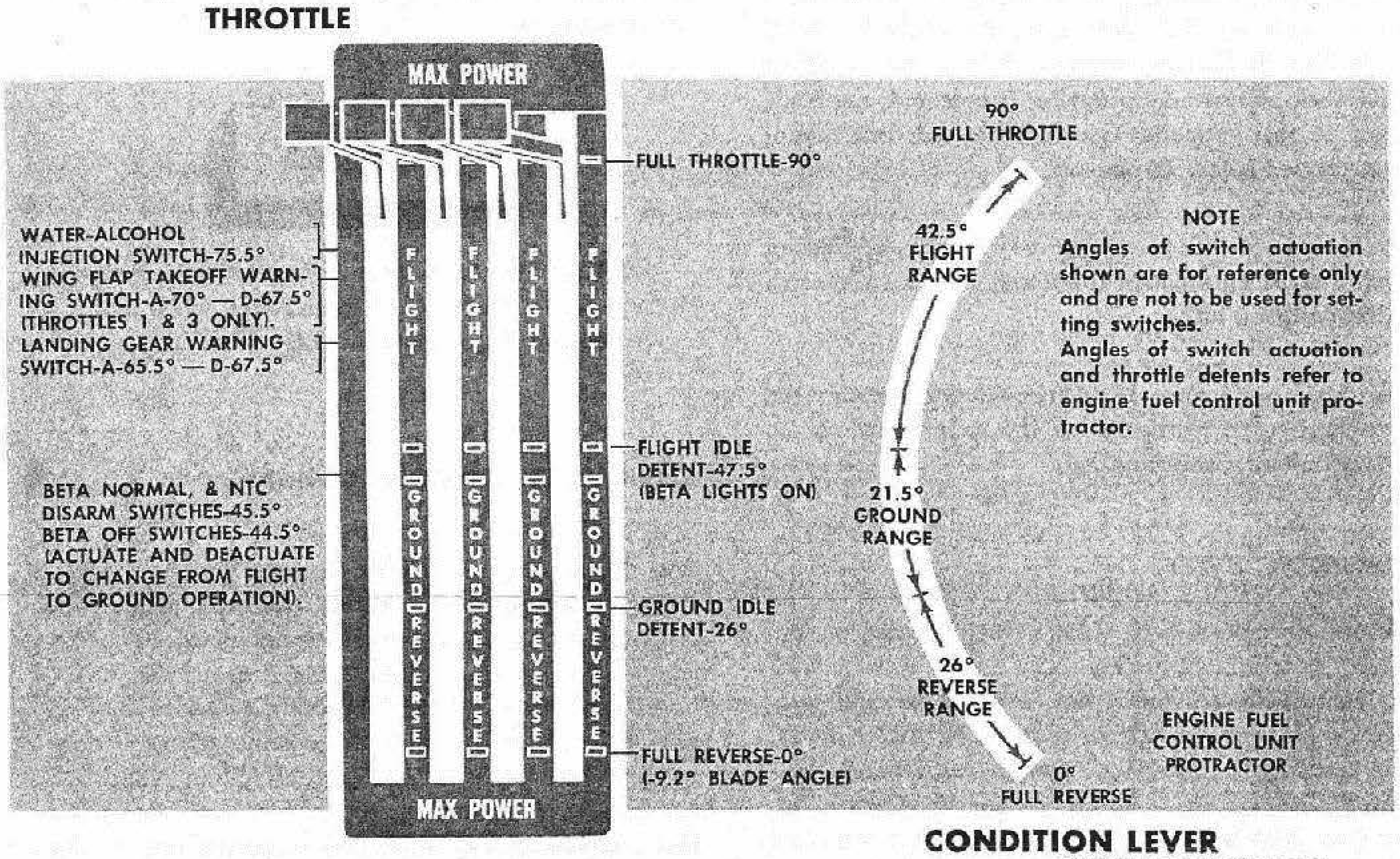
STATIC PITCH CONTROL SWITCHES.

Four 2-position, static pitch control switches *(figure 1-8)* are located on the pilots' overhead panel. The switches, which have the placarded positions INCR and NORMAL, are spring loaded from the INCR position to the NORMAL position. In addition, each switch is placarded with a numeral, corresponding to the propeller which it controls. In the NORMAL position, each switch completes a 28-volt d-c circuit that supplies power from the propeller bus to the normal Beta control circuit of its repective propeller. When a switch is held in the INCR position, it completes a 28-volt d-c circuit that supplies power from the propeller bus to actuate the air start motor of its respective propeller, providing the condition lever for that propeller is in either the RUN-FUEL ON or FUEL OFF position, and the throttle is in the GROUND range. As long as the switch is held in the INCR position, the air start motor will continue to increase the blade angle of the propeller until the blades reach the feathered position. In addition to their normal function of providing a control for conducting a static check of the propellers, the switches also permit the propeller of an inoperative engine to be feathered on the ground. See Section VII for Propeller Static Check.

PROPELLER GOVERNORS.

An acceleration-stabilized propeller governor, located on the rear of each propeller power unit, is provided to correct the blade angle of its respective propeller, as necessary, to maintain the desired engine speed

Throttle and Condition Lever Positions



NOTE

Angles of switch actuation shown are for reference only and are not to be used for setting switches.

Angles of switch actuation and throttle detents refer to engine fuel control unit protractor.

CONDITION LEVER POSITION	FUEL	PROPELLER
AIR START	ON	FIXED PITCH IF BLADE ANGLE IS BELOW 74° WHEN CONDITION LEVER IS PLACED IN AIR START OR PROPELLER WILL BE DRIVEN TO 74° BLADE ANGLE IF ABOVE 74° WHEN CONDITION LEVER IS PLACED IN AIR START
RUN–FUEL ON	ON	GOVERNING
FUEL OFF	OFF	GOVERNING
FEATHER	OFF	FEATHERED TO 86.5° BLADE ANGLE

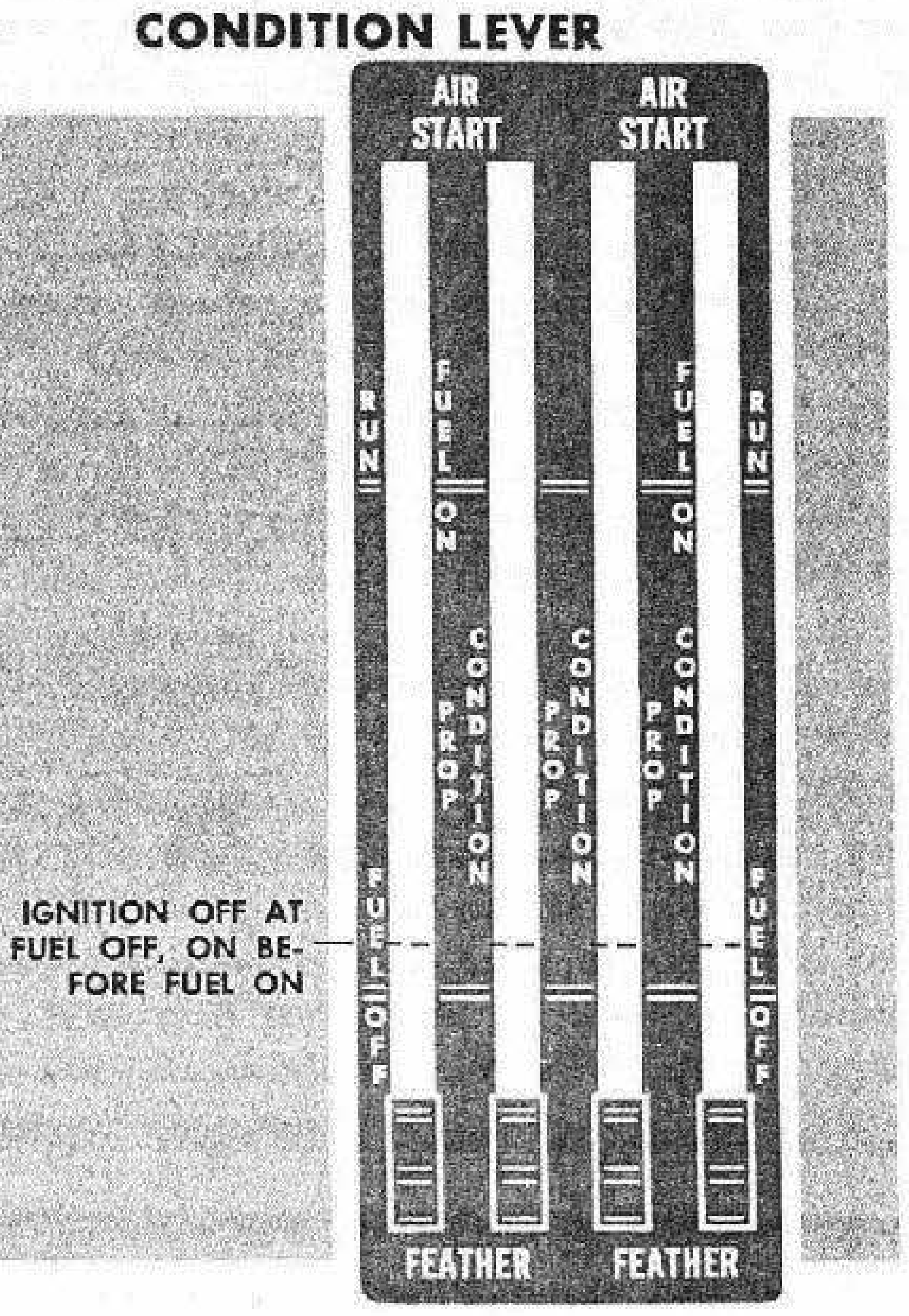


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Figure 1-9

for any flight attitude. The propeller governor will control the rpm of its respective engine either electrically, through the propeller synchronizer or mechanically, through an individual mechanical reference governor, whenever the throttle of that engine is in the FLIGHT range.

PROPELLER SYNCHRONIZER.

A 28-volt d-c powered propeller synchronizer, located on the forward electronic rack *(8, figure 4-10)*, provides the 115-volt, 3-phase, variable frequency a-c reference signal which drives each propeller governor reference motor at the same speed to achieve synchronized speed operation of all engines. The propeller synchronizer is energized, during engine operation, whenever the throttles are in the FLIGHT range and the propeller synchronizer buttons are pushed in. With the synchronizer in operation, the blade angle of the propellers will be controlled so that all four engines operate at a synchronized rpm. The propeller synchronizer will provide synchronous engine operation at any engine speed between the range of 94.5 to 100 percent rpm. During synchronizer operation, the speed of all engines will be synchronized to the speed of the engine with the most forward throttle position. In the event a malfunction causes the rpm of an engine to become either less than 92.5 percent rpm or greater than 103 percent rpm, control of that engine will automatically be changed from the propeller synchronizer to its mechanical reference governor, and will be maintained at 97.7 percent rpm. If the throttle of an engine whose speed is being controlled by its mechanical reference governor is advanced forward of the other three throttles, the speed of the synchronizer-controlled engines will increase. Under these conditions, the torque of the mechanical reference governor controlled engine will increase, as its throttle is advanced, but its rpm will remain at 97.7 percent. The propeller synchronizer incorporates an underspeed protective device which will automatically cause a changeover from synchronizer to mechanical reference governor control on all four engines, in the event a propeller synchronizer failure causes engine speed to be reduced more than 2.3 percent below the selected rpm.

Propeller Synchronizer Buttons.

Four 2-position propeller synchronizer buttons *(figure 1-8)* are located on the pilots' overhead panel and are placarded PROP SYNCHRONIZER PUSH TO SYNCH PROP IN FLIGHT. The buttons are spring loaded from the IN to the OUT position, and incorporate holding coils for the IN position. During engine operation, when the synchronizer buttons are pushed IN, the propellers will be synchronized for operation between 94.5 and 100 percent rpm by means of a synchronous-speed reference motor. When the rpm falls below 92.5 percent, or exceeds 103 percent, a rpm error switch will open the 28-volt d-c circuit to the synchronous-speed reference motor, the holding coil will release, the synchronizer button will pop OUT, and the propeller will be mechanically governed to 97.7 percent rpm. The button may be manually pulled OUT whenever desired.

PROPELLER SYNCHRONIZER RPM TRIM SYSTEM.

A propeller synchronizer rpm trim system is installed which allows the pilot to operate the engines at the desired schedule. The propeller synchronizer rpm trim system is effective only while operating on synchronizer reference governing (propeller synchronizer buttons IN). See Section VII for propeller synchronizer rpm trim operation.

Propeller Synchronizer RPM Trim Lever.

A propeller synchronizer rpm trim lever *(31, figure 1-11)*, located on the left side of the control pedestal, is mechanically linked to the synchronizer control drum. The trim lever has the placarded positions INCREASE, NEUTRAL, and DECREASE. When the trim lever is in NEUTRAL, the normal throttle-synchronizer rpm relationship exists. When moved to the INCREASE position, the trim lever rotates the synchronizer drum biasing the throttle-synchronizer rpm relationship and will increase rpm approximately 0.5 percent. At no time can the rpm be trimmed above 100 percent. When in the full DECREASE position, the trim lever will bias the throttle-synchronizer rpm relationship; and, at an 85.5-degree throttle angle, rpm will decrease approximately 4.5 percent. At throttle angles below 85.5 degrees, the amount of down trim is limited by the synchronizer minimum rpm speed of 94.5 percent. At throttle angles above 85.5 degrees, the amount of down trim decreases with increasing throttle angle to a maximum down trim of 90-degrees throttle angle (MAX power) of approximately 2 percent rpm.

PROPELLER SYNCHROPHASING SYSTEM.

A propeller synchrophasing system is installed which effectively reduces structural fatigue loads imposed on the aircraft by sonic vibration. The propeller on engine No. 2 is used as the master propeller for the synchrophasing system, which may be utilized whenever the propeller synchronizer is in operation. During operation, the synchrophasing system controls the rotational speed of the propellers on engines No. 1, 3, and 4 by varying the blade angle of these propellers so that the blades of each propeller rotate in a preset position, in relation to the position of the blades of the other three propellers. The synchrophasing system consists of four pulse generators, one of which forms an integral part of each propeller; three slave channel amplifiers, located on a shelf at the right side of the lavatory; and a control switch, located on the pilot's overhead panel. The synchrophasing system is connected into the control circuits of the propeller synchronizer and the propeller governor reference motors.

Propeller Synchrophasing Control Switch.

A 2-position propeller synchrophasing control switch *(figure 1-8)*, placarded SYNCH PHASE, is installed on the pilots' overhead panel. The switch has the placarded positions ON and OFF. Placing the switch in the ON position completes a 28-volt d-c circuit, from the propeller bus to the three slave channel amplifiers, that supplies power for energizing the synchrophasing control circuits. Placing the switch in the OFF position opens the circuit between the propeller bus and the slave channel amplifiers, causing the synchrophasing control circuits to be deenergized.

AUXILIARY FEATHERING SWITCHES.

Four 2-position, lift-to-unlock, auxiliary feathering switches *(3, figure 1-11),* located on the control pedestal provide an additional means of propeller feathering control in the event of malfunction of the normal propeller feathering circuits. The switches have positions placarded FEATHER and NORMAL. When an auxiliary feathering switch is pulled up and positioned to FEATHER, the normal propeller circuit is opened and the 28-volt d-c auxiliary circuit is completed from the bus to feather the respective propeller. Auxiliary feather power is obtained from the essential flight deck left-hand auxiliary circuit breaker panel (propeller bus). The auxiliary feathering circuit, when energized, also provides a hunt-to-feather feature to effectively maintain the propeller in the feathered position, regardless of airspeed. The auxiliary feathering switches should not be actuated to energize the auxiliary feathering circuit using battery power alone. Battery voltage alone is lower than bus voltage and should only be used in an emergency for auxiliary feathering. Whenever possible, at least one transformer-rectifier or the air-driven generator should be supplying power to the bus before energizing this circuit.

PROPELLER BETA WARNING LIGHTS.

Four amber propeller Beta warning lights *(16, figure 1-7),* are located on the pilots' instrument panel and are placarded PROP BETA WARNING. The propeller Beta warning lights are wired into the circuitry of the respective propellers so that they will come on when the propeller blade angle is below 10½ degrees, regardless of throttle or condition lever position. Power for operation of the propeller Beta warning lights is obtained from the 28-volt d-c propeller bus, on the flight engineer's overhead panel. Circuit protection, for both configurations, is provided by circuit breakers located on the flight engineer's overhead circuit breaker panel. During ground runup, the propeller Beta warning light should not go off when the throttle is moved from the GROUND range to FLIGHT IDLE, due to overlapping propeller and aircraft switch settings. However, movement of the throttle to or above governing rpm will cause the light to go off. Once the light has gone off, movement of the throttle throughout the FLIGHT range should not cause the propeller Beta warning light to come on under any circumstances.

NEGATIVE TORQUE CONTROL (NTC) SYSTEM.

A dual (emergency and normal) negative torque control (NTC) system *(17, figure 1-4)* is installed on each engine to automatically provide an increase pitch (decrease rpm) signal whenever a condition of negative torque (propeller driving the turbine) exists. If a condition of negative torque is sensed by either NTC system, the propeller increase pitch circuit is actuated to start the propeller toward the feather position. The propeller will continue toward the feather position until a blade angle is reached where negative torque is less than that required to actuate the circuit. The system will not drive the propeller completely to feather. If engine power is restored prior to feathering, normal propeller operation is restored automatically. The NTC system is automatic during operation in the FLIGHT range, while using synchronizer or mechanical reference governing, whenever power is supplied to the 28-volt d-c system. Emergency NTC power is obtained from the essential flight deck auxiliary left-hand circuit breaker panel (propeller bus). The normal NTC and the normal propeller operating circuits are inoperative when the condition lever is in the AIR START position.

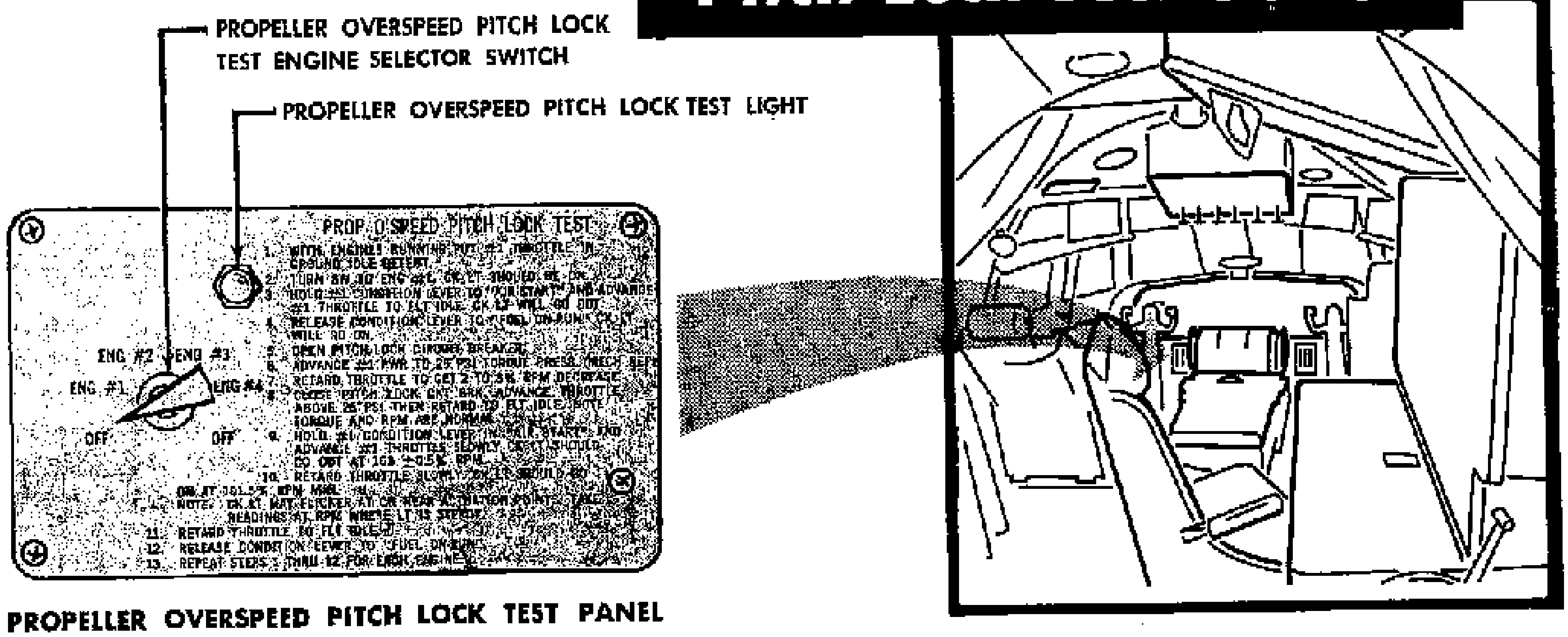
NTC Indicator Lights.

Four amber NTC indicator lights *(17, figure 1-7)* and a reset switch, installed on the pilots' instrument panel, are placarded NTC WARNING. Power for operation of the lights is obtained from the 28-volt d-c propeller bus. Circuit protection is provided by circuit breakers located on the flight deck left-hand auxiliary circuit breaker panel. The circuit breakers are wired into the NTC circuit so that whenever the emergency NTC circuit is energized, the respective NTC indicator light will come on. Actuating the reset switch will cause the light to go off. If the light comes on again following an increase in power setting, it will indicate to the pilot that a higher power setting is required, or that warranted NTC actuation has occurred.

PROPELLER PITCH LOCK SYSTEM.

An automatic pitch lock system is installed which mechanically prevents the propeller blade angle from decreasing, in the event certain malfunctions occur during flight. A pitch lock mechanism, which includes a 28-volt d-c solenoid-actuated racheting clutch, a pitch lock assembly, and a pitch lock release cam, is located in the forward spinner of each propeller. During normal operation, the solenoid is energized and prevents the clutch from engaging the lock. In the event a malfunction occurs that results in an engine overspeeding in excess of 103 percent rpm, a propeller attaining a

Propeller Overspeed Pitch Lock Test Panel



PROPELLER OVERSPEED PITCH LOCK TEST PANEL

Figure 1-10

UAB1-120

blade angle of 8 degrees or less, or a failure of the d-c power supply, the solenoid will become deenergized and will release the clutch, permitting the clutch to engage the lock. With the pitch lock engaged, propeller blade angle may be increased, but cannot be decreased until the malfunction that permitted the pitch lock to become engaged has been corrected.

PROPELLER OVERSPEED PITCH LOCK TEST SYSTEM.

A propeller overspeed pitch lock test system is installed to permit testing the propeller pitch lock system for proper operation during the preflight check. A propeller overspeed pitch lock test panel, on which the instructions for conducting the propeller overspeed pitch lock test are placarded, is mounted on the control pedestal, forward of the throttles. A propeller overspeed pitch lock test engine selector switch and a propeller overspeed pitch lock test light are installed on the test panel.

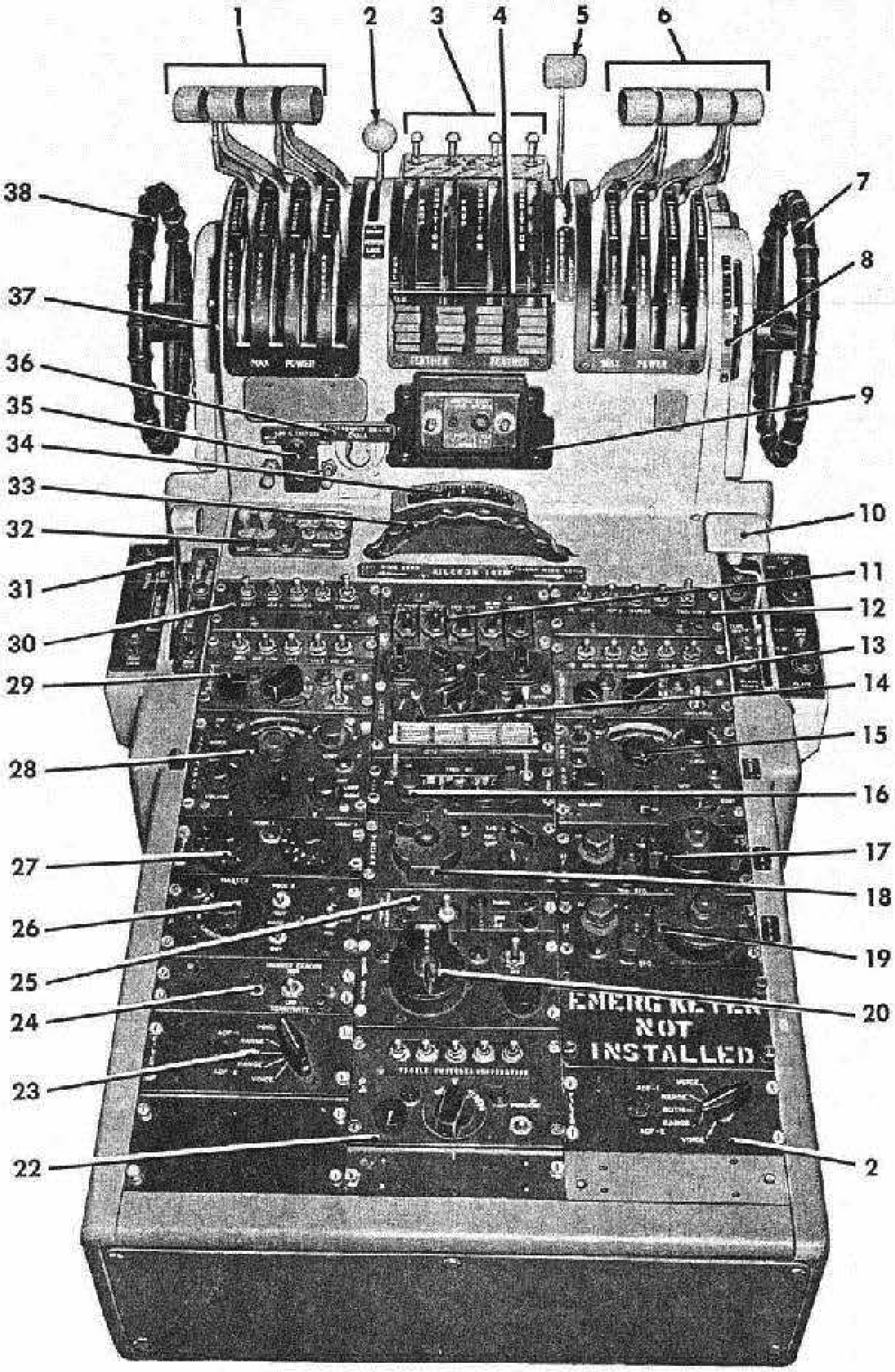
Propeller Overspeed Pitch Lock Test Engine Selector Switch.

A 6-position, rotary, propeller overspeed pitch lock test engine selector switch *(5, figure 1-10)* is located on the propeller overspeed pitch lock test panel. The switch has the placarded positions OFF, ENG #1, ENG #2, ENG #3, ENG #4, and OFF. Placing the engine selector switch in the ENG #1, ENG #2, ENG #3, or ENG #4 position will select the individual engine propeller overspeed pitch lock system test circuit to be tested. When the switch is placed in either of the two OFF positions, the propeller overspeed pitch lock system test circuits are open.

Propeller Overspeed Pitch Lock Test Light.

A green, 28-volt d-c propeller overspeed pitch lock test light *(4, figure 1-10)* is installed on the propeller overspeed pitch lock test panel. The test light will come on when the propeller overspeed pitch lock test engine selector switch is placed in one of the engine positions and the throttle for that engine is in the GROUND range, or if the speed of the selected engine is less than approximately 102 percent rpm and the blade angle of the propeller on that engine is greater than approximately 8 degrees. The test light will go off when the throttle of the selected engine is in the FLIGHT range and the blade angle of the propeller on that engine is less than approximately 8 degrees, or when the speed of the selected engine is greater than approximately 103 percent rpm. A press-to-test feature incorporated in the test light permits the lamp filament to be tested when the test light is pressed. Power for the operation of the pitch lock test light is obtained

Control Pedestal — Typical



1. PILOT'S THROTTLES
2. THROTTLE LOCK LEVER
3. AUXILIARY FEATHERING SWITCHES
4. CONDITION LEVERS
5. SURFACE SNUBBER LEVER
6. COPILOT'S THROTTLES
7. COPILOT'S ELEVATOR TRIM WHEEL
8. ELEVATOR TRIM INDICATOR
9. GROUND SPEED CONTROL SWITCHES
10. WING FLAP LEVER
11. AUTOPILOT FUNCTION SELECTOR PANEL
12. COPILOT'S INTERPHONE CONTROL MIXER SWITCHES
13. COPILOT'S INTERPHONE CONTROL PANEL
14. UHF COMMAND CONTROL PANEL
15. RADIO COMPASS (ADF) NO. 2 CONTROL PANEL
16. VHF COMMAND (VHF-101) CONTROL PANEL (T.C.T.O. 756)
17. HF LIASON NO. 1 CONTROL PANEL
18. TACAN CONTROL PANEL
19. HF LIASON NO. 2 CONTROL PANEL
20. VHF NAVIGATION CONTROL PANEL
21. COPILOT'S RADIO COMPASS FILTER
22. PA SYSTEM CONTROL PANEL
23. PILOT'S RADIO COMPASS FILTER
24. MARKER BEACON SENSITIVITY SWITCH
25. VOR-ILS/TACAN SELECTOR SWITCH PANEL
26. IFF CONTROL PANEL (AF59-522 AND SUBS.)
27. SIF CONTROL PANEL
28. RADIO COMPASS (ADF) NO. 1 CONTROL PANEL
29. PILOT'S INTERPHONE CONTROL PANEL
30. PILOT'S INTERPHONE CONTROL MIXER SWITCHES
31. PROPELLOR SYNCHRONIZER RPM TRIM LEVER
32. WING LANDING LIGHT CONTROL SWITCHES
33. AILERON TRIM WHEEL
34. AILERON TRIM INDICATOR
35. NOSE GEAR LANDING AND TAXI LIGHT SWITCHES
36. EMERGENCY AIRBRAKE HANDLE
37. ELEVATOR TRIM INDICATOR
38. PILOT'S ELEVATOR TRIM WHEEL

UAB1-121

Figure 1-11

Flight Engineer's Station - Typical

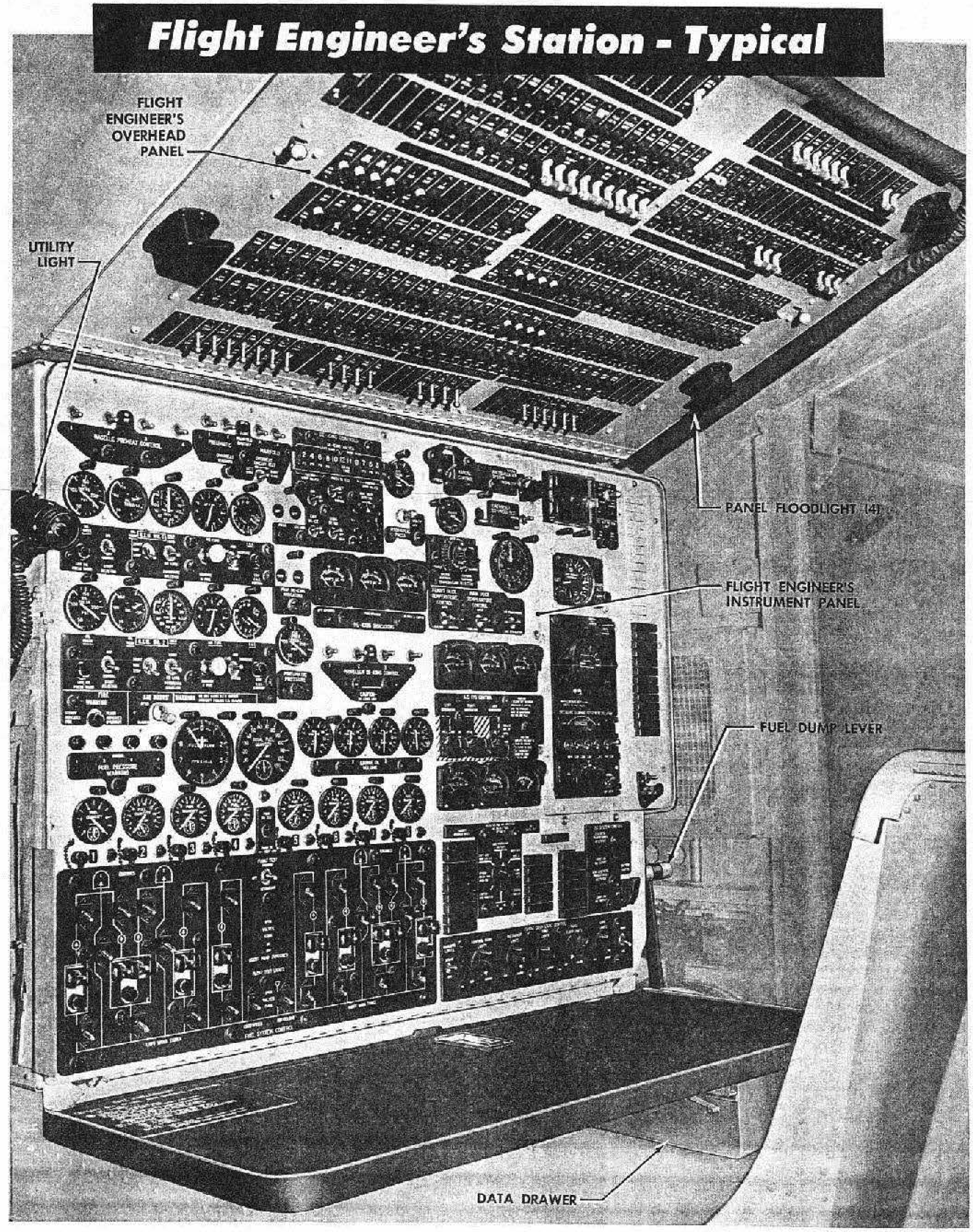


Figure 1-12

from the 28-volt d-c propeller bus. Circuit protection is provided by a circuit breaker located on the flight engineer's overhead circuit breaker panel.

ENGINE OIL SUPPLY SYSTEM.

Each engine is provided with an independent engine oil supply system. Lubricating oil is supplied to each engine from an individual oil tank, located aft of the firewall in each engine nacelle. Each oil tank has a capacity of 15 gallons of usable oil and is provided with adequate expansion space above the oil level. (For oil specifications and filler points, see Servicing Diagram, *figure 1-44.*) Each oil tank is protected from pressures in excess of approximately 4 psi by a pressure relief valve installed in the vent line. A float-actuated oil quantity transmitter, containing an integral oil low-level warning switch, is installed in each tank. The oil quantity transmitter actuates an oil quantity indicator located on the flight engineer's instrument panel. The oil low-level warning switch causes a light on the pilot's instrument panel and another light on the flight engineer's instrument panel to come on, to warn that a low oil level condition exists. An oil temperature bulb, installed in the sump at the bottom of each oil tank, senses and transmits the temperature of the oil being supplied to the engine to an oil temperature indicator on the pilot's instrument panel.

Oil is gravity and pressure fed from the oil tank through an electrically actuated engine oil firewall shutoff valve (see Fire Warning and Extinguishing Systems, this section) directly to the engine-driven oil pressure pump. The oil pressure pump is a single-section, gear-type pump designed to provide an adequate flow of oil under all engine operating conditions. In addition to its normal function of supplying oil under pressure for the lubrication and cooling of bearings and gears within the engine, the oil pressure pump also provides pressurized oil for the operation of the engine torque pressure indicating system.

From various drain and collection points in the engine, four individual gear-type scavenging pumps return the oil to be cooled and recycled. Depending upon the temperature and pressure of the scavenged oil, it is either directed through or is bypassed around the core of the oil cooler before being returned to the oil tank. A bypass relief valve, incorporated in the oil cooler, permits high pressure oil to bypass the core of the oil cooler whenever the pressure differential between the inlet port and the outlet port of the oil cooler core exceeds 40 psi.

Note

> High differential pressures may be encountered during cold weather engine starting or in the event the oil cooler core becomes clogged.

Ram air, entering a ram air scoop at the top of the engine, is ducted through the oil cooler to dissipate the heat of the oil. The flow of ram air through the oil cooler is controlled by the position of the electrically actuated oil cooler door.

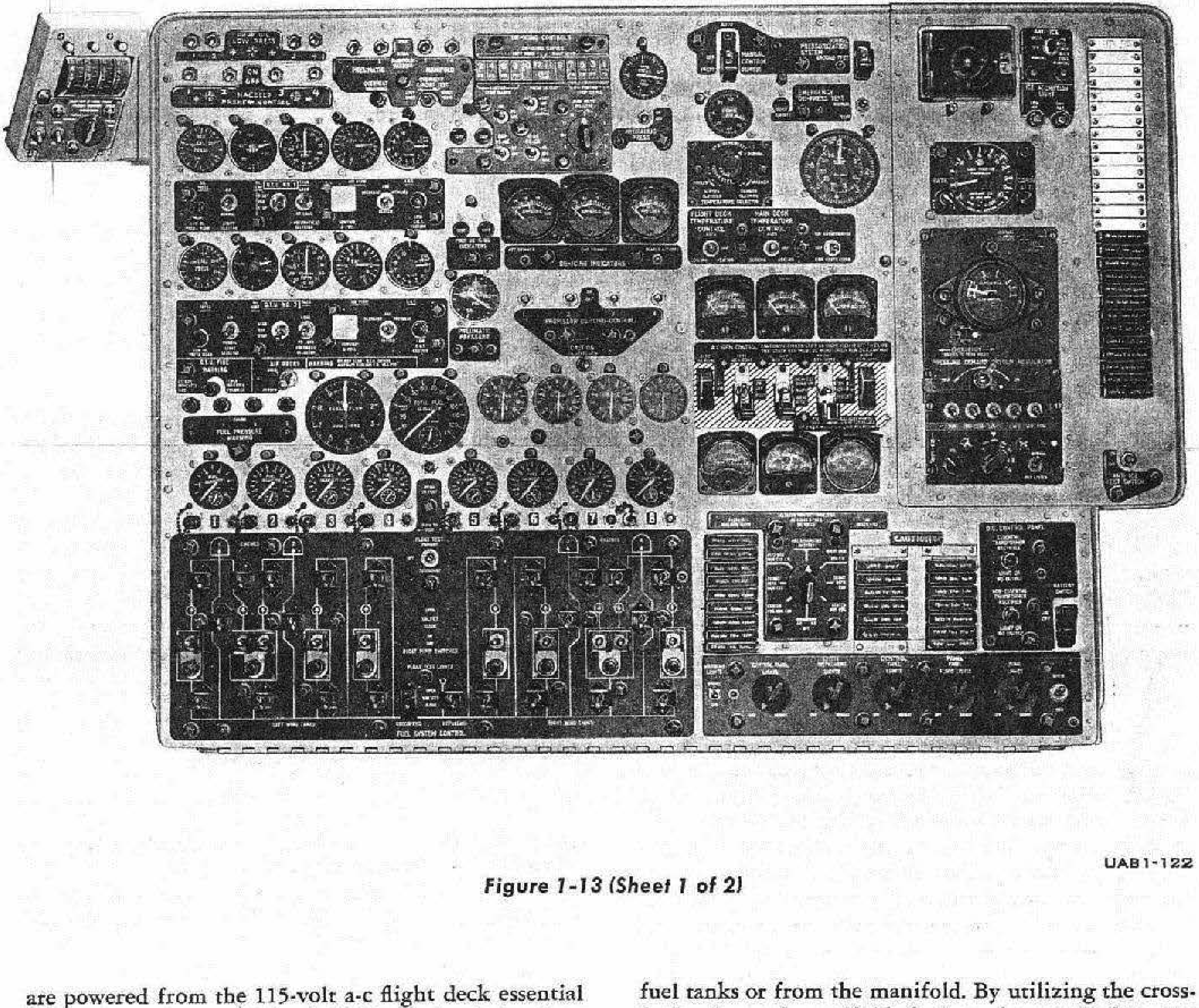
From the oil cooler, oil is returned to the top of the oil tank where it flows down a conical baffle to remove entrained air, before returning to the engine. The oil tank sump acts as a reservoir for any sludge or water that may accumulate in the tank.

On those aircraft equipped with fuel heaters, scavenged oil is either directed through or is bypassed around the fuel heater, depending upon oil pressure and fuel and oil temperatures, before reaching the oil cooler. The fuel heater transfers heat from the oil to the fuel being supplied to the engine, to minimize the formation of ice crystals in the fuel. The fuel heater is equipped with a pressure bypass valve which will permit the oil to bypass the core of the heater if a differential pressure of 16 psi exists between the oil inlet and the oil outlet ports of the fuel heater.

OIL COOLER DOOR SWITCHES.

Four, 4-position oil cooler door switches located on the pilots' overhead panel *(figure 1-6)* permit the operation of the oil cooler doors to be controlled either manually or automatically. Each switch has the placarded positions OPEN, CLOSE, and AUTO, and is spring loaded from the OPEN and CLOSE positions to the OFF (center) position. The AUTO position provides automatic control of the oil cooler doors. When placed in the AUTO position, each switch establishes a 115-volt a-c circuit to its respective oil cooler door thermostat. The thermostat, sensing variations in the temperature of the oil, then completes the circuit to cause the oil cooler door actuator to open or close the door. When an oil cooler door switch is held in either the OPEN or CLOSE position, it completes a 115-volt a-c circuit directly to its respective oil cooler door actuator. Placing a switch in the OFF, or center position, removes all electrical power from the circuit. The oil cooler doors may be manually controlled by using the OPEN, CLOSE, and OFF positions of the switches to stop the oil cooler doors in any intermediate position. The actuating circuits for each oil cooler door

Flight Engineer's



UAB1-122

Figure 1-13 (Sheet 1 of 2)

are powered from the 115-volt a-c flight deck essential bus, and are protected by individual circuit breakers on the flight engineer's overhead circuit breaker panel. On those aircraft equipped with fuel heaters, the revised operating oil temperature range of the oil cooler bypass valves may not permit the oil cooler doors to close during automatic operation at certain high ambient temperatures.

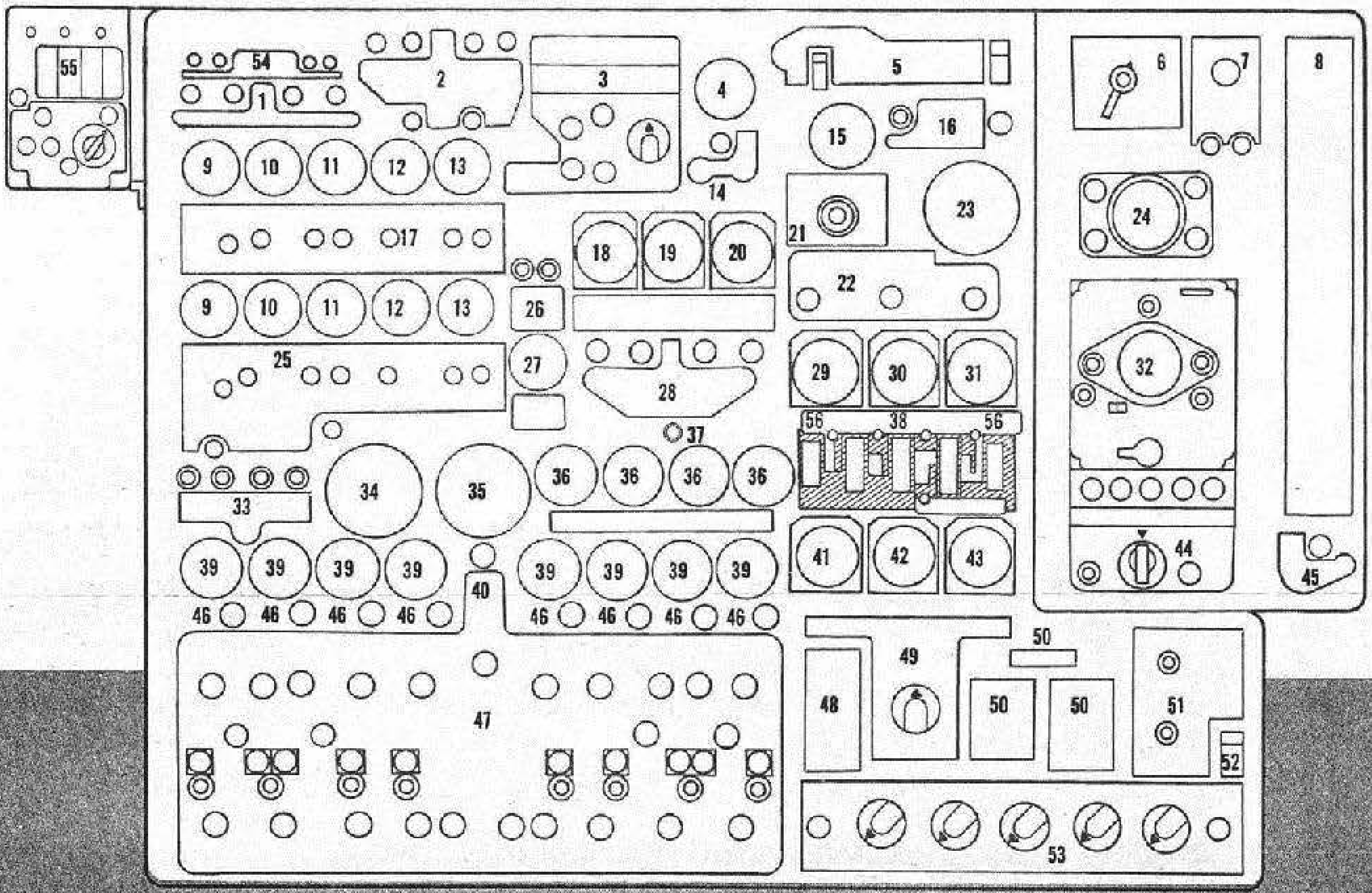
FUEL SUPPLY SYSTEM.

The fuel supply system *(figure 1-16)* is an eight tank, single manifold, crossfeed system, capable of providing fuel to each engine and the GTU's directly from the fuel tanks or from the manifold. By utilizing the crossfeed valve and manifold, fuel can be supplied to any engine from any tank, or transferred between any two tanks.

Servicing of the fuel system can be accomplished either by means of single point refueling or by overwing filler caps. A refueling riser vent is installed which permits residual fuel in the refueling riser to be drained into the single-point refueling unit, after completion of refueling. Provisions are also made for emergency jettisoning of fuel during flight.

All control valves in the fuel supply system are electrically actuated by switches on the fuel system control

Instrument Panel – Typical



1. NACELLE PREHEAT SWITCHES
2. PNEUMATIC MANIFOLD SWITCHES AND OVERHEAT WARNING PANEL
3. WING AND EMPENNAGE DEICING CONTROL PANEL
4. HYDRAULIC SYSTEM PRESSURE INDICATOR
5. PRESSURIZATION SYSTEM CONTROL PANEL
6. EMERGENCY DEPRESSURIZATION CONTROL HANDLE
7. ANTI-ICE CONTROL PANEL
8. ANTI-ICE SYSTEM ANNUNCIATOR PANEL
9. GTU OIL PRESSURE INDICATOR
10. GTU OIL TEMPERATURE INDICATOR
11. GTU TACHOMETER
12. GTU AIRFLOW DIFFERENTIAL PRESSURE (ΔP) INDICATORS
13. GTU EXHAUST GAS TEMPERATURE INDICATORS
14. HYDRAULIC PUMP CONTROL SWITCH
15. CABIN AIR TEMPERATURE INDICATOR
16. EMERGENCY DEPRESSURIZATION CIRCUIT TEST SWITCH
17. GTU NO. 1 CONTROL PANEL
18. AFT SPINNER DEICING AMMETER
19. FORWARD SPINNER DEICING AMMETER
20. BLADES AND CUFFS DEICING AMMETER
21. FLIGHT DECK AND MAIN CABIN TEMPERATURE SELECTOR
22. AIR CONDITIONING CONTROL PANEL
23. CABIN ALTIMETER
24. CABIN PRESSURE CONTROLLER
25. GTU NO. 2 CONTROL PANEL
26. PROPELLER DEICING INDICATORS
27. PNEUMATIC PRESSURE INDICATOR
28. PROPELLER DEICING CONTROL SWITCHES
29. LEFT GENERATOR AMMETER
30. RIGHT GENERATOR AMMETER
31. AUXILIARY GENERATOR AMMETER
32. OXYGEN REGULATOR AND FLOW INDICATOR
33. FUEL PRESSURE WARNING LIGHTS
34. TOTAL FUEL FLOW INDICATOR
35. TOTAL FUEL QUANTITY INDICATOR
36. ENGINE OIL VOLUME INDICATORS
37. OIL LOW-LEVEL WARNING LIGHT
38. A-C CONTROL PANEL
39. FUEL QUANTITY INDICATORS
40. TOTAL FUEL QUANTITY INDICATOR TEST SWITCH
41. A-C VOLTMETER
42. FREQUENCY METER
43. D-C VOLTMETER
44. INTERPHONE CONTROL PANEL
45. ANTI-ICE TEST SWITCH
46. FUEL QUANTITY INDICATOR TEST SWITCHES
47. FUEL SYSTEM CONTROL PANEL
48. TAKEOFF WARNING INDEX PANEL
49. VOLTMETER AND FREQUENCY METER SELECTOR SWITCH
50. A.C. CHECKLIST ANNUNCIATOR PANEL
51. TRANSFORMER-RECTIFIER WARNING LIGHTS
52. BATTERY SWITCH
53. FLIGHT DECK LIGHT CONTROL PANEL
54. PROPELLER LOW OIL PRESSURE WARNING LIGHTS (T.C.T.O. 571)
55. ENGINE VIBRATION INDICATOR (T.C.T.O. 612)
56. GENERATOR DISCONNECT SWITCHES (T.C.T.O. 596)

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Figure 1-13 (Sheet 2 of 2)

Navigator's Station–Typical

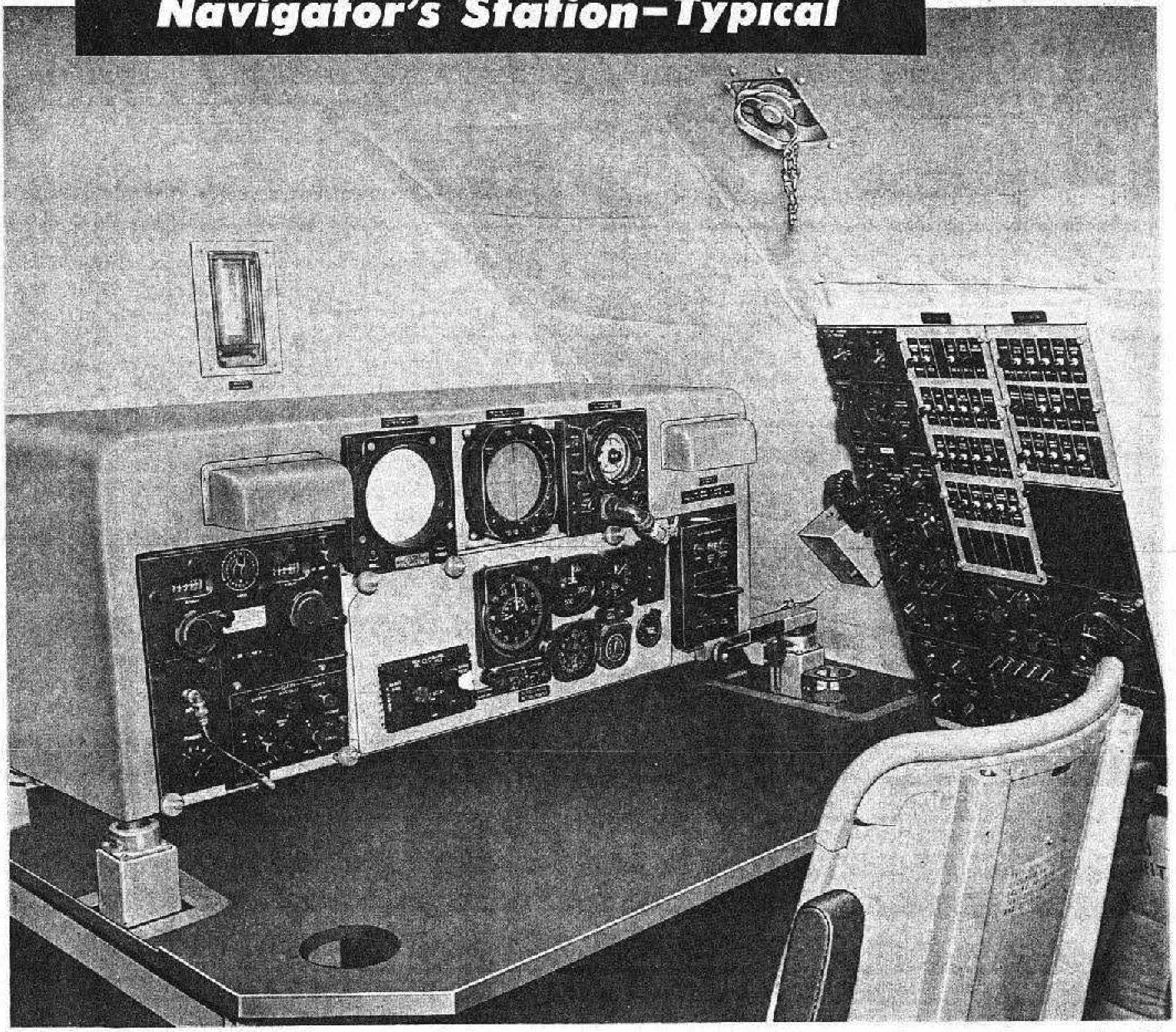

Figure 1-14

panel *(figure 1-19)* and on the fire control section of the pilots' overhead panel *(figure 1-6)*. All control valves will relieve thermal expansion pressures in excess of approximately 120 psi back to the tanks. The float-actuated tank inlet control valves, which control the level of fuel in the tanks during refueling, are automatic. The fuel dump valves, which control jettisoning of fuel, are manually operated.

FUEL TANKS AND MANIFOLD.

The fuel supply for the aircraft is contained in eight tanks which form an integral part of the wing structure, and four bladder type fuel cells. The tanks are numbered 1 through 8 from left to right and the bladder type fuel cells are mounted in the wing constant section and interconnected with tanks No. 4 and 5 to supplement the supply in these tanks. The total tank capacity is 18,236 gallons. (See figure 1-44 for fuel grade and specification.)

All tanks except No. 4 and 5 have dipstick openings through which the dipstick may be inserted to visually check the fuel level. Tanks No. 4 and 5 are equipped with filler caps on the top of the wing, through which

Fuel Quantity Data Table

FUEL - JP-4 AT 6.5 LB/GAL (BASED ON STANDARD DAY CONDITIONS)

BASED ON: TEST DATA

TANK	USABLE FUEL LEVEL FLIGHT (GALLONS)	USABLE FUEL LEVEL FLIGHT (POUNDS)	FULLY SERVICED GROUND ATTITUDE (GALLONS)	FULLY SERVICED GROUND ATTITUDE (POUNDS)	NON-JETTISONABLE FUEL (GALLONS)	NON-JETTISONABLE FUEL (POUNDS)
1	1390	9035	1402	9113	160	1040
2	2416	15,704	2433	15,814.5	1200	7800
3	2382	15,483	2388	15,522	NOT JETTISONABLE UNLESS TRANSFERRED TO TANKS 1, 2, 7 AND 8	NOT JETTISONABLE UNLESS TRANSFERRED TO TANKS 1, 2, 7 AND 8
4	2920	18,980	2933	19,064.5		
5	2920	18,980	2933	19,064.5		
6	2382	15,483	2388	15,522		
7	2416	15,704	2433	15,814.5	1200	7800
8	1390	9035	1402	9113	160	1040
MANIFOLD	20	130	★88	572		
TOTAL	18,236	118,534	18,400	119,600	2720	17.680

★ MINUS 10 GALLONS IF REFUELING RISER IS DRAINED

WARNING

The fuel gages are calibrated for level inflight reading. When the aircraft is on the ground the fuel gages will indicate up to 3075 pounds more fuel than is actually on board, depending on the fuel load. See Fuel Quantity Correction Table and Correction Chart — Total Indicated Fuel vs Usable Fuel, this section. Fuel quantity readings on the ground should be taken with the aircraft level within ±1 degree.

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Figure 1-15

the aircraft may be fueled when single-point refueling equipment is not available. The filler caps also serve as dipstick openings for these tanks.

Each tank is equipped with an overboard vent line with a float actuated shutoff valve located at the tank end of the line to prevent siphoning and leakage of fuel whenever fuel is covering the vent opening. A pressure relief valve is incorporated in each vent shutoff valve to prevent buildup of excessive pressure within the tank when the vent valve is closed.

Fuel is routed between the tanks through the manifold which is mounted internally in the tanks and contains plug-in type shutoff valves for the control of fuel flow. Each tank is equipped with an automatic, fuel inlet control valve for control of fuel level during refueling. An inlet and an outlet valve on each tank controls fuel flow from the tanks to the engines and between tanks during transfer of fuel. Tanks No. 2 and 7 have an additional control valve for control of fuel to the outboard engines and the GTU's. Tanks No. 2 and 7 also contain the gravity feed line to the GTU's. A center wing crossfeed valve is installed in the manifold to control the flow of fuel from one side of the aircraft to the other to maintain symmetrical loading.

FUEL SYSTEM CONTROL VALVE SWITCHES.

The fuel system control valve switches are all located on the fuel system control panel (*figure 1-19*). The switches are 2-position switches and have the placarded positions OPEN and CLOSE. Placing a switch in the OPEN or CLOSE position completes a 28-volt d-c circuit to the respective valve acutator motor to open or close the valve. Power for operation of the fuel system control valves is obtained from the 28-volt d-c essential bus on the flight engineer's overhead circuit breaker panel.

Fuel Tank Outlet Valve Switches.

Ten fuel tank outlet valves switches (*7, figure 1-19*) control the outlet valves from the tanks. The outlet valves for tanks No. 3, 4, 5, and 6 control the flow of fuel from the respective tanks to the manifold where

Fuel System

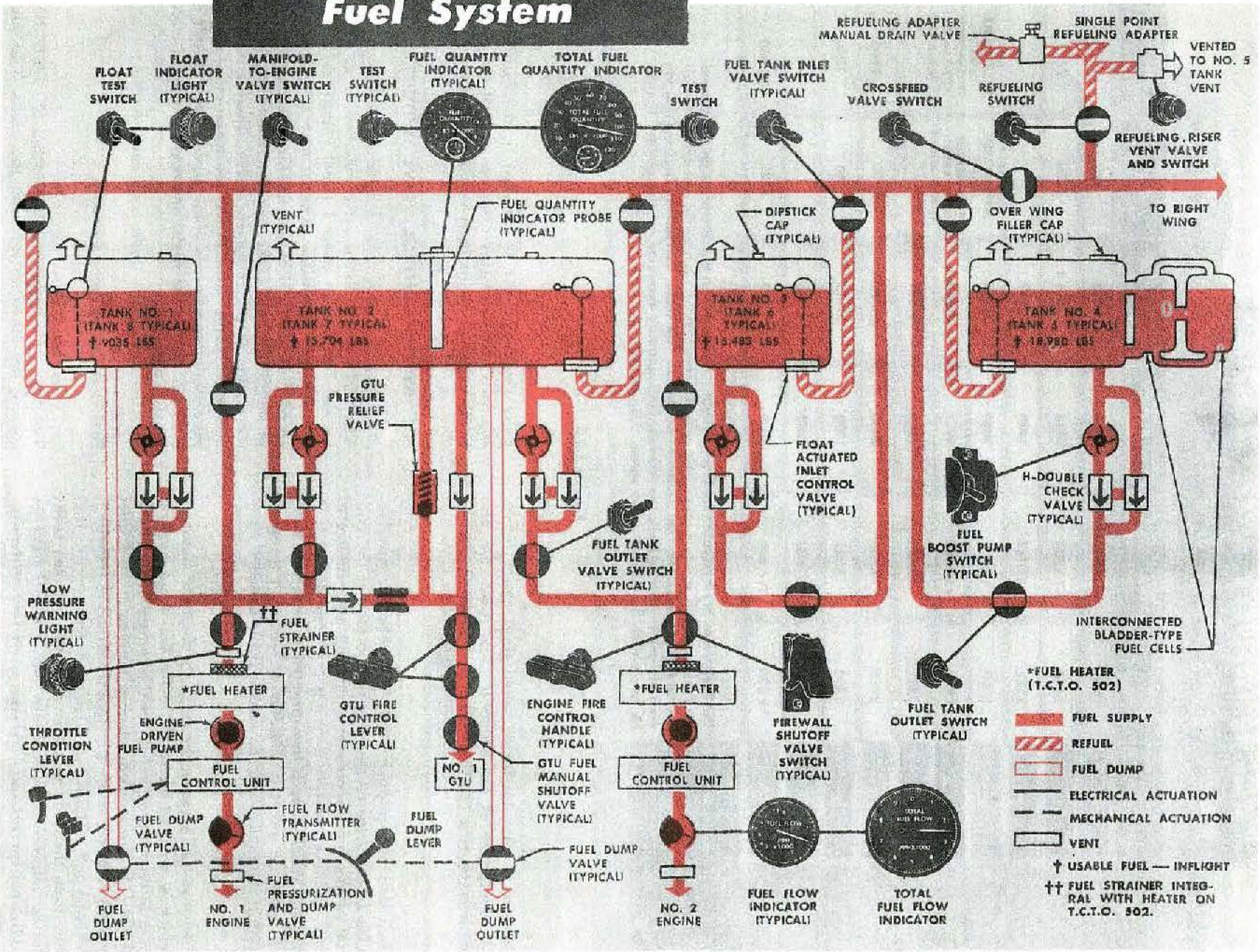

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Figure 1-16

it can then be routed to the engines or to other tanks. The six remaining tank outlet valve switches control the outlet valves from tanks No. 1, 2, 7, and 8 to the engines. Tanks No. 1 and 8 feed directly to the outboard engines. Tank No. 2 has two outlet valves, one feeding directly to No. 2 engine and the other feeding to No. 1 engine and No. 1 GTU. Tank No. 7 also has two outlet valves, one supplying fuel directly to No. 3 engine and the other supplying fuel to No. 4 engine and No. 2 GTU. The fuel tank outlet valves will also allow fuel to be directed to the manifold when the manifold-to-engine valves are opened.

Fuel Manifold-to-Engine Valve Switches.

Four fuel manifold-to-engine valve switches *(8, figure 1-19)* control the manifold valves which allow fuel to be fed directly to each engine from the manifold. These valves must be open to transfer fuel from tanks No. 1, 2, 7, or 8.

Fuel Tank Inlet Valve Switches.

Eight fuel tank inlet valve switches *(11, figure 1-19)* control the tank inlet valves and permit fuel to be directed to each tank from the manifold during fuel transfer or refueling operation.

Fuel Crossfeed Valve Switch.

One fuel crossfeed valve switch *(13, figure 1-19)* controls the crossfeed valve to permit the flow of fuel from one side of the aircraft to the other during transfer or refueling operations.

GTU FUEL SUPPLY SYSTEM.

Fuel is supplied to the GTU's either from the fuel tanks or manifold under boost pump pressure, or directly from the tanks by gravity feed for starting when no external power is available. No. 1 GTU is supplied either by gravity feed from tank No. 2, or under pressure from No. 1 or No. 2 auxiliary boost pump. Fuel can also be supplied from the fuel manifold providing No. 1 manifold-to-engine valve is open and the manifold is pressurized by any boost pump. No. 2 GTU receives fuel either by gravity feed from No. 7 tank, or under pressure from No. 7 or No. 8 auxiliary boost pump, or from the fuel manifold, providing No. 4 manifold-to-engine valve is open and the manifold is pressurized by any boost pump.

GTU Pressure Relief Valve.

A pressure relief valve *(figure 1-16)* is installed in each GTU fuel supply line to relieve excess pressure from the boost pumps to the GTU's. No return line from the GTU fuel supply is installed since the relief valves relieve directly into tanks No. 2 and 7. When fuel is being supplied to No. 1 and 4 engines from tanks No. 1 and 8, approximately 400 pounds per hour may be returned to tanks No. 2 and 7. Fuel will also be returned to tanks No. 2 and 7 if fuel is being supplied from the manifold. During ground operation, when tanks are full, fuel must be supplied to the GTU's from tanks No. 2 and 7 to prevent overflow of the tanks. To prevent overflow of the tanks during flight follow procedures outlined under Fuel Management Procedures in Section VII.

GTU Fuel Shutoff Valves.

Four 28-volt d-c electrically actuated, motor-driven fuel shutoff valves *(figure 1-16)*, two for each GTU, are installed in the fuel supply system for each GTU. One is located in each wing, aft of the rear spar, at the wing root. The other two are located at the aft end of the wheel well. They can be closed by pulling out the GTU fire control handle. Placing the GTU start-run-stop switch to STOP will also deenergize the circuit to the ignition and fuel switch. (See Gas Turbine Units, and Fire Warning and Extinguisher Systems, in this Section.) Each valve is equipped with a manual override for ground operation of the valve.

GTU Manual Fuel Shutoff Valve.

A manually operated fuel shutoff valve *(figure 1-16)* is installed in the fuel system of each GTU forward of the fuel strainer. The valves are located in the forward end of each GTU compartment. These valves are used to shut off the fuel to the GTU's during ground maintenance.

FUEL BOOST PUMPS.

Eight fuel boost pumps *(figure 1-16)*, one for each tank, are mounted on the aft spar of the wing. Tanks No. 2 and 7 are equipped with an auxiliary fuel boost pump mounted on the forward spar. Dams around the boost pump inlets in tanks No. 1, 2, 7, and 8 retain a limited supply of fuel for the respective pumps during unusual flight attitudes to aid in preventing cavitation of the pumps.

The boost pumps supply fuel under pressure to the engines and are also used to transfer fuel and for defueling. No. 1 pump feeds to No. 1 engine or to the manifold, No. 2 pump feeds to No. 2 engine or manifold, No. 7 pump feeds to No. 3 engine or the manifold, and No. 8 pump feeds to No. 4 engine or the manifold. The auxiliary pumps in tanks No. 2 and 7 supply fuel to the outboard engines, to No. 1 and No. 2 GTU respectively, or to the manifold.

Fuel, either from the tanks or the manifold passes through engine and GTU firewall shutoff valves. The shutoff valves are controlled by the fire control handles and the firewall shutoff valve switches *(figure 1-41)* located on the pilots' overhead panel. (See Fire Warning and Extinguishing Systems, this section.)

H-Double Check Valve.

An H-Double check valve *(figure 1-16)* is incorporated in each fuel boost pump mount which permits free flow from the boost pump, when the boost pump is operating, or by engine fuel pump suction, or gravity flow when the boost pump is not operating. The H-double check valves also prevent fuel pressure escaping back into the fuel tank from the manifold or the boost pump.

Fuel Boost Pump Switches.

Ten 2-position fuel boost pump switches are located on the fuel system control panel *(figure 1-16)*. Each switch has the positions ON and OFF. The boost pumps in Tanks No. 1, 3, 4, 5, 6, and 8, have one switch each. Tanks No. 2 and 7 have two boost pumps, controlled by individual switches, installed in each tank. Placing a boost pump switch in the ON position completes a circuit from the 115-volt a-c essential bus on the flight engineer's overhead circuit breaker panel which energizes the respective boost pump relay. The relay, when energized, completes a circuit from the 200-volt a-c essential bus on the left hand fuselage circuit breaker panel which supplies power to operate the fuel boost pump motor. Fuel is then supplied under pressure to the engine or the fuel manifold. The OFF position opens the circuit to the relay, deenergizing the fuel boost pump motor. A thermal switch is located in each boost pump to prevent overheating of the pump in case a malfunction occurs. This switch opens the boost pump circuit breaker in case of overheating. If this occurs, the thermal switch will not allow the circuit breaker to be reset without replacing the pump. The boost pump switches for the tanks supplying fuel to the engines should be ON whenever the engines are operating, to increase engine-driven pump life.

FUEL QUANTITY INDICATING SYSTEM.

A 115-volt a-c, compensated-capacitor type fuel quantity indicating system is installed which provides a visual indication of the quantity of fuel contained in each tank as well as the total quantity of fuel contained in all eight tanks. The system consists of fuel quantity sensing capacitors in each tank, a fuel quantity indicator for each tank, a total fuel quantity indicator, a test switch for each individual fuel quantity indicator, and a test switch for the total fuel quantity indicator. An amplifier is mounted on the back of each indicator. Power for operation of the system is obtained from the 115-volt, single-phase, a-c essential bus on the flight deck. Circuit protection is provided by nine, 2-amp fuses.

The fuel quantity indicating system operates by comparing the capacitance of a fixed reference capacitor with the capacitance of sensing capacitors in each fuel tank. Any variation in the quantity of fuel contained in a specific tank will cause a similar variation in the capacitance of the sensing capacitors in that tank. Any change in the capacitance of the sensing capacitors causes a voltage to be supplied to the amplifier of the respective fuel quantity indicator. The amplified voltage drives the motor, located inside the indicator, which repositions the pointers of the indicator to indicate the new quantity of fuel. The total fuel quantity indicator adds the fuel quantities indicated on each of the individual fuel quantity indicators and indicates the total. To facilitate loading computations, fuel quantities are indicated in weight rather than in volume.

Due to variations in wing deflection caused by differences in the amount of the fuel and cargo load, a difference will exist between the actual quantity of fuel in the tanks and the quantity of fuel indicated by the fuel quantity indicators and the total fuel quantity indicator. Greater variations between the indicated fuel quantity and the actual fuel quantity occur on the ground because of the reversal of wing deflection loads and the fact that the fuel quantity indicating system is calibrated for inflight attitudes.

The difference between the indicated fuel quantity and the actual fuel quantity must be considered when computing both the fuel loading for takeoff, and the amount of fuel remaining during flight. Although the fuel quantity indicating system will indicate the total quantity of fuel within accepted limits during flight, the difference between indicated fuel quantity and actual fuel quantity resulting from various cargo and fuel loads should be considered, in order to obtain accurate fuel management.

The fuel quantity correction table *(figure 1-17)* is for ground attitude only. A correction chart *(figure 1-18)* is provided to assist in computing the amount of usable fuel for both inflight and ground attitudes. The following examples explain how the chart is used.

Example 1.

Given:

Aircraft Attitude = On ground.

Total Indicated Fuel Quantity = 70,000 pounds.

Enter the chart at a total indicated fuel quantity of 70,000 pounds (A). Read up to the ground attitude curve (B). Read across to find the correction factor of −2,525 pounds (C). Subtracting the correction factor (−2,525 pounds) from the total indicated fuel quantity (70,000 pounds) will determine that the amount of usable fuel is 67,475 pounds.

Example 2.

Given:

Aircraft Attitude = In Flight.

Cargo Weight = Zero.

Total Indicated Fuel Quantity = 30,000 pounds.

Enter the chart at a total indicated fuel quantity of 30,000 pounds (A'). Read up to the zero cargo weight curve (B'). Read across to find the correction factor of −680 pounds (C'). Subtracting the correction factor (−680 pounds) from the total indicated fuel quantity (30,000 pounds) will determine that the amount of usable fuel is 29,320 pounds.

Fuel Quantity Indicators.

Eight 115-volt a-c fuel quantity indicators *(2, figure 1-19)*, one for each tank, are located on the flight engineer's instrument panel. Each indicator is equipped with both a main dial and pointer, and a smaller dial and pointer. The main dial of each indicator is graduated in 1000-pound increments, and the smaller dial in 100-pound increments. The even-numbered increments on both the main dial and the smaller dial are placarded with a numeral indicating their value. The indicators for tanks No. 1 and 8 have a range of from zero to 10,000 pounds. The indicators for tanks No. 2, 3, 6, and 7 have a range of from zero to 17,000 pounds, and the indicators for tanks No. 4 and 5 have a range of from zero to 21,000 pounds. The pointers of each indicator are moved by a 2-phase induction motor inside the indicator case. An amplifier, mounted on the back of each indicator, amplifies the voltage it receives from the sensing capacitors in its respective tank and supplies this amplified voltage to the pointer positioning motor. The pointers of each indicator indicate the weight of the fuel in its respective tank. The circuit for each indicator is individually protected by a 2-amp fuse. The fuses for the fuel quantity indicator circuits are located on the a-c power distribution panel on the floor behind the engineer's panel. Failure of any of the individual fuel quantity indicators will result in unreliable indications on the total fuel quantity indicator. In the event of a power failure in the fuel quantity indicating system, the pointers of the fuel quantity

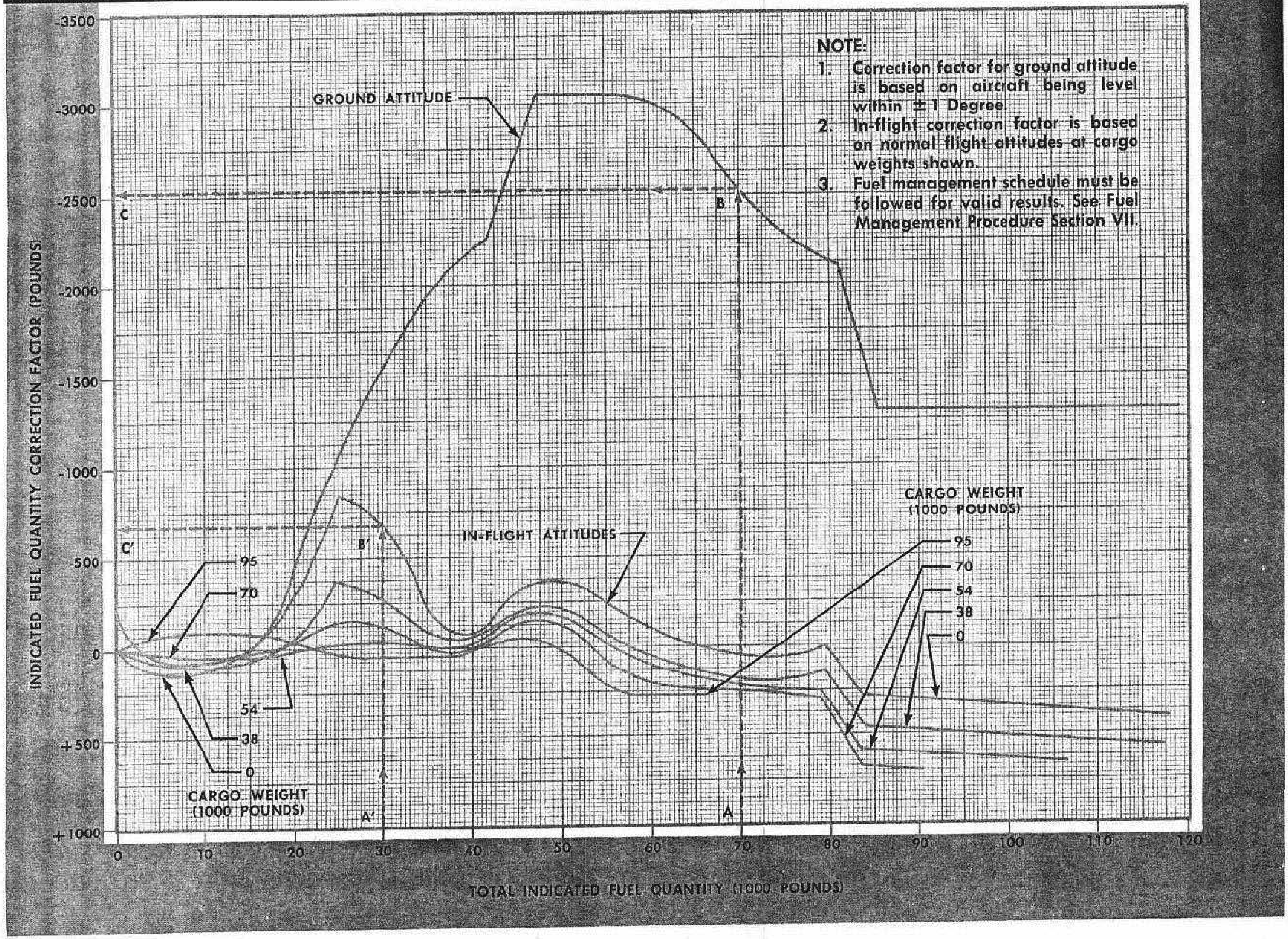
FUEL QUANTITY CORRECTION TABLE

Indicated Fuel Quantity (Pounds)	*Total Usable Fuel (Pounds)**
5,000	5,050
10,000	10,100
15,000	14,975
20,000	19,325
25,000	23,800
30,000	28,375
35,000	33,075
40,000	37,825
45,000	42,275
50,000	46,925
55,000	51,950
60,000	57,000
65,000	62,175
70,000	67,475
75,000	72,725
80,000	77,875
85,000	83,575
90,000	88,700
95,000	93,700
100,000	98,700
105,000	103,700
110,000	108,700
115,000	113,700
120,000	118,700

*Aircraft on the ground and level within ± 1 degree.

Figure 1-17

Correction Chart — Total Indicated Fuel vs Usable Fuel



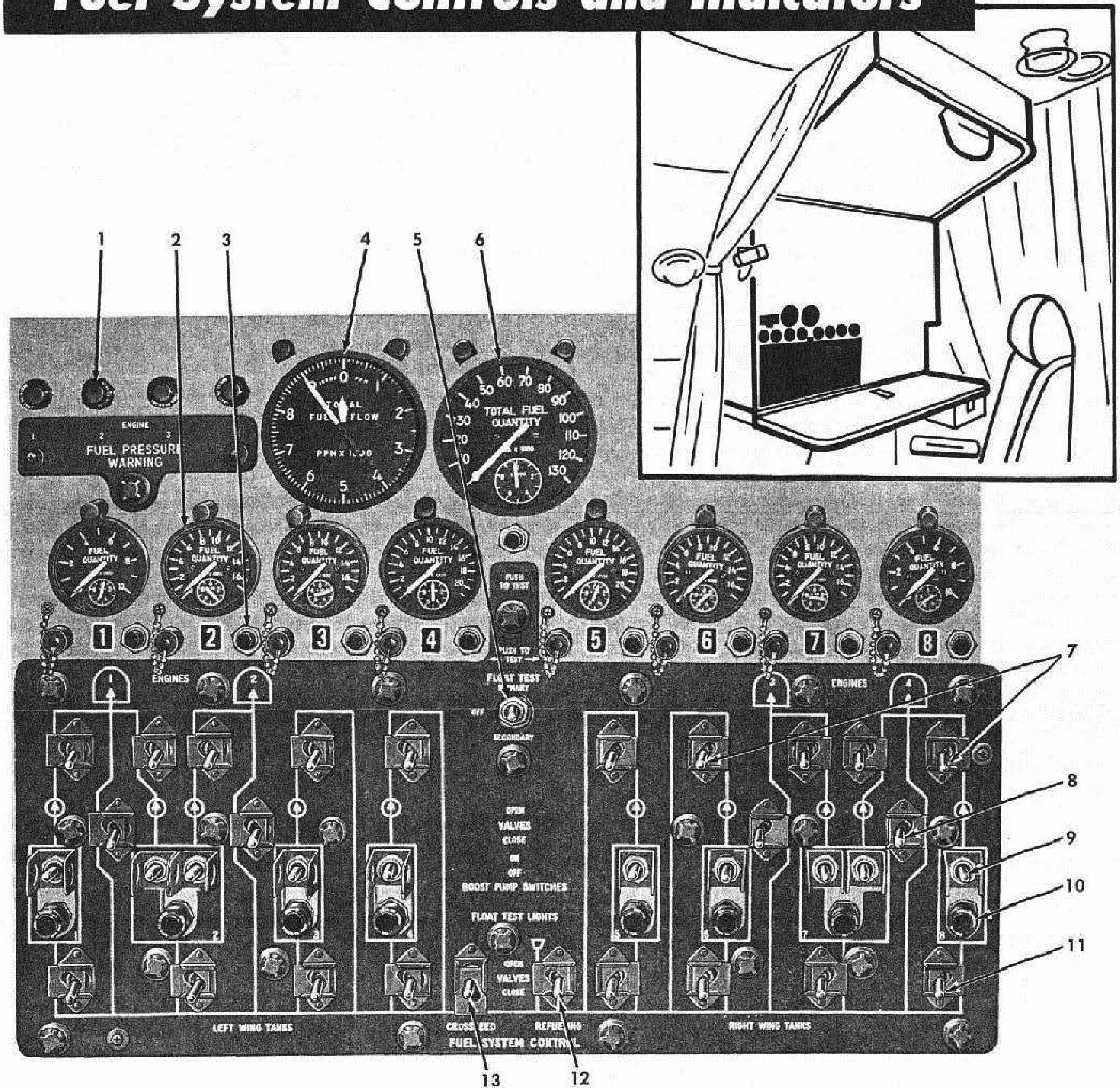
NOTE:

1. Correction factor for ground attitude is based on aircraft being level within ±1 Degree.
2. In-flight correction factor is based on normal flight attitudes at cargo weights shown.
3. Fuel management schedule must be followed for valid results. See Fuel Management Procedure Section VII.

Figure 1-18

UAB1-12 B

Fuel System Controls and Indicators



1. FUEL LOW-PRESSURE WARNING LIGHTS (4)
2. FUEL QUANTITY INDICATORS (8)
3. FUEL QUANTITY INDICATOR TEST SWITCHES (9)
4. TOTAL FUEL FLOW INDICATOR
5. FLOAT TEST SWITCH
6. TOTAL FUEL QUANTITY INDICATOR
7. FUEL TANK OUTLET VALVE SWITCHES (10)
8. MANIFOLD-TO-ENGINE VALVE SWITCHES (4)
9. BOOST PUMP SWITCHES (10)
10. FLOAT INDICATOR LIGHTS (8)
11. FUEL TANK INLET VALVE SWITCHES (8)
12. REFUELING VALVE SWITCH
13. CROSSFEED VALVE SWITCH

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Figure 1-19

indicators will remain in the position they were in when the power failure occurred.

Total Fuel Quantity Indicator.

A 115-volt a-c total fuel quantity indicator *(6, figure 1-19)* is located on the flight engineer's instrument panel. The indicator is equipped with both a main dial and pointer, and a smaller dial and pointer. The main dial is graduated in 10,000-pound increments, and the smaller dial in 1000-pound increments. The even-numbered increments on both the main dial and the smaller dial are placarded with a numeral indicating their value. The indicator has a range of from zero to 130,000 pounds. The pointers of the indicator are moved by a 2-phase induction motor inside the indicator case. An amplifier, mounted on the back of the indicator, amplifies the voltage it receives from each of the individual fuel quantity indicators and supplies this amplified voltage to the pointer positioning motor of the total fuel quantity indicator. The pointers of the indicator indicate the total weight of the fuel in all eight tanks as indicated by the individual fuel quantity indicators. The circuit for the total fuel quantity indicator is protected by a 2-amp fuse located on the a-c power distribution panel on the floor behind the engineer's panel. Failure of any of the individual fuel quantity indicators will result in unreliable indications on the total fuel quantity indicator. In the event of a power failure in the fuel quantity indicating system, the pointers of the total fuel quantity indicator will remain in the position they were in when the power failure occurred.

Fuel Quantity Indicator Test Switches.

Nine pushbutton-type fuel quantity indicator test switches *(3, figure 1-19)* are located on the flight engineer's instrument panel. One of the test switches is mounted beneath each fuel quantity indicator, and one beneath the total fuel quantity indicator. The test switches permit each of the fuel quantity indicators and the total fuel quantity indicator to be individually checked for proper operation. When a test switch is pushed in, a sensing circuit to the respective indicator is opened, causing the pointers of the indicator to rotate in a counterclockwise direction. When the test switch is released, the pointers of the indicator should return to their former position.

FUEL DIPSTICK.

A fuel dipstick *(41, figure 1-2)* is provided for making a visual check of the fuel supply. The dipstick consists of a transparent plastic tube in a 4-sided slotted shaft which is lowered into the tank and, when the top is sealed by the thumb, may be read upon withdrawal. It is stowed in spring-type clips on the aft wall of the crew equipment storage compartment. The dipsticks are to be utilized only for a visual check of the fuel level in each tank with the aircraft level horizontally and laterally. Dipstick readings can not be used for an accurate check of the aircraft fuel quantity system.

REFUELING SYSTEM.

The aircraft is normally refueled through a single-point refueling adapter *(22, figure 1-2)*. Refueling is controlled by the refueling valve switch, the fuel cross-feed valve switch, and the eight fuel tank inlet valve switches, located on the fuel control panel at the flight engineer's station.

The single-point refueling adapter, located on the forward section of the right main gear pod, provides a positive connection for the ground servicing nozzle during refueling operations. As the fuel tanks are filled with fuel, the dual high-level float units will rise and close off the sensing pipes. The resulting fuel pressure buildup in the sensing pipes will actuate the diaphragms in the float-actuated fuel inlet valves, causing the valves to close. This same fuel pressure buildup actuates the pressure switches that cause the float test light to come on.

A solenoid-actuated refueling riser vent valve *(figure 1-16)*, controlled by the refueling riser vent valve switch, is used to vent the refueling riser and allow residual fuel in the riser to drain back to the refueling unit. The refueling adapter is drained through a manually operated drain valve. The aircraft may also be refueled through filler openings in tanks No. 4 and 5 and use of the normal fuel transfer system to fill all other tanks.

Refueling Valve Switch.

A 2-position refueling valve switch *(12, figure 1-19)*, located on the fuel system control panel, has the placarded positions OPEN and CLOSE. When the switch is placed in the OPEN position, a circuit is completed from the 28-volt d-c essential bus on the flight engineer's overhead panel to the valve actuator motor to open the refueling valve and permit fuel to flow to the manifold from the refueling riser. When the switch is placed in the CLOSE position, the circuit is completed to the valve actuator motor to close the valve.

Float Test Switch.

A 3-position, high-level float test switch *(5, figure 1-19)*, with the placarded positions PRIMARY, OFF, and SECONDARY, is located on the flight engineer's instrument panel. The switch, which is spring loaded from the PRIMARY and SECONDARY positions to the OFF position, permits checking the float-actuated fuel tank inlet control valves in each tank for proper operation during the preflight check of the fuel system. In order to perform this check, electrical power must be available, there must be fuel pressure in the manifold, and the fuel tank inlet valves must be open. The switch may also be used to determine if fuel is flowing into the tanks during refueling and fuel transfer operations. When the switch is held in either the PRIMARY or SECONDARY position, a circuit is completed from the flight deck 28-volt d-c nonessential bus which supplies power to energize the corresponding solenoid of the float level control valve in each tank. The energized solenoids will raise the high level floats, closing the fuel tank inlet control valves, and simulate a full tank condition. If the fuel tank inlet valves are open, and fuel pressure is available in the manifold, the resulting pressure buildup caused by the closed fuel tank inlet control valves will actuate a pressure-sensitive switch for each tank. As each pressure-sensitive switch is actuated, it complete a circuit from the flight deck 28-volt a-c nonessential bus which supplies power to its respective float test light, causing the light to come on. Placing the float test switch in the OFF position de-energizes the test circuit. The circuits between the test switch and the control valve solenoids are protected by a circuit breaker located on the flight engineer's overhead circuit breaker panel.

Float Indicator Lights.

Eight green 28-volt a-c, float indicator lights *(10, figure 1-19)* are installed on the flight engineer's instrument panel. The lights are controlled by pressure-sensitive switches, two of which are installed for each fuel tank. During the fuel system preflight check, with the float test switch held in either the PRIMARY or SECONDARY position, the lights will come on, indicating that the fuel tank inlet control valves are functioning properly and will shut off the flow of fuel when the tanks are full. During refueling or fuel transfer operations, each light will come on when its respective tank is full. Circuit protection for the float indicator light circuits is provided by a circuit breaker located on the flight deck right hand auxiliary circuit breaker panel.

Refueling Riser Vent Valve.

A 28-volt d-c, solenoid operated vent valve *(figure 1-16)* is installed in the refueling riser, to permit draining of residual fuel back to the refueling unit after completion of refueling operations. The valve receives power from the 28-volt d-c nonessential bus located on the right hand center fuselage circuit breaker panel. When the valve is opened, the refueling riser is vented to tank No. 5 vent line to allow fuel to drain from the riser.

Refueling Riser Vent Valve Switch.

A two-position, pushbutton type switch *(figure 1-16)*, placarded RESIDUAL FUEL DRAIN VALVE, is located on the interphone panel in the right main gear pod. When the switch is pushed in, a 28-volt d-c circuit is completed to the refueling riser vent valve solenoid, causing the vent valve to open, and vent the riser to tank No. 5 vent line and permit the fuel in the riser to drain back into the refueling unit. The refueling riser vent valve solenoid receives power from the 28-volt d-c nonessential bus and is protected by the fuel drain valve circuit breaker located on the center fuselage d-c circuit breaker panel.

Manually Operated Fuel Drain Valve.

A manually operated fuel drain valve *(figure 1-16)*, located in the right, forward wheel well, allows the refueling riser and adapter to be drained of fuel if the refueling equipment does not have provisions for reverse flow.

FUEL JETTISON SYSTEM.

A fuel jettison system is installed to permit jettisoning fuel during flight. Fuel may be jettisoned only from tanks No. 1, 2, 7, and 8. If requirements are such that additional fuel must be jettisoned from tanks No. 3, 4, 5, and 6, fuel from these tanks must first be transferred to tanks No. 1, 2, 7, or 8. The total quantity of fuel that may be jettisoned from tanks No. 1, 2, 7, and 8, with the tanks full, is approximately 30,000 pounds. (See figure 3-9 for fuel jettisoning rate). Approximately 17,680 pounds of fuel will remain in the tanks after jettisoning; tanks No. 1 and 8 will each retain approximately 1040 pounds of fuel, and tanks No. 2 and 7 will each retain approximately 7800 pounds of fuel.

The fuel jettison system consists of four gate-type dump valves, one each mounted on the aft spar in tanks No. 1, 2, 7, and 8. The dump valves are connected by piping to faired outlets located in the trailing edge of the wing between the flaps and the ailerons. The valves are cable operated from the fuel dump lever located at the flight engineer's station. The fuel jettison system is designed so that the jettison lines drain completely during normal aircraft operation.

Fuel Dump Lever.

The fuel dump lever *(figure 1-12),* located on a quadrant at the aft end of the flight engineer's table, has the placarded positions SECURE and DUMP. When the lever is moved to the DUMP position, a linkage attached to the lever actuates a cable drum, which in turn operates cables to open the fuel dump valves. When the dump lever is moved to the SECURE position, the cable operated, spring-loaded dump valves are closed. Detents at each end of the fuel dump lever quadrant hold the lever in the desired position. Approximately 90 pounds of force may be required to move the fuel dump lever from the SECURE to the DUMP position.

ELECTRICAL SYSTEMS.

Alternating current (115/200-volt a-c) is used as a basic power source, and is furnished by two engine-driven a-c generators (alternators) or by an auxiliary a-c generator *(figure 1-20)* driven by the No. 1 gas turbine unit (GTU). Direct current (dc) is provided by the a-c system through the use of two transformer-rectifiers *(figure 1-21).* A 24-volt battery is also installed to provide an additional source of d-c power. On the ground, 200-volt a-c power may be supplied from an external source when plugged into the external supply receptacle. Circuit protection is provided by circuit breakers, current limiters, or fuses *(figures 1-23 through 1-27).* The electrical load is divided between the two engine-driven generators. If one generator fails, the other will automatically take over the entire load. The auxiliary generator may be used as a source of electrical power for ground operation when the engines are inoperative, or during flight if both of the engine-driven generators should fail.

An air-driven 28-volt d-c generator *(figure 1-28)* is installed to provide emergency d-c power during flight.

A-C SYSTEM.

The a-c system *(figure 1-20)* supplies 200-volt, 3-phase, 400-cycle current and 115-volt, single-phase, 400-cycle current to the essential and nonessential busses for operation of the various equipment. Transformers are used to supply the single-phase, 28-volt, and 3-phase, 115-volt, a-c power requirements. A-c power is normally supplied by two engine-driven generators, one mounted on the accessory drive of each inboard engine. The generator output is connected to the generator control panel through a frequency-sensitive relay which completes the circuit to the control panel when the frequency is within limits. Each generator system is protected against faults by a generator control panel which controls the automatic circuit breaker for its generator (with generator switch ON) by closing the automatic circuit breaker whenever the generator output requirements are met, and by opening the automatic circuit breaker if any faults are sensed. (See Annunciator Panel—A-C Checklist, this section.) The voltage regulator maintains the generator voltage output by sampling the line voltage. The output of each engine-driven generator is connected to an essential and a nonessential load transfer relay. If one engine-driven generator fails, the other generator will automatically energize the failed generator's nonessential load transfer relay and power will be supplied to both the essential and the nonessential busses. When the auxiliary generator switch is in the AUTO position, the auxiliary generator, driven by the No. 1 GTU, will automatically supply all essential busses with power if both main generators fail. It may also be used to supply power to the nonessential busses when the auxiliary generator switch is positioned to NON-ESS BUS ON. The auxiliary generator is protected against faults by a control panel. If the auxiliary generator is taken off the line by the automatic feature, the auxiliary generator switch must be manually reset to get the generator back on the line. Before the auxiliary generator can supply power to the busses, both engine-driven generators must be inoperative. An external power receptacle *(44, figure 1-2)* for supplying 200-volt, 3-phase, a-c power from an external ground source is provided on the underside of the fuselage nose section.

A-C Generator Switches.

Two guarded, 3-position switches *(figure 1-22)* for the engine-driven generators are mounted on the a-c system control panel. The generator switch positions are ON, OFF, and RESET. The ON position connects the generator output to the busses. The OFF position disconnects the generator from the busses, but leaves the generator operating in a standby condition. The RESET position is used to reestablish the generator exciter field circuits from the battery, the nonessential d-c bus, or generator residual power after the circuits have been interrupted by the automatic fault sensing protective device.

Generator Disconnect Switches (Aircraft With T.C.T.O. 596).

Two 2-position generator disconnect switches *(56, figure 1-13)* are installed on the flight engineer's instrument panel to enable the flight engineer to disconnect the engine driven generators from the engine in the event of failure of the generator bearings, to prevent possible damage to the generator drive train, and to avoid the necessity for shut down of the engine due to generator bearing malfunction indication. The switches are guarded and are safetied in the OFF position to prevent inadvertent disconnection of the generator drive during flight. Placing either of the switches in the ON position completes a circuit to a rotary solenoid installed on the generator shaft, which pulls the generator shaft from the engine accessory drive. Once disconnected, the generator drive cannot be reengaged during flight. Power to the generator disconnect solenoid is supplied from the battery bus on the flight engineer's overhead circuit breaker panel.

Auxiliary A-C Generator Switch.

A guarded, 3-position switch *(figure 1-22)* for the GTU-driven auxiliary generator is mounted on the a-c system control panel. The switch positions are NON-ESS BUS ON, AUTO, and GEN RESET. The GEN RESET position is used to reestablish the generator exciter field circuits after they have been interrupted. The AUTO position places the auxiliary generator in standby, ready to take over the essential loads if both engine-driven generators fail. The NON-ESS BUS ON position connects the nonessential busses to the auxiliary generator if both main generators fail or are turned off. The load must be monitored not to exceed 110 amperes. To insure proper circuit operation, the switch should be positioned to GEN RESET before placing the switch in either AUTO or NON-ESS BUS ON.

A-C Warning System (AF54-135 Through AF57-1615).

The a-c warning system provides a visual indication of system condition through the use of an annunciator panel (A-C Checklist) and a master warning light, located at the flight engineer's station. The master warning light and the annunciator panel light will come on simultaneously to indicate various conditions. A toggle-type selector switch is provided to turn off the master warning light and reset it for further indication, leaving the annunciator panel light on. Power for operation of the a-c warning system is obtained from the flight deck 28-volt d-c essential bus through the flight engineer's dimming relay. Circuit protection is provided by a circuit breaker located on the flight engineer's overhead circuit breaker panel.

A-C Warning System (AF59-522 And Subsequent).

The a-c warning system provides a visual indication of system condition through the use of an annunciator panel (A-C Checklist) and a caution light located on the flight engineer's instrument panel. The caution light and the annunciator panel light will come on simultaneously to indicate various conditions. The caution light PUSH-TO-RESET feature is provided to turn off the caution light and reset it, however, the annunciator panel light will remain on until the indicated condition or fault is corrected. Power for operation of the a-c warning system is obtained from the flight deck 28-volt d-c essential bus, through the flight engineer's dimming relay. Circuit protection is provided by a circuit breaker located on the flight engineer's overhead circuit breaker panel.

A-C Checklist Annunciator Panel (Aircraft AF54-135 Through AF57-1615).

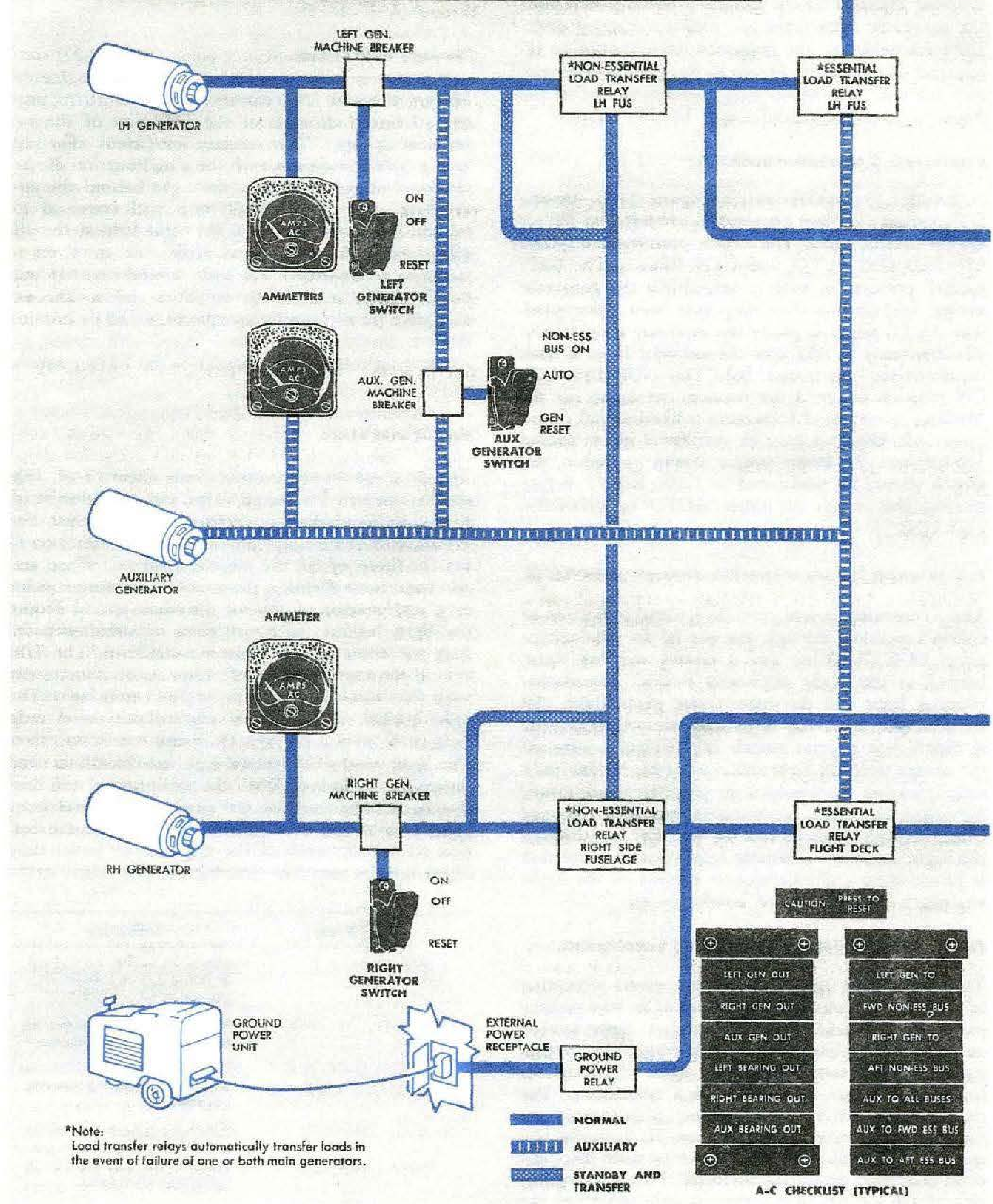
The a-c checklist annunciator panel *(figure 1-22)* consists of eleven strips, located on the flight engineer's instrument panel. The annunciator panel strips provide a visual indication of the condition of the a-c electrical system. When certain conditions affecting the a-c electrical system exist, or a malfunction of the a-c electrical system occurs, the light behind the appropriate annunciator panel strip will come on to indicate the condition. The light behind the strip will remain on as long as the condition exists. The annunciator panel strip lights may be tested by holding the a-c checklist annunciator panel and master a-c warning light test selector switch in the TEST position.

A-C Checklist Annunciator Panel (Aircraft AF59-522 And Subsequent).

The a-c checklist annunciator panel *(figure 1-22)* consists of thirteen individual strips and a caution strip, located on the flight engineer's instrument panel. The annunciator panel strips provide a visual indication of the condition of the a-c electrical system. When certain conditions affecting the a-c electrical system exist, or a malfunction of the a-c electrical system occurs, the light behind the appropriate annunciator panel strip will come on to indicate the condition. The light behind the caution strip will come on simultaneously with the individual annunciator panel strip light. The light behind the individual annunciator panel strip light will remain on as long as the condition exists. The light behind the caution strip will remain on until the caution strip is pressed. The caution strip will then remain off until an additional a-c checklist annunciator panel strip comes on. With the exception of the caution strip light, each of the annunciator panel strip lights may be tested by pressing the individual strips.

Panel Reads	*Indicating*
1. LEFT GEN OUT	*Left generator is over or under voltage, has an open phase, is under frequency, or has a ground fault (left generator switch ON).
2. RIGHT GEN OUT	*Right generator same as condition 1 (right generator switch ON).
3. AUX GEN OUT	*Auxiliary generator same as condition 1 (auxiliary generator switch in AUTO or NON-ESS BUS ON).
4. LEFT BEARING OUT	Main shaft bearing in left generator burned out or excessively worn.

A-C Power Supply—Typical



*Note:
Load transfer relays automatically transfer loads in the event of failure of one or both main generators.

Figure 1-20 (Sheet 1 of 2)

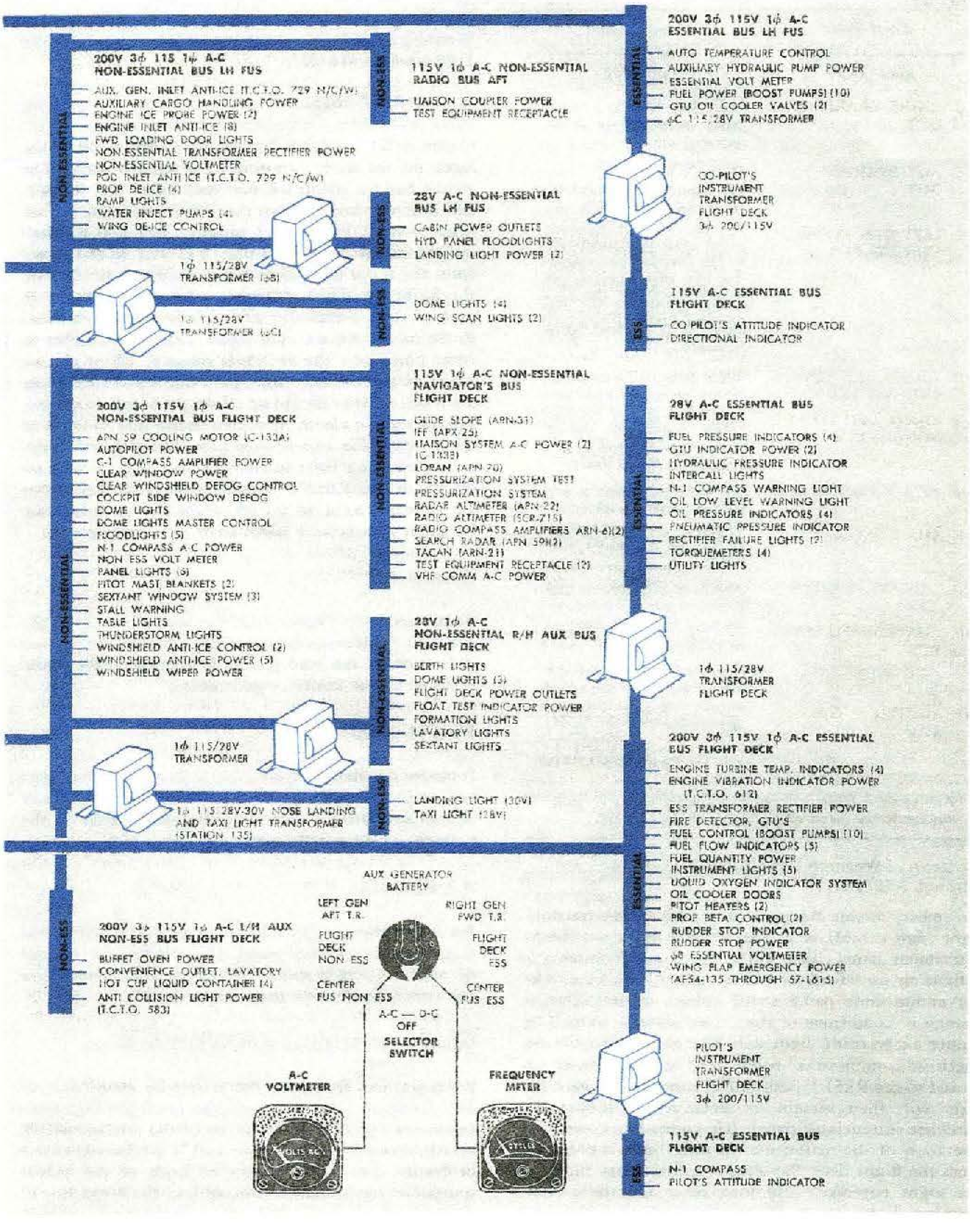


Figure 1-20 (Sheet 2 of 2)

Panel Reads	*Indicating*
5. RIGHT BEARING OUT	Main shaft bearing in right generator burned out or excessively worn.
6. AUX BEARING OUT	Main shaft bearing in auxiliary generator burned out or excessively worn.
7. LEFT GEN TO FWD NON-ESS BUS	Left generator is supplying power to the forward nonessential bus, or auxiliary generator is supplying power to the forward nonessential bus and engine-driven generators are off the line. (This condition may be noted with external power connected.)
8. RIGHT GEN TO AFT NON-ESS BUS	Right generator is supplying power to the aft non-essential bus, or ground power is being supplied to the aft nonessential bus and no generators are on the line.
9. AUX TO ALL BUSSES	Auxiliary generator is supplying power to all busses. (Auxiliary a-c generator switch in NON-ESS BUS ON.)
10. AUX TO FWD ESS BUS	Auxiliary generator is supplying power to the forward essential bus. (Auxiliary a-c generator switch in AUTO.)
11. AUX TO AFT ESS BUS	Auxiliary generator is supplying power to the aft essential bus. (Auxiliary a-c generator switch in AUTO.)

* Any of these faults will result in the a-c generator being automatically taken off the line.

Master A-C Warning Light (Aircraft AF54-135 Through AF57-1615).

An amber, 28-volt d-c, press-to-test, master a-c warning light *(figure 1-22)* is located on the flight engineer's instrument panel. The warning light will automatically come on whenever one or more of the a-c checklist annunciator panel strips come on indicating a change in conditions of the a-c electrical system. The master a-c warning light will remain on until the a-c checklist annunciator panel test selector switch is moved to the RESET position. The master a-c warning light will then remain off until an additional a-c checklist annunciator panel strip comes on. Power for operation of the master a-c warning light is obtained from the flight deck 28-volt d-c essential bus, through the flight engineer's dimming relay and the master warning light relay. When the warning light is pressed to test the lamp filament, a circuit is completed from the flight deck 28-volt d-c essential bus directly to the warning light. Circuit protection is provided by a circuit breaker located on the flight engineer's overhead circuit breaker panel.

A-C Checklist Annunciator Panel and Master A-C Warning Light Test Selector Switch (Aircraft AF-54-135 Through AF57-1615).

A 3-position, toggle-type, a-c checklist annunciator panel and master a-c warning light test selector switch *(figure 1-22)* is located below the master a-c warning light, on the flight engineer's instrument panel. The switch has the placarded positions TEST and RESET, and is spring-loaded from the TEST and RESET positions to the OFF (center) position. When the switch is held in the TEST position, a circuit is completed from the flight deck 28-volt d-c essential bus, through the flight engineer's dimming relay, to the lights in each of the a-c checklist annunciator panel strips and to the master a-c warning lights, causing the lights to come on. When the switch is released, all of the a-c checklist annunciator panel strip lights and the master a-c warning light should go off. In the event a malfunction of the a-c electrical system causes one or more of the a-c checklist annunciator panel strips and the master a-c warning light to come on, moving the selector switch to the RESET position will cause the master a-c warning light to go off while the energized a-c checklist annunciator panel strip light remains on.

Ammeters.

Three ammeters *(figure 1-22)* are located on the flight engineer's instrument panel to provide continuous indication of the load on the two engine-driven generators and the auxiliary generator.

Frequency Meter.

A frequency meter *(figure 1-22)* is located on the flight engineer's instrument panel. It indicates the frequency of any a-c power source or feeder bus selected on the voltage and frequency selector switch.

A-C Voltmeter.

An a-c voltmeter *(figure 1-22)* is mounted on the flight engineer's instrument panel. It indicates the voltage of any a-c power source or feeder bus selected on the voltage and frequency selector switch.

Voltmeter and Frequency Meter Selector Switch.

An 8-position voltmeter and frequency meter selector switch *(figure 1-22)* is mounted on the flight engineer's instrument panel. Each position of the selector switch simultaneously selects an a-c and a d-c power source or feeder bus. The voltages of both of the power sources or feeder busses selected and the frequency of the a-c power source or feeder bus selected are indicated on the a-c voltmeter, d-c voltmeter, and frequency meter. This enables the flight engineer to monitor and troubleshoot the electrical system. The positions of the voltmeter and frequency meter selector switch are placarded as follows:

AC DC OFF, CENTER FUS NON ESS, FLIGHT DECK NON ESS, LEFT GEN AFT T.R., AUX GENERATOR BATTERY, RIGHT GEN FWD T.R., FLIGHT DECK ESS, and CENTER FUS ESS.

CAUTION

Do not leave the voltmeter and frequency meter selector switch in the AUX GENERATOR BATTERY position when no other power is applied to the aircraft. This will prevent any unnecessary drain on the battery.

D-C SYSTEM.

Twenty-eight-volt d-c power for normal operation is furnished by two 200-ampere transformer-rectifiers. The forward transformer-rectifier, placarded FWD, is located behind the flight engineer's station. The aft transformer-rectifier, placarded AFT, is located at the d-c power distribution center on the right side of the center fuselage area. The input power to the transformer-rectifiers is supplied from the a-c system. The 200-volt a-c input voltage is stepped down and rectified by the transformer-rectifiers to the required 28.5 d-c voltage.

To provide emergency d-c power during flight, in the event the main or auxiliary a-c generators are inoperative, an air-driven 400-ampere, 28-volt d-c generator *(figure 128)*, is installed in the forward end of the left pod. The air-driven generator has sufficient capacity to provide continuous power for all normal d-c power requirements at airspeeds above 150 knots.

A 24-volt, 36-ampere-hour battery *(34, figure 1-2)*, located in the left pod, aft of the wheelwell, is provided to supply intermittent emergency d-c power, and power for starting the GTU's.

D-c power is distributed through a split bus system. Each bus is classified as either essential or nonessential, depending on the function of the equipment the bus powers. The propeller busses are powered from the essential busses. During normal operation, all d-c busses are powered by the forward and aft transformer-rectifiers, which are in parallel and share the electrical load. With the battery switch in the ON position, the battery busses will be powered and the battery charged from the essential bus. The flight deck nonessential busses are normally powered by the forward transformer-rectifier and control relay. The aft nonessential busses are powered by the aft transformer-rectifier and control relay.

In the event of failure of the FWD or AFT transformer-rectifier, the operative transformer-rectifier will automatically assume the essential load of the failed transformer-rectifier, in addition to the normal load. If either transformer-rectifier or the power supply to it fails, the nonessential busses from that transformer-rectifier will lose all power. If both main generators fail, with the auxiliary generator switch in the AUTO position, both transformer-rectifiers will still be energized, but the flight deck nonessential d-c busses will not be powered. This condition is due to the FWD transformer-rectifier control relay being deenergized.

If all a-c power is lost (or turned off) and the air-driven generator is not extended and operating, the battery bus will receive power from the battery regardless of the battery switch position. When the battery switch is turned ON, the battery busses and the d-c essential busses are both powered by the battery. Only the equipment necessary for continuing the flight should be operated from the battery in order to prolong battery life. To provide d-c power after loss of a-c power, the air-driven generator should be extended. The air-driven generator is connected in parallel with the battery bus and when operating will provide continuous d-c power for all normal operation.

Battery Switch and Isolation Relay.

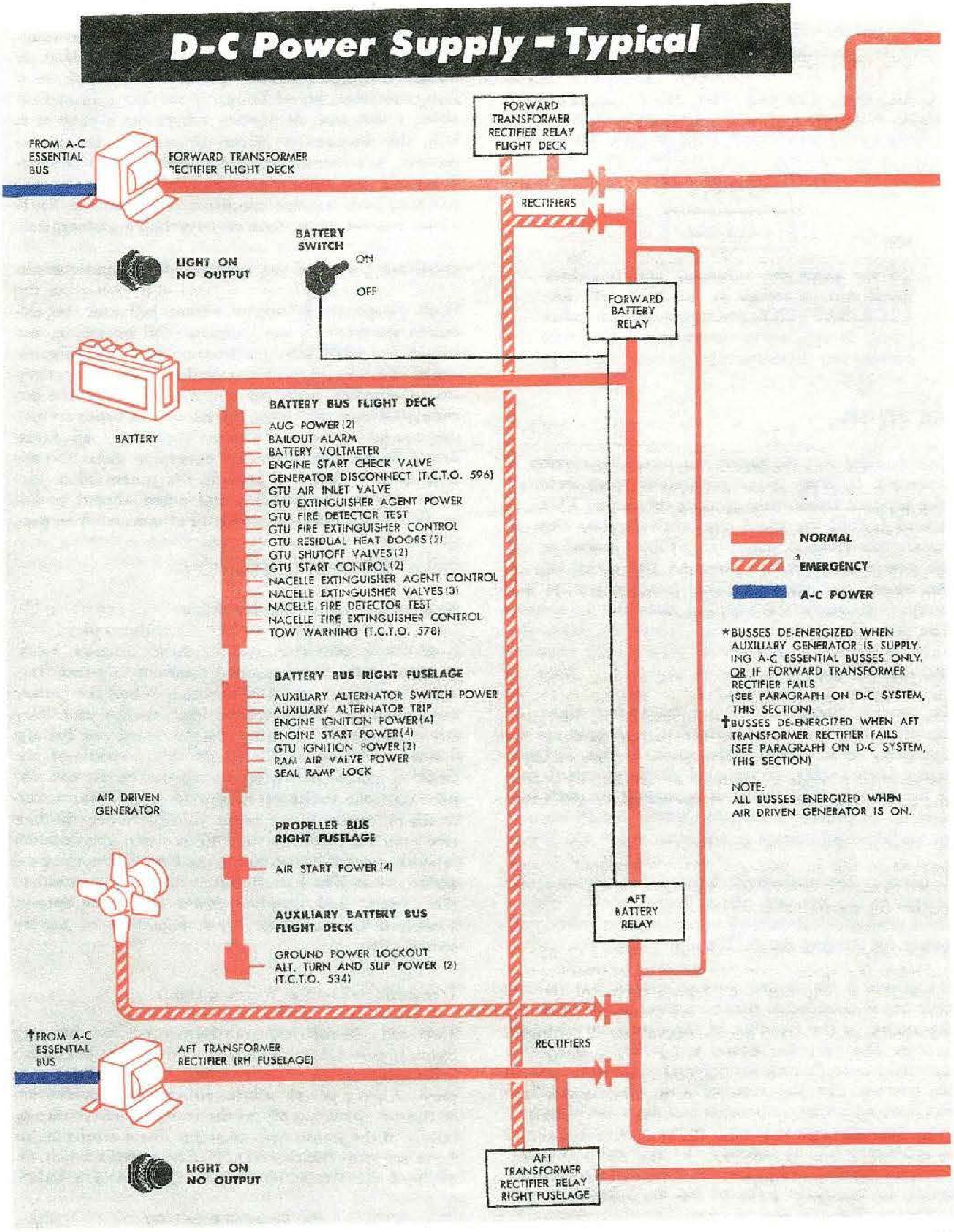
A guarded, 2-position battery switch *(figure 1-22)*, mounted on the flight engineer's instrument panel, controls the battery circuit through an isolation relay. The switch has the placarded positions ON and OFF, and is guarded in the ON position. When the battery switch is placed in the ON position, the isolation relay closes to permit charging the battery from the d-c essential bus. In addition, the ON position of the switch permits the battery to supply the d-c essential busses in the event of failure of both transformer-rectifiers, or loss of a-c input voltage. When the battery switch is placed in the OFF position, the isolation relay is opened to disconnect the battery from the d-c essential bus. The battery bus is directly connected to the battery, and supplies power to the equipment connected to the battery bus, regardless of battery switch position.

Transformer-Rectifier Warning Lights.

Two red, 28-volt a-c transformer-rectifier warning lights *(figure 1-22)* are located on the flight engineer's instrument panel. The warning lights come on to warn of a d-c power failure, either from interruption of the a-c power supply to the transformer-rectifier or failure of the transformer-rectifier. The warning lights are placarded FORWARD TRANSFORMER-RECTIFIER—LIGHT ON NO OUTPUT, and AFT TRANS-

(Continued on Page 1-48)

D-C Power Supply - Typical



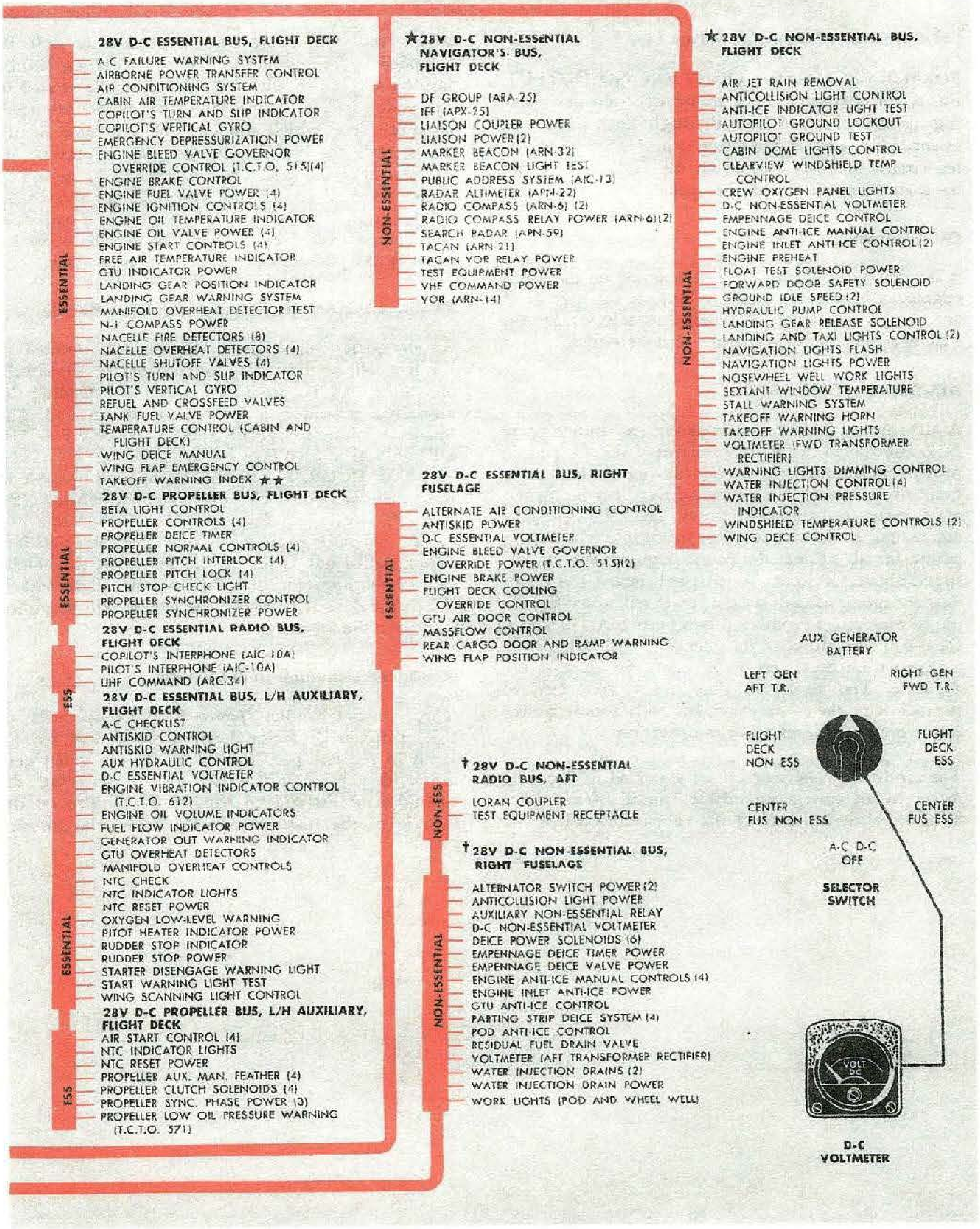
*BUSSES DE-ENERGIZED WHEN AUXILIARY GENERATOR IS SUPPLYING A-C ESSENTIAL BUSSES ONLY, OR IF FORWARD TRANSFORMER RECTIFIER FAILS (SEE PARAGRAPH ON D-C SYSTEM, THIS SECTION).

†BUSSES DE-ENERGIZED WHEN AFT TRANSFORMER RECTIFIER FAILS (SEE PARAGRAPH ON D-C SYSTEM, THIS SECTION)

NOTE:
ALL BUSSES ENERGIZED WHEN AIR DRIVEN GENERATOR IS ON.

UAB1-145

Figure 1-21 (Sheet 1 of 2)



28V D-C ESSENTIAL BUS, FLIGHT DECK

- A-C FAILURE WARNING SYSTEM
- AIRBORNE POWER TRANSFER CONTROL
- AIR CONDITIONING SYSTEM
- CABIN AIR TEMPERATURE INDICATOR
- COPILOT'S TURN AND SLIP INDICATOR
- COPILOT'S VERTICAL GYRO
- EMERGENCY DEPRESSURIZATION POWER
- ENGINE BLEED VALVE GOVERNOR OVERRIDE CONTROL (T.C.T.O. 515)(4)
- ENGINE BRAKE CONTROL
- ENGINE FUEL VALVE POWER (4)
- ENGINE IGNITION CONTROLS (4)
- ENGINE OIL TEMPERATURE INDICATOR
- ENGINE OIL VALVE POWER (4)
- ENGINE START CONTROLS (4)
- FREE AIR TEMPERATURE INDICATOR
- GTU INDICATOR POWER
- LANDING GEAR POSITION INDICATOR
- LANDING GEAR WARNING SYSTEM
- MANIFOLD OVERHEAT DETECTOR TEST
- N-1 COMPASS POWER
- NACELLE FIRE DETECTORS (8)
- NACELLE OVERHEAT DETECTORS (4)
- NACELLE SHUTOFF VALVES (4)
- PILOT'S TURN AND SLIP INDICATOR
- PILOT'S VERTICAL GYRO
- REFUEL AND CROSSFEED VALVES
- TANK FUEL VALVE POWER
- TEMPERATURE CONTROL (CABIN AND FLIGHT DECK)
- WING DEICE MANUAL
- WING FLAP EMERGENCY CONTROL
- TAKEOFF WARNING INDEX ★★

28V D-C PROPELLER BUS, FLIGHT DECK

- BETA LIGHT CONTROL
- PROPELLER CONTROLS (4)
- PROPELLER DEICE TIMER
- PROPELLER NORMAL CONTROLS (4)
- PROPELLER PITCH INTERLOCK (4)
- PROPELLER PITCH LOCK (4)
- PITCH STOP CHECK LIGHT
- PROPELLER SYNCHRONIZER CONTROL
- PROPELLER SYNCHRONIZER POWER

28V D-C ESSENTIAL RADIO BUS, FLIGHT DECK

- COPILOT'S INTERPHONE (AIC-10A)
- PILOT'S INTERPHONE (AIC-10A)
- UHF COMMAND (ARC-34)

28V D-C ESSENTIAL BUS, L/H AUXILIARY, FLIGHT DECK

- A-C CHECKLIST
- ANTISKID CONTROL
- ANTISKID WARNING LIGHT
- AUX HYDRAULIC CONTROL
- D-C ESSENTIAL VOLTMETER
- ENGINE VIBRATION INDICATOR CONTROL (T.C.T.O. 612)
- ENGINE OIL VOLUME INDICATORS
- FUEL FLOW INDICATOR POWER
- GENERATOR OUT WARNING INDICATOR
- GTU OVERHEAT DETECTORS
- MANIFOLD OVERHEAT CONTROLS
- NTC CHECK
- NTC INDICATOR LIGHTS
- NTC RESET POWER
- OXYGEN LOW-LEVEL WARNING
- PITOT HEATER INDICATOR POWER
- RUDDER STOP INDICATOR
- RUDDER STOP POWER
- STARTER DISENGAGE WARNING LIGHT
- START WARNING LIGHT TEST
- WING SCANNING LIGHT CONTROL

28V D-C PROPELLER BUS, L/H AUXILIARY, FLIGHT DECK

- AIR START CONTROL (4)
- NTC INDICATOR LIGHTS
- NTC RESET POWER
- PROPELLER AUX. MAN. FEATHER (4)
- PROPELLER CLUTCH SOLENOIDS (4)
- PROPELLER SYNC. PHASE POWER (3)
- PROPELLER LOW OIL PRESSURE WARNING (T.C.T.O. 571)

★28V D-C NON-ESSENTIAL NAVIGATOR'S BUS, FLIGHT DECK

- DF GROUP (ARA-25)
- IFF (APX-25)
- LIAISON COUPLER POWER
- LIAISON POWER (2)
- MARKER BEACON (ARN-32)
- MARKER BEACON LIGHT TEST
- PUBLIC ADDRESS SYSTEM (AIC-13)
- RADAR ALTIMETER (APN-22)
- RADIO COMPASS (ARN-6) (2)
- RADIO COMPASS RELAY POWER (ARN-6)(2)
- SEARCH RADAR (APN-59)
- TACAN (ARN-21)
- TACAN VOR RELAY POWER
- TEST EQUIPMENT POWER
- VHF COMMAND POWER
- VOR (ARN-14)

28V D-C ESSENTIAL BUS, RIGHT FUSELAGE

- ALTERNATE AIR CONDITIONING CONTROL
- ANTISKID POWER
- D-C ESSENTIAL VOLTMETER
- ENGINE BLEED VALVE GOVERNOR OVERRIDE POWER (T.C.T.O. 515)(2)
- ENGINE BRAKE POWER
- FLIGHT DECK COOLING OVERRIDE CONTROL
- GTU AIR DOOR CONTROL
- MASSFLOW CONTROL
- REAR CARGO DOOR AND RAMP WARNING
- WING FLAP POSITION INDICATOR

†28V D-C NON-ESSENTIAL RADIO BUS, AFT

- LORAN COUPLER
- TEST EQUIPMENT RECEPTACLE

†28V D-C NON-ESSENTIAL BUS, RIGHT FUSELAGE

- ALTERNATOR SWITCH POWER (2)
- ANTICOLLISION LIGHT POWER
- AUXILIARY NON-ESSENTIAL RELAY
- D-C NON-ESSENTIAL VOLTMETER
- DEICE POWER SOLENOIDS (6)
- EMPENNAGE DEICE TIMER POWER
- EMPENNAGE DEICE VALVE POWER
- ENGINE ANTI-ICE MANUAL CONTROLS (4)
- ENGINE INLET ANTI-ICE POWER
- GTU ANTI-ICE CONTROL
- PARTING STRIP DEICE SYSTEM (4)
- POD ANTI-ICE CONTROL
- RESIDUAL FUEL DRAIN VALVE
- VOLTMETER (AFT TRANSFORMER RECTIFIER)
- WATER INJECTION DRAINS (2)
- WATER INJECTION DRAIN POWER
- WORK LIGHTS (POD AND WHEEL WELL)

★28V D-C NON-ESSENTIAL BUS, FLIGHT DECK

- AIR JET RAIN REMOVAL
- ANTICOLLISION LIGHT CONTROL
- ANTI-ICE INDICATOR LIGHT TEST
- AUTOPILOT GROUND LOCKOUT
- AUTOPILOT GROUND TEST
- CABIN DOME LIGHTS CONTROL
- CLEARVIEW WINDSHIELD TEMP CONTROL
- CREW OXYGEN PANEL LIGHTS
- D-C NON-ESSENTIAL VOLTMETER
- EMPENNAGE DEICE CONTROL
- ENGINE ANTI-ICE MANUAL CONTROL
- ENGINE INLET ANTI-ICE CONTROL (2)
- ENGINE PREHEAT
- FLOAT TEST SOLENOID POWER
- FORWARD DOOR SAFETY SOLENOID
- GROUND IDLE SPEED (2)
- HYDRAULIC PUMP CONTROL
- LANDING GEAR RELEASE SOLENOID
- LANDING AND TAXI LIGHTS CONTROL (2)
- NAVIGATION LIGHTS FLASH
- NAVIGATION LIGHTS POWER
- NOSEWHEEL WELL WORK LIGHTS
- SEXTANT WINDOW TEMPERATURE
- STALL WARNING SYSTEM
- TAKEOFF WARNING HORN
- TAKEOFF WARNING LIGHTS
- VOLTMETER (FWD TRANSFORMER RECTIFIER)
- WARNING LIGHTS DIMMING CONTROL
- WATER INJECTION CONTROL (4)
- WATER INJECTION PRESSURE INDICATOR
- WINDSHIELD TEMPERATURE CONTROLS (2)
- WING DEICE CONTROL

UAB1-146

Figure 1-21 (Sheet 2 of 2)

(Continued from Page 1-45)

FORMER-RECTIFIER—LIGHT ON NO OUTPUT. Power for operation of the transformer-rectifier warning lights is obtained from the flight deck 28-volt a-c essential bus. Circuit protection is provided by individual circuit breakers located on the flight deck right-hand auxiliary circuit breaker panel.

D-C Voltmeter.

A d-c voltmeter *(figure 1-22)* is mounted on the flight engineer's instrument panel to indicate the voltage of any d-c power source or feeder bus selected by the voltmeter and frequency meter selector switch.

AIR-DRIVEN GENERATOR.

A 400-ampere, 28-volt d-c air-driven generator *(figure 1-28)* is installed in the forward end of the left pod, to provide emergency d-c power during flight in the event of failure of the main and auxiliary a-c generators or the transformer-rectifiers. The air-driven generator has sufficient capacity to supply continuous power for all normal d-c power requirements at airspeeds above 150 knots. At airspeeds below 150 knots, selective monitoring of the d-c power will allow limited use of essential d-c powered equipment. At 70 knots, the d-c power output of the generator will be approximately 64 amperes, and at 50 knots, 50 amperes are available. The air-driven generator is connected in parallel with the battery bus and will supply power to the essential busses when in operation.

The air-driven generator can be extended in flight by means of an emergency release handle *(figure 1-29)* located on the left side of the cabin, forward of the wheel well. On the ground, the governor may be extended by means of the emergency release handle inside the cabin or with the control handle located in the pod, adjacent to the generator. When extended, an inner door which supports the generator mount struts, seals the opening in the pod to prevent air turbulence in the pod. Once extended, the generator cannot be retracted in flight. The generator is retracted on the ground hydraulically, by means of a hydraulic cylinder controlled by a hydraulic selector valve located in the pod adjacent to the generator door.

Air-Driven Generator Emergency Release Handle.

An emergency release handle *(figure 1-29)*, located on the left side of the cabin, forward of the wheelwell, above the catwalk, provides a means of extending the air-driven generator in flight or on the ground. The handle is placarded EMERGENCY HANDLE—AIR DRIVEN GENERATOR—PULL TO OPEN GENERATOR DOOR. The handle is connected by cable to the generator door latch mechanism and when pulled out will release the door latches and allow the air-driven generator to drop out into operating position. When pulled out to release the generator, the handle will extend approximately 8 inches out of the socket. When the door is retracted, the handle will be pulled back into the socket.

Air-Driven Generator Door Controls.

Three control handles *(figure 1-29)* for operation of the air-driven generator door on the ground, are located in the left pod, foward of the air-driven generator door. An instruction placard covering the operation of the control handles is mounted on the outside of the pod immediately below the forward

Electrical System Control Panels

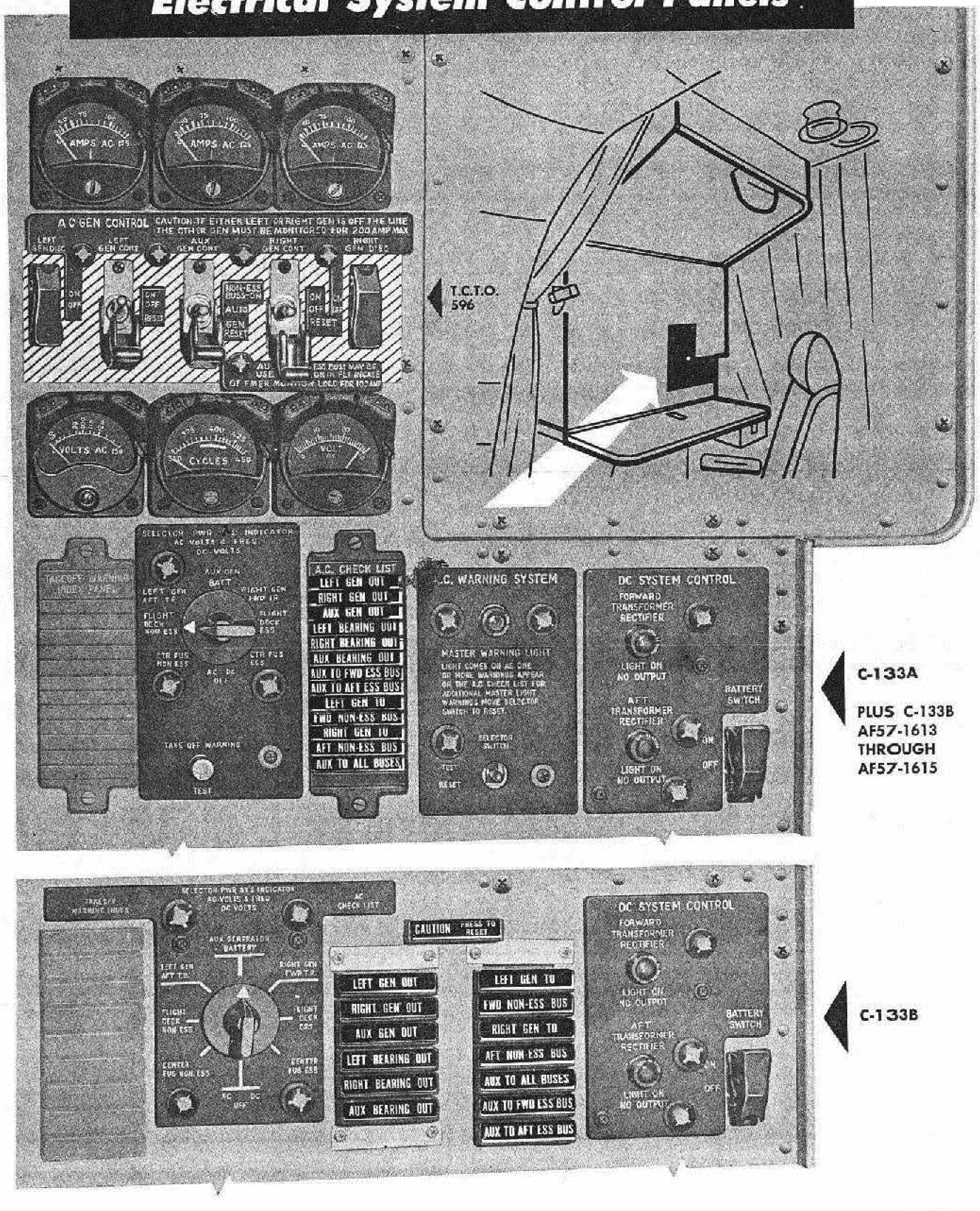
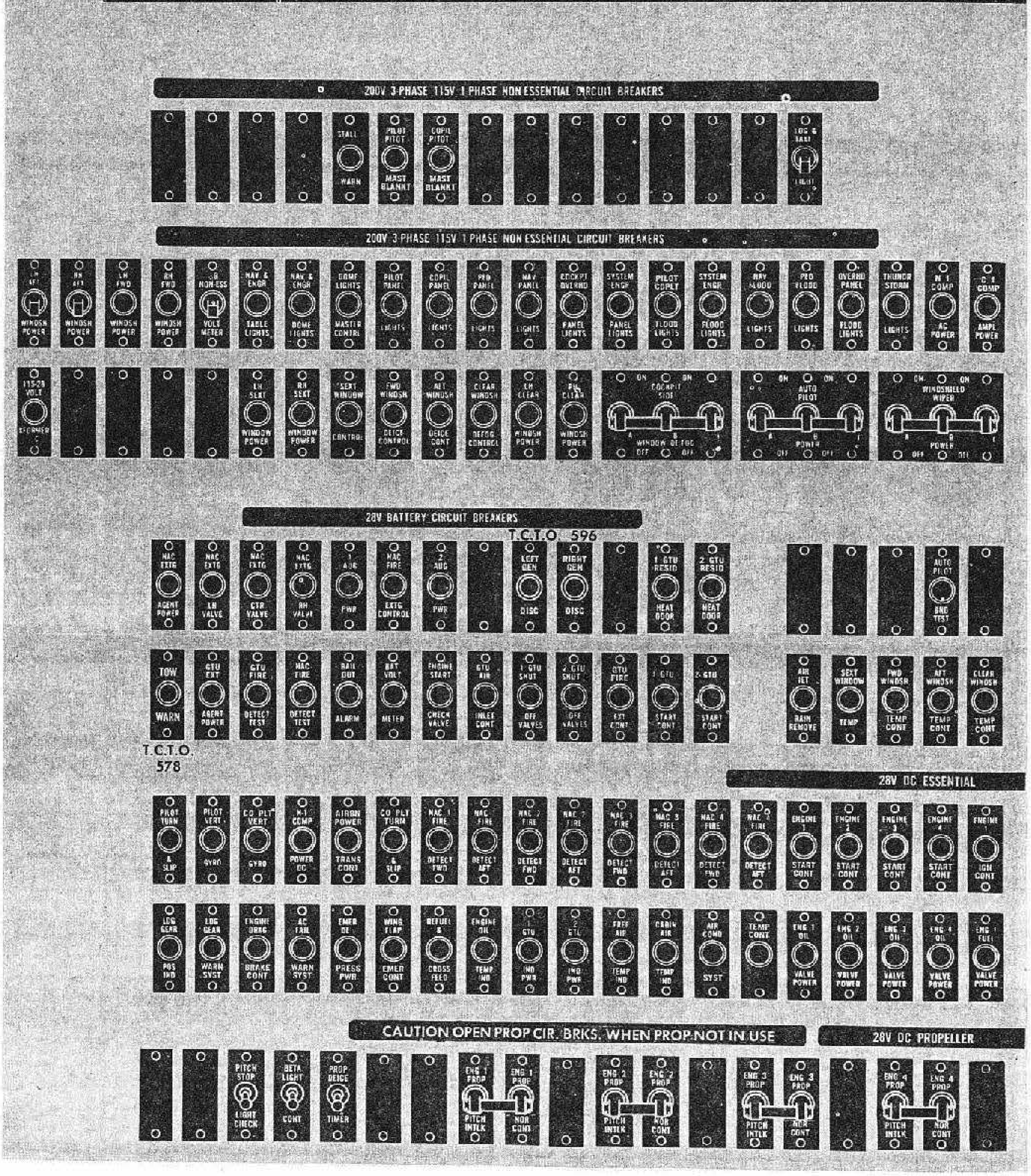


Figure 1-22

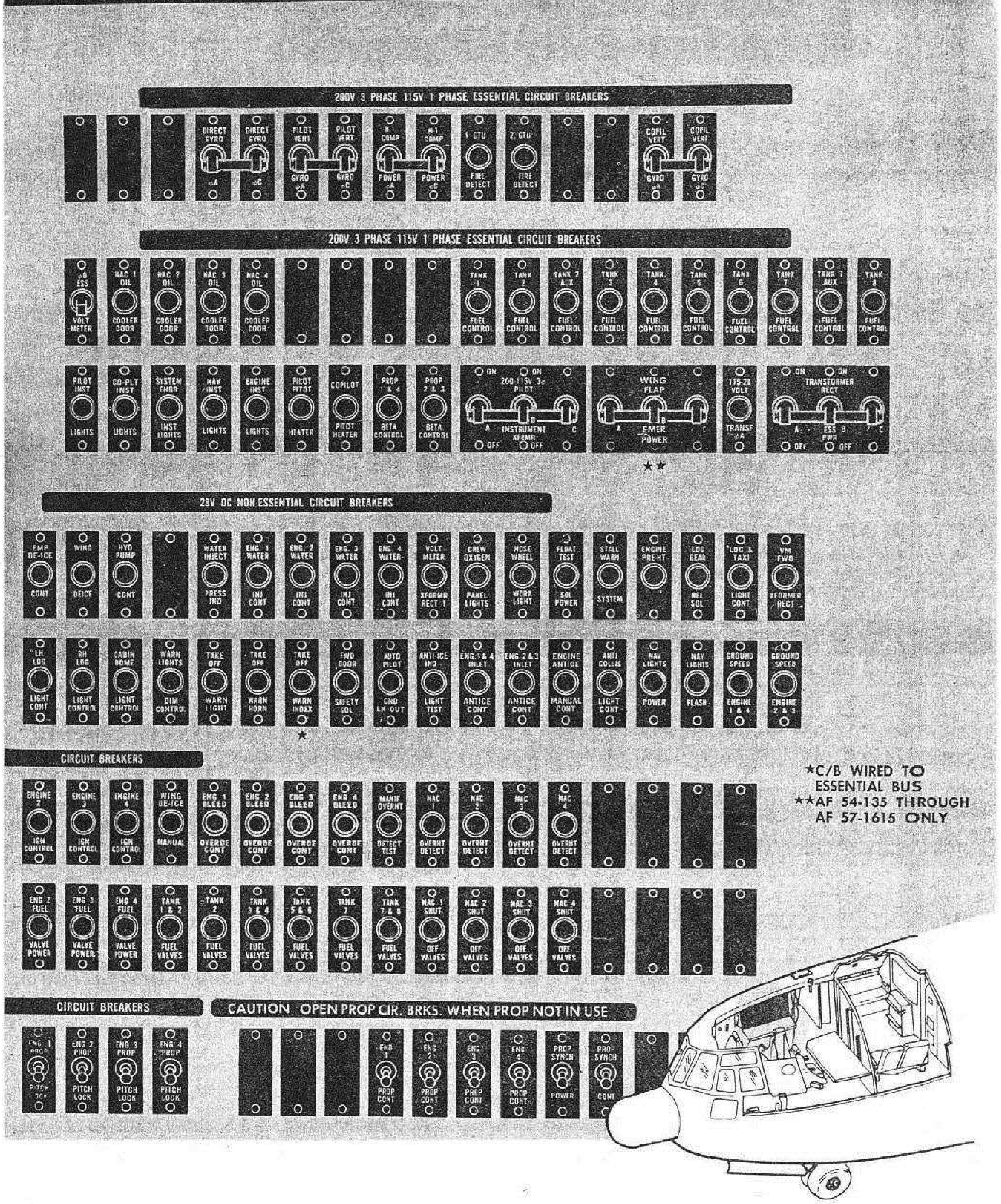
Flight Engineer's Overhead Circuit



UAB1-150

Figure 1-23 (Sheet 1 of 2)

Breaker Panel



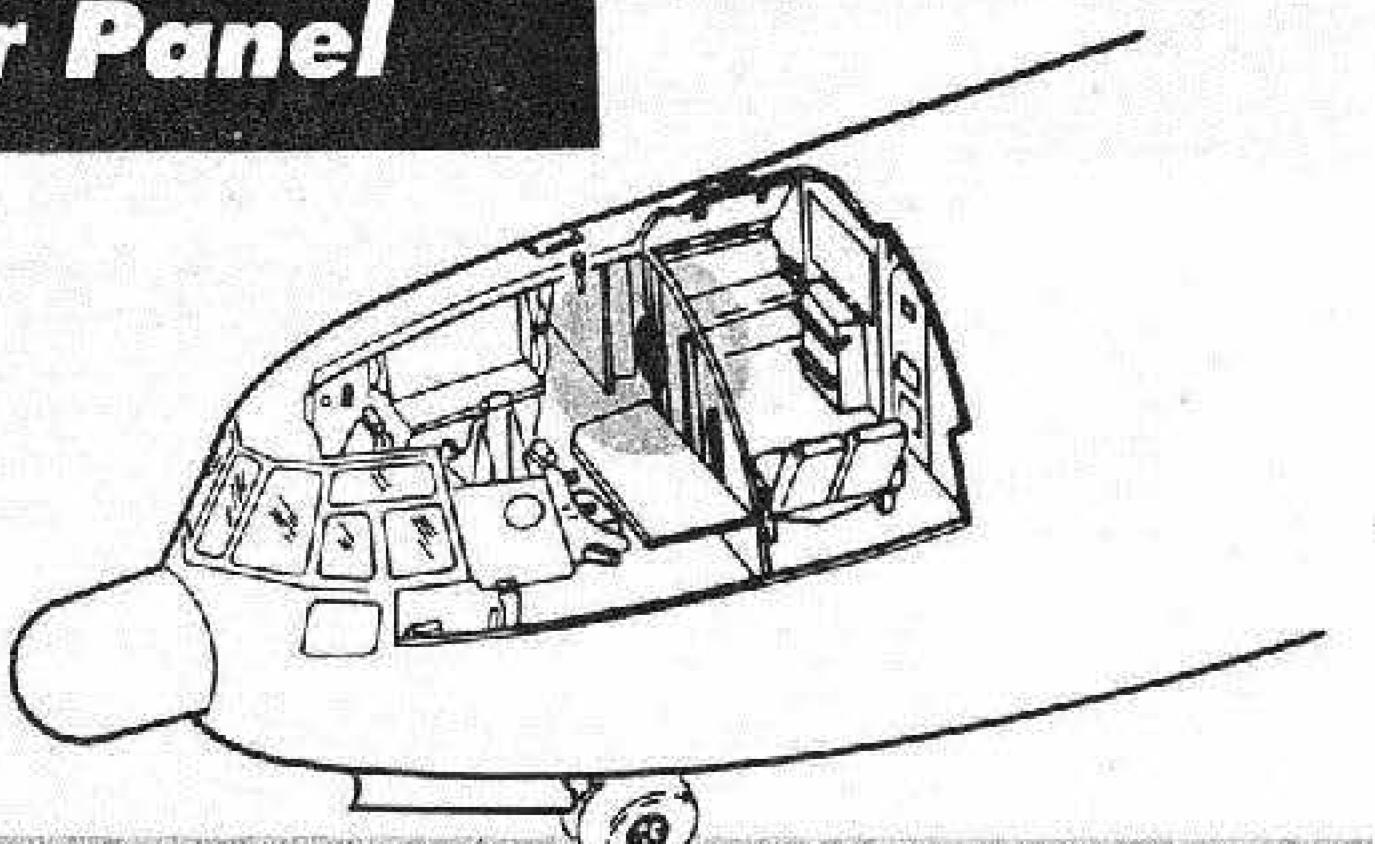
★C/B WIRED TO ESSENTIAL BUS
★★AF 54-135 THROUGH AF 57-1615 ONLY

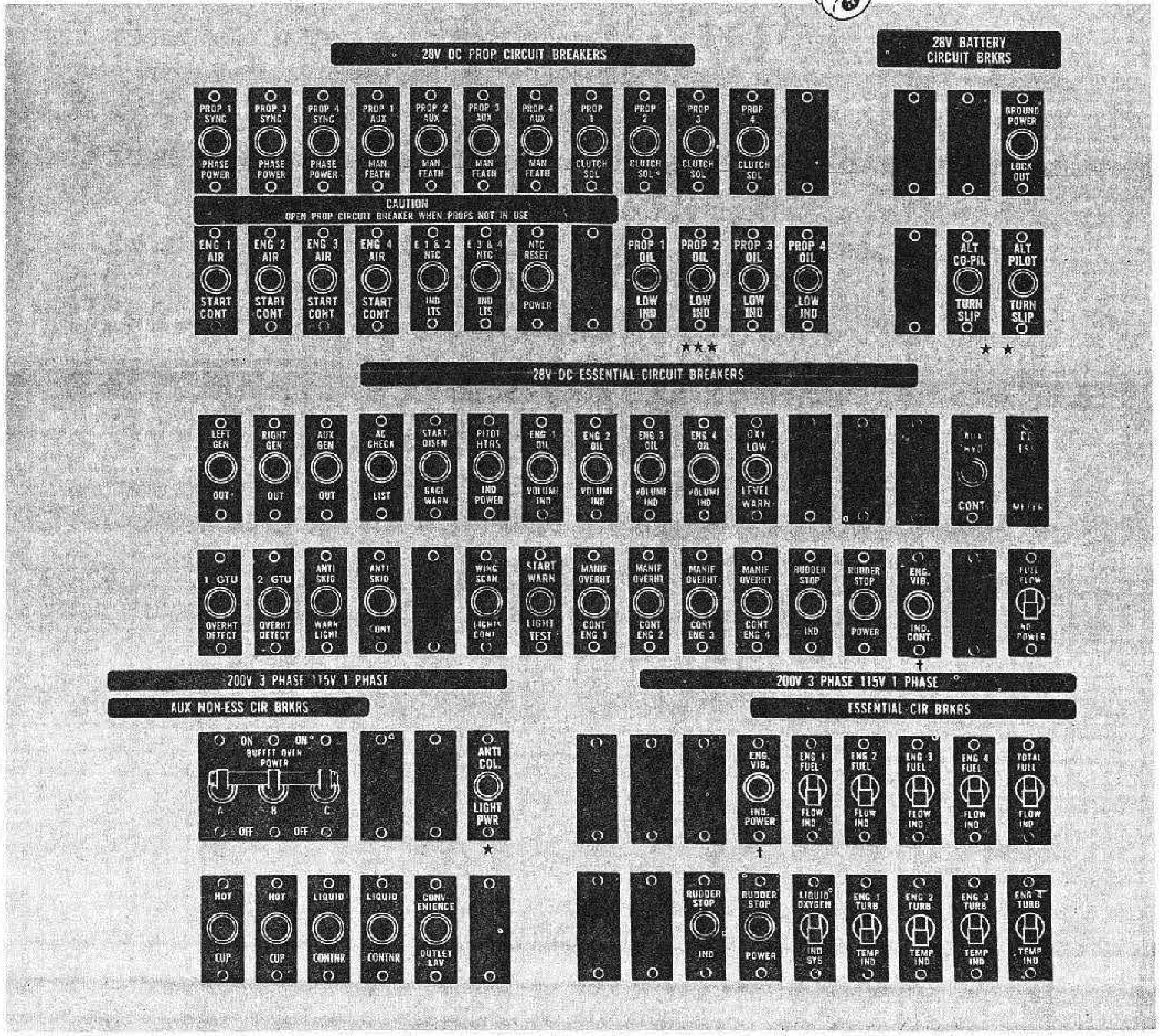
UAB1-151

Figure 1-23 (Sheet 2 of 2)

Flight Deck Left Hand Auxiliary Circuit Breaker Panel

★T.C.T.O. 583
★★T.C.T.O. 534
★★★T.C.T.O. 571
†T.C.T.O. 612

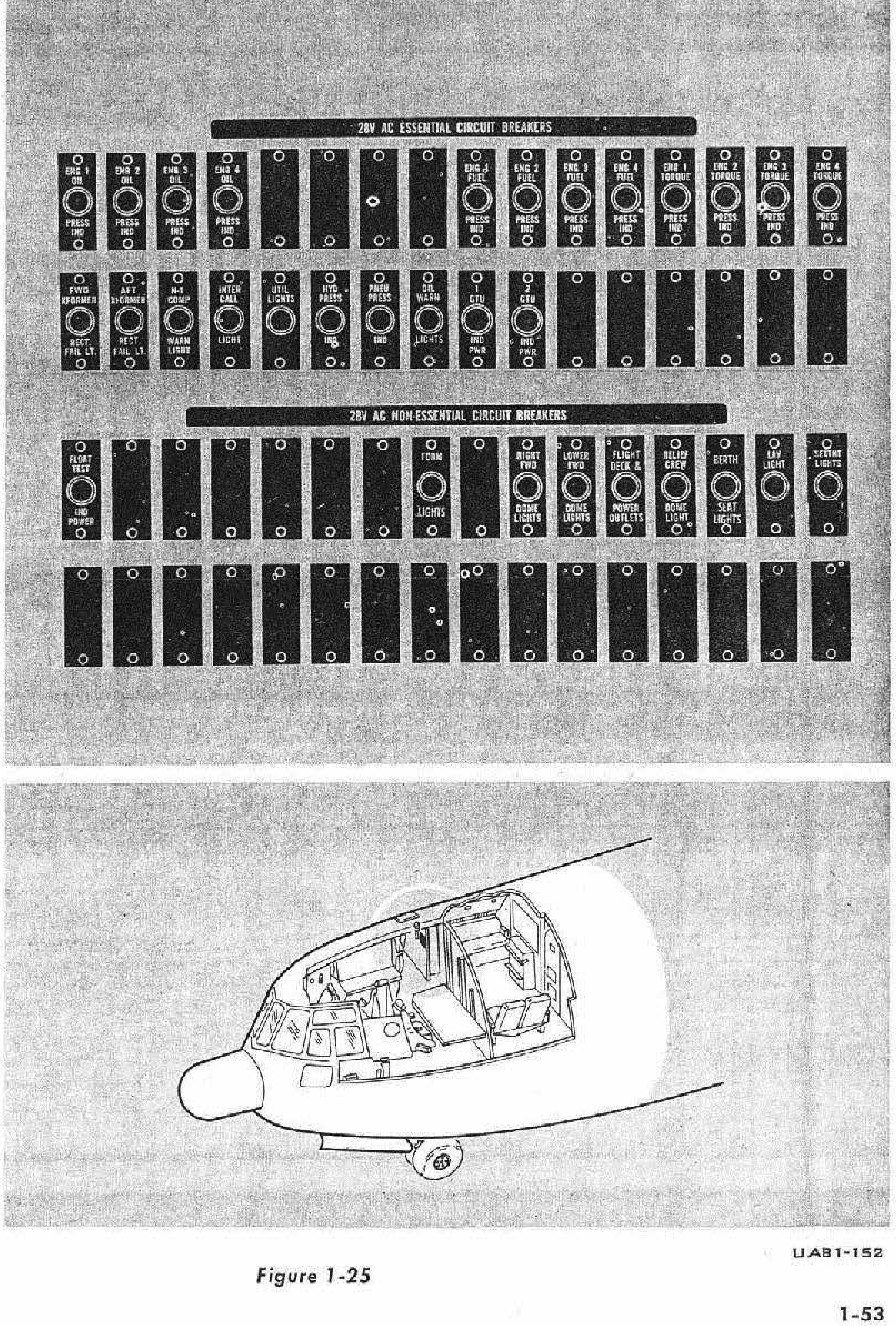




UAB1-154

Figure 1-24

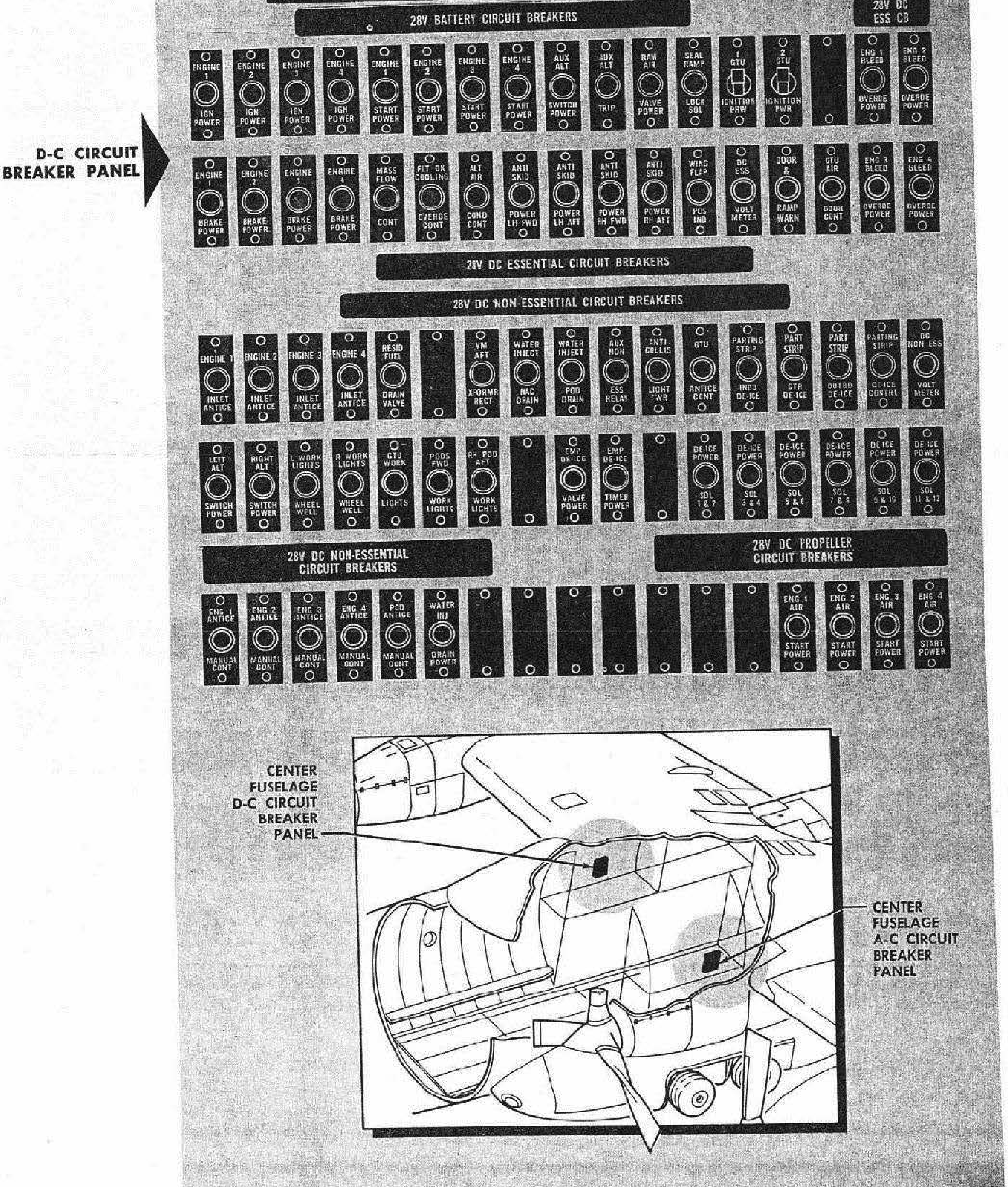
Flight Deck Right Hand Auxiliary Circuit Breaker Panel—Typical



UAB1-152

Figure 1-25

Center Fuselage D-C and

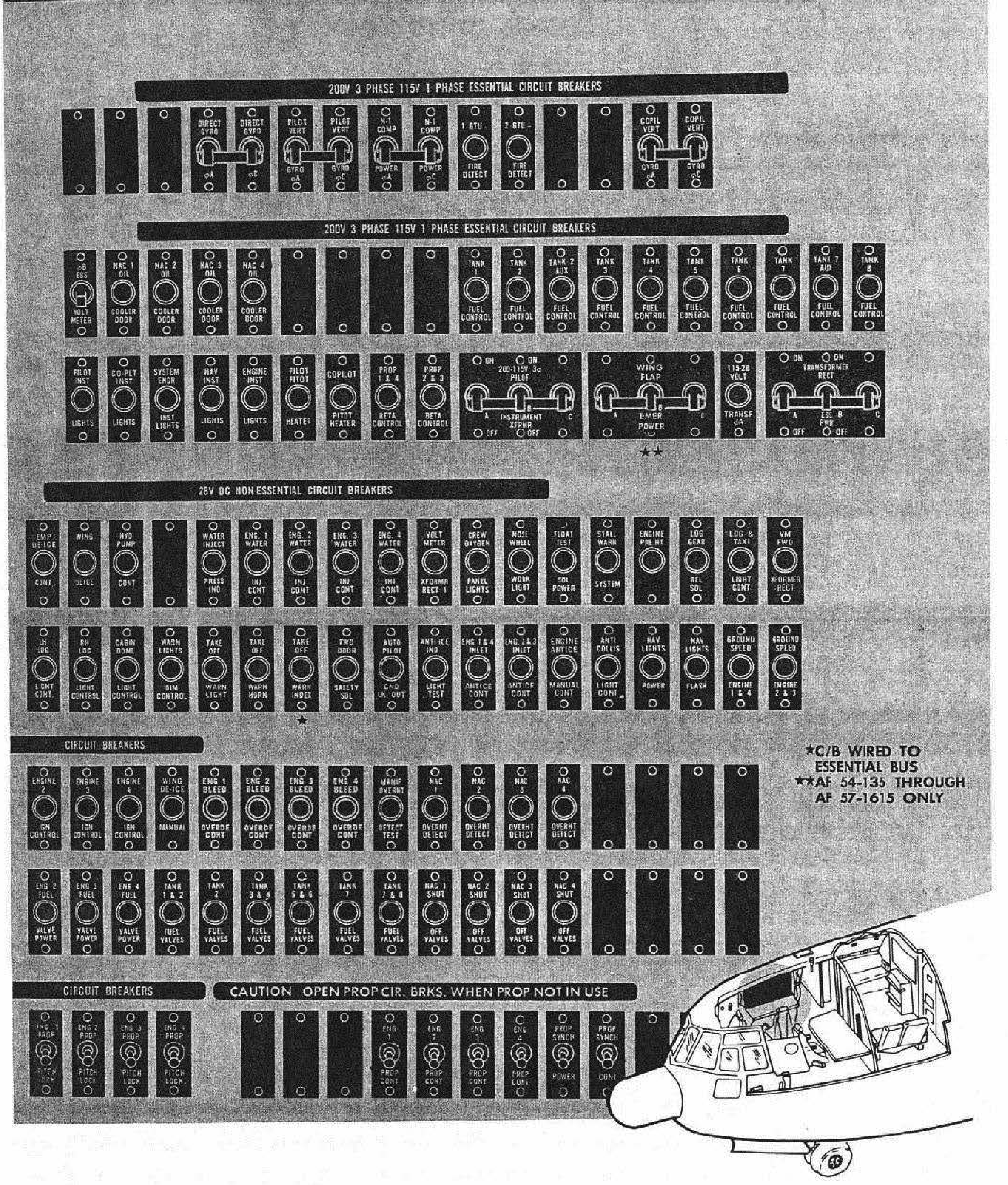


UAB1-156

Figure 1-26 (Sheet 1 of 2)

Pages 1-55 thru 1-60 deleted.

Breaker Panel

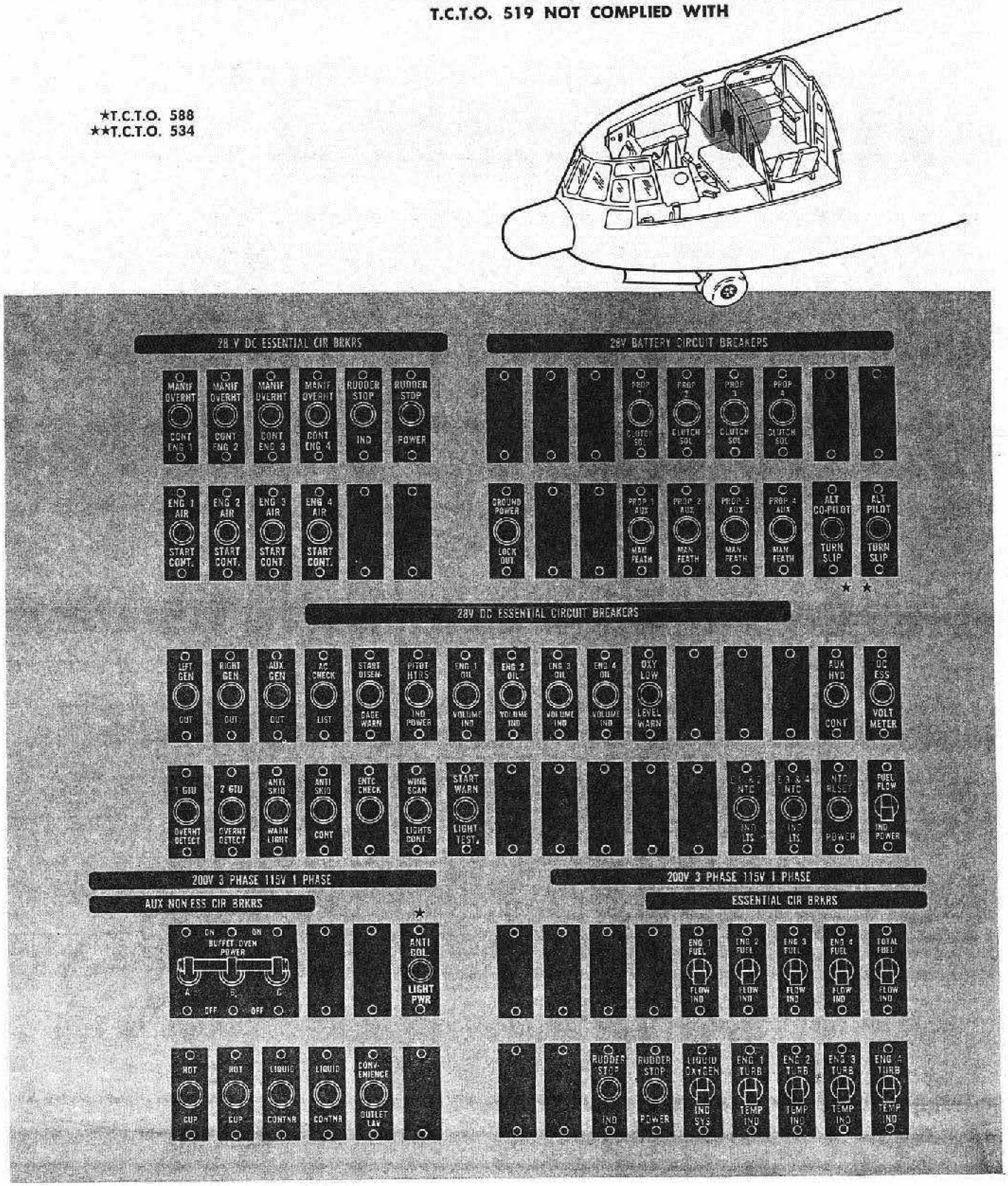


★C/B WIRED TO ESSENTIAL BUS
★★AF 54-135 THROUGH AF 57-1615 ONLY

Figure 1-23 (Sheet 4 of 4)

Flight Deck Left Hand Auxiliary

T.C.T.O. 519 NOT COMPLIED WITH



★T.C.T.O. 588
★★T.C.T.O. 534

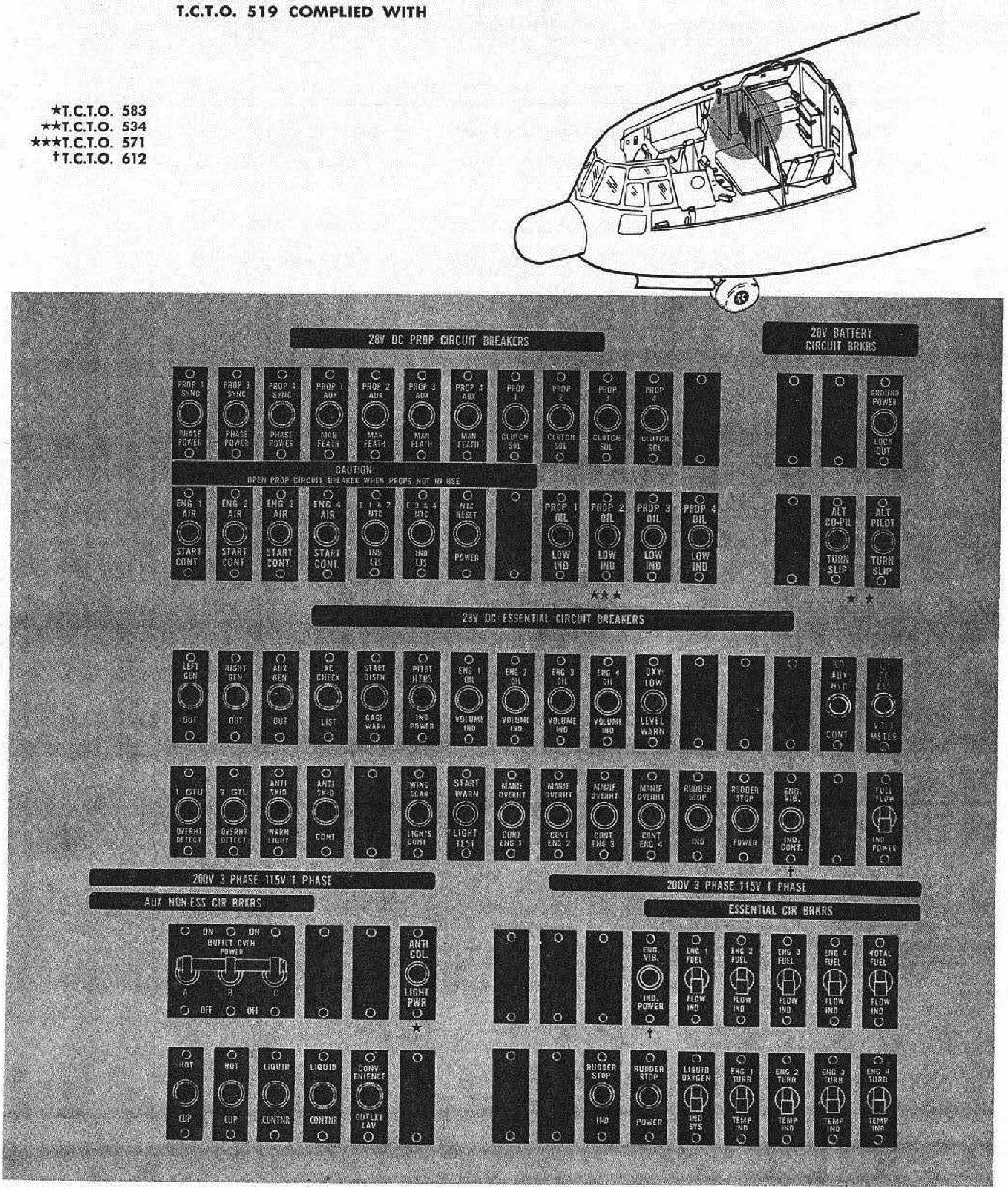
UAB1-153

Figure 1-24 (Sheet 1 of 2)

Circuit Breaker Panel

T.C.T.O. 519 COMPLIED WITH

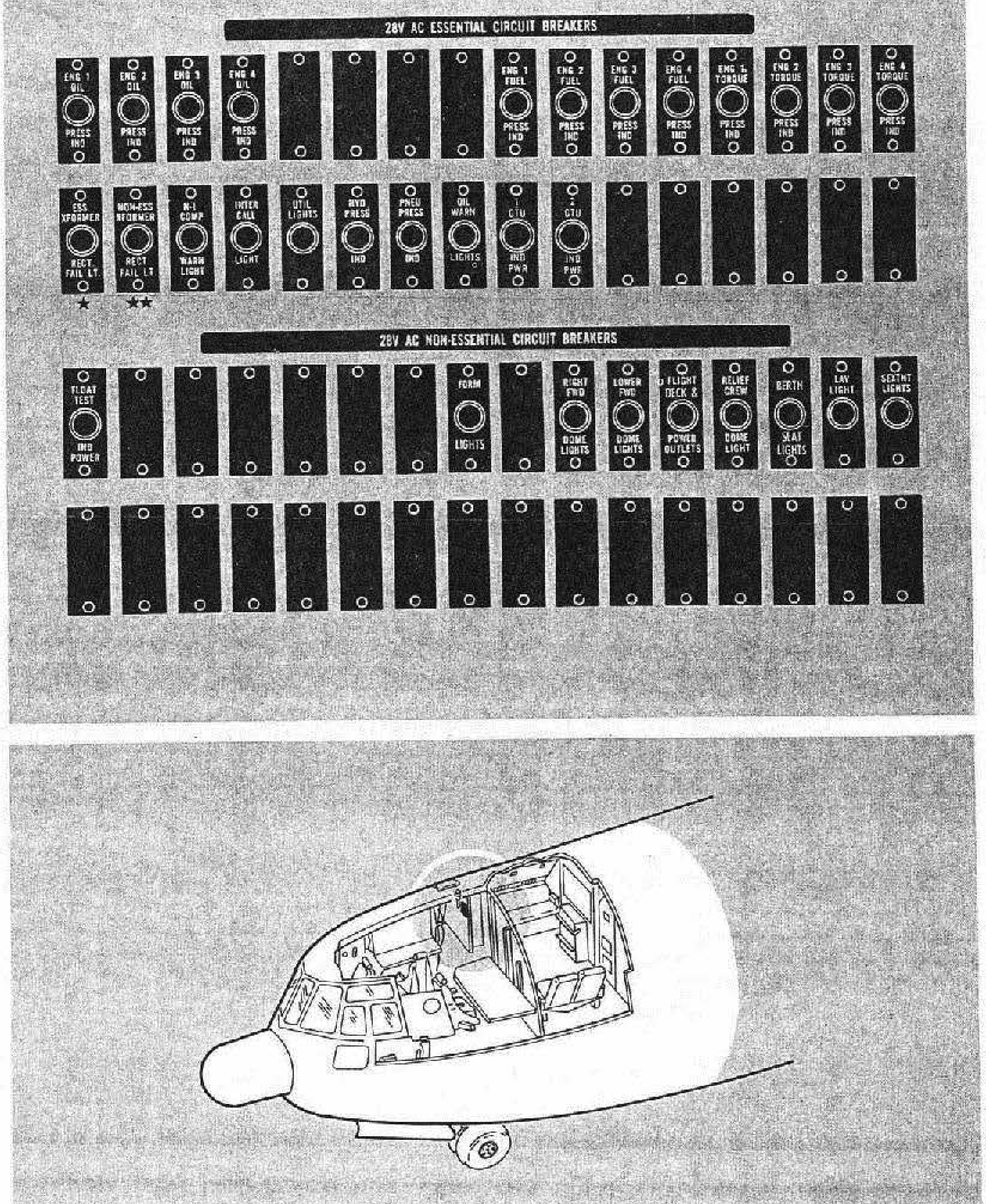
★T.C.T.O. 583
★★T.C.T.O. 534
★★★T.C.T.O. 571
†T.C.T.O. 612



UAB1-154

Figure 1-24 (Sheet 2 of 2)

Flight Deck Right Hand Auxiliary Circuit Breaker Panel—Typical



★T.C.T.O. 519
FWD XFORMER
RECT. FAIL LT.

★★T.C.T.O. 519
AFT XFORMER
RECT. FAIL LT.

UAB1-152

Figure 1-25

(Continued from Page 1-51)

Battery Switch and Isolation Relay.

A guarded, 2-position battery switch *(figure 1-22)*, mounted on the flight engineer's instrument panel, controls the battery circuit through an isolation relay. The switch has the placarded positions ON and OFF, and is guarded in the ON position. When the battery switch is placed in the ON position, the isolation relay closes to permit charging the battery from the d-c essential bus. In addition, the ON position of the switch permits the battery to supply the d-c essential busses in the event of failure of both transformer-rectifiers, or loss of a-c input voltage. When the battery switch is placed in the OFF position, the isolation relay is opened to disconnect the battery from the d-c essential bus. The battery bus is directly connected to the battery, and supplies power to the equipment connected to the battery bus, regardless of battery switch position.

Transformer-Rectifier Warning Lights.

Two red, 28-volt a-c transformer-rectifier warning lights *(figure 1-22)* are located on the flight engineer's instrument panel. The warning lights come on to warn of a d-c power failure, either from interruption of the a-c power supply to the transformer-rectifier or failure of the transformer-rectifier. **On aircraft without T.C.T.O. 519,** the warning lights are placarded ESSENTIAL TRANSFORMER-RECTIFIER — LIGHT ON NO OUTPUT, and NON-ESSENTIAL TRANSFORMER — LIGHT ON NO OUTPUT. **On aircraft with T.C.T.O. 519,** the warning lights are placarded FORWARD TRANSFORMER-RECTIFIER — LIGHT ON NO OUTPUT, and AFT TRANSFORMER-RECTIFIER—LIGHT ON NO OUTPUT. Power for operation of the transformer-rectifier warning lights is obtained from the flight deck 28-volt a-c essential bus. Circuit protection is provided by individual circuit breakers located on the flight deck right hand auxiliary circuit breaker panel.

D-C Voltmeter.

A d-c voltmeter *(figure 1-22)* is mounted on the flight engineer's instrument panel to indicate the voltage of any d-c power source or feeder bus selected by the voltmeter and frequency meter selector switch.

AIR-DRIVEN GENERATOR (AIRCRAFT WITH T.C.T.O. 519).

A 400-ampere, 28-volt d-c air driven generator *(figure 1-28)* is installed in the forward end of the left pod, to provide emergency d-c power during flight in the event of failure of the main and auxiliary a-c generators or the transformer-rectifiers. The air-driven generator has sufficient capacity to supply continuous power for all normal d-c power requirements at airspeeds above 150 knots. At airspeeds below 150 knots, selective monitoring of the d-c power will allow limited use of essential d-c powered equipment. At 70 knots, the d-c power output of the generator will be approximately 64 amperes, and at 50 knots, 50 amperes are available. The air-driven generator is connected in parallel with the battery bus and will supply power to the essential busses when in operation.

The air-driven generator can be extended in flight by means of an emergency release handle *(figure 1-29)* located on the left side of the cabin, forward of the wheel well. On the ground, the governor may be extended by means of the emergency release handle inside the cabin or with the control handle located in the pod, adjacent to the generator. When extended, an inner door which supports the generator mount struts, seals the opening in the pod to prevent air turbulence in the pod. Once extended, the generator cannot be retracted in flight. The generator is retracted on the ground hydraulically, by means of a hydraulic cylinder controlled by a hydraulic selector valve located in the pod adjacent to the generator door.

Air-Driven Generator Emergency Release Handle.

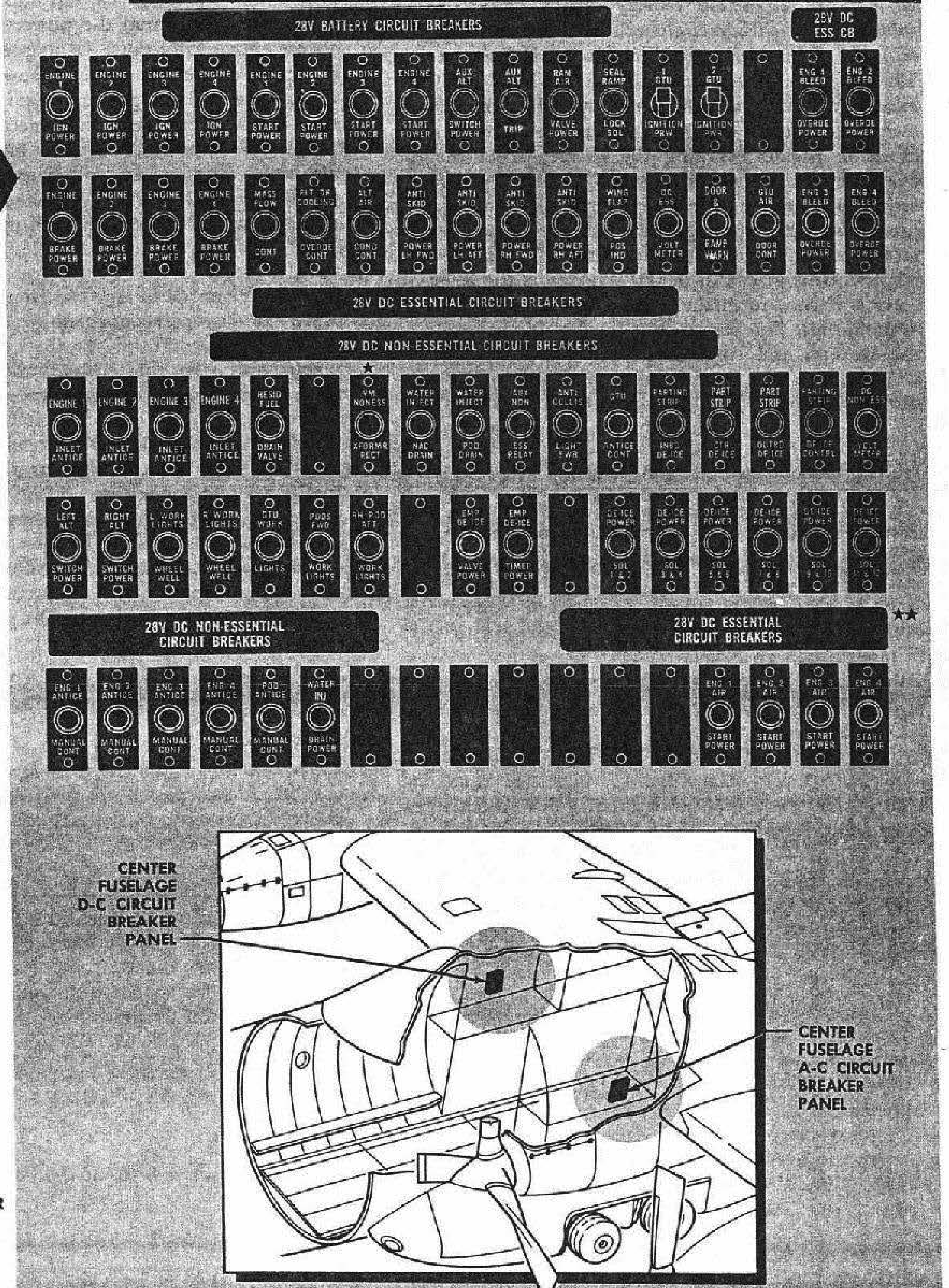
An emergency release handle *(figure 1-29)*, located on the left side of the cabin, forward of the wheel well, above the catwalk, provides a means of extending the air-driven generator in flight or on the ground. The handle is placarded EMERGENCY HANDLE — AIR DRIVEN GENERATOR — PULL TO OPEN GENERATOR DOOR. The handle is connected by cable to the generator door latch mechanism and when pulled out will release the door latches and allow the air-driven generator to drop out into operating position. When pulled out to release the generator, the handle will extend approximately 8 inches out of the socket. When the door is retracted, the handle will be pulled back into the socket.

Air-Driven Generator Door Controls.

Three control handles *(figure 1-29)* for operation of the air-driven generator door on the ground, are located in the left pod, forward of the air-driven generator door. An instruction placard covering the operation of the control handles is mounted on the outside of the pod immediately below the forward

Center Fuselage D-C and

D-C CIRCUIT BREAKER PANEL



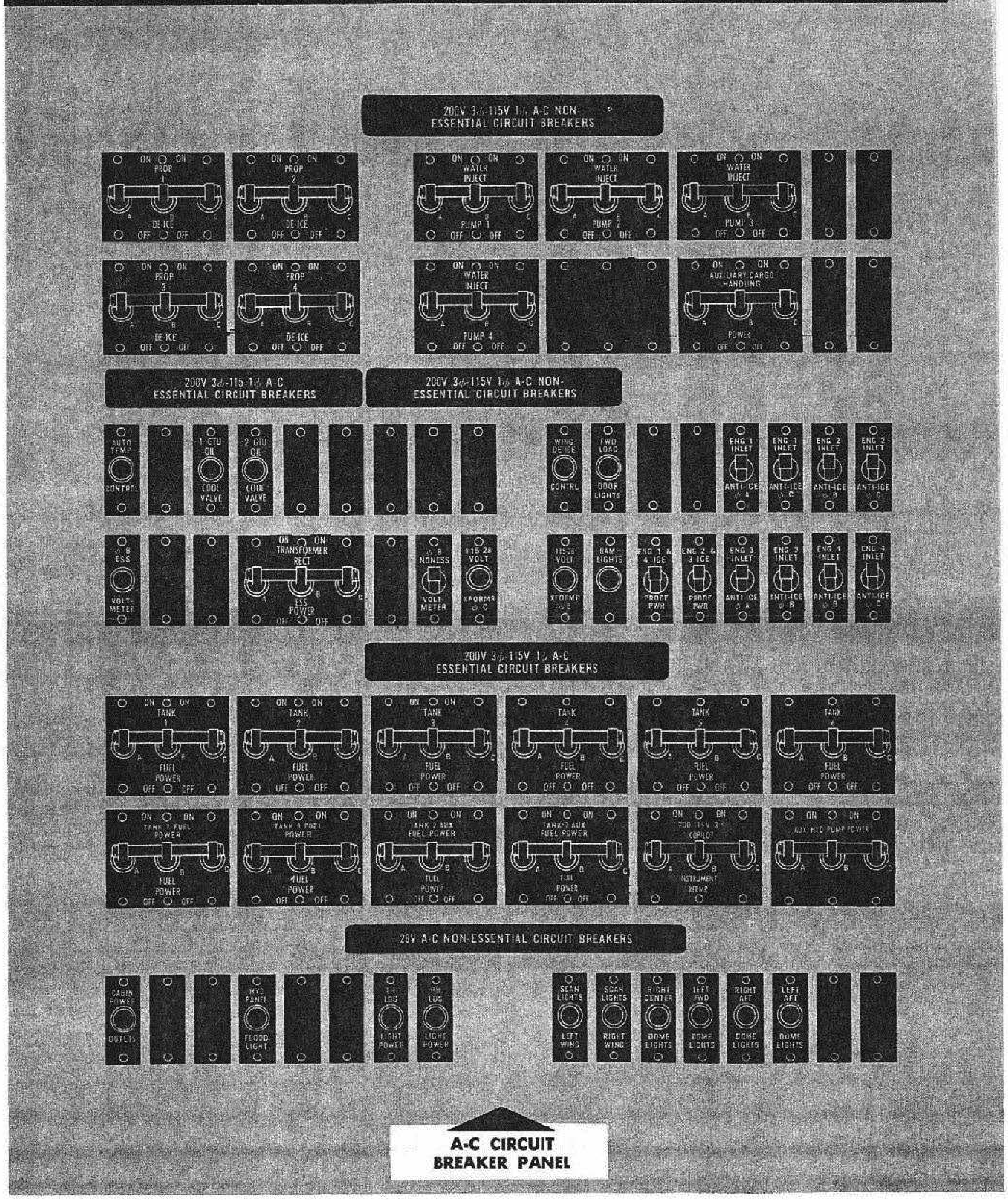
★T.C.T.O. 519
VM AFT
XFORMR RECT

★★T.C.T.O. 519
28V DC PROPELLER
CIRCUIT BREAKERS

UAB1-156

Figure 1-26 (Sheet 1 of 2)

A-C Circuit Breaker Panels—Typical



UAB1-157

Figure 1-26 (Sheet 2 of 2)

Navigator's Radio and Aft Loading Door Radio Circuit Breaker Panels

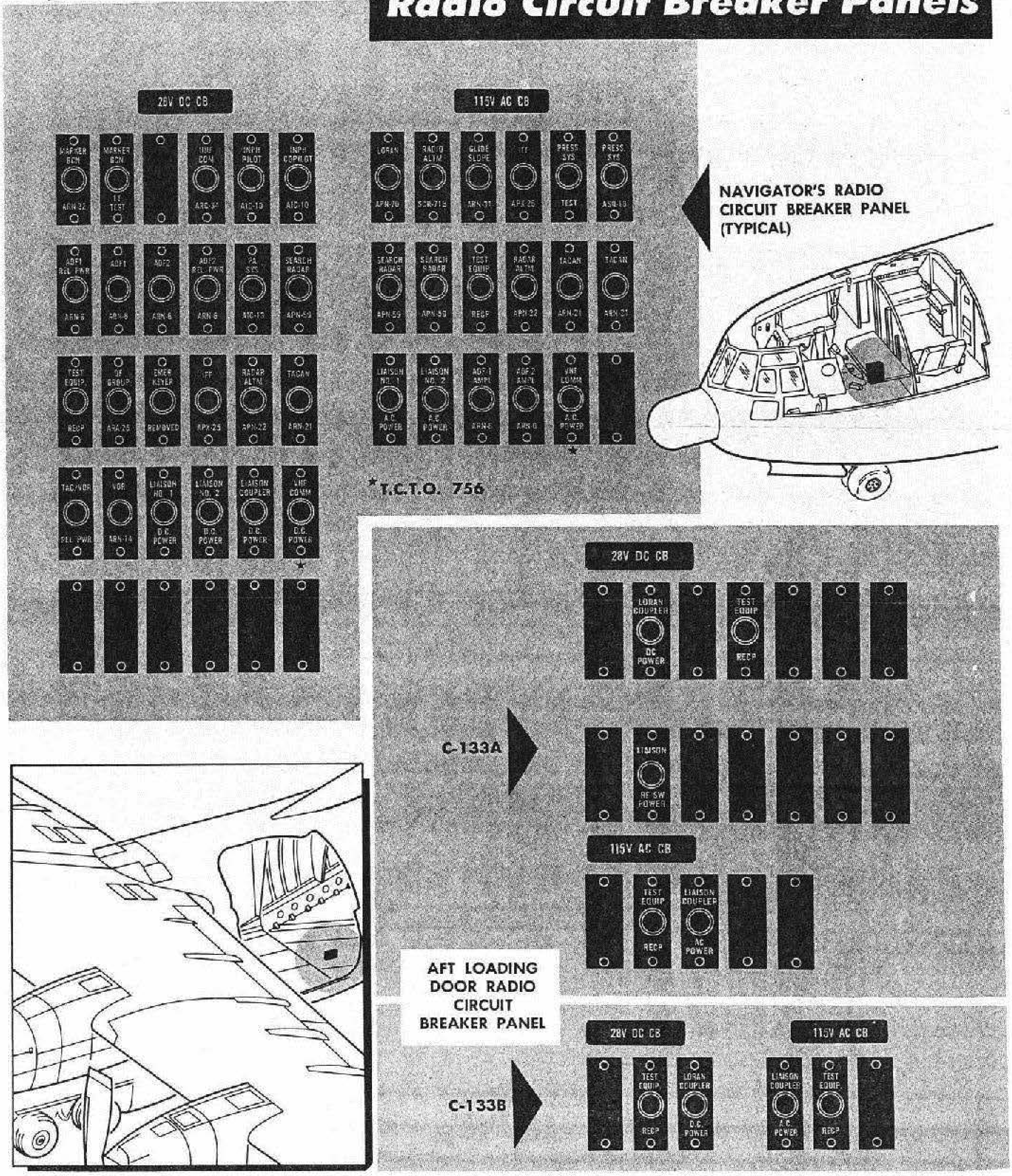


Figure 1-27

Air Driven Generator

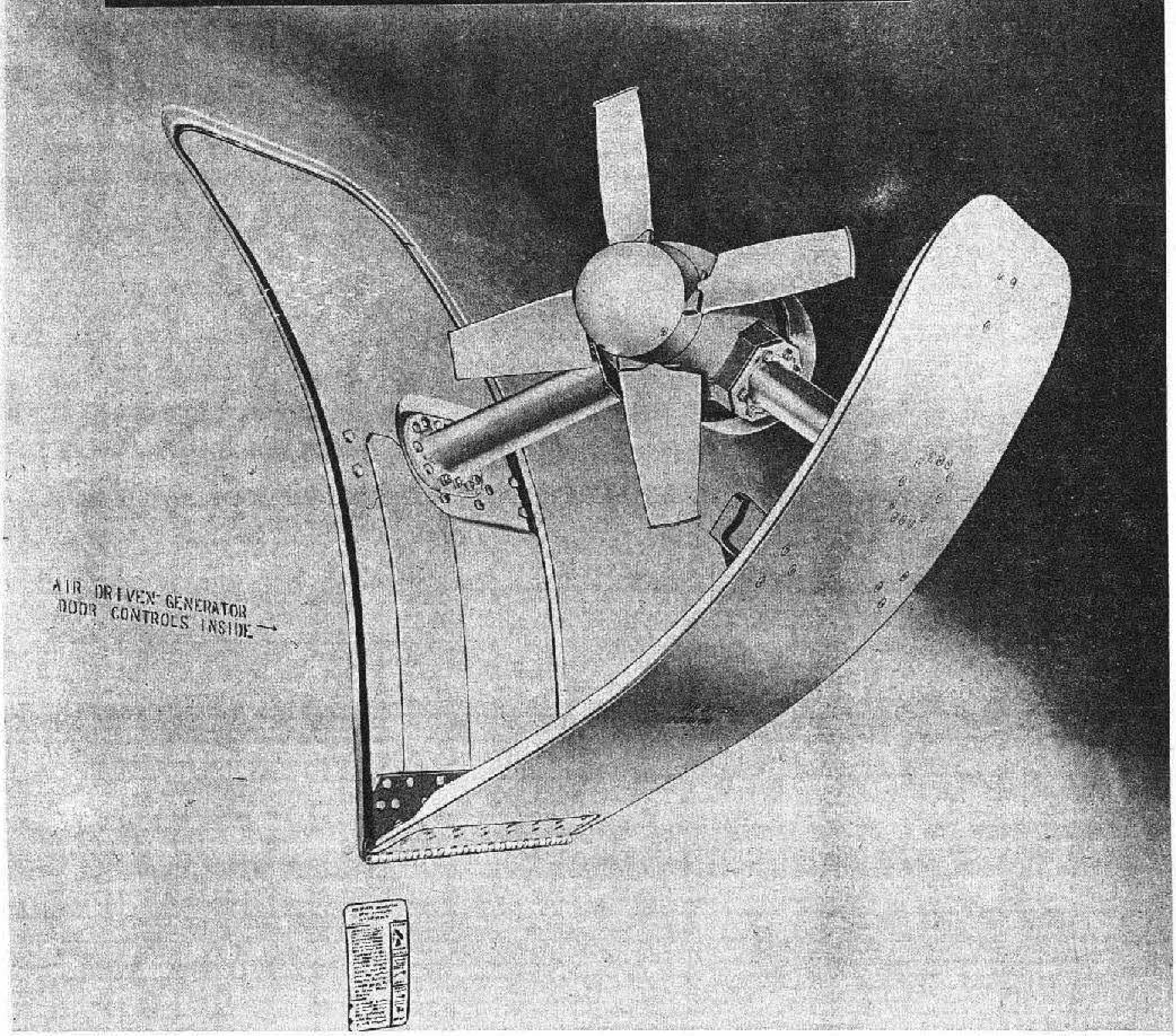
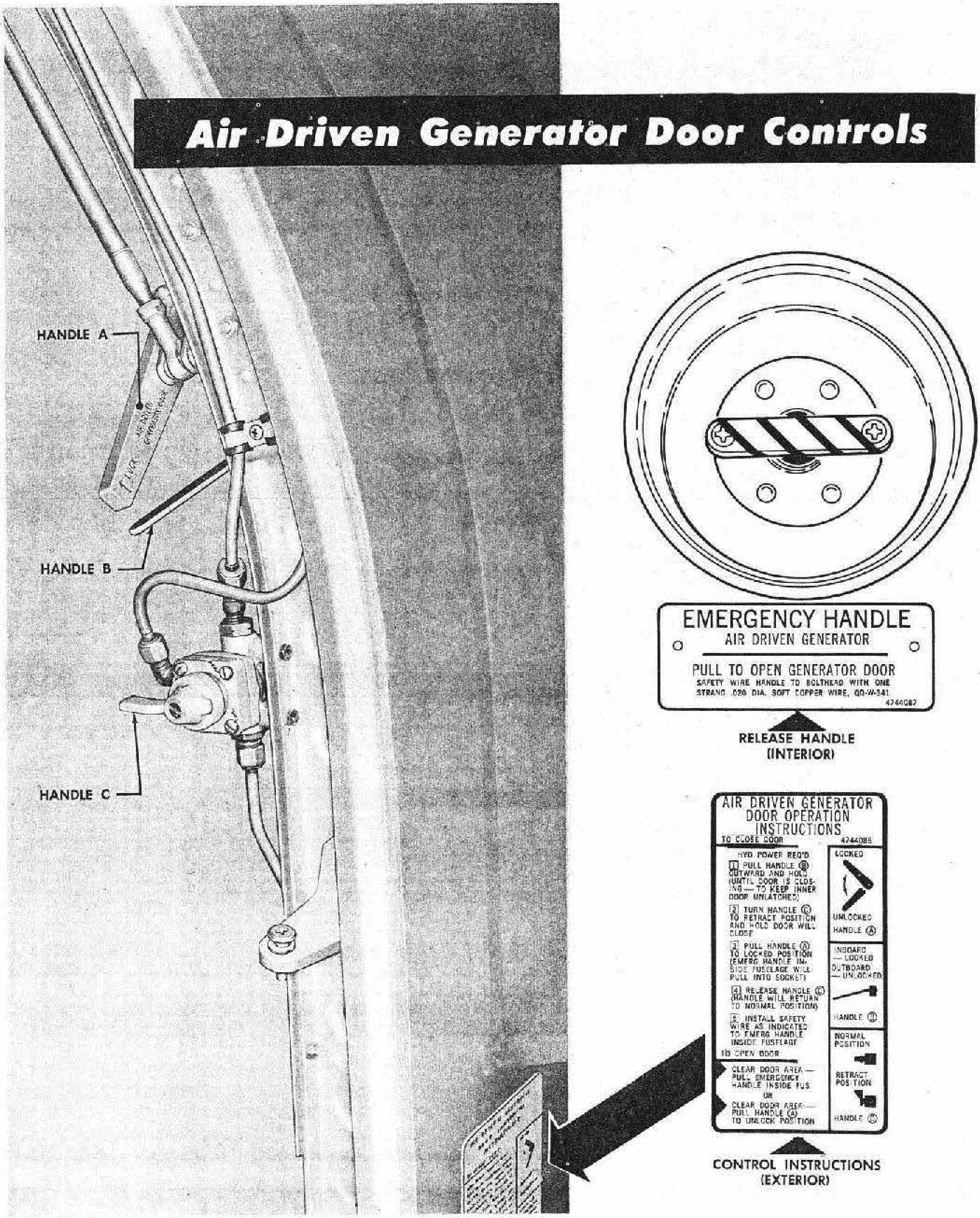


Figure 1-28

edge of the air-driven generator door. The latch control handle, HANDLE A, is mechanically linked to the latch mechanism of the generator door. When pulled from the LOCKED (up) position to the UNLOCKED (down) position, the door latches will be released, allowing the air-driven generator to drop out into the extended position. When the generator is being retracted, moving the handle to the LOCKED position will position the door latches to hold the generator door in the closed position and also pull the emergency handle, inside the cabin, into its socket.

The generator door unlatching handle, HANDLE B, is mechanically linked to a spring-loaded latch assembly which holds the air-driven generator door in the extended position after having been released. Pulling the handle to the UNLOCKED (outboard) position, releases the latches on the inner door to allow the air-driven generator to be retracted. The handle is left in the LOCKED (inboard) position during normal operation to allow the latches to engage when the air-driven generator is released.

Air Driven Generator Door Controls



EMERGENCY HANDLE
AIR DRIVEN GENERATOR

PULL TO OPEN GENERATOR DOOR
SAFETY WIRE HANDLE TO BOLTHEAD WITH ONE STRAND .020 DIA. SOFT COPPER WIRE, QQ-W-341
4744087

AIR DRIVEN GENERATOR
DOOR OPERATION
INSTRUCTIONS

TO CLOSE DOOR 4744086

HYD POWER REQ'D

1. PULL HANDLE Ⓑ OUTWARD AND HOLD (UNTIL DOOR IS CLOSING — TO KEEP INNER DOOR UNLATCHED)
2. TURN HANDLE Ⓒ TO RETRACT POSITION AND HOLD DOOR WILL CLOSE
3. PULL HANDLE Ⓐ TO LOCKED POSITION (EMERG HANDLE INSIDE FUSELAGE WILL PULL INTO SOCKET)
4. RELEASE HANDLE Ⓒ (HANDLE WILL RETURN TO NORMAL POSITION)
5. INSTALL SAFETY WIRE AS INDICATED TO EMERG HANDLE INSIDE FUSELAGE

TO OPEN DOOR

- CLEAR DOOR AREA — PULL EMERGENCY HANDLE INSIDE FUS
  OR
- CLEAR DOOR AREA — PULL HANDLE Ⓐ TO UNLOCK POSITION

LOCKED
UNLOCKED
HANDLE Ⓐ

INBOARD — LOCKED
OUTBOARD — UNLOCKED
HANDLE Ⓑ

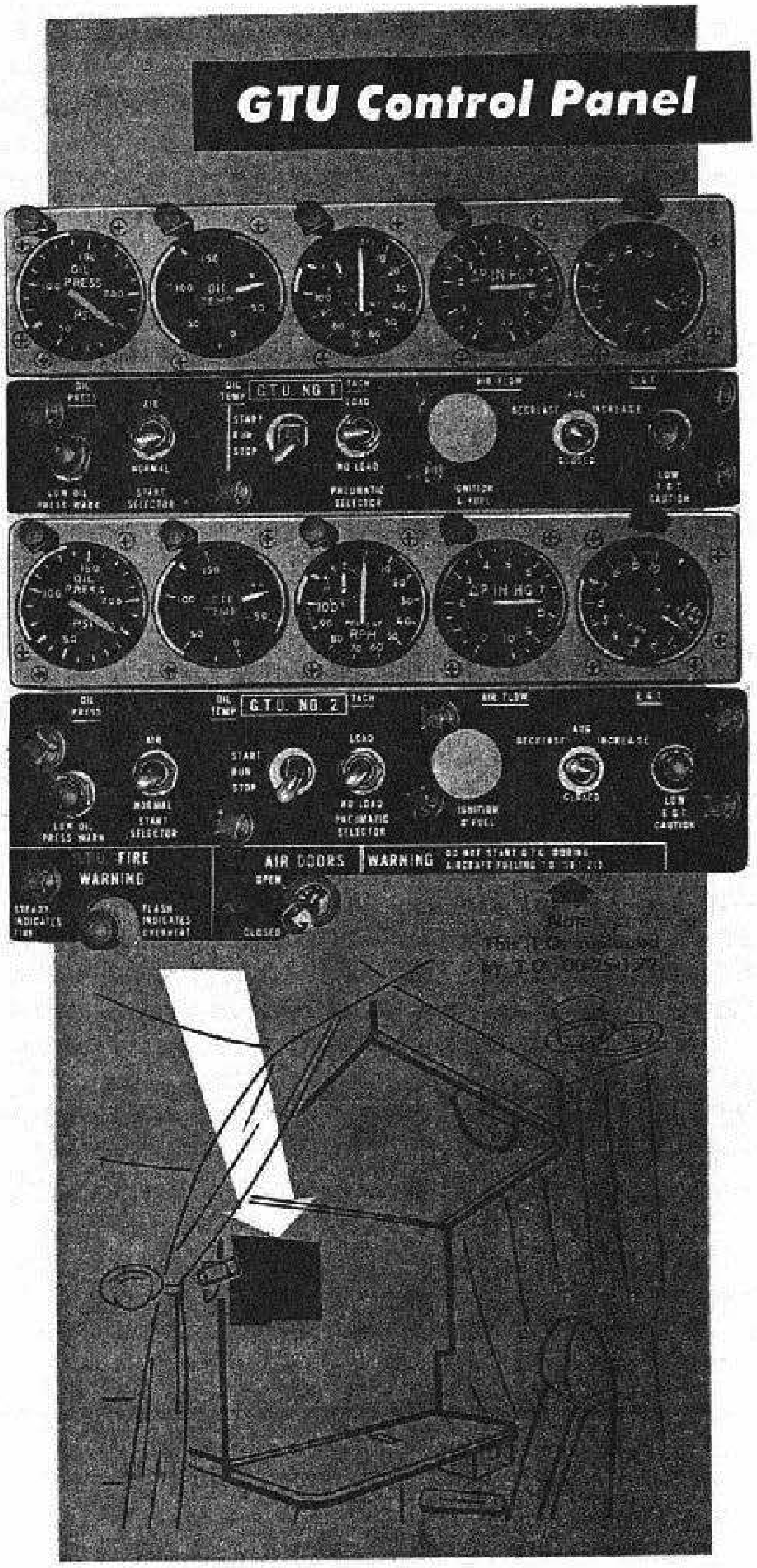
NORMAL POSITION
RETRACT POSITION
HANDLE Ⓒ

Figure 1-29

A spring-loaded retraction control handle, HANDLE C, controls the flow of hydraulic fluid to the retraction cylinder to retract the air-driven generator. Placing the control handle in the RETRACT position will direct hydraulic fluid to the retraction cylinder to retract the generator and close the door. When the handle is released, it will return to the NORMAL position and shut off the flow of hydraulic fluid to the retraction cylinder.

GAS TURBINE UNITS (GTU'S).

Two 85-3 GTU's *(32 and 33, figure 1-2)* are located in the left pod, immediately aft of the wheel well area. These units are mounted in tandem and are isolated from the wheel well area and from each other by firewalls. The function of the two GTU's is to supply compressor bleed air for the aircraft air conditioning system, supply nacelle preheat, jet blast rain removal, start the four engines, pressurize the hydraulic reservoir, and drive the two hydraulic pumps. In addition, the auxiliary generator is driven by the No. 1 GTU. The GTU's are designed to be self-sufficient except for electrical power for controls and starting, a fuel source, and a supply of main engine bleed air required for augmentation under certain modes of operation. The two GTU's have self-contained oil supply systems, each having a capacity of 1.45 gallons. The No. 1 GTU receives its fuel under pressure from the No. 1 engine inlet fuel line, and the No. 2 GTU from the No. 4 engine inlet lines. If no pressure supply is available, fuel will gravity-feed from tanks No. 2 and 7, respectively. The fuel supply is gravity- and pressure-fed to each unit, and has solenoid-triggered fuel shutoff valves utilized in the control system of each unit. The GTU is designed to supply simultaneous shaft power and compressor bleed air, or either of the two independently. The GTU multi-purpose gas turbine is a two-stage centrifugal-type turbine, utilizing two radial flow impellers. Ambient or ram air is compressed in the compressor. Part of this air, at the temperature of the compression, is made available for pneumatic power and air conditioning through the bleed air port of the unit. The rest of the air flows into a single can-type combustor, where the fuel is added and combustion takes place. The hot compressed gases, leaving the combustor, flow through a single-stage, radial-inflow turbine to provide power to a shaft that drives the compressor and a set of gears, which in turn, drive the GTU accessories as well as the auxiliary generator and hydraulic pumps. The GTU operates at essentially constant speed, either as a self-powered, gas turbine compressor unit, or as a gas turbine compressor and power motor. When the unit is operating as a gas turbine compressor unit, all the required turbine airflow is supplied by the unit compressor. Any combination of bleed air and shaft power is available up to the maximum output of the unit. Thus, shaft power is available for driving the auxiliary generator and hydraulic pump while simultaneously providing bleed air for the air conditioning system or for engine starting.


GTU Control Panel

UAB1-181

Figure 1-30

When the total demand for bleed air and shaft power is beyond the capabilities of the normal mode of operation, the unit may operate as a gas turbine compressor and power motor, differing in that main engine bleed air is utilized to augment that portion of the compressor airflow available to the turbine. While the unit is operating in this manner, it is capable of producing bleed air in excess of that which would be available in the normal mode of operation. See Section VII for GTU augmentation characteristics and GTU operation. The GTU control panel *(figure 1-30)*, is located on the flight engineer's panel.

The GTU compartments are ventilated on the ground and in flight by air entering through the ram air duct and leaving through the residual heat doors located on top of the pod over each GTU compartment. The residual heat doors and the nonram air doors are controlled by a switch at the flight engineer's station.

GTU AIR DOORS SWITCH.

A 2-position air doors switch with the placarded positions OPEN and CLOSED, is located on the GTU control panel *(figure 1-30)*. The switch shall be in the OPEN position for GTU operation. When the switch is in the OPEN position, the air doors are operated automatically by the main landing gear uplock switches. During ground operation, these switches actuate the residual heat doors and the nonram doors to open. During flight, these same switches actuate the nonram doors and the residual heat doors to the CLOSED position. When the aircraft is parked and the GTU's are not required, placing the GTU air doors switch in the CLOSED position will override the landing gear switches and complete a circuit from the flight deck 28-volt d-c battery bus. The battery will then supply power to close both the nonram doors and the residual heat doors, even if the battery switch is in the OFF position and external power is not connected to the aircraft. The GTU fire control switch overrides the automatic operation of the doors. When a GTU fire control switch is actuated, it closes the residual heat door and the oil cooler air valve that closes off all cooling air except the air to the auxiliary generator.

GTU PNEUMATIC SELECTOR SWITCHES.

A 2-position pneumatic selector switch, with the placarded positions LOAD and NO LOAD, is installed on each GTU control panel *(figure 1-30)*. When placed in the LOAD position, each switch completes a 28-volt d-c circuit to its respective GTU load control valve solenoid which permits the load control valve to be pneumatically actuated by GTU bleed air. Placing the switch in the LOAD position also establishes a 28-volt d-c circuit to the augmentation valve clutch which permits the position of the augmentation valve to be controlled by the GTU augmentation switch. When the pneumatic selector swith is placed in the NO LOAD position, the circuits to both the load control valve and the augmentation valve clutch are deenergized. The pneumatic selector switches must be placed in the NO LOAD position before starting the GTU's.

GTU START SELECTOR SWITCHES.

A 2-position start selector switch is installed on each GTU control panel *(figure 1-30)*. The switches have the positions NORMAL and AIR. The NORMAL position completes a circuit to the start power relay. This relax closes the electrical circuit between the battery and the starter motor. When the 35 percent rpm switch closes, the circuit to the start power relay is interrupted, thus disengaging the starter motor. The AIR position of the switch bypasses the starter motor and provides power to the augmentation valve through the INCREASE position of the augmentation switch. The valve may then be opened for air to start the GTU. After the GTU is started, the start selector switch is returned to the NORMAL position. This will allow the unit to be loaded.

GTU START-RUN-STOP SWITCHES.

Two 3-position START-RUN-STOP switches, one for each GTU, are located on the GTU control panel *(figure 1-30)*. Each switch is spring loaded from the START to the RUN position. To prevent electrical overload, an interlock is provided so that only one GTU can be started at a time. The START position completes a 28-volt d-c circuit from the flight deck battery bus and energizes the GTU start relay. The switch must be held in the START position until the GTU accelerates to 95 percent rpm. Actuation of the start relay sets the starter in motion, meshing automatically with the accessory gear train. Under the combined drive of the starter and energy absorbed from the hot combustion products, the unit accelerates. At 35 percent rpm, the starter relay is deenergized due to actuation of a centrifugal switch. Denergizing the starter relay opens the starter circuit, allowing the starter to be disengaged. Under its own power, the unit continues to accelerate until normal governed speed is attained. When the switch is released to the RUN position, the ignition unit is deenergized. The switch is left in the RUN position during normal operation. When the switch is positioned to STOP, the holding coil of the ignition and fuel switch is deenergized, opening the electrical circuit to the fuel shutoff valve. Cooling of the units is better with the air doors open.

GTU IGNITION AND FUEL SWITCHES.

A spring-loaded, press-type ignition and fuel switch is located on each GTU control panel *(figure 1-30)*. During starting of a GTU, the switch is pushed in when the rpm reaches 3 to 5 percent. This completes the circuit to the fuel shutoff valve, ignition unit, and the ignition and fuel switch holding coil. The ignition and fuel switch no longer needs to be held in. Releasing the START-RUN-STOP switch to RUN de-energizes the ignition unit. When the unit is shut down, the START-RUN-STOP switch should be placed in the STOP position thus shutting off the fuel supply. The ignition and fuel switch will also be released as a result of the opened circuit.

GTU AUGMENTATION SWITCHES.

Each GTU has a 4-position augmentation (AUG) switch, located on the GTU control panel *(figure 1-30)*, which allows the operator complete control of GTU augmentation. When the GTU is loaded, the INCREASE position of the augmentation switch completes a 28-volt d-c circuit to slowly open the motor-driven augmentation valve; the DECREASE position slowly closes the valve. An intermediate position of the valve may be obtained by releasing the switch from either the INCREASE or DECREASE spring-loaded position to its centered position. If the switch is placed in the CLOSED position or if electrical power is withdrawn, the valve will quickly close. The augmentation valve will not open with the pneumatic selector switch in NO LOAD and the start selector switch in NORMAL.

The valve also functions in the INCREASE position of the switch during an augmented air start of the GTU. When the switch is released, the valve is de-energized and a spring load closes it (see GTU Operation Section VII for augmentation instructions).

GTU LOAD CONTROL VALVES.

A load control valve is located in the duct between the compressor outlet of each GTU and the aircraft pneumatic ducting. Bleed air extracted from the GTU is controlled by the valve to maintain proper airflow in relation to GTU exhaust gas temperature. Each load control valve is electrically energized by its respective GTU pneumatic selector switch and is pneumatically operated by GTU bleed air. The valves are controlled by flow regulators in the pneumatic system and thermostats located in the GTU turbine exhaust. The valves are closed automatically when the emergency depressurization control is operated.

GTU SAFETY SHUTDOWN PROVISIONS.

In addition to the normal stopping provisions controlled by the STOP switch, the GTU's will automatically shut down when the safety of the units requires it. A speed-sensing centrifugal switch located in each GTU will electrically shut off the fuel supply to the discharge nozzle if the speeds of the GTU's should exceed 110 percent of normal rpm.

GTU MANUAL FUEL SHUTOFF VALVES.

Two manual fuel shutoff valves *(figure 1-16)*, one for each GTU, are located on the firewall, forward of each GTU unit. The valves must be in the OPEN position to supply the required fuel from the main fuel supply system to the GTU's for operation. The valves permit fuel to be shut off during maintenance and servicing.

GAS TURBINE UNIT INDICATORS.

GTU Tachometer Indicators.

Two tachometer indicators, one for each GTU, calibrated in percent rpm, are located on the GTU control panel *(figure 1-30)*. The indicators are powered by individual tachometer generators, and indicate GTU turbine shaft speed. The tachometer generators produce variable-voltage, variable-frequency, 3-phase a-c power which drives the synchronous motor of the tachometer indicator.

GTU Exhaust Gas Temperature Indicators.

Two exhaust gas temperature indicators, one for each GTU, are located on the GTU control panel *(figure 1-30)*. The indicators are calibrated in degrees centigrade from zero to 1000. Temperatures are sensed at the turbine exhausts by means of thermocouples.

Low EGT Caution Lights.

Two amber, 28-volt d-c, low EGT caution lights, one for each GTU, are located on the GTU control panel *(figure 1-30).* The purpose of these lights is to warn of excessive GTU augmentation. The lights are set to come on when the EGT falls below 525°C. Power for operation of the low EGT caution lights is obtained from the flight deck 28-volt d-c battery bus. Circuit protection is individually provided by two circuit breakers, placarded GTU START CONT, located on the flight engineer's overhead panel.

GTU Airflow Differential Pressure (ΔP) Indicators.

Two airflow differential pressure (ΔP) indicators, one for each GTU, are located on the GTU control panel *(figure 1-30).* The indicators are actuated by remote synchro-transmitters adjacent to each GTU. The indicators are calibrated in inches of mercury from zero to 10, and show the rate of airflow from the GTU compressor discharge, in terms of differential pressure. Power for operation of the differential pressure indicators is obtained from the flight deck 28-volt a-c essential bus. Circuit protection is individually provided by two circuit breakers placarded GTU IND PWR, located on the flight deck right hand auxiliary circuit breaker panel.

GTU Oil Pressure Indicators.

Two oil pressure indicators, one for each GTU, are located on the GTU control panel *(figure 1-30).* The indicators are calibrated in pounds per square inch from zero to 200. Oil pressure is sensed at the pressure side of the oil pump by a 28-volt a-c synchro-transmitter. Power for operation of the oil pressure indicators is obtained from the flight deck 28-volt a-c essential bus. Circuit protection is individually provided by two circuit breakers, placarded GTU IND PWR, located on the flight deck right hand auxiliary circuit breaker panel.

GTU Oil Temperature Indicators.

Two oil temperature indicators, one for each GTU, are located on the GTU control panel *(figure 1-30).* The indicators are calibrated in degrees centigrade from −70 to +150. Temperature sensing bulbs located in each GTU oil system transmit the temperature to the indicator. Power for operation of the oil temperature indicators is obtained from the flight deck 28-volt d-c essential bus. Circuit protection is individually provided by two circuit breakers, placarded GTU IND PWR, located on the flight engineer's overhead circuit breaker panel.

GTU Low-Oil Pressure Warning Light.

Two red, 28-volt d-c low-oil pressure warning lights, one for each GTU, are located on the GTU control panel *(figure 1-30).* Each light is controlled by a low oil pressure switch on its respective GTU. The low oil pressure switch causes its respective light to come on when the oil pressure is less than approximately 45 psi and the START-RUN-STOP switch is in either the START or RUN position. Power for operation of the low oil pressure lights is obtained from the flight deck 28-volt d-c battery bus. Circuit protection is individually provided by two circuit breakers, placarded GTU START CONT, located on the flight engineer's overhead circuit breaker panel.

HYDRAULIC POWER SUPPLY SYSTEM.

Two variable displacement pumps *(figures 1-31 and 1-32),* one driven by each GTU, furnish the required 3000-psi hydraulic system pressure in varying volume as required for operation of the landing gear, brakes, wing flaps, side cargo door, ramp and clamshell doors, aft door, nose gear steering, and aileron surface lock. A pressure relief valve prevents excessive system pressure from developing if the pumps fail to regulate the pressure within limits. The valve is set to relieve at approximately 3800 psi. The pumps can be solenoid-actuated to lock in the feathered position when hydraulic pressure is not required during flight by placing the hydraulic pressure switch in the OFF position. However, when the landing gear or wing flap lever is placed in any position other than full UP, the electrical circuit will be opened, deenergizing the solenoid on the pumps, causing the pumps to unfeather. The pumps will also unfeather in the event of an electrical power failure. Internal controls in each pump automatically adjust the output from zero to a maximum of approximately 9.75 gallons per minute in response to pressure demands of the system.

An electrically driven auxiliary hydraulic pump is provided for emergency operation and to supplement the utility system when the GTU's are not operating. A hydraulic hand pump is provided for use on the ground when no other hydraulic power is available. Two accumulators *(24 and 45, figure 1-2),* each equipped with a pressure gage, are installed, one for the aileron surface lock and the other for the parking brakes. The accumulators provide a reserve supply of fluid under pressure during the time the aircraft is parked. There is no emergency hydraulic system provided; however, each landing gear can be mechanically released and will free-fall and lock down over center without hydraulic pressure. **On aircraft AF59-135 through AF57-**

1615, the wing flap system incorporates an electric drive for emergency operation. There are separate air bottles for emergency operation of the brakes, the side cargo door, and the ramp and clamshell doors.

HYDRAULIC SYSTEM RESERVOIR.

The hydraulic system reservoir *(35, figure 1-2)* is located inside the cabin on the left side of the aircraft at fuselage station 911. The reservoir and the system have a total capacity of approximately 22 gallons **on aircraft AF54-135 through AF57-1612**, and 23 gallons **on aircraft AF57-1613, 57-1614, and 57-1615.** Five gallons of the total amount is the filling capacity of the reservoir. **On aircraft AF59-522 and subsequent,** approximately 25½ gallons are in the entire system, of which approximately 6 gallons are contained in the reservoir.

The auxiliary hydraulic system shares the main utility system reservoir for fluid storage. **On aircraft AF59-522 and subsequent,** 3.1 quarts of hydraulic fluid are reserved within the base of the reservoir and can only be used by the electric motor driven auxiliary hydraulic pump.

All reservoirs are refillable in flight. A sight gage is provided, and instructions are placarded on the reservoir. A drip pan is provided below the reservoir to take care of any overflow or spillage of fluid. The drip pan has an overboard drain line, fitted with a shut-off valve, to permit drainage as necessary. The reservoirs are pressurized by main engine bleed air or GTU bleed air, whichever is higher. The bleed air **on aircraft AF54-135 through AF57-1612** is regulated at 9 to 12 psi by a regulator containing an integral relief valve set to crack at approximately 12 psi. **On aircraft AF57-1613 and subsequent,** the bleed air is regulated at 10 to 12.5 psi and the relief valve is set to crack at approximately 15 psi.

AUXILIARY HYDRAULIC PUMP (AIRCRAFT AF54-135 THROUGH AF57-1615).

An electrically driven auxiliary hydraulic pump, located in the left pod aft of the No. 2 GTU, may be used to pressurize the entire aircraft hydraulic system during ground operations when ground electrical power is connected to the aircraft and both GTU's are not operating, or during flight in the event both GTU's fail. The maximum output of the auxiliary hydraulic pump is eight gallons per minute, which is slightly less than the output of one GTU hydraulic pump; therefore, if the auxiliary hydraulic pump is used to operate any two units at the same time, the operating time of each unit will be increased. The electrical circuit of the auxiliary hydraulic pump motor is protected by two circuit breakers; one on the flight deck left hand auxiliary circuit breaker panel, and one on the center fuselage a-c circuit breaker panel, left side. The pump may be operated by either one of three auxiliary hydraulic pump switches. One switch is located at the flight engineer's station, and the other two are located in the main cabin. The pump should not be operated continuously for more than a half hour with a full hydraulic reservoir. If operated continuously, the auxiliary hydraulic pump will automatically shut off when overheated and cannot be restarted until it has cooled. No shutoff warning is provided. To prevent overheating of the pump and to maintain proper hydraulic fluid temperatures, the auxiliary pump should be operated with a duty cycle of not more than 30 minutes ON and 30 minutes OFF.

AUXILIARY HYDRAULIC PUMP (AIRCRAFT AF59-522 AND SUBSEQUENT).

An electrically driven auxiliary hydraulic pump is installed in the left pod in the compartment aft of the GTU's. The pump is used to provide hydraulic power for emergency flap operation and to pressurize the hydraulic system if the GTU hydraulic pumps are not operating and the reservoir fluid level is in the normal range. The pump may be operated by any one of three auxiliary hydraulic pump switches or by the hydraulic pressure switch at the flight engineer's station. The pump also operates when the emergency flap switch is actuated. When the auxiliary hydraulic pump has been energized by the emergency flap switch, a time delay switch will shut off the auxiliary hydraulic pump motor 30 seconds after the flaps have reached the pre-selected position, to prevent possible overheating of the remaining hydraulic fluid. If operated continuously, the auxiliary hydraulic pump will automatically shut off when overheated and cannot be restarted until it has cooled. No shutoff warning is provided. To prevent overheating of the pump and to maintain proper hydraulic fluid temperatures, the auxiliary pump should be operated with a duty cycle of not more than 30 minutes ON and 30 minutes OFF.

Auxiliary Hydraulic Pump Switches (Aircraft AF54-135 through AF57-1615).

Two 2-position auxiliary hydraulic pump switches, one located at the side cargo door control panel and

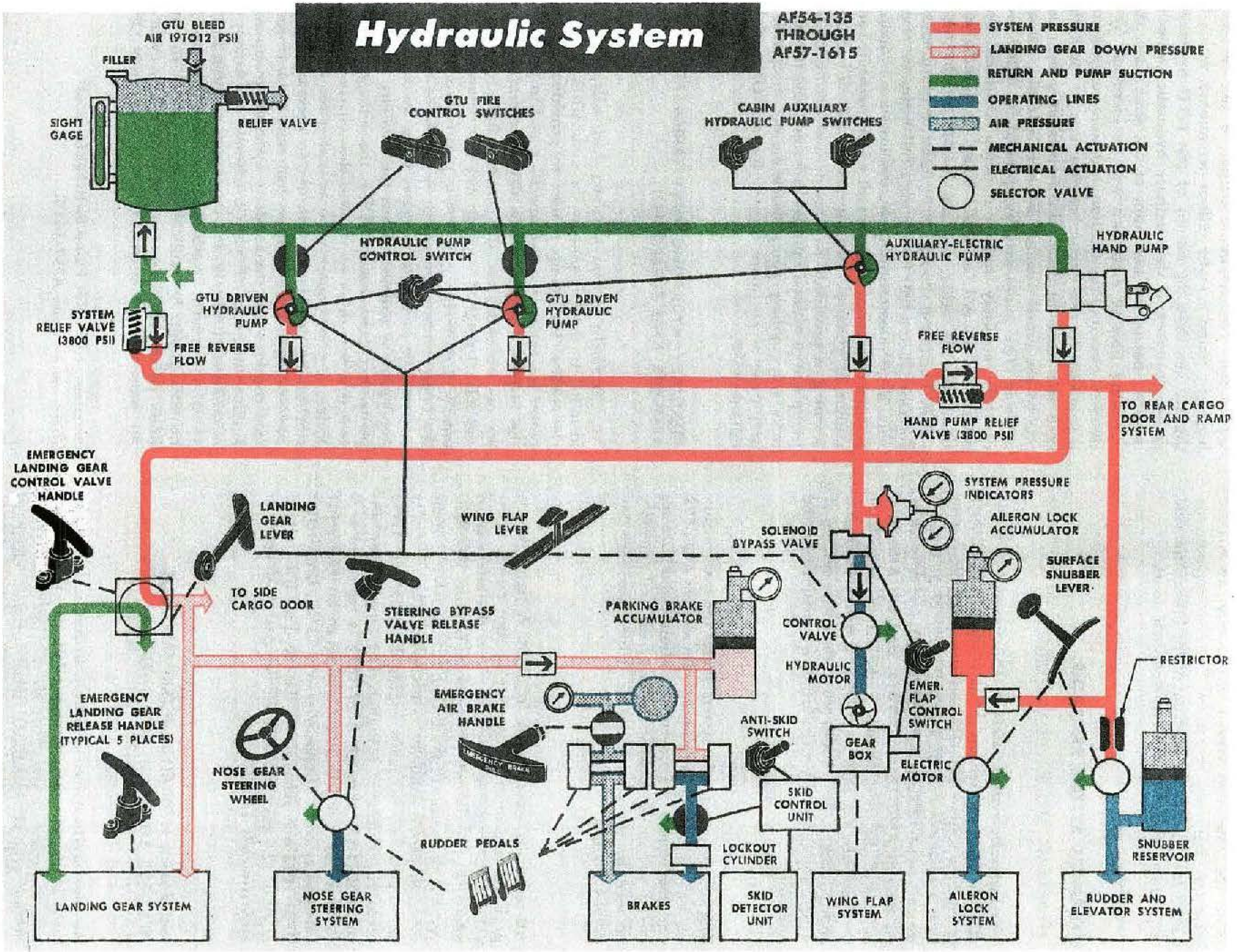


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Figure 1-31

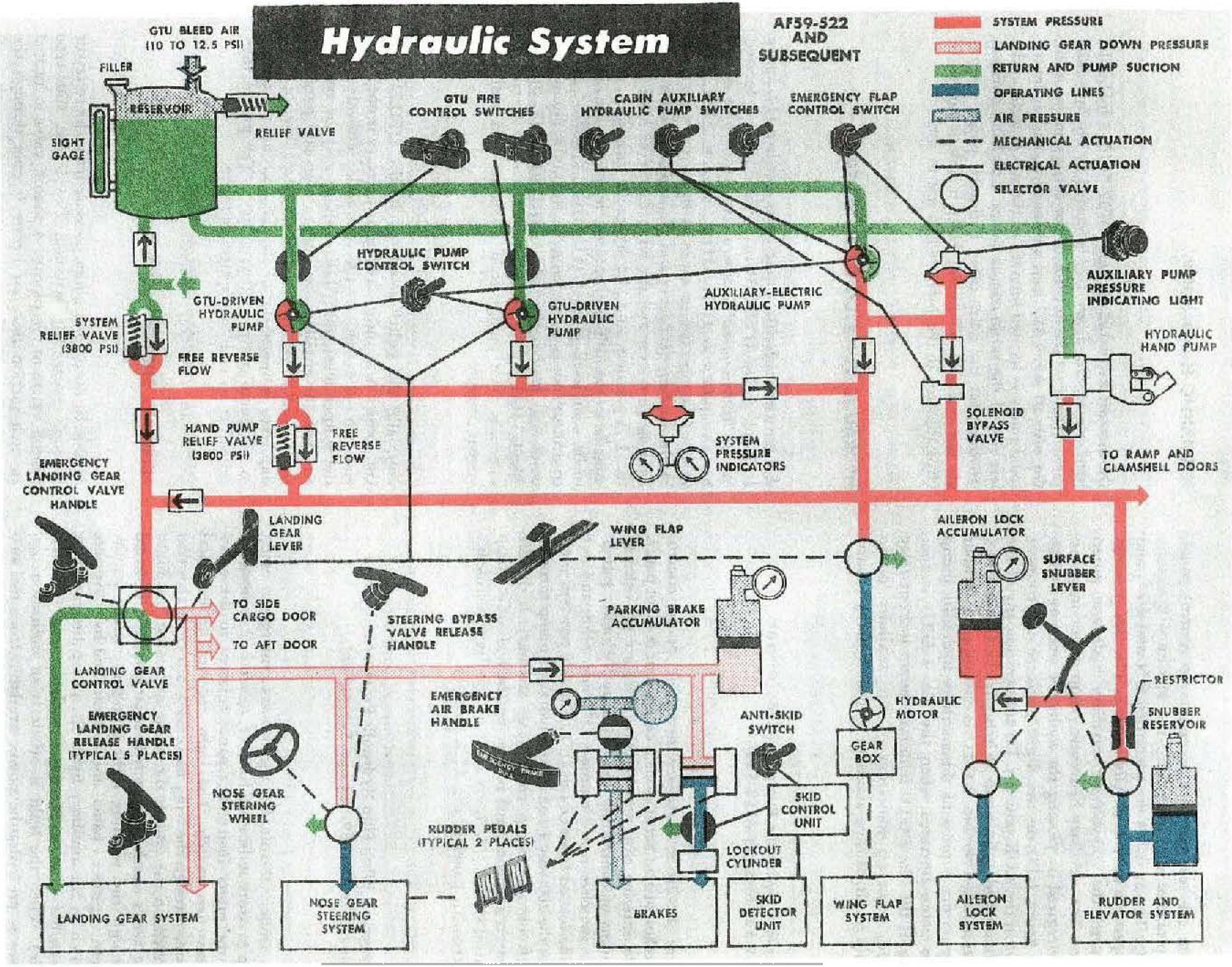

Hydraulic System
AF59-522 AND SUBSEQUENT
SYSTEM PRESSURE
LANDING GEAR DOWN PRESSURE
RETURN AND PUMP SUCTION
OPERATING LINES
AIR PRESSURE
MECHANICAL ACTUATION
ELECTRICAL ACTUATION
SELECTOR VALVE
GTU BLEED AIR (10 TO 12.5 PSI)
FILLER
RESERVOIR
RELIEF VALVE
SIGHT GAGE
GTU FIRE CONTROL SWITCHES
CABIN AUXILIARY HYDRAULIC PUMP SWITCHES
EMERGENCY FLAP CONTROL SWITCH
HYDRAULIC PUMP CONTROL SWITCH
AUXILIARY PUMP PRESSURE INDICATING LIGHT
AUXILIARY-ELECTRIC HYDRAULIC PUMP
GTU-DRIVEN HYDRAULIC PUMP
GTU-DRIVEN HYDRAULIC PUMP
SYSTEM RELIEF VALVE (3800 PSI)
FREE REVERSE FLOW
HYDRAULIC HAND PUMP
HAND PUMP RELIEF VALVE (3800 PSI)
FREE REVERSE FLOW
SYSTEM PRESSURE INDICATORS
SOLENOID BYPASS VALVE
TO RAMP AND CLAMSHELL DOORS
EMERGENCY LANDING GEAR CONTROL VALVE HANDLE
LANDING GEAR LEVER
WING FLAP LEVER
AILERON LOCK ACCUMULATOR
SURFACE SNUBBER LEVER
TO SIDE CARGO DOOR
TO AFT DOOR
STEERING BYPASS VALVE RELEASE HANDLE
PARKING BRAKE ACCUMULATOR
LANDING GEAR CONTROL VALVE
EMERGENCY AIR BRAKE HANDLE
EMERGENCY LANDING GEAR RELEASE HANDLE (TYPICAL 5 PLACES)
ANTI-SKID SWITCH
HYDRAULIC MOTOR
RESTRICTOR
SNUBBER RESERVOIR
GEAR BOX
NOSE GEAR STEERING WHEEL
SKID CONTROL UNIT
RUDDER PEDALS (TYPICAL 2 PLACES)
LOCKOUT CYLINDER
LANDING GEAR SYSTEM
NOSE GEAR STEERING SYSTEM
BRAKES
SKID DETECTOR UNIT
WING FLAP SYSTEM
AILERON LOCK SYSTEM
RUDDER AND ELEVATOR SYSTEM

Figure 1-32

one at the rear cargo door and ramp control panel, are provided for controlling the auxiliary hydraulic pump. The switches are placarded ON and OFF, and are spring loaded from ON to OFF. The ON position energizes the 200-volt a-c auxiliary hydraulic pump motor. The auxiliary hydraulic pump motor may also be energized by placing the hydraulic pressure switch *(12, figure 1-13)* on the flight engineer's instrument panel in the AUX position. Do not position any of the auxiliary hydraulic pump switches to the ON or AUX position when the No. 2 GTU is operating. A lockout relay normally prevents the auxiliary hydraulic pump from being operated when the No. 2 GTU is running. If the No. 2 GTU hydraulic pump lockout relay failed, however, starvation of the auxiliary pump would result, causing auxiliary hydraulic pump failure.

Auxiliary Hydraulic Pump Switches (Aircraft AF59-522 through AF59-536).

Three 2-position auxiliary hydraulic pump control switches, one adjacent to each cargo door control panel, (side, interior rear, and exterior rear) are provided as a means of controlling the auxiliary hydraulic pump. The switches are placarded ON and OFF and are spring loaded from ON to OFF. The ON position energizes the 200-volt a-c auxiliary hydraulic pump through a 28-volt d-c pump relay. The auxiliary hydraulic pump is also energized by placing the hydraulic pump control switch *(14, figure 1-13)* on the flight engineer's instrument panel in the AUX position.

Emergency Wing Flap Hydraulic Pressure Indicating Light (Aircraft AF59-522 and Subsequent).

An amber, 28-volt d-c, push-to-test, emergency wing flap pressure indicating light *(4, figure 1-7)*, is installed on the pilots' instrument panel adjacent to the emergency flap switch. The light receives its electrical power through the wing flap emergency circuit breaker located on the 28-volt d-c essential bus on the flight engineer's overhead circuit breaker panel. It is wired through the warning light dimming switch on the flight engineer's panel, and is controlled by a pressure switch in the auxiliary hydraulic pump pressure line, accessible from inside the aircraft (station 1050 left side). When the light is off, it is an indication that there is no hydraulic power available from the auxiliary hydraulic pump. The light will come on at approximately 600 psi to indicate that pressure of 600 psi or more is available and is the only indication of pressure from the auxiliary hydraulic pump.

HYDRAULIC HAND PUMP.

On aircraft AF54-135 through AF57-1615, a hydraulic hand pump, *(36, figure 1-2)* is located by the hydraulic power panel on the left side of the cargo compartment. **On aircraft AF59-522 and subsequent**, the hydraulic hand pump is located forward of the wheel well on the left side of the cargo compartment. The hand pump is provided for use when other hydraulic power sources are not available. The hand pump handle is stowed in clips adjacent to the pump when not in use.

HYDRAULIC PUMP CONTROL SWITCH.

A 3-position hydraulic pump control switch *(14, figure 1-13)* placarded HYDRAULIC PRESSURE is located on the flight engineer's instrument panel. The switch has the positions OFF, UTILITY, and AUX. The switch is connected in series with switches actuated by the landing gear lever and the wing flap lever. The landing gear lever and the wing flap lever must be in the UP position, and the hydraulic pressure switch must be in the OFF position for the 28-volt d-c circuit to be completed to the GTU-driven hydraulic pump control solenoids. Energizing the hydraulic pump solenoids will feather the GTU-driven hydraulic pumps. The UTILITY position opens the circuit to the control solenoids. The pumps then unfeather and maintain system pressure.

Normally the switch is placed in the UTILITY or OFF position. If utility hydraulic pressure is not available, and the fluid in the hydraulic reservoir is at the proper level, the AUX position may be used to energize the auxiliary hydraulic pump and pressurize the hydraulic system. If the landing gear lever or wing flap lever is moved out of the UP position, the circuit to the pump control solenoid opens. The pumps then unfeather to maintain system pressure.

FIREWALL SHUTOFF VALVES.

Hydraulic fluid flows under pressure from the reservoir through electrically actuated, 28-volt d-c, slide-type shutoff valves to the pumps. A shutoff valve is located in each suction line just before it goes through the fuselage firewall. The valves can be used to shut off the hydraulic fluid when a GTU malfunction occurs. See Fire Warning and Extinguishing Systems, this section for description of controls.

HYDRAULIC PRESSURE INDICATORS.

Two 28-volt a-c hydraulic pressure indicators *(32, figure 1-7; 4, figure 1-13)* calibrated in pounds per square inch are provided: one on the pilots' instrument panel and one on the flight engineer's instrument panel. The pressure indicators show utility system pressure when the GTU hydraulic pumps are operating. **On aircraft 59-522 and subsequent**, the auxiliary hydraulic pump pressure to the utility hydraulic system will not be indicated. The 28-volt a-c circuit is protected by a 5-ampere circuit breaker on the flight deck auxiliary circuit breaker panel.

HYDRAULIC RESERVOIR QUANTITY GAGE.

A graduated, direct-reading sight gage *(35, figure 1-2)*, calibrated in various system conditions and aircraft configurations, is mounted on the face of the hydraulic reservoir located in the center fuselage on the left side.

HYDRAULIC SYSTEM ACCUMULATORS.

Two accumulators are installed to provide a reserve supply of fluid under pressure during the time the aircraft is parked. The parking brake accumulator *(45, figure 1-2)* is located in the left side of the lower nose compartment and is equipped with a fitting for servicing. The accumulator supplies fluid only to the brakes, and receives its fluid from the main landing gear downline.

The aileron surface lock accumulator *(24, figure 1-2)* is located in the top of the fuselage, aft of the wing spar, above the hydraulic system panel. The fitting for servicing the accumulator is located on the left side of the fuselage aft of the hydraulic reservoir. Fluid from the accumulator is supplied only to the aileron surface lock cylinder.

Hydraulic System Accumulator Pressure Indicators.

Each accumulator is provided with a pressure indicator calibrated in pounds per square inch, which indicates the pressure charge in the accumulator. The parking brake accumulator indicator is located adjacent to the accumulator servicing fitting on the left side of the nosewheel well. The aileron surface lock accumulator indicator is located on the left side of the fuselage, aft of the hydraulic reservoir.

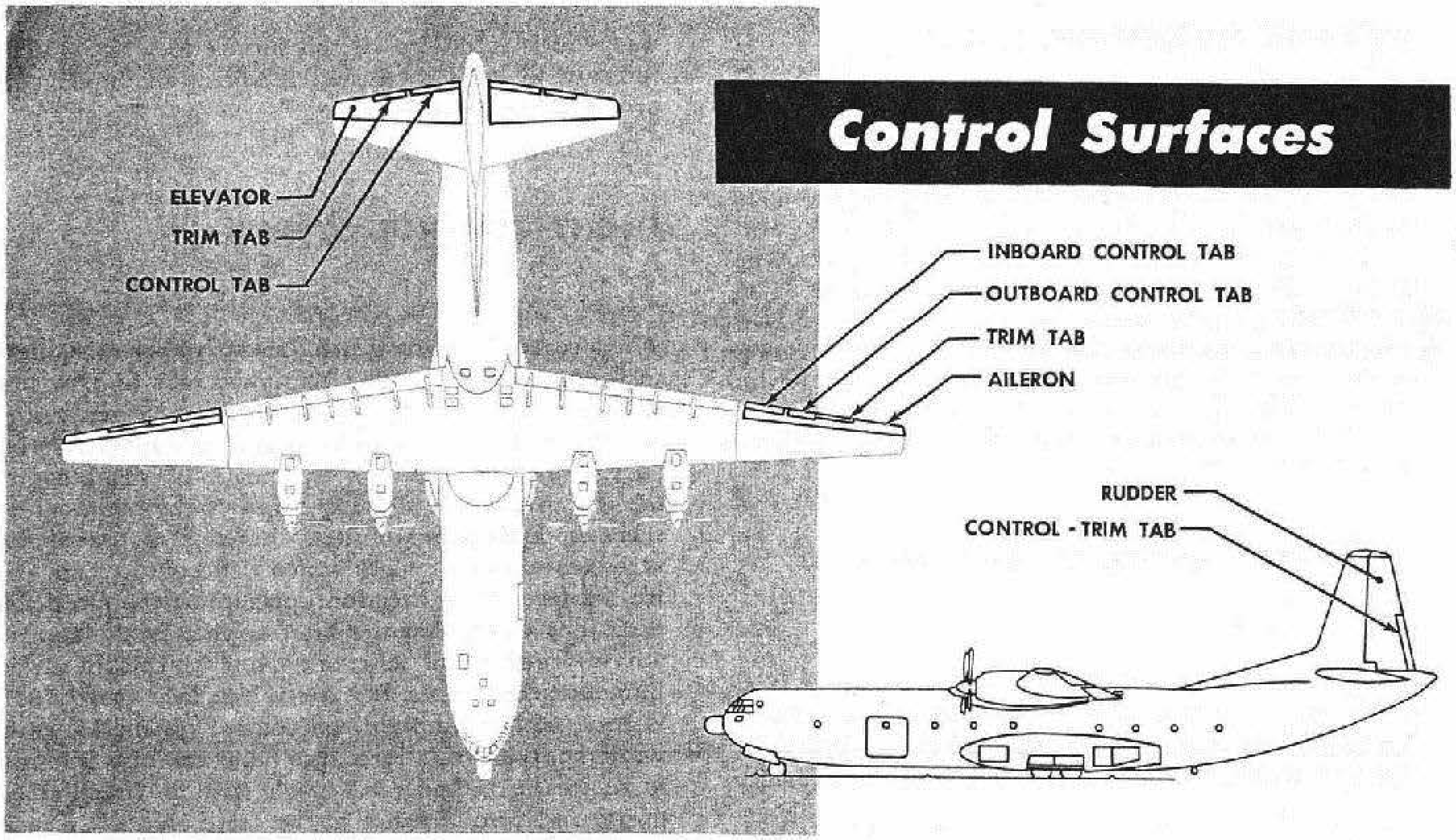
FLIGHT CONTROL SYSTEM.

The aircraft is controlled by means of ailerons, elevators, and a rudder, aided by linked tabs to give aerodynamic boost in movement of the primary control surfaces *(figure 1-33)*. The linked tab system derives energy for its operation by means of small control tabs located in the trailing edges of the main control surfaces. Deflection of these linked tabs provides an aerodynamic boost force which deflects the main control surfaces in a direction opposite to the tab deflection. The effort that the pilot applies to the controls applies force to the bellcrank about the control surface hingeline, deflecting the control surface exactly as it is done with a simple direct control system. However, while applying this force, the bellcrank also transmits force to the linked tab, which is in a direction opposite and prior to that of the main control surfaces, causing areodynamic boost. Dual control columns *(6, figure 1-5)* provide aileron and elevator control. Two switches are installed on each control column wheel. One is the autopilot release switch, and the other is a 3-position microphone switch.

RUDDER-AILERON INTERCONNECT SYSTEM.

The rudder-aileron interconnect system connects the ailerons to the rudder control trim tab for the purpose of reducing pilot rudder effort for coordinated turns. It has no effect on forces to overcome asymmetric power, but does give a desirable increase in rudder force for cross control (sideslip) maneuvers. The net effect on rudder force in combination with the rudder vortex generators is a sizeable reduction in rudder force to coordinate turns and a moderate increase in rudder force for crossed controls. Because the input is from the primary aileron system rather than the aileron tab system, there is almost no increase in aileron forces for any maneuvers other than ground checkout.

Cables are used for transmitting force from the aileron bus to a cable drum. A double-acting bungee spring connects this drum to another drum which is connected to the rudder tab bellcrank. The bungee is capable of transmitting force and motion, and is also a flexible link which provides an override to allow independent motion of the rudder and ailerons.



Control Surfaces

Figure 1-33

RUDDER CONTROL.

The rudder is mechanically controlled by a duplicate set of hinged rudder pedals *(14, figure 1-5)* of the conventional suspended-type. The rudder pedals can be mechanically adjusted for leg length by individual handcranks, one located at the pilot's station and one at the copilot's station, below the instrument panel. The rudder control system incorporates a standard linked tab mechanism for aerodynamic boost. The rudder control tab system is interconnected to the ailerons by means of a cable system and a bungee spring, to assist in making coordinated turns.

Rudder Pedal Adjustment Handcranks.

Two rudder pedal adjustment handcranks *(figure 1-34)*, placarded RUDDER PEDAL ADJUSTMENT, are provided to permit adjusting the rudder pedals for leg length. One of the handcranks is installed on the rudder pedal housing, below the instrument panel, in front of each control column. Each handcrank individually controls the leg length adjustment of its respective set of rudder pedals. Turning either handcrank clockwise will move the respective set of rudder pedals forward. Turning either handcrank counterclockwise will move the respective set of rudder pedals aft. A placard, located adjacent to each handcrank, indicates the direction of rotation necessary for the desired adjustment with two arrows, placarded FWD and AFT.

RUDDER TRIM CONTROL SYSTEM.

A mechanically-actuated rudder trim control system is installed which permits the position of the control tab on the rudder to be changed in order to reduce pilot effort during steady flight conditions. Since the rudder control tab that is used for primary control of the rudder is also used for rudder trim, a separate rudder trim tab is not installed. When rudder trim is desired, the position of the rudder control tab, which is normally controlled with the rudder pedals, can be manually controlled by a rudder trim wheel located above the glare shield, at the center of the pilots' instrument panel. A rudder trim indicator is located beneath the trim wheel. To compensate for increased effectiveness of the control tab and prevent excessive control tab movement at high air speeds, the system incorporates a rudder spring trim mechanism. The spring also serves as a centering spring for the rudder system.

Rudder Pedal Adjustment Handcranks

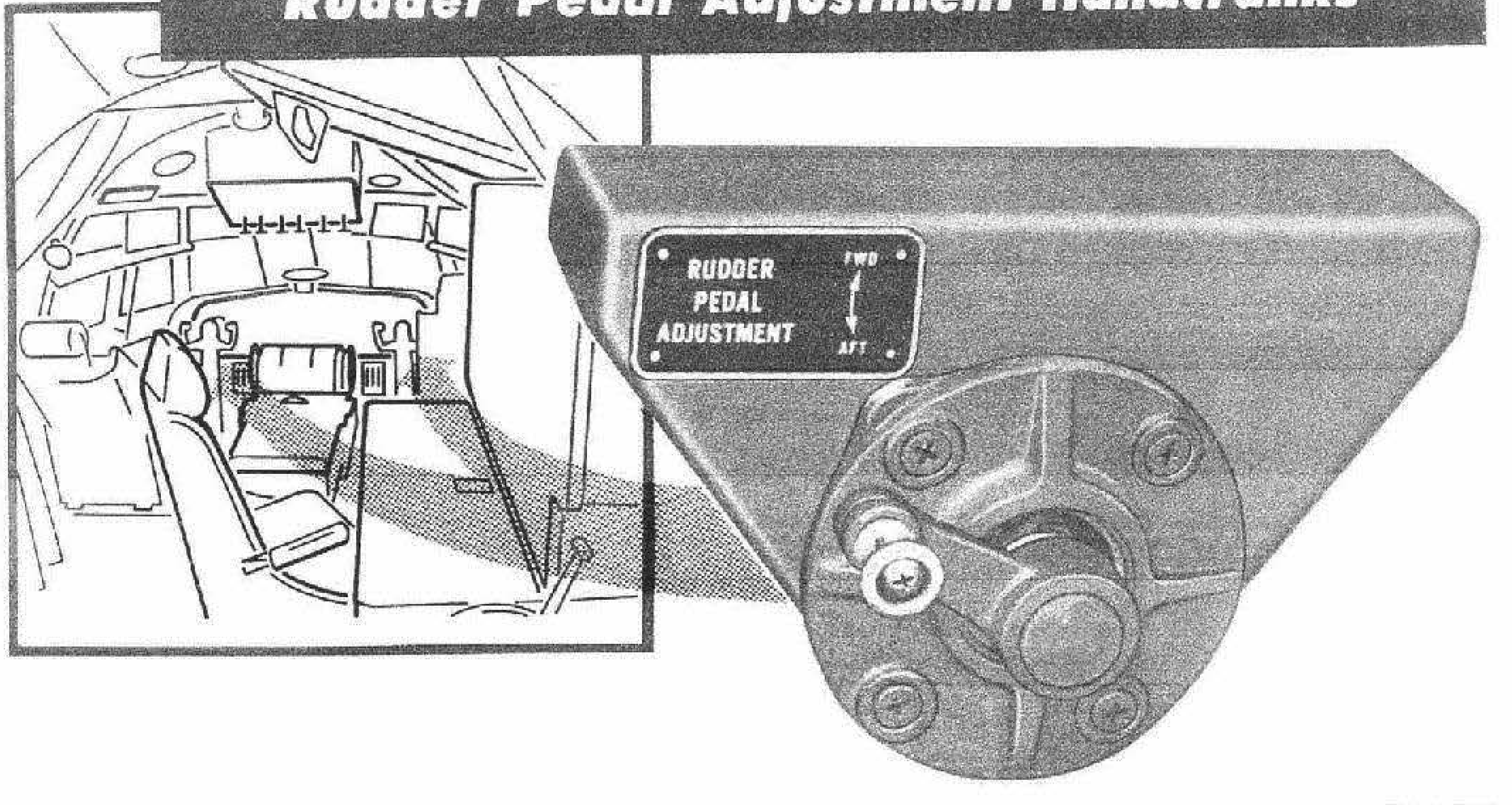


Figure 1-34

Rudder Trim Wheel.

A rudder trim wheel *(15, figure 1-5)* is installed above the glare shield, at the center of the pilots' instrument panel. Manually rotating the trim wheel, either to the left or to the right, turns a cable drum. Cables connect the drum to a rudder spring trim mechanism located in the empennage. The spring trim mechanism is mechanically linked to the rudder control tab. On the ground, with no aerodynamic forces being exerted upon the control tab, the tab will be free to move when the trim wheel is rotated, and the spring in the spring trim mechanism will neither be compressed nor expanded. During flight, however, as airspeed is increased the spring must be compressed or expanded to a greater degree by rotation of the trim wheel before the control tab will move, due to the increased aerodynamic forces exerted upon the tab. Rotating the trim wheel to the left (clockwise) causes the rudder control tab to move to the left. Rotating the trim wheel to the right (counterclockwise) causes the control tab to move to the right. The trim wheel can be rotated approximately six turns to either side of neutral.

Rudder Trim Indicator.

A rudder trim indicator, placarded RUDDER TRIM, is located just below the rudder trim wheel *(15, figure 1-5)*. The trim indicator consists of a movable pointer and a fixed indicator dial. The movable pointer is mechanically actuated by movement of the rudder trim wheel. The indicator dial is marked in increments of rudder trim wheel rotation. Each increment indicates one and one-half turns of the trim wheel. The left side of the indicator dial is placarded NOSE LEFT and the right side is placarded NOSE RIGHT.

TWO-POSITION RUDDER STOPS.

A 2-position rudder stop is incorporated in the rudder snubber system *(figure 1-35)* to limit rudder travel at airspeeds above approximately 168 knots IAS. Below approximately 168 knots IAS, full rudder travel of 18.5 degrees is allowed by the rudder snubber cylinder. Above this airspeed, the rudder stop Q switch will complete a circuit to close a 2-position valve between the snubber control valve and the snubber cylinder, trapping fluid in a portion of the cylinder. The trapped fluid provides a partial snubbing action which limits the travel of the snubber cylinder and allows only 7 degrees of rudder travel. Structural protection is provided by the rudder stops throughout the speed range of the aircraft. Under any condition where the rudder has been deflected beyond 7 degrees prior to the 7-degree stop taking effect (such as attempting to check

Rudder and Elevator Surface Snubber System

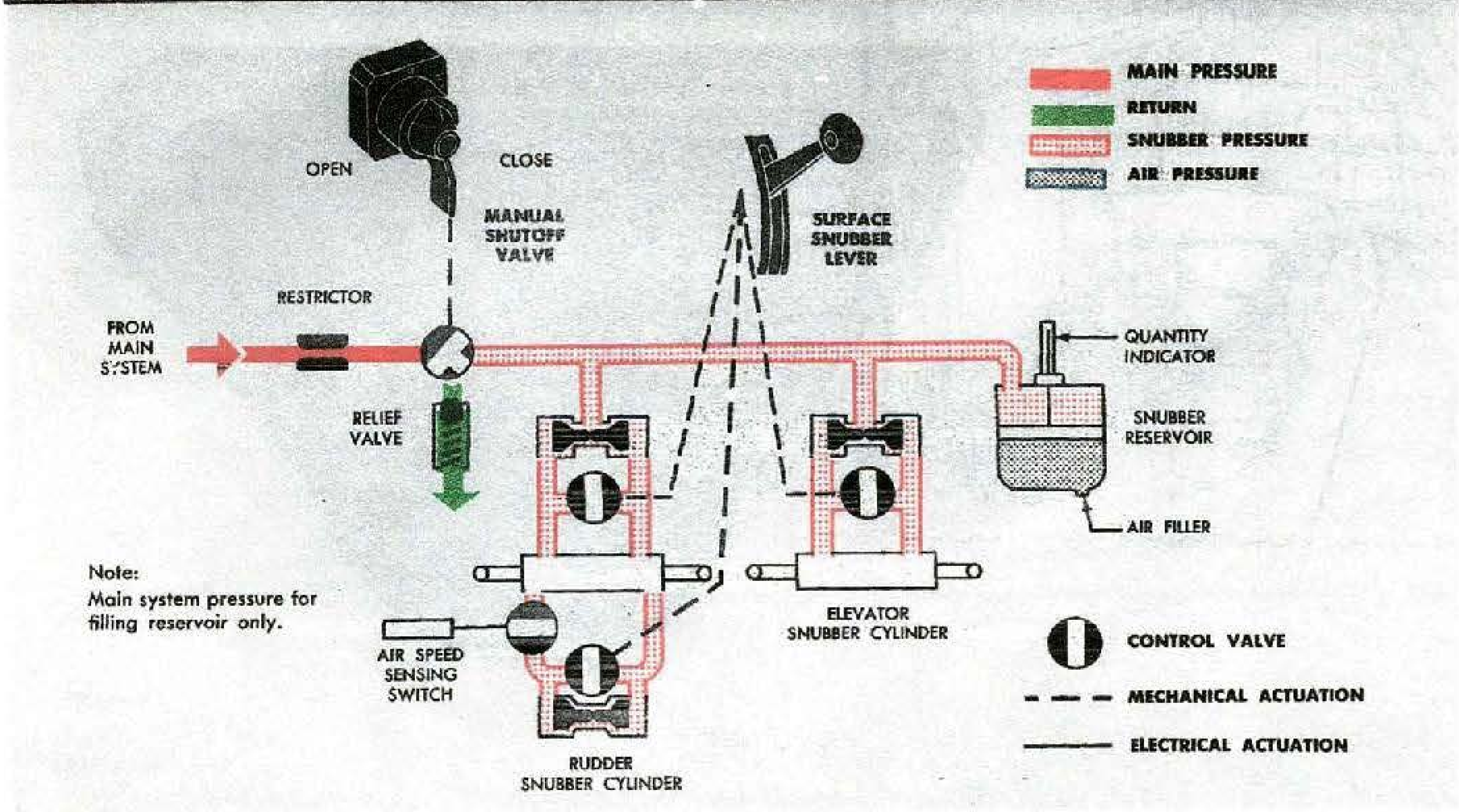


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Figure 1-35

the rudder stop system in high wind), the stop angle will correspond to the rudder deflection angle until rudder deflection has been reduced to an angle of 7 degrees or less. Upon loss of electrical power or snubber hydraulic fluid, the 7-degree stop will be inoperative. Power for operation of the two-position rudder stop system is obtained from both the flight deck 28-volt d-c nonessential bus and the flight deck 115-volt a-c essential bus. Circuit protection for the system is provided by four circuit breakers located on the flight deck left hand auxiliary circuit breaker panel.

Two-Position Rudder Stop Caution Indicator.

A 2-position rudder stop caution indicator *(45, figure 1-7)*, consisting of two annunciator strips, is located on the pilots' instrument panel, placarded 18½ DEG. RUDDER and the bottom strip is placarded 7 DEG. RUDDER. If airspeed is above approximately 168 knots IAS, and the 18½ DEG. RUDDER strip comes on, it is an indication that the 7-degree rudder stop is inoperative, and caution should be exercised during maneuvers to avoid exceeding structural limits. If airspeed is below approximately 168 knots IAS and the 7 DEG. RUDDER strip comes on, it is an indication that only 7 degrees of rudder control is available, and caution should be exercised. During the switching phase (from 165 to 170 knots IAS), the caution light of the operative stop may come on due to switch tolerances. Power for operation of the two-position rudder stop caution indicator is obtained from the flight deck 28-volt d-c nonessential bus and is controlled by power obtained from the flight deck 115-volt a-c essential bus. Circuit protection for the caution indicator is provided by a 28-volt d-c essential bus circuit breaker located on the flight deck left hand auxiliary circuit breaker panel.

Two-Position Rudder Stop Test Switch.

A push-button type test switch *(45, figure 1-7)*, placarded PUSH TO TEST, is located on the pilots' instrument panel. The switch permits testing of the 2-position rudder stop system. Pushing the switch IN will actuate the 7-degree rudder stop, limiting rudder travel to 7 degrees in either direction, and will cause the 7 DEG. RUDDER annunciator strip to come on.

ELEVATOR CONTROL.

The elevators are mechanically controlled by the pilot's and copilot's control columns that are connected to a torque tube mounted under the flight compartment floor. Connected to this torque tube is a system of links and springs which provide a gradually increasing elevator control (push) force thereby assuring positive stick force gradient in the nose down direction. Dual sets of cables, attached to a pair of bellcranks on the torque tube under the flight compartment floor, are routed aft to the elevator control torque tube. The elevator control system incorporates a standard linked tab mechanism in conjunction with a tab-up spring, a bob weight, trim tabs, and an elevator feel spring.

ELEVATOR TRIM TAB CONTROL SYSTEM.

A mechanically-actuated elevator trim tab control system is installed which permits the position of the trim tab on each elevator to be changed in order to reduce pilot effort during steady flight conditions. The position of the elevator trim tabs is manually controlled by two elevator trim wheels installed on the control pedestal. An elevator trim indicator located at each trim wheel indicates the position of the trim tabs.

Elevator Trim Wheels.

Two elevator trim wheels *(7 and 38, figure 1-11)*, one of which is located on each side of the control pedestal, are provided. Both wheels are mounted on the same shaft. Manually rotating either wheel turns the shaft, which transmits motion by means of a chain and sprocket drive to a cable drum. Cables connect the drum to trim tab actuators installed in the horizontal stabilizer at each side of the aircraft. Rotating either trim wheel aft causes the trim tabs to be moved down. The trim tabs are moved up when either trim wheel is rotated forward. The trim wheels can be rotated from the neutral position approximately three and one-quarter turns aft, or two and three-quarter turns forward.

Elevator Trim Indicators.

Two elevator trim indicators *(8 and 37, figure 1-11)* are provided. One of the indicators is installed on each side of the control pedestal, just inboard of each elevator trim wheel. Each indicator consists of a movable pointer and a fixed indicator plate. The movable pointer is mechanically actuated by movement of the trim wheel. The indicator plate is marked in 2-degree increments of elevator trim tab travel. Near the top, the indicator plate is placarded 10 degrees, indicating the 10-degree up trim tab position. The trim tab neutral position is placarded with a diamond symbol. Near the bottom, the indicator plate is placarded 10 degrees, indicating the 10-degree down trim tab position, and 15 degrees, indicating the 15-degree down position.

AILERON CONTROL.

The aileron system is mechanically controlled by the pilot's and copilot's control wheels and incorporates for each aileron, two control tabs and a control tab centering spring mechanism, a trim tab and trim mechanism, and a force limiting mechanism. The ailerons have an aerodynamic seal and are pressure balanced. The control tab is operated by means of the linked tab mechanism. The control tab centering spring holds the control tab at zero deflection until approximately 2 pounds of wheel force is applied.

Above 2 pounds of wheel force, the centering spring deflects to allow normal operation of the control tab. The aileron force limiter is designed to prevent structural overloads by limiting the aileron deflection proportionate to a maximum of 85 pounds control wheel force. To increase the control effectivity of the aileron surfaces, vortex generators, mounted at angle to each other, are installed along the 50-percent chord line on the upper wing surface and along the 75-percent chord line on the lower wing surface. The vortex generator installation serves to increase the rate of roll by providing a more aerodynamically efficient airflow over the aileron surfaces. Aileron deflection is limited to 23 degrees up and 15 degrees down. The ailerons are interconnected to the rudder control trim tab by means of a cable system and a bungee spring, to assist in making coordinated turns.

AILERON TRIM TAB CONTROL SYSTEM.

A mechanically-actuated aileron trim tab control system is installed which permits the position of the trim tab on each aileron to be changed in order to reduce pilot effort during steady flight conditions. The position of the aileron trim tabs is manually controlled by an aileron trim wheel located on the control pedestal.

An aileron trim indicator, located forward of the trim wheels, indicates the position of the trim tabs.

Aileron Trim Wheel.

An aileron trim wheel *(33, figure 1-11)* is installed at the center of the control pedestal, below the condition levers. Manually rotating the trim wheel, either to the left or to the right, turns a cable drum. Cables connect the drum to trim tab actuators located in each wing, just forward of the trim tabs. Rotating the trim wheel to the right causes the right aileron trim tab to move downward and the left aileron trim tab to move upward. The trim wheel can be rotated approximately three turns to either side of neutral. An AILERON TRIM placard, located just aft of the trim wheel, has directional arrows placarded LEFT WING DOWN and RIGHT WING DOWN.

Aileron Trim Indicator.

An aileron trim indicator *(34, figure 1-11)* is installed on the control pedestal, just forward of the aileron trim wheel. The trim indicator consists of a movable pointer and a fixed indicator plate. The movable pointer is mechanically actuated by movement of the trim wheel. The indicator plate, which is marked in 2-degree increments of aileron trim tab travel, is placarded 20°, 10°, 0, 10°, 20°.

SURFACE SNUBBERS.

The rudder and elevators are snubbed by a self-contained, mechanically actuated, hydraulic snubber system *(figure 1-35)*. The elevator is snubbed by an elevator snubbing cylinder and the rudder is snubbed by the 2-position rudder stop cylinder. A pressurized reservoir is incorporated to provide adequate fluid to cylinders. The aileron lock system is connected to the main hydraulic system through a check valve, and operates at approximately 3000 psi. The ailerons are centered and locked by a cylinder that first centers the ailerons and then prevents any movement. An accumulator is installed in the aileron lock system *(figures 1-31 and 1-32)* to provide sufficient fluid pressure to hold the controls for approximately four days. Brake-type snubbers are provided for the rudder and aileron tabs, and the tab-up spring on the elevator tab is sufficient to hold it against gust loads. When the snubber system is engaged, it also restricts throttle action so that only one throttle for an engine on each side of the aircraft may be advanced to FLIGHT range at a time.

Surface Snubber Lever.

The surface snubber lever *(5, figure 1-11)*, located on the control pedestal, mechanically actuates the rudder and elevator snubber hydraulic system control valves and the aileron lock system control valve. The lever positions are placarded UNLOCKED, AILERON UNLOCKED, and LOCKED. In the LOCKED position, all surfaces and tabs (excluding the elevator control tab) are snubbed or locked. Each elevator control tab is spring loaded to the UP position. In the AILERON UNLOCKED position, the rudder and elevator surfaces are snubbed, and respective control tabs free, and the aileron and aileron tab unlocked. The UNLOCKED position frees all surfaces and tabs. The lever is spring loaded to fit into notches in the LOCKED and AILERON UNLOCKED positions, and must be pulled back and toward the copilot before the lever can be moved forward to the UNLOCKED position. In the LOCKED or AILERON UNLOCKED positions, only one throttle for an engine on each side of the aircraft may be advanced to FLIGHT range at a time. Rudder pedal nose gear steering is inoperative when the surface snubber lever is in either the AILERON LOCKED or the LOCKED position.

Snubber Manual Shutoff Valve.

A 2-position manual shutoff valve *(figure 1-35)*, located on the left side of the cargo compartment forward of the loading ramp, is installed in the rudder and elevator snubber hydraulic system to provide means of filling the snubber reservoir. When the shutoff valve is in the CLOSED position, fluid from the main hydraulic system is blocked. When the shutoff valve is held in the OPEN position, the fluid is routed to the reservoir for filling. When the pressure in the piping between the shutoff valve and the reservoir reaches approximately 110 psi, a relief valve in the return line opens and excess pressure is ported to return. The shutoff valve should be in the CLOSED position except when servicing the reservoir.

WING FLAPS (AIRCRAFT 54-135 THROUGH AF57-1615).

The wing flaps are partial-span and double-slotted, extending from the wing-root to the ailerons. They are mounted on carriages which roll on 16 curved tracks extending aft from the trailing edge on the wing structure. Three jackscrews on each side of the wing are used in extending and retracting the wing flaps. A hydraulic motor is mounted on a gearbox and drives the jackscrews by means of torque tubes. Normally, the wing flaps are extended and retracted hydraulically; however, an electrical emergency system may be used in the event of hydraulic failure. The electric emergency motor is mounted on, and drives through, the same gearbox. If the wing flaps are 2.5 degrees out of synchronization, the flap system is automatically stopped (both hydraulically and electrically). The flaps will stay locked in the out-of-synchronization position until they are rerigged by the ground crew. A restrictor check valve in the wing flap downline permits full flow when the flaps are being extended, but serves to restrict the flow when the flaps are being retracted. Normal extension time is 9 to 12 seconds and normal retraction time is 16 to 26 seconds. The time required to either extend or to retract the flaps, using the emergency provisions, is 30 to 40 seconds.

WING FLAPS (AIRCRAFT 59-522 AND SUBSEQUENT).

The wing flaps are partial-span and double-slotted, extending from the wing root to the ailerons. The flaps are mounted on carriages which roll on 16 curved tracks extending aft from the trailing edge of the wing structure. Three jackscrews on each side of the wing are used in extending and retracting the wing flaps. A hydraulic motor is mounted on a gearbox and drives the jackscrews by means of torque tubes. Normally, the wing flaps are extended and retracted by utility system hydraulic power. In the event of utility hydraulic system failure, emergency flap extension may be accomplished by actuation of the emergency wing flap switch and using auxiliary hydraulic power. If the wing flaps are 2.5 degrees out of synchronization, the flap system shutoff valve automatically shuts off utility and emergency hydraulic power to the system. The valve is connected to the outboard flap jackscrews by means of drums and cables. The flaps will stay locked until they are rerigged by the ground crew. A flow regulator valve in the wing flap downline permits full flow when the flaps are being extended, but serves to restrict flow when the flaps are being retracted. Normal extension time is 9 to 12 seconds and normal retraction time is 16 to 26 seconds. The time required to either extend or to retract the flaps, using the emergency provisions, is 18 to 24 seconds.

WING FLAP LEVER.

The wing flap lever *(10, figure 1-11)*, located on the control pedestal, has the placarded positions FLAPS UP, TAKE OFF, and FLAPS DOWN. The increments of flap extension are placarded 0°, 15°, 25° and 35°. When the lever is placed in the desired position, the flap control valve is mechanically positioned to control the fluid flow to the wing flap gearbox hydraulic motor and the followup linkage from the gearbox returns the control valve to the off position as the wing flaps reach the desired degree of extension or retraction. In this type of control there is no neutral setting; once a particular degree of flap extension or retraction has been selected, the hydraulic motor will drive the flaps to this point and automatically stop. Changes can be made in either direction by repositioning the flap lever to the desired setting.

Wing Flap Position Indicator.

A 28-volt d-c wing flap position indicator *(10, figure 1-7)* is installed on the pilots' instrument panel. The dial of the indicator is calibrated in five degree increments, and has the placarded positions UP, 10, 20, 30, 40, and DOWN. The pointer of the indicator is controlled by a flap position transmitter, located on the flap main gear box in the cargo compartment. An edge-lighted placard at the side of the indicator indicates the maximum airspeed, in knots, for the various flap positions. The wing flap position indicator circuit receives power from the 28-volt d-c essential bus on the right side of the center fuselage. Circuit protection is provided by a circuit breaker located on the center fuselage d-c circuit breaker panel.

EMERGENCY FLAP SWITCH (AIRCRAFT AF54-135 THROUGH AF57-1615).

The emergency flap switch *(3, figure 1-7)* is located on the pilots' instrument panel. The 2-position toggle switch has the placarded positions OFF and ON, and is normally in the OFF position. When the switch is placed in the ON position, it completes a 28-volt d-c circuit to the flap hydraulic shutoff relay, and in turn to the shifting solenoid hydraulic shutoff valve, bypass valve, flap start lockout relay, and flap start time-delay relay. The flaps hydraulic shutoff relay simultaneously completes a 115-volt a-c circuit through either the UP or DOWN flap followup switch to a relay. The relay then completes a 200-volt a-c circuit to the flap emergency drive electric motor. After the emergency flap switch is placed in the ON position, the wing flap lever on the control pedestal is used, in the normal manner, to position the flaps. Reversal of direction of travel when the flaps are in motion imposes loads that exceed the design capabilities of the emergency wing flap electric motor. Therefore, during functional check or operational use of the emergency flap system, do not move the wing flap lever to reverse the direction of wing flap travel while the flaps are in motion. To avoid damage to the flap driving mechanism, do not operate the emergency flap switch while the flaps are moving under hydraulic pressure. To avoid overheat and possible damage to the flap driving motor, a cooling period of 5 minutes minimum is required after each continuous operation of 1½ minutes.

EMERGENCY FLAP SWITCH (AIRCRAFT AF59-522 AND SUBSEQUENT).

The emergency flap switch *(3, figure 1-7)* is located on the pilots' instrument panel. The 2-position toggle switch has the placarded positions OFF and ON, and is normally in the OFF position. When the switch is placed in the ON position, it starts the auxiliary hydraulic pump. After 30 seconds, the pump will stop if the wing flap lever is not repositioned. With the emergency flap switch ON, any repositioning of the wing flap control lever will again energize the pump. The pump will remain energized for 30 seconds after the flap surfaces reach the angle selected by the wing flap control lever.

LANDING GEAR SYSTEM.

The landing gear is a fully retractable tricycle-type. The main gear consists of two dual wheel units in tandem located in pods on each side of the aircraft. Each duel wheel is an independent system with its own shock strut and retracting linkage. The nose gear consists of a dual wheel unit and incorporates hydraulic steering. The nose gear may be turned 50 degrees to each side of center. The hydraulic steering pressure is taken from the landing gear downline and is therefore available only when the landing gear lever is in the DOWN position. The gear extends and retracts hydraulically. The latching mechanism for the nose gear is hydraulically actuated and latches the nose gear in both the up and down positions. The main gear uplatches are hydraulically actuated, but the main gear downlatches are actuated by mechanical linkage. The main gear doors and the nosewheel doors are mechanically actuated and are automatically opened and closed by gear retraction or extension. The landing gear door latching mechanisms are all actuated overcenter hydraulically but do not require hydraulic pressure to keep them locked. The hydraulic and mechanically actuated main gear door uplatches also serve as the main gear uplatches. In the event that hydraulic pressure is not available, a cable release is provided to mechanically unlatch the landing gear doors. The hydraulically operated tail bumper is actuated when the main gear is extended or retracted and is installed to prevent dragging the tail section in case of a landing in excess of a 7½-degree tail-down attitude. The tail bumper is not equipped for emergency extension since it is not normally used during landings. When retracted, the tail bumper protrudes slightly below the bottom of the fuselage, providing partial protection in the event an excessive tail down landing is made. When the main gear is extended, its travel is in a straight downward direction; the nose gear extends down and aft; the tail bumper extends down and slightly forward. Normal landing gear extension time is 5 to 15 seconds and retraction time is 5 to 10 seconds. There are provisions for mechanically locking the nose and each main gear in the down position by ground safety pins. Provisions for the stowage of the safety pins are made in a stowage rack, *(39, figure 1-2)* located on the aft wall of the crew equipment stowage compartment on the right side.

LANDING GEAR LEVER.

The landing gear hydraulic system is controlled by the landing gear lever *(49, figure 1-7)* on the pilots' instrument panel. The lever is mechanically linked to a hydraulic pilot valve that hydraulically positions the landing control valve mounted on the hydraulic power panel in the center fuselage. The lever has the positions of GEAR UP and GEAR DOWN. The GEAR UP position supplies hydraulic pressure to the up side of the nose gear, the main gear retract cylinders, and the nose gear latching mechanism. The GEAR DOWN position supplies pressure to unlock the nose gear door, main gear door, nose gear latching mechanism, and supplies pressure to the nose gear steering system, main gear brake system, side cargo door system, aft inward opening door system, and the down side of the nose gear, main gear, and the tail wheel bumper retract cylinders. A 28-volt d-c operated latch mechanism prevents movement of the landing gear lever from the DOWN position until the main aft landing gear oleo struts are fully extended after takeoff.

Landing Gear Downlock Override Button.

A solenoid actuated latch is installed in the landing gear lever mechanism to prevent the landing gear lever from being inadvertently positioned to the GEAR UP position before the weight of the aircraft is off the gear. When the aircraft is airborne, micro switches on the gear struts complete a 28-volt d-c circuit to release the latch and allow the landing gear lever to be positioned to GEAR UP.

The landing gear downlock override button *(38, figure 1-7)*, is installed on the pilots' panel adjacent to the landing gear lever to allow the latch to be released in the event of a malfunction in the solenoid actuated latch mechanism. The override button is covered by a plastic guard. The cover is lifted and the button pushed IN to mechanically release the solenoid actuated latch.

LANDING GEAR EMERGENCY SELECTOR HANDLE.

A landing gear emergency selector handle and an instruction placard are installed in the center fuselage, on the left side, adjacent to the left landing gear emergency release handles. The handle is connected to the hydraulic landing gear control valve by cables. Pulling the handle OUT will mechanically position the control valve to the gear down position. In the event of hydraulic failure, the landing gear emergency release handles must then be pulled to release the latches and allow the gear to fall.

LANDING GEAR EMERGENCY RELEASE HANDLES.

Five landing gear emergency release handles *(23, figure 1-2)* are installed in the aircraft to mechanically release the gear uplatches in the event the gears fail to extend when actuated normally. Two landing gear emergency release handles and an instruction placard are installed in the center fuselage on the left side adjacent to the landing gear emergency selector handle, to release their respective left forward or aft gear uplatches. Two emergency release handles are installed in the center fuselage on the right side to release their respective right forward or aft gear uplatches. The main gear emergency release handles are spring loaded to the reset position. One emergency release handle is installed in the lavatory to release the nose gear. The tail bumper is not equipped for emergency extension. After the main gear release handles have been pulled, the main gears will free-fall and lock. The nose gear release handle must be held out until the gear is locked down. The nose gear emergency release handle is not spring loaded to the reset position. After actuation of the nose gear emergency release handle, recycling of the gear will reset the cable. Viewing windows adjacent to each gear facilitate checking the gear position while in flight. For visual indication of gear down and locked, see figure 1-36. Extension time for the nose gear when using emergency extension is approximately 15 seconds; for the main gear, approximately 5 seconds.

Emergency Nose Gear Unlock Link (T.C.T.O. 614).

On aircraft with T.C.T.O. 614, a nose gear unlock link *(figure 1-36)* is installed to release the nose gear latching mechanism in the event of malfunction of the mechanism. Access to the unlock link is gained by breaking the nose gear viewing window. The nose gear is unlocked by pulling the unlock link aft with the nose gear ground safety pin, after hydraulic system pressure has been reduced to zero to relieve pressure on the latching mechanism. The nose gear emergency release handle must still be pulled after releasing the unlock link to release the nosewheel doors and allow the gear to free-fall.

Landing Gear Position Indicators.

Five 28-volt d-c landing gear position indicators *(21, figure 1-7)* and one tail bumper position indicator, located on the pilots' instrument panel, indicate the position of each gear. Each indicator reads UP if its respective gear is up and locked. Each indicator shows a picture of a wheel if its respective gear is down and locked. At all other times, or when no electrical power is on the aircraft, striped markers appear on the indicators. Since no provision is made for emergency extension of the tail bumper, its indicator will read UP after emergency gear extension.

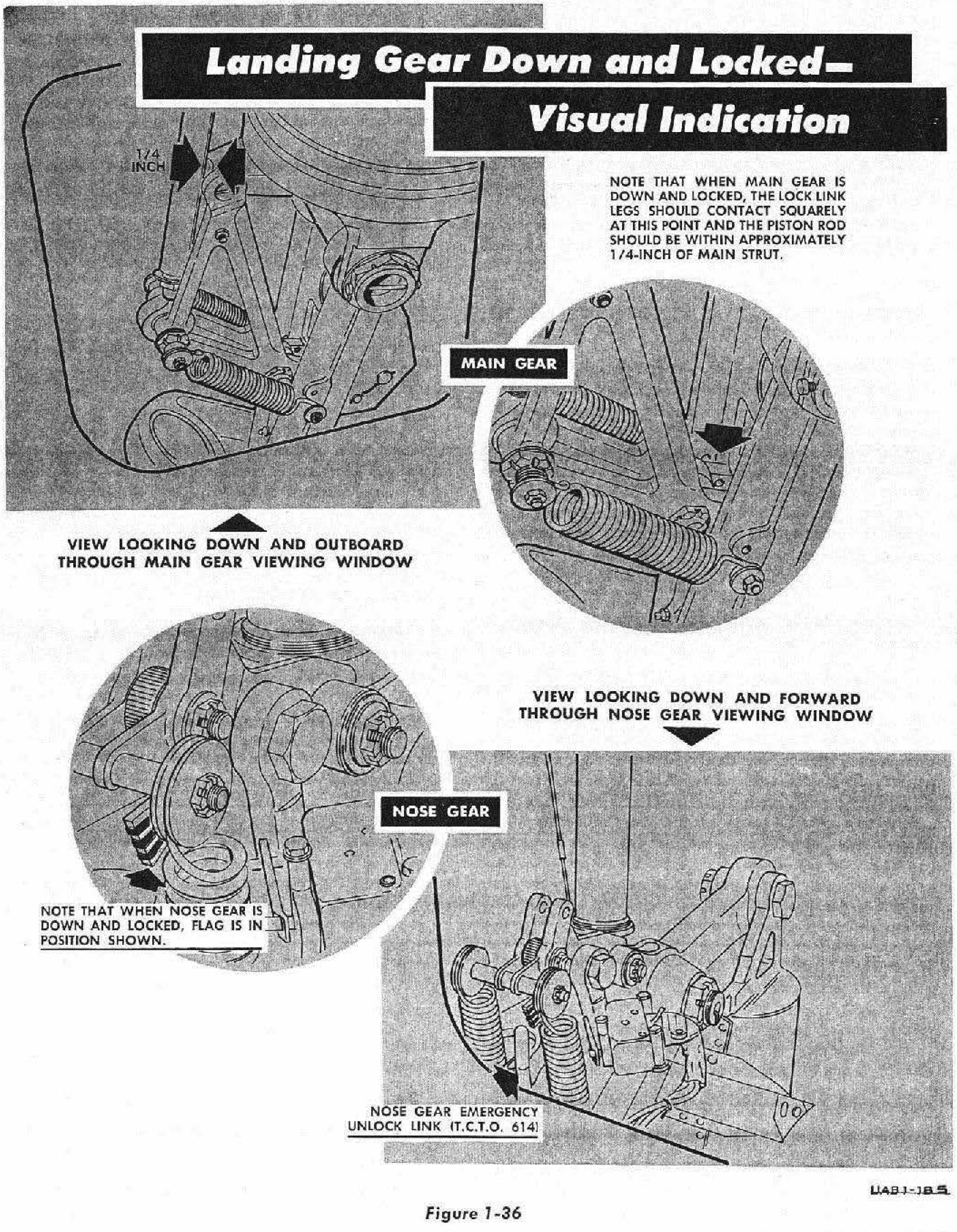
Landing Gear Warning Light.

A red, 28-volt d-c landing gear warning light is located in the knob of the landing gear lever *(49, figure 1-7)*. The warning light will come on whenever any of the landing gears are not up and locked, or down and locked. The light will also come on whenever any of the landing gears (except the tail bumper) is not down and locked and a throttle lever is retarded aft of the 65.5-degree position *(figure 1-9)*. The landing gear warning light is included in the warning lights dimming circuit and will be dimmed whenever the instrument lights are on and the warning light dimming switch on the pilots' overhead panel is positioned to DIM. Power for operation of the landing gear warning light is obtained from the flight deck 28-volt d-c essential bus. Circuit protection is provided by a circuit breaker on the flight engineer's overhead circuit breaker panel.

Landing Gear Warning Horn.

A 28-volt d-c warning horn, mounted forward of the pilots' instrument panel, automatically sounds when any throttle is retarded aft of the 65.5-degree position *(figure 1-9)*, and any of the landing gears (except the tail bumper) are not down and locked. Power for operation of the landing gear warning horn is obtained from the flight deck 28-volt d-c essential bus. Circuit protection is provided by a circuit breaker on the flight engineer's overhead circuit breaker panel.

Landing Gear Down and Locked— Visual Indication



NOTE THAT WHEN MAIN GEAR IS DOWN AND LOCKED, THE LOCK LINK LEGS SHOULD CONTACT SQUARELY AT THIS POINT AND THE PISTON ROD SHOULD BE WITHIN APPROXIMATELY 1/4-INCH OF MAIN STRUT.

VIEW LOOKING DOWN AND OUTBOARD THROUGH MAIN GEAR VIEWING WINDOW

VIEW LOOKING DOWN AND FORWARD THROUGH NOSE GEAR VIEWING WINDOW

NOTE THAT WHEN NOSE GEAR IS DOWN AND LOCKED, FLAG IS IN POSITION SHOWN.

NOSE GEAR EMERGENCY UNLOCK LINK (T.C.T.O. 614)

Figure 1-36

Landing Gear Safety Pins

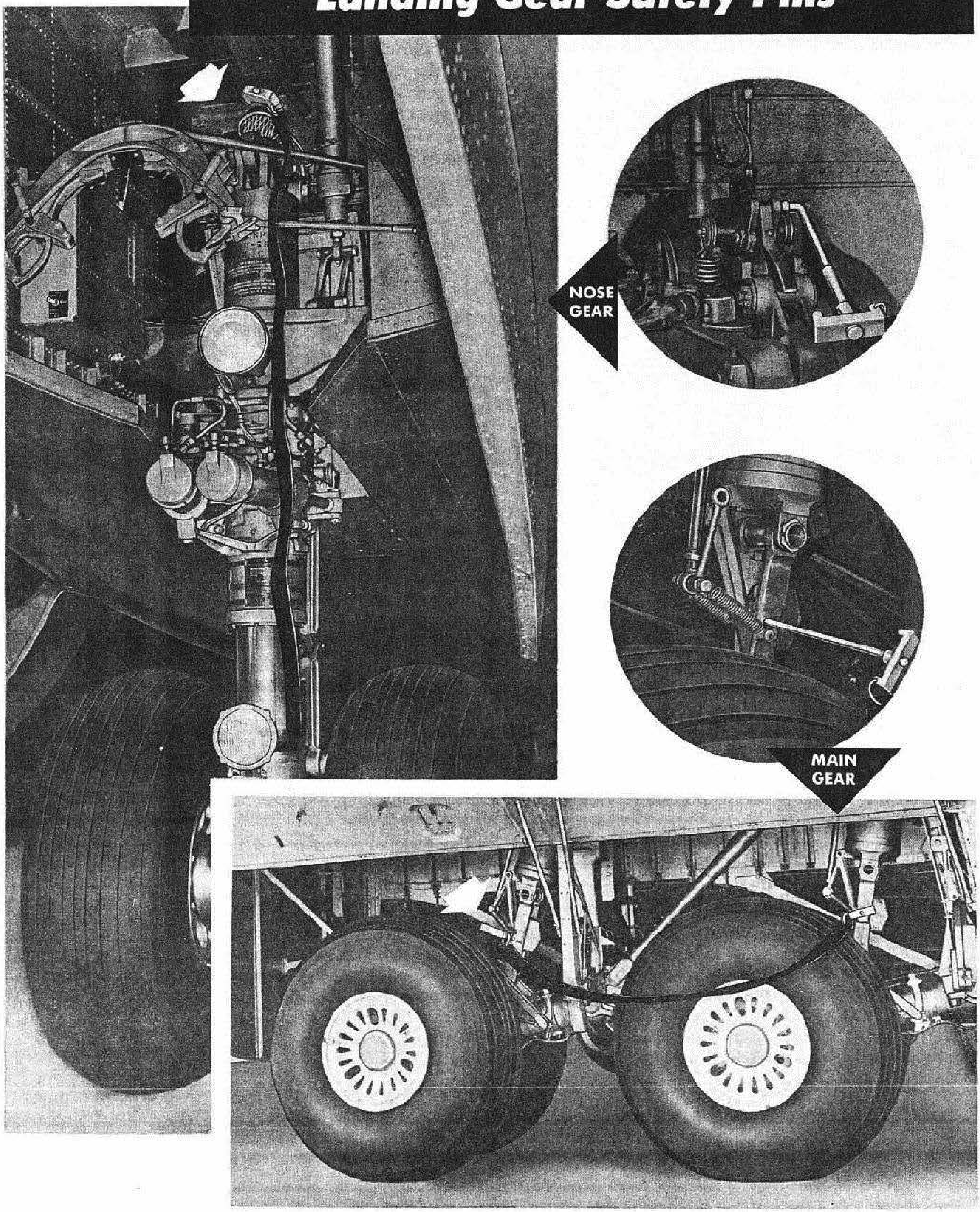


Figure 1-37

UA81-186

Nosegear Steering Wheel and Parking Brake Knob

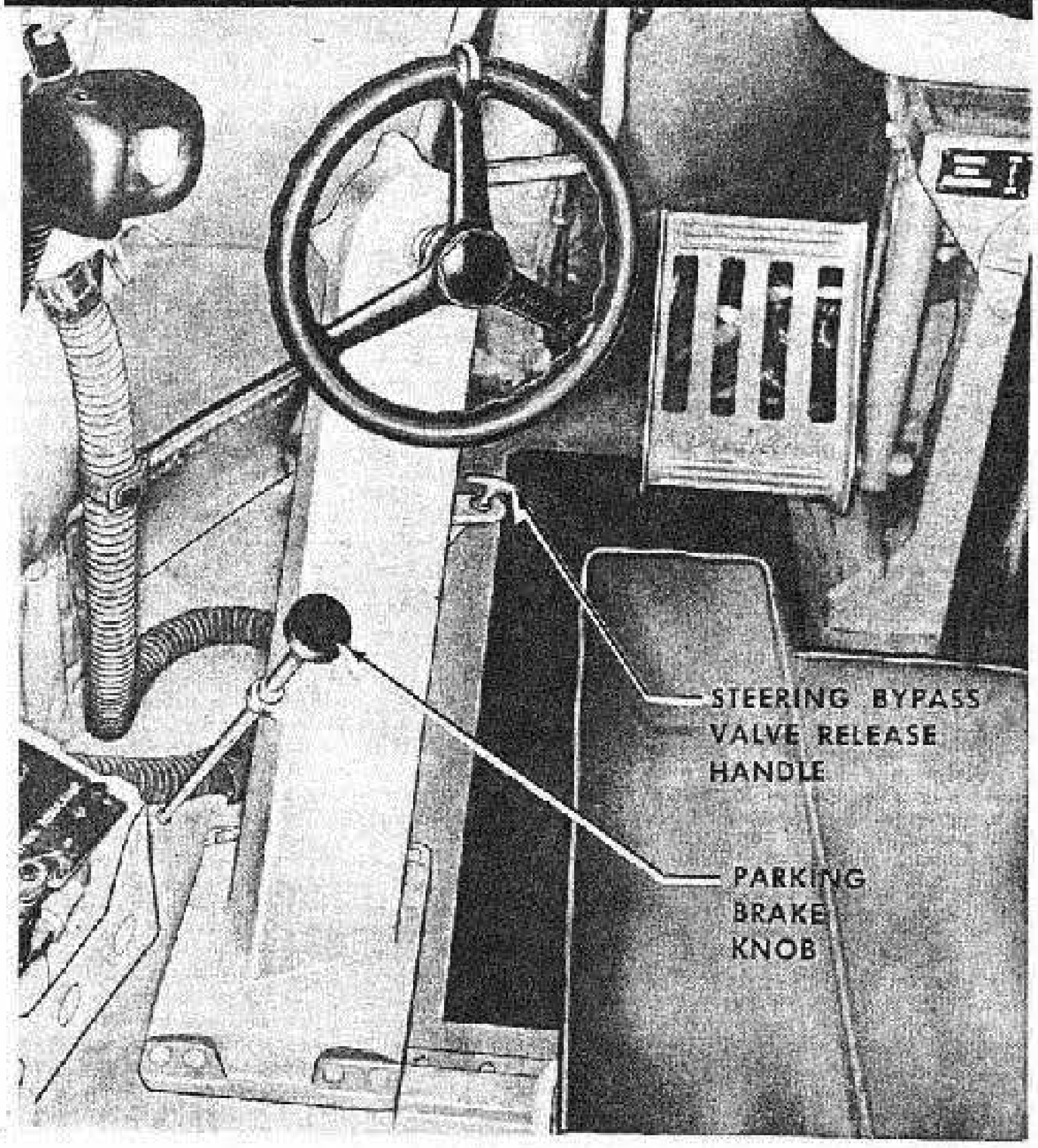


Figure 1-38

Landing Gear Warning Light Test and Horn Cutoff Switch.

A 3-position 28-volt d-c switch *(22, figure 1-7)*, placarded SIGNAL, is mounted on the pilots' instrument panel to provide a means of checking the operation of the landing gear warning light and to silence the landing gear warning horn. When the switch is actuated to the LIGHT TEST position, the light in the landing gear lever knob will come on; when the switch is released to the spring-loaded center position, the light will go out. When the switch is actuated to the OFF position, the landing gear warning horn circuit is opened to silence the warning horn. The warning horn circuit is rearmed when the switch is released to the center position. The warning horn cannot be tested, by means of the test switch, when the gear is retracted.

NOSE GEAR STEERING SYSTEM.

The nose gear is hydraulically controlled by movement of the nose gear steering wheel or the rudder pedals. The landing gear hydraulic system supplies pressure for operation of the nose gear steering system *(figures 1-31 and 1-32)* when the landing gear is extended. Flexible control cables are connected to the nose gear steering wheel drum, the rudder pedal steering sector, and to the nose gear steering assembly. The cables are routed over a pulley assembly that positions the steering control valve when steering tension is applied to the cables. A shifting linkage in the connection between the rudder pedals and the rudder pedal steering sector is automatically positioned so that the rudder pedals will not operate the steering system when the nose gear shock strut is extended. When the nose gear is fully extended, the nose gear is held in the centered position by means of integral cams in the shock strut piston and cylinder. For towing operations, a steering bypass valve release is provided to allow the nose gear to caster freely.

NOSE GEAR STEERING WHEEL.

The nose gear steering wheel *(figure 1-38)* is located on the steering column to the left of the pilot's station. Rotation of the steering wheel transmits steering tension to the control cables connected to the steering wheel drum, which in turn operate the steering control valve to provide hydraulic pressure to the steering cylinders. A stop on the steering wheel drum limits nose gear steering wheel travel. Angular movement of the nose gear is limited to 50 degrees either side of center with steering wheel operation.

RUDDER PEDAL STEERING.

The rudder pedals *(14, figure 1-5)* control nose gear steering by means of linkage that connects the rudder pedals to the rudder pedal steering sector. Movement of the rudder pedals transmits tension to the cables connected to the steering sector, which in turn operate the steering control valve to provide hydraulic pressure to the steering cylinders. Angular movement of the nose gear is limited to 16 degrees either side of center with full rudder pedal travel. Operation of the nose gear steering wheel overrides rudder pedal steering.

STEERING BYPASS VALVE RELEASE HANDLE.

A steering bypass valve release handle *(figure 1-38)* is located on the steering column immediately below the nose gear steering wheel to the left of the pilot's station. When the release handle is pulled UP, the bypass valve is positioned to shut off hydraulic pressure to the steering control valve and bypass the pressure between the steering cylinders. This allows the nose gear to caster freely for towing operations. The steering bypass valve release handle shall be pulled UP prior to towing operations to prevent damage to the nose gear. The release handle must be pushed IN to obtain rudder pedal or steering wheel nose gear steering. In the event a failure of the nose gear steering system occurs, the steering bypass valve release handle should be pulled UP to allow the nose gear to caster freely.

BRAKE SYSTEM.

Hydraulic pressure for the brake system is supplied from the landing gear downline to a set of brake control valves which are actuated by linkage connected to the toe pedals on the pilot's and copilot's rudder controls. These valves reduce and meter the main system pressure, as required, to the eight multiple-disc brakes on the main landing gear wheels. An accumulator, installed in the lower nose compartment, supplies pressure for the brakes when the aircraft is parked. When the landing gear lever is positioned to UP, the hydraulic pressure in the brake accumulator is ported to return. Porting of the brake accumulator pressure to return prevents application of the brakes during and after retraction of the gear. Application of the brakes during retraction of the gear is undesirable because of the excessive loads imposed on the structure. An anti-skid brake control system is installed to prevent locking of the braked wheels during the landing roll due to excessive pressure being metered to the brakes by the pilot. An emergency airbrake system is provided in the event of hydraulic system failure. An air bottle, located in the lower nose compartment, supplies the air pressure. The antiskid system is inoperative during emergency airbrake operation. Lockout cylinders are installed in the brake system to insure that at least 50 percent of braking power is available on the affected side of the aircraft, in the event a malfunction occurs at the wheel or between the lockout cylinder and the brake.

NORMAL BRAKE CONTROLS.

The hydraulic brakes are actuated by toe pressure applied to the hinged rudder pedals *(14, figure 1-5)*; the pressure applied to the brakes being in proportion to the pressure applied to the brake pedals.

PARKING BRAKE KNOB.

The hydraulic brakes can be mechanically locked for parking purposes by using the parking brake knob *(figure 1-38)* on the nosewheel steering wheel column. The parking brakes are set by fully depressing the brake pedals, then pulling UP the parking brake knob, and then releasing the brake pedals. Release of the parking brakes is accomplished by fully depressing either set of brake pedals.

ANTISKID SYSTEM.

A 28-volt d-c antiskid brake control system is installed to prevent locking of the braked wheels in the event excess brake pressure is metered by the pilot during any phase of the landing roll. The system is put into operation by a switch located on the pilots' instrument panel. The antiskid action is accomplished through a brake-releasing and pressure-modulating system, which is controlled by a skid-sensing detector mounted in each wheel. The skid detector can detect both rapid change of wheel speed and nonrotation. The detector is used with an electrical skid control system to exercise remote control over a 3-way solenoid valve, installed in the brake system, that releases and reapplies metered brake pressure as the braked wheel departs from, or returns to (or near to), nonslip speed. Corrective action to lessen excessive metered brake pressure is accomplished by a pressure modulator. There is a reduction of the skid-inducing excess brake pressure with each skid control cycle until cycling stops, followed by a gradual increase of pressure to match the increasing wheel load as the aircraft decreases speed and wing lift. A 4-second time delay is incorporated in the system to prevent landing with the brakes locked. This is accomplished through two safety switches, one on each aft main gear oleo, which completes the antiskid control circuit after the weight of the aircraft is on the main gear. The electrical control system incorporates fail-safe operation that automatically reverts the brake system to normal brakes in the event of system failure.

Antiskid Control Switch.

A 2-position antiskid control switch *(46, figure 1-7)*, with the placarded positions ON and OFF, is installed on the pilots' instrument panel. The switch is used to select either normal braking (OFF position) or antiskid braking (ON position). When the switch is placed in the ON position, the 28-volt d-c antiskid circuits are armed, and when the weight of the aircraft is on the main gear, the circuits are completed to provide antiskid braking.

Antiskid Warning Light.

An amber, 28-volt d-c, antiskid warning light *(46, figure 1-7)*, is installed on the pilots' instrument panel. The light is wired through two landing gear downlock switches, one on each forward main gear, and will come on if any one of the four antiskid control systems are inoperative when the main gear is extended and the antiskid control switch is in the ON position. The light will also come on when the gear is down and the antiskid control switch is in the OFF position. The light may be checked by pressing the light assembly. Power for operation of the antiskid warning light is obtained from the flight deck 28-volt d-c essential bus. Circuit protection is provided by a circuit breaker located on the flight deck left hand auxiliary circuit breaker panel.

Antiskid Wheels Unlocked Indicator Light.

A green, 28-volt d-c, antiskid wheels unlocked indicator light *(46, figure 1-7)* is installed on the pilots' instrument panel. The indicator light, together with the antiskid test switch, provide a means of checking actuation of the four antiskid control valves prior to landing. When the antiskid control switch is in the ON position and the skid detectors are sensing a no-rotation condition of the main gear wheels, the wheel unlocked relays are closed and the antiskid control valves are actuated. If the wheel unlocked relays are closed, the antiskid wheels unlocked indicator light will come ON when the antiskid test switch is pushed IN, to indicate that the four antiskid control valves have been energized. If the indicator light does not come ON when the test switch is pushed IN, it indicates that the brakes could be applied by brake pedal actuation during or immediately after landing, in which case the antiskid system should be turned off by placing the antiskid control switch in the OFF position. The wheels unlocked indicator light may be checked by pressing the light assembly. Power for operation of the antiskid wheels unlocked indicator light is obtained from the flight deck 28-volt d-c essential bus. Circuit protection is provided by a circuit breaker located on the flight deck left hand auxiliary circuit breaker panel.

Antiskid Test Switch.

A 2-position, push-button type antiskid test switch *(46, figure 1-7)*, placarded PUSH TO TEST, is located on the pilots' instrument panel. When the antiskid control switch is in the ON position and the antiskid test switch is pushed IN, it will complete a 28-volt d-c circuit and cause the wheels unlocked indicator light to come ON, providing the wheel unlocked relays are closed and the antiskid control valves are energized.

EMERGENCY AIRBRAKE SYSTEM.

An emergency airbrake system is installed to provide braking in case hydraulic pressure is not available. A 3000-psi airbrake bottle, located beneath the floor of the flight deck, supplies air to a shutoff valve which is opened by a handle located on the pilots' control pedestal. From the shutoff valve, air is supplied to the airbrake control valves, mounted adjacent to the hydraulic brake control valves, and then to the brakes. The airbrakes operate by use of the regular brake pedals after the emergency airbrake control has been actuated. Air pressure moves the shuttle valve at each of the eight brake units to isolate the hydraulic system when the airbrake system is utilized for emergency brake operation. The emergency airbrake system bypasses the antiskid system. A filler valve for recharging the airbrake bottle is located on the left side of the nose wheel well.

Emergency Airbrake Handle.

An emergency airbrake handle *(36, figure 1-11)* is located on the control pedestal. When the handle is pulled out, it mechanically opens the shutoff valve, and releases the pressurized air into the airbrake control valves. The handle cannot be pushed in until the shutoff valve has been manually reset.

Emergency Airbrake Pressure Indicator (Aircraft AF54-135 through AF57-1615).

A direct-reading, bourdon tube-type emergency airbrake pressure indicator *(34, figure 1-7)* is located on the pilots' instrument panel. The indicator is calibrated in 100 psi increments from zero to 4000 psi, and indicates the amount of air pressure contained in the emergency airbrake bottle.

Emergency Airbrake Pressure Indicator (Aircraft AF59-522 and Subsequent).

A 28-volt a-c emergency airbrake pressure indicator *(34, figure 1-7)* is located on the pilots' instrument panel. The indicator is calibrated in 100 psi increments from zero to 4000 psi, and indicates the amount of air pressure contained in the emergency airbrake bottle. The indicator pointer is moved by a synchromotor which receives signals from an emergency airbrake pressure transmitter. The pressure transmitter, located in the lower nose compartment forward of the nose wheelwell, consists of bourdon tube-actuated synchro. When pressure is applied to the pressure port of the transmitter, the bourdon tube tends to straighten out. As the bourdon tube moves, it repositions the rotor of the synchro by means of a mechanical linkage. Any change in the position of the transmitter rotor causes a similar change in the rotor of the indicator synchro-motor. Power for operation of the emergency airbrake pressure indicating system is obtained from the flight deck 28-volt a-c essential bus. Circuit protection is provided by a circuit breaker, placarded PNEU PRESS IND, located on the flight deck right hand auxiliary circuit breaker panel.

INSTRUMENTS.

This paragraph covers only instruments which are not part of a complete system, such as the fuel system, engine, etc.

DIRECTIONAL INDICATORS.

A 115-volt, 3-phase a-c and 28-volt d-c type N-1 compass system is installed. This system uses one master indicator *(8, figure 4-13)* and two repeater indicators (settable dial indicators) *(14 and 51, figure 1-7)*. The navigator's is a type N-1 compass master indicator, the pilot's is a type V-7A, and the copilot's is a type V-8. The N-1 compass system also uses a compass amplifier. This provides reference heading information for the compass cards of five radio magnetic indicators. In addition to the N-1 compass system, a 115-volt, 3-phase, a-c directional indicator *(23, figure 1-7)* is located on the pilots' instrument panel. A standby magnetic compass is mounted in the center windshield area.

N-1 Compass Power-Off Light.

Two amber 28-volt a-c, press-to-test, N-1 compass power-off lights *(12, figure 1-7)*, one near the pilot's V-7A directional repeater indicator and one near the navigator's master directional indicator *(8, figure 4-13)*, come on when power is not supplied to the N-1 compass system.

ATTITUDE INDICATORS.

Two type B-1A remote attitude indicators *(15, figure 1-7)* are located on the pilots' instrument panel, one for the pilot, the other for the copilot. Two completely independent systems are installed; 115-volt, 3-phase a-c and 28-volt d-c power are required for operation of the type K-4B attitude indicating system. The system contains a self-erecting gyro and senses the aircraft attitude in pitch and roll and transmits it electrically to the B-1A indicator. A power OFF warning flag is incorporated in the type B-1A indicator, which is exposed whenever either a-c or d-c power, or both, are removed from the system. The flag disappears approximately 2 minutes after d-c power is applied and disappears immediately upon reapplication of a-c power. Refer to Section VII for further information concerning the effects of electrical power failure on the K-4B attitude indicating system.

K-4B vertical gyro malfunctions have occurred with no warning flag indicating the malfunction. The red warning flag on the B-1A indicator warns primarily of power interruption to the instrument. Internal malfunctions within the system can occur with no visual warning indicated. If the horizon adjustment knob is rotated for adjustment and no action takes place, a malfunction of the pitch circuitry is indicated. If, however, the horizon bar is displaced normally, the pitch circuitry can be assumed to be functioning properly. Power for operation of the K-4B attitude indicating system is obtained from the flight deck 28-volt d-c essential bus and the flight deck 115-volt a-c essential bus. Circuit protection is provided by six circuit breakers, placarded PILOT VERT GYRO, and CO PLT VERT GYRO, located on the flight engineer's overhead circuit breaker panel.

WARNING

The OFF flag on the attitude indicator will appear in case of a complete a-c or d-c power failure. However, a slight reduction in a-c or d-c power, or failure of certain electrical or mechanical components within the system, may not cause the OFF flag to appear even though the system is not functioning properly. Therefore, it is possible that a malfunction of the attitude indicator may be determined only by checking it with the slaved gyro magnetic compass and the turn-and-slip indicator. If, for any reason, a-c power to the K-4B indicating system is interrupted without an interruption in d-c power, the B-1A attitude indicator should be cross-checked with the other flight instruments for proper indication upon reapplication of a-c power. If a-c power is interrupted for a period longer than 5 minutes, open the PILOT VERT GYRO and CO PLT VERT GYRO a-c and d-c circuit breakers for 20 seconds prior to reengaging a-c or d-c power. If d-c power is interrupted, avoid changes in aircraft attitude until the power is reapplied. Cross-check the B-1A attitude indicator with the other flight instruments upon reapplication of d-c power. A slight amount of pitch error in the indication of the type B-1A attitude indicator will result from accelerations or decelerations. It will appear as a slight climb indication after a forward acceleration and as a slight dive indication after deceleration, when the aircraft is flying straight and level. This error will be most noticeable at the time the aircraft breaks ground during the takeoff run. At this time a climb indication error of about 1½ bar widths will normally be noticed. The exact amount of error will depend on acceleration of each takeoff. The erection system will automatically remove the error after acceleration ceases.

AIRSPEED INDICATORS.

Two type K-3 airspeed indicators *(13, figure 1-7)*, calibrated in knots, are installed on the pilots' instrument panel, one for each pilot. In addition to the normal airspeed indicating pointer, each instrument is equipped with an additional striped pointer that is mechanically actuated by changes in barometric pressure. (Refer to Section V for operating limitations.)

TRUE AIRSPEED INDICATOR.

One type M-1A true airspeed indicator *(9, figure 1-7)*, calibrated in knots, is installed on the pilots' instrument panel. This indicator continuously presents the aircraft's true airspeed (TAS). This is accomplished mechanically within the instrument by integrating the normal pitot pressure with the outside air temperature (OAT) and pressure altitude information. The resulting corrected indication is then presented by the indicating pointer and corresponds to the TAS of the aircraft. A duplicate indicator is also installed at the navigator's station.

ALTIMETER.

Two type MA-1 pressure altimeters *(26, figure 1-7)* are installed on the pilot's instrument panel and one is installed on the navigator's instrument panel. The altimeters provide a warning, by means of a flag-type indicator on the face of the instrument, when the aircraft enters altitudes below 16,000 feet. Since altimeter system error is negligible, no corrections are required.

TURN AND SLIP INDICATORS.

Two 28-volt d-c powered turn and slip indicators *(27, figure 1-7)* are located on the pilots' instrument panel, one each for the pilot and copilot. The instruments are of the conventional gyro-stabilized needle and ball type.

Turn and Slip Emergency Battery Power Switches (T.C.T.O. 534).

Two, guarded, turn and slip emergency battery power switches are installed to insure a source of power to the turn and slip indicators in the event of loss of electrical power to the 28-volt d-c essential busses. The switches are installed adjacent to each of the turn and slip indicators and have the placarded positions ALTERNATE and NORMAL (guarded). When the switches are in the NORMAL position, electrical power to the respective turn and slip indicator is supplied from the 28-volt d-c essential bus on the flight engineer's overhead panel. When the switches are placed in the ALTERNATE position, the indicators are powered from the battery bus on the auxiliary flight deck panel.

PITOT-STATIC SYSTEM.

The pitot-static system incorporates a primary and secondary static source *(figure 1-39)*. The primary static source is to be used normally and the secondary source is to be used during abnormal or icing conditions. The pilot's and copilot's static source selectors *(figures 1-39)* should be indicating the same source; either PRIMARY or SECONDARY. Refer to the Airspeed Position Error Correction Charts in *T.O. 1C-133A-1-1* for position error of the primary or secondary sources being used. The two pitot tubes *(figure 1-39)* are located beneath the sliding windows on either side of the aircraft. The tubes are accessible from the ground. The two pitot systems are isolated from each other, with the left tube supplying dynamic pressure to the pilot's airspeed indicator, true airspeed indicator, rudder stop Q switch, and navigator's true airspeed indicator. The right tube supplies dynamic pressure to the copilot's airspeed indicator, autopilot air data sensor, and the rudder stop Q switch. The pitot tubes and tube masts

Pitot-Static System — Sources and Selectors

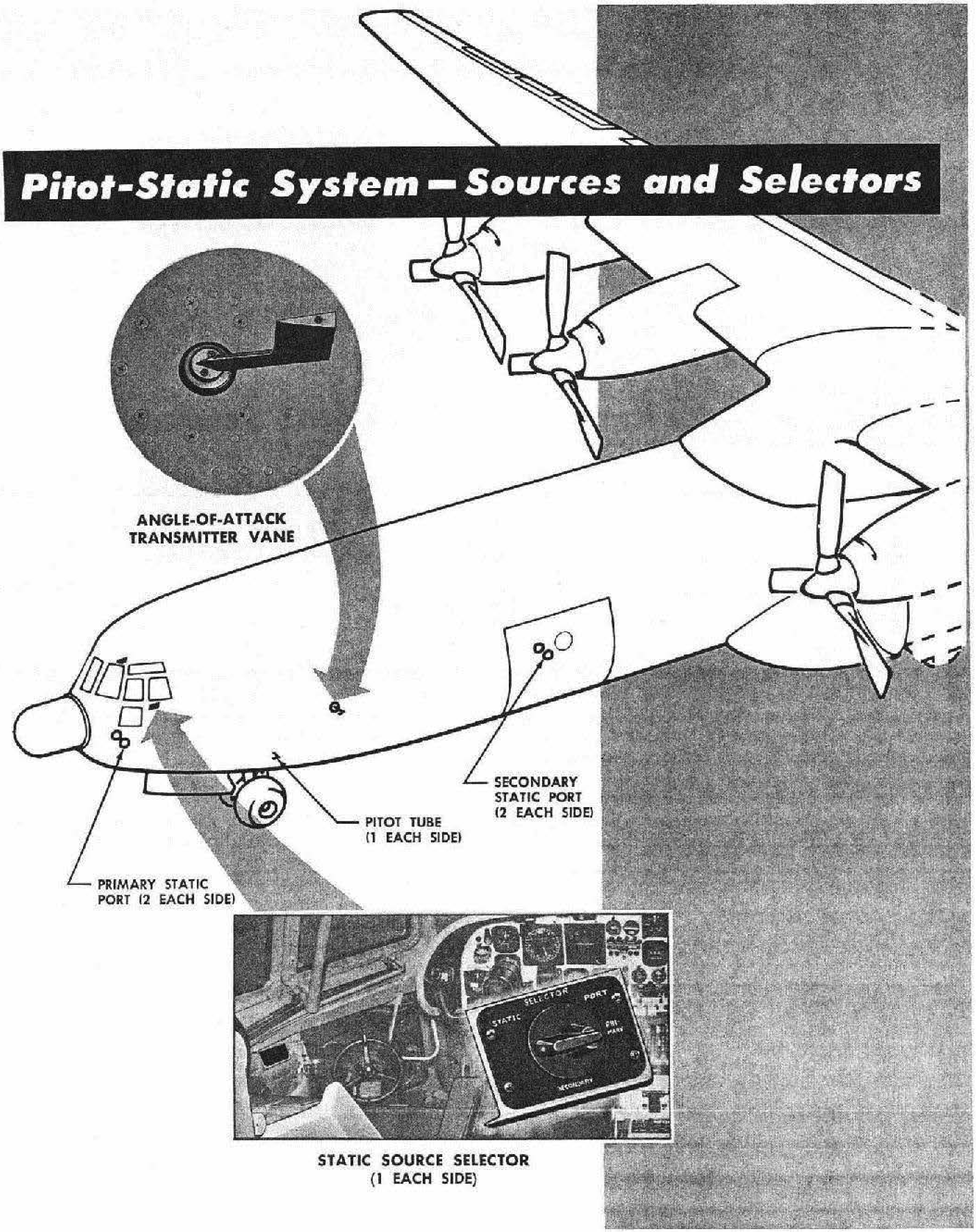


Figure 1-39

Takeoff Warning Index Panel

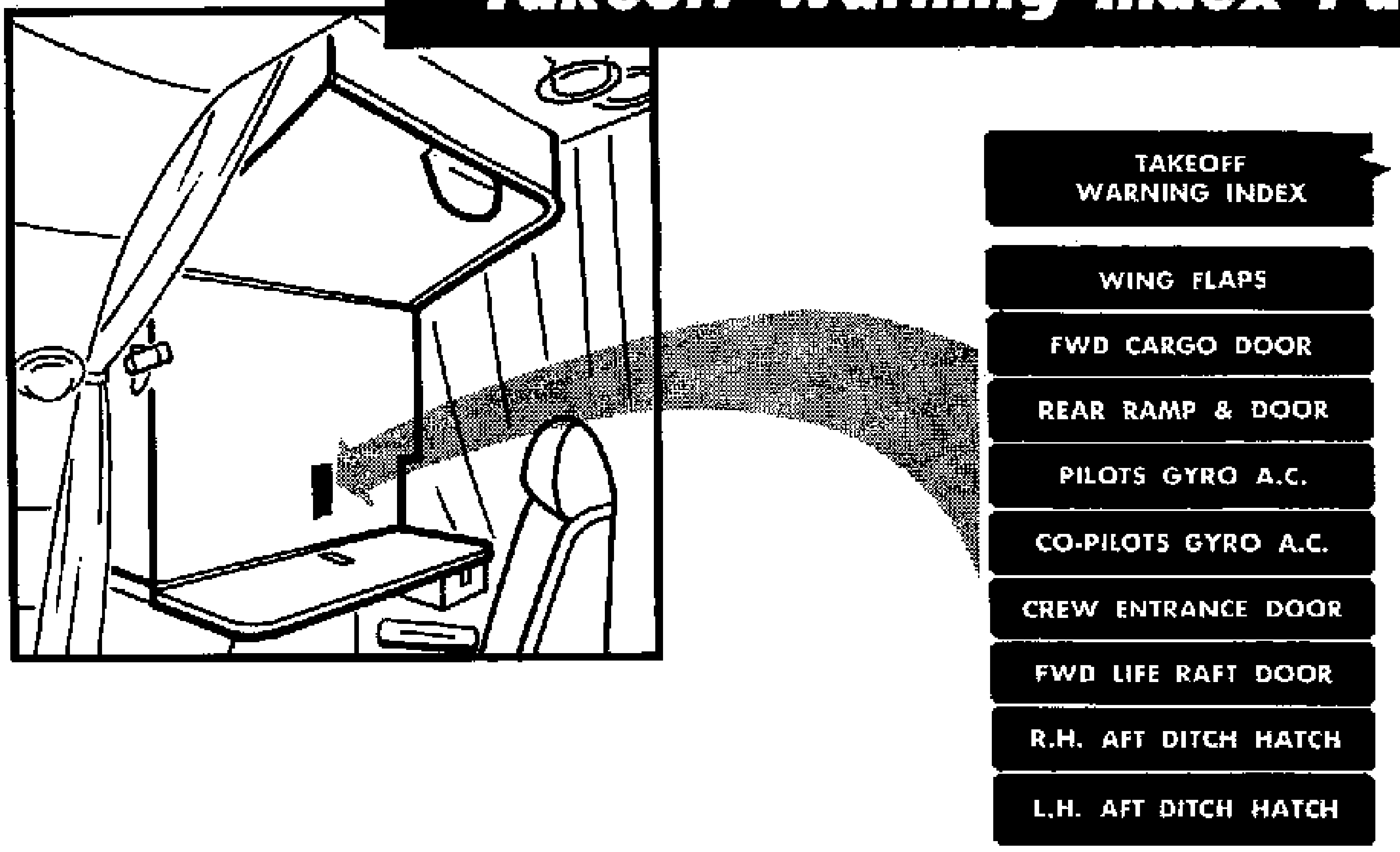


Figure 1-40

are anti-iced electrically by separate switches *(figure 4-8)* on the pilots' overhead panel. (See Anti-Icing and Deicing, Section IV for operation.) The static sources *(figure 1-39)* consist of eight flush mounted ports. Four primary static ports *(figure 1-39)* are located approximately 80 inches forward of the pitot tubes on each side of the aircraft. The two left secondary static ports *(figure 1-39)* are located in the side cargo door and the two right secondary ports are opposite them.

STATIC SOURCE SELECTORS.

The pilot's and copilot's static source selectors *(figure 1-39)*, located outboard of the pilots' seats below the clearview windows, have the placarded positions PRIMARY and SECONDARY.

STALL WARNING SYSTEM.

WARNING

The stall warning system, if installed, has been rendered inoperative and should not be used. This restriction will be lifted on the completion of the flight test program to define the operating envelope of the system.

A stall warning system is installed to provide the pilot and copilot with an indication that the aircraft is approaching stall. The system consists of a control column shaker, an amplifier, a flap position transmitter, and an angle-of-attack transmitter vane *(figure 1-39)* projecting out of the left side of the fuselage just forward of the cargo loading door. Angle-of-attack signals automatically control the action of the shaker after being integrated in the amplifier so that the warning is initiated between approximately 1.15 and 1.05 V_S for all power and gross weight conditions. Continuous electric anti-icing is provided for the angle-of-attack transmitter vane while the aircraft is in flight.

TAKEOFF WARNING SYSTEM.

The 28-volt d-c takeoff warning system includes a red press-to-test warning light *(11, figure 1-7)* on the copilot's side of the instrument panel, a take-off warning horn installed on the flight deck floor, and a takeoff warning index panel *(figure 1-40)* on the flight engineer's instrument panel. The warning light will come on and the horn will sound if the aircraft is unsafe for takeoff when the throttle for engine No. 1 or No. 3 is advanced above the 70-degree position *(figure 1-9)*, and the weight of the aircraft is on the gear. In addition, the respective lights in the takeoff warning index panel will come on to indicate the item or items that have not been properly positioned for takeoff. In flight the warning system will function except for the wing flap unsafe indication and the takeoff warning horn. The copilot's takeoff warning light will also come on if a door or hatch (except the crew escape hatch) opens.

FIRE WARNING AND EXTINGUISHING SYSTEMS.

FIRE AND OVERHEAT DETECTOR SYSTEMS.

Each nacelle is divided into the following three zones: zone I (inside the exhaust cooling shroud), zone II (accessory section), and zone III (outside the exhaust cooling shroud). Fire detectors are installed in zones I and II, which are protected against fire by provisions for the discharge of fire extinguishing agent. Overheat detectors only are installed in zone III, which has no provisions for the discharge of agent. The GTU's in the aft section of the left landing gear pod are equipped with both fire detectors and overheat detectors and are protected against fire by provisions for the discharge of a fire extinguishing agent. The fire and overheat detectors actuate warning lights in the heads of the fire control handles to indicate the location of a fire or overheat condition. The area around the main pneumatic manifold, extending along the wing leading edge, is equipped with an overheat detection system; however, there are no provisions made for the discharge of fire extinguishing agent in the manifold area. An overheat condition in this area is indicated by an overheat warning light at the engineer's station. **On aircraft AF59-536 and aircraft with T.C.T.O. 549,** failure of a fire detector unit will give a steady fire warning signal. Four pneumatic manifod switches are installed on the flight engineer's instrument panel for shutting off the bleed air from the engines to the pneumatic manifold in the event an overheat condition is indicated. For detailed information on operation of the pneumatic manifold switches and overheat warning light, see Pneumatic System, Section IV.

Engine Overhaul and Fire Warning Lights.

Two red, 28-volt d-c engine overheat and fire warning lights are located in each of the four engine fire control handles *(figure 1-41)* on the pilot's overhead panel to indicate a fire or overheat condition. A flashing light indicates an overheat condition and a steady light indicates a fire. The dual lamps in each handle come on at the same time. A red master fire warning light *(2, figure 1-7)* is also installed on the pilots' instrument panel. The master light is wired into the overheat warning system and the fire warning system for the engines. **On aircraft AF59-536, and aircraft with T.C.T.O. 592,** the GTU fire and overheat warning system is also wired to the master fire warning light so that the light will indicate fire or overheat for both engines or GTU's. A flashing master warning light indicates an overheat condition and a steady light indicates a fire. Power for operation of the engine overheat and fire warning lights is obtained from the flight deck 28-volt d-c essential bus. Circuit protection is provided by circuit breakers located on the flight engineer's overhead circuit breaker panel.

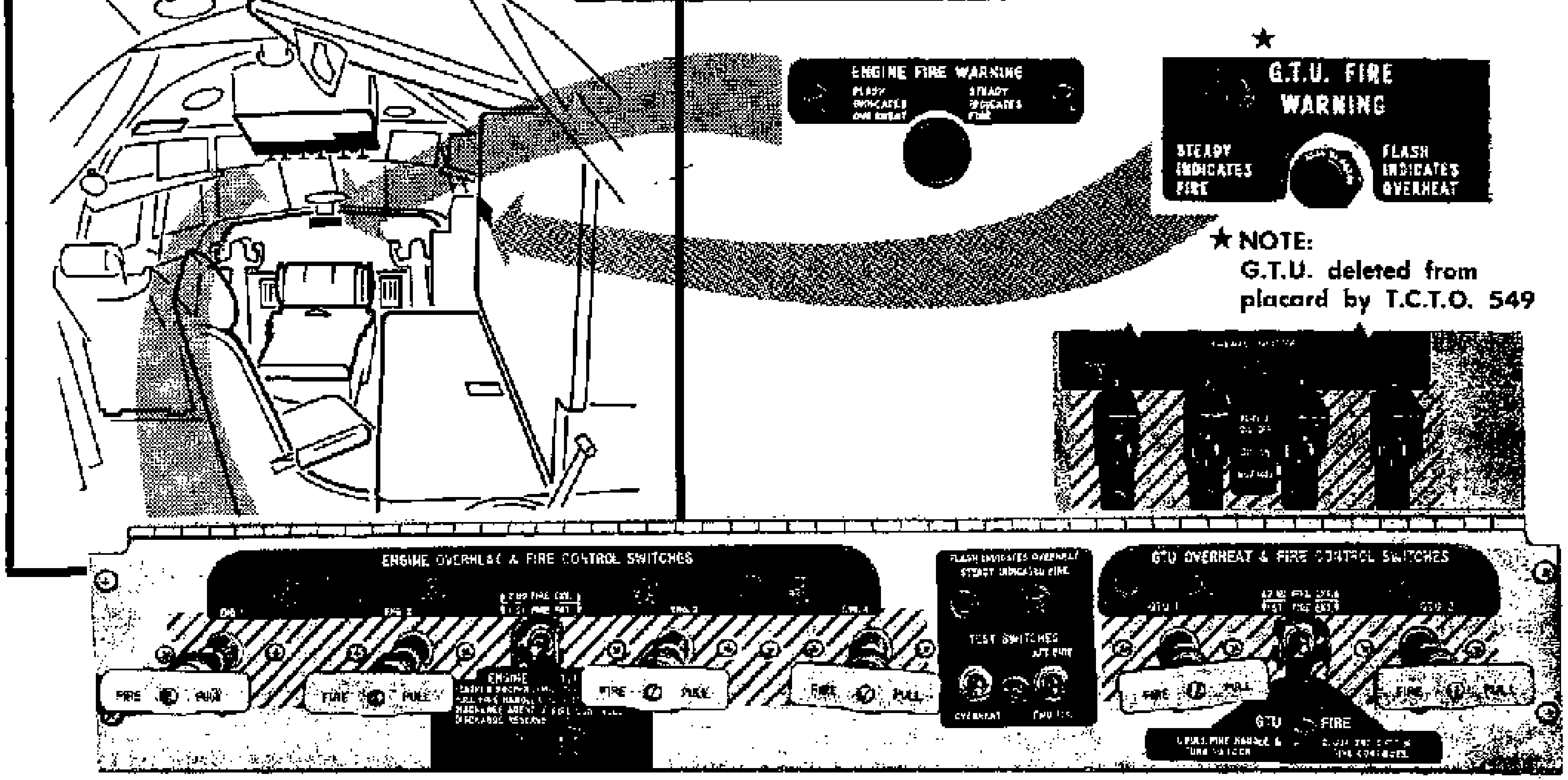
GTU Fire Warning Lights.

Two red, 28-volt d-c GTU fire warning lights are located in each of the two GTU fire control handles *(figure 1-41)* to indicate a fire or overheat condition. A flashing light indicates an overheat condition and a steady light indicates a fire. The dual lamps in each handle come on at the same time. A red master fire warning light *(figure 1-41)* for the two GTU's is located on the flight engineer's instrument panel. The warning light is wired into the GTU overheat and fire warning system. **On aircraft AF59-536 and aircraft with T.C.T.O. 592,** the engine fire and overheat warning system is also wired to the GTU master fire warning light so that the light will indicate fire or overheat for both engines or GTU's. A flashing master warning light indicates an overheat condition and a steady light indicates a fire. Power for operation of the GTU fire warning lights is obtained from both the flight deck 28-volt d-c essential bus and the flight deck 115-volt a-c essential bus. Circuit protection is provided by circuit breakers located on both the flight engineer's overhead circuit breaker panel and the flight deck left hand auxiliary circuit breaker panel.

Overheat and Fire Warning Light Test Switches.

Two test switches *(figure 1-41)* are located on the pilots' overhead panel. The overheat warning test switch is a 2-position switch, spring loaded to OFF. Actuation of the OVERHEAT switch will cause the lights in the engine fire control handles and the GTU fire control handles to flash. The master fire warning light on the pilots' instrument panel and on the flight engineer's instrument panel will also flash. The fire

Fire Warning Indicators and Extinguisher Controls



★ NOTE:
G.T.U. deleted from placard by T.C.T.O. 549

Figure 1-41

warning test switch has three positions and is spring loaded to the center (OFF) position. The other positions are placarded AFT FIRE and FWD FIRE. The AFT FIRE position checks the 28-volt d-c fire detector circuits in the exhaust shroud area of the four engines, the 115-volt a-c aft fire detector circuits for both GTU's and the 28-volt d-c lights. The FWD FIRE position checks the 28-volt d-c fire detector circuits in the four engine accessory sections, the 115-volt a-c forward fire detector circuits for both GTU's, and the 28-volt d-c lights. Actuation of the switch to the AFT FIRE or the FWD FIRE position will cause six steady lights to come on in the engine and GTU fire control handles, and will cause the master fire warning lights on the pilots' instrument panel and on the flight engineer's instrument panel to come on.

Pneumatic Manifold Overheat Warning Light.

A red, 28-volt d-c, press-to-test, pneumatic manifold overheat warning light is located on the pneumatic manifold and overheat warning panel *(2, figure 1-13)* on the flight engineer's instrument panel. The light will come ON when an overheat condition in the area of the pneumatic manifold is detected, or when the pneumatic manifold overheat warning circuit test switch is held in either the LEFT WING or RIGHT WING positions. The overheat warning light may be checked by pressing the light assembly. Power for operation of the pneumatic manifold overheat warning light is obtained from the flight deck 28-volt d-c essential bus. Circuit protection is provided by circuit breakers located on the flight deck left hand auxiliary circuit breaker panel.

Pneumatic Manifold Overheat Warning Circuit Test Switch.

A 3-position switch, placarded OVERHEAT CIRCUIT TEST, is located on the pneumatic manifold and overheat warning panel *(2, figure 1-13)*. The test switch has the placarded positions LEFT WING and RIGHT WING, and is spring loaded from these positions to the center, or OFF position. Holding the switch in either the LEFT WING or RIGHT WING position completes a circuit from the flight deck 28-volt d-c essential bus which supplies power for testing the continuity of the pneumatic manifold overheat detector test circuits in the respective wing, and causes the pneumatic manifold overheat warning light to come ON.

FIRE EXTINGUISHING SYSTEM.

Engine zone I (inside the exhaust cooling shroud) and zone II (accessory section) is protected by a 28-volt d-c, electrically operated 2-shot fire extinguishing system using dibromodifluoromethane as the fire extinguishing agent. Each GTU unit is protected by a 28-volt d-c, electrically operated 2-shot fire extinguishing system using the same agent. The supply of fire extinguishing agent for the engines is contained in two spherical containers located in No. 2 nacelle. One container holds the supply of fire extinguishing agent for the first shot. The other container holds the supply for the second shot. The supply of fire extinguishing agent for the GTU's is contained in two spherical containers located in the aft section of the left pod. The containers for the GTU's are divided into two systems to provide two shots, one from each container to either GTU. The fire extinguishing system is wired to the battery bus and will operate regardless of the position of the battery switch.

Engine Overheat and Fire Control Handles.

Four overheat and fire control handles *(figure 1-41)*, one for each engine, are located on the pilots' overhead panel. The handles are push-pull type T-shaped handles, incorporating dual warning lights. The handles are placarded FIRE PULL. Turning a handle after it is pulled will lock it. When a handle is pulled OUT, it completes the necessary 28-volt d-c circuits to close the respective engine firewall fuel and oil shutoff valves, and the engine pneumatic manifold shutoff valve. It will also establish the circuits for positioning the direction valves to route the fire extinguishing agent to the selected engine, for the activation of the agent containers, and to permit discharge of the fire extinguishing agent when the engine fire extinguisher discharge switch is actuated. If more than one fire control handle has been pulled OUT, the previous fire extinguishing agent routing circuit is cancelled by actuation of the next handle, thus eliminating split shots.

Engine Fire Extinguisher Discharge Switch.

A 3-position engine fire extinguishing agent discharge switch *(figure 1-41)*, placarded ENGINE FIRE, is located on the pilots' overhead panel. The switch has the placarded positions 1ST FIRE EXT and 2ND FIRE EXT, and is spring loaded to the off position. When the switch is held in the 1ST FIRE EXT position, the circuit previously established by the pulled engine overheat and fire control handle will be completed, the proper direction valve will be positioned to direct the flow of fire extinguishing agent to the preselected engine, and the fire extinguishing agent contained in the main container will be discharged. Holding the switch in the 2ND FIRE EXT position will also position the proper direction valve, but will discharge the fire extinguishing agent contained in the reserve container. The switch must be held in either the 1ST FIRE EXT or the 2ND FIRE EXT position for a minimum of 3 seconds to ensure proper actuation of the circuits, routing, and discharge of the fire extinguishing agent. The engine fire extinguisher discharge switch will not function unless an engine overheat and fire control handle has been pulled out and turned to lock. Once the fire extinguishing agent is released, it cannot be stopped.

GTU Overheat and Fire Control Handles.

Two overheat and fire control handles *(figure 1-41)*, one for each GTU, are located on the pilots' overhead panel. The handles are push-pull type, T-shaped handles incorporating dual warning lights. The handles are placarded FIRE PULL. Turning a handle after it is pulled will lock it. When a handle is pulled OUT, the 28-volt d-c circuits are completed to close the respective GTU residual heat door, the GTU oil cooler valve, and the GTU fuel and hydraulic shutoff valves. It will also establish the circuit for activation of the agent container, position the selector valve to route the fire extinguishing agent to the desired GTU compartment, and the circuit to permit discharge of the fire extinguishing agent when the GTU fire extinguisher discharge switch is actuated.

GTU Fire Extinguisher Discharge Switch.

A 3-position GTU fire extinguishing agent discharge switch *(figure 1-41)*, placarded GTU FIRE, is located on the pilots' overhead panel between the two GTU overheat and fire control handles. The switch has the placarded positions 1ST FIRE EXT and 2ND FIRE EXT, and is spring loaded to the off position. When the switch is held in the 1ST FIRE EXT position, the circuit previously established by the pulled GTU overheat and fire control handle will be completed, and the fire extinguishing agent in one of the GTU fire extinguishing agent containers will be discharged into the preselected GTU compartment. Holding the switch in the 2ND FIRE EXT position will discharge the fire extinguishing agent in the other container. The switch must be held in either the 1ST FIRE EXT or the 2ND FIRE EXT position for a minimum of 3 seconds to ensure proper actuation of the circuits, routing, and discharge of the fire extinguishing agent. The GTU fire extinguisher agent discharge switch will not function unless one of the GTU overheat and fire control handles has been pulled out and turned to lock. Once the fire extinguishing agent is released, it cannot be stopped.

Engine Pneumatic Manifold Shutoff Switches.

Four 2-position engine pneumatic manifold shutoff switches *(2, figure 1-13)*, placarded OPEN and CLOSED, are installed on the flight engineer's instrument panel. The individual switches may be used to isolate an engine from the pneumatic manifold when the engine is causing contamination of the bleed air system, when engine maximum power is required, or when manifold overheat is indicated. The engine pneumatic manifold shutoff valve is closed when the respective engine fire control handle is actuated.

Firewall Shutoff Valve Switches.

Four three-position, guarded, firewall shutoff valve switches *(figure 1-41)*, are mounted on the pilots' overhead panel. The switches are placarded FUEL & OIL OFF, OIL ON, and NORMAL. Before the guard is closed the switch should be placed in the NORMAL position. In order for the switches to function when in the FUEL & OIL OFF or NORMAL position, the fire control handle for the respective switch must be IN since the fire control handle overrides the firewall shutoff switch in these positions.

When a switch is positioned to NORMAL, a circuit is completed between the 28-volt d-c essential bus on the flight engineer's overhead panel and fuel and oil firewall shutoff valves, to open the valves. Placing the switches in the FUEL & OIL OFF position completes the circuit to close the fuel and oil firewall shutoff valves. When the engine fire control handles are pulled OUT, placing the switches in the OIL ON position completes the circuit, overriding the fire control handles, to open the oil shutoff valve and allow oil to circulate for engine lubrication. The OIL ON position does not affect the fuel shutoff valve.

EMERGENCY EQUIPMENT.

Note

> The following equipment does not form part of another complete system.

CREW BAILOUT ALARM SYSTEM.

A 28-volt d-c crew bailout alarm system installed in the aircraft permits the pilot to alert the crew in case bailout or ditching of the aircraft becomes necessary. The bailout alarm system is wired directly to the battery bus, and will provide the crew with both audible and visual alarm signals regardless of the position of the battery switch. The bailout alarm system is controlled by a switch on the pilots' overhead panel.

Bailout Alarm Bells.

Four bailout alarm bells *(4, figure 3-1)* provide audible signals to alert the crew in case bailout or ditching of the aircraft becomes necessary. One of the bells is located in the relief crew compartment. The other three bells are located in the cabin area.

Bailout Alarm Lights.

Five, red, bailout alarm lights *(13, figure 3-1)* provide visual signals to alert the crew in case bailout or ditching of the aircraft becomes necessary. All five of the bailout alarm lights are located in the cabin area.

Bailout Alarm Switch.

A guarded, 3-position bailout alarm switch *(figure 1-42)* is installed on the pilots' overhead panel. The switch has the placarded positions BAILOUT, OFF, and STANDBY. When the switch is placed in the STANDBY position, the bailout alarm lights flash on and off. When the switch is placed in the BAILOUT position, the bailout alarm lights glow steadily and the bailout alarm bells ring.

LIFERAFTS.

Five 20-man liferafts are provided for use in the event ditching becomes necessary. The crew liferaft *(12, figure 3-1)*, together with its accessory kits, survival kits, and a portable emergency radio transmitter for use in the raft, is stowed in a container located just aft of the relief crew compartment, at the top, right hand side of the fuselage. The four cabin liferafts *(14, figure 3-1)* together with their individual accessory and survival kits, are each stowed in a separate container located in the top of the wing, forward of the cabin

Bailout Alarm Switch

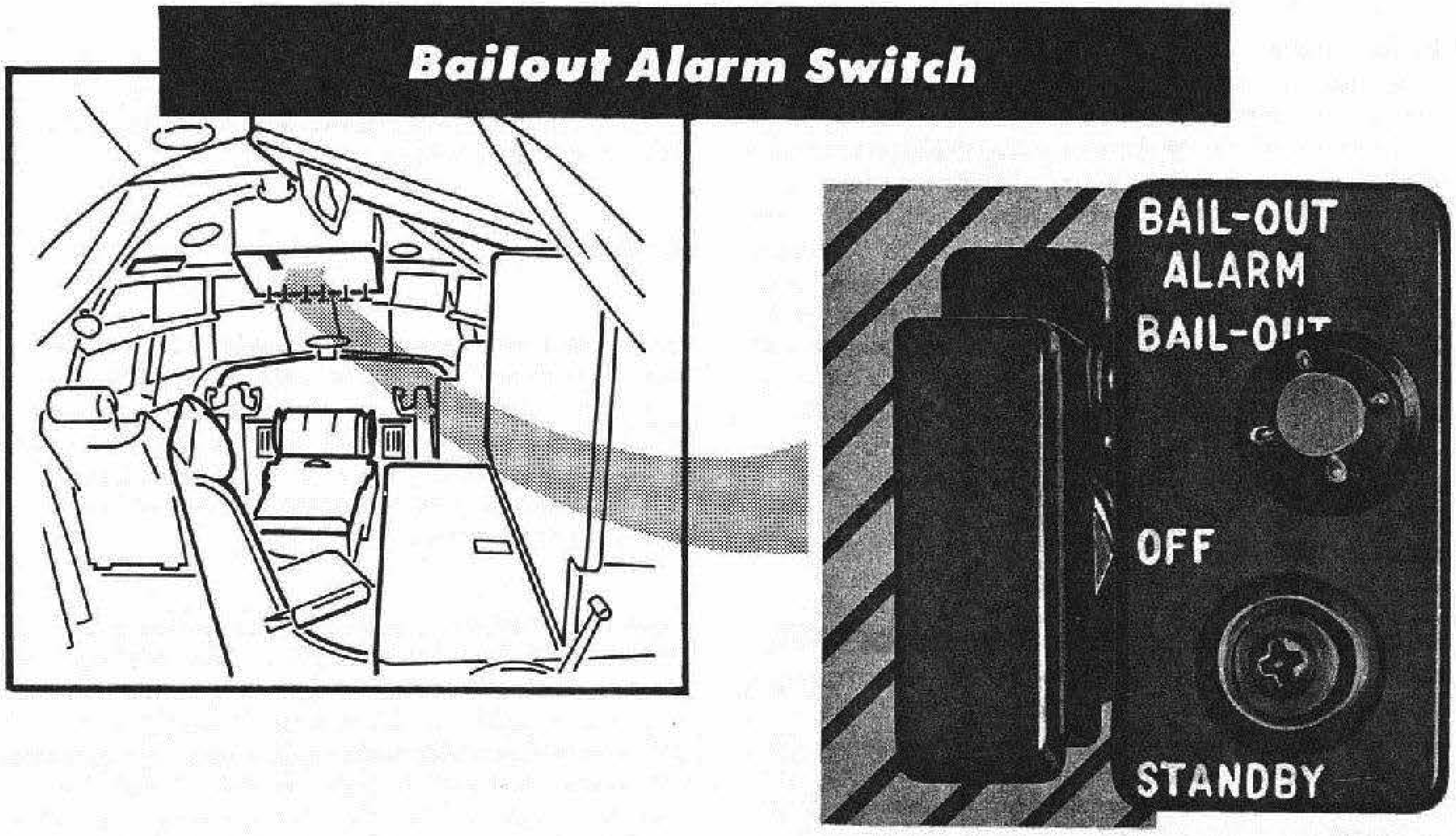


Figure 1-42

escape hatches. Each of the five liferaft stowage containers is equipped with an exterior, jettisonable door. A plastic window installed in each liferaft stowage container permits visual inspection of the individual liferaft while stowed. Detachable mooring tapes, attached to both the liferafts and the fuselage, prevent the rafts from drifting away from the aircraft before the personnel are safely on board. Other tapes secure the emergency radio transmitter, survival kits, and accessory kits, which are enclosed in water-proof containers, to the respective liferafts.

Crew Liferaft Controls.

The crew liferaft release handle *(6, figure 3-1)* is located above the buffet, on the aft bulkhead of the relief crew compartment, and is placarded LIFE RAFT—PULL TO RELEASE. A plastic guard, installed over the release handle, prevents inadvertent release of the liferaft. Pulling the release handle first jettisons the exterior door of the liferaft stowage container, then releases the CO_2 gas which inflates and ejects the liferaft, together with the emergency radio transmitter, accessory kits, and survival kits, from the stowage container. To assure complete ejection of the liferaft, the liferaft release handle must be pulled through its full travel, which is approximately 9½ inches.

In the event the liferaft fails to be ejected when the release handle is pulled, the liferaft can be manually removed from its stowage container from outside the fuselage. Raising an access door on the exterior surface of the liferaft container door exposes a handle, which when turned will release the latches of the stowage container door. The door may then be lifted off, using the latch release handle as a handgrip. After the door is removed, the liferaft may be manually removed from the stowage container and will be automatically inflated by means of a cable attached to the gas release valve of the CO_2 bottle on the raft.

Cabin Liferaft Controls.

A liferaft release handle *(15, figure 3-1)* is provided for each of the four cabin liferafts. Two of the release handles are located at the forward outboard corner of each of the two cabin escape hatches, at the top of the fuselage. Each of the release handles, when pulled, first jettisons the door of its respective liferaft stowage container, then releases the CO_2 gas which inflates and ejects the liferaft together with its accessory and survival kits, from the stowage container. To assure complete ejection of the liferaft, the liferaft release handle must be pulled through its full travel, which is approximately 9½ inches.

In the event any of the cabin liferafts fail to be ejected when its respective release handle is pulled, the liferaft can be manually removed from its stowage container from the top of the wing. Raising an access door on the exterior surface of the liferaft container door exposes a handle, which when turned will release the latches of the stowage container door. The door may then be lifted off, using the latch release handle as a handgrip. After the door is removed, the liftraft may be manually removed from its stowage container and will be automatically inflated by means of a cable attached to the gas release valve of the CO_2 bottle on the raft.

PORTABLE EMERGENCY RADIO TRANSMITTER (AN/CRT-3).

An AN/CRT-3 portable emergency radio transmitter *(12, figure 3-1)* is stowed in the crew liferaft stowage container and is ejected with the crew liferaft. A tape secures the radio transmitter to the liferaft. The AN/CRT-3 unit, known as the Gibson Girl, is a complete radio emergency transmitting system, designed for operation from a liferaft. Enclosed in a water-tight bag with the transmitter are two antennas, a box kite (to raise the antenna when the wind is above 7 miles per hour), two balloons (to raise the antenna when the wind is below 7 miles per hour), two hydrogen gas generators for inflating the balloons, and a signal lamp. The radio transmitter is powered by a hand-cranked generator, and transmits on a frequency of 500 kilocycles or 500 and 8364 kilocycles alternately, depending on the position of the emission switch. When transmitting on a frequency of 500 kilocycles, the transmitter has a range of from 5 to 300 miles. When transmitting on a frequency of 8364 kilocycles, the transmitter has a range of 750 to 1500 miles during the daytime, and possibly several thousand miles at night. Provisions are made for removing the AN/CRT-3 transmitter from the crew liferaft stowage container from inside the aircraft.

ESCAPE HATCHES.

Crew Emergency Escape Hatch.

A crew emergency escape hatch *(11, figure 3-1)* is provided to permit crew members to exit from the flight deck in the event the aircraft is ditched, or a ground emergency should occur. The crew emergency escape hatch is located at the top centerline of the relief crew compartment, and is hinged to open inward, laterally. The escape hatch is equipped with both an interior and an exterior latch control handle which permits the hatch to be unlocked and opened from either the inside or the outside of the fuselage. The exterior latch control handle is located in a recess in the center exterior surface of the hatch, beneath a hinged access cover. The crew escape hatch is reached by means of the crew escape ladder.

Cabin Emergency Escape Hatches.

Two cabin emergency escape hatches *(20, figure 3-1)* are provided to permit personnel in the cabin area to exit from the aircraft in the event the aircraft is ditched, or a ground emergency should occur. The two hatches are located approximately 3 feet either side of the top centerline of the cabin, just aft of the wing, and are hinged to open outward.

Each of the escape hatches is equipped with both an interior and an exterior latch control handle which permits the hatch to be unlocked and opened from either the inside or the outside of the aircraft. The exterior latch control handles are located in recesses in the center exterior surface of each hatch, beneath hinged access covers. The cabin emergency escape hatches are reached by means of the cabin escape ladders.

ESCAPE LADDERS.

Crew Escape Ladder.

A crew escape ladder *(8, figure 3-1)* is provided to permit crew members to reach the crew emergency escape hatch. The ladder is stowed, by means of support brackets, on the aft side of the relief crew compartment aft bulkhead, at the right side of the flight deck entrance door. In use, fittings on the upper and lower ends of the ladder rails engage in fittings provided in the floor of the relief crew compartment and on the jamb of the crew escape hatch.

Cabin Escape Ladders.

Two cabin escape ladders *(16, figure 3-1)* are provided to permit crew members or other personnel in the cabin area to reach the cabin escape hatches. One of the cabin escape ladders is stowed on each sidewall of the cabin by means of straps and support brackets. In use, the cabin escape ladders, which are hinged in the center, are unfolded, the hinge locked by means of lockpins, and the upper ends of each ladder are attached to hooks on the outboard jamb of each cabin escape hatch. The lower ends of the ladders are then secured by straps which are passed through cargo tie-down rings in the cabin floor.

CREW ESCAPE ROPE.

A crew escape rope *(5, figure 3-1)* is provided to permit crew members, leaving the aircraft through the crew emergency escape hatch, to lower themselves to the crew liferaft or to the ground, in the event the aircraft is ditched or a ground emergency occurs. The escape rope, which is woven of 3/4-inch cotton, is approximately 25 feet long and is equipped with a series of phenolic fittings, spaced 18 inches apart, which hold the rope away from the fuselage. The escape rope is stowed above a removable panel at the top of the relief crew compartment, just aft of the crew escape hatch. The removable panel is held in place by a series of snap fasteners, and is equipped with a fabric strap at each aft corner. Pulling downward on the two straps disengages the snap fasteners and removes the panel. The escape rope may then be lowered from the escape hatch. Figure 3-8 illustrates the use of the escape rope during ditching. Brackets are mounted adjacent to each of the cabin escape hatches, to which an escape rope may be attached.

PARACHUTE STATIC LINE.

A parachute static line *(10, figure 3-1)* is provided for use in evacuating wounded crew members from the aircraft during bailout. The parachute static line is stowed in a fabric container just aft of the crew entrance door.

JETTISON SAFETY HARNESSES.

Two jettison safety harnesses *(18, figure 3-1)* are provided for use by personnel during cargo jettisoning operations. The harnesses are stowed in containers attached to the left and right sidewalls of the cabin, above the rear cargo ramp. Each harness is fastened to a ring attached to the fuselage torque box, but may also be snapped onto any of the ramp cargo tiedown fittings. Each harness is long enough to permit the crew member wearing it to move inboard to the center of the ramp, and aft to the end of the ramp.

ANTIEXPOSURE SUIT STOWAGE PROVISIONS.

Stowage facilities for ten antiexposure suits *(3, figure 3-1)* are provided under the lounge seat at the right side of the relief crew compartment.

PYROTECHNIC INSTALLATION.

A pyrotechnic installation *(9, figure 3-1)* consisting of a signal flare pistol, a signal flare container, and a flare pistol port *(figure 1-14)*, is provided in the aircraft to permit pyrotechnic signalling to other aircraft, or between the aircraft and the ground. The flare pistol is stowed in a canvas holder attached to the signal flare container by snap fasteners. The signal flare container consists of a canvas bag equipped with pockets for holding 20 signal flares, which is stowed by means of straps and snap fasteners to the flight deck floor, just outboard of the navigator's seat. The flare pistol port is located in the fuselage wall above the outboard end of the navigator's table, and is provided with a cap and plug assembly which seals the port, when not in use, to prevent loss of cabin pressurization. When the handle attached to the cap is turned, the cap and plug may be removed to permit the flare pistol to be installed in the port.

PORTABLE FIRE EXTINGUISHERS.

Three portable, hand-operated fire extinguishers *(1, figure 3-1)*, containing bromochloromethane (CB), are installed in the aircraft for use in extinguishing interior fires. One Type A-20 extinguisher is located on the flight deck, beneath the forward end of the flight engineer's table. A second Type A-20 extinguisher is located on the aft bulkhead of the crew equipment stowage compartment, in the forward end of the cabin. The third, and largest of the portable fire extinguishers is a Type D-2 extinguisher, located on the right side wall of the fuselage at the forward end of the cargo ramp. The Type A-20 fire extinguishers are inoperative when inverted.

FIRST AID KITS.

Three first aid kits *(2, figure 3-1)* are provided in the aircraft. One kit is attached to the aft side of the pilot's map case. A second kit is installed on the flight deck floor at the right side of the fuselage, just forward of the flight compartment aft bulkhead. The third kit is installed on the floor of the relief crew compartment, just forward of the relief crew compartment aft bulkhead, and outboard of the flight deck entrance door.

IMPACT EMERGENCY LIGHTS.

Seven impact emergency lights *(7, figure 3-1)* are installed in the aircraft to provide emergency lighting, independent of the aircraft electrical systems, in the event of a crash landing or ditching. One of the lights is installed on the flight deck, above and behind the flight engineer's seat and one in the relief crew compartment, aft of the crew escape hatch. The other five lights are installed in the cabin, one above the crew entrance door, one aft of the side cargo door, one aft of each cabin escape hatch, and one above the ramp and clamshell door control panel. Each impact emergency light is powered by a self-contained 4.5-volt dry-cell battery, and is equipped with an inertia switch, a reset switch, and a test switch. The inertia switch will be actuated and will turn on the light whenever it is subjected to the sudden application of a force exceeding 1.5g's, resulting from an abrupt stop or impact. The reset switch is used to reset the inertia switch if it should accidentally be actuated. The test switch permits the operation of the battery and light to be tested.

WINDOW PRESSURE BARRIERS (T.C.T.O. 579).

Two window pressure barriers (22, figure 3-1), are stowed in the crew closet for use in the event of failure of the pilot's or copilot's sliding window. The barriers when installed do not provide a perfect air seal, although the barrier is designed for pressures in excess of 6.8 psi differential. The primary purpose of the barrier is to prevent explosive decompression following partial failure of the window panel.

CREW ENTRANCE DOOR.

Normal entrance into the aircraft is gained through the crew entrance door, located at the forward right side of the fuselage *(19, figure 1-2)*. The door incorporates built-in steps which provide a stairway for entry into the aircraft from the ground when the door is open. The door is mechanically operated from either inside or outside the aircraft by means of a handcrank located immediately forward of the door. Door operating instructions are outlined on a placard located adjacent to the handcrank. Latching in the closed position is accomplished by six bayonet latches, two on each side of the door, and two at the top of the door. The latches may be visually inspected for engagement from inside the aircraft. A jettison handle is provided for emergency operation of the door, which, when actuated, allows the door to be dropped completely from the aircraft.

SEATS.

PILOTS' SEATS.

The pilots' seats *(figure 1-43)* are installed on tracks to provide forward and aft, transverse, vertical and reclining position adjustments. Each seat is equipped with a removable headrest *(figure 1-43)*, which can be adjusted and locked in position by a lockpin on each end of the headrest, a safety belt, and a shoulder harness. The armrests of each seat can be pivoted to a vertical position. An ashtray *(figure 1-43)* is located in the forward end of the outboard armrest of each seat.

Fore and Aft Adjustment Lever.

A fore and aft adjustment lever *(figure 1-43)*, is installed on the inboard side of each seat. When the lever is pulled UP the seat is free to move in either direction. When the lever is released, the seat will lock in that position.

Lateral Adjustment Lever.

Lateral movement of the seat is controlled by a foot lever *(figure 1-43)* located at the front of the seat. When the lever is depressed, the seat is free to move laterally. When the lever is released, the seat locks if it is at either the inboard or the outboard position.

Vertical Adjustment Lever.

The seat is adjusted for height by using the vertical adjustment lever *(figure 1-43)*, located on the inboard side to release the lock. When the lever is pulled UP, increasing or decreasing the downward force on the seat will adjust the seat height. The vertical adjustment lever should not be released when the seats are unoccupied, since the vertical movement of the seats is spring loaded to the highest position in order to facilitate adjustments.

Reclining Adjustment Lever.

The seat is adjusted to a reclining position when the reclining lever *(figure 1-43)*, located on the outboard side of the seat, is pulled UP and the force on the back of the seat is increased.

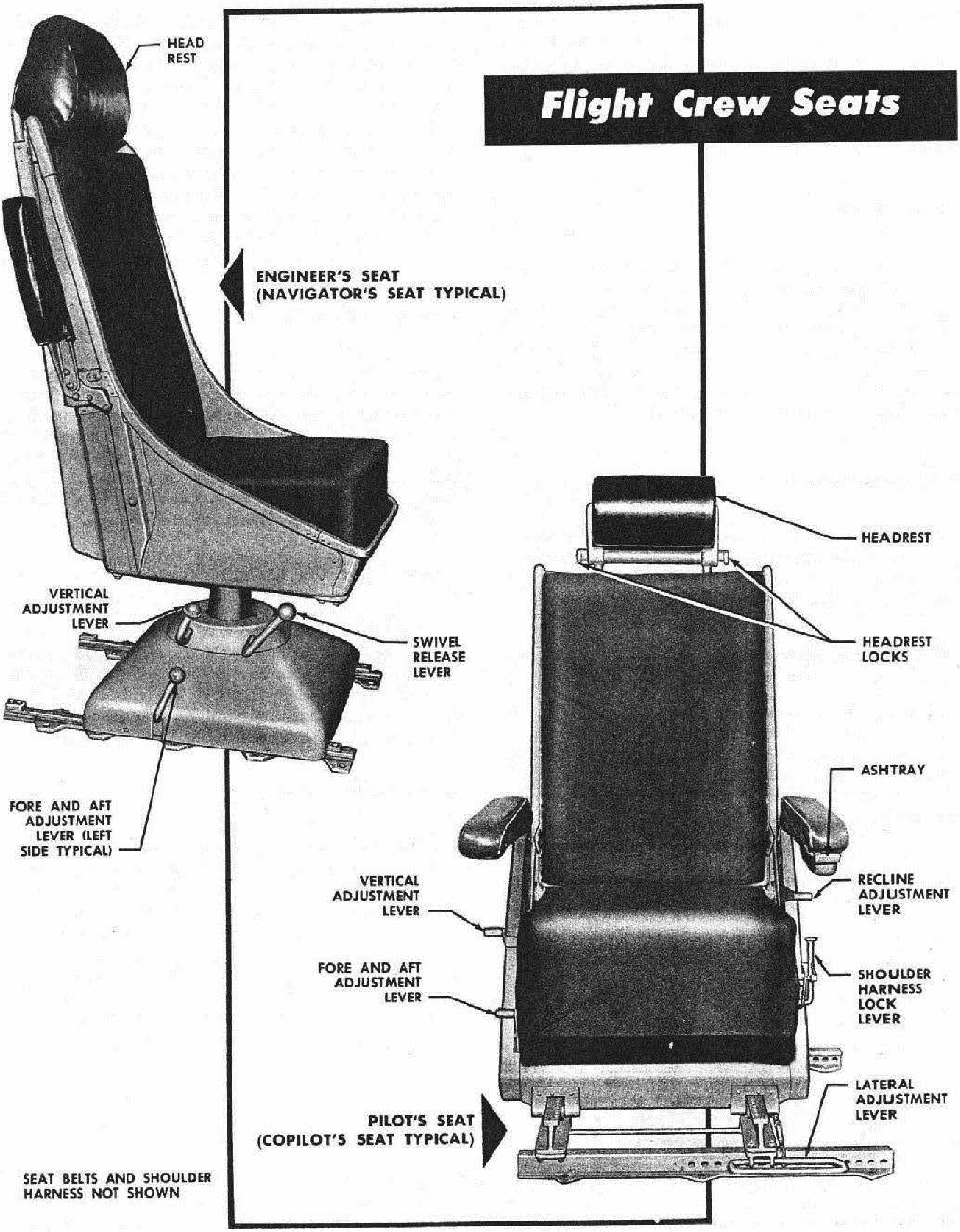
Shoulder Harness Lock Lever.

A 2-position shoulder harness inertia reel lock lever *(figure 1-43)* is located on the outboard side of the pilot's and copilot's seats. A latch is provided for positively retaining the lock lever at either position of the quadrant. By pressing down on the top of the lock lever, the latch is released and the lock lever may then be moved freely from one position to another. When the lock lever is in the UNLOCKED (aft) position, the reel harness cable will extend to allow the pilot to lean forward; however, the reel cable will automatically lock when an impact force of 2 to 3 g's is encountered. When the reel is locked in this manner, it will remain locked until the lock lever is moved forward to the LOCKED position and then returned to the UNLOCKED position. When the lock lever is in the LOCKED (forward) position, the reel harness cable is manually locked so that the pilot is prevented from bending forward. The LOCKED position is used only when a crash landing or ditching is anticipated. This position provides an added safety precaution over and above that of the automatic safety lock.

ENGINEER'S AND NAVIGATOR'S SEATS.

The engineer's and navigator's stations are equipped with full-swivel, vertically and horizontally adjustable

Flight Crew Seats



SEAT BELTS AND SHOULDER HARNESS NOT SHOWN

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Figure 1-43

seats *(figure 1-43)*. The navigator's seat can be moved fore and aft, and the engineer's seat can be moved laterally to provide adjustment at the tables. The seats are equipped with a lap safety belt, head rests, and movable armrests which can be pivoted to a vertical position. The seats should be turned to face aft for crash landings.

Vertical Adjustment Lever.

The seat is adjusted vertically when the vertical adjustment lever *(figure 1-43)* on the right side is pulled UP, releasing the lock. Increasing or decreasing the downward force on the seat gives the desired adjustment. The vertical adjustment lever should not be released when the seats are unoccupied, since the vertical movement of the seats is spring loaded to the highest position in order to facilitate adjustment.

Swivel Adjustment Lever.

The swivel adjustment lever *(figure 1-43)*, located on the right of the seat, is used to lock or unlock the seat so it can be swiveled to the desired position. When the lever is pulled UP, the seat unlocks.

Fore and Aft Adjustment Lever.

The fore and aft adjustment levers *(figure 1-43)*, located on each side of the seat base, unlock the seat to allow adjustment toward or away from the table. When the lever is pulled UP, the seat is unlocked so that it is free to move fore and aft. When the lever is released, the seat locks in position.

RELIEF CREW SEATS.

Two adjustable, airline-type seats *(14, figure 1-2)* and a convertible lounge *(11, figure 1-2)*, located in the relief crew compartment, provide seating accommodations for six relief crew members.

The two airline-type seats are installed on the left side of the relief crew compartment. The back of each of the airline-type seats can be individually adjusted to a reclining position to suit the comfort of the occupant. The center armrest between the two seats is also adjustable. The forward and aft armrests are each equipped with an ash tray. Each seat is equipped with a retractable leg rest and a safety belt. The backs of the airline-type seats may be folded forward (inboard) to gain access to the luggage tiedown straps installed on the floor, outboard of the seats.

The convertible lounge is installed on the right side of the relief crew compartment. The back of the lounge can be adjusted to three different positions. With the back of the lounge in either of the two upper positions, the lounge may be used either as a seat for four occupants, or as a lounge for one occupant. Lowering the back of the lounge into the third, or horizontal position, converts the lounge into a bunk. The lounge is equipped with four safety belts. An armrest containing an ash tray is provided at each end of the lounge. The seat portion of the lounge may be raised to gain access to the anti-exposure suit stowage compartment.

Seat Back Adjustment Buttons.

A seat back adjustment button is located in the forward and aft armrest of the airline-type seats. When the button is pressed in, the back of the respective seat is unlocked and may be adjusted to suit the comfort of the occupant by increasing or decreasing the force against the seat back. The seat back, which is spring loaded to the upright position, will lock in whatever position it is in when the button is released.

Armrest Adjustment Lever.

An armrest adjustment lever is installed in the center armrest between the two airline-type seats. Raising the lever unlocks the armrest and permits it to be moved upward and outboard, or downward and inboard. The armrest has two positions, and the armrest adjustment lever locks at the end of travel in either position.

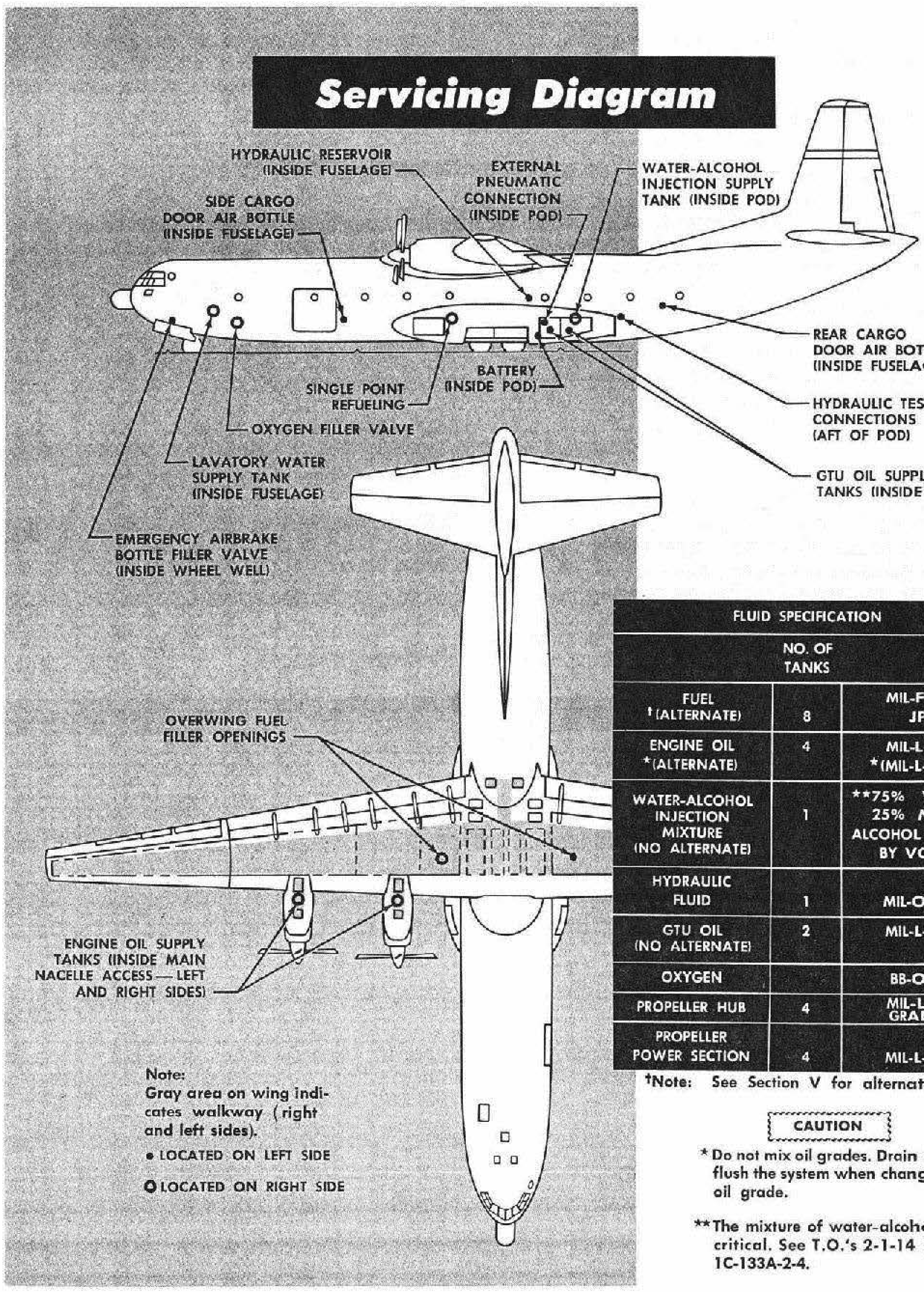
Leg Rest Control Buttons.

Two leg rest control buttons are installed on the inboard side of the seat frame of the airline-type seats. One of the buttons is located near the forward end of the forward seat, and the other near the aft end of the aft seat. When one of the buttons is pressed in, the leg rest of the respective seat is unlocked and may be withdrawn from beneath the seat. The leg rest will lock in either the extended or the stowed position. When the leg rest is in the extended position, pressing the button in will unlock the leg rest and permit it to be returned to the stowed position.

Seat Back Release Latch.

Two seat back release latches are installed on the airline-type seats. One of the latches is installed at the forward side of the forward seat back, and the other at the aft side of the aft seat back. When one of the latches is released, the back of the respective seat is

Servicing Diagram



FLUID SPECIFICATION

	NO. OF TANKS	
FUEL †(ALTERNATE)	8	MIL-F-5624 JP-4
ENGINE OIL *(ALTERNATE)	4	MIL-L-7808 *(MIL-L-25336)
WATER-ALCOHOL INJECTION MIXTURE (NO ALTERNATE)	1	**75% WATER 25% METHYL ALCOHOL (0-M-232) BY VOLUME
HYDRAULIC FLUID	1	MIL-O-5606
GTU OIL (NO ALTERNATE)	2	MIL-L-7808
OXYGEN		BB-O-925
PROPELLER HUB	4	MIL-L-6086 GRADE M
PROPELLER POWER SECTION	4	MIL-L-7870

†Note: See Section V for alternate fuels

CAUTION

* Do not mix oil grades. Drain and flush the system when changing oil grade.

** The mixture of water-alcohol is critical. See T.O.'s 2-1-14 and 1C-133A-2-4.

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Figure 1-44

unlocked and may be folded forward to gain access to the luggage tiedown straps behind the seat.

Lounge Back Lock Lever.

A lever, placarded SEAT BACK LOCK CONTROL, is located on the inboard side of the lounge seat frame, near the center of the lounge. The lock lever is spring loaded to the locked position, which is indicated by a directional arrow pointing forward. Moving the lock lever aft and into a notch unlocks the back of the lounge, which is spring loaded to the upright position. The lounge back may then be lowered to either of the other two positions by applying force on the back of the lounge. Lifting the lock lever out of the notch and releasing it to the locked position will lock the lounge back in the desired position.

Lounge Seat Lock Lever.

A lever, placarded SEAT BOTTOM LOCK CONTROL, is located on the inboard side of the lounge seat frame, near the center of the lounge. The lock lever is spring loaded to the locked position, which is indicated by a directional arrow pointing aft. Moving the lock lever forward and into a notch unlocks the seat of the lounge. The lounge seat is hinged at the outboard side and is spring loaded to open several inches when unlocked. The lounge seat may then be raised manually, to gain access to the anti-exposure suit stowage compartment. The lounge seat may be locked down by lifting the lock lever out of the notch and releasing it to the locked position while applying a downward force on the lounge seat.

AUXILIARY EQUIPMENT.

The following auxiliary equipment is described in Section IV.

Pneumatic System.

Cabin Pressurization System.

Air Conditioning System.

Anti-icing and Deicing System.

Communication and Electronic Equipment.

Lighting Equipment.

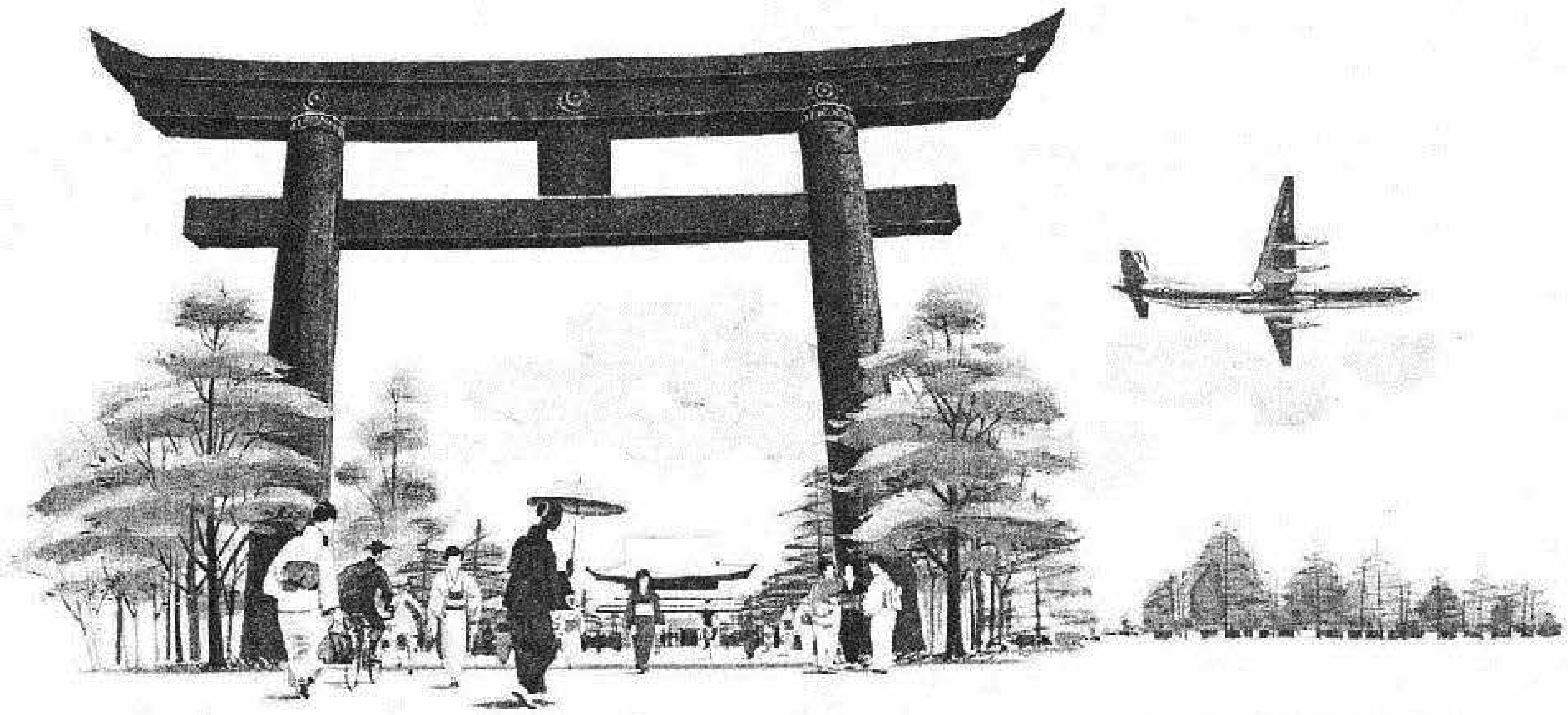
Oxygen System.

Autopilot.

Navigation Equipment.

Cargo Loading Equipment.

Miscellaneous Equipment.



NORMAL PROCEDURES SECTION II

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TABLE OF CONTENTS

PREPARATION FOR FLIGHT.

PROCEDURES REQUIRING COORDINATED ACTIONS.

Certain items and procedures presented in this section are of such nature that they require coordinated actions. Coordinated actions between the pilot, engineer, and scanner/ground controller are indicated by having the item begin on the same line, and by placing the sequence numbers within a circle in the following manner: ⑤. When an item is followed by a crew position designator (i.e. S/GC for Scanner/Ground Controller), the crew member so designated makes his report to the crew member executing the checklist.

In the case of the Scanner/Ground Controller position, this manual implies throughout that the same person will be performing Ground Controller duties while outside of the aircraft, and he will be performing Scanner duties while inside the aircraft.

It should be noted that no attempt is made to have like numbers opposite each other in the columns.

Whenever a checklist item is affected by climatic conditions or hours of darkness, CLIMATIC, or AS REQUIRED will be substituted for the usual action entry. During accomplishment of the checklist, CLIMATIC or AS REQUIRED will not be used in the response; instead, the actual position of the unit will be stated.

FLIGHT RESTRICTIONS.

For aircraft flight restrictions, refer to Section V. For performance restrictions and limitations, refer to *T.O. 1C-133A-1-1.*

FLIGHT PLANNING.

Flight planning data, such as required fuel, airspeed, power settings, etc., needed to complete a mission should be determined (see *T.O. 1C-133A-1-1* for necessary performance data).

TAKEOFF AND LANDING DATA CARDS.

Takeoff and landing data cards are contained in the Pilots' Abbreviated Flight Crew Checklist, *T.O. 1C-133A-(CL)1-1.* Compute the Takeoff and Landing Data Cards as illustrated in the Mission Planning section of *T.O. 1C-133A-1-1.*

WEIGHT AND BALANCE.

Check the aircraft weight and balance (refer to *T.O. 1-1B-40*). Make certain that Form 365F, Weight and Balance Clearance, is satisfactory. Make certain that the grade and quantity of fuel and oil, and any special equipment carried are suited to the mission to be performed. Refer to Section V for aircraft limitations, and check the takeoff and anticipated landing gross weights.

CHECKLISTS.

Each flight crew member is required to use and to make direct reference to the appropriate checklist during aircraft ground and flight operations except during taxi, takeoff, landing, or critical emergencies. In the latter instances, he will review the applicable checklist items either before performing them or afterward, as a cleanup reference.

ENTRANCE.

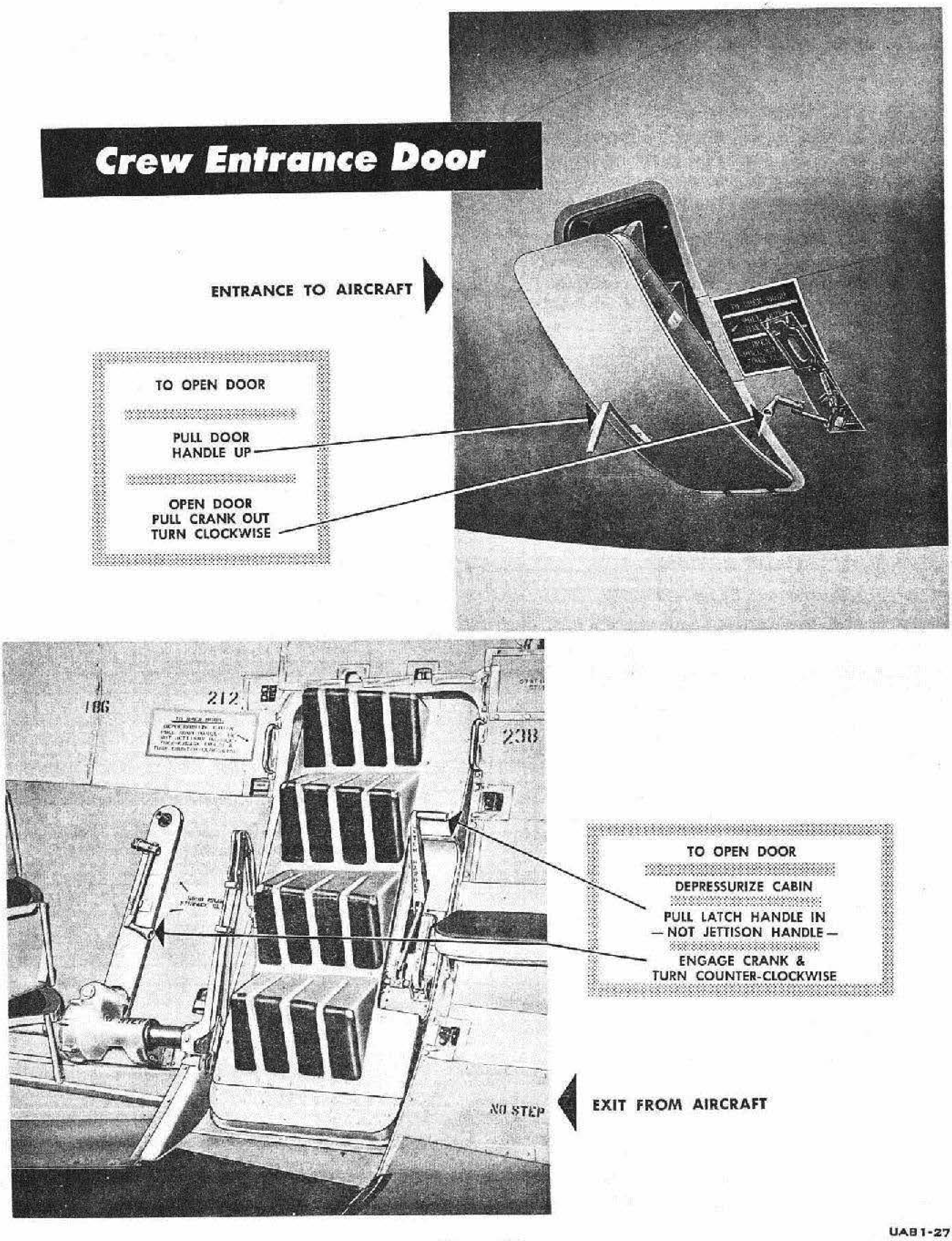
The crew entrance door is located on the lower forward right side of the fuselage. Entrance is gained through the door by unlatching the door and operating the crank (see figure 2-1).

PREFLIGHT CHECK.

AIRCREW VISUAL INSPECTION.

Check the Form 781 for the status of the aircraft. It will be the responsibility of the pilot to insure that the Interior, Exterior, Top-of-Aircraft, and Electrical Power-On inspections are accomplished by the flight engineer before each flight. In addition, it will be the responsibility of the pilot to determine that a Preflight or a Basic Post Flight inspection, as required by *T.O. 1C-133A-6,* has been performed. Only those items iden-

Crew Entrance Door



ENTRANCE TO AIRCRAFT

TO OPEN DOOR

PULL DOOR HANDLE UP

OPEN DOOR PULL CRANK OUT TURN CLOCKWISE

TO OPEN DOOR

DEPRESSURIZE CABIN

PULL LATCH HANDLE IN — NOT JETTISON HANDLE —

ENGAGE CRANK & TURN COUNTER-CLOCKWISE

EXIT FROM AIRCRAFT

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Figure 2-1

tified by an asterisk are required for the Aircrew Thru-Flight Visual Inspection.

Note

> The Aircrew Visual Inspection procedures outlined in this section are based on the assumption that maintenance personnel have completed all requirements contained in *T.O. 1C-133A-6* for Preflight or Basic Post Flight inspection. Therefore, duplicate inspections and operational checks of systems by aircrew members have been eliminated, except for certain items required in the interest of flying safety.

BEFORE EXTERIOR INSPECTION (FLIGHT ENGINEER).

1. Chocks and Landing Gear Safetypins—INSTALLED.

* 2. Form 781—CHECKED.

3. Battery Switch—OFF.

* 4. Propeller Deicing Control Switches—OFF.

* 5. Landing Gear Lever—GEAR DOWN.

6. Trim Tabs—CHECKED.

Check for freedom and set to ZERO.

7. Bailout Alarm Bell and Lights—CHECKED.

★ ★ ★ ★ ★

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLER).

The Electrical Power-On Check is performed from the flight deck, and is coordinated by interphone between the flight engineer (on the flight deck) and the scanner/ground controller. The flight engineer actuates the necessary switches and controls, and the scanner/ground controller reports results by interphone *(see figure 2-2).*

FLIGHT ENGINEER

* 1. External Electrical Power—CONNECTED.

Check that external electrical power unit is operating properly.

2. Voltmeter and Frequency Selector Switch—AUX GENERATOR BATTERY.

* 3. Battery Switch—ON.

* 4. Flight Deck Circuit Breakers—CLOSED (Ignition Circuit Breakers—OPEN).

CAUTION

> Close pitch lock circuit breakers first, then close all other circuit breakers to prevent damage to the propeller mechanism.

* 5. Fuel Quantity—CHECKED.

Push indicator test switches and check for a simultaneous decrease indication on individual and total fuel quantity indicators.

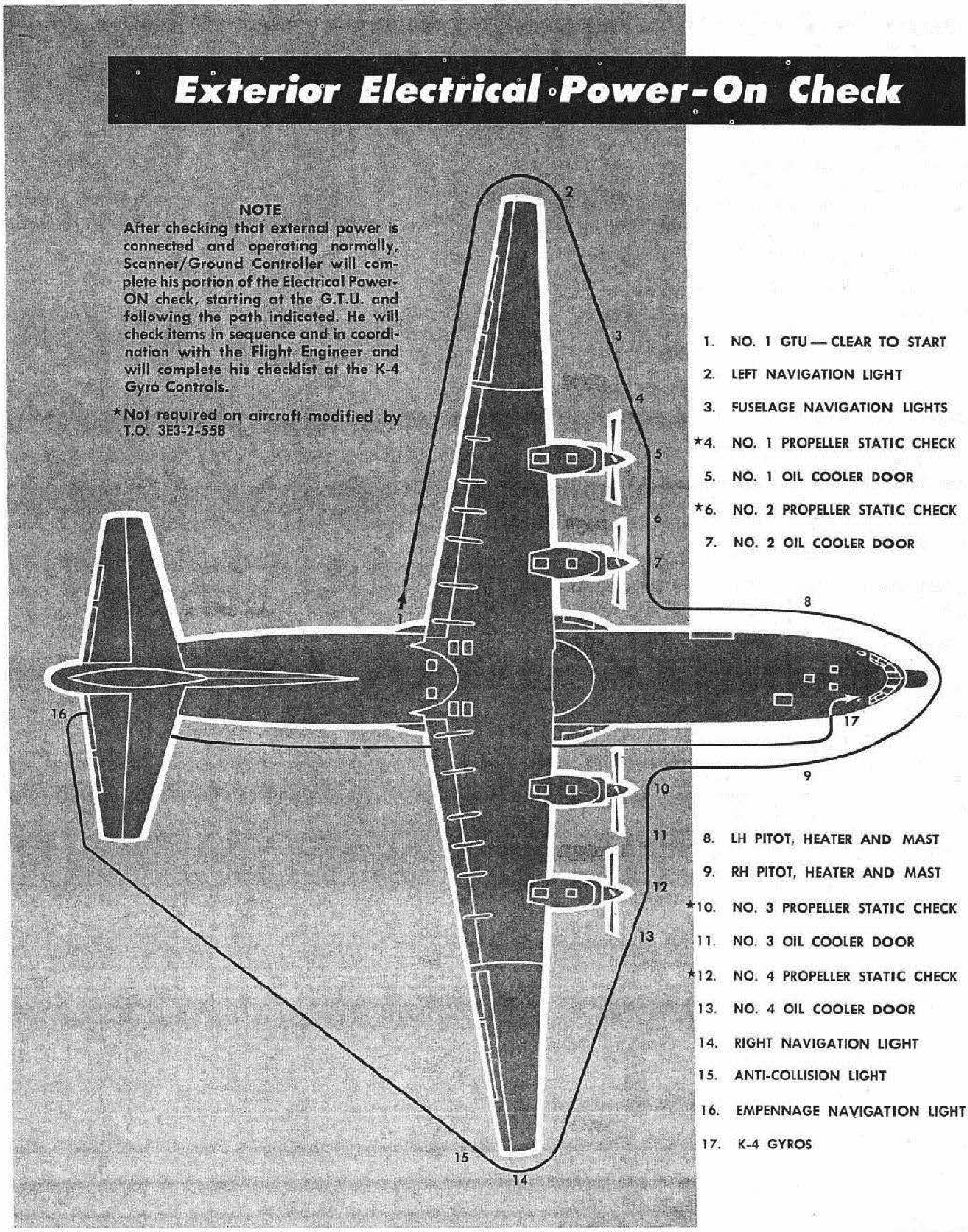
WARNING

> The fuel gages are calibrated for level inflight reading. When the aircraft is on the ground, and all eight tanks are fully serviced, the fuel gages will indicate approximately 2000 pounds more than is actually aboard due to the difference between ground and inflight wing deflection.

SCANNER/GROUND CONTROLLER

(CONTINUED ON PAGE 2-6)

Exterior Electrical Power-On Check



NOTE

After checking that external power is connected and operating normally, Scanner/Ground Controller will complete his portion of the Electrical Power-ON check, starting at the G.T.U. and following the path indicated. He will check items in sequence and in coordination with the Flight Engineer and will complete his checklist at the K-4 Gyro Controls.

*Not required on aircraft modified by T.O. 3E3-2-558

1. NO. 1 GTU — CLEAR TO START
2. LEFT NAVIGATION LIGHT
3. FUSELAGE NAVIGATION LIGHTS
*4. NO. 1 PROPELLER STATIC CHECK
5. NO. 1 OIL COOLER DOOR
*6. NO. 2 PROPELLER STATIC CHECK
7. NO. 2 OIL COOLER DOOR
8. LH PITOT, HEATER AND MAST
9. RH PITOT, HEATER AND MAST
*10. NO. 3 PROPELLER STATIC CHECK
11. NO. 3 OIL COOLER DOOR
*12. NO. 4 PROPELLER STATIC CHECK
13. NO. 4 OIL COOLER DOOR
14. RIGHT NAVIGATION LIGHT
15. ANTI-COLLISION LIGHT
16. EMPENNAGE NAVIGATION LIGHT
17. K-4 GYROS

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Figure 2-2

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLER). *(Continued)*

FLIGHT ENGINEER

6. Alternate Windshield Heat Sensing Switches—NORMAL.

7. Fuel system—PRESSURIZED.

   a. Fuel Boost Pump Switches for Tanks 2 and 7—ON.

   b. All Fuel System Valve Switches—OPEN.

   c. Refueling Valve Switch—CLOSED.

   d. Tank Inlet Valve Switches—CLOSED.

8. Engine Brake Switches—OFF.

9. Engine Starter Switches—PUSH TO START. Switches should stay IN.

10. Engine Brake Switches—ON.

Engine starter switches should pop OUT.

11. Engine Starter Disengage Warning Test Switch—ON.

12. Engine Bleed Valve Governor Override Switches—OFF.

13. Water-Alcohol Injection Switch—OFF.

14. Windshield Anti-Ice Switches—OFF.

15. Jet Blast Rain Removal Switch—OFF.

* 16. Firewall Shutoff Valve Switches—NORMAL.

* 17. Engine Overheat and Fire Control Handles—IN.

* 18. GTU Overheat and Fire Control Handles—IN.

* 19. Engine and GTU Fire and Overheat Detector Systems—CHECKED.

   a. Overheat Warning Test Switch—OVERHEAT.

Check that all fire warning lights are flashing.

   b. Fire Warning Test Switch—AFT FIRE, then FWD FIRE.

Check that all fire warning lights are on and glowing steadily.

Note

A-c power is required when performing a checkout of the GTU fire detector systems.

20. Cockpit Lights—ON, then AS REQUIRED.

SCANNER/GROUND CONTROLLER

(CONTINUED ON NEXT PAGE)

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLER). *(Continued)*

FLIGHT ENGINEER

Check for proper operation of all lights and controls.

21. Emergency Flap Switch—OFF.

*22. Landing Gear Warning Horn and Light—CHECKED.

23. Antiskid System—CHECKED.

   a. Antiskid Switch—OFF.

Check that amber antiskid warning light comes on.

   b. Antiskid Switch—ON.

Check that amber antiskid warning light goes out.

*24. Warning and Indicator Lights—PRESS-TO-TEST.

Note

> At this point, the engineer will move to the engineer's station and perform the following steps.

*25. Warning and Indicator Light —PRESS-TO-TEST.

26. Nacelle Preheat Switches—OFF.

27. Pneumatic Manifold Switches—CLOSED.

* 28. Pneumatic Manifold Overheat Warning—CHECKED.

   a. Pneumatic Manifold Overheat Circuit Test Switch—LEFT WING, then RIGHT WING.

Check that pneumatic manifold overheat warning light comes on, goes out as switch passes through center-off position, and then comes on again.

29. Wing and Empennage Deicing Switches—OFF.

*30. Hydraulic Pump Control Switch—UTILITY.

WARNING

> Before operating the hydraulic system, make certain that all hydraulic controls are in a safe position, and that personnel and equipment are clear of hydraulically operated units. Damage to the aircraft or injury to personnel may result if this care is not exercised.

SCANNER/GROUND CONTROLLER

(CONTINUED ON NEXT PAGE)

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLER). *(Continued)*

FLIGHT ENGINEER	***SCANNER/GROUND CONTROLLER***

31. Pressurization Manual Control Switch—AUTO.

32. Pressurization Test Switch—NORMAL.

33. Emergency Depressurization Test Switch—TEST, then NORMAL.

Check that emergency depressurization indicator shows SAFE, then goes blank.

34. Emergency Depressurization Control Handle—PRESSURIZE.

35. Cabin Pressure Controller—SET.

Set cabin pressure controller to 1000 feet above field elevation.

36. Engine and GTU Anti-Ice Switch—OFF.

Press-to-test ice accretion lights.

37. Flight Deck and Cabin Temperature Selector Controls—NORMAL.

38. Flight Deck and Cabin Temperature Switches—AUTO.

39. Air Conditioning-Ram Ventilation Switch—OFF.

40. Left and Right A-c Generator Switches—OFF.

41. A-c Checklist Annunciator Panel and Caution Light—CHECKED.

On Aircraft AF59-522 and subsequent, set one a-c generator control switch ON to check caution light.

* 42. Takeoff Warning Index Panel—CHECKED.

* 43. Oil Volume Indicators—CHECKED.

44. GTU Air Doors Switch—OPEN.

* 45. Fuel System Preflight Check—COMPLETED.

See Section VII for fuel system management procedures.

Note

The following coordinated items are accomplished with the scanner/ground controller on headset for coordination.

WARNING

Stand clear of danger areas. Failure to do so may cause injury or death *(see figure 2-3).*

(CONTINUED ON NEXT PAGE)

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLER). *(Continued)*

FLIGHT ENGINEER

㊻ No. 1 GTU—CLEAR TO START.

Scanner/ground controller reports "Clear to Start." (S/GC)

WARNING

Before operating the hydraulic system, make certain that all hydraulic controls are in a safe position, and that personnel and equipment are clear of hydraulically operated units. Damage to the aircraft or injury to personnel may result if this care is not exercised.

SCANNER/GROUND CONTROLLER

① No. 1 GTU—CLEAR TO START.

Report "Clear to start" at engineer's request.

(CONTINUED ON PAGE 2-9)

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLED). (*Continued*)

FLIGHT ENGINEER

47. No. 1 GTU—START.

See Section VII for GTU operating procedures, and note hydraulic pressure after GTU has started.

㊽ External Electrical Power Unit Switch—OFF.

Scanner/ground controller reports "External power switch OFF." (S/GC)

CAUTION

> Insure that all electronic equipment such as radar is turned off prior to turning electrical power ON or OFF, to prevent damage to equipment.

49. Auxiliary A-c Generator Switch—Reset, then AUTO.

Monitor load to a maximum of 110-amps, and check the a-c checklist annunciator panel for AUX TO FWD ESS BUS and AUX TO AFT ESS BUS indications.

50. Auxiliary A-c Generator Switch—NON-ESS BUS ON.

51. D-c System—CHECKED.

See Section VII for d-c system checkout procedures.

(52) External Electrical Power Unit Switch—ON.

Scanner/ground controller reports "External Power Unit switch ON." (S/GC)

(53) No. 2 GTU—CLEAR TO START.

Scanner/ground controller reports "Clear to start." (S/GC)

54. No. 2 GTU—START.

See Section VII for GTU operating procedures.

55. Parking Brake—SET.

56. Preoil Engines—IF REQUIRED.

See Section VII for engine preoiling procedures.

Note

> To insure ample lubrication of the propeller shaft reduction gear assemblies and pinion bearings, engines which have been idle for 24 hours or more shall be preoiled prior to starting.

SCANNER/GROUND CONTROLLER

② External Electrical Power Unit Switch—OFF.

Report "External power switch OFF" at engineer's request.

③ External Electrical Power Unit Switch—ON.

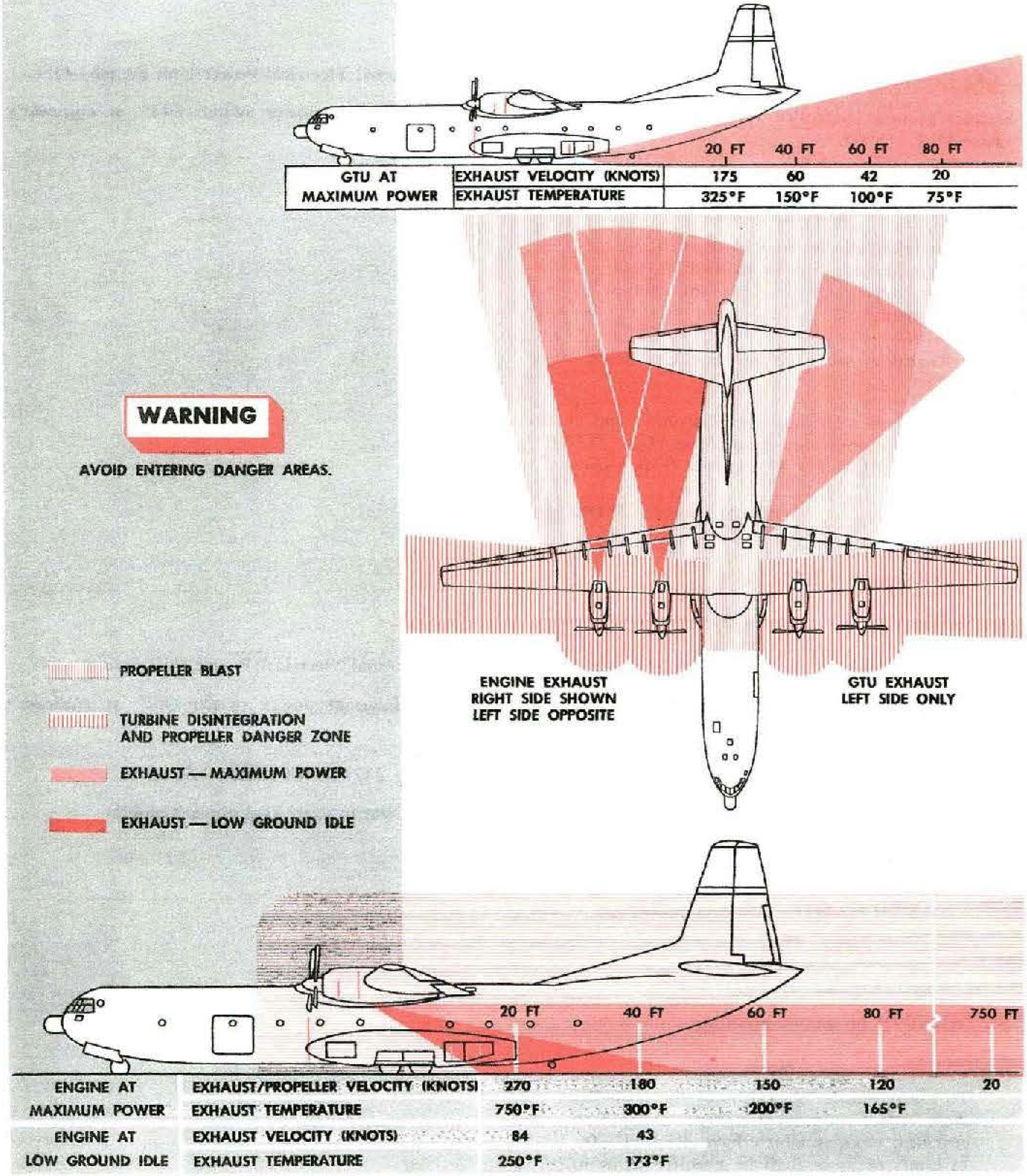
Report "External power switch ON" at engineer's request.

④ No. 2 GTU—CLEAR TO START.

Report "Clear to start" at engineer's request.

(CONTINUED ON PAGE 2-11)

Danger Areas



WARNING

AVOID ENTERING DANGER AREAS.

- ▥ PROPELLER BLAST
- ▥ TURBINE DISINTEGRATION AND PROPELLER DANGER ZONE
- ▨ EXHAUST — MAXIMUM POWER
- 🟥 EXHAUST — LOW GROUND IDLE

		20 FT	40 FT	60 FT	80 FT
GTU AT MAXIMUM POWER	EXHAUST VELOCITY (KNOTS)	175	60	42	20
	EXHAUST TEMPERATURE	325°F	150°F	100°F	75°F

		20 FT	40 FT	60 FT	80 FT	750 FT
ENGINE AT MAXIMUM POWER	EXHAUST/PROPELLER VELOCITY (KNOTS)	270	180	150	120	20
	EXHAUST TEMPERATURE	750°F	300°F	200°F	165°F	
ENGINE AT LOW GROUND IDLE	EXHAUST VELOCITY (KNOTS)	84	43			
	EXHAUST TEMPERATURE	250°F	173°F			

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Figure 2-3

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLER). *(Continued)*

FLIGHT ENGINEER	***SCANNER/GROUND CONTROLLER***
57. Wing and Empennage Deicing Systems—CHECKED AS REQUIRED. **Note** Ground operational check of the wing and empennage deicing systems is required only prior to flights into known or anticipated icing conditions (see Section IV, anti-icing and deicing systems).	
58. No. 1 GTU—STOP. See section VII for normal shutdown procedures, and note hydraulic pressure after GTU stops.	
59. No. 2 GTU—STOP. See section VII for normal shutdown procedures.	
(60) Left Navigation Light—CHECKED. Set switch to FLASH, STEADY, and OFF. Scanner/ground controller reports "Checked." (S/GC)	⑤ Left Navigation Light—CHECKED. As engineer sets switch to FLASH, STEADY, and OFF, check operation and condition of navigation light, and report "Checked."
(61) Fuselage Navigation Lights—CHECKED. Set switch to FLASH, STEADY, and OFF. Scanner/ground controller reports "Checked." (S/GC)	⑥ Fuselage Navigation Lights—CHECKED. As engineer sets switch to FLASH, STEADY, and OFF, check operation and condition of navigation lights, and report "Checked."
(62) No. 1 Propeller Static Check—COMPLETED (S/GC). (Aircraft without T.O. 3E3-2-558.) **Note** Propeller Static Check, steps 62, 64, 68, and 70 (scanner/ground controllers steps 7, 9, 13, and 15) is not required on aircraft modified by T.O. 3E3-2-558.	⑦ No. 1 Propeller Static Check—COMPLETED. (Aircraft without T.O. 3E3-2-558.)
(63) No. 1 Oil Cooler Door—CHECKED. Position No. 1 oil cooler door switch to OPEN, CLOSE, and AUTO. Scanner/ground controller reports "Checked." (S/GC) **CAUTION** Do not hold the oil cooler door switch in the OPEN or CLOSE position longer than 1 minute in any 10 minute period; otherwise, internal damage to the electrical actuator may occur.	⑧ No. 1 Oil Cooler Door—CHECKED. As engineer positions switch to OPEN, CLOSE, and AUTO, check for proper operation of the No. 1 oil cooler door, and report "Checked."
(64) No. 2 Propeller Static Check—COMPLETED (S/GC). (Aircraft without T.O. 3E3-2-558). See section VII for propeller static check procedures.	⑨ No. 2 Propeller Static Check—COMPLETED. (Aircraft without T.O. 3E3-2-558).

(CONTINUED ON NEXT PAGE)

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLER). *(Continued)*

FLIGHT ENGINEER	**SCANNER/GROUND CONTROLLER**
(65) No. 2 Oil Cooler Door—CHECKED. Position No. 2 oil cooler door switch to OPEN, CLOSE, and AUTO. Scanner/ground controller reports "Checked." (S/GC) **CAUTION** Do not hold the oil cooler door switch in the OPEN or CLOSE position longer than 1 minute in any 10-minute period; otherwise, internal damage to the electrical actuator may occur.	⑩ No. 2 Oil Cooler Door—CHECKED. As engineer positions switch to OPEN, CLOSE, and AUTO, check for proper operation of the No. 2 oil-cooler door, and report "Checked."
(66) Left Pitot Heater and Mast and Warning Lights—CHECKED. Set pitot heater switch to ON and OFF, and check warning lights. Scanner/ground controller reports "Checked." (S/GC)	11. Left Pitot Heater and Mast—CHECKED. When engineer sets switch to ON, check that pitot heater and mast become hot, and report "Checked."
(67) Right Pitot Heater and Mast and Warning Lights—CHECKED. Set pitot heater switch to ON and OFF, and check warning lights. Scanner/ground controller reports "Checked."	⑫ Right Pitot Heater and Mast—CHECKED. When engineer sets switch to ON, check that pitot heater and mast become hot, and report "Checked."
(68) No. 3 Propeller Static Check—COMPLETED (S/GC). (Aircraft without T.O. 3E3-2-558.) See section VII for propeller static check procedures.	⑬ No. 3 Propeller Static Check—COMPLETED. (Aircraft without T.O. 3E3-2-558)
(69) No. 3 Oil Cooler Door—CHECKED. Position No. 3 oil cooler door switch to OPEN, CLOSE, and AUTO. Scanner/ground controller reports "Checked." (S/GC) **CAUTION** Do not hold the oil cooler door switch in the OPEN or CLOSE position longer than 1 minute in any 10-minute period; otherwise, internal damage to the electrical actuator may occur.	⑭ No. 3 Oil Cooler Door—CHECKED. As engineer positions switch to OPEN, CLOSE, and AUTO, check for proper operation of the No. 3 oil-cooler door, and report "Checked."
(70) No. 4 Propeller Static Check—COMPLETED (S/GC). (Aircraft without T.O. 3E3-2-558) See section VII for propeller static check procedures.	⑮ No. 4 Propeller Static Check—COMPLETED. (Aircraft without T.O. 3E3-2-558).

(CONTINUED ON NEXT PAGE)

ELECTRICAL POWER-ON CHECK (FLIGHT ENGINEER AND SCANNER/GROUND CONTROLLER). *(Continued)*

FLIGHT ENGINEER	***SCANNER/GROUND CONTROLLER***
(71) No. 4 Oil Cooler Door—CHECKED.	⑯ No. 4 Oil Cooler Door—CHECKED.
Position No. 4 oil cooler door switch to OPEN, CLOSE, and AUTO. Scanner/ground controller reports "Checked." (S/GC)	As engineer positions switch to OPEN, CLOSE, and AUTO, check for proper operation of the No. 4 oil cooler door, and report "Checked."
CAUTION Do not hold the oil cooler door switch in the OPEN or CLOSE position longer than 1 minute in any 10 minute period; otherwise, internal damage to the electrical actuator may occur.	
(72) Right Navigation Light—CHECKED.	⑰ Right Navigation Light—CHECKED.
Set switch to FLASH, STEADY, and OFF. Scanner/ground controller reports "Checked." (S/GC)	As engineer sets switch to FLASH, STEADY, and OFF, check operation and condition of the navigation light, and reports "Checked."
(73) Anticollision Light—CHECKED.	⑱ Anticollision Light—CHECKED.
Set anticollision light switch to ON and OFF. Scanner/ground controller reports "Checked." (S/GC)	As engineer sets switch to ON and OFF, check operation and condition of the anticollision light, and report "Checked."
(74) Empennage Navigation Lights—CHECKED.	⑲ Empennage Navigation Lights—CHECKED.
Set switch to FLASH, STEADY, and OFF. Scanner/ground controller reports "Checked." (S/GC)	As engineer sets switch to FLASH, STEADY, and OFF, check operation and condition of the navigation light, and report "Checked."
75. Condition Levers—FUEL OFF.	
76. Auxiliary Feathering Switches—NORMAL.	
(77) K4 Gyros—CHECKED (S/GC).	⑳ K4 Gyros—CHECKED.
Observe pilot's and copilot's attitude indicators while the scanner/ground controller rotates the control boxes. Both indicators must indicate both pitch and roll movement.	Rotate the K4 gyro control boxes fore and aft, and left and right.

★ ★ ★ ★ ★

EXTERIOR INSPECTION (FLIGHT ENGINEER).

The following inspection procedures are keyed to figure 2-4. Inspect the aircraft in accordance with the following items and in the order shown on figure 2-4.

I Crew Entrance Door to Right Pod.

1. Crew Entrance Door—CONDITION.

* 2. Exterior Skin—CONDITION.

3. Right Aft Static Ports and Pressure Drains—CLEAR.

II Right Pod Area.

* 1. Single Point Refueling Adapter and Cap—SECURED.

* 2. Main Gear Struts, Tires, Wheels, Doors, and Linkage—CONDITION.

* 3. Water-Alcohol Injection Tank—FLUID QUANTITY.

Fluid must be visible above filler neck screen.

* 4. Pod Access and Inspection Doors—CLOSED & SECURED.

III Lower Wing Surface—Right Side—Fuselage—Outboard Engine.

* 1. Exterior Skin—CONDITION & LEAKS.

* 2. Access and Inspection Doors—CLOSED & SECURED.

IV Engines—Right Side.

* 1. Cleanliness—FUEL & OIL LEAKS.

* 2. Cowling—SECURED.

* 3. Propellers—BLADE ANGLE, LEAKS, & CONDITION.

V Lower Wing Surface—Right Side—Outboard Engine—Wing Tip—Fuselage.

* 1. Exterior Skin—CONDITION & LEAKS.

* 2. Landing Light—CONDITION.

* 3. Vortex Generators—CONDITION.

* 4. Static Eliminators—CONDITION.

* 5. Aileron and Tabs—CONDITION & POSITION.

* 6. Wing Flaps—CONDITION.

* 7. Access and Inspection Doors—CLOSED & SECURED.

* 8. Tail Pipes—CONDITION.

VI Fuselage—Right Side—Pod—Empennage.

* 1. Exterior Skin—CONDITION.

* 2. Tail Bumper—CONDITION.

* 3. Rear Cargo Door and Ramp—CONDITION.

* 4. Emergency Depressurization Door—CLOSED.

VII Empennage.

* 1. Deicer Boots—CONDITION.

* 2. Access and Inspection Doors—CLOSED & SECURED.

* 3. Control Surfaces and Tabs—CONDITION & POSITION.

* 4. Static Eliminators—CONDITION.

* 5. Vortex Generators—CONDITION.

VIII Fuselage—Left Side—Empennage—Pod.

* 1. Exterior Skin—CONDITION.

* 2. Access and Inspection Doors—CLOSED & SECURED.

IX Lower Wing Surface—Left Side—Fuselage—Wing Tip—Outboard Engine.

* 1. Tail Pipes—CONDITION.

* 2. Access and Inspection Doors—CLOSED & SECURED.

* 3. Wing Flaps—CONDITION.

* 4. Aileron and Tabs—CONDITION & POSITION.

* 5. Static Eliminators—CONDITION.

* 6. Vortex Generators—CONDITION.

* 7. Landing Light—CONDITION.

* 8. Exterior Skin—CONDITION & LEAKS.

X Engines—Left Side.

* 1. Cleanliness—FUEL & OIL LEAKS.

* 2. Cowling—SECURED.

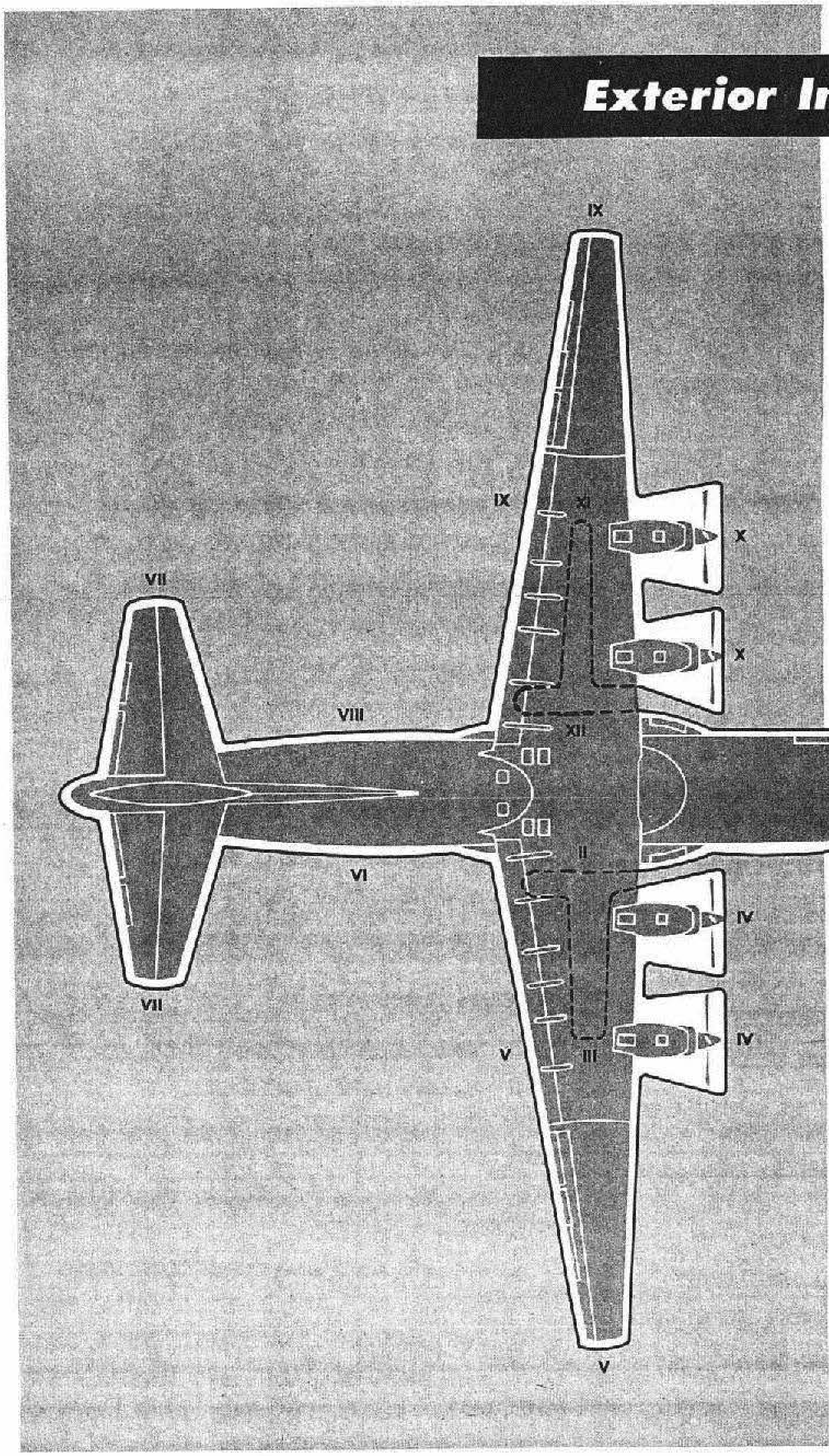
* 3. Propellers—BLADE ANGLE, LEAKS, & CONDITION.

XI Lower Wing Surface—Left Side—Outboard Engine—Fuselage.

* 1. Exterior Skin—CONDITION & LEAKS.

* 2. Access and Inspection Doors—CLOSED & SECURED.

Exterior Inspection



I CREW ENTRANCE DOOR TO RIGHT POD
II RIGHT POD AREA
III LOWER WING SURFACE — RIGHT SIDE — FUSELAGE — OUTBOARD ENGINE
IV ENGINES — RIGHT SIDE
V LOWER WING SURFACE — RIGHT SIDE — OUTBOARD ENGINE — WING TIP — FUSELAGE
VI FUSELAGE — RIGHT SIDE — POD — EMPENNAGE
VII EMPENNAGE
VIII FUSELAGE — LEFT SIDE — EMPENNAGE — POD
IX LOWER WING SURFACE — LEFT SIDE — FUSELAGE — WING TIP — OUTBOARD ENGINE
X ENGINES — LEFT SIDE
XI LOWER WING SURFACE — LEFT SIDE — OUTBOARD ENGINE — FUSELAGE
XII LEFT POD AREA
XIII LEFT POD TO CREW ENTRANCE DOOR

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Figure 2-4

XII Left Pod Area.

* 1. Fire Extinguishing Agent Containers—CONDITION & PRESSURE.

* 2. Auxiliary Hydraulic Pump—CONDITION.

* 3. Gas Turbine Units:

  a. Oil Quantity—CHECKED & FILLER CAPS SECURED.

  b. Electrical Wires—CONDITION.

  c. Tubing—CONDITION.

* 4. Battery—CONDITION, CONNECTION, & SAFETIED.

5. Air Doors—CONDITION.

* 6. Main Gear Struts, Tires, Wheels, Doors, and Linkage—CONDITION.

* 7. Access and Inspection Doors—CLOSED & SECURED.

* 8. Air Driven Generator Door—CLOSED.

XIII Left Pod to Crew Entrance Door.

* 1. Exterior Skin—CONDITION.

* 2. Side Cargo Door—CONDITION & CLOSED.

3. Left Aft Static Ports—CLEAR.

* 4. Oxygen Filler Vent Valve—CLOSED & DOOR SECURED.

5. Angle of Attack Transmitter—CONDITION.

6. Left Forward Static Ports—CLEAR.

* 7. Nosewheel Compartment—CONDITION.

* 8. Nose Tire and Strut—INFLATION & CONDITION.

* 9. Static Ground Wire—CONDITION.

* 10. Taxi Lights and Nose Landing Light—CONDITION.

* 11. Nose Gear Doors—CONDITION.

* 12. Radome—CONDITION & SECURITY.

* 13. Nose Access Doors—CLOSED & SECURED.

14. Right Forward Static Ports—CLEAR.

INTERIOR INSPECTION (FLIGHT ENGINEER).

The following inspection procedures are keyed to figure 2-5. Inspect the aircraft in accordance with the following items and in the order shown on figure 2-5.

I Flight Deck and Relief Crew Compartment.

1. Lights—CONDITION.

* 2. Oxygen System—CONDITION & QUANTITY.

* 3. Portable Oxygen Equipment—CONDITION, PRESSURE & STOWED.

4. Cockpit Windows—CLEANLINESS & CONDITION.

5. Portable Fire Extinguisher—CONDITION & CHARGE.

6. Night Curtains—AS REQUIRED.

7. Fuel Dump Lever—SECURED.

8. Impact Emergency Lights—CHECKED.

9. Aldis Lamp—CHECKED, then STOWED.

10. Escape Rope—SECURED & STOWED.

11. Liferaft Release Handle—SAFETIED.

12. First Aid Kits—STOWED.

13. Publications—CHECKED.

14. Fire Axe—STOWED.

II B and C Compartments.

1. Equipment—CONDITION.

2. Plumbing—CONDITION.

3. Conduits and Cables—CONDITION.

III Cargo Compartment.

* 1. Interior Lighting—CONDITION.

2. Lavatory Facilities—CHECKED.

3. Nose Gear Emergency Release Handle—IN & SAFETIED.

* 4. Portable Oxygen Equipment—CONDITION, PRESSURE, & STOWED.

5. Portable Fire Extinguisher—CONDITION & CHARGE.

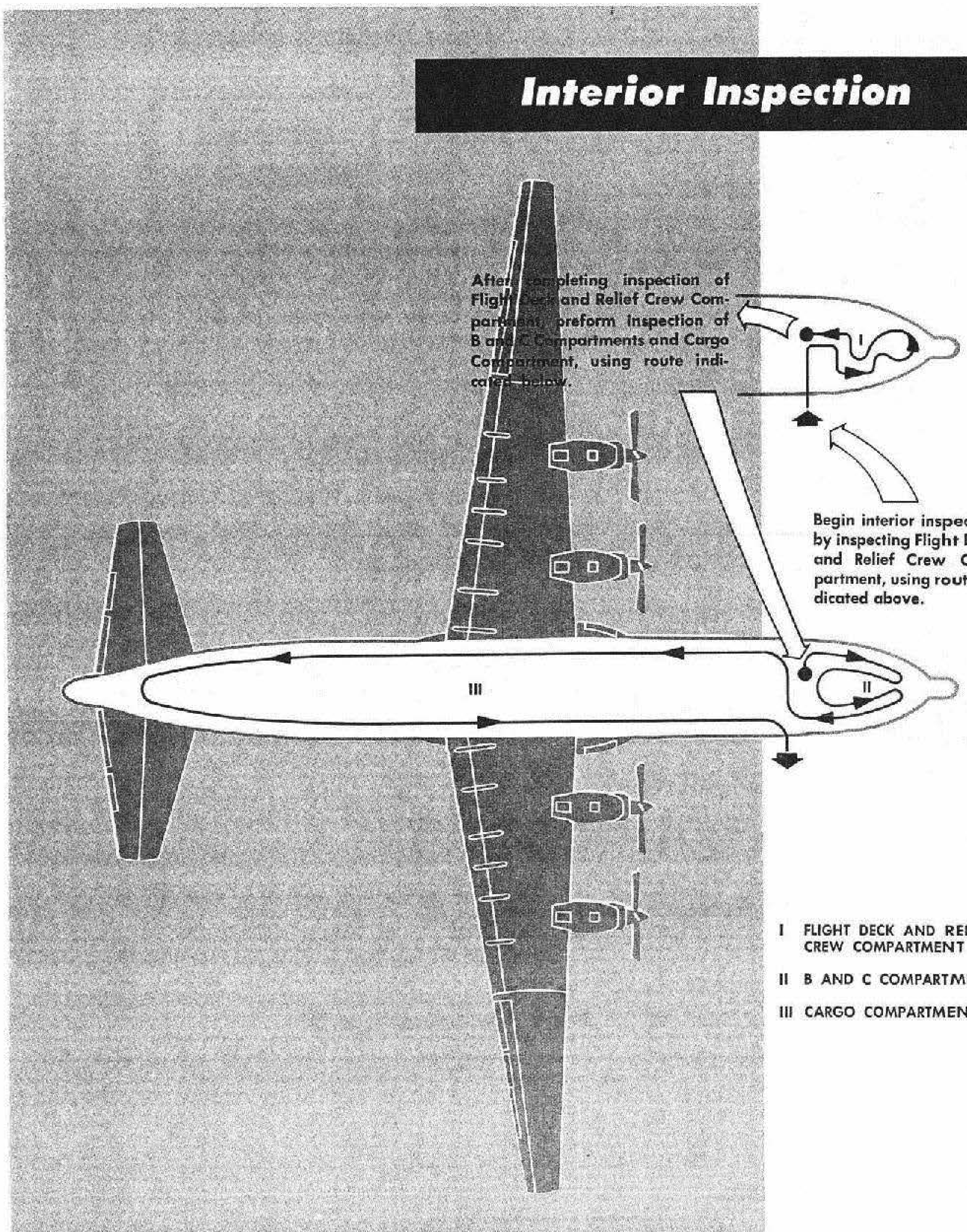
* 6. Fuel Dipstick—CONDITION & STOWED.

7. Side Cargo Door Emergency Air Pressure—CHECKED.

8. Forward Ladder—STOWED.

9. Air Driven Generator Release Handle—SAFETIED.

Interior Inspection



After completing inspection of Flight Deck and Relief Crew Compartment, preform inspection of B and C Compartments and Cargo Compartment, using route indicated below.

Begin interior inspection by inspecting Flight Deck and Relief Crew Compartment, using route indicated above.

I FLIGHT DECK AND RELIEF CREW COMPARTMENT

II B AND C COMPARTMENTS

III CARGO COMPARTMENT

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Figure 2-5

10. Left Main Gear Emergency Release and Selector Handles—IN & SAFETIED.

* 11. Left Center Fuselage Power Panels—CHECKED.

* 12. Hydraulic Panel—CHECKED (Fluid level, leaks, drip pan drain closed).

13. Rear Cargo Door Emergency Air Pressure—CHECKED.

14. Emergency Depressurization Door—CLOSED.

15. Jettisoning Safety Harnesses—STOWED.

16. Portable Fire Extinguisher—CONDITION & CHARGE.

17. Fire Axe—STOWED.

* 18. Rear Wing Spar Area—LEAKS & CONDITION.

* 19. Right Center Fuselage Power Panels—CHECKED.

20. Right Main Gear Emergency Release Handles—IN & SAFETIED.

* 21. Cargo and Loose Equipment—SECURED.

* 22. Cargo Compartment—GENERAL CONDITION (Windows clean).

* 23. Side Cargo Door—CLOSED, LOCKED, & PINS INSTALLED.

* 24. Rear Cargo Ramp and Door—CHECKED (Condition, closed and locked, control valves neutral).

* 25. Load Jack and Ramp Toes—STOWED.

TOP-OF-AIRCRAFT INSPECTION (FLIGHT ENGINEER).

WARNING

All necessary safety precautions should be observed. Access to the top of aircraft will not be through the crew escape hatch. Conducting this inspection during high winds or other severe weather conditions can be dangerous. Under these circumstances, the pilot may waive items 1 through 8 of this inspection.

Conduct a top-of-aircraft inspection as outlined in figure 2-6.

* 1. Liferaft Compartments and Inspection Doors—CLOSED & SECURED.

* 2. Fuel Filler Caps and Dipstick Caps—SECURED.

* 3. Wings, Ailerons, Flaps, and Vortex Generators—CONDITION.

* 4. Wing Leading Edge Crawlways—CONDITION (Check through each nacelle access door).

* 5. Nacelles—CONDITION.

* 6. Oil Tanks—CAPS SECURE.

* 7. Engine Fire Extinguisher Containers (No. 2 Nacelle)—CONDITION & PRESSURE.

* 8. Cowling, Access and Inspection Doors—SECURED.

* 9. Cabin Escape Hatches—CLOSED & LOCKED.

10. Cabin Liferaft Release Handles—IN & SAFETIED.

* 11. Cabin Escape Ladders—IN PLACE (If feasible).

12. Liferaft Viewing Windows—CHECK LIFERAFT INSTALLATION.

13. Cabin Escape Ropes—CHECKED & STOWED.

★ ★ ★ ★ ★

BEFORE STARTING ENGINES.

WARNING

Stand clear of danger areas. Failure to do so may cause injury or death *(see figure 2-3)*.

(CONTINUED ON PAGE 2-20)

Top-of-Aircraft Inspection

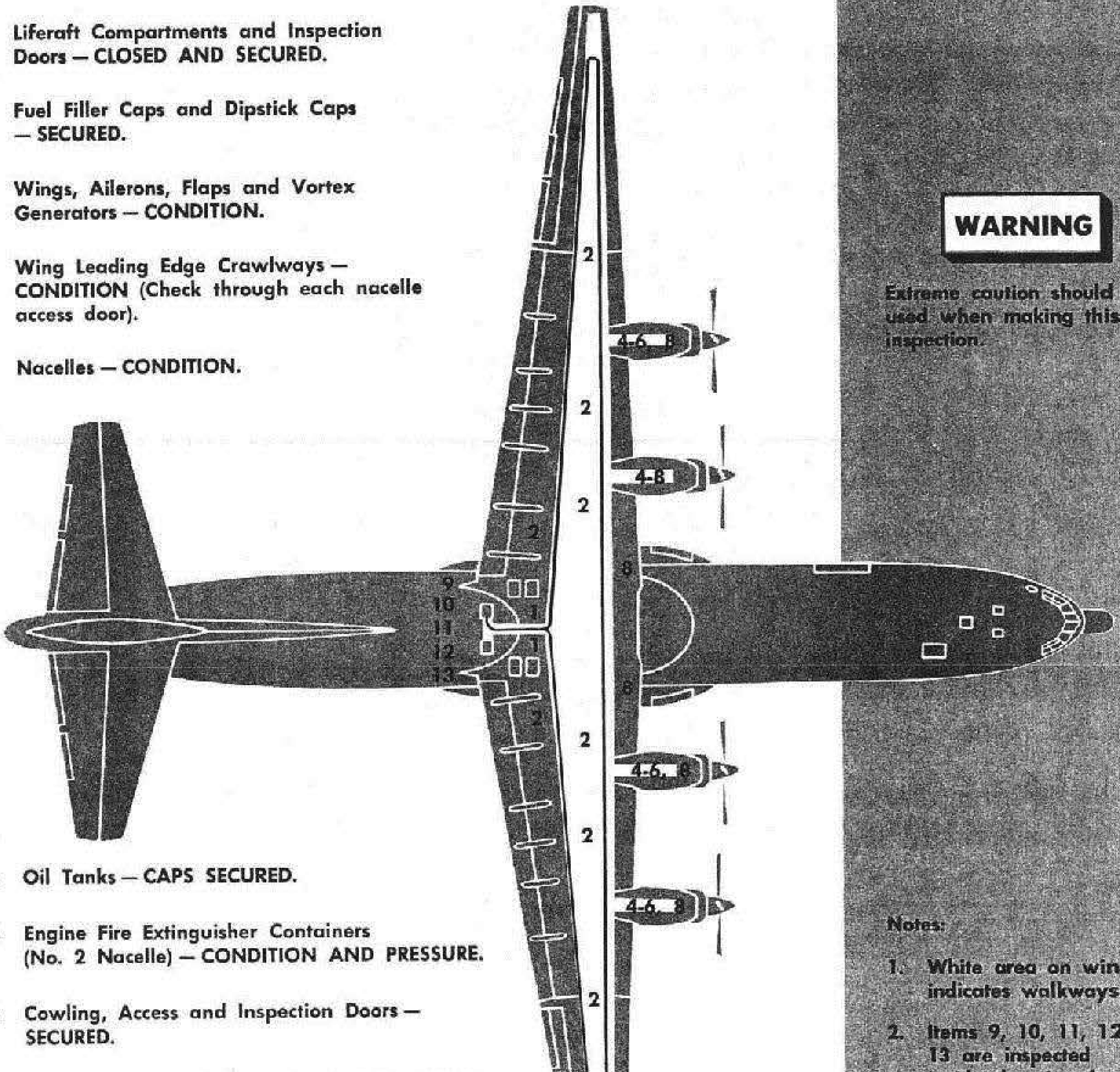
*1. Liferaft Compartments and Inspection Doors — CLOSED AND SECURED.

*2. Fuel Filler Caps and Dipstick Caps — SECURED.

*3. Wings, Ailerons, Flaps and Vortex Generators — CONDITION.

*4. Wing Leading Edge Crawlways — CONDITION (Check through each nacelle access door).

*5. Nacelles — CONDITION.



*6. Oil Tanks — CAPS SECURED.

*7. Engine Fire Extinguisher Containers (No. 2 Nacelle) — CONDITION AND PRESSURE.

*8. Cowling, Access and Inspection Doors — SECURED.

*9. Cabin Escape Hatches — CLOSED AND LOCKED.

10. Cabin Liferaft Release Handles — IN AND SAFETIED.

*11. Cabin Escape Ladders — IN PLACE (if feasible).

12. Liferaft Viewing Windows — CHECK LIFERAFT INSTALLATION.

13. Cabin Escape Ropes — CHECKED AND STOWED.

WARNING

Extreme caution should be used when making this inspection.

Notes:

1. White area on wing indicates walkways.
2. Items 9, 10, 11, 12, and 13 are inspected inside the aircraft.
3. Those items identified by an asterisk are required for the Aircrew Thru-Flight Visual Inspection.

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Figure 2-6

BEFORE STARTING ENGINES. *(Continued)*

PILOTS

1. Aircrew Visual Inspections—COMPLETED (P).

Indicates all crew members have completed their visual inspections.

2. Forms 781 and 365F—CHECKED & SIGNED (P).

Preflight or Basic Post Flight inspection performed (see T.O. 1C-133A-6), and weight and balance within limits.

3. Performance Data — COMPUTED (P).

Data checked, and verified as computed.

④ Oxygen Equipment — CHECKED (CP, P, E, N).

See Section IV for oxygen equipment check procedures.

5. Seats and Rudder Pedals—ADJUSTED (CP, P).

6. Surface Snubber Lever — UNLOCKED (P).

CAUTION

To prevent damage to the flight control mechanism during windy conditions, the pilot should apply a firm pressure to the controls prior to unlocking the snubbers.

7. Nose Gear Steering Bypass Valve Release Handle — PULLED (P).

⑧ Flight Controls—CHECKED & FREE (P,S/GC).

Scanner/ground controller reports individual control surface and tab movement when directed by pilot.

FLIGHT ENGINEER

1. Circuit Breakers—CLOSED.

2. Autopilot Power Switch — NORMAL.

3. External Electrical Power Unit—CONNECTED & OPERATING.

Note

If no external power is available, start No. 1 GTU first.

4. Battery Switch—OFF.

Check voltage, then set switch ON.

⑤ Oxygen Equipment — CHECKED.

⑥ No. 2 GTU—START.

Start GTU after receiving "Clear to start" from scanner/ground controller. (S/GC)

7. Hydraulic Pressure — NORMAL.

⑧ No. 1 GTU—START.

Start GTU after receiving "Clear to start" from scanner/ground controller. (S/GC)

9. No. 2 GTU Start-Run-Stop Switch—START, then RUN.

Set switch to START momentarily, note hydraulic pressure, then set to RUN.

10. Auxiliary A-c Generator Switch — RESET, then NON-ESS BUS ON.

⑪ External Electrical Power—DISCONNECTED (S/GC).

12. Electrical Power—CHECK.

Using voltmeter and frequency selector switch, check a-c and d-c buses.

SCANNER/GROUND CONTROLLER

① No. 2 GTU — CLEAR TO START.

After insuring GTU exhaust area is clear, report "Clear to start."

② No. 1 GTU — CLEAR TO START.

After insuring GTU exhaust area is clear, report "Clear to start."

③ External Electrical Power—DISCONNECTED.

④ Flight Controls—CHECKED & FREE.

Report individual control surface and tab movement when directed by pilot.

(CONTINUED ON NEXT PAGE)

BEFORE STARTING ENGINES. *(Continued)*

PILOTS

Note

> At times, the flight controls cannot be checked adequately prior to starting the engines due to a crosswind or tailwind. When this occurs, the control check may be postponed until the aircraft is headed into the wind. Under these conditions, after the engines are running, the controls may be checked by the scanner/ground controller in the crew escape hatch.

9. Nose Gear Steering Bypass Valve Release Handle—IN (P).

10. Hydraulic and Emergency Airbrake Pressure—WITHIN LIMITS (CP).

Copilot answers "Within limits," indicating that pressures are within tolerances.

11. Parking Brake—SET (P).

To set parking brake, the pedals must be fully depressed.

⑫ Chocks and Landing Gear Safety Pins—REMOVE (P, S/GC).

Pilot directs scanner/ground controller to remove chocks and landing gear safety pins. Scanner/ground controller reports "Removing chocks and pins." (S/GC)

13. Navigation and Cockpit Light Controls — AS REQUIRED (CP, P).

Note

> Use of the anticollision light on the ground should be kept to a minimum for best bulb life, and to avoid confusion with ground emergency vehicles.

14. Radios—CHECKED & SET AS REQUIRED (CP).

FLIGHT ENGINEER

13. GTU Pneumatic Selector Switches—LOAD.

14. Pneumatic Manifold Switches—OPEN.

15. Nacelle Preheat —CLIMATIC.

See Section IX for operation of nacelle preheat system.

16. Fuel Boost Pump Switches —SET.

Tank No. 2, both ON; tank No. 7, both ON; tanks Nos. 1, 3, 4, 5, 6, and 8 OFF.

CAUTION

> Those fuel boost pumps supplying fuel to the engines should be ON during all engine operation. Even though engine operation may appear normal with the fuel boost pumps off, this practice may reduce the useful life of the engine pumping elements.

17. Fuel Pressure Warning Lights—OFF.

18. Air Conditioning-Ram Ventilation Switch—OFF.

SCANNER/GROUND CONTROLLER

⑤ Chocks and Landing Gear Safety Pins—REMOVE.

Remove chocks and landing gear safety pins when directed by pilot, and report "Removing chocks and pins."

(CONTINUED ON NEXT PAGE)

BEFORE STARTING ENGINES. *(Continued)*

PILOTS	FLIGHT ENGINEER	SCANNER/GROUND CONTROLLER
Note A minimum of one radio will be tuned to the tower. Turn ON and set such additional navigational equipment as required for the mission.		
15. Static Source Selectors—PRIMARY (CP, P).		
16. Oil Cooler Door Switches—AUTO (CP).		
17. Windshield Anti-Ice Switches—NORMAL (P).		
⑱ Scanner/Ground Controller's Report—"SCANNER/GROUND CONTROLLER'S BEFORE STARTING ENGINES CHECK COMPLETED." (S/GC)		⑥ Scanner/Ground Controller's Report—"SCANNER/GROUND CONTROLLER'S BEFORE STARTING ENGINES CHECK COMPLETED." Pitot covers, tail supports, gear pins and chocks have been removed, fire guard is in place. Clear to start engines.
19. Engine Brake Switches—OFF (P).		
⑳ Engineer's Report—"ENGINEER'S BEFORE STARTING ENGINES CHECK COMPLETED." (E).	⑲ Engineer's Report—"ENGINEER'S BEFORE STARTING ENGINES CHECK COMPLETED."	
21. "Before Starting Engines Check—COMPLETED" (CP).		

STARTING ENGINES.

For all engine starts the pneumatic manifold switches must be OPEN, and the jet blast rain removal and nacelle preheat switches must be OFF. It is recommended that the engines be started in the following order: 1-2-3-4.

Prior to starting each engine, the pilot will identify the engine to be started by stating, "No. .... clear." The scanner/ground controller will acknowledge, "No. .... clear." After the scanner/ground controller has reported the engine clear, the pilot will depress the respective engine starter switch, and state, "Turning No. ....." The scanner/ground controller will report, "No. .... turning." This complete procedure will be followed for each individual engine.

PILOTS	FLIGHT ENGINEER
1. Engines—STARTING (P).	

Start engines as follows:

(CONTINUED ON NEXT PAGE)

STARTING ENGINES. *(Continued)*

PILOTS

a. Engine Starter Switch—PUSH TO START (Engine being started).

b. Condition Lever—RUN-FUEL ON.

Set lever to RUN-FUEL ON after engine oil pressure rises, and engine tachometer indicates 10 percent rpm.

c. Fuel Flow Indicator—CHECK FOR INDICATION OF FUEL FLOW.

See Section V for starting fuel flow schedule.

d. EGT or TIT Indicator—CHECK FOR RISE.

CAUTION

To avoid overtemperatures in the engine turbine section seals, and to hold the metal temperatures of the turbine to reasonable values, it is desirable not to exceed 1 minute from engaging the starter to attaining GROUND IDLE rpm. To avoid damage to the starter, in no case should starting time exceed 2 minutes. Whenever the engine fails to start within 2 minutes, discontinue the start and allow a cooling period of at least 30 seconds before attempting another start.

e. Ground Idle Speed Control Switch — LO IDLE.

Set switch to LO IDLE when engine tachometer indicates 20 percent rpm, or above.

f. Engine Starter Switch (next engine)—PUSH TO START.

Note

To prevent an unnecessary surge on the pneumatic system, when the engine being started reaches approximately 40 percent rpm, engage starter for next engine.

CAUTION

The starter should disengage automatically at approximately 48 or 56 percent engine rpm, depending on the type of starter installed. If the starter does not disengage prior to reaching 55 percent engine rpm, pilot will manually pull the engine starter switch.

FLIGHT ENGINEER

(CONTINUED ON NEXT PAGE)

STARTING ENGINES. *(Continued)*

PILOTS

FLIGHT ENGINEER

g. Starter Disengage Warning Light—OFF.

CAUTION

If the starter disengage warning light remains on after the engine starter switch is pulled, a failure of the starter shutoff valve is indicated. The affected engine should be shut down, the pneumatic manifold switch set to CLOSE, and the starter shutoff valve checked for proper operation.

h. Engine Instruments—CHECKED.

SATISFACTORY START.

If all of the following conditions have been met, the engine has started satisfactorily.

a. Engine acceleration fuel flow normal (see Section V for desired schedule).

b. Light-up takes place within approximately 15 to 20 seconds after the condition lever has been placed in the RUN-FUEL ON position.

c. Engine accelerates to GROUND IDLE rpm within 2 minutes.

d. EGT or TIT does not exceed limits during the transition to GROUND IDLE rpm.

e. EGT or TIT stabilizes within limits after GROUND IDLE rpm is reached.

f. Oil Pressure is within limits at GROUND IDLE rpm.

g. Repeat the starting procedures for engines 2, 3, and 4.

CAUTION

Do not exceed HIGH GROUND IDLE rpm when engine oil temperature is below 25°C.

UNSATISFACTORY START.

An unsatisfactory start has occurred if one or more of the following conditions take place.

(CONTINUED ON NEXT PAGE)

STARTING ENGINES. *(Continued)*

PILOTS

a. Excessive fuel flow versus rpm (see Section V for desired schedule).

b. Hot start (EGT or TIT exceeds temperature limits).

CAUTION

Inspection of tailpipe and turbine for evidence of overheat and trapped fuel is required prior to attempting another start.

c. Abort start — The engine does not light up within 20 to 30 seconds after the condition lever has been placed in the RUN-FUEL ON position. If the EGT or TIT indicator does not indicate a temperature rise, a light-up has not been obtained.

d. False start — After a light-up has occurred, the rpm does not increase to GROUND IDLE, but remains at some intermediate point, with EGT or TIT at or below temperature limits.

FLIGHT ENGINEER

Procedure in Event of an Unsatisfactory Start.

PILOTS

a. Condition Lever—FUEL OFF.

b. Engine Starter Switch—PULL TO RESET.

Note

It may be desirable to leave the starter engaged until EGT or TIT decreases. When EGT or TIT is within limits, disengage starter and allow the engine to coast to a stop.

FLIGHT ENGINEER

a. Fuel Tank Outlet Valve Switch—CLOSE.

b. Fuel Boost Pump Switch—OFF.

CAUTION

An unsatisfactory start shall be followed by a clear engine procedure prior to attempting another engine start.

CLEAR ENGINE PROCEDURE.

PILOTS

a. Condition Lever—FUEL OFF.

FLIGHT ENGINEER

a. Fuel Tank Outlet Valve Switch—CLOSE.

(CONTINUED ON NEXT PAGE)

STARTING ENGINES. *(Continued)*

PILOTS

b. Engine Rpm—ZERO PERCENT.

c. Engine Brake Switch—OFF.

CAUTION

If start is aborted and fuel is draining from the engine and shroud drains, wait until flow through the drains has stopped before proceeding with step d.

d. Engine Starter Switch — PUSH TO START. Maintain starter operation for 25 to 30 seconds.

e. Engine Starter Switch—PULL TO RESET.

Note

Allow engine to coast to a stop after starter is disengaged.

CAUTION

Inspection of the tailpipe and turbine for evidence of overheat and trapped fuel is required prior to attempting another start.

FLIGHT ENGINEER

b. Fuel Boost Pump Switch—OFF.

Note

This procedure is recommended since fuel leakage might have been the reason for the execution of the Clear Engine Procedure.

ENGINE GROUND OPERATION.

CAUTION

Close observation and rigid adherence to the maximum allowable temperature limits are imperative for dependable engine operation. Maximum EGT and TIT limits are contained in Section V. Starting, ground operation, and acceleration limits contained in Section V apply regardless of the outside air temperature or compressor inlet temperature. Temperatures for all other power conditions vary with inlet temperature, and must be computed from data contained in Section V.

Do not exceed HIGH GROUND IDLE rpm when engine oil temperature is below 25°C.

BEFORE TAXIING.

PILOTS

① Scanner/Ground Controller's Report—"ALL CLEAR" (S/GC)—"CLEARED TO BOARD AIRCRAFT" (P).

FLIGHT ENGINEER

1. Air Conditioning-Ram Ventilation Switch—AIR CONDITIONING.

SCANNER/GROUND CONTROLLER

① Scanner/Ground Controller's Report—"ALL CLEAR," then "COMING ABOARD."

(CONTINUED ON NEXT PAGE)

BEFORE TAXIING. *(Continued)*

PILOTS

Upon receipt of "All clear" from scanner/ground controller, pilot states "Cleared to board aircraft." Scanner/ground controller acknowledges pilot's clearance with "Coming aboard."

2. Radio Call—COMPLETED (CP).

Taxi and takeoff instructions received.

3. Altimeter and Flight Instruments — (State Altimeter Setting) SET & CHECKED (CP, P, N).

Note

When in uneven terrain areas, altitude indications other than the field's listed elevation may occur.

WARNING

When setting altimeter, check the 10,000 foot pointer. It is possible for the correct reading to be set in the Kollsman window while the altimeter is 10,000 feet in error.

a. Directional Indicators — CHECKED & SET.

b. Attitude Indicators — CHECKED & SET.

Horizon bar and bank indices checked, and warning flags out of sight. Rotate horizon bar adjustment knob ½ turn right and ½ turn left, and observe horizon bar for normal operation. Set miniature aircraft for takeoff (recommend ½ bar below the horizon).

FLIGHT ENGINEER

2. Hydraulic Pressure—WITHIN LIMITS.

3. Electrical Systems—CHECKED.

4. Takeoff Warning Index Panel—CHECKED.

Check panel after wing flaps are set to 15 degrees.

SCANNER/GROUND CONTROLLER

After checking that external power is removed; chocks are clear of aircraft; gear pins are aboard; and aircraft clear of all obstructions, state "All clear" and await pilot's clearance. After receiving pilot's clearance, state "Coming aboard," and proceed to the crew escape hatch unless otherwise directed.

(CONTINUED ON NEXT PAGE)

BEFORE TAXIING. *(Continued)*

PILOTS

FLIGHT ENGINEER

SCANNER/GROUND CONTROLLER

WARNING

K-4B vertical gyro malfunctions have occurred with no warning flag indicating the malfunction. The red warning flag on the B1-A indicator warns primarily of power interruption to the instrument. Internal malfunctions can occur with no visual warning indicated. If the horizon bar adjustment knob is rotated for adjustment, and no action takes place, a malfunction of the pitch circuits is indicated. However, if the horizon bar is displaced normally, the pitch circuits can be assumed to be operating properly.

c. Vertical Velocity Indicator—CHECKED.

If not in zero position, reset.

d. Airspeed Indicators — CHECKED.

e. Turn and Slip Indicators —CHECKED.

Pointer should be centered, and slip indicator free of bubbles.

f. Standby Magnetic Compass—CHECKED.

Free of bubbles; full of fluid; and free in race.

④ IFF—STANDBY (P, or N).

5. Wing Flaps—15 DEGREES (CP).

Copilot extends flaps to 15 degrees.

(CONTINUED ON NEXT PAGE)

BEFORE TAXIING. *(Continued)*

PILOTS

⑥ Engineer's Report—"ENGINEER'S BEFORE TAXIING CHECK COMPLETED" (E).

⑦ Scanner/Ground Controller's Report—"READY to TAXI" (S/GC).

8. Taxi Clearance — CLEAR RIGHT (CP); CLEAR LEFT (P).

Receive visual clearance from the ground crew that the aircraft is clear to taxi. Copilot states "Clear right"; pilot states "Clear left."

9. "Before Taxiing Check — COMPLETED" (CP).

FLIGHT ENGINEER

⑤ Engineer's Report — "ENGINEER'S BEFORE TAXIING CHECK COMPLETED."

SCANNER/GROUND CONTROLLER

② Scanner/Ground Controller's Report—"READY TO TAXI."

TAXIING.

A steady pressure on the nose steering wheel and/or rudder pedals is adequate for normal taxiing. The nose gear steering wheel may be used to overpower rudder pedal steering in case of reverse loads in high winds, or if it becomes necessary to make large changes in direction. Caution should be exercised in the use of nose gear steering to avoid sidewise skidding of the nose gear tires, which is frequently mistaken for nose gear shimmy. For minimum turning radius and ground clearances, see figure 2-7.

PILOTS

1. Brakes—CHECKED (P).

Note

The pilot will check the brakes and hydraulic pressure as soon as practicable after leaving the blocks, and not necessarily wait for the accomplishment of the taxiing checklist.

2. Hydraulic and Emergency Airbrake Pressure—WITHIN LIMITS (CP).

Check hydraulic and emergency brake pressure indicators. (Copilot periodically checks these indicators during all ground operations.)

3. Flight Instruments—CHECKED (CP, P).

   a. Turn and Slip Indicators—CHECKED.

Check indicators in right and left turn.

   b. RMI Compass Cards—SWINGING FREE.

   c. Directional Indicators—SWINGING FREE.

FLIGHT ENGINEER

1. Propeller Deicing System—CHECKED & OFF.

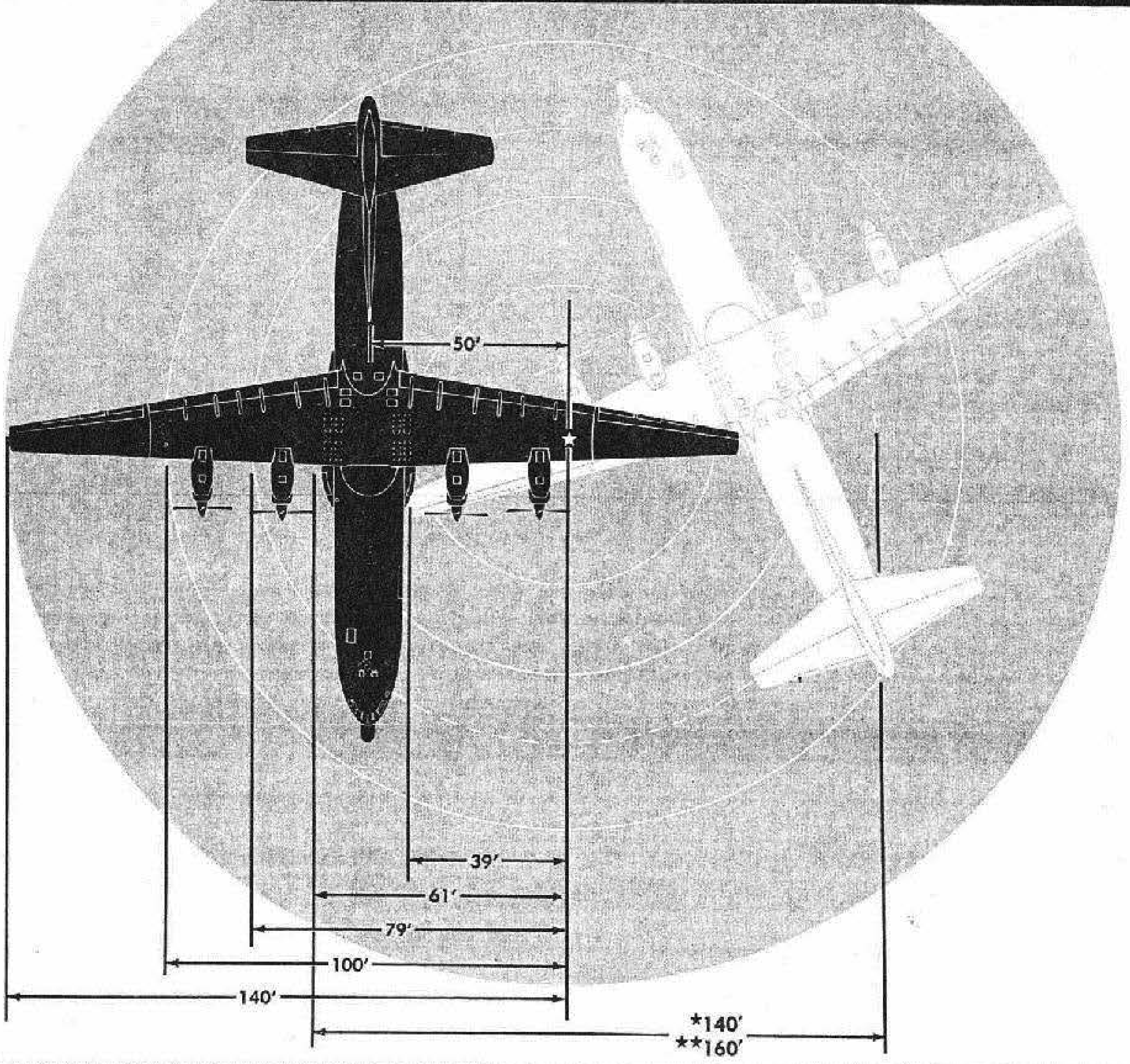
See Section VII for normal operation of the propeller deicing systems.

2. Engine and GTU Anti-Icing System—CHECKED, then AUTO.

See Section IV, Anti-Icing and Deicing Systems and Engine and GTU Anti-Icing Systems Operation and Test.

(CONTINUED ON PAGE 2-31)

Minimum Turning Radius And Ground Clearance



VERTICAL CLEARANCES	
VERTICAL STABILIZER TIP	48'9"
PROPELLER INBOARD	8'0"
PROPELLER OUTBOARD	8'8"
TOP OF FUSELAGE	18'3"
WING TIP	22'3"

Note:

For ground maneuvering, with nosegear turned to the maximum of 50 degrees, aircraft pivots about a point (indicated by ☆) outboard of main gear.

*Turning area required is a circle 280 feet in diameter. Turning surface required for a 180 degree turn is 140 feet, using brakes and power to assist turn.

**Without brakes or power assistance, a minimum ramp width of 160 feet is required for a 180 degree turn and 175 feet for a 360 degree turn.

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Figure 2-7

TAXIING. *(Continued)*

PILOTS	***FLIGHT ENGINEER***
④ Engineer's Report—"ENGINEER'S TAXIING CHECK COMPLETED" (E).	③ Engineer's Report—"ENGINEER'S TAXIING CHECK COMPLETED."
5. "Taxiing Check—COMPLETED" (CP).	

AIRCRAFT BACKING USING REVERSE THRUST.

The use of reverse thrust for backing the aircraft should be restricted to those infrequent occasions required by operational necessity.

WARNING

Insure that the maneuver area is free of debris which could cause damage to the propellers or injure ground personnel. Brief the taxi signalmen in the congested area to insure understanding of path and distance to be traversed and the aircraft's maneuvering and stopping capability.

a. Scanner/ground controller should be positioned in top hatch on interphone. Wingwalkers should be positioned forward of each wingtip, with man at left wing position providing appropriate handsignals to pilot.

b. Taxi slowly and anticipate stopping so that forward thrust can be used for braking action.

c. It is recommended that all propellers be reversed simultaneously.

d. Use forward thrust as primary means of stopping.

ENGINE RUNUP.

The copilot will maintain an alert watch outside the aircraft and, during night operation, the taxilight will remain on. It is recommended that the aircraft be headed into the wind to provide adequate nacelle cooling, and to lessen propeller vibration.

Daily runup is required prior to the first flight of the day. Aircraft not modified by T.O. 3E3-2-558 also require a propeller static check prior to first flight. However, if performed prior to departure on a mission from the home station, they need not be reaccomplished at enroute stations, providing ground time does not exceed 24 hours. If propeller malfunction has been experienced or suspected, or if maintenance has been performed on the propeller or engine accessories, the complete engine and propeller check outlined in Section VII will be accomplished on the affected propeller and engine.

(CONTINUED ON NEXT PAGE)

ENGINE RUNUP. *(Continued)*

PILOTS

1. Parking Brake—SET (P).

2. Engine Instruments—CHECKED (P).

CAUTION

Do not operate engines above HIGH GROUND IDLE rpm until engine oil temperatures and pressures are within limits.

3. Engine Runup—AS REQUIRED (P).

Perform daily runup as follows:

b. All throttles—FLIGHT IDLE.

Position throttles to approximately 1 inch above flight IDLE, then return to FLIGHT IDLE.

c. All Propeller Beta Warning Lights—ON.

Note

If a Beta warning light goes off, return respective throttle to GROUND IDLE. Position condition lever to AIR START, and hold. Advance throttle to approximately 1 inch above FLIGHT IDLE, then return to FLIGHT IDLE. Release condition lever, and Beta warning light should remain on.

d. No. 1 Condition Lever—FUEL OFF, then RUN-FUEL ON.

Accomplish this action rapidly. Repeat this step for Nos. 2, 3, and 4 condition levers.

Note

A condition lever in the FEATHER position will give a false NTC indication.

e. All Propeller Beta Warning Lights—OFF.

f. All NTC Indicator Lights—ON.

WARNING

If any propeller Beta warning light does not go off, or if any NTC indicator light does not come on, a malfunction may be indicated.

FLIGHT ENGINEER

(CONTINUED ON NEXT PAGE)

ENGINE RUNUP. *(Continued)*

PILOTS

g. All Throttles—GROUND IDLE.

h. NTC Indicator Lights—RESET.

i. All Propeller Beta Warning Lights—ON.

j. Generators and Transfer Relays—CHECKED.

While Nos. 2 and 3 engines are operating at HIGH GROUND IDLE rpm, the pilot will clear the engineer to conduct the generators and transfer relays check by stating "Check generators."

3A. Water-Alcohol Injection Switch—AS REQUIRED

If water-alcohol is to be used during takeoff, place No. 3 engine in HIGH GROUND IDLE and turn right a-c generator ON. The pilot will turn the water-alcohol switch ON, check indicator ON, then turn switch OFF.

Note

If the APN-59 radar is required during or immediately after takeoff, leave No. 3 engine in HIGH GROUND IDLE and turn APN-59 function switch to STANDBY for warmup purposes.

④ Engineer's Report—"ENGINEER'S ENGINE RUNUP CHECK COMPLETED" (E).

5. "Engine Runup Check—COMPLETED" (CP).

FLIGHT ENGINEER

① Engineer's Report—"ENGINEER'S ENGINE RUNUP CHECK COMPLETED."

While Nos. 2 and 3 engines are operating at HIGH GROUND IDLE rpm, and after the pilot has stated "Check generators," perform the generator and transfer relay check (see Section VII for generator and transfer relay check procedures.

BEFORE TAKEOFF.

PILOTS

1. Flight Instruments—SET (CP, P).

a. Directional Indicator—SET.

Runway heading set under index.

b. Attitude Indicator—SET.

Recommend setting miniature aircraft ½ bar below the horizon.

② Altimeter—STATE SETTING (CP, P, N).

3. Trim Tabs—SET (P).

Trim tab controls set for takeoff (elevator 4 degrees nose up).

4. Propeller Rpm Trim Lever—NEUTRAL (P).

5. Wing Flaps—STATE SETTING (P).

Check wing flap position indicator and lever.

6. Autopilot Engage Switch—OFF (P).

⑦ Radios, Radar, Radio Altimeter—SET (CP, P, N).

WARNING

Due to penetration of radio and radar waves in deep snow or ice, terrain clearance errors of as much as 1600 feet greater than actual clearance have been recorded when operating over deep snow or ice fields. Therefore, do not rely on the SCR-718 radio altimeter, or the AN/APN-22 radar altimeter to provide accurate terrain clearance information when flying over areas covered by large depths of snow and ice.

FLIGHT ENGINEER

1. Circuit Breakers—CLOSED.

2. Fuel System—SET FOR TAKEOFF.

a. Tank Outlet Valve Switches—ALL OPEN.

b. Manifold-to-Engine Fuel Valve Switches—CLOSED.

c. Fuel Boost Pump Switches—SET.

Tank No. 2, both ON; tank 7, both ON; all other fuel boost pump switches, OFF.

d. Tanks 2 and 7 Inlet Valve Switches—OPEN.

e. Tanks 1, 3, 4, 5, 6, and 8 Inlet, Crossfeed, and Refueling Valve Switches—CLOSED.

SCANNER/GROUND CONTROLLER

1. Rear Cargo Door Seal Pressure—CHECKED.

2. Oxygen Equipment—CHECKED.

(CONTINUED ON NEXT PAGE)

BEFORE TAKEOFF. *(Continued)*

PILOTS

WARNING

On aircraft without T.C.T.O. 517, turn TACAN set OFF during a VOR or ILS departure. This will prevent automatic switchover to TACAN in the event of VOR or ILS power failure.

⑧ Flight Compartment Windows and Hatches—CLOSED & LOCKED (CP, P, E).

Copilot's and pilot's windows closed and locked; engineer checks crew escape hatch.

⑨ Seat Belt and Shoulder Harnesses—FASTENED&UNLOCKED (CP, P, E, N).

The copilot, pilot, engineer, and navigator, as applicable, will identify their positions and state in order "Fastened and unlocked." The engineer or scanner/ground controller will ascertain that all crew members and/or passengers in their respective compartments are secured; this check will not be made by interphone.

10. Crew Briefing—AS REQUIRED (P).

Pilot will brief the crew as required, and insure each crew member's understanding.

11. Anticollision Light—ON (P).

12. Navigation Lights—CLIMATIC (P).

If lights are required, set the navigation light switch to STEADY.

FLIGHT ENGINEER

③ Crew Escape Hatch — CLOSED & LOCKED.

④ Seat Belt—"FASTENED."

5. Takeoff Warning Index Panel—CHECKED (After wing flaps set for takeoff).

6. Pneumatic Manifold Switches—CLIMATIC.

Note

The pneumatic manifold switches must be OPEN if maximum windshield jet blast rain removal is desired. To avoid loss of engine power, limited rain removal may be obtained from the GTU's; but only if the pneumatic manifold switches are in the CLOSED position, and the air conditioning system is turned off.

SCANNER/GROUND CONTROLLER

(CONTINUED ON NEXT PAGE)

BEFORE TAKEOFF. *(Continued)*

PILOTS	FLIGHT ENGINEER	SCANNER/GROUND CONTROLLER
⑬ Anti-Icing and Deicing Systems—CLIMATIC (P, E).	⑦ Anti-icing and Deicing Systems—CLIMATIC.	
14. Surface Snubber Lever—UNLOCKED (P). Pilot checks position of lever.	If icing is anticipated, engine and GTU inlet anti-icing switch should be set to AUTO; wing and empennage deicing switches—AS REQUIRED; and propeller deicing switches—AS REQUIRED.	
15. Flight Controls—CHECKED & FREE (P). Pilot will hold nose gear steering wheel to avoid scrubbing nose wheel tires.		
16. Pitot Heater Switches—CLIMATIC (P). If moisture penetration is anticipated, pitot heat should be used.		
17. IFF—NORMAL (P or N). Mode and code as briefed.		
⑱ Crew Member's Report—"BEFORE TAKEOFF CHECK COMPLETED" (E, N, S/GC).	⑧ Engineer's Report—"ENGINEER'S BEFORE TAKEOFF CHECK COMPLETED."	③ Scanner/Ground Controller's Report — "SCANNER/GROUND CONTROLLER'S BEFORE TAKEOFF CHECK COMPLETED."
19. "Before Takeoff Check—COMPLETED" (CP).		

TAKEOFF.

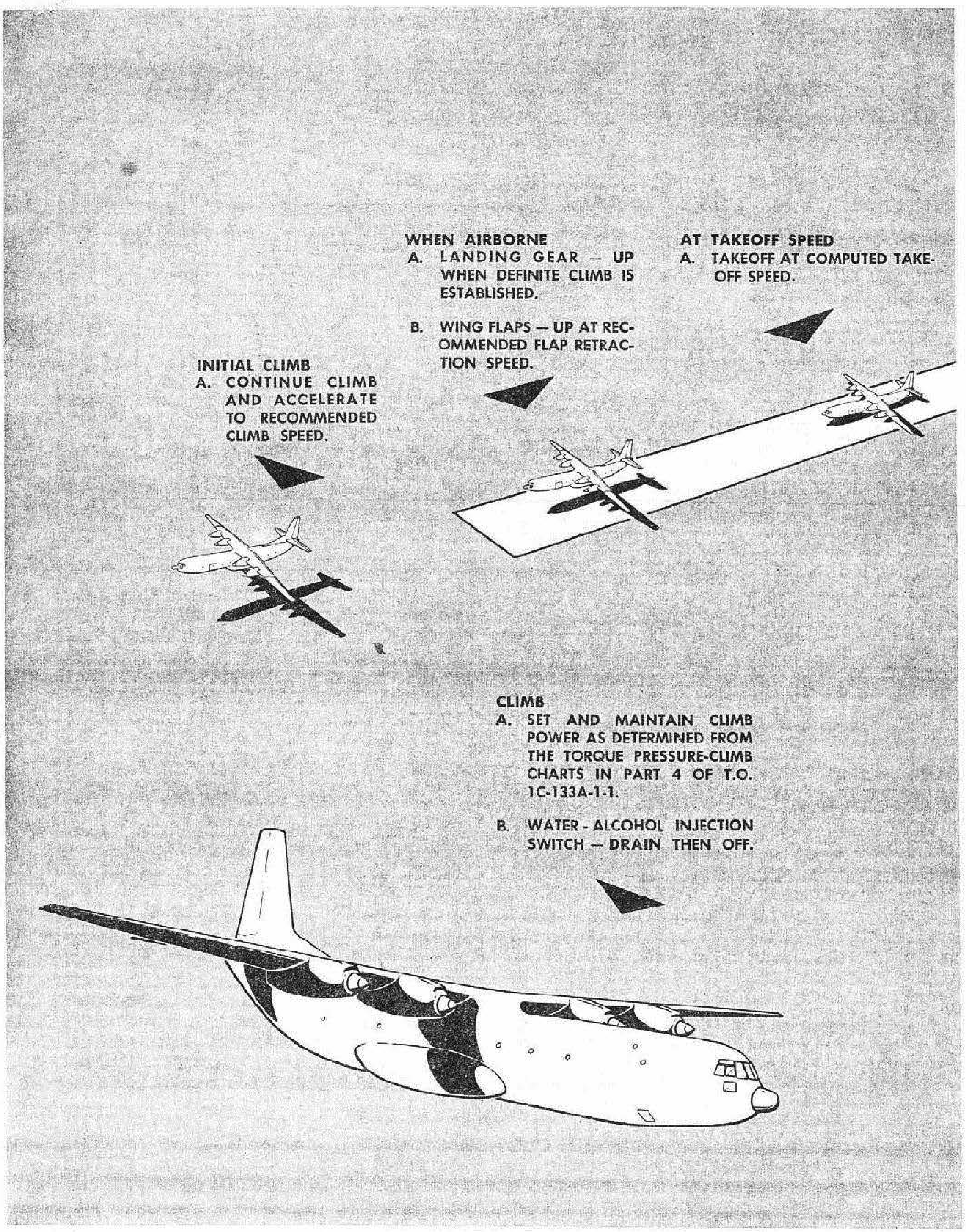
C-133A Aircraft.

To obtain takeoff performance (wet or dry) as given in Parts 2 and 3 of *T.O. 1C-133A-1-1*, the following procedures are recommended *(see figure 2-8)*.

The pilot will position the aircraft in such a manner as to utilize the entire length of the available runway. With the brakes set, the pilot will advance the throttles to approximately 20 to 25 psi torque pressure. As the rpm reaches a minimum of 92.5 percent, the copilot will push IN the propeller synchronizer buttons. After all four synchronizer buttons remain in, the copilot will state, "Syncs in." As the throttles are advanced, and while the copilot is pushing IN the synchronizer buttons, the flight engineer will place the generators on the line, check his instruments, and scan the AC checklist. After the flight engineer has determined that all indications are normal, he will report to the pilot. "Generators on the Line." The copilot will set the synchrophase switch ON. The pilot will release the brakes and advance the throttles to predicted dry power. At this point, the copilot will scan all engine and flight instruments, check predicted dry power and make any required power adjustment. Predicted torque pressure minus charted tolerance represents the minimum power for takeoff.

For wet takeoffs, predicted dry power will be checked with brakes set. After predicted dry power has been checked; if dry torque pressure is 36 psi or less, leave the throttles set; if dry torque pressure is more than 36 psi, retard the throttle to 36 psi. Turn ON the water-alcohol injection switch, note water-injection pressure, and check predicted wet power. Reset the throttles if EGT is above limits or if shaft horsepower exceeds limit less 1.5 psi torque pressure (see Water-Alcohol Power Relationship Chart), then release brakes.

(CONTINUED ON PAGE 2-38)



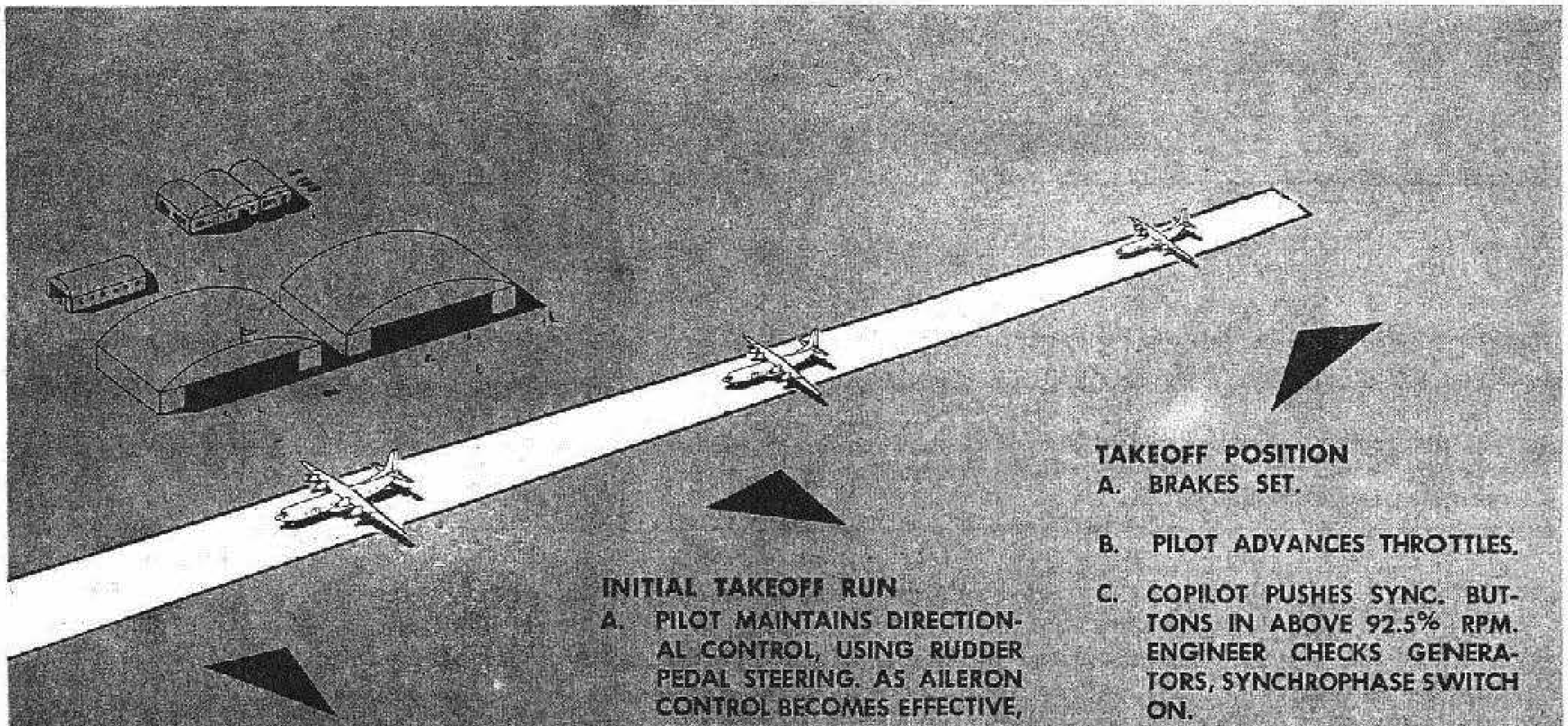
AT TAKEOFF SPEED
A. TAKEOFF AT COMPUTED TAKEOFF SPEED.

WHEN AIRBORNE
A. LANDING GEAR — UP WHEN DEFINITE CLIMB IS ESTABLISHED.
B. WING FLAPS — UP AT RECOMMENDED FLAP RETRACTION SPEED.

INITIAL CLIMB
A. CONTINUE CLIMB AND ACCELERATE TO RECOMMENDED CLIMB SPEED.

CLIMB
A. SET AND MAINTAIN CLIMB POWER AS DETERMINED FROM THE TORQUE PRESSURE-CLIMB CHARTS IN PART 4 OF T.O. 1C-133A-1-1.
B. WATER - ALCOHOL INJECTION SWITCH — DRAIN THEN OFF.

Figure 2-8 (Sheet 1 of 2)



TAKEOFF POSITION

A. BRAKES SET.

B. PILOT ADVANCES THROTTLES.

C. COPILOT PUSHES SYNC. BUTTONS IN ABOVE 92.5% RPM. ENGINEER CHECKS GENERATORS, SYNCHROPHASE SWITCH ON.

D. BRAKES RELEASED.

E. PILOT SETS AND CHECKS POWER (DRY).

Note

For wet takeoff accomplish (1), (2), and (3) prior to brake release.

(1). PILOT SETS THROTTLES.
(2). COPILOT TURNS ON WATER - ALCOHOL INJECTION.
(3). PILOT SETS AND CHECKS PREDICTED POWER.
(4). BRAKES RELEASED.

INITIAL TAKEOFF RUN

A. PILOT MAINTAINS DIRECTIONAL CONTROL, USING RUDDER PEDAL STEERING. AS AILERON CONTROL BECOMES EFFECTIVE, IT SHOULD BE USED AS A FURTHER MEANS OF DIRECTIONAL CONTROL.

B. COPILOT MAINTAINS MAX POWER, MONITORS ENGINE OPERATION, AND VERIFIES THE ACCELERATION AT THE PREDETERMINED DISTANCE MARKER OR ELAPSED TIME. IF THE ACCELERATION SPEED IS LOWER THAN COMPUTED, HE WILL STATE "REJECT." IF ACCELERATION IS SATISFACTORY, HE WILL STATE "GO" AT THE MAXIMUM REFUSAL SPEED.

WARNING

All refusal airspeeds and field lengths are valid only if the aircraft acceleration is normal. Therefore, acceleration checks are mandatory to insure safe takeoff operation.

Note

If at any time prior to reaching refusal airspeed any flight crew member notices an indication of a malfunction affecting flight safety, the takeoff will be aborted.

PRIOR TO TAKEOFF

A. PILOT APPLIES LIGHT BACK PRESSURE ON ELEVATOR CONTROL APPROXIMATELY 5 KNOTS BELOW TAKEOFF SPEED.

B. ASSUME TAKEOFF ATTITUDE.

Takeoff and Initial Climb—Typical

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Figure 2-8 (Sheet 2 of 2)

TAKEOFF. *(Continued)*

WATER-ALCOHOL INJECTION POWER RELATIONSHIP

Percent Rpm	*Torque Pressure (Psi)*
95 to 96	47.0
96 to 97	46.5
97 to 98	46.0
98 to 99	45.5
99 to 100	45.0

*The torque pressure values shown here are approximately 1.5 psi below the 6500 shaft horsepower limit in order to preclude the necessity for adjusting the throttles to compensate for ram rise during the takeoff run. Do not exceed the operating limits given in Section V.

Note

No further throttle adjustment should be necessary for the duration of wet-thrust operation to compensate for the torque pressure increase due to ram rise, provided the operating limitations given in Section V are not exceeded.

The copilot will check indicated power against the minimum predicted power (see Power Check Curves, *T.O. 1C-133A-1-1*). Abort the takeoff if indicated power is less than minimum predicted.

During the acceleration to takeoff speed, rudder pedal steering will provide adequate directional control. The ailerons become effective above 50 knots IAS and should be used as further means of directional control. The copilot monitors engine operation and verifies the acceleration at the predetermined distance marker or elapsed time. If the acceleration speed is lower than computed, he will state, "Reject." If acceleration is satisfactory, he will state, "Go," at the maximum refusal speed.

If at any time prior to reaching refusal speed, any flight crew member notices an indication of malfunction affecting flight safety, the takeoff will be aborted (see Takeoff and Landing Emergencies, Section III).

Note

If a takeoff is aborted because of an engine fire warning light coming on, another takeoff will not be attempted until that engine has been inspected.

C-133B Aircraft

To obtain takeoff performance (wet or dry) as given in Parts 2 and 3 of *T.O. 1C-133A-1-1*, the following procedures are recommended *(see figure 2-8)*.

The pilot will position the aircraft in such a manner as to utilize the entire length of the available runway. With the brakes set, the pilot will advance the throttles to approximately 20 to 25 psi torque pressure. As the rpm reaches a minimum of 92.5 percent, the copilot will push IN the propeller synchronizer buttons. After all four synchronizer buttons remain in, the pilot will state, "Syncs in." As the throttles are advanced and while the copilot is pushing IN the synchronizer buttons, the flight engineer will place the generators on the line, check his instruments, and scan the A-C checklist. After the flight engineer has determined that all indications are normal, he will report to the pilot, "Generators on the line." The copilot will set the synchrophase switch ON. The pilot will release the brakes and advance the throttles to 935°C TIT or 6950 SHP, whichever occurs first. At this point, the copilot will scan the engine and flight instruments, check predicted dry power and make any required power adjustment. Predicted torque pressure minus charted tolerance represents the minimum power for takeoff.

For wet takeoffs, predicted dry power will be checked with brakes set. After predicted dry power has been checked, set 915°C TIT or 40 psi torque pressure, whichever is limiting. Turn ON the water-alcohol injection switch, note water-alcohol injection pressure, and check predicted wet power. Reset the throttles if TIT is above 950° or if shaft horsepower exceeds limit less 1.5 psi torque pressure (see Water-Alcohol Power Relationship Chart), then release brakes.

(CONTINUED ON NEXT PAGE)

TAKEOFF. (Continued)

WATER-ALCOHOL INJECTION POWER RELATIONSHIP

Turbine Inlet Temperature (°C)	*Percent Rpm*	**Torque Pressure (psi)*	*Torque Pressure (psi) (70 knots IAS)*
950	95 to 96	50.5	51.5
950	96 to 97	50.0	51.0
950	97 to 98	49.5	50.5
950	98 to 99	49.0	50.0
950	99 to 100	48.5	49.5

*The torque pressure values shown here are approximately 1.5 psi below the 6950 shaft horsepower limit in order to preclude the necessity for adjusting the throttles to compensate for ram rise during the takeoff run. Do not exceed the operating limits given in Section V.

Note

No further throttle adjustment should be necessary for the duration of wet-power operation to compensate for the torque pressure due to ram rise, providing the operating limitations given in Section V are not exceeded.

The copilot will check indicated power against the minimum predicted power (see Max Wet Power Check Curves, Part 2 of *T.O. 1C-133A-1-1*). Abort the takeoff if indicated power is less than minimum predicted.

During the acceleration to takeoff speed, rudder pedal steering will provide adequate directional control. The ailerons become effective above 50 knots IAS, and should be used as a further means of directional control.

The copilot monitors engine operation and verifies the acceleration at the predicted distance marker or elapsed time. If the acceleration speed is lower than computed, the copilot will state "Reject." If acceleration is satisfactory, the copilot will state "Go" at the maximum refusal speed. If at any time prior to reaching refusal speed, any flight crew member notices an indication of malfunction affecting flight safety, the takeoff will be aborted (see Takeoff and Landing Emergencies, Section III).

Note

If a takeoff is aborted because of an engine fire warning light coming on, another takeoff will not be attempted until that engine has been inspected.

NORMAL TAKEOFF.

PILOTS	***FLIGHT ENGINEER***
a. Propeller Synchronizer Buttons—IN (CP).	a. Generators—ON THE LINE.
b. Generators—ON THE LINE (CP, E).	
c. Synchrophase Switch—ON (CP).	

The following steps constitute a normal dry takeoff:

1. Brakes—SET (P).
2. Throttles—ADVANCE (P).

(CONTINUED ON NEXT PAGE)

TAKEOFF. *(Continued)*

PILOTS

FLIGHT ENGINEER

3. Propeller Synchronizer Buttons—IN (CP).

As engines accelerate above 92.5 percent rpm, copilot will push IN synchronizer buttons and report "Synchs IN." Engineer will report "Generators on the line."

4. Synchrophase Switch—ON (CP).

5. Brakes—RELEASED (P).

6. Throttles—SET & CHECK PREDICTED DRY POWER (P, CP).

For -7WA engines, predicted TP not to exceed 6500 SHP or EGT limits. For -9W engines, 935°C TIT, predicted TP not to exceed 6950 SHP.

WARNING

If the minimum torque pressure is not obtained, do not attempt takeoff.

Note

Normally further power adjustment will not be necessary during takeoff. However, TIT/EGT and torque pressure must be closely monitored, and the throttles retarded as necessary to prevent exceeding the prescribed maximum engine limits due to ram rise.

The following steps constitute a normal wet takeoff:

Note

The use of water-alcohol is restricted to ambient temperatures greater than 0°C, and to altitudes below 8000 feet.

1. Brakes—SET (P).

2. Throttles—ADVANCE (P).

3. Propeller Synchronizer Buttons—IN (CP).

As engines accelerate above 92.5 percent rpm, copilot will push IN synchronizer buttons and report "Synchs IN." Engineer will report "Generators on the line."

4. Synchrophase Switch—ON (CP).

(CONTINUED ON NEXT PAGE)

TAKEOFF. *(Continued)*

PILOTS

FLIGHT ENGINEER

(5) Throttles—SET (P).

For -7WA engines, if dry TP is 36 psi or less, leave throttles set; if dry TP is more than 36 psi, retard the throttles to approximately 36 psi. For -9W engines, set throttles at 915°C TIT or 40 psi TP, whichever is limiting.

(6.) Water-Alcohol Injection Switch—ON (CP).

CAUTION

An increase in TIT of approximately 35°C, and an increase in torque pressure of approximately 9 psi will occur when water-alcohol injection cuts in. If water-alcohol injection does not cut in, turn water-alcohol injection switch OFF, and do not attempt wet power takeoff. Proceed with takeoff at predicted dry power, conditions permitting.

(7) Throttles—CHECK AND SET (P).

Retard if TIT/EGT is above limits, or if SHP exceeds limit less 1.5 psi TP. (See Walter-Alcohol Power Relationship Chart, this section.)

WARNING

If the minimum torque pressure is not obtained, do not attempt takeoff.

(8) Brakes—RELEASED (P).

Note

Setting predicted power prior to releasing the brakes normally precludes further adjustment during takeoff. However, TIT/EGT and torque pressure must be closely monitored, and the throttles retarded as necessary to prevent exceeding the prescribed maximum engine limits due to ram rise.

CAUTION

During a wet takeoff, if a throttle is retarded below the throttle position which deactivates the water-alcohol system, water-alcohol will be cut off from that engine.

CROSSWIND TAKEOFF.

WARNING

During pushover maneuvers with the wing flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nosedown pitch which may result from this change in elevator control forces.

During takeoff, aileron displacement is required to keep the wings level *(see figure 2-9)*. The amount of aileron displacement depends upon the crosswind component (see Takeoff Crosswind chart in Part 3 of *T.O. 1C-133A-1-1*). In severe crosswind, the takeoff run should be started with full aileron deflection to depress the upwind wing. As the aircraft accelerates, deflection is reduced as necessary to maintain directional control. A slight amount of bank into the wind (on the ground and after liftoff) can be used effectively to assist in maintaining directional control. After takeoff, the aircraft should be crabbed into the wind to maintain a straight path and to reduce control force requirements.

WARNING

Under conditions where sideslip angles are greater than 5 degrees, approaching stall speed in the power approach or takeoff configurations, or with right angle crosswind components of 25 knots or more, errors existing in the airspeed indicating system may be greater than those shown on the Airspeed Position Error Correction charts in Part 1 of *T.O. 1C-133A-1-1*. Under the conditions cited, the proper indicated airspeed reading shall be determined only from that indicator which does not fluctuate, and which gives the higher of the two airspeed readings.

NO FLAP TAKEOFF.

For gross weights above 160,000 pounds, use 15 degrees flap. Below 160,000 pounds, zero flap is required (see Performance Data in *T.O. 1C-133A-1-1*).

Note

Takeoffs using 10 degrees flap may be accomplished when three-engine climb performance is marginal with 15 degrees flap, and the use of zero degrees flap for takeoff would increase the maximum ground speed above the recommended limits for tire strength (see figure 5-10 and takeoff performance charts in part 3 of *T.O. 1C-133A-1-1*).

Note

If takeoff is made with zero flaps, the takeoff warning system will be actuated. The takeoff warning horn may be silenced by pulling the circuit breaker for the horn only. This will not deenergize the takeoff warning index panel, nor the redlights. The pilot and the engineer will coordinate to ensure that the takeoff warning index panel is closely monitored, and that only the wing flaps are indicated on the panel.

OBSTACLE CLEARANCE TAKEOFF.

For obstacle clearance takeoff information, see Climbout Flight Path Data in Part 3 of *T.O. 1C-133A-1-1*.

MINIMUM RUN TAKEOFF.

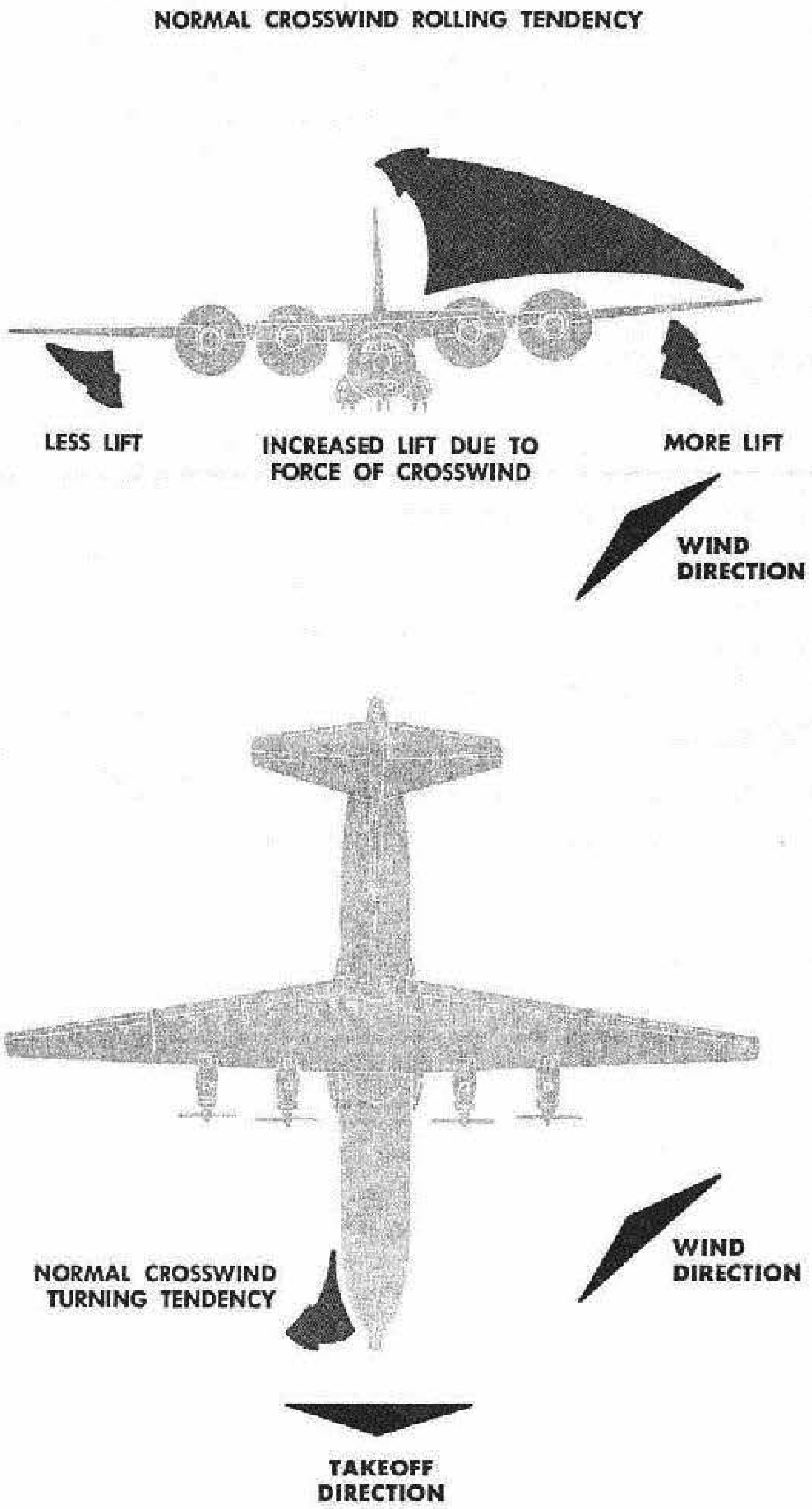
There are no special procedures for minimum run takeoffs. See Takeoff Ground Run charts in Part 3 of *T.O. 1C-133A-1-1*.

AFTER TAKEOFF-CLIMB.

When the aircraft is safely off the ground, the pilot will direct the copilot to retract the landing gear by means of the standard oral and visual signals. The copilot will acknowledge, "Gear up," and place the landing gear lever in the GEAR UP position. After the landing gear indicators read UP, and the landing gear warning light is out, the copilot will report, "Gear up."

(CONTINUED ON PAGE 2-44)

Normal Crosswind Takeoff – Four-Engine



Aerodynamic Forces:

Increased lift on upwind wing.

Aircraft Reaction:

Rolling and turning tendency – downwind.

Note

In the event of an aborted takeoff, use of reverse thrust will increase the above reaction considerably.

Pilot's Corrective Action:

Apply rudder pedal steering in conjunction with coordinated aileron, as required, to maintain directional control and keep the aircraft headed straight down the runway.

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Figure 2-9

AFTER TAKEOFF-CLIMB. *(Continued)*

CAUTION

During landing gear retraction, maintain as near zero sideslip as possible to prevent excessive side loads on the landing gear doors. Do not exceed 5 degrees sideslip.

Initial climb speed will be takeoff speed plus 5 knots, either wet or dry. When obstacle clearance is a factor, leave the wing flaps extended and maintain takeoff airspeed. During normal departure, the optimum technique is to continue climb and acceleration to minimum wing flap retraction speed (takeoff speed plus approximately 20 knots). When minimum wing flap retraction speed is reached (see Takeoff, Minimum Rotation Speed, and Flap Retraction Speeds charts in Part 3 of *T.O. 1C-133A-1-1*), the pilot will state, "Flaps up." The copilot acknowledges, "Flaps up," and places the wing flap lever in the UP position.

WARNING

If a loss of power is experienced immediately after takeoff, the wing flaps must not be retracted at speeds below the recommended wing flap retraction speed for the gross weight of the aircraft. These speeds are minimum safe speeds consistent with optimum performance and safety, and they apply regardless of the number of engines in operation.

WARNING

When water-alcohol injection is used for takeoff, the throttles may be aft of the MAX power position. Immediately upon exhaustion of the water-alcohol supply, the throttles must be advanced to insure the use of predicted dry power.

After the aircraft has accelerated to recommended climb speed (see Climb charts in Part 4 of *T.O. 1C-133A-1-1),* the pilot will call for climb power. The copilot will acknowledge and set the power.

Note

Following takeoff, and during the first turn from takeoff heading, cross-check the pilot's and co-pilot's attitude indicators with each other and with the turn and slip indicator to assure that the roll axis circuits of the system are functioning properly.

Note

NORMAL RATED power should be used for climb when terrain clearance, traffic control, etc., do not require the use of MILITARY RATED power. MILITARY RATED power may be used as an alternate when conditions dictate. MILITARY RATED and NORMAL RATED Power Climb charts are contained in Part 4 of *T.O. 1C-133A-1-1.*

Note

The after takeoff-climb check will be accomplished at a minimum altitude of 1000 feet above terrain.

(CONTINUED ON NEXT PAGE)

AFTER TAKEOFF-CLIMB. *(Continued)*

PILOTS

1. Engine Instruments—CHECKED (CP).

All engine instruments within limits.

Note

To relieve vibrational stress and to improve specific fuel consumption, the use of maximum down-trim is recommended at normal rated power and below, when OAT is below 10°C.

2. Landing Gear and Wing Flap Levers—UP (CP).

3. Landing and Taxi Lights—RETRACTED & OFF (CP).

4. Water-Alcohol Injection Switch—DRAIN, then OFF (CP).

CAUTION

The water-alcohol mixture must be drained from the system immediately after takeoff to prevent possible damage to the water-alcohol supply tank and piping due to freezing of the water-alcohol mixture, which occurs at approximately −15°C. If the water-alcohol mixture remains in the system when the OAT is −15°C or below, note in Form 781.

Note

Items 1, 2, 3, and 4 may be performed by the copilot without verbal challenge or reply.

FLIGHT ENGINEER

1. Pneumatic Manifold Switches—OPEN.

Open individually, and cross-check engine instruments.

2. Hydraulic Pump Control Switch—OFF (After gear and flaps are up).

WARNING

The hydraulic pump control switch must be in the UTILITY position for normal gear and flap retraction.

3. Air Conditioning System—CHECKED.

4. Pressurization Switches—AS REQUIRED.

5. Deicing Switches—CLIMATIC.

6. Engine and GTU Anti-Icing Switch—AUTO.

7. Electrical System—CHECKED.

Check a-c and d-c meters for voltage and load.

8. Auxiliary A-c Generator Switch—AUTO.

⑨ Scanner/Ground Controller's Report—"SCAN OKAY (or cite exception)" (S/GC).

Engineer receives scanner/ground controller's report.

SCANNER/GROUND CONTROLLER

① Scanner/Ground Controller's Report—"SCAN OKAY (or cite exception)."

Check cargo and personnel secured; and any malfunction affecting aircraft operation.

(CONTINUED ON NEXT PAGE)

AFTER TAKEOFF-CLIMB. *(Continued)*

PILOTS

⑤ IFF—CHECKED (P or N).

Note

As soon after takeoff as flight conditions permit, positive operation of the IFF should be established with an air traffic control facility if the route of flight will require an operative IFF. Consult appropriate FLIP documents for IFF/SIF traffic control requirements and procedures.

⑥ Engineer's Report—"ENGINEER'S AFTER TAKEOFF-CLIMB CHECK COMPLETED" (E).

7. "After Takeoff-Climb Check—COMPLETED" (CP).

FLIGHT ENGINEER

⑩ Engineer's Report—"ENGINEER'S AFTER TAKEOFF-CLIMB CHECK COMPLETED."

SCANNER/GROUND CONTROLLER

CLIMB.

Refer to the Takeoff and Initial Climb typical diagram *(figure 2-8)* for initial climb and climb techniques that will result in performance as presented in the Climb charts in Part 4 of *T.O. 1C-133A-1-1.*

CRUISE.

Level off upon reaching cruising altitude, and maintain climb power until desired cruising airspeed is attained. At this time, notify the copilot to establish cruise power at maximum downtrim (see Range Data in Part 5 of *T.O. 1C-133A-1-1* for cruise control.

PILOTS

1. Cruise Power—SET (CP).

Pilot directs the copilot to establish cruise power. The copilot makes the necessary adjustments (see Range Data in Part 5 of *T.O. 1C-133A-1-1).*

2. Engine Instruments—WITHIN LIMITS (CP).

③ Engineer's Report — "ENGINEER'S CRUISE CHECK COMPLETED" (E).

4. "Cruise Check—COMPLETED" (CP).

FLIGHT ENGINEER

1. Fuel System—AS REQUIRED.

See Section VII for fuel system management procedures.

2. Pressurization System—AS REQUIRED.

3. Air Conditioning System—AUGMENT AS REQUIRED.

④ Engineer's Report — "ENGINEER'S CRUISE CHECK COMPLETED."

FLIGHT CHARACTERISTICS.

Refer to Section VI for detailed information on the aircraft's flight characteristics.

DESCENT.

When possible, descents should be made in accordance with recommended descent schedules contained in Part 7 of *T.O. 1C-133A-1-1.* The descent will be determined by altitude, distance from field, terrain, and weight of the aircraft. Power reductions should be made in accordance with the charts contained in *T.O. 1C-133A-1-1* to maintain efficient and economical engine operation. A glide and approach is made by varying the throttles between FLIGHT IDLE and MAX power positions as required by the gross weight, glide angle, or approach conditions. Engine acceleration and response will be rapid.

DESCENT. *(Continued)*

WARNING

The throttles must not be moved below FLIGHT IDLE into GROUND range during flight. This would result in severe drag and possible aircraft control difficulties.

Note

When remaining in the traffic pattern, only those items marked with an asterisk need be accomplished on the descent check list.

PILOTS

① Altimeter Setting—STATE SETTING (CP, P, N).

2. Crew and Passengers—PREPARE FOR LANDING (P).

Pilot gives order over interphone or public address system. Receipt and compliance with these instructions will be positively determined.

* ③ Hydraulic Pump Control Switch—UTILITY (E).

4. Parking Brake—OFF (P).

5. Nose Gear Steering Bypass Valve Release Handle—IN (P).

⑥ Seat Belt and Shoulder Harnesses—FASTENED & UNLOCKED (CP, P, E, N).

The copilot, pilot, engineer, and navigator, as applicable, will identify their positions and state in order "Fastened and unlocked." The engineer or scanner/ground controller will ascertain that all crew members and/or passengers in their respective compartments are secured; this check will not be made by interphone.

* ⑦ Landing Data—COMPUTED (P).

The engineer will give the copilot the landing weight and CG. The copilot will advise the pilot of the landing weight, approach speeds, landing roll, and flare distance.

* ⑧ Approach Minimums—CHECKED (CP, P, N).

9. Radar Altimeter—SET (P).

FLIGHT ENGINEER

1. Pressurization System—SET.

Set cabin pressure controller to 1000 feet above field elevation.

* ② Hydraulic Pump Control Switch—UTILITY.

Check that pressure is within limits.

3. A-c and D-c Electrical System—CHECKED.

Check a-c and d-c meters for voltage and load.

4. Fuel System—SET AS REQUIRED.

* 5. Circuit Breakers—ALL CLOSED.

⑥ Seat Belt—"FASTENED."

⑦ Landing Data—COMPUTED & GIVEN TO COPILOT.

8. GTU Augmentation Switches—AS REQUIRED.

(CONTINUED ON NEXT PAGE)

DESCENT. *(Continued)*

PILOTS

WARNING

Due to penetration of radar waves in deep snow or ice, terrain clearance errors of as much as 1600 feet greater than actual clearance have been recorded when operating over deep snow or ice fields. Therefore, do not rely on the AN/APN-22 radar altimeter to provide accurate terrain clearance information when flying over areas covered by large depths of snow and ice.

* 10. Crew Briefing—AS REQUIRED (P).

Pilot will brief the crew as required, and will insure each crew member's understanding.

·11. Propeller Beta Warning Lights — CHECKED (P).

12. Propeller Rpm Trim Lever—NEUTRAL (P).

* ⑬ Engineer's Report—"ENGINEER'S DESCENT CHECK COMPLETED" (E).

13A. IFF—CHECKED (P or N).

⑭ Navigator's Report—"NAVIGATOR'S DESCENT CHECK COMPLETED" (N).

* 15. "Descent Check—COMPLETED" (CP).

FLIGHT ENGINEER

* ⑨ Engineer's Report—"ENGINEER'S DESCENT CHECK COMPLETED."

BEFORE LANDING.

See figure 2-10 for typical landing pattern.

PILOTS

1. Landing Gear—DOWN & LOCKED (CP).

The pilot directs the copilot to lower the landing gear. The copilot checks that the landing gear indicators show GEAR DOWN and the light in the landing gear lever is off. The pilot will visually check the position of the landing gear lever and the gear indicators. After all gears indicate down and locked, and the warning light is off, the copilot will test the warning light to insure proper operation.

Note

During landing gear extension, maintain as near zero sideslip as possible. Do not exceed 5-degrees sideslip.

FLIGHT ENGINEER

1. Anti-Icing and Deicing Systems—CLIMATIC.

If icing is anticipated, the anti-icing and deicing systems should be turned on.

WARNING

The empennage deicing system must be turned off before landing. Operation of the empennage deicer boots disturbs the airflow over the elevator, and reduces elevator effectiveness.

2. Pneumatic Manifold Switches—CLIMATIC.

3. Auxiliary A-C Generator—RESET, then NON-ESS BUS ON.

(CONTINUED ON NEXT PAGE)

BEFORE LANDING. *(Continued)*

PILOTS

2. Hydraulic and Emergency Airbrake Pressure—WITHIN LIMITS (CP).

3. Antiskid Switch—ON & CHECKED (P).

When switch is set to ON, amber warning light should be off. Check for wheel unlock indication, green light on, while depressing the test switch.

WARNING

If the safe (wheel unlocked) green indicator light does not come on, a wheel locked condition may exist when brakes are applied after landing. Time permitting, turn the antiskid switch OFF, and momentarily apply brakes to stop wheel rotation. If the green light still does not come on (when tested with the antiskid switch ON), or if the amber warning light comes on (with the antiskid switch ON), the antiskid switch should be set to OFF.

4. Landing and Taxi Lights—AS REQUIRED (P).

⑤ Engineer's Report—"ENGINEER'S BEFORE LANDING CHECK COMPLETED" (P, E).

6. "Before Landing Check—COMPLETED" (CP).

FLIGHT ENGINEER

④ Engineer's Report — "ENGINEER'S BEFORE LANDING CHECK COMPLETED."

LANDING.

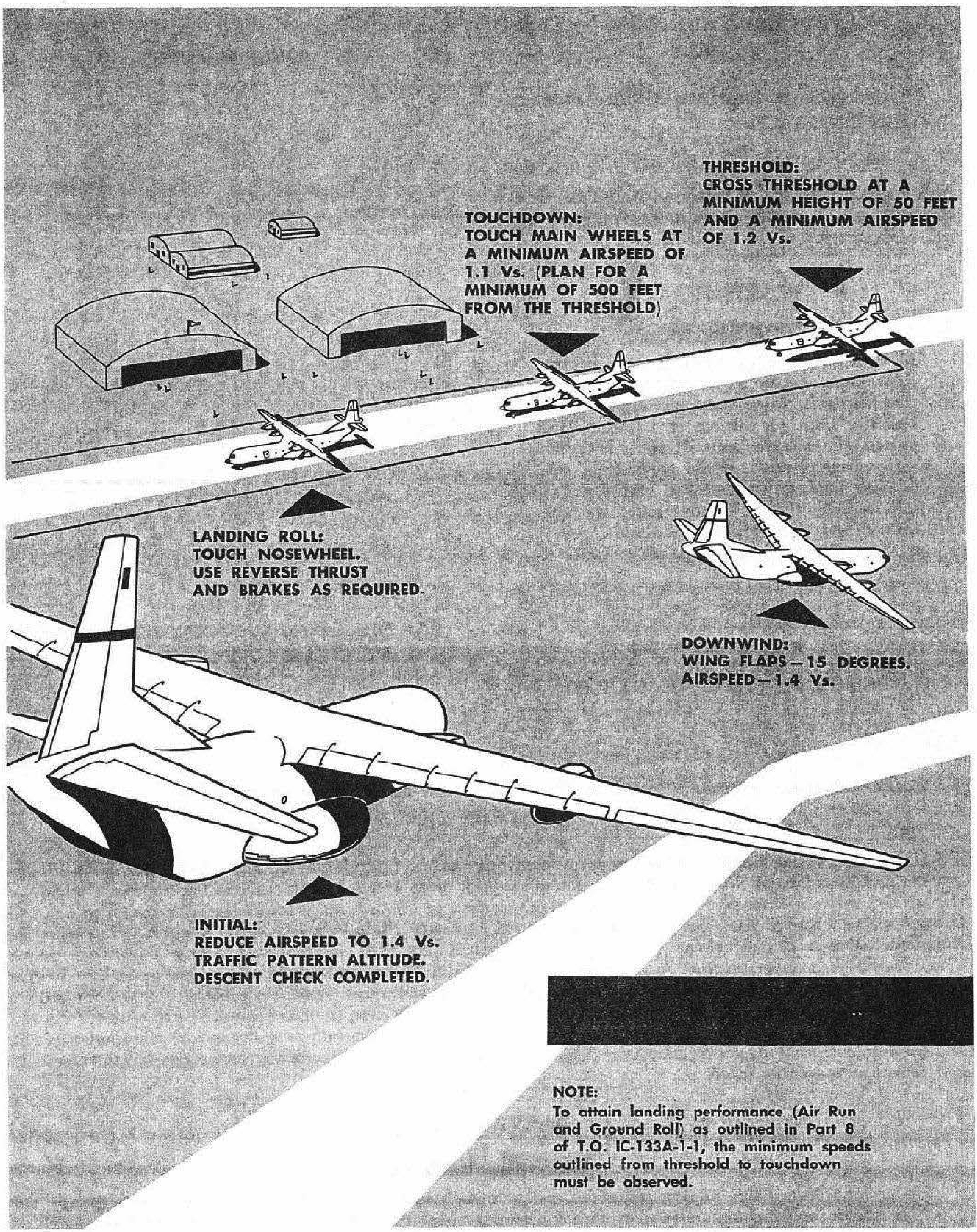
To obtain landing performance as shown in the Approach and Landing charts contained in Part 8 of *T.O. 1C-133A-1-1,* the techniques described in the following paragraphs are recommended.

On all approaches for landing, including instrument approaches, the pilot flying the aircraft during the traffic pattern or final approach will be advised by the other pilot or crew member assisting in the approach, whenever the aircraft varies 5 knots below the computed traffic pattern or final approach speed (refer to the Approach and Landing Speed chart in Part 8 of *T.O. 1C-133A-1-1.* In addition, the pilot will be kept advised of any visual or instrument cross-checks which may indicate that the aircraft is dangerously low to the ground or other obstructions. The other crew member assisting in the approach will continuously monitor the airspeed, altimeter, and other instruments, as well as visually referencing the ground or obstructions (when possible) to insure immediate recognition of a dangerous condition for relay to the pilot flying the aircraft. The minimum altitude over the end of the usable runway (threshold) should normally be 50 feet, so that touchdown will occur at a minimum of 500 feet from that point. A power-on approach with a moderate rate of descent as the aircraft approaches the threshold and flare point is recommended.

WARNING

Under conditions where sideslip angles are greater than 5 degrees, approaching stall speed in the power approach or takeoff configurations, or with right angle crosswind components of 25 knots or more, errors

(CONTINUED ON PAGE 2-52)



THRESHOLD:
CROSS THRESHOLD AT A MINIMUM HEIGHT OF 50 FEET AND A MINIMUM AIRSPEED OF 1.2 Vs.

TOUCHDOWN:
TOUCH MAIN WHEELS AT A MINIMUM AIRSPEED OF 1.1 Vs. (PLAN FOR A MINIMUM OF 500 FEET FROM THE THRESHOLD)

LANDING ROLL:
TOUCH NOSEWHEEL.
USE REVERSE THRUST AND BRAKES AS REQUIRED.

DOWNWIND:
WING FLAPS — 15 DEGREES.
AIRSPEED — 1.4 Vs.

INITIAL:
REDUCE AIRSPEED TO 1.4 Vs.
TRAFFIC PATTERN ALTITUDE.
DESCENT CHECK COMPLETED.

[redacted]

NOTE:
To attain landing performance (Air Run and Ground Roll) as outlined in Part 8 of T.O. 1C-133A-1-1, the minimum speeds outlined from threshold to touchdown must be observed.

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Figure 2-10 (Sheet 1 of 2)

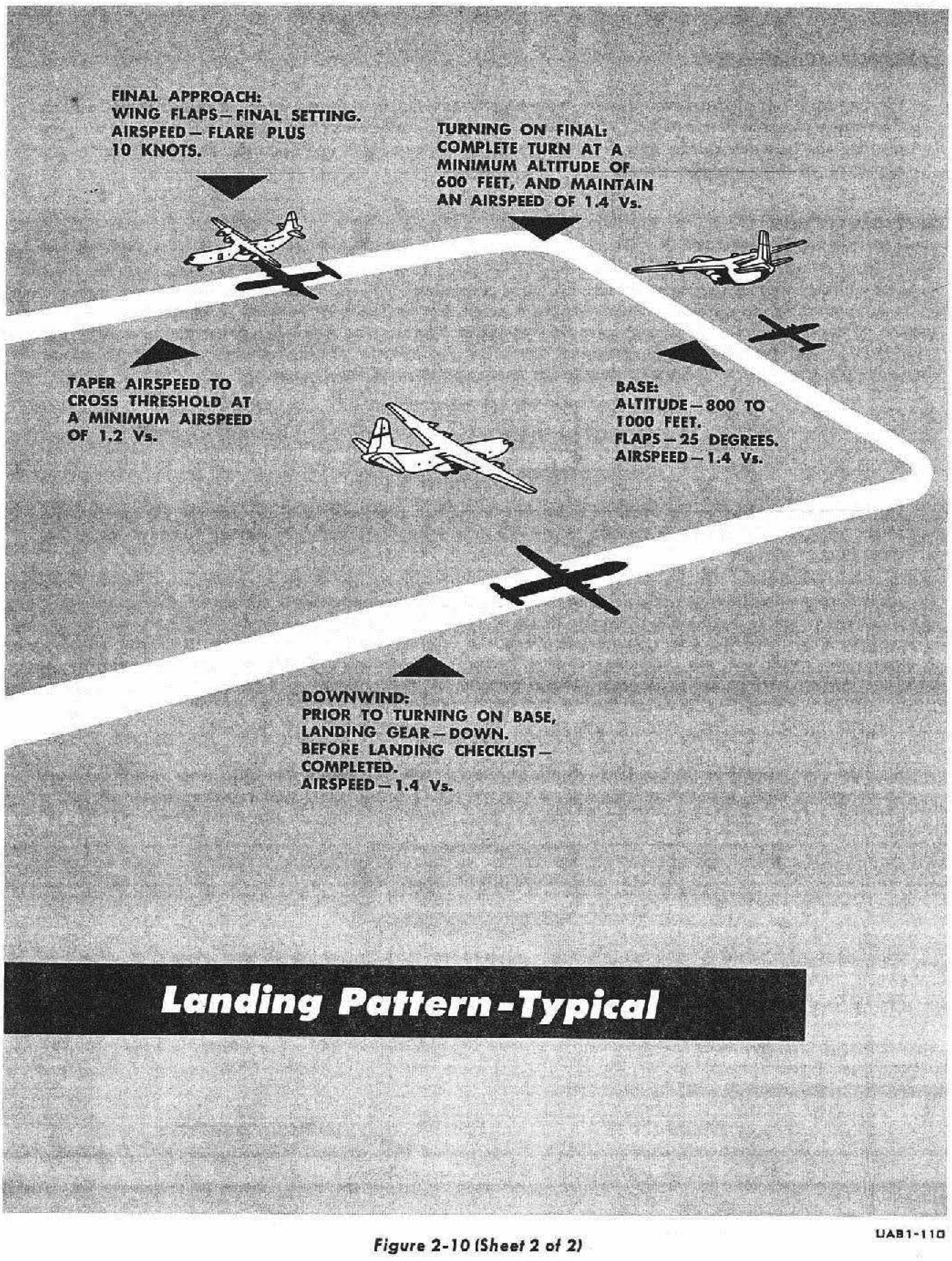

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Figure 2-10 (Sheet 2 of 2)

LANDING. *(Continued)*

existing in the airspeed indicating system may be greater than those shown on the Airspeed Position Error Correction charts in Part 2 of *T.O. 1C-133A-1-1.* Under the conditions cited, the proper indicated airspeed reading shall be determined only from that indicator which does not fluctuate, and which gives the higher of the two airspeed readings.

GUST CORRECTION.

When gusty winds exist, a correction factor should be added to the best flare speed to compensate for maneuver loads which the pilot may impose on the aircraft while correcting for gusts. The gust correction factor is determined by the amount the wind is gusting over the constant wind. For example, if the wind is reported as 30 knots with gusts to 35 knots, the gust velocity and correction would be 5 knots. The maximum gust correction that should be added is 10 knots. The procedure for using gust correction is as follows: Fly the traffic pattern at the recommended airspeeds. The gust correction is added only to the final approach and flare speeds.

WARNING

During pushover maneuvers with the wing flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch which may result from this change in elevator control force.

The procedures outlined herein are minimum requirements, and do not preclude the use of additional procedures left to the discretion of the pilot in command of the aircraft (refer to the Landing Ground Roll charts contained in Part 8 of *T.O. 1C-133A-1-1* for ground roll distances). It is considered good practice to make all landings as though reverse thrust were not available; however, reverse thrust should normally be used to prolong the service life of the brakes (see Section VII for brake system operation).

Note

Effective braking may not be possible with the antiskid switch ON during very light gross weight landings when reverse thrust is *not* used. This difficulty is created by a main gear wheel loading under the above conditions. If this is encountered, apply reverse thrust, if available, or turn the antiskid switch OFF.

WARNING

Caution should be used when landing with CG locations forward of 23 percent because of a lack of elevator effectiveness with power off. Power should be left on until landing is assured, or the flare speed should be increased by approximately 10 knots.

After landing, if reverse thrust is to be used, the nose gear should be lowered to the runway as soon as practicable. Lower the nose gear as lightly as possible, as impact shimmy may result from hard contact. The following is the recommended procedure for landing using reverse thrust.

PILOTS	***FLIGHT ENGINEER***
a. Throttles—MAINTAIN REQUIRED APPROACH IAS (P).	
b. Throttles—GROUND IDLE, after nose gear touches down (P).	

(CONTINUED ON NEXT PAGE)

LANDING. *(Continued)*

PILOTS

Note

After nose gear is in firm contact with the runway, and directional and lateral control is assured, the pilot, before applying reverse thrust, will position the throttle to GROUND IDLE and pause momentarily to check that propeller Beta warning lights come on.

The following steps constitute a normal landing procedure.

a. Propeller Beta Warning Lights—CHECK ON (CP, P).

Copilot will report "Beta lights on," or cite exception; for example, "No. 1 Beta off."

CAUTION

If one or more propeller Beta warning lights do not come on, individual throttle movement may be necessary to obtain maximum controllable reverse thrust.

b. Throttles — REVERSE, as necessary, then GROUND IDLE (P).

Note

Throttles will not be moved to GROUND RANGE until the nose gear is in firm contact with the runway and the pilot has directional and lateral control of the aircraft. The pilot will maintain control with aileron and rudder pedal steering. Throttle action may be used to assist in maintaining directional control.

CAUTION

If difficulty is encountered in maintaining directional control during reversing because of improper technique or failure of the reversing system, immediately move all throttles to GROUND IDLE.

c. Ground Idle Speed Control Switches—DEPRESS TO LO IDLE, THEN RELEASE (P).

FLIGHT ENGINEER

(CONTINUED ON NEXT PAGE)

LANDING. *(Continued)*

PILOTS

Note

To reduce rpm and forward thrust after coming out of reverse, the pilot will actuate the ground speed control switches to LO IDLE when auxiliary generator power is available.

Note

The procedures for landing without reverse thrust are similar to those utilizing reverse thrust. After the throttles are positioned to GROUND IDLE, actuate the ground speed control switches to LO IDLE. Use brakes only as required. On a long runway, allow the aircraft to roll until it loses speed. Prior to reaching the end of the runway, check the brakes to insure that braking action is available.

FLIGHT ENGINEER

★ ★ ★ ★ ★

HEAVY GROSS WEIGHT LANDINGS.

For landings at high gross weights, see the Landing Ground Roll charts in Part 8 of *T.O. 1-C-133A-1-1*. Conditions permitting, it is recommended that excess fuel be jettisoned to reduce the landing gross weight to normal limits. See Section III for fuel jettisoning procedures.

CROSSWIND LANDING.

The approach for landing during crosswind conditions should be made at the recommended approach and flare speeds (see Approach and Landing Speed chart, and Landing Crosswind chart in *T.O. 1C-133A-1-1*).

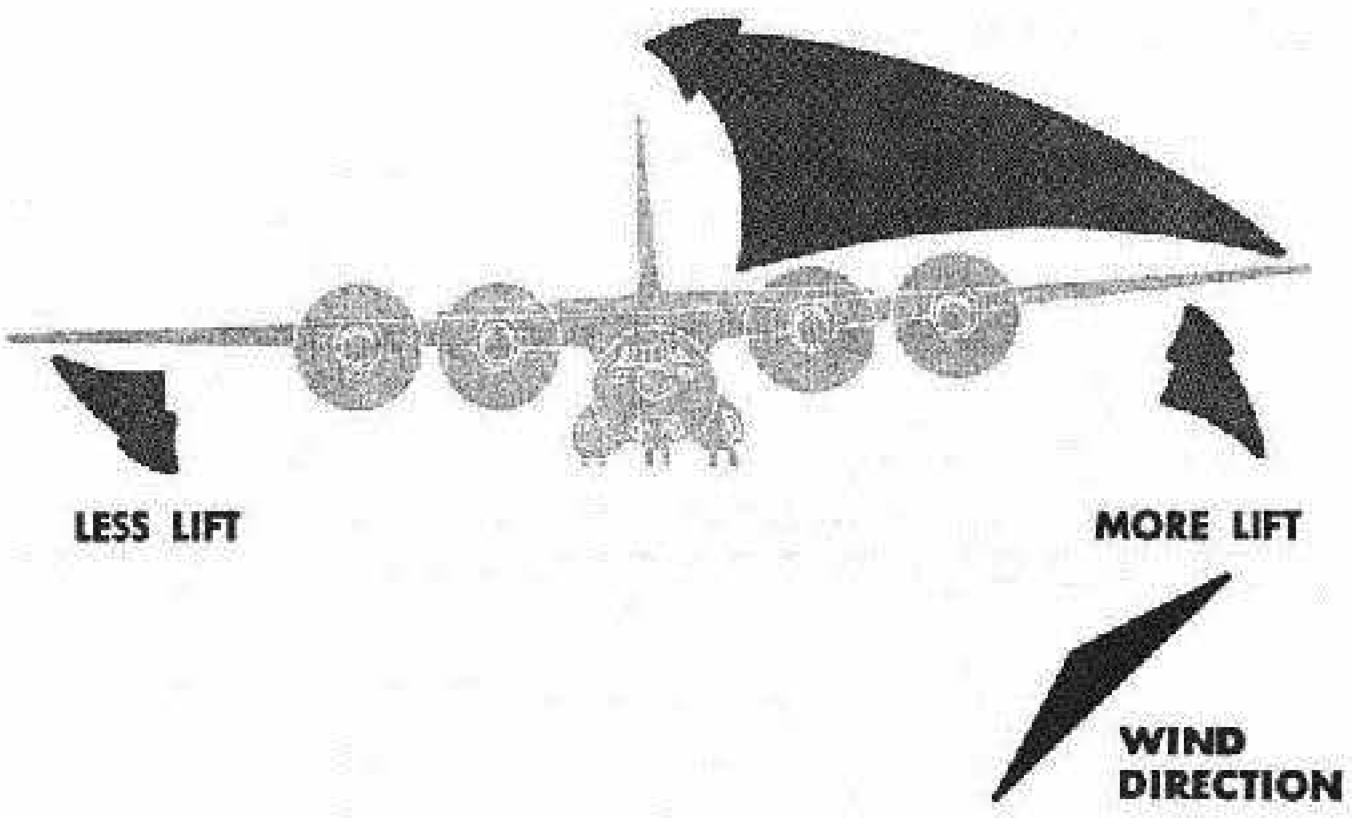
On final approach, a crab into the wind, a wingdown sideslip, or a combination of both may be used; however, prior to touchdown, the crab angle must be removed, and the upwind wing lowered, using aileron and rudder control as necessary to maintain a straight path down the runway.

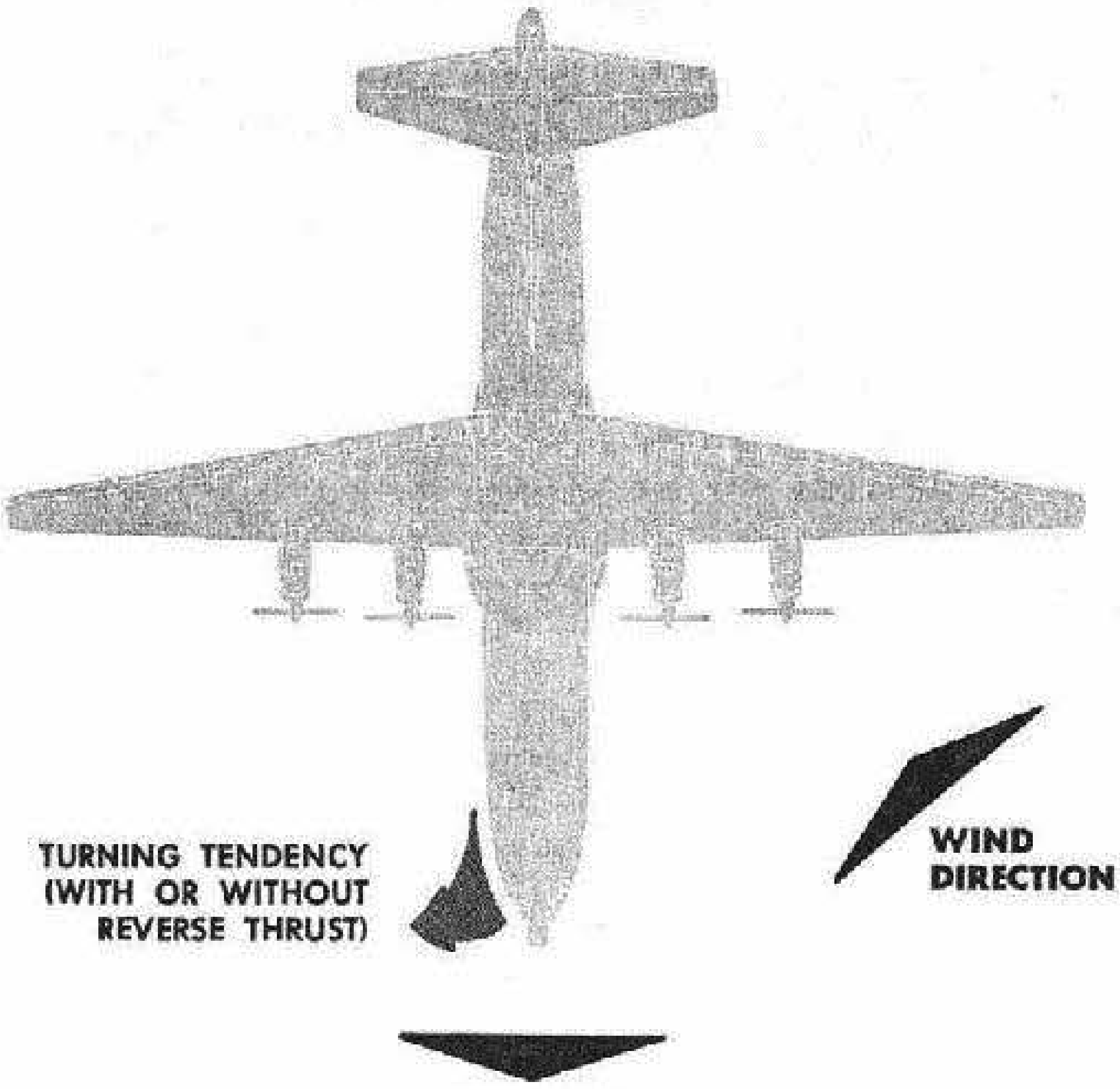
At touchdown the aircraft may tend to heel over downwind; therefore, the upwind wing should be depressed as necessary to maintain directional control *(see figure 2-11)*. As in a crosswind takeoff, the normal tendency of the aircraft is to heel over and turn downwind. Aileron control can be used to bank the aircraft into the wind for an effective assist in maintaining directional control. This technique will be especially useful on wet or icy runways when nose gear steering effectiveness is reduced. The copilot should be alert in placing the wing flaps in the takeoff position on command of the pilot, in the event of a missed approach or go-around. After the nose gear is in firm contact with the runway, and directional control is assured, the throttles may be lifted over the FLIGHT IDLE detent into the GROUND range. At all times, and especially in crosswinds, reversing of the propellers should be accomplished without haste. Before applying full reverse thrust, the pilot should pause in the GROUND range (approximately 1 inch aft of the FLIGHT IDLE detent) and check the propeller Beta warning lights ON to make certain that all propellers are functioning properly. When the engine thrust is reversed, the natural downwind tendency will increase markedly due to the crosswind effect, which produces an aerodynamically cleaner upwind wing. This produces more lift on the upwind wing than on the downwind wing, resulting in a rolling tendency about the longitudinal axis. The effects should be corrected quickly by the use of aileron control to bank the aircraft slightly into the wind, along with coordinated application of rudder control. If the crosswind is severe, the pilot can minimize the downwind banking and turning tendency by reversing only the inboard propellers.

(See Note on Page 2-56)

Normal Crosswind Landing — Four-Engine

ROLLING TENDENCY (WITH OR WITHOUT REVERSE THRUST)





Aerodynamic Forces:

Increased lift on upwind wing.

Aircraft Reaction:

Rolling and turning tendency — downwind.

Note

Use of reverse thrust will increase the above reaction considerably.

Pilot's Corrective Action:

To maintain wings level or upwind wing slightly depressed, apply aileron deflection in conjunction with coordinated rudder. On the approach, use a crab into the wind, a wing-down sideslip or a combination of both. Immediately prior to touchdown, any crab angle must be removed. To assist in directional control after touchdown, the upwind wing may be depressed slightly. With directional control assured, and after the nosewheel is in firm contact with the runway, the pilot should place the throttles in GROUND IDLE. Pause in GROUND IDLE momentarily before placing throttles in REVERSE. Apply rudder pedal steering, in conjunction with coordinated aileron, to maintain directional control.

Note

If the crosswind is severe the pilot should reverse the thrust of the inboard propellers only. This will minimize the rolling and turning tendency.

UAB1-116

Figure 2-11

Note

The use of brakes as a means of directional control is less effective on this aircraft than on aircraft with wide tread landing gear. For this reason, the brakes should not be relied upon for directional control, especially on wet or icy runways.

NO FLAP LANDING.

The no flap landing is accomplished similar to a normal landing, except that the final approach is extended. The slightly longer final approach is necessary to allow additional time required to establish and maintain the desired rate of descent and approach airspeed. During the approach continue to simulate clearing a 50 foot obstacle at the threshold. If the threshold cannot be cleared by the required 50 feet, consideration should be given to going to an alternate field affording greater margins of safety.

WARNING

Flare distance and the effect of unusual runway conditions require considerably more runway than during normal landings. Refer to the Approach and Landing charts in Part 8 of *T.O. 1C-133A-1-1* for landing and flare distances.

LANDING ON SLIPPERY RUNWAYS.

When landing on slippery runways, apply the brakes lightly and intermittently for the initial phase of the landing run. After most of the weight is on the landing gear, more brake pressure may be used. When maximum braking is essential, wing flaps should be raised as soon as the wheels are definitely on the ground. It should be remembered that braking efficiency increases as greater weight is put on the wheels, and also that as weight increases, the tires tend to flatten out, greatly increasing their traction.

MINIMUM RUN LANDING.

The procedure for minimum run landings is the same as for normal landings, except that full reverse thrust and maximum antiskid braking are used. See Approach and Landing charts in Part 8 of *T.O. 1C-133A-1-1* for ground roll distances.

WARNING

During every landing, the pilot must be alert to prevent landing the aircraft short of the intended touchdown point. Attempting to touchdown near the threshold is particularly hazardous in this aircraft as the pilot sits approximately 70 feet forward of aft main gear.

TOUCH-AND-GO LANDINGS.

Touch-and-go landings introduce a significant element of danger because of the many rapid actions which must be executed while rolling on the runway at high speed, or while flying in close proximity to the ground. The following procedures outline the necessary steps required to perform the maneuver. However, touch-and-go landings should be made only when authorized or directed by the major Air Command concerned.

WARNING

Touch-and-go landings or other low-altitude operations after prolonged cruise at altitude, and where surface ambient temperature is less than 0°C are prohibited except for emergency situations because of fuel system icing potentials. These operations may be conducted regardless of temperatures providing the aircraft has not descended from high-altitude cruise conditions.

BEFORE LANDING.

The pilot will brief the crew on the necessary steps to be performed during the approach, immediately after landing, while on the runway, and during the climb-out. The Approach and Landing charts in Part 8 of *T.O. 1C-133A-1-1* provide the necessary information for computing stopping distance with 15 degrees flap. Reference should be made to this data to determine a refusal speed in the event that an emergency occurs while on the runway. An estimate can be made of the runway used between the time of touchdown and subsequent takeoff. Wing flap retraction from 35 degrees to 15 degrees will require from 10 to 15 seconds. Normally, the aircraft is progressing at an average rate of approximately 170 feet per second during the deceleration after touchdown and acceleration prior to takeoff. The amount of runway required will depend upon the time elapsing from touchdown to takeoff. Normally a touch-and-go landing can be accomplished within a maximum period of approximately 25 seconds without hurrying on the part of any crew member. The technique to be followed on the final approach and during touchdown are identical to those prescribed under the normal landing techniques.

ON THE RUNWAY.

After touchdown, the pilot will retard the throttles to FLIGHT IDLE, and lower the nose gear in the normal manner.

WARNING

> If the throttles are inadvertently retarded below FLIGHT IDLE, the takeoff must be aborted. Drag effects, and subsequent deceleration under these conditions are quite high, and runway required for continued takeoff is prohibitive.

If the takeoff is continued, the pilot will direct the copilot to retract the wing flaps to 15 degrees by stating, "Flaps 15." The copilot will acknowledge, and retract the wing flaps to 15 degrees. While the wing flaps are being retracted, the copilot will reset the trim to approximately 4 degrees nose up, or as briefed by the aircraft commander. After the trim is reset, and the wing flaps are at 15 degrees, the copilot will state, "Flaps set." After the copilot has stated, "Flaps set," the pilot will advance the throttles to the predicted dry power setting. As the pilot advances the throttles, the copilot will reset the propeller synchronizer buttons, and continue as in a normal takeoff.

WARNING

> Minimum rotation speed must be obtained prior to takeoff.

If any malfunction is noted prior to takeoff, the standard procedure for abort will be followed. An aborted takeoff will be handled as prescribed in Section III. If persistent popping of one or more propeller synchronizer buttons occurs, this will not necessarily be considered as reason to abort the takeoff. Satisfactory takeoff may be accomplished with one or more synchronizer buttons popped, since the propeller will go to mechanical reference governing, and the rpm will remain at 97.7 percent. Any research of the cause for popping synchronizer buttons will be accomplished after the aircraft has leveled off or, if the aircraft has aborted, when clear of the runway.

AFTER TAKEOFF.

After takeoff and climb, procedures will be the same as previously described in this section. If a propeller synchronizer button pops after takeoff, the copilot or pilot may reset the button, conditions and circumstances permitting. The pilot may desire to leave the landing gear extended if the aircraft is to remain in the traffic pattern, and a series of touch-and-go landings are planned. Climbout performance at low gross weights with the landing gear extended is better than climbout performance at high gross weights with the landing gear retracted.

GO-AROUND.

If the pilot considers it necessary to make a go-around, he will accomplish the following:

a. Throttles—MAX power.

b. Crew—ALERT.

Give the command, "Go-Around," to the copilot and the engineer.

c. Wing Flaps—Direct the copilot to retract the wing flaps to 15 degrees (before leaving ground, if contact has been made).

Note

> Raising the wing flaps from the full down position to 15 degrees immediately, rather than waiting for the airspeed to build up, is of paramount importance. In case of an engine failure, the airspeed may not increase as long as the flaps are full down, due to the high flap drag. As long as normal approach speeds are used, the airspeed will be high enough so that the flaps may be raised to 15 degrees immediately, without stalling the aircraft.

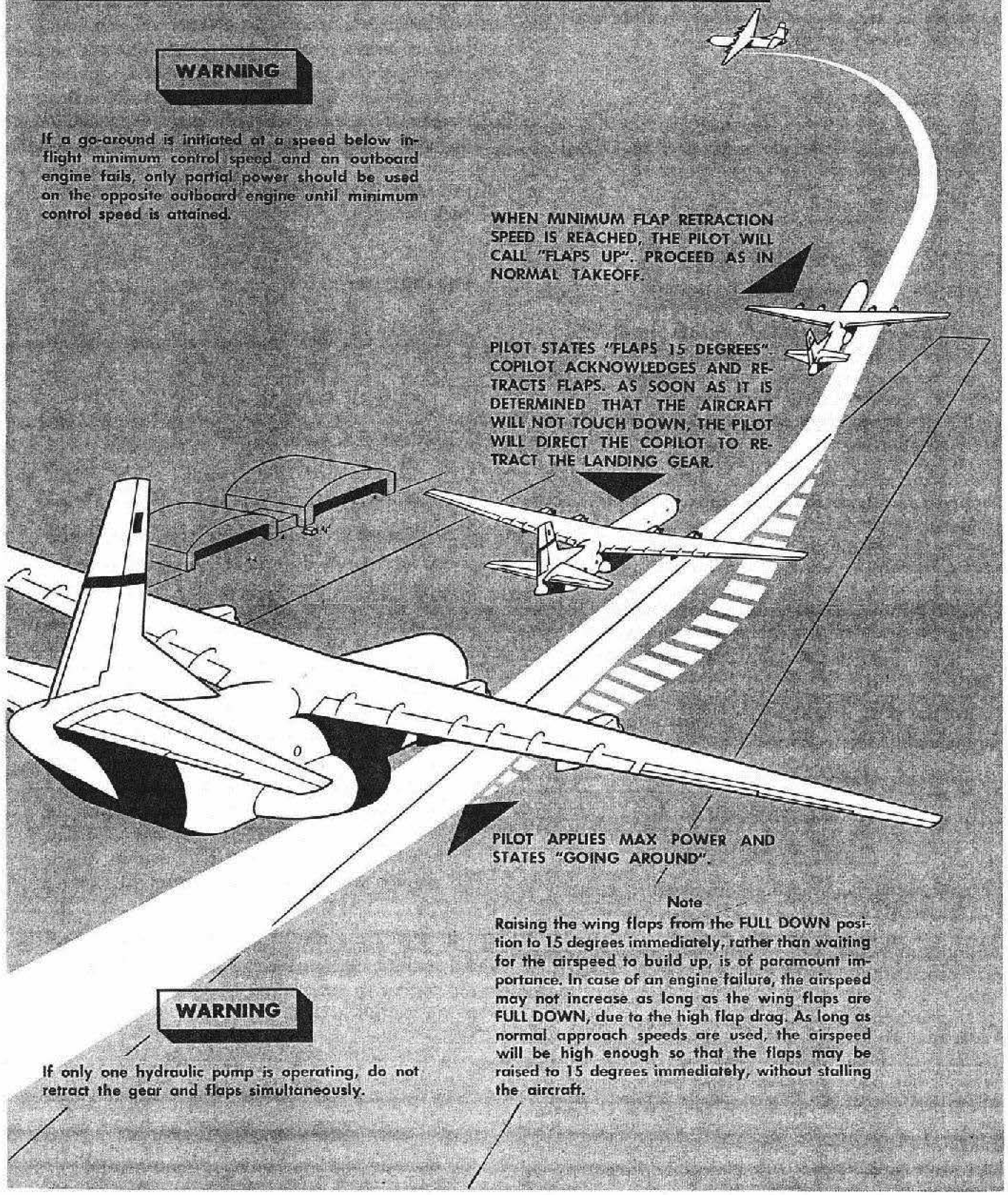
d. Landing gear—As soon as it is determined that the aircraft will not touch down, the pilot will direct the copilot to retract the landing gear, and proceed as in a normal takeoff.

WARNING

> Due to the large volume of fluid required to retract the gear and flaps simultaneously, the

(Continued on Page 2-59)

Go-Around Pattern-Typical



WARNING

If a go-around is initiated at a speed below in-flight minimum control speed and an outboard engine fails, only partial power should be used on the opposite outboard engine until minimum control speed is attained.

WHEN MINIMUM FLAP RETRACTION SPEED IS REACHED, THE PILOT WILL CALL "FLAPS UP". PROCEED AS IN NORMAL TAKEOFF.

PILOT STATES "FLAPS 15 DEGREES". COPILOT ACKNOWLEDGES AND RETRACTS FLAPS. AS SOON AS IT IS DETERMINED THAT THE AIRCRAFT WILL NOT TOUCH DOWN, THE PILOT WILL DIRECT THE COPILOT TO RETRACT THE LANDING GEAR.

PILOT APPLIES MAX POWER AND STATES "GOING AROUND".

Note

Raising the wing flaps from the FULL DOWN position to 15 degrees immediately, rather than waiting for the airspeed to build up, is of paramount importance. In case of an engine failure, the airspeed may not increase as long as the wing flaps are FULL DOWN, due to the high flap drag. As long as normal approach speeds are used, the airspeed will be high enough so that the flaps may be raised to 15 degrees immediately, without stalling the aircraft.

WARNING

If only one hydraulic pump is operating, do not retract the gear and flaps simultaneously.

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Figure 2-12

> flaps must be retracted to 15 degrees before raising the gear, in order to obtain nominal flap retraction time.

The copilot will accomplish the following:

a. Wing Flaps—RETRACT TO 15 DEGREES.

b. Landing Gear—GEAR UP, at pilot's command.

The flight engineer will accomplish the following:

a. Anti-Icing and Deicing Switches—AS REQUIRED.

b. Pressurization Switch—AS REQUIRED.

c. Air Conditioning Switches—AS REQUIRED.

After the previous procedures have been completed, proceed with a normal takeoff.

★ ★ ★ ★ ★

AFTER LANDING.

Note

This checklist will be accomplished after the landing ground roll is completed.

PILOTS

1. Pitot Heater Switches—OFF (CP).

2. Hydraulic and Emergency Airbrake Pressure—WITHIN LIMITS (CP).

The copilot periodically checks the pressure indicators during all ground operations.

3. Wing Flaps—UP (CP).

4. Trim Tabs—RESET (CP).

Note

> Items 1, 2, 3, and 4 may be performed by the copilot without verbal challenge, or reply.

5. Anticollision Lights—OFF (P).

6. Navigation Lights—CLIMATIC (P).

7. Windshield Anti-Icing Switches—OFF (CP).

⑧ IFF—OFF (P or N).

⑨ Navigator's Report—"AFTER LANDING CHECK COMPLETED" (N).

⑩ Engineer's Report—"ENGINEER'S AFTER LANDING CHECK COMPLETED" (E).

11. "After Landing Check—COMPLETED" (CP).

FLIGHT ENGINEER

1. Cabin Pressurization—DEPRESSURIZED.

2. Anti-Icing and Deicing Switches—OFF.

3. Propeller Deicing Switches—OFF.

4. Air Conditioning Switches—CHECKED.

⑤ Engineer's Report—"ENGINEER'S AFTER LANDING CHECK COMPLETED."

Note

> In congested areas, the scanner/ground controller will be in the crew escape hatch on interphone. During night operations, he will be equipped with an Aldis lamp.

POSTFLIGHT.

An aircrew postflight engine runup is not normally required for this aircraft.

ENGINE SHUTDOWN.

WARNING

Check that the aircraft is fully depressurized before any doors, windows, or hatches are opened.

1. Parking Brake—SET (P).
2. Rpm—HIGH GROUND IDLE (P).
3. Surface Snubber Lever—LOCKED (CP).

Note

T-34 engines operate at cooler internal temperatures at HIGH GROUND IDLE than at LOW GROUND IDLE. To prevent turbine blade rubbing, the engine should always be shut down from HIGH GROUND IDLE. Following engine operation at LOW GROUND IDLE, the engine should be allowed to cool for a minimum of 2 minutes at HIGH GROUND IDLE prior to shutdown. Taxi time in HIGH GROUND IDLE may be counted as part of the 2 minute cooling period. Should only 2 engines be required for taxiing, it is permissible to shut down the other 2 engines after landing prior to going to LOW GROUND IDLE.

4. Condition Levers—FUEL OFF (P).

BEFORE LEAVING AIRCRAFT.

CAUTION

In addition to established requirements for reporting any system defects, unusual and excessive operations, the flight crew will also make entries in Form 781 to indicate when any limits in the flight manual have been exceeded.

PILOTS

① Scanner/Ground Controller—"CLEARED TO DEPART AIRCRAFT" (P, S/GC).

After receiving pilot's clearance, scanner/ground controller replies "Departing Aircraft."

2. Oil Cooler Door Switches—OFF (CP).

3. Radios, Radar—OFF (CP).

FLIGHT ENGINEER

1. Air Conditioning and Pressurization Systems—OFF.

2. Fuel System—OFF.

After engine shutdown, perform the following:

a. All Fuel Boost Pump Switches—OFF.

b. All Fuel Valve Switches—CLOSED.

SCANNER/GROUND CONTROLLER

① Scanner/Ground Controller—"DEPARTING AIRCRAFT."

After receiving pilot's clearance state, "Departing Aircraft."

(CONTINUED ON NEXT PAGE)

BEFORE LEAVING AIRCRAFT. *(Continued)*

PILOTS

④ Scanner/Ground Controller's Report—"PINS & CHOCKS IN PLACE & GROUND POWER CONNECTED" (S/GC).

5. Parking Brake—AS REQUIRED (P).

Release the parking brakes if chocks are in place.

6. Nose Gear Steering Bypass Valve Release Handle — PULLED (P).

7. Engine Brake Switches—ON (P).

CAUTION

It is advisable for the engine brake switch to be left in the ON position at all times when the engine is not running. However, to enable the turbine blades to cool as much as possible before engine rotation stops, the brake should not be applied until the engine coasts to zero rpm, except in cases of emergency. In any case, the brake should not be applied until the engine rpm is below 45 percent.

8. Lights and Switches — OFF (CP, P).

FLIGHT ENGINEER

3. Circuit Breakers — AS REQUIRED.

    a. Ignition Breakers—**OPEN.**

    b. Pilot's Vertical Gyro A-c and D-c Circuit Breakers—OPEN.

    c. Copilot's Vertical Gyro A-c and D-c Circuit Breakers — OPEN.

    d. Engine Propeller Control Circuit Breaker—OPEN.

    e. Propeller Synchronizer Power Circuit Breaker—OPEN.

    f. Propeller Deicing Timer Circuit Breaker—OPEN.

    g. Beta Circuit Breakers — OPEN.

    h. Fuel Flow Indicator Power Circuit Breaker—OPEN.

    j. EGT/TIT Circuit Breakers—OPEN.

4. Autopilot Power Switch — GROUND.

5. Main A-c Generator Switches—OFF.

CAUTION

If the voltmeter selector is left in AUX GENERATOR BATTERY position, the battery will lose its charge in a short period.

7. Battery Switch—OFF.

8. No. 2 GTU Start-Run-Stop Switch—STOP.

9. No. 1 GTU Start-Run-Stop Switch—STOP.

Check hydraulic pressure.

(CONTINUED ON NEXT PAGE)

SCANNER/GROUND CONTROLLER

② Scanner/Ground Controller's Report—"PINS & CHOCKS IN PLACE & GROUND POWER CONNECTED."

BEFORE LEAVING AIRCRAFT. *(Continued)*

PILOTS	***FLIGHT ENGINEER***	***SCANNER/GROUND CONTROLLER***
⑨ Engineer's Report—"ENGINEER'S BEFORE LEAVING AIRCRAFT CHECK COMPLETED" (E).	⑩ Engineer's Report—"ENGINEER'S BEFORE LEAVING AIRCRAFT CHECK COMPLETED."	
10. "Before Leaving Aircraft Check—COMPLETED" (CP).		

STRANGE FIELD PROCEDURES.

When compelled to operate through bases not normally visited by the aircraft, and the ground crew is not familiar with the aircraft, the flight crew will perform the required inspections contained in *T.O. 1C-133A-6*.

PILOTS' TAKEOFF AND LANDING DATA CARDS

C-133 TAKEOFF DATA CARD

GROSS WEIGHT ____________ POUNDS
PRESSURE ALTITUDE ____________ FEET
RUNWAY TEMPERATURE ____________ °C
RUNWAY LENGTH ____________ FEET
RUNWAY SLOPE ____________
WIND COMPONENT ____________ KNOTS
FLAP SETTING ____________ DEGREES
TAKEOFF FACTOR ____________
GROUND RUN ____________ FEET
CRITICAL FIELD LENGTH ____________ FEET
GROSS WEIGHT LIMITED BY—
- CRITICAL FIELD LENGTH ____________ POUNDS
- 3-ENGINE CLIMB PERFORMANCE ____________ POUNDS
- CLIMBOUT OVER OBSTACLE ____________ POUNDS

	Flaps 0°	*Flaps 15°*
EMERGENCY 3-ENGINE CLIMB SPEED		

Torque	*Min*	*Predicted*	*Max*	*EGT/TIT*
Wet				
Dry				
SHAFT H.P. (MIN.)				

ACCELERATION TIME/MARKER ____________
ACCELERATION AIRSPEED ____________
REFUSAL AIRSPEED ____________
TAKEOFF AIRSPEED ____________
FLAP RETRACTION ____________

NORMAL CLIMB DATA

BEST CLIMB AIRSPEED ____________ IAS
FIRST CLIMB TORQUE ____________ PSI
EGT/TIT LIMIT ____________ °C

C-133 LANDING DATA CARD

DESTINATION INFORMATION

PRESSURE ALTITUDE ____________ FEET
RUNWAY LENGTH ____________ FEET
RUNWAY TEMPERATURE ____________ °C
WIND COMPONENT ____________ KNOTS

FOUR & THREE ENGINE GO-AROUND FLAP RETRACTION AIRSPEED
AFTER T.O. DESTINATION
1.2 Vs (35 DEGREE FLAPS) PLUS 10 KNOTS ____________ KNOTS

			After Takeoff	*At Destination*
GROSS WEIGHT				
SPEEDS	VELOCITY STALL	FLAPS		
INITIAL	1.4 Vs	0°		
DOWNWIND	1.4 Vs	15°		
BASE	1.4 Vs	25°		
FINAL	1.2 Vs + 10 KNOTS	35°		
FLARE	1.2 Vs	35°		
LANDING GROUND ROLL + FLARE DISTANCE (BRAKES PLUS 2-ENGINE REVERSE THRUST—OVER 50-FT. OBSTACLE)		GROUND ROLL PLUS UNUSUAL PLUS FLARE TOTAL		

Figure 2-13

FLIGHT ENGINEER'S TAKEOFF AND LANDING DATA CARD AND INFLIGHT DATA CARD

INFLIGHT DATA CARD

CL. TO FT. AT HRS Ƶ

CLIMB POWER NR. ALT. FT.	CR. POWER FT.
TOP PSI	TOP PSI
MAX. EGT/TIT °C	EGT/TIT MAX. SCHED.
FUEL FLOW	FUEL FLOW
PILOTS IAS	PILOTS IAS

3 ENG. DATA

ALTITUDE

ALT. FT.

FUEL DATA

FUEL REMAINING AT

HRS Ƶ

(FUEL LBS) (HOURS)

TAKEOFF DATA

GR.WT.______________LBS.

C.G.______________%MAC

Static Top______________PSI

Max.EGT/TIT______________°C

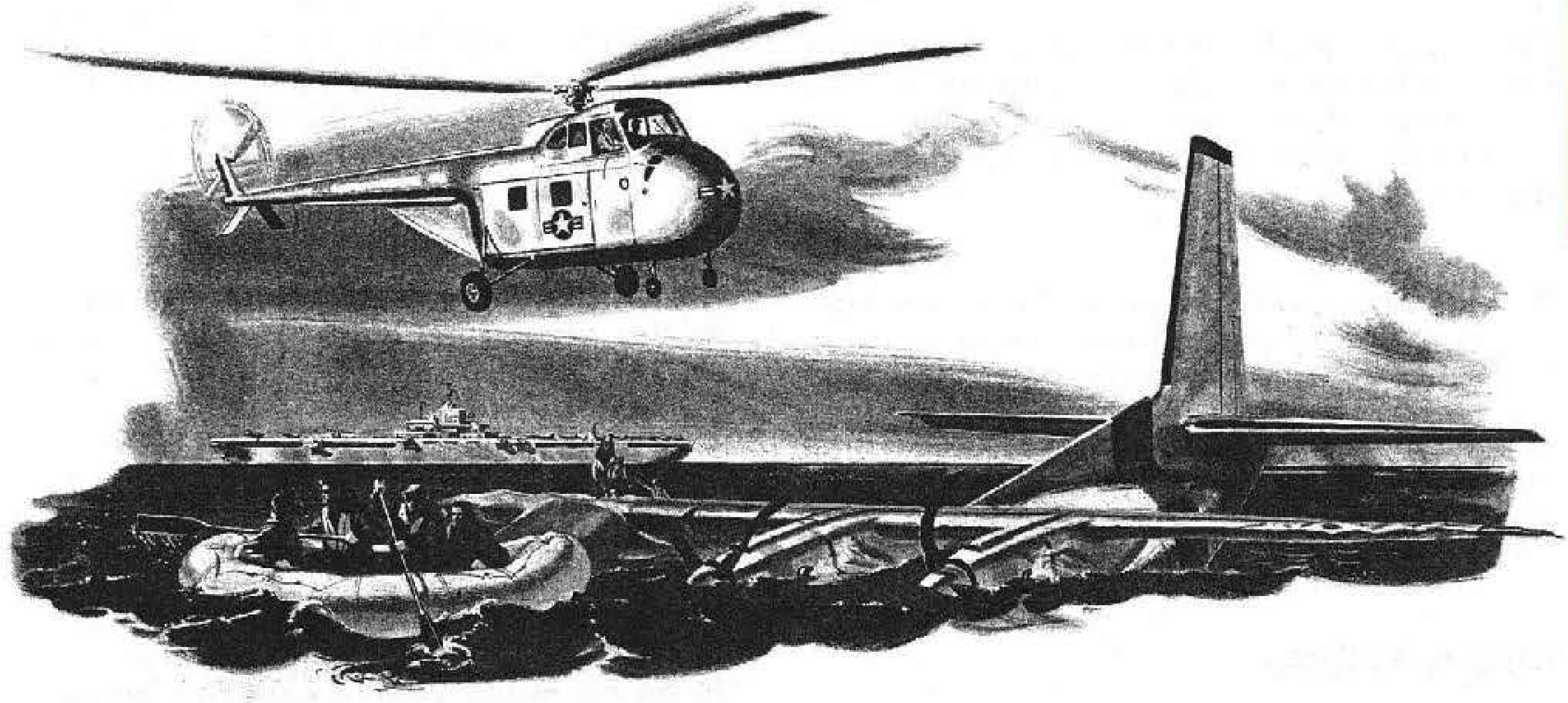
LANDING DATA

GR.WT.______________LBS.

C.G.______________%MAC

(Not required if TOLD Card is completed by pilot)

Figure 2-14



EMERGENCY PROCEDURES SECTION III

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TABLE OF CONTENTS

INTRODUCTION.

This section provides the best possible emergency operating instructions under most circumstances, but is a poor substitute for sound judgment. Multiple emergencies may require modification of procedures contained herein.

Most procedures in this section require that a substantial list of items be accomplished to handle the emergency. Certain critical items, however, usually provide immediate control of the situation and are printed in bold face type. The accomplishments of these items should be as nearly instinctive as possible, and should be handled by the flight crew without reference to the checklist.

ENGINE FAILURE.

If an engine failure occurs, the NTC system will reduce the drag caused by the windmilling propeller by moving the propeller blades toward the feathered position.

CAUTION

> The NTC system will not move the propeller to a full feathered position. The propeller must be feathered by using the respective condition lever and/or auxiliary feathering switch as soon as it is determined that an engine failure has occurred.

Engine failure may be determined by checking that EGT/TIT indicator and the torque pressure indicator.

ENGINE BLEED VALVE SYSTEM FAILURE.

Bleed valve governor failure will be indicated by a large drop in torque pressure, a fluctuation or reduction in engine rpm, and a drop in EGT/TIT temperature and fuel flow. Placing the engine bleed valve governor override switch in the OVERRIDE position will restore the engine to normal operation.

CAUTION

> To prevent the engine compressor from stalling, the engine bleed valve governor override switch must be placed in the OFF position before the engine is operating at LOW GROUND IDLE rpm.

Note

> When moving the throttle from the FLIGHT range to GROUND IDLE, a mechanical stop in the fuel control unit prevents the engine from going to LOW GROUND IDLE until the ground idle speed control switch is set to LO IDLE.

FLIGHT CHARACTERISTICS UNDER PARTIAL POWER CONDITIONS.

The most critical condition requiring directional control is that resulting from engine failure during takeoff.

Minimum Rotation Speed.

Minimum rotation speed is defined as the minimum speed at which directional control of the aircraft may be maintained in the event an outboard engine fails as the nosewheel lifts off of the runway during takeoff. To maintain directional control by rudder pedal steering, the nosewheel must be kept in firm contact with the runway until the minimum rotation speed is reached.

Minimum rotation speeds are presented on the Takeoff, Minimum Rotation, and Flap Retraction Speeds chart in Part 3 of *T.O. 1C-133A-1-1.*

WARNING

> Whenever the minimum rotation speed is less than the normal liftoff speed ($1.02V_S$), normal liftoff speed shall be used for takeoff.

Inflight Minimum Control Speed.

Inflight minimum control speed is defined as the minimum speed at which directional control of the aircraft may be maintained, during flight, with one or two engines inoperative on one side of the aircraft and the remaining engines operating at maximum power. Inflight minimum control speed is less than ground minimum rotation speed as bank angles greater than 5 degrees are obtainable during flight. The inflight minimum control speeds shown in the following table are for takeoff configuration only. More detailed inflight minimum control speeds are presented on the Emergency Climb charts in Part 4 of *T.O. 1C-133A-1-1.*

WARNING

Whenever the inflight minimum control speed is less than the stall speed, the stall speed must be used for minimum aircraft speeds.

INFLIGHT MINIMUM CONTROL SPEEDS (TAKEOFF CONFIGURATION)

**Condition*	6500 SHP	6950 SHP
	IAS (Knots)	IAS (Knots)
One Outboard Propeller Feathered	102	104
One Outboard Engine Failed, Propeller Windmilling On NTC	108	110
Two Propellers Feathered On Same Side	131	133
Two Engines On Same Side Failed, Propellers Windmilling On NTC	137	139

*For all gross weights; MAX power on operating engines; wing flaps at 15 degrees; landing gear down; and a bank angle of 5 degrees.

Note

Directional trim is sufficient to trim the aircraft for cruising with two propellers feathered on one side.

Driftdown.

Driftdown is defined as a descent, resulting from the loss of power of one or more engines, to an altitude that represents the absolute ceiling of the aircraft with the available engine power. Terrain clearance in relation to time and distances during driftdown may become critical under conditions of one-engine-out or two-engine-out operation. Therefore, it is important that the pilot know the expected altitude loss, the recommended driftdown airspeed, and the time and distance required to drift down to the three-engine or two-engine absolute ceiling. This data may be obtained from the Driftdown charts in Part 5 of *T.O. 1C-133A-1-1.*

The Driftdown charts are based on speeds for minimum rates of descent and maximum range. The time and distance curves are based on a descent to the altitude where the aircraft has a 25-feet per minute rate of descent, and takes into account the fuel consumed during descent. The 25-feet per minute rate was selected as a conservative figure, and is intended to prevent optimism that could result from including the high values of time and distance that are associated with drifting down to absolute ceiling.

★ ★ ★ ★ ★

ENGINE FAILURE DURING TAKEOFF.

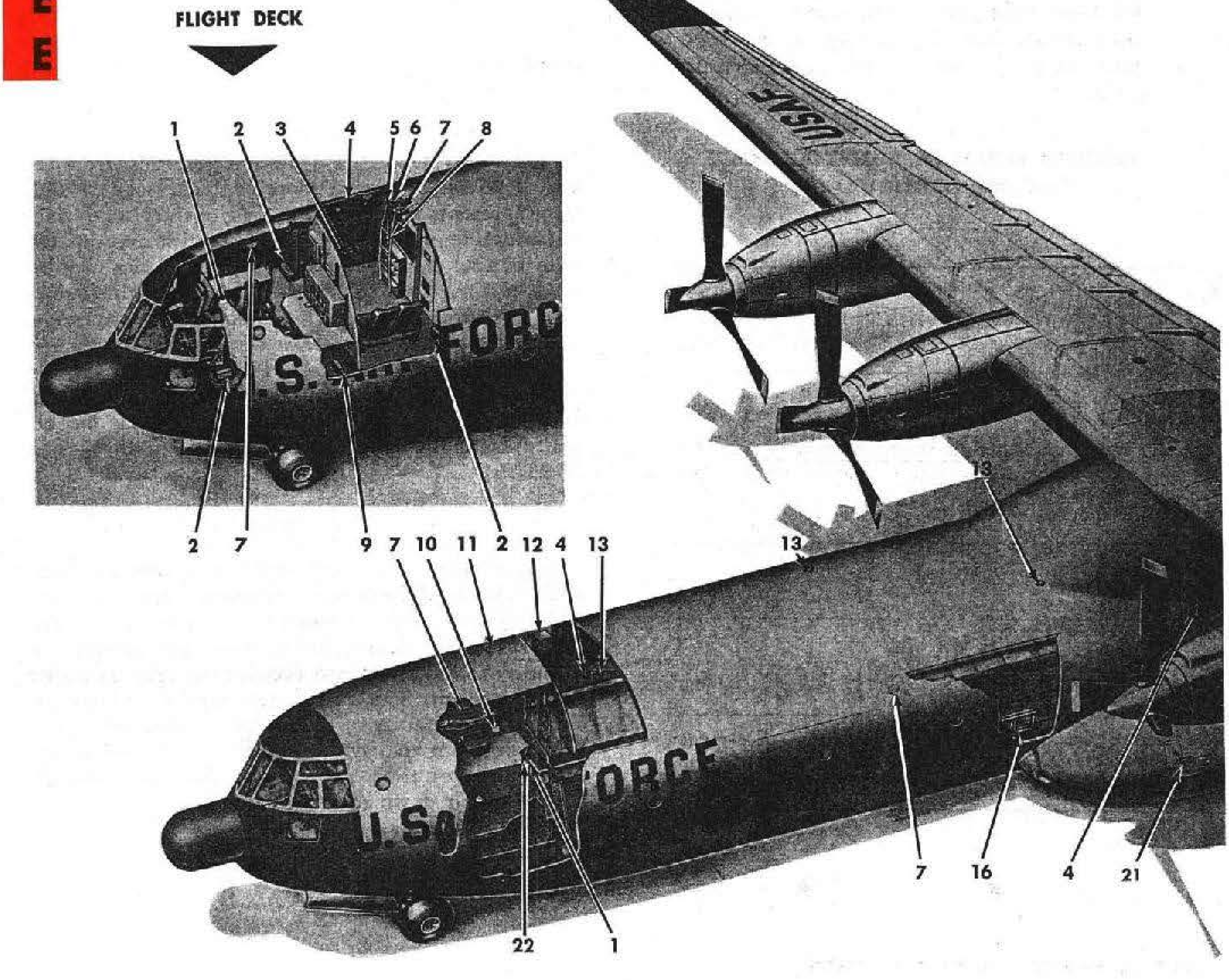
Engine Failure Before Reaching Refusal Speed.

If an engine should fail before reaching refusal speed, the takeoff must be aborted. At the instant of engine failure, the aircraft will tend to turn in the direction of the failed engine. The pilot should use rudder pedal steering in conjunction with the ailerons to maintain directional control, and should immediately reduce power on all engines to FLIGHT IDLE, and then place the throttle in the GROUND IDLE position. Using individual throttle movement, the pilot should obtain maximum controllable reverse thrust. Asymmetrical braking will not materially increase directional control due to the narrow tread width of the landing gear.

The abort procedures for all engine conditions are contained in the Takeoff and Landing Emergencies in this section.

(CONTINUED ON PAGE 3-6)

Emergency



1. PORTABLE FIRE EXTINGUISHERS (3 PLACES)
2. FIRST AID KITS (3 PLACES)
3. ANTIEXPOSURE SUITS STOWAGE PROVISIONS
4. ALARM BELLS (4 PLACES)
5. CREW ESCAPE ROPE (STOWED)
6. CREW LIFERAFT RELEASE HANDLE
7. IMPACT EMERGENCY LIGHTS (7 PLACES)
8. CREW ESCAPE LADDER

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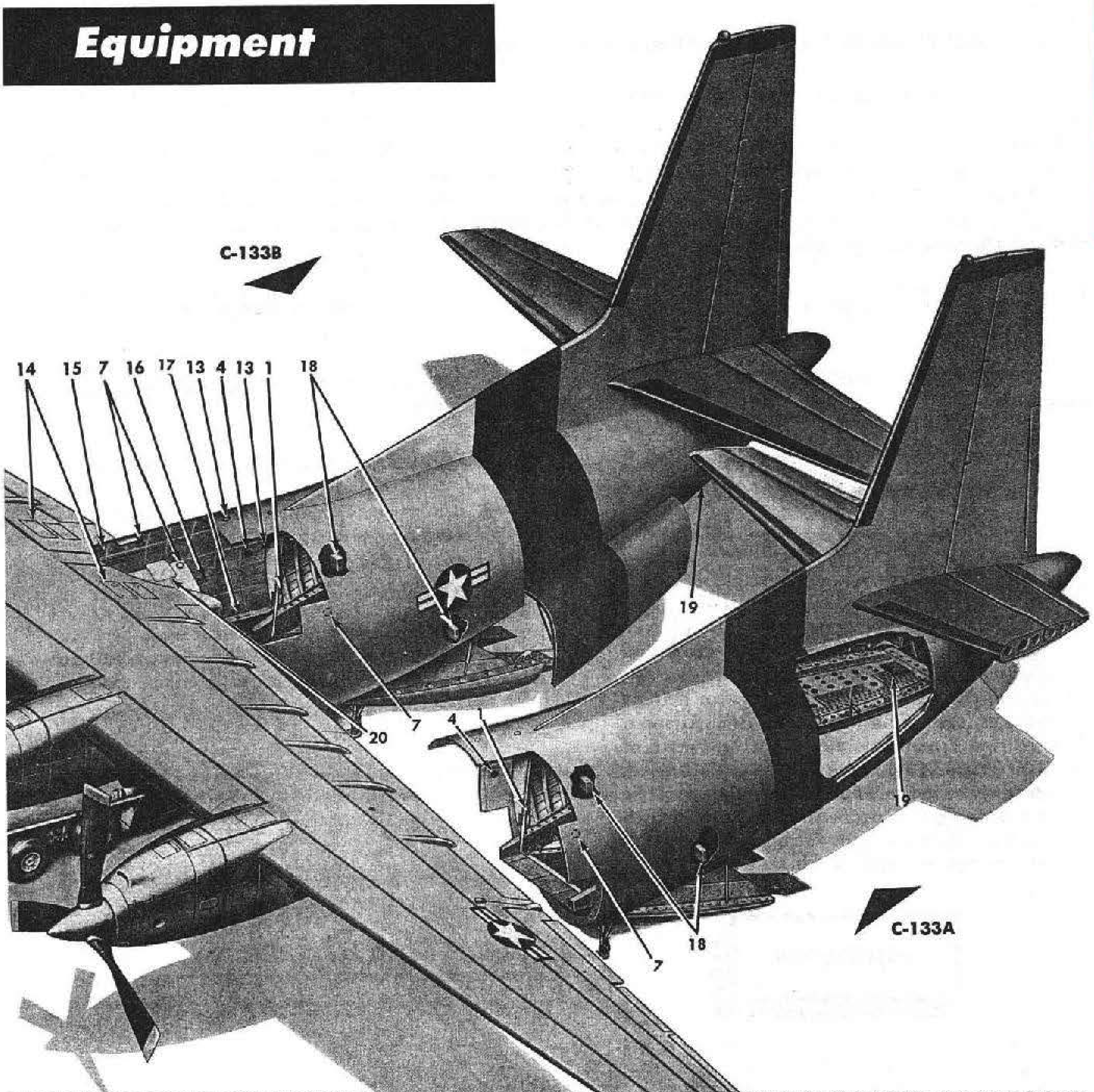
Figure 3-1 (Sheet 1 of 2)

Equipment



9. PYROTECHNIC INSTALLATION
10. PARACHUTE STATIC LINE
11. CREW EMERGENCY ESCAPE HATCH
12. CREW LIFERAFT AND EMERGENCY RADIO
13. BAILOUT ALARM LIGHTS (5 PLACES)
14. CABIN LIFERAFTS (2 EACH WING)
15. CABIN LIFERAFT RELEASE HANDLES (2 EACH SIDE)
16. CABIN ESCAPE LADDERS (2 PLACES)
17. FIRE AXE
18. JETTISON SAFETY HARNESSES (2 PLACES)
19. EMERGENCY DEPRESSURIZATION DOOR(LOCATED IN REAR CARGO DOOR ON C-133A, AND IN AFT DOOR ON C-133B. C-133B DOOR NOT SHOWN)
20. CABIN EMERGENCY ESCAPE HATCH (1 EACH SIDE)
21. AIR DRIVEN GENERATOR (T.C.T.O. 519)
22. WINDOW PRESSURE BARRIERS (STOWED IN CREW EQUIPMENT STOWAGE COMPARTMENT)

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Figure 3-1 (Sheet 2 of 2)

ENGINE FAILURE DURING TAKEOFF. *(CONTINUED)*

Engine Failure or Fire After Reaching Refusal Speed.

If an engine should fail, or if an engine fire should occur after passing refusal speed, continue the takeoff. Rudder pedal steering, in conjunction with ailerons, will be effective in maintaining directional control. The nose gear should be kept in contact with the runway until takeoff speed is reached. The aircraft should be banked approximately 5 degrees away from the inoperative engine during takeoff rotation to assure adequate directional control. Perform the following operations.

PILOTS

1. **DIRECTIONAL CONTROL AND AIRSPEED — MAINTAIN.**

WARNING

Under conditions where sideslip angles are greater than 5 degrees, approaching stall speed in the power approach or takeoff configurations, or with right angle crosswind components of 25 knots or more, errors existing in the airspeed indicating system may be greater than those shown on the Airspeed Position Error Correction charts in Part 2 of *T.O. 1C-133A-1-1.* Under the conditions cited, the proper indicated airspeed reading shall be determined only from that indicator which does not fluctuate, and which gives the higher of the two airspeed readings.

WARNING

Whenever the minimum rotation speed is less than the normal liftoff speed (1.02 V), normal liftoff speed must be used for takeoff.

WARNING

Whenever inflight minimum control speed is less than the stall speed, the stall speed must be used for minimum aircraft speed.

2. **CONDITION LEVER (AFFECTED ENGINE) — FEATHER.**

FLIGHT ENGINEER

1. **FUEL BOOST PUMP SWITCH (AFFECTED ENGINE) — OFF.**

2. Fuel Management — AS REQUIRED.

3. Automatic Generator Changeover — CHECK. (If inboard propeller is feathered)

Note

If an inboard engine is feathered, perform the necessary Electrical Power System Failure procedures, outlined in this section.

(CONTINUED ON NEXT PAGE)

ENGINE FAILURE DURING TAKEOFF. *(CONTINUED)*

PILOTS

3. **ENGINE FIRE CONTROL HANDLE (AFFECTED ENGINE) — PULL OUT & TURN TO LOCK.**

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguisher agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

4. **THROTTLE (AFFECTED ENGINE, IF WATER-ALCOHOL IS BEING USED) — FLIGHT IDLE.**

WARNING

To insure maximum available water on the operating engines, the inoperative engine throttle must be retarded.

5. **LANDING GEAR LEVER — GEAR UP AFTER SAFETY AIRBORNE.**

6. Auxiliary Feathering Switch (Affected engine)—FEATHER.

If the propeller continues to rotate, set auxiliary feathering switch to NORMAL (off) to actuate the normal feathering circuit. If the propeller continues to rotate very slowly, set engine brake switch to ON. If the engine brake does not stop propeller rotation, immediately set switch to OFF.

CAUTION

To prevent overheating, under no circumstances should the engine brake be used if propeller rotation exceeds 1 blade per second as determined by a visual check.

FLIGHT ENGINEER

(CONTINUED ON NEXT PAGE)

ENGINE FAILURE DURING TAKEOFF. *(CONTINUED)*

PILOTS

7. Wing Flaps — FLAPS UP.

Retract wing flaps after reaching minimum wing flap retraction speed (see Takeoff, Minimum Rotation, and Flap Retraction Speeds chart in Part 3 of *T.O. 1C-133A-1-1).*

8. Affected Engine — VISUALLY CHECK.

Pilot directs a crew member to visually check the affected engine.

CAUTION

> If propeller continues to rotate, and no engine fire exists, set the firewall shutoff valve switch to OIL ON.

9. Engine Fire Extinguisher Discharge Switch (If fire exists) — 1ST FIRE EXT (Hold for minimum of 3 seconds).

10. Oil Cooler Door Switch (Affected engine) — CLOSE, then release to OFF.

11. Operating Engines — ADJUST.

Maintain power as necessary.

12. Aircraft — TRIM.

FLIGHT ENGINEER

ENGINE FAILURE DURING FLIGHT.

If an engine fails, or if an engine fire occurs during flight, it is imperative that the affected engine's propeller be feathered. Perform the following steps for that engine.

PILOTS

1. **DIRECTIONAL CONTROL AND AIRSPEED — MAINTAIN.**

2. **CONDITION LEVER — FEATHER.**

FLIGHT ENGINEER

1. Fuel Boost Pump Switch — OFF.

Place switch in OFF position after propeller is feathered.

2. Fuel Management — AS REQUIRED.

(CONTINUED ON NEXT PAGE)

ENGINE FAILURE DURING FLIGHT. *(CONTINUED)*

PILOTS

3. Auxiliary Feathering Switch — FEATHER.

If the propeller continues to rotate, set auxiliary feathering switch to NORMAL (off) to actuate the normal feathering circuit. If the propeller continues to rotate very slowly, set engine brake switch to ON. If the engine brake does not stop propeller rotation, immediately set switch to OFF.

CAUTION

> To prevent overheating, under no circumstances should the engine brake be used if propeller rotation exceeds 1 blade per second as determined by a visual check.

4. Engine Fire Control Handle — PULL OUT & TURN TO LOCK.

WARNING

> To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

CAUTION

> If the propeller continues to rotate, and no engine fire exists, set the firewall shutoff valve switch to OIL ON to prevent engine damage.

5. Affected Engine — VISUALLY CHECK.

Pilot directs a crew member to visually check the affected engine.

6. Fire Extinguisher Discharge Switch (If fire exists) —1ST FIRE EXT (Hold for a minimum of 3 seconds).

7. Oil Cooler Door — CLOSE.

FLIGHT ENGINEER

3. Automatic Generator Changeover — CHECK (if inboard propeller is feathered).

Note

> If an inboard engine is feathered, perform the necessary Electrical Power System Failure procedures outlined in this section.

(CONTINUED ON NEXT PAGE)

ENGINE FAILURE DURING FLIGHT. *(CONTINUED)*

PILOTS	***FLIGHT ENGINEER***
8. Operating Engines — ADJUST.	
Maintain power as necessary.	
9. Aircraft — TRIM.	

Note

If a safe altitude cannot be maintained with aircraft in a clean configuration, jettison nonessential equipment, cargo, and fuel.

Note

The drag resulting from a windmilling propeller is greater at high airspeeds and altitudes; therefore, if unable to feather the propeller, reduce airspeed and descend, conditions permitting, to a lower altitude.

Failure of Two or Three Engines.

In the event of failure of two or three engines, when a safe altitude cannot be maintained and/or a chosen airfield cannot be reached, jettison fuel and cargo as required (see Jettisoning, this section). In addition, it may be necessary to drift down to a lower altitude (see Driftdown charts in Part 5 of *T.O. 1C-133A-1-1*). The ability of the aircraft to maintain altitude at 5000 feet on one inboard engine operating at MAXIMUM power was demonstrated at a gross weight of 150,000 pounds. With inoperative propellers feathered, flaps and gear up, the MAX power, single-engine operation is not possible at gross weights exceeding 170,000 pounds at sea level, standard atmospheric conditions. Two-engine operation depends upon the aircraft gross weight, configuration, altitude, temperature, power available, and airspeed (see Part 4 of *T.O. 1C-133A-1-1* for emergency climb performance data).

During inflight emergency, when two engines on the same side are inoperative, directional control for maneuvering with the rudder stop in the 7-degree position may be marginal. Therefore, if additional control under these conditions is required, open the 28-volt d-c rudder stop circuit breaker on the flight deck auxiliary d-c circuit breaker panel. This will allow 18.5 degrees of rudder travel to either side of center at all airspeeds.

CAUTION

No automatic structural protection is provided when the rudder stop power circuit breaker is open. It is imperative that large slip angles and abrupt rudder motions be avoided at airspeeds greater than 165 knots IAS.

ENGINE RESTART DURING FLIGHT.

CAUTION

The recommended unfeathering airspeed is $1.4V_S$, conditions permitting. Engines should not be restarted unless it is determined that it is reasonably safe to do so. Insure scanner is in position to observe initial engine rotation prior to all inflight restarts.

(CONTINUED ON NEXT PAGE)

ENGINE RESTART DURING FLIGHT. *(CONTINUED)*

Affected Engine:

PILOTS

1. Engine Fire Control Handle — IN.

This opens the fuel and oil firewall shutoff valves.

2. Firewall Shutoff Valve Switch — NORMAL.
3. Oil Cooler Door Switch — AUTO.
4. Throttle — FLIGHT IDLE.
5. NTC Indicator Light — RESET.
6. Engine Brake Switch — OFF.
7. Auxiliary Feathering Switch — NORMAL.

⑧ Engineer's Report — "ENGINEER'S ENGINE RESTART CHECK COMPLETED."

Note

The following inflight restart procedures are applicable to aircraft modified by T.O. 3E3-2-558. For aircraft on which T.O. 3E3-2-558 is not complied with, omit steps 9 through 11 and accomplish steps 12 through 20.

9. Condition Lever — RUN-FUEL ON.
10. Engine Starter Switch — PUSH TO START.

FLIGHT ENGINEER

1. Fuel Management — AS REQUIRED.
2. Fuel Boost Pump Switch — ON.

Check that fuel pressure warning light is off.

3. Main Generator Switch — ON.

If restarting inboard engine, check for electrical load transfer.

④ Engineer's Report — "ENGINEER'S ENGINE RESTART CHECK COMPLETED."

(CONTINUED ON NEXT PAGE)

ENGINE RESTART DURING FLIGHT. *(CONTINUED)*

PILOTS

11. Engine Starter Switch — PULL TO RESET.

CAUTION

When scanner reports engine rotation, pull engine starter switch to reset, check for starter disengage warning light OFF. If light does not go off, return condition lever to FEATHER and set pneumatic manifold switch to CLOSE.

12. Condition Lever — AIR START.

Note

Place condition lever to AIR START to hold rpm at approximately 15 percent.

13. Oil Pressure — CHECK FOR RISE.

14. EGT/TIT — CHECK FOR RISE.

15. Condition Lever — RUN-FUEL ON.

16. Propeller Synchronizer Button — PUSH IN.

Push and hold synchronizer buttons IN prior to reaching synchronizer range.

Note

Hold propeller synchronizer buttons IN until propeller operation has stabilized in synchronizer range.

17. NTC Indicator Light Reset Switch — RESET.

Note

If the NTC indicator light comes on after power has stabilized at FLIGHT IDLE, advance the throttle while continuing to reset until the NTC indicator light stays off.

18. Oil Temperature — 40°C (Minimum)

19. Oil Pressure — WITHIN LIMITS.

20. Throttle — AS REQUIRED.

FLIGHT ENGINEER

LANDING WITH ONE OR MORE ENGINES INOPERATIVE.

During landings with one or more engines inoperative, the propeller of the failing engine should be feathered only if the engine is entirely useless.

Landing With One Engine Inoperative.

a. Make a normal approach and landing.

b. After landing, obtain positive direction and lateral control of the aircraft before using reverse thrust. Then apply symmetrical reverse thrust by simultaneously reversing opposite inboard or outboard engines. If deemed necessary, the remaining engine reverse thrust may be used to the limits of directional and lateral control.

Landing with Two Engines Inoperative.

Since 2-engine performance is limited, any additional power that is available from the failing engines will increase the safety factor. When operating on two engines, remain in the clean configuration, maintaining $1.4V_s$ until the aircraft is on final approach. When beginning the descent on final approach, lower the landing gear and extend the wing flaps 25 degrees. Maintain a minimum of 140 knots IAS and do not extend the flaps more than 25 degrees until landing is positively assured. As power is reduced, remove excessive trim. When landing is positively assured, extend wing flaps to 35 degrees and reduce airspeed to commence flare at a minimum of $1.2V_s$. After landing, maintain positive directional and lateral control of the aircraft. When necessary, apply symmetrical reverse thrust if available; if symmetrical reverse thrust is not available, reverse the inboard engine. Then, after directional control is definitely established, slowly reverse the remaining engine to the limit of directional and lateral control. To attain landing ground roll performance as outlined in Part 8 of *T.O. 1C-133A-1-1,* the speeds outlined from the threshold to touchdown must be observed.

GO-AROUND WITH ONE OR MORE ENGINES INOPERATIVE.

The sooner the decision to go-around is made, the better the chances are for success. When considering the possibilities for go-around, altitude, airspeed, gross weight, aircraft configuration, wind conditions, runway facilities, and visibility should always be considered (see Emergency Climb charts in Part 4 of *T.O. 1C-133A-1-1*). The pilot should always consider the advantages of a controlled crash landing over an unsuccessful go-around, especially if aircraft performance is critical or altitude is marginal.

Go-Around With One Engine Inoperative.

The procedure for 3-engine go-around is the same as that outlined for 4-engine go-around in Section II, except when an outboard engine is out and the aircraft is at or near minimum control speed. Under these conditions, apply MAX power to engines No. 2 and 3, and bring in the remaining outboard engine to maximum power consistent with ability to maintain directional control. Be alert to meet control requirements resulting from application of MAX power at low airspeed.

Go-Around With Two Engines Inoperative.

WARNING

When attempting to go-around with two engines inoperative on one side of the aircraft, do not allow the airspeed to drop below the inflight minimum control speed. (See Flight Characteristics Under Partial Power Conditions, this section.) A go-around should not be attempted below inflight minimum control speed.

Within the normal range of operating gross weights, if 2-engine go-around is required at airspeeds below the best climb speed (see Part 4 of *T.O. 1C-133A-1-1),* and the aircraft is in the landing configuration (landing gear down and wing flaps extended), transition to the best climb (clean) configuration and speed must be made before a positive rate of climb can be established. The amount of altitude lost during this transition will vary with gross weight, degree of wing flap extension, and airspeed existing at the time the go-around is initiated. Apply MAX power and retract the wing flaps; when wing flaps are full UP, retract the landing gear, and then accelerate to best climb speed. A missed approach should not be attempted after the wing flaps have been extended more than 25-degrees, or the airspeed reduced below 140 knots IAS.

WARNING

Due to the large volume of fluid required to retract the gear and flaps simultaneously, the flaps must be retracted before raising the gear in order to obtain nominal flap retraction time.

If obstacle clearance is necessary, start the climb and maintain existing airspeed. After obstacles are cleared, increase speed to the best climb speed as rapidly as possible.

Maintain MAX power until sufficient altitude is reached to maneuver, then reduce power to the amount required to maintain level flight at the best climb speed. At the design landing weight clean configuration, the resulting rate of climb will be approximately 150 feet per minute when using MAX power on a standard day at sea level.

If obstacle clearance is not required, the climb should be made at the best climb configuration and speed. A speed of 140 knots IAS is a nominal flaps up best climb speed for a gross weight range of 150,000 to 200,000 pounds with the propellers of inoperative engines windmilling or feathered (see Emergency Climb — Two-Engine — Zero Degrees Flap in Part 4 of *T.O. 1C-133A-1-1*). MAX power should be used during the initial go-around transition, and then the power should be reduced to MILITARY RATED power. At inflight minimum control speed (propellers of inoperative engines feathered), with two engines on one side operating as power is applied for the go-around, full rudder, nearly full aileron, and a 5-degree bank angle toward the two operating engines will be required to maintain a constant heading.

The aircraft must be flown straight directionally, but with a bank angle of approximately 5 degrees, in order to attain the altitude required for both acceleration and climb performance.

If 2-engine go-around is required from a speed at or above the best climb airspeed, and the aircraft is in the clean configuration, apply MAX power, establish best climb speed, maintain MAX power until sufficient altitude is reached to maneuver, then reduce power to the amount required to maintain level flight at the best climb speed.

THREE-ENGINE TAKEOFFS.

Three-engine takeoffs are practical for emergency type operation such as evacuating the aircraft from a hazardous weather area, inaccessible landing strip or combat area. The value of an expeditious recovery must be carefully weighed against the dangers of a 3-engine takeoff. If it is deemed necessary to make a 3-engine takeoff, the main hazard is loss of the second engine on the same side below the 2-engine inoperative, inflight minimum control speed. The aircraft should be as light as possible but with sufficient fuel to allow for 2-engine cruise in case another engine fails enroute. See Part 5 of *T.O. 1C-133A-1-1* for performance data.

The following procedure is recommended.

a. Wing flaps — FLAPS UP.

b. Engines — RUNUP.

Make a normal engine runup, then check that the condition lever and the auxiliary feathering switch of the inoperative engine are in the FEATHER position to prevent propeller rotation during takeoff.

c. Aircraft—LINE UP.

Line up on centerline and set power on symmetrical engines. Place throttle for unsymmetrical engine to FLIGHT IDLE.

d. Brakes — RELEASE.

After releasing the brakes, the pilot should hold nose-down elevator and bank away from the inoperative engine.

WARNING

Under conditions where sideslip angles are greater than 5 degrees, approaching stall speed in the power approach or takeoff configurations, or with right angle crosswind components of 25 knots or more, errors existing in the airspeed indicating system may be greater than those shown on the Airspeed Position Error correction charts in Part 2 of *T.O. 1C-133-1-1*. Under the conditions cited, the proper indicated airspeed reading shall be determined only from that indicator which does not fluctuate, and which gives the higher of the two airspeed readings.

e. Nosewheel — MAINTAIN RUNWAY CONTACT.

Keep the nosewheel on the runway to maintain rudder pedal steering effectiveness.

f. Unsymmetrical Engine — APPLY POWER.

Bring unsymmetrical engine up to takeoff power as rapidly as directional control permits.

g. Aircraft — ROTATE TO TAKEOFF ATTITUDE.

Start a slow smooth rotation at the 1-engine inoperative minimum rotation speed and apply a 5-degree bank away from the inoperative engine.

h. Landing gear — CLEAR UP.

Retract the landing gear when airborne and accelerate to 140 knots IAS as soon as possible.

Engine-Out Crosswind Takeoff — Upwind Outboard Engine Fails and Propeller NTC's.

When engine failure initially occurs, the aircraft will tend to roll and turn upwind, the degree of turn depending somewhat on airspeed and wind velocity.

If the decision is made to abort and the remaining throttles are placed in FLIGHT IDLE, this tendency will still be apparent but will be less severe. When the remaining throttles are placed in GROUND IDLE or REVERSE, the aircraft will reverse tendency and roll downwind, and if allowed to bank, will turn downwind. Therefore aileron control must be carefully monitored, and reverse thrust applied gradually *(see figure 3-2)*.

Engine-Out Crosswind Takeoff — Downwind Outboard Engine Fails and Propeller NTC's.

When engine failure initially occurs, the aircraft will tend to roll and turn downwind. If the decision is made to abort and the remaining throttles are placed in FLIGHT IDLE, this tendency will still be apparent, but will be less severe. When the remaining throttles are placed in GROUND IDLE or REVERSE, the aircraft will reverse tendency and roll upwind and if allowed to bank, will tend to turn upwind. Therefore, aileron control must be carefully monitored and reverse thrust applied gradually *(see figure 3-3)*.

PRACTICE MANEUVERS WITH ONE OR MORE ENGINES INOPERATIVE.

Simulated engines inoperative may be accomplished by retarding the throttle to FLIGHT IDLE.

CAUTION

Do not allow unwanted NTC to occur. Advance throttle until NTC indicator light remains off.

PROPELLER FAILURE.

ALL PROPELLERS HUNTING OR SURGING.

If all propellers are hunting or surging, all propeller synchronizer buttons should be pulled OUT, thus placing the propellers on mechanical reference governing (97.7 percent rpm). If the malfunction is in the synchrophase system, synchronous governing may be restored by placing the synchrophase switch OFF, then installing the bypass plug in the propeller synchronizer control unit, thus isolating the synchrophase system.

Note

Install the propeller synchronizer bypass plug when synchrophase switch is left in the OFF position for any extended period of flight.

INDIVIDUAL PROPELLER HUNTING OR SURGING.

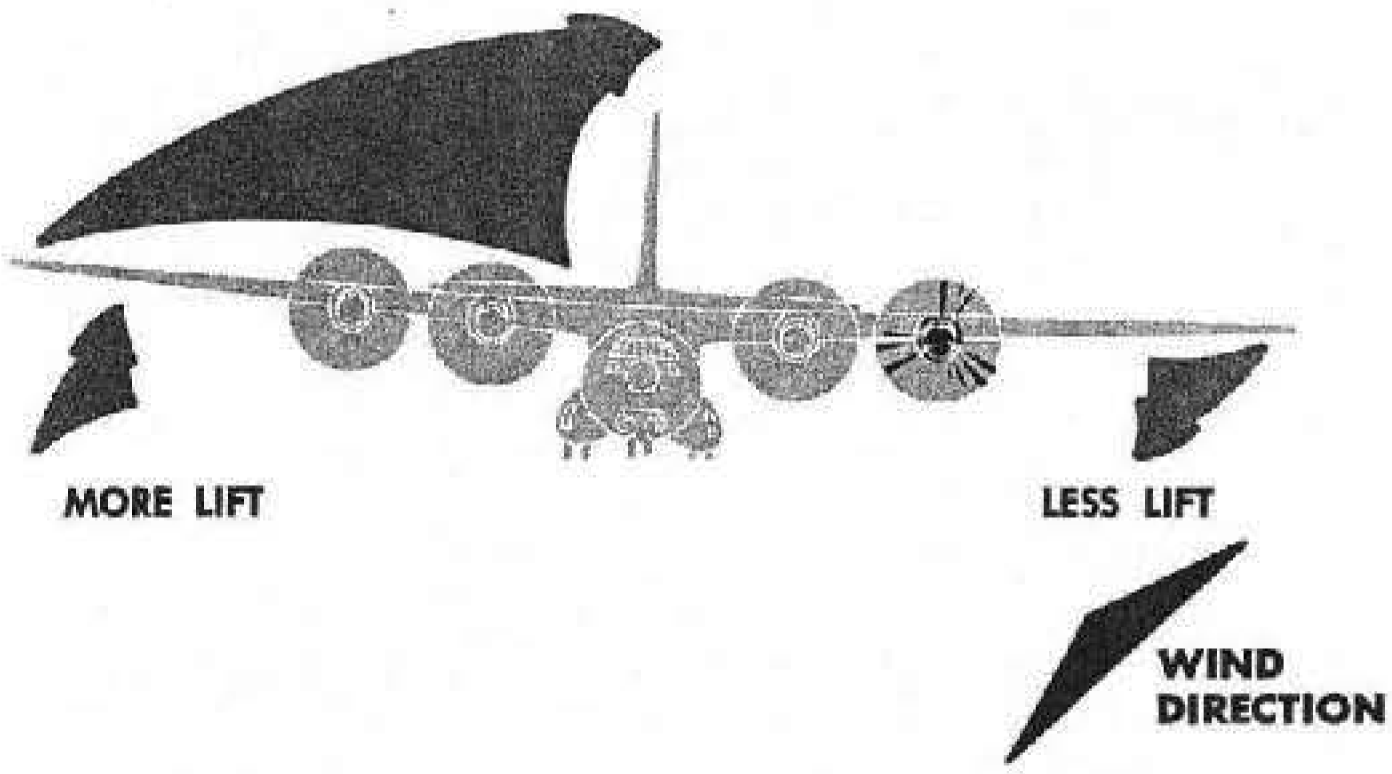
WARNING

If propeller rpm exceeds the limitations outlined in Section V, feathering is recommended when conditions permit.

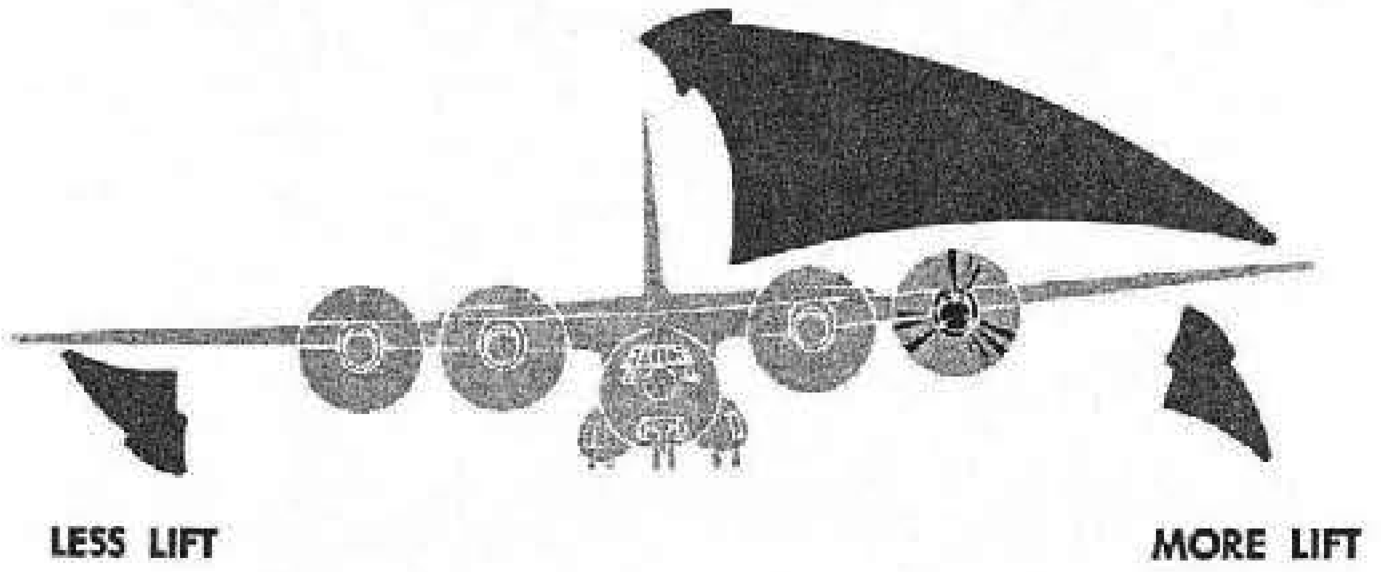
Engine-Out Crosswind Takeoff

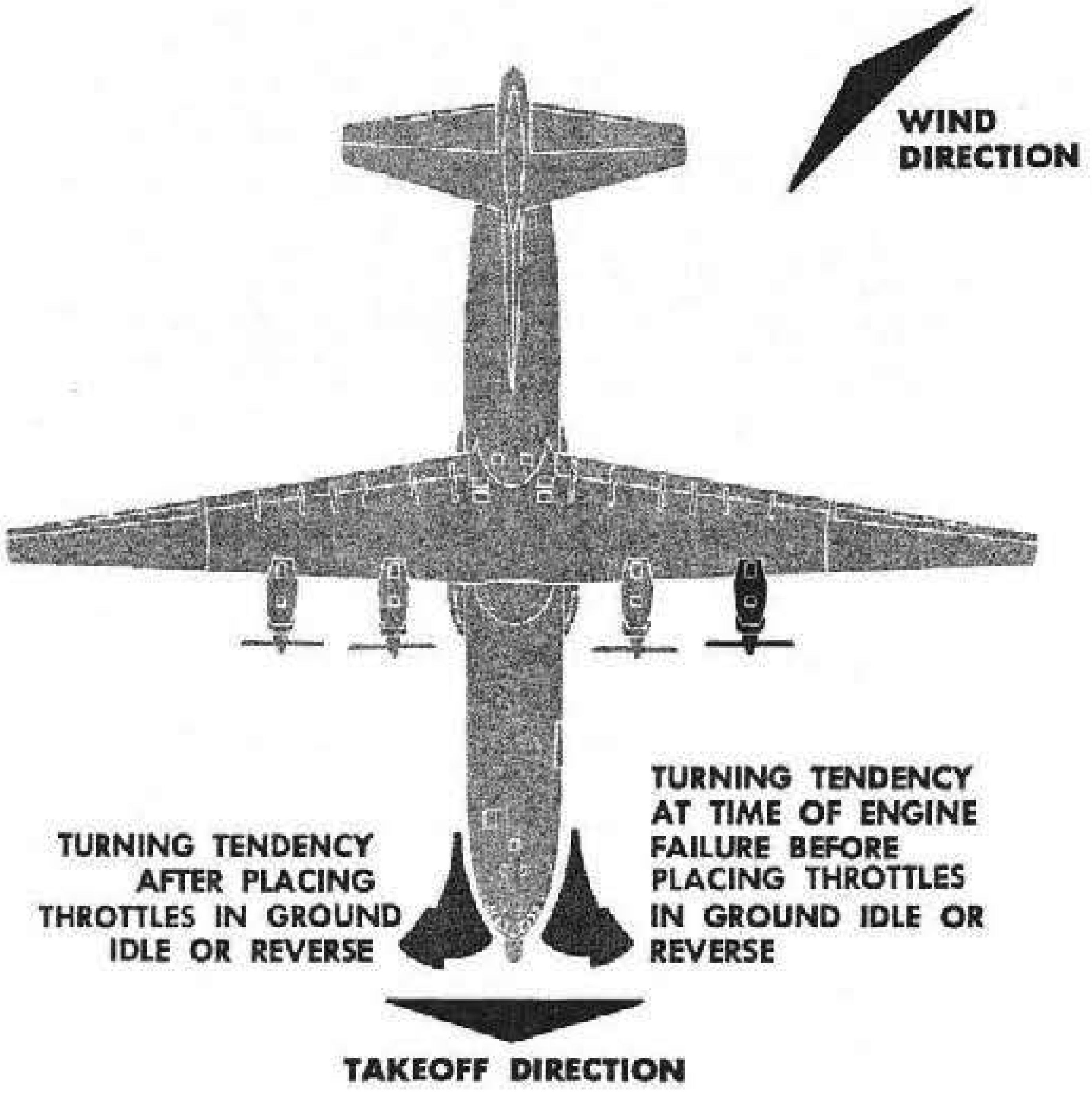
UPWIND OUTBOARD ENGINE FAILS AND PROPELLER NTC'S

ROLLING TENDENCY AT TIME OF ENGINE FAILURE BEFORE PLACING THROTTLES IN GROUND IDLE OR REVERSE



ROLLING TENDENCY AFTER PLACING THROTTLES IN GROUND IDLE OR REVERSE





Aerodynamic Forces:

1. Initially, the lift on the downwind wing is greater.
2. Initially, the thrust on the downwind side is higher.
3. After placing the throttles in GROUND IDLE or REVERSE the lift on the upwind wing is greater.

Aircraft Reaction:

At time of engine failure, the aircraft will tend to heel over and turn upwind, the degree depending somewhat on the airspeed and wind velocity. If the decision is made to abort and the remaining throttles are placed in FLIGHT IDLE, this tendency will remain but will be less severe. If the remaining throttles are placed in GROUND IDLE or REVERSE, the aircraft will reverse tendency and roll down wind and, if allowed to bank, will turn downwind.

Pilot's Corrective Action:

Continuation of Takeoff – Apply rudder pedal steering in conjunction with coordinated aileron to maintain directional control. A slight bank DOWNWIND (on the ground and after liftoff) can be used effectively to assist in maintaining directional control. After liftoff, the aircraft can be crabbed into the wind to maintain a straight path over the ground and to reduce control force requirements. The takeoff must be made at or above minimum control speed for a windmilling engine.

Aborted Takeoff – Place all throttles in FLIGHT IDLE and maintain directional control by use of rudder pedal steering in conjunction with coordinated aileron. When the throttles are placed in GROUND IDLE or REVERSE, the turning tendency is reversed and the aircraft will turn downwind. The pilot must be alert to take corrective action as necessary. Normally, only the throttles for the inboard engines should be placed in reverse; however, if considered necessary, the throttle for the operative outboard engine may be placed in REVERSE to the limit of lateral and directional control.

Note

Aileron control must be carefully monitored and reverse thrust applied gradually.

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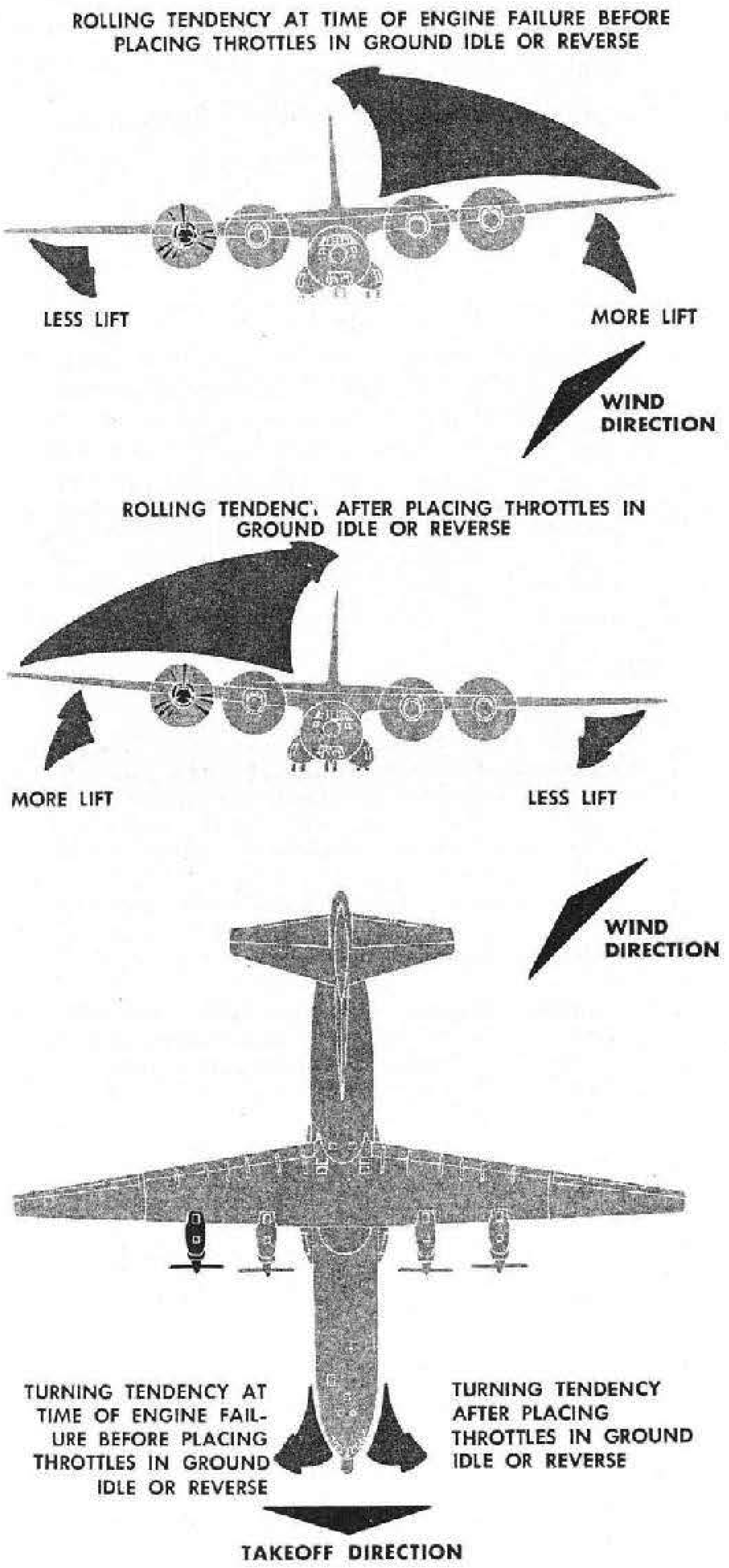
Figure 3-2

Engine-Out Crosswind Takeoff

DOWNWIND OUTBOARD ENGINE FAILS AND PROPELLER NTC'S



Aerodynamic Forces:

1. Initially, the lift of the upwind wing is greater.
2. Initially, the thrust on the upwind side is higher.
3. After placing the throttles in GROUND IDLE or REVERSE, the lift on the downwind wing is greater.

Aircraft Reaction:

At time of engine failure, the aircraft will tend to heel over and turn downwind. If the decision is made to abort, and the throttles on the remaining engines are placed in FLIGHT IDLE, this tendency will remain but will be less severe. If the throttles on the remaining engines are placed in GROUND IDLE or REVERSE, the aircraft will reverse tendency and roll upwind and, if allowed to bank, will turn upwind.

Pilot's Corrective Action:

Continuation of Takeoff — Apply rudder pedal steering in conjunction with coordinated aileron to maintain directional control. A slight bank UPWIND (on the ground and after liftoff) can be used effectively to assist in maintaining directional control. After liftoff, the aircraft can be crabbed into the wind to maintain a straight path over the ground, and to reduce control force requirements. The takeoff must be made at or above minimum control speed for a windmilling engine.

Aborted Takeoff — Place all throttles in FLIGHT IDLE. Maintain directional control by use of rudder pedal steering in conjunction with coordinated aileron. When the throttles are placed in GROUND IDLE or REVERSE, the turning tendency is reversed and the aircraft will turn upwind. The pilot must be alert to take corrective action as necessary. Normally, only the throttles for the inboard engines should be placed in REVERSE; however, if considered necessary, the throttle for the operative outboard engine may be placed in REVERSE to the limit of lateral and directional control.

Note

Aileron control must be carefully monitored and reverse thrust applied gradually.

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Figure 3-3

If an individual propeller is hunting or surging (as indicated by rpm fluctuation), pull the respective synchronizer button OUT. If the malfunction is in the synchrophase system, synchronous governing may be restored by placing the synchrophase switch OFF, then installing the bypass plug in the synchronizer control unit, thus isolating the synchrophase system. If the hunting or surging continues, move the respective condition lever to AIR START position. This will place the propeller in a fixed pitch position. If the hunting or surging still exists after the condition lever has been placed in AIR START, it is an indication that the fuel control unit is not functioning correctly.

Note

> This condition may occur during cold weather operation (see Cold Weather Operation in Section IX for nacelle preheat procedures). Place the condition lever to RUN-FUEL-ON or FEATHER at the discretion of the pilot. If FEATHER is selected, the auxiliary feathering switch should be actuated to the FEATHER position after the normal feathering operation is completed.

Note

> If surging stops when the condition lever is set to AIR START, the PROPELLER NORMAL CONTROL circuit breaker can be OPENED to avoid holding the condition lever in the AIR START position if engine operation is essential. Changes in power should be made slowly. Opening the PROPELLER NORMAL CONTROL circuit breaker deactivates normal NTC and normal governing circuits.

WARNING

> If the propeller rpm starts to increase when the condition lever is placed in AIR START, immediately return the condition lever to the RUN-FUEL-ON position. The increase in rpm may be an indication of propeller brake malfunction.

PROPELLER OVERSPEEDING.

Perform the following steps immediately.

a. Propeller — FEATHER.

Feather the overspeeding propeller.

b. Engine Failure During Flight Check — COMPLETE.

Complete the steps under Engine Failure During Flight, this section.

Note

> The rpm and drag of a windmilling propeller may be partially restored to normal by decreasing indicated airspeed or descending to a lower altitude if conditions permit.

PROPELLER OIL PRESSURE MONITORING (T.C.T.O. 571).

Four amber, press-to-test, low oil pressure lights are located on the flight engineer's instrument panel *(figure 1-12)*. The lights are powered from the 28-volt d-c propeller bus on the flight deck left hand auxiliary circuit breaker panel, and are protected by individual circuit breakers. Each propeller is equipped with a bellows type pressure switch which actuates at 5 to 6 psi oil pressure. When the propeller oil pressure drops to less than 5 to 6 psi, the low oil pressure light for that propeller will come on. The lights are rendered inoperative through disarm switch action when the condition lever is in the FUEL-OFF or FEATHER position.

Note

> Flickering of the propeller low oil pressure light at low ground idle can be expected at low ground idle rpm due to lower oil pressure at that rpm. If the light comes on at high ground idle rpm, or above, propeller oil pressure is low.

Propeller Low Oil Pressure Light Comes on in Flight.

In the event that the propeller low oil pressure light comes on perform the following steps:

a. Propeller — FEATHER.

Feather the affected engine.

b. Engine Failure During Flight Check — COMPLETED.

Complete the steps under Engine Failure During Flight, this section.

WARNING

If fire becomes uncontrollable, it will be necessary to land, ditch, or bail out as conditions dictate.

Fire is always considered an emergency. When fire is discovered by any crew member, he must notify the pilot immediately, and the crew will proceed with the recommended fire control measures.

ENGINE FIRE.

Engine Fire On The Ground.

PILOTS

1. **ALL CONDITION LEVERS — FUEL OFF.**

Note

If the fire occurs during starter engagement, maintain engine cranking until evidence of fire no longer exists or for a maximum of 20 seconds. If starter has disengaged, wait until engine has decelerated below 40 percent before reengaging the starter.

Affected Engine:

2. **ENGINE FIRE CONTROL HANDLE — PULL OUT & TURN TO LOCK.**

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

3. **FIRE EXTINGUISHER DISCHARGE SWITCH — 1ST FIRE EXT (HOLD FOR A MINIMUM OF 3 SECONDS).**

Note

If second shot is necessary, set discharge switch to 2ND FIRE EXT (hold for a minimum of 3 seconds).

4. **CREW — ALERT.**

FLIGHT ENGINEER

1. Pneumatic Manifold Switch — OPEN.
2. Air Conditioning Ram Ventilation Switch—OFF.
3. Fuel Boost Pump Switches — OFF.
4. Fuel Tank Outlet Valve Switches — CLOSE.

Note

The following items will be accomplished after the pilot has directed "Electrical Power Off."

5. **GTU'S — STOP.**
6. Battery Switch — OFF.
7. Abandon the Aircraft.

(CONTINUED ON NEXT PAGE)

ENGINE FIRE. *(CONTINUED)*

PILOTS

5. Radio Notification — NOTIFY.

Advise appropriate station of condition, if time permits.

6. Electrical Power — OFF.

7. Ground Crew — DIRECT.

Direct the ground crew to use ground fire extinguishers if fire is indicated in an unprotected nacelle area.

8. Abandon the Aircraft.

FLIGHT ENGINEER

Engine Fire in Flight.

If an engine fire occurs in flight, perform the following steps immediately.

1. DIRECTIONAL CONTROL AND AIRSPEED — MAINTAIN.

Affected Engine:

2. CONDITION LEVER — FEATHER.

3. ENGINE FIRE CONTROL HANDLE — PULL OUT AND TURN TO LOCK.

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

4. FIRE EXTINGUISHER AGENT DISCHARGE SWITCH — 1ST FIRE EXT (HOLD FOR MINIMUM OF 3 SECONDS).

Note

If second shot is necessary, position discharge switch to 2ND FIRE EXT (hold for minimum of 3 seconds).

5. CREW — ALERT (HAVE CREW MEMBER VISUALLY CHECK AFFECTED ENGINE).

1. Pneumatic Manifold Switch — CLOSED.

2. Fuel Boost Pump Switch — OFF.

3. Fuel Management — AS REQUIRED.

CAUTION

Close the fuel tank outlet valve to the engine and discontinue use of the fuel manifold in the affected wing until fire has definitely been extinguished. Do not use the affected manifold if a safe landing can be accomplished without transfer of fuel.

4. Generator Automatic Changeover — CHECK (If an inboard propeller is feathered).

(CONTINUED ON NEXT PAGE)

ENGINE FIRE. *(CONTINUED)*

PILOTS

6. Auxiliary Feathering Switch — FEATHER.

If the propeller continues to rotate, set auxiliary feathering switch to NORMAL (off) to actuate the normal feathering circuit. If the propeller continues to rotate very slowly, set engine brake switch to ON. If the engine brake does not stop propeller rotation, immediately set switch to OFF.

CAUTION

To prevent overheating, under no circumstances should the engine brake be used if propeller rotation exceeds 1 blade per second as determined by a visual check.

7. Radio Notification — NOTIFY.

Advise appropriate station of condition and location.

8. Oil Cooler Door — CLOSE.

9. Operating Engines — ADJUST.

Maintain power as necessary.

10. Aircraft — TRIM.

Note

If safe altitude cannot be maintained with the aircraft in a clean configuration, jettison fuel. Refer to Part 5 of *T.O. 1C-133A-1-1* for drift-down data.

FLIGHT ENGINEER

Note

Oil to the engine is required for lubrication. However, pilot's discretion should be utilized in determining whether the oil flow will constitute a fire hazard. If the propeller windmills, and engine fire is extinguished (determined by visual check), perform the following (to supply oil to the engine):

11. Firewall shutoff valve switch — OIL ON.

Note

The drag resulting from a windmilling propeller is greater at high airspeeds and altitudes; therefore, if unable to feather the propeller, reduce airspeed and descend, conditions permitting, to a lower altitude.

ENGINE OVERHEAT.

In the event an engine overheat condition occurs, as indicated by a flashing engine overheat and fire warning light, and master fire warning light, proceed as follows:

Engine Overheat on the Ground.

PILOTS

1. **ALL CONDITION LEVERS — FUEL OFF.**

FLIGHT ENGINEER

1. Pneumatic Manifold Switch — OPEN.

(CONTINUED ON NEXT PAGE)

ENGINE OVERHEAT. *(CONTINUED)*

PILOTS

Note

If the overheat occurs during starter engagement, maintain engine cranking until evidence of overheat no longer exists or for a maximum of 20 seconds. If starter has disengaged, wait until engine has decelerated below 40 percent before reengaging the starter.

Affected Engine:

2. **ENGINE FIRE CONTROL HANDLE — PULL OUT & TURN TO LOCK.**

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

3. **CREW — ALERT.**

4. Radio Notification — NOTIFY.

Advise appropriate station of condition, if time permits.

5. Electrical Power — OFF.

6. Ground Crew — DIRECT.

Direct the ground crew to use ground fire extinguishers if fire is indicated in an unprotected nacelle area.

7. Abandon the aircraft.

FLIGHT ENGINEER

2. Air Conditioning Ram Ventilation Switch—OFF.

3. Fuel Boost Pump Switches — OFF.

4. Fuel Tank Outlet Valve Switches — CLOSE.

Note

The following items will be accomplished after the pilot has directed "Electrical Power Off."

5. **GTU'S — STOP.**

6. Battery Switch — OFF.

(CONTINUED ON NEXT PAGE)

ENGINE OVERHEAT. *(CONTINUED)*

Engine Overheat in Flight.

If an engine overheat condition occurs during flight, perform the following steps immediately.

PILOTS

1. **DIRECTIONAL CONTROL AND AIRSPEED — MAINTAIN.**

Affected Engine.

2. **CONDITION LEVER — FEATHER.**

3. **ENGINE FIRE CONTROL HANDLE — PULL OUT & TURN TO LOCK.**

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

4. **CREW — ALERT (HAVE CREW MEMBER VISUALLY CHECK AFFECTED ENGINE).**

5. Auxiliary Feathering Switch — FEATHER.

If the propeller continues to rotate, set auxiliary feathering switch to NORMAL (off) to actuate the normal feathering circuit. If the propeller continues to rotate very slowly, set engine brake switch to ON. If the engine brake does not stop propeller rotation, immediately set switch to OFF.

CAUTION

To prevent overheating, under no circumstances should the engine brake be used if propeller rotation exceeds 1 blade per second, as determined by a visual check.

6. Radio Notification — NOTIFY.

Advise appropriate station of condition and location.

7. Oil Cooler Door Switch — CLOSE, then OFF.

8. Operating Engines—ADJUST.

Maintain power as necessary.

9. Aircraft — TRIM.

FLIGHT ENGINEER

1. Pneumatic Manifold Switch — CLOSE.

2. Fuel Boost Pump Switch — OFF.

3. Fuel Management — AS REQUIRED.

CAUTION

Close the fuel tank outlet valve to the engine and discontinue use of the fuel manifold in the affected wing until the engine overheat condition no longer exists. Do not use the affected manifold if a safe landing can be accomplished without transfer of fuel.

4. Generator Automatic Changeover — CHECK (If an inboard propeller is feathered).

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ENGINE OVERHEAT. *(CONTINUED)*

PILOTS

Note

If safe altitude cannot be maintained with the aircraft in a clean configuration, jettison fuel. Refer to Part 5 of *T.O. 1C-133A-1-1* for driftdown data.

Note

Oil to the engine is required for lubrication. However, pilot's discretion should be utilized in determining whether the oil flow will constitute a fire hazard. If the propeller windmills, and no engine fire exists (determine by visual check), perform the following (to supply oil to the engine):

10. Firewall Shutoff Valve Switch — OIL ON.

FLIGHT ENGINEER

If engine overheat and fire warning light continues to flash, perform the following step:

5. All Pneumatic Manifold Switches — CLOSE.

FUSELAGE FIRE.

In the event of a fuselage fire, proceed as follows:

PILOTS

1. **CREW — ALERT.**

Crew members will use 100 percent oxygen.

2. **OXYGEN MASK — ON (USE 100 PERCENT OXYGEN).**

3. **FIRE — ATTACK.**

Use all available emergency fire equipment.

WARNING

Prolonged exposure (5 minutes or more) to high concentrations (pronounced irritation

FLIGHT ENGINEER

1. **OXYGEN MASK — ON (USE 100 PERCENT OXYGEN).**

2. Air Conditioning-Ram Ventilation Switch—OFF.

3. Pressurization System Manual Control Switch—DEPRESSURIZE.

Note

It is advisable to depressurize the aircraft in the event of a fuselage fire to prevent possible overload on the outflow and safety valves due to thermal expansion within the fuselage. If a malfunction occurs in the normal pressurization control system, the aircraft can be depressurized by utilizing the emergency de-

(CONTINUED ON NEXT PAGE)

FUSELAGE FIRE. *(CONTINUED)*

PILOTS

of eye and nose) of bromochloromethane (CB) or its decomposition products should be avoided. CB is an anesthetic agent of moderate intensity. It is safer to use than previous fire extinguishing agents (carbon tetrachloride, methylbromide). However, especially in confined spaces, adequate respiratory and eye protection from excessive exposure, including the use of oxygen when available, should be sought as soon as the primary fire emergency will permit. Type A-20 extinguishers are inoperative when inverted.

4. Radio Notification — NOTIFY.

Advise appropriate stations of condition and intentions as soon as practicable.

FLIGHT ENGINEER

pressurization provisions. It should be noted, however, that actuation of the emergency depressurization valve handle closes the GTU load control valves and opens the ram ventilation valves, creating airflow through the cabin which may be undesirable. Circumstances will dictate the procedure to be followed.

4. Emergency Depressurization Control Handle — DEPRESSURIZE (if necessary).

Note

When the emergency depressurization control handle is placed in the DEPRESSURIZE position, the emergency depressurization door is unlatched by an explosive cartridge. The door can be manually closed to restore pressurization but the protection afforded by the emergency door will no longer be available. The pilot will make the decision to repressurize, or not to repressurize, based upon such factors as altitude required to complete the mission, fuel consumption, oxygen supply available, and the risk of encountering further circumstances which would necessitate emergency depressurization.

WARNING

On C-133A aircraft, if combustible fumes are known to be present, use the manual depressurization system, as the emergency door actuation charge could set off an explosion in the aft fuselage area.

After Fire Is Out.

WARNING

Keep flight deck windows closed during a fire aft of the flight deck. Flight test data reveals that opening any of the flight deck windows causes airflow from the main cabin into the flight compartment. This could result in possible smoke or fume concentration in the flight compartment which would hinder the crew in performing their duties.

(CONTINUED ON NEXT PAGE)

FUSELAGE FIRE. *(CONTINUED)*

PILOTS

FLIGHT ENGINEER

5. Emergency Depressurization Control Handle (if actuated) — PRESSURIZE (door must be closed manually).

6. Air Conditioning- Ram Ventilation Switch — AIR CONDITIONING (to eliminate smoke and fumes).

7. Pressurization System Manual Control Switch — AUTO.

Pneumatic Manifold Overheat.

If the pneumatic manifold overheat warning indicator light comes on, perform the following:

PILOTS

1. **JET-BLAST RAIN REMOVAL SWITCH — OFF.**

FLIGHT ENGINEER

1. **PNEUMATIC MANIFOLD SWITCHES — CLOSE.**
2. **NACELLE PREHEAT SWITCHES — OFF.**
3. Wing and Empennage Deice Switches — OFF.
4. GTU Augmentation Switches — CLOSED.

WING FIRE.

If a fire occurs in the wing during flight, attempt to control it as follows:

PILOTS

1. **JET-BLAST RAIN REMOVAL SWITCH — OFF.**
2. **CREW — ALERT.**

③ ELECTRICAL EQUIPMENT (IN AFFECTED WING) — OFF.

Turn off all electrical equipment in the affected wing.

4. Navigation Lights — OFF.
5. Formation Lights — OFF.
6. Wing Leading Edge Scanning Lights — OFF.
7. Radio Notification — NOTIFY.

Advise appropriate stations of condition and intentions as soon as practicable.

FLIGHT ENGINEER

1. **PNEUMATIC MANIFOLD SWITCHES — CLOSE.**
2. **NACELLE PREHEAT SWITCHES — OFF.**

③ ELECTRICAL EQUIPMENT — OFF.

Unless necessary to maintain flight, turn off all electrical equipment in the affected wing.

4. **FUEL VALVE CIRCUIT BREAKERS — OPEN.**
5. **FUEL BOOST PUMP SWITCHES — OFF.**
6. Fuel Tank Float Test Indicator Circuit Breakers — OPEN.
7. Landing Light Circuit Breaker — OPEN.
8. Wing and Empennage Deice Switches — OFF.
9. GTU Augmentation Switches — CLOSED.

(CONTINUED ON NEXT PAGE)

ELECTRICAL FIRE.

WARNING

> Circumstances should dictate the crew procedure before cutting off electrical power. The essential d-c bus must be powered for rapid depressurization of the aircraft, to have radio and interphone communication, to operate propeller pitch change, to power the turn and slip indicators, and to provide antiskid braking. Turning the battery switch OFF leaves only the battery busses powered.

If fire or smoke is definitely identified as being of electrical origin, attempt to isolate the circuit involved. If the circuit cannot be readily identified, perform the following steps.

PILOTS

1. **CREW — ALERT.**

Crew members will use 100 percent oxygen.

2. **OXYGEN MASK — ON (USE 100 PERCENT OXYGEN).**

3. **FIRE — ATTACK.**

Use all available fire equipment.

WARNING

> Prolonged exposure (5 minutes or more) to high concentrations (pronounced irritation of eye and nose) of bromochloromethane (CB) or its decomposition products should be avoided. CB is an anesthetic agent of moderate intensity. It is safer to use than previous fire extinguishing agents (carbon tetrachloride, methylbromide). However, especially in confined spaces, adequate respiratory and eye protection from excessive exposure, including the use of oxygen when available, should be sought as soon as the primary fire emergency will permit. Type A-20 extinguishers are inoperative when inverted.

4. Radio Notification — NOTIFY.

Advise appropriate stations of condition and intentions as soon as practicable.

FLIGHT ENGINEER

1. **OXYGEN MASK — ON (USE 100 PERCENT OXYGEN).**

2. **BATTERY SWITCH — OFF.**

3. **MAIN GENERATOR SWITCHES — OFF.**

4. **GTU PNEUMATIC SELECTOR SWITCHES — NO LOAD.**

5. **NO. 1 GTU START-RUN-STOP SWITCH — MOMENTARILY START (TO REMOVE THE AUXILIARY GENERATOR FROM THE LINE).**

Every effort should be made to continue flight at the existing altitude and airspeed while further attempts are made to identify and isolate the faulty electrical circuits. If the attempt is successful, isolate the faulty circuit and restore power to the remaining circuits. If the source of the malfunction cannot be found, restore electrical power as follows:

a. All Essential A-C and D-C Circuit Breakers — OPEN.

(CONTINUED ON NEXT PAGE)

ELECTRICAL FIRE. *(CONTINUED)*

b. Auxiliary Generator Switch — RESET, then AUTO.
c. Transformer-Rectifier Circuit Breaker — CLOSE.
d. Essenital Circuit Breakers — CLOSE.

Close one at a time as needed, while maintaining a close watch to insure that smoke or fire does not recur.

If the situation is such that electrical power cannot be restored, proceed as outlined under Electrical Power System Failure, this section.

GTU FIRE OR OVERHEAT.

CAUTION

Characteristics of the GTU fire detection system are such that a fire may exist when an overheat warning is indicated. An overheat warning should be treated in the same manner as a fire warning.

If a GTU fire warning light or overheat light comes on, perform the following steps.

PILOTS

Affected GTU:

1. **GTU FIRE CONTROL HANDLE — PULL OUT AND TURN TO LOCK.**

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

2. **FIRE EXTINGUISHER AGENT DISCHARGE SWITCH — 1ST FIRE EXT (HOLD FOR MINIMUM OF 3 SECONDS).**

3. **CREW — ALERT.**

Have a crew member visually check affected GTU.

WARNING

The GTU fire control handle must remain OUT after the fire or overheat condition has been eliminated to prevent the possibility of restarting the fire.

4. Radio Notification — NOTIFY.

Advise appropriate station of condition and location.

FLIGHT ENGINEER

1. **GTU START-RUN-STOP SWITCH — STOP.**

2. **HYDRAULIC PUMP CONTROL SWITCH — OFF.**

3. Cabin Altitude — CHECK.

SMOKE AND FUME ELIMINATION.

In the event of heavy smoke or toxic fume concentration in the flight compartment, perform the following:

WARNING

Keep flight deck windows closed during a fire aft of the flight deck. Flight test data reveals that opening any of the flight deck windows causes airflow from the main cabin into the flight compartment. This could result in possible smoke or fume concentration in the flight compartment which would hinder the crew in performing their duties.

PILOTS

1. **CREW — ALERT.**

All crew members will use 100 percent oxygen.

2. **OXYGEN MASK — ON (USE 100 PERCENT OXYGEN).**

FLIGHT ENGINEER

1. **OXYGEN MASK — ON (USE 100 PERCENT OXYGEN).**

2. Pressurization System Manual Control Switch — DEPRESSURIZE.

WARNING

On C-133A aircraft, if combustible fumes are known to be present, use the manual depressurization system, as the emergency door actuation charge could set off an explosion in the aft fuselage area.

3. Air Conditioning - Ram Ventilation Switch — AIR CONDITIONING.

Note

After elimination of smoke and fumes, restore pressurization.

If smoke is emanating from the air conditioning ducts, perform the following:

4. Air Conditioning - Ram Ventilation Switch — RAM VENTILATION.

BAILOUT.

The following are the standard alarm signals for bailout:

THREE SHORT RINGS . . . . PREPARE FOR BAILOUT

ONE LONG, SUSTAINED RING . . . . BAILOUT

BAILOUT PROCEDURE.

Upon the first indication of an emergency, the pilot will give a warning signal to prepare for bailout. This signal will be three short rings on the alarm system. The pilot will also position the bailout alarm switch to STANDBY. When all crew members are ready for bailout, he will be notified by the engineer. When the pilot desires to have all on board abandon the aircraft, he will give the warning signal to bail out, which will be one long, sustained ring on the alarm system and position the bailout alarm switch to BAIL-OUT. In addition to the alarm signals, the pilot will give verbal warnings over the interphone and public address system. The crew will leave the flight deck by means of the flight deck ladder. The static line may be used to evacuate personnel who have been injured or are incapacitated.

BAILOUT EXITS.

The bailout exits *(figure 3-4)* are the crew entrance door on the right side of the aircraft and the ramp and rear cargo doors.

WARNING

Under no circumstances should bailout be attempted from the flight deck escape hatch, the side cargo door, or the two main escape hatches due to the possibility of personnel striking the propellers or stabilizers during exit. Bailout from the rear cargo doors is not recommended at airspeeds in excess of 150 knots IAS as this speed is the maximum allowable airspeed for operation of the rear cargo doors.

BAILOUT PROCEDURE — CREW DUTIES.

Pilot:

a. Crew — NOTIFY.

Notify crew and receive acknowledgement. Ring alarm bell three short rings and place the bailout alarm switch in STANDBY position. (This will be an automatic signal for crew members to perform all preparatory duties for bailout.) Order engineer to depressurize the aircraft.

b. Aircraft — SLOW TO 150 KNOTS IAS (If time permits).

c. Wing Flaps — EXTEND TO 15 DEGREES.

d. Autopilot — ON.

Trim as required.

e. Antiexposure Suit (And lifevest if over water)— DON.

f. Parachute — DON.

g. Bailout Alarm Switch — BAIL-OUT.

Alarm bell and lights on continuous signal.

h. After Engineer Evacuates Aircraft—BAIL-OUT.

After receipt of "All Clear" signal from engineer, pilot orders engineer to bail out, and follows him out.

Copilot:

a. Pilot's Bailout Instructions—ACKNOWLEDGE.

b. Radio Transceiver — DON.

c. Antiexposure Suit (And lifevest if over water)— DON.

d. Parachute — DON.

e. Emergency Voice Signals — TRANSMIT.

Note

Radio transmissions (emission patterns) are considerably stronger at plus or minus 90 degrees to the aircraft's heading.

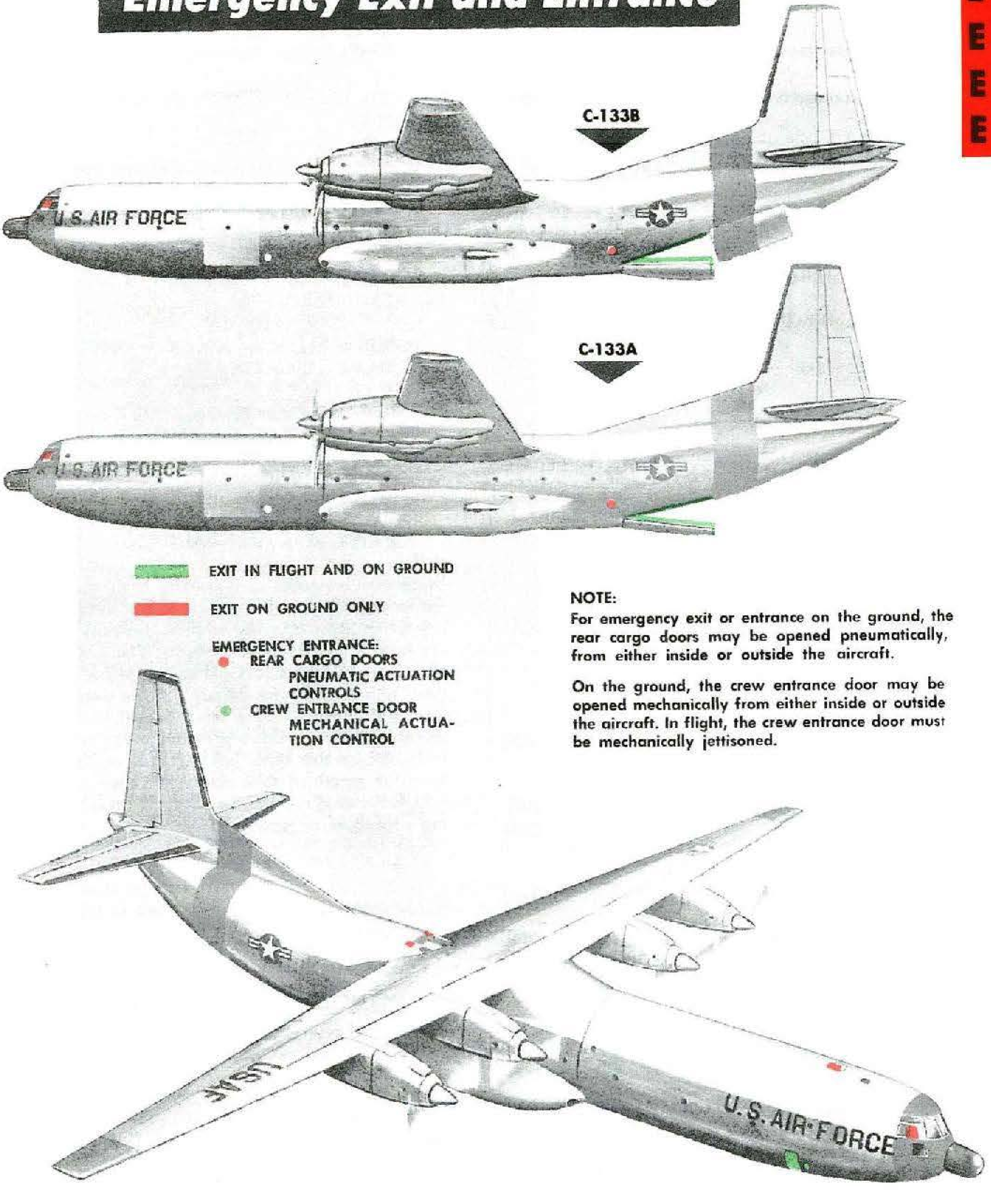
f. Landing Lights — EXTEND, and TURN ON.

g. Until Bailout Signal Is Given — ASSIST PILOT AS DIRECTED.

h. IFF — EMERGENCY.

i. Bailout Signal — BAILOUT.

Emergency Exit and Entrance



🟩 EXIT IN FLIGHT AND ON GROUND

🟥 EXIT ON GROUND ONLY

EMERGENCY ENTRANCE:
- ● REAR CARGO DOORS PNEUMATIC ACTUATION CONTROLS
- ● CREW ENTRANCE DOOR MECHANICAL ACTUATION CONTROL

NOTE:

For emergency exit or entrance on the ground, the rear cargo doors may be opened pneumatically, from either inside or outside the aircraft.

On the ground, the crew entrance door may be opened mechanically from either inside or outside the aircraft. In flight, the crew entrance door must be mechanically jettisoned.

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Figure 3-4

Navigator:

a. Pilot's Bailout Instructions—ACKNOWLEDGE.

b. Radio Transceiver – DON.

c. Antiexposure Suit (And lifevest if over water)—DON.

d. Parachute – DON.

e. Aircraft Position – REPORT TO PILOT, CO-PILOT AND ENGINEER.

f. IFF – EMERGENCY.

g. Bailout Signal – BAILOUT.

Flight Engineer:

a. Pilot's Bailout Instructions—ACKNOWLEDGE.

b. Aircraft – DEPRESSURIZE.

c. Air Conditioning-Ram Ventilation Switch – OFF.

d. Pilots – ASSIST (Cope with the emergency).

e. Antiexposure Suit (And lifevest if over water)—DON.

f. Parachute – DON.

g. Bailout Signal – ASSIST CREW MEMBERS THROUGH BAILOUT EXITS.

h. Pilot – NOTIFY AND RECEIVE ACKNOWLEDGEMENT AFTER ALL OTHER CREW MEMBERS HAVE BAILED OUT.

If a definite acknowledgement is not received, engineer goes to the flight deck and notifies the pilot.

i. On Pilot's Order – BAILOUT.

Scanner/Ground Controller:

a. Pilot's Bailout Instructions—ACKNOWLEDGE.

b. Loadmaster – ASSIST IN PREPARING PASSENGERS FOR BAILOUT.

c. Antiexposure Suit (And lifevest if over water)—DON.

d. Parachute – DON.

e. Bailout Signal – BAILOUT.

Loadmaster:

a. Pilot's Bailout Instructions—ACKNOWLEDGE.

b. Passengers – ASSIST IN PREPARING FOR BAILOUT.

c. Antiexposure Suit (And lifevest if over water) – DON.

d. Parachute – DON.

e. Bailout Exits – OPEN AFTER AIRCRAFT IS DEPRESSURIZED.

f. Bailout Signal – ASSIST PASSENGERS TO EVACUATE AIRCRAFT.

g. After All Other Personnel Are Evacuated, With the Exception of Engineer and Pilot – BAILOUT.

OVERWATER RECOMMENDATIONS.

Bailout is not recommended unless visual contact is made with adequate surface help. If no rescue vessels are in the vicinity, bailout should be used only as a last resort because of the extreme difficulty of getting the crew together in the water. The large liferafts offer more elaborate survival and signaling equipment than do one-man rafts. In any but the warmest seas, a man will survive only a few hours if kept afloat by means of a lifevest alone. Wearing an antiexposure suit will increase this time, but this still cannot compare with the length of time survival is possible in a liferaft. If bailout is required or decided upon, the following procedure is recommended.

a. If surface help is available, it is much easier for rescue crews to find and rescue two or three men at a time in a small area than to rescue 10 or more men strung out in a long line in the water. Always head the aircraft in a direction to allow the crew to drift onto the course and just ahead of the rescue vessel.

b. If surface help is not available, it is still important to keep the crew as close together as possible. Individual members can aid each other, especially if any are injured. Most important of all, a group of men on liferafts is much easier to find than a single individual. This is true whether the search is from a surface vessel or from an aircraft. In view of the above, the aircraft should be flown in as tight a circle as conditions will permit, bailing out two or three men at a time, then coming around in relation to the other men or the surface vessel before bailing out the other members. This should be accomplished to place the members as close as possible to the other men or the surface vessel.

c. As in ditching, try to plan bailout before the last minute. The pilot must warn the crew as soon as bailout is decided upon. Give three short rings on the alarm bell, and, if time permits, warn the crew on the interphone and receive acknowledgements.

d. When the bailout warning is given, crew members should check each other's equipment to insure that all straps and packs are properly secured and adjusted. Upon receiving the bailout signal, crew and passengers will exit, with the least possible delay through the normal bailout exits, in accordance with the preceeding procedure or as prescribed by the pilot.

EMERGENCY DESCENT.

For emergency descent, use zero degrees wing flap and FLIGHT IDLE power with maximum allowable Mach number or maximum allowable indicated airspeed, whichever is limiting.

WARNING

This procedure will give the maximum rate of descent but may not be the safest letdown procedure, depending on the type of emergency.

WARNING

To avoid excessive negative pressure in the fuselage during rapid emergency descents, air must be supplied to the cabin by either the normal air conditioning system or by ram ventilation.

TAKEOFF AND LANDING EMERGENCIES — (EXCEPT DITCHING).

Note

When an emergency landing is required, the crew will assume the same locations that are required for ditching *(figure 3-7)*. The alarm bell procedure is the same as for ditching. See Landing With One or More Engines Inoperative, this section, for approach technique.

ABORT.

During an aborted takeoff, obtain positive directional and lateral control of the aircraft before using reverse thrust. Apply symmetrical reverse thrust by reversing the thrust of the inboard or outboard engines simultaneously. As soon as control has been positively established, the throttle for the remaining engine may be placed in reverse to the limits of directional and lateral control. Apply aileron control as necessary, keeping in mind that the aircraft is exceptionally sensitive to lateral control during ground maneuvers at any speed. The steering effects of lateral control in many cases can exceed the combined effect of rudder and rudder pedal steering. This is especially true on slippery runway surfaces.

To obtain maximum deceleration, place the throttles in full REVERSE (within the limits of lateral and directional control), then apply maximum brake pedal pressure. Reversing the thrust of the propellers before applying the wheel brakes increases the load on the tires, which will result in more efficient braking action. If the antiskid system is turned on, antiskid protection will automatically be provided as the brakes are applied. If the antiskid system is not in operation, apply the brakes by partially depressing the brake pedals, then gradually increasing the braking pressure to the maximum that is possible without skidding. There is little or no indication to the pilot of a skidding tire; therefore, if the condition of the runway warrants or if a skidding tire is suspected, momentarily release the brakes, reapply, release, reapply, etc.

Note

The After Landing check must be accomplished after an aborted takeoff. The Before Takeoff check must be reaccomplished prior to the next takeoff.

ENGINE OUT CROSSWIND LANDING.

The crosswind landing procedures are based on the most critical situation: that of an outboard engine failure. Those situations involving inboard engine failure will demonstrate similar characteristics but will be less severe. In general, the aircraft has adequate control to land satisfactorily in any reasonable combination of wind or engine out conditions. The relatively narrow tread width of the main landing gear combines with the powerful aileron control system to make the aircraft more sensitive on the ground to aileron deflections than aircraft with wide tread landing gear. This factor and the downwind turning tendency of the aircraft requires a certain amount of technique on the part of the pilot. The following general rules may be applied to crosswind landings of this aircraft.

WARNING

Under conditions where sideslip angles are greater than 5 degrees, approaching stall speed in the power approach or takeoff configurations, or with right angle crosswind components of 25 knots or more, errors existing in the airspeed indicating system may be greater than those shown on the Airspeed Position Error Correction charts in Part 2 of *T.O. 1C-133A-1-1*. Under the conditions cited, the proper indicated airspeed reading shall be determined only from that indicator which does not fluctuate, and which gives the higher of the two airspeed readings.

a. Do not be hasty in applying reverse thrust. Raise the throttles into the GROUND range slowly, check for propeller Beta lights ON and apply aileron and rudder quickly in conjunction with rudder pedal steering to assist in maintaining the directional control.

b. Pilot should not hesitate to use the aileron control to bank the aircraft slightly to assist in directional control. Improper use of aileron control can cancel out the effectiveness of rudder and rudder pedal steering. This situation is especially critical under adverse weather conditions at night.

c. The brakes can be used to assist in directional control, but the effectiveness is comparatively low due to the narrow tread width of the main landing gear.

WARNING

Landings are not recommended in crosswinds in excess of those indicated by the Takeoff and Landing Crosswind chart, Part 5 of *T.O. 1C-133A-1-1.*

Engine-Out Crosswind Landing — Upwind Outboard Propeller Feathered.

The characteristics of the aircraft during approach and landing in crosswind conditions with an upwind outboard propeller feathered are similar to those outlined under the paragraph for Crosswind Landing, except during the ground roll after touchdown. After touchdown with three engines operating at FLIGHT IDLE power (upwind outboard propeller feathered), the normal downwind turning tendency is somewhat balanced, depending upon the airspeed and wind velocity, by greater thrust lift on the downwind wing. For this reason if no reverse thrust is planned, or if only the symmetrical propellers are reversed, landing with the feathered propeller upwind will assist in directional control *(see figure 3-5).*

Engine-Out Crosswind Landing—Downwind Outboard Propeller Feathered.

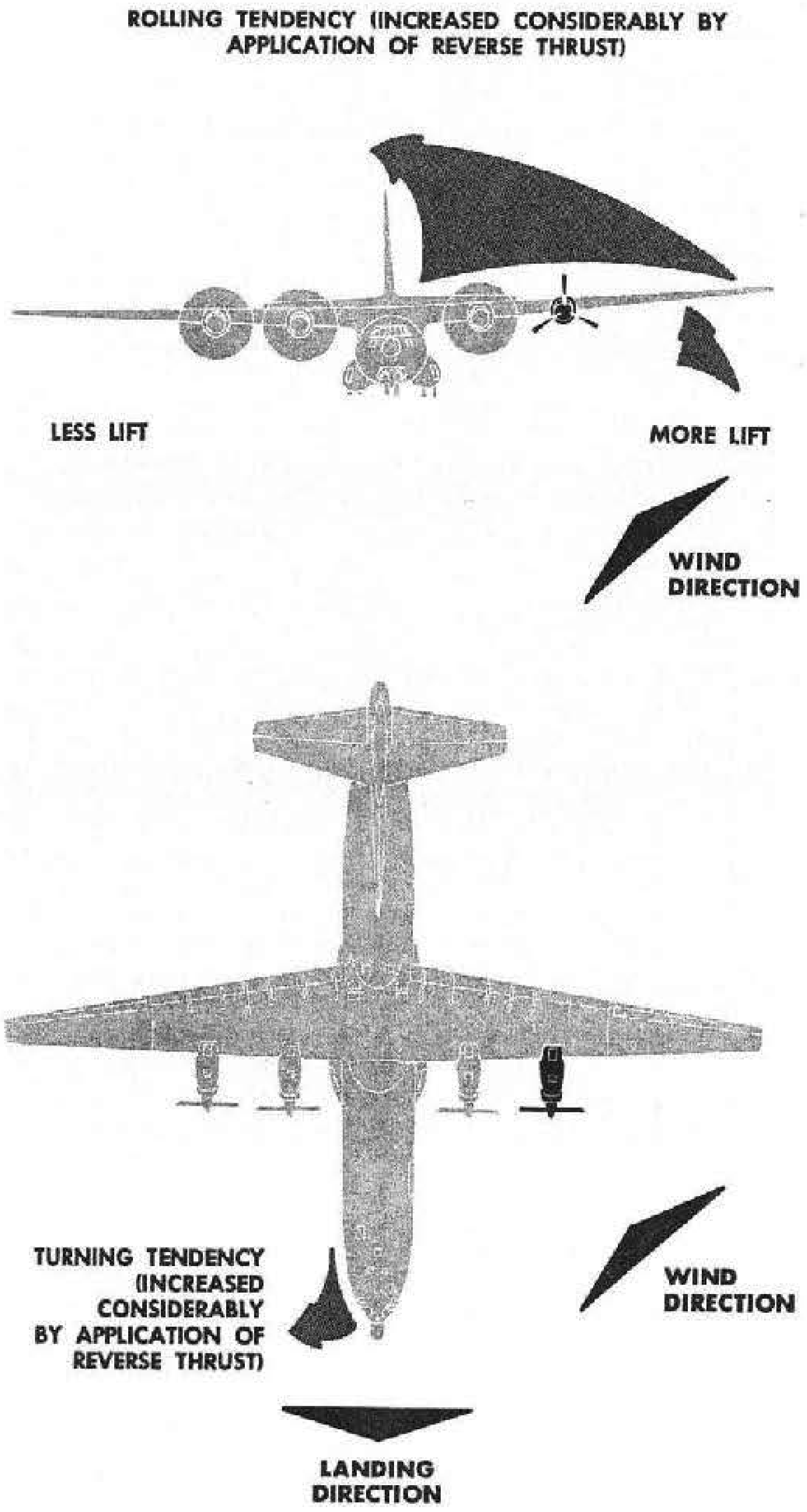
The characteristics of the aircraft during approach and landing in crosswind conditions with a downwind outboard propeller feathered are similar to those outlined under the paragraph for Crosswind Landing, except after touchdown. After touchdown with three engines operating at FLIGHT IDLE power (downwind outboard propeller feathered), the normal downwind rolling and turning tendency will be increased considerably due to the loss of thrust lift on the downwind wing. For this reason, if the landing is planned with reverse thrust, the landing should be accomplished with the feathered propeller downwind, if practical, so that the reversing will assist in lateral and directional control *(see figure 3-6).*

MAIN GEAR TIRE FAILURE.

If both tires on any gear are flat, stop the aircraft on the runway; do not attempt to taxi. If one tire is flat, clear the runway, after which towing is recommended. If both tires are flat on one main gear, or one tire on each tandem gear, as a result of striking some object on the runway, there may be more damage than just a flat tire condition. For example, a hydraulic hose may be torn loose, a wheel may be broken, or the landing gear may be damaged. The aircraft has a tendency to turn towards the side of a flat tire; however, this tendency may be counteracted by differential braking, nose gear steering (use forward pressure on the control column to give good steering characteristics), and by use of aileron control. Asymmetric reverse thrust may also be used, if required. If one or both tires are flat on one main gear when landing, put the nose gear on the runway as quickly as possible after touchdown. Landing with a flat tire on one main gear presents no unusual problem; however, the rate of sink at touchdown should be reduced as much as possible to avoid undue stress on the remaining tires.

(See CAUTION on Page 3-35).

Engine-Out Crosswind Landing – Upwind Outboard Propeller Feathered



Aerodynamic Forces:

1. Increased lift on upwind wing from crosswind effect.
2. Reduced lift on downwind wing during REVERSE.
3. Asymmetrical thrust.

Aircraft Reaction:

Rolling and turning tendency – downwind.

Note

Use of reverse thrust will increase the above reaction considerably.

Pilot's Corrective Action:

Use the same technique on approach as for normal crosswind landing. After touchdown, apply aileron control to depress upwind wing. After the nosewheel is firmly on the runway, apply rudder pedal steering, in conjunction with coordinated aileron, to maintain directional control. In severe crosswinds, and particularly if full reverse thrust is required, land with the feathered propeller downwind, if practicable. If reverse thrust is required, initially only the throttles for the inboard engines should be placed in REVERSE. If maximum reverse thrust is required, the throttle for the operative outboard engine may be placed in REVERSE to the limit of lateral and directional control. The effects of reversing should be corrected quickly by banking slightly into the wind, using rudder pedal steering in conjunction with coordinated aileron to maintain directional control.

Note

When the thrust of the propeller is reversed, the normal downwind turning tendency will increase considerably, causing a further loss of lift on the downwind wing. If reverse thrust is required, reversing the thrust of the inboard propellers only will minimize the rolling and turning tendency.

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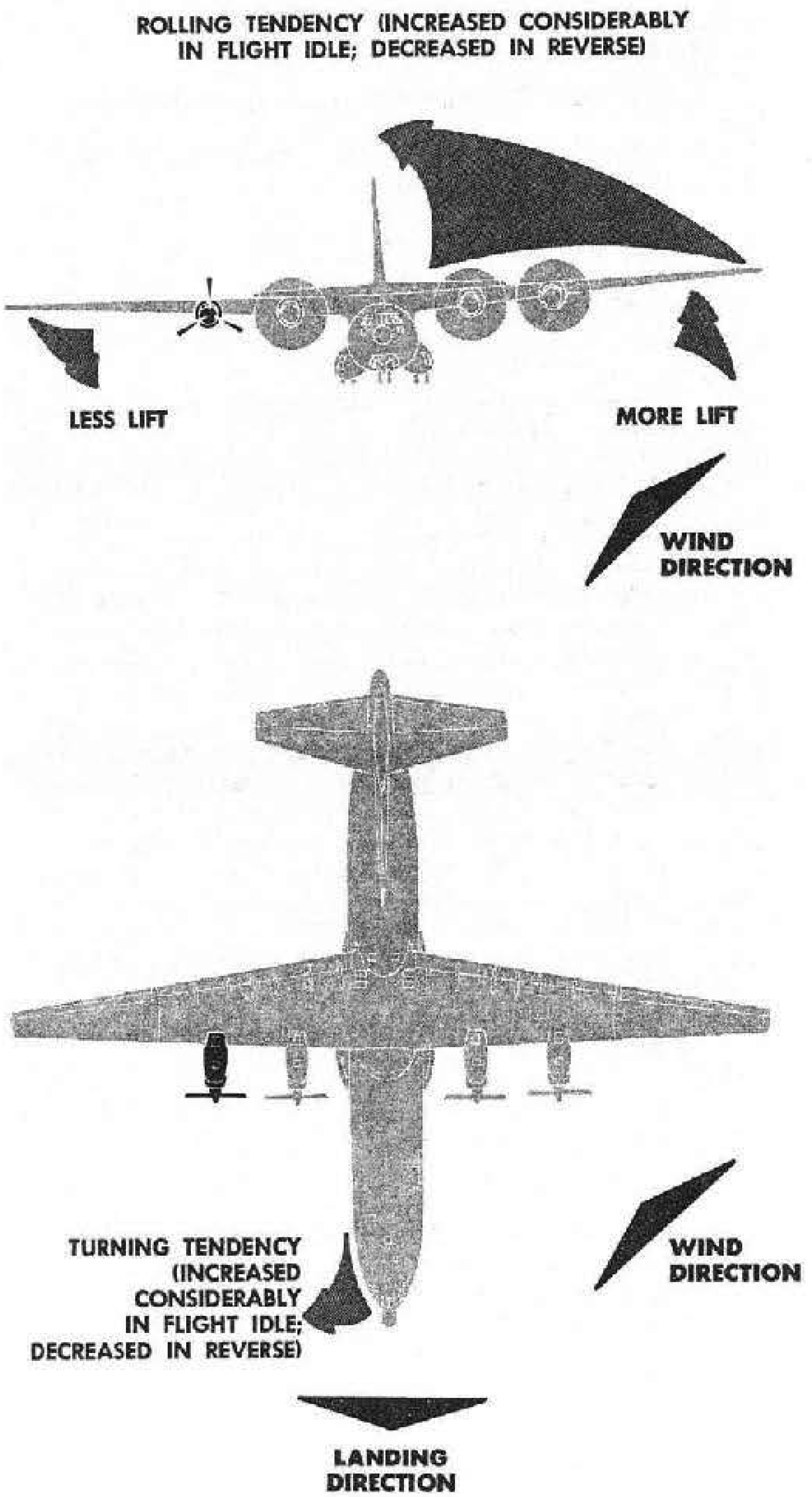
Figure 3-5

Engine-Out Crosswind Landing – Downwind Outboard Propeller Feathered



Aerodynamic Forces:

1. Increased lift on upwind wing from crosswind effect.
2. Reduced lift on upwind wing during REVERSE.
3. Asymmetrical Thrust.

Aircraft Reaction:

Rolling and turning tendency — downwind.

Note

The above reaction will be increased considerably when the throttles are placed in FLIGHT IDLE, and will be decreased when the throttles are placed in REVERSE.

Pilot's Corrective Action:

Use the same technique on approach as for normal crosswind landing. After touchdown, apply aileron control to depress the upwind wing. After the nosewheel is firmly on the runway apply rudder pedal steering, in conjunction with coordinated aileron, to maintain directional control. In severe crosswinds and particularly if reverse thrust is not required, land with the feathered propeller upwind, if practicable; however, if reverse thrust is required, the landing should be made with the feathered propeller downwind. When reverse thrust is required initially only the throttles for the inboard engines should be placed in REVERSE. If maximum reverse thrust is required, the throttle for the operative outboard engine may be placed in REVERSE to the limit of lateral and directional control.

Note

When the thrust of the propellers is reversed, the normal downwind turning tendency will be decreased as a result of the reduction in lift on the upwind wing.

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Figure 3-6

CAUTION

If tire failure is detected prior to gear retraction, leave the gear extended.

NOSE GEAR TIRE FAILURE.

If a nose gear tire is flat at the time of landing, keep the nose gear off the ground as long as possible. If cargo can be shifted safely, move the cargo aft to obtain an aft cg of 32 percent MAC. Use minimum braking; utilize reverse thrust if necessary. The aircraft can be safely taxied with one nose gear tire flat. No special precautions are necessary.

NOSE GEAR SHIMMY.

Nose gear shimmy is an indication of an unbalanced condition of the nose gear wheel and tire assembly or failure of the steering system. If this occurs during the takeoff run and the remaining runway is sufficient to stop the aircraft with a minimum of braking, abort the takeoff. If this is not possible, continue the takeoff, pulling the nose gear clear of the ground as soon as possible. If shimmy occurs during the landing roll, decelerate gradually and apply up-elevator, maintaining as little load on the nose gear as possible. In landing with a known shimmy condition, keep the nose gear off the ground as long as possible, lowering the nose gear just before loss of elevator effectiveness.

Emergency Nose Gear Unlock (T.C.T.O. 614).

On aircraft with T.C.T.O. 614, if the nose gear fails to extend, release the nose gear latching mechanism by means of the emergency nose gear unlock link as outlined in Emergency Landing Gear Extension Procedures, this section.

NOSE GEAR LOCKING MECHANISM MALFUNCTION.

If the nose gear position indicator shows a gear unsafe condition prior to landing and an investigation shows that the red and white warning flag is not in the proper position *(see figure 1-36)*, the nose gear viewing window should be broken and the ground lockpin inserted before landing.

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NOSE GEAR RETRACTED — MAIN GEAR DOWN.

If a landing must be made with the nose gear retracted and the main gear down, and if the cargo can be safely moved, shift it to an aft cg location of not more than 32 percent MAC. Have the crew escape hatch unlatched. Use the following procedure to land with the nose gear up.

PILOTS

a. Shoulder Harness — LOCKED; Seat Belt — FASTENED.

WARNING

The pilot is prevented from bending forward when the harness is locked; therefore, all switches not readily accessible should be properly positioned before locking the harness.

b. Landing — NORMAL (with a slight nose-high attitude).

c. Immediately Upon Ground Contact — Apply sufficient up-elevator to keep the aircraft in a level attitude.

d. Reverse Thrust — APPLY AS NECESSARY.

FLIGHT ENGINEER

a. Pressurization System Manual Control Switch — DEPRESSURIZE.

b. Crew Escape Ladder — IN PLACE.

c. Crew Escape Hatch — UNLATCHED.

d. Seat Belt — FASTENED (seat facing aft).

After the Aircraft Has Come To a Stop:

e. Fuel Boost Pump Switches — OFF.

f. Fuel System Control Switches — OFF.

g. GTU Start-Run-Stop Switches — STOP.

h. Battery Switch — OFF.

(CONTINUED ON NEXT PAGE)

NOSE GEAR RETRACTED — MAIN GEAR DOWN. *(CONTINUED)*

PILOTS

e. Aircraft — Maintain a level attitude and ease the nose down prior to loss of elevator effectiveness. If the tail is too low just before elevator effectiveness is lost, nose contact with the ground will be severe.

f. Brakes — USE MINIMUM BRAKING.

g. Portable Fire Extinguishers — BE PREPARED TO USE.

h. Condition Levers — FUEL OFF.

After the aircraft has come to a stop.

FLIGHT ENGINEER

ANY ONE MAIN GEAR RETRACTED — NOSE GEAR DOWN; OR ONE MAIN GEAR ON EACH SIDE OF THE AIRCRAFT RETRACTED — NOSE GEAR DOWN.

If any one main gear fails to extend or latch down, or if any one main gear on each side of the aircraft fails to extend or latch down, proceed as in a normal landing, except as follows:

PILOTS

a. Fuel Supply — REDUCE.

If feasible, circle the landing area until remaining fuel supply is approximately 1200 pounds for each engine. (Make use of fuel jettisoning provisions as applicable.)

b. Crew Members — WARN TO ASSUME DITCHING STATIONS.

c. Shoulder Harness — LOCKED; Seat Belt — FASTENED.

WARNING

The pilot is prevented from bending forward when the harness is locked; therefore, all switches not readily accessible should be properly positioned before locking the harness.

d. Landing — LAND THE AIRCRAFT AT AS LOW A SINK RATE AS POSSIBLE.

FLIGHT ENGINEER

a. Fuel Supply — REDUCE.

Use fuel jettisoning provisions as applicable.

b. Pressurization System Manual Control Switch — DEPRESSURIZE.

c. Crew Escape Ladder — IN PLACE.

d. Crew Escape Hatch — UNLATCHED.

e. Seat Belt — FASTENED (Seat facing aft).

(CONTINUED ON NEXT PAGE)

ANY ONE MAIN GEAR RETRACTED — NOSE GEAR DOWN; OR ONE MAIN GEAR ON EACH SIDE OF THE AIRCRAFT RETRACTED — NOSE GEAR DOWN. *(CONTINUED)*

PILOTS

e. Brakes — USE MINIMUM BRAKING.

CAUTION

On landing at aft cg locations, with only the forward main gears and the nose gear down and latched, the aircraft will settle on the tail bumper when elevator control becomes ineffective. Use of reverse thrust under these conditions may cause damage to the tail bumper and/or damage to the support structure.

FLIGHT ENGINEER

At gross weights below 235,000 pounds the aircraft can be safely landed with one of the main gears up, provided there is minimum crosswind effect. Turning should be performed at very low taxi speeds and brakes applied cautiously. Transfer of fuel to the opposite side of the aircraft to create an intentional cg eccentricity is beneficial.

TWO MAIN GEARS ON SAME SIDE OF AIRCRAFT RETRACTED.

If two main gears on the same side of the aircraft fail to extend or latch down, retract all gears and make a belly landing.

BELLY LANDING.

There may be a slight tendency to overshoot during a belly landing because of the reduction in drag resulting from the fully retracted gear. Perform the following steps prior to making a belly landing.

PILOTS

a. Fuel Supply — REDUCE.

If feasible, circle the landing area until remaining fuel supply is approximately 1200 pounds for each engine. (Make use of fuel jettisoning provisions as applicable.)

b. All Loose Cargo and Equipment — JETTISON.

Order crew to jettison all loose cargo and equipment.

FLIGHT ENGINEER

a. Fuel Supply — REDUCE.

Use fuel jettisoning provisions as applicable.

b. Pressurization System Manual Control Switch — DEPRESSURIZE.

c. Crew Escape Ladder — IN PLACE.

d. Crew Escape Hatch — UNLATCHED.

After Cargo Has Been Jettisoned:

e. Ramp — CLOSED.

f. Rear Cargo Door — OPENED (C-133A only).

(CONTINUED ON NEXT PAGE)

BELLY LANDING. *(CONTINUED)*

PILOTS

ⓒ GTU Fire Control Handles — PULL OUT AND TURN TO LOCK.

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

d. GTU Fire Control Handles — UNLOCK AND PUSH IN.

e. Crew Members — DITCHING STATIONS.

Direct crew members to take ditching stations.

f. Approach — NORMAL.

g. Shoulder Harness — LOCKED; Seatbelt — FASTENED.

CAUTION

The pilot is prevented from bending forward when the harness is locked; therefore, all switches not readily accessible should be properly positioned before locking the shoulder harness.

h. Wing Flaps — FULL DOWN (As soon as landing is assured).

Use emergency flap switch.

i. Brace for Impact — GIVE SIGNAL.

j. Condition Levers — FUEL OFF.

Set condition levers to FUEL OFF after touchdown, and when engine power is no longer needed to maintain directional control.

k. Firewall Shutoff Valve Switches — FUEL AND OIL OFF.

FLIGHT ENGINEER

g. GTU Start-Run-Stop Switches — STOP.

ⓗ No. 1 and No. 2 GTU Firewall Shutoff Valve Circuit Breaker (Engineer's Overhead Panel) — OPEN.

i. Seatbelt — FASTENED (Seat facing aft).

j. All Fuel Boost Pump Switches — OFF (When brace for impact signal is given).

k. All Fuel System Controls — OFF (After engines have been shutdown).

l. Battery Switch — OFF (Prior to leaving aircraft).

(CONTINUED ON NEXT PAGE)

BELLY LANDING. *(CONTINUED)*

PILOTS

FLIGHT ENGINEER

If Engine Fire Occurs:

l. Engine Fire Control Handle (Affected Engine) — PULL OUT AND TURN TO LOCK.

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

m. Engine Fire Extinguisher Discharge Switch — 1ST FIRE EXT (Hold for minimum of 3 seconds). If second shot is necessary, position discharge switch to 2ND FIRE EXT, and hold for a minimum of 3 seconds.

If GTU Fire Occurs:

n. GTU Fire Control Handle (Affected GTU) — PULL OUT AND TURN TO LOCK.

WARNING

To insure proper actuation of the fire extinguisher directional valves and routing of fire extinguishing agent to the proper location, engine and GTU fire control handles must be pulled out slowly.

(CONTINUED ON NEXT PAGE)

BELLY LANDING. *(CONTINUED)*

PILOTS

o. Fire Extinguisher Agent Discharge Switch — 1ST FIRE EXT (Hold for minimum of 3 seconds).

Note

If second shot is necessary, position discharge switch to 2ND FIRE EXT, and hold for a minimum of 3 seconds.

WARNING

The GTU Fire warning lights will not come on without a-c power on the aircraft. Fire procedures should be based upon visual observation.

FLIGHT ENGINEER

A forced landing at any place other than an airfield should be made according to the procedures outlined for a belly landing, except that the landing gear should be extended prior to touchdown.

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EMERGENCY ENTRANCES AND EXITS.

Emergency entrances and exits *(figure 3-4)* are provided as follows: rear cargo doors and crew entrance door. These doors may be opened by external or internal controls located adjacent to each door. Exit may also be made from the cabin and crew escape hatches and from the pilot's and copilot's side windows. Escape ropes should be used when making an exit from escape hatches, whenever possible.

REAR CARGO DOORS AND RAMP GROUND EMERGENCY OPERATION.

For emergency operation of the rear cargo doors and ramp from inside the aircraft, proceed as follows:

a. Open hinged cover over emergency control handle.

b. Turn emergency control handle to OPEN position.

For emergency operation from outside aircraft, proceed as follows:

a. Push button directly below emergency control handle to release handle.

b. Turn emergency control handle to OPEN position.

Note

The ramp and doors should be operated through several cycles after emergency operation to bleed the system of air.

DITCHING.

The ditching chart *(figure 3-7)* and ditching sequence diagram *(figure 3-8)* give duties of personnel prior to, and during ditching.

The following are the standard alarm signals for ditching.

SIX SHORT RINGS .....PREPARE FOR DITCHING
ONE LONG RING ....BRACE FOR IMPACT

Note

The essential bus must be powered to provide electrical power for the operation of the UHF radio and interphone.

CAUTION

The battery switch must be positioned to OFF immediately prior to impact.

EMERGENCY DITCHING EQUIPMENT.

Ditching equipment should be in readiness at all times when flying over water. Prior to each overwater flight, the pilot will ensure that the necessary equipment is aboard, in serviceable condition, and stowed in the proper places.

EMERGENCY DITCHING EXITS (FLIGHT CREW).

Refer to figure 3-4 for emergency exits. Normally, all flight crew members will use the crew emergency escape hatch *(11, figure 3-1)* for exit after ditching. In the event the two escape hatches in the cabin are to be used for emergency exit by crew members, two folding escape ladders *(16, figure 3-1)* are provided for access to the hatches.

Note

At least one cabin escape ladder should be installed before takeoff. Evacuation operations through the escape hatches may be seriously hampered by the time and effort required to install the ladders during adverse flight conditions.

EMERGENCY DITCHING EXITS (PASSENGERS).

When overwater flight with passengers is anticipated, the loadmaster and the scanner/ground controller will assist in evacuating passengers and carrying out the duties outlined in the Ditching Chart *(figure 3-7)*. The pilot should ensure that at least one escape ladder is installed at a cabin emergency escape hatch and that the normal passenger briefing is augmented with the following information.

a. Ditch alarm signals.

b. Instructions to remain seated with safety belts fastened until it is ascertained that the aircraft has stopped forward movement during ditching. On water landings, there are normally two or more water impacts. The initial impact is (normally) lighter than the second water impact and the subsequent impacts (if any) will diminish in force.

c. Operation of the escape hatch latch control handles.

Note

Normally a crew member will release the latch control handles prior to ditching and after depressurization. With the cabin depressurized, the hatches will not open in flight at maneuvering airspeeds. If structural deflections occur during actual ditching the hatches may spring open.

d. Proper exit route.

Note

Each passenger should have a preplanned route to an emergency escape hatch ladder. If liferafts are stowed in the cabin liferaft compartments *(figure 3-8)*, the first man up the ladder should pull the liferaft release handles *(15, figure 3-1)* to release the rafts for passenger use. If there are no cabin liferafts aboard, the passengers must walk forward on top of the fuselage to the crew liferaft after exiting through the hatch.

PREPARATION FOR DITCHING.

Wind Speeds and Directions.

Surface winds are fairly predictable by the way they affect the water. Use the following reference for estimating the surface wind velocity.

a. Glassy Sea ....Less than 1 knot

b. Ripples With the Appearance Of
Scales Are Formed, But Without
Foam Crest...1 to 3 knots

c. Small Wavelets, Still Short But More Pronounced; Crests Have a Glassy Appearance and Do Not Break................4 to 6 Knots

d. Large Wavelets; Crests Begin to Break. Foam of Glassy Appearance. Perhaps Scattered Whitecaps....................7 to 10 knots

e. Small Waves, Becoming Longer; Fairly Frequent Whitecaps....................11 to 16 knots

f. Moderate Waves, Taking a More Pronounced Form; Many Whitecaps..17 to 21 knots

g. Large Waves Begin to Form; the White Foam Crests Are More Extensive. (Probably Some Spray)..22 to 27 knots

h. Sea Heaps Up and White Foam From Breaking Waves Begins To Be Blown In Well-Marked Streaks Along the Direction Of the Wind....................28 to 33 knots

i. Moderately High Waves of Great Length; Edges of Crests Break Into Spindrift. The Foam Is Blown In Well-Marked Streaks Along the Direction Of the Wind..34 to 40 knots

j. High Waves. Dense Streaks Of Foam Along the Direction Of the Wind. Sea Begins To Roll................................41 to 47 knots

k. Very High Waves With Long Overhanging Crests. Foam Is Blown In Dense White Streaks Along the Direction Of the Wind. On the Whole, the Surface Of the Sea Takes a White Appearance..............48 to 55 knots

Plans for ditching cannot be made without taking the wind direction into consideration. Waves move downwind, and the spray from wave crests is also blown downwind. Swells, however, do not always indicate wind directions and can be very large even when the wind is calm. Swells are the result of underwater disturbances. Over a sea, a pilot must be more exacting and alert when judging height.

Flight Deck.

At the time the Prepare for Ditching order is given by the pilot, the crew assignments will be: Pilot and copilot will don antiexposure suits and lifevests in turn, after the copliot transmits the necessary emergency signals. The engineer will install the escape ladder, unlatch the crew emergency escape hatch, don antiexposure suit and lifevest, return to his station, and stand by to assist the pilots. The navigator will switch the IFF to emergency and relay the speed, course, altitude, position, and estimated ditching position to the copilot. He will also stow essential equipment in the emergency equipment bag and stow the bag in the relief crew compartment. Upon completion of these duties, he will don antiexposure suit and lifevest and return to his station. If a relief crew is aboard, the personnel will assist the copilot and navigator as assigned, don antiexposure suits and lifevests, and return to the relief crew compartment to await further orders. Upon hearing one long ring of the alarm bell, all crew members will assume the Brace for Impact position *(figure 3-8)*.

Note

> The navigator should make certain that the size of the emergency equipment bag will allow it to go through the crew escape hatch without difficulty.

ABANDONING AIRCRAFT.

Evacuation of the aircraft after ditching should be accomplished in an orderly manner in the shortest time possible. This cannot be done well without practice and in the event that the fuselage is dark and filling with water, further difficulty can be expected.

CAUTION

> The crew and/or passengers must not leave ditching positions until it is ascertained that the aircraft has stopped forward movement. Serious injuries have occurred as the result of personnel unfastening safety belts prior to the aircraft coming to a full stop. Upon water ditching the initial impact is normally lighter than the second impact. Subsequent impacts will be lighter depending on water conditions (waves or ripples) and the forward velocity of the aircraft.

Immediately after the aircraft comes to rest, additional necessary emergency equipment may be collected and distributed to each crew member. The crew members must carry out their After Ditching duties *(figure 3-7)* and then evacuate the aircraft through the hatch previously assigned to them in the correct order carrying the equipment which each has been allotted. They must also see to it that each piece of equipment for use in the liferaft is secured by lines to prevent its being lost overboard in passing from the aircraft to the liferaft. The escape rope provided should be used until all personnel are safely in the assigned liferaft.

Ditching Chart

FIRST ACTIONS	WHEN DITCHING IS IMMINENT (10 MINUTES LEFT)	POSITION	AFTER DITCHING
PILOT 1. Warns crew to prepare for ditching, giving approximate time remaining. 2. Orders loadmaster to assume duties. 3. Orders copilot to start emergency procedures. 4. Dons anti-exposure suit and lifevest. 5. Procures flashlight. 6. Fastens shoulder harness and seat belt.	1. Alerts cabin personnel with signal No. 1: Six short rings on alarm bell, 2 seconds each. 2. Orders copilot to send final distress signal. 3. Orders to all crew members and passengers to turn on emergency flashlights connected to lifevests. This procedure will provide light after ditching and will aid in locating persons injured during ditching. 4. Orders all on board to secure themselves in ditching position. 5. If at night, turns ON formation lights and orders engineer and scanner/ground controller to turn on impact lights. 6. Immediately prior to ditching, gives signal No. 2: "Brace for Impact" on interphone and one long ring on alarm bell (approximately 6 seconds).	Pilot's seat	1. Leaves aircraft through crew escape hatch and assists with liferafts. Note: Aircraft commander and loadmaster, in conference prior to departure, will determine distribution of personnel in rafts.
COPILOT 1. On pilot's orders sends MAYDAY followed by emergency message giving position, flight time, nature of emergency, and other pertinent information, on HF, UHF, and VHF. (Use normal frequencies if possible.) 2. Obtains DF service and bearing fixes on normal ground frequency if possible. 3. Dons radio transceiver, anti-exposure suit and lifevest. 4. Procures flashlight. 5. Fastens seat belt and shoulder harness. 6. Continues the radio emergency procedure every 10 minutes.	1. Sends final MAYDAY position, altitude, course, speed, and intention of pilot as to ditching. 2. Assists pilot.	Copilot's seat	1. Exits through crew escape hatch.

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Figure 3-7 (Sheet 1 of 2)

FLIGHT ENGINEER 1. Stands by at panel to assist pilot and copilot if required. 2. Procures flashlight. 3. Dons anti-exposure suit and lifevest.	1. Pressurization system manual control — DEPRESSURIZE. 2. Installs crew escape ladder. 3. Unlatches crew escape hatch. 4. Turns on all flight deck impact lights. 5. Fastens seat belt and faces aft. 6. Immediately prior to impact turns off generators and battery (daylight only).	Engineer's seat, facing AFT.	1. Pulls liferaft release handle in relief crew compartment. 2. Exits through crew escape hatch and checks crew liferaft for proper ejection. 3. Obtains emergency radio.
NAVIGATOR 1. Turns IFF to EMERGENCY. 2. Passes information on speed, course, altitude, position, and estimated ditching position to copilot for inclusion in distress signal. 3. Stows essential navigational equipment, Very pistol, signal flares, smoke signals, first aid kit and crew water tank in emergency equipment bag and stows bag in relief crew compartment. Places periscopic stand in the UP position. 4. Informs crew and passengers of distance and direction of nearest land or rescue vessel. 5. Dons radio transceiver, anti-exposure suit and lifevest. 6. Procures flashlight.	1. Assists pilot as directed. 2. Fastens seat belt and faces aft.	Navigator's seat, facing AFT.	1. Passes out emergency equipment bag and exits through crew escape hatch.
LOADMASTER 1. Advises scanner/ground controller and passengers of the impending emergency. 2. Jettisons cargo, closes all hatches that might take in water. 3. Secures cargo that cannot be jettisoned. 4. Puts escape ladders in position. 5. Notifies pilot when cabin is secured.	1. Dons anti-exposure suit and lifevest. 2. Procures flashlight. 3. Insures that passengers are properly seated and secured. 4. Unlatches cabin escape hatches. 5. Fastens safety belts.	Relief crew bunk, in relief crew compartment.	1. Exits through the crew escape hatch. 2. Assists other crew members to evacuate the aircraft.
		In cabin, when carrying passengers.	1. Opens left cabin escape hatch. 2. Releases liferafts from the left wing compartment. 3. Exits through the cabin escape hatch. 4. Assists other crew members and passenger to evacuate aircraft.
SCANNER/GROUND CONTROLLER 1. Assists loadmaster to jettison cargo and position equipment. 2. Closes all hatches that might take in water. 3. Assists passengers and crew members into anti-exposure suits and lifevests.	1. Turns on cabin impact lights. 2. Dons anti-exposure suit and lifevest. 3. Procures flashlight. 4. Assumes ditching position.	Relief crew bunk, in relief crew compartment.	1. Exits through the crew escape hatch. 2. Assists other crew members to evacuate aircraft.
		In cabin, when carrying passengers.	1. Opens right cabin escape hatch. 2. Releases liferafts from the right wing compartment. 3. Exits through cabin escape hatch. 4. Assists other crew members and passenger to evacuate aircraft.

Figure 3-7 (Sheet 2 of 2)

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Ditching

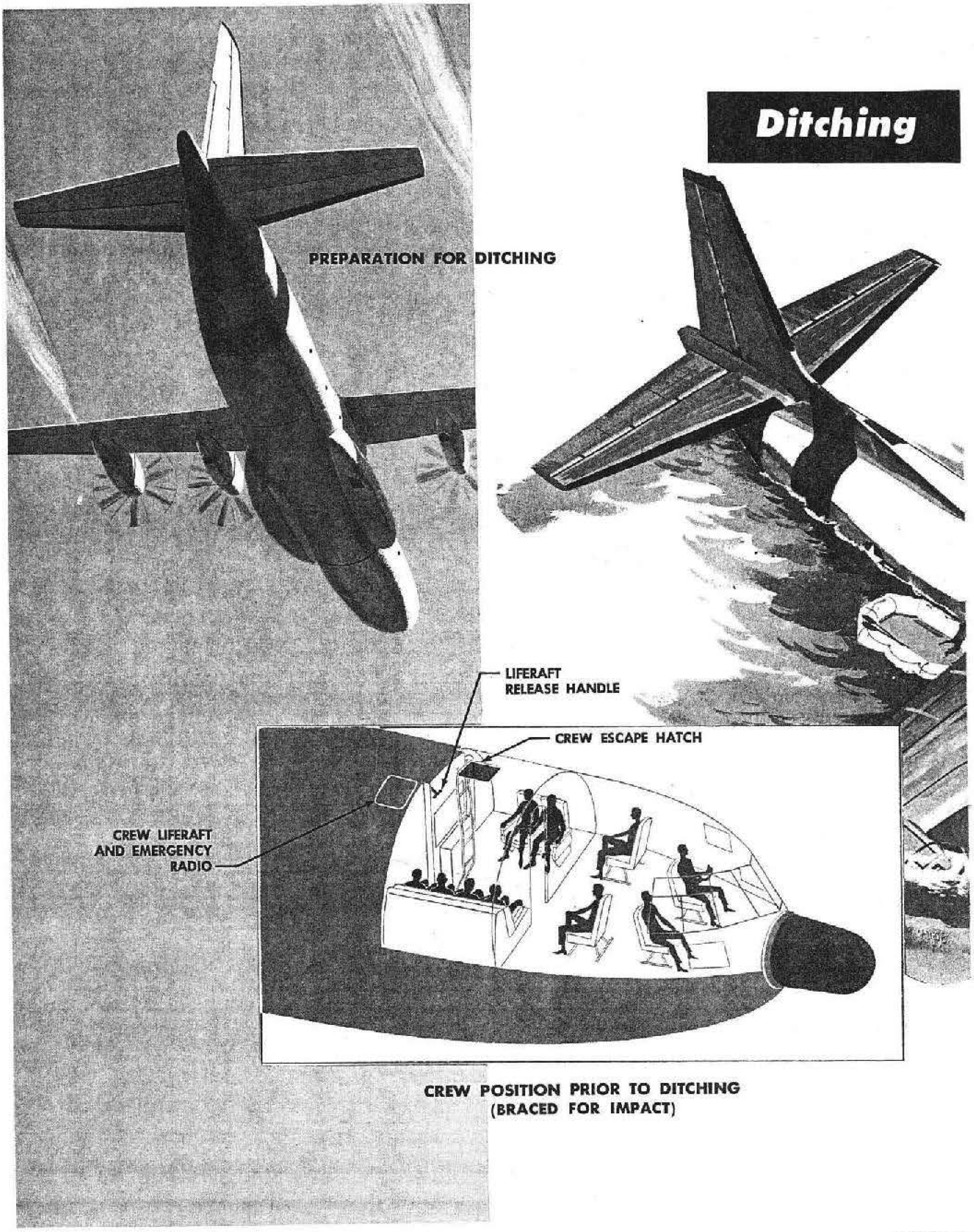
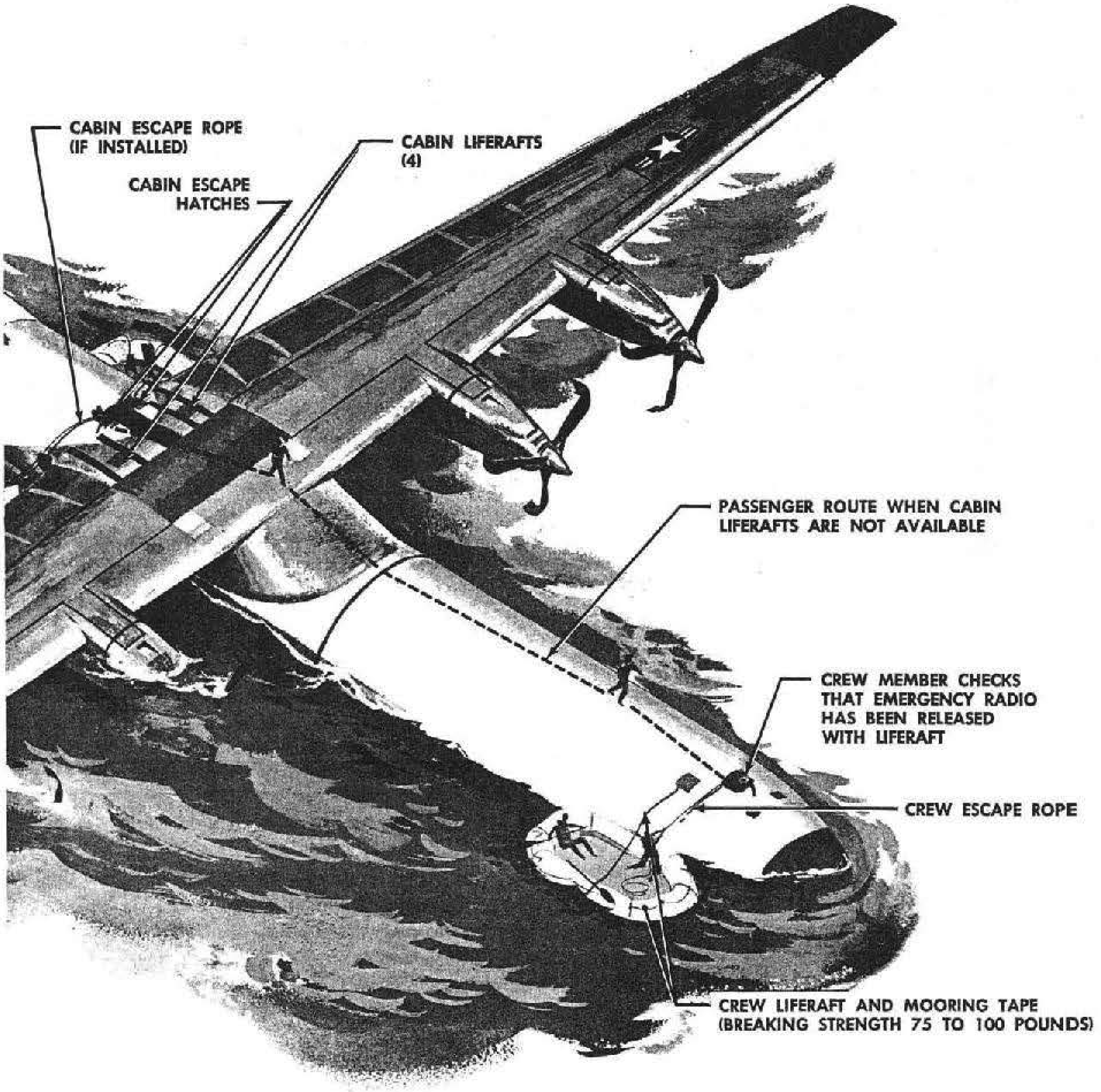


Figure 3-8 (Sheet 1 of 2)

Sequence Diagram



BOARDING THE LIFERAFTS

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Figure 3-8 (Sheet 2 of 2)

Crew Duties.

When it is certain that the aircraft has come to a complete stop, each crew member will proceed with the following duties: The engineer checks the pilot and copilot to see that they are uninjured, then pulls the crew liferaft release handle and casts the escape rope through the escape hatch over the side of the aircraft. He then exits through the crew escape hatch and, supporting himself by use of the escape rope, ensures that the liferaft and emergency radio have been properly ejected. If they have not been released, he should open the crew liferaft compartment door by means of the external handle, manually remove the liferaft, survival kits, and emergency radio. The liferaft will inflate during removal. When he has ascertained that all equipment is properly launched, he descends the escape rope over the side of the aircraft and boards the liferaft.

WARNING

> When the liferaft release handle is pulled, it first jettisons the liferaft container door, then releases the CO_2 gas to inflate and eject the liferaft. To assure complete ejection of the liferaft, the liferaft release handle must be pulled through its full travel (approximately 9½ inches).

The navigator retrieves the emergency equipment bag from the relief crew compartment and lifts it up through the crew escape hatch, lowering it carefully over the side of the aircraft to the engineer waiting in the liferaft. He then exits through the crew escape hatch and joins the engineer.

The pilot and copilot will check each other to see if either one has been injured. It is quite possible for either or both pilots to receive severe blows on the head or other parts of the body, making it impossible for them to leave the aircraft unassisted. The copilot, if uninjured, after checking to see that all switches and controls are off, exits through the crew escape hatch and descends over the side of the aircraft, joining the navigator and engineer. If the situation demands it, the pilot's and the copilot's clearview windows may be used as emergency exits.

The pilot ensures that all emergency equipment has been removed and all crew members have been safely evacuated, and then exits through the crew escape hatch. He descends the escape rope and joins the other crew members in the liferaft.

DITCHING TECHNIQUES.

Normal Power-On Ditching.

Experience gained in ditching aircraft has shown that best results are obtained by following the procedure outlined.

a. If possible, use up most of the fuel supply to lighten the aircraft and reduce stalling speed. Empty tanks are also a contribution to flotation. Use the fuel dumping provisions, as applicable.

b. Ditch while power is available. Power will allow you to choose the spot for ditching to obtain best possible sea conditions and most favorable landing position and attitude.

c. Use 25-degrees flap and keep landing gear up.

d. Ditch at 10 knots above stalling speed. This will give an approximate angle of ditching slightly above level flight. Under no circumstances should the aircraft be stalled in, since this will result in severe impact and cause the aircraft to nose into the sea.

e. In daylight, it is recommended that the aircraft be ditched along the top of the swell, parallel to the rows of the swells, if the wind does not exceed 30 knots. In high winds, it is recommended that ditching be conducted upwind to take advantage of lowered forward speed. However, it must be remembered that the possibility of ramming nose-on into a wave is increased, as is the possibility of striking the tail on a wave crest and nosing in.

f. Immediately prior to impact, turn OFF generators and battery.

Partial Power Ditching.

When ditching with one or more engines inoperative, the following should be borne in mind.

a. With two engines inoperative on the same side of the aircraft, use power on the inboard engine only.

b. If power is available from the No. 2 and 4 engines, or the No. 1 and 3 engines, considerable power may be used to control the aircraft.

c. With symmetrical power conditions, use power as required to give flattest approach.

d. On final approach, it is advisable to hold speed 20 knots above stall speed until flareout, at which time speed will be reduced to 10 knots above stall speed.

e. Immediately prior to impact turn OFF generators and battery.

Crosswind Ditching.

The basic rules for ditching listed in Normal Power-On Ditching will still apply, in addition to the following:

WARNING

> Under conditions where sideslip angles are greater than 5 degrees, approaching stall speed in the power approach or takeoff configurations, or with right angle crosswind components of 25 knots or more, errors existing in the airspeed indicating system may be greater than those shown on the Airspeed Position Error Correction charts in Part 2 of *T.O. 1C-133A-1-1*. Under the conditions cited, the proper indicated airspeed reading shall be determined only from that indicator which does not fluctuate, and which gives the higher of the two airspeed readings.

a. Crab the aircraft to kill drift.

b. Land on downward side of the swell or wave.

Upwind Ditching.

The basic rules for ditching listed in Normal Power-On Ditching will still apply, in addition to the following:

a. Maintain nose-up condition, avoid nose striking wave face.

b. Touch down immediately behind the crest of a rising wave, avoid the face of the wave.

c. Hold nose up after first impact.

Night Ditching.

a. Night ditching will be conducted with the aid of instruments to establish proper attitude of aircraft.

b. Make an instrument letdown, holding airspeed 20 knots above stall speed. At 500 to 700 feet above the water (use the APN-22 if available) set up approximately 200 feet per minute rate of descent at 10 knots above stall speed using 25 degree flap.

c. Use landing lights as necessary.

d. Hold wings level to avoid digging a wing into the water and cartwheeling the aircraft.

e. Land at 10 knots above stall speed, using 25-degree flaps and keeping landing gear up. Touchdown immediately behind the crest of a rising wave, avoid the face of the wave.

EMERGENCY JETTISONING.

In the event one or more engines fail during flight, and it is determined (from the Driftdown charts, Part 5 of *T.O. 1C-133A-1-1*) that the resulting driftdown will not permit safe completion of the flight, it will become necessary to jettison either fuel, cargo, or both, in order to maintain a safe altitude and reach a chosen destination. Under these conditions, jettisoning of fuel to reduce the gross weight of the aircraft is preferable to jettisoning of cargo, providing adequate fuel is retained to accomplish a safe landing. If necessary, fuel and cargo may be jettisoned simultaneously. The possibility that it may become necessary to jettison either fuel or cargo, or both, should be considered during preflight planning. Immediately after an engine failure occurs, the specific amounts of fuel or cargo that may become necessary to jettison should be computed from the Jettisoning Requirements charts, Part 5 of *T.O. 1C-133A-1-1*.

FUEL JETTISONING.

Fuel jettisoning is accomplished by positioning the fuel dump lever *(figure 1-12)* at the flight engineer's station to DUMP. The aircraft should be maintained in as near wings level attitude as practical to permit symmetrical jettisoning. Fuel jettisoning rate will vary with fuel load. For flow rate and time required, see figure 3-9. A nose up attitude will increase the jettisoning rate slightly at low fuel quantities and conversely, a nose down attitude will decrease the jettisoning rate. Approximately 1040 pounds will remain in each of tanks No. 1 and 8, and 7800 pounds in each of tanks No. 2 and 7 after complete fuel jettisoning. See Load Factor Restrictions During Emergency Fuel Jettisoning, Section V.

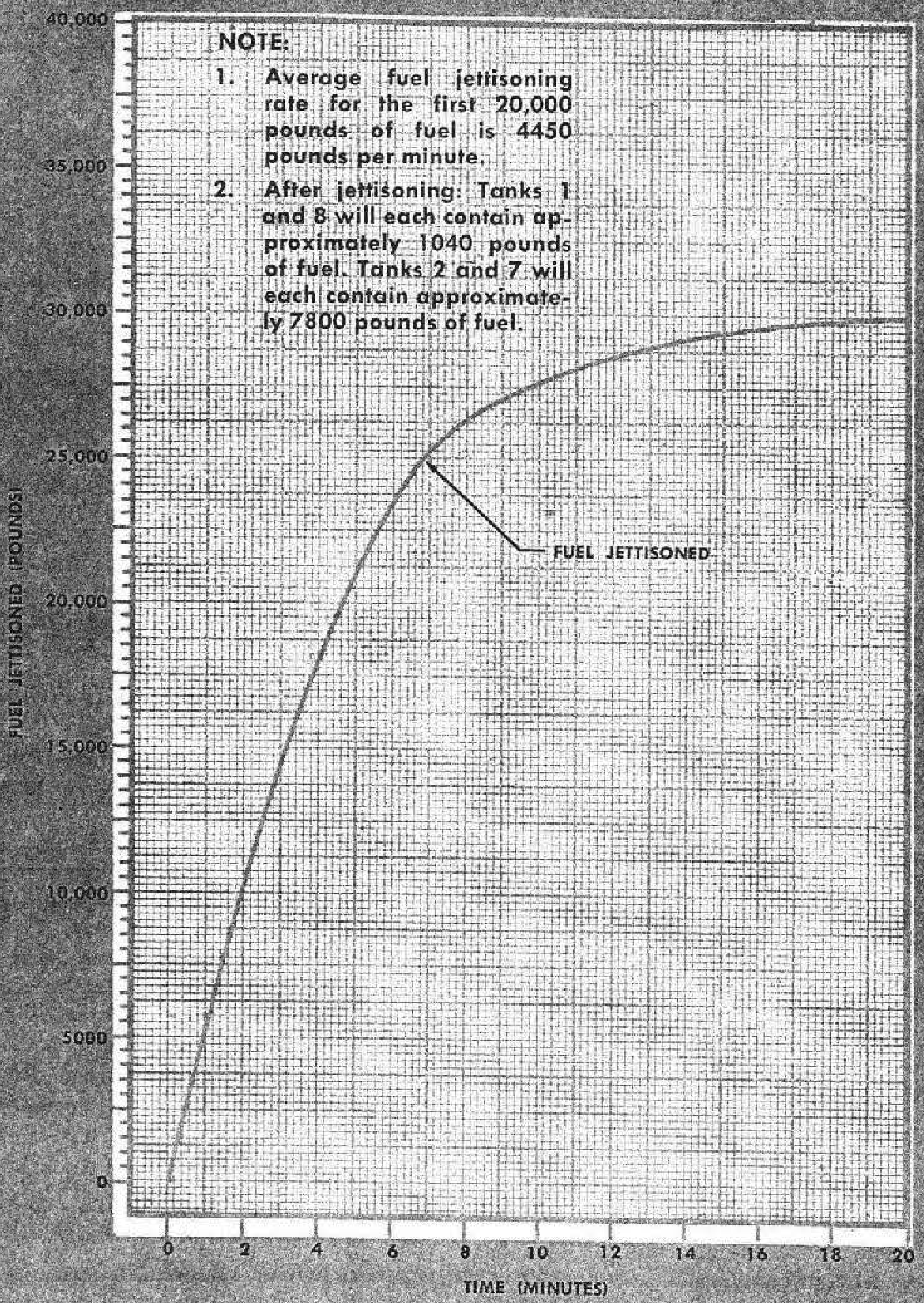
Effect of Asymmetric Fuel on Aerodynamic Control During Approach, Flare, and Landing Run.

Asymmetric fuel does not present a major problem in the aerodynamic control of the aircraft, either in the air or during the landing taxi run on the ground. The most severe control requirement with asymmetric fuel exists during flare-out while landing at 100 knots

Fuel Jettisoning

FUEL JETTISONED VS TIME

CONDITIONS:
NORMAL CRUISE ATTITUDE



NOTE:

1. Average fuel jettisoning rate for the first 20,000 pounds of fuel is 4450 pounds per minute.
2. After jettisoning: Tanks 1 and 8 will each contain approximately 1040 pounds of fuel. Tanks 2 and 7 will each contain approximately 7800 pounds of fuel.

UAB1-213

Figure 3-9

(fiare speed) using ⅔ of the total design aileron deflection. The lateral control is adequate to permit any of the wing tanks to be full and the opposite symmetric tank to be empty. The landing taxi run is not critical for the most severe condition of fuel asymmetry. Compared to turning and crosswinds, fuel asymmetry for ground taxi represents a relatively minor tip-over stability problem.

CARGO JETTISONING (C-133A AIRCRAFT).

The possibility of cargo jettisoning should be considered during loading of the aircraft. Whenever possible, nonjettisonable and/or high priority cargo should be positioned forward and jettisonable items should be located aft, near the rear cargo door. The maximum height of pallets that may be jettisoned should be less than 90 inches to provide sufficient clearance between the pallets and the cargo door. If it is necessary to jettison cargo, the rear cargo door is the only suitable exit. Do not attempt to open or jettison cargo through the side cargo door. Instructions for opening the rear cargo doors in flight are given in Section IV. (See Section V for Rear Cargo Door and Ramp Limitations.)

CAUTION

> Before the rear cargo doors can be opened in flight, the aircraft must be depressurized, the air conditioning system turned off, and the hydraulic system turned on.

Aircraft Control Prior to Door Operation.

Directional control can be maintained down to the stall by reducing asymmetric thrust. However, the minimum speed at which a steady heading can be maintained for the most critical condition of two engines inoperative on the same side, propellers feathered, is approximately 139 knots IAS at sea level with NORMAL RATED power and at any gross weight.

At higher altitudes this minimum speed will be reduced. Flight should be maintained between the above limit (139 knots) and the airspeed limit for rear door operation (150 knots), while the aircraft is maintained in the clean configuration, if possible, to give a minimum rate of descent. However, wing flap deflection may be used to maintain a reasonable speed margin above the stall and to control the attitude of the aircraft at a given speed. During jettisoning and periods when the rear cargo doors are open, the aircraft is restricted to a maximum of 25 degrees flap deflection, 150 knots IAS, and ±8.4 degrees sideslip due to structural limitations. Abrupt rolling or directional maneuvers which result in high tail loads should also be avoided.

Aircraft Control During Door Operation.

Opening and closing of the rear cargo doors should not be attempted while the aircraft is in a condition that requires high loads on the vertical stabilizer, since there is a possibility that the doors will bind due to the resulting fuselage distortion. This condition may be alleviated by reducing power on the asymmetric operating engines so that high rudder forces are not required to maintain zero sideslip. Power may be reapplied as soon as the doors have cleared the jambs, but do not increase power to such a degree that it is necessary to sideslip the aircraft to maintain directional control. As the rear doors open, a slight nose-up pitching moment may be expected at the cruise configuration at zero sideslip. This is followed by a nose-down moment of higher magnitude as the doors fully open. Sideslipping the aircraft increases the magnitude of this pitching tendency to an appreciable, though not dangerous, level.

With the maximum allowable flap deflection for rear cargo door opening (25 degrees), the initial nose-up pitching moment is eliminated; however, a nose-down moment exists. This nose-down pitching moment (with 25 degrees flap) is slightly greater in magnitude than the zero sideslip (zero flaps) case, and is nearly independent of sideslip. Because of the lack of nose-up pitching with flaps down, the use of 25 degrees flap for rear cargo door opening is recommended, while maintaining as near zero sideslip as possible and carefully monitoring the controls to counteract any nose-down tendency. As the doors open, there is an initial, slight reduction in directional stability, which is recovered and increased as the doors are fully opened.

Operation of Rear Cargo Door and Ramp In Flight.

CAUTION

> Do not operate the rear cargo door and ramp with the cabin pressurized. The air conditioning system must be turned off and the cabin pressure completely dumped before operating the door and ramp. The pressurization system manual control switch should be kept in the DEPRESS position for a minimum of 45 seconds to ensure dumping of all cabin pressure. Do not move the door control handle until the light above the handle is on.

Pallet Group Position

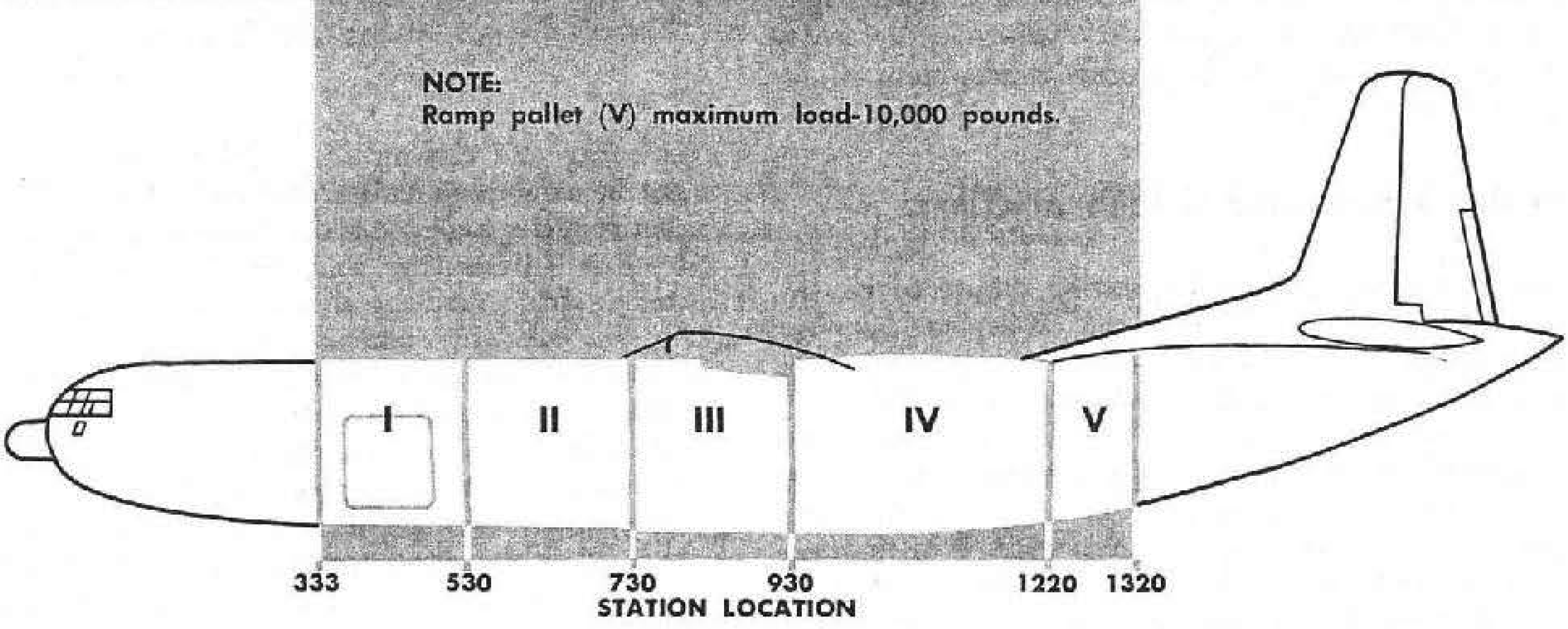

NOTE:
Ramp pallet (V) maximum load-10,000 pounds.

Figure 3-10

To Open Door and Ramp:

a. Air Conditioning-Ram Ventilation Switch — OFF.

b. Hydraulic Pump Control Switch — UTILITY.

c. Aircraft — DEPRESSURIZE.

d. Asymmetric Engine Power — REDUCE TO MINIMIZE RUDDER TRIM.

e. No. 1 Door Indicator Light — ON; Door Latch Valve No. 1 — OPEN.

f. No. 2 Door Indicator Light — ON; Door Control Valve No. 2 — OPEN.

If the rear cargo door does not open, proceed with steps g and h. The door should open after the ramp starts to open.

g. No. 3 Door Indicator Light — ON; Ramp Latch Valve No. 3 — OPEN.

h. No. 4 Door Indicator Light — ON; Ramp Control Valve No. 4 — DOWN.

If the ramp does not open, turn handle No. 4 to FLIGHT DOWN position to start the ramp down only. After ramp has started down (cleared the door seals), return handle No. 4 to DOWN.

CAUTION

The ramp should not be allowed to extend beyond the TRAIL position, which is approximately 7 degrees below the floor plane. Ramp extension below the TRAIL position will result in adverse flight characteristics.

i. Ramp — TRAIL.

When the ramp reaches the TRAIL position lock by placing the ramp control handle No. 4 in NEUTRAL.

To Close Door and Ramp:

a. Asymmetric Engine Power — REDUCE TO MINIMIZE RUDDER TRIM.

b. No. 4 Door Indicator Light — ON; Ramp Control Valve No. 4 — CLOSED.

c. No. 3 Door Indicator Light — ON; Ramp Latch Valve No. 3 — CLOSED.

d. No. 2 Door Indicator Light — ON; Door Control Valve No. 2 — CLOSED.

e. No. 1 Door Indicator Light — ON; Door Latch Valve No. 1 — CLOSED.

f. Control Valve Handles — NEUTRAL.

Return control valve handles No. 1, 2, 3, and 4 to the NEUTRAL position in sequence. Close cover.

g. Aircraft — PRESSURIZE.

h. Air Conditioning-Ram Ventilation Switch — AIR CONDITIONING.

g. Hydraulic Pump Control Switch — OFF.

Aircraft Control During Jettisoning.

As the pallets move down the ramp during jettisoning, the momentary change in cg position will cause the aircraft to pitch up. During this pitch-up, the stalling angle of attack could be exceeded unless corrective action is taken by the pilot. Conversely, overcorrecting could slow down or even stop the pallet, leaving the aircraft with a dangerous cg position. However, reasonable care in monitoring the controls during jettisoning should eliminate excessive changes in aircraft attitude. Any necessary adjustment to aircraft attitude should be accomplished gradually, avoiding abrupt control deflections. Large changes in cg position should be corrected, if necessary, by repositioning cargo after jettisoning operation is completed so that the most forward landing cg (17% MAC) is not exceeded.

CARGO JETTISONING (C-133B AIRCRAFT).

WARNING

Except in cases of emergency, do not unlatch or open the ramp and clamshell doors in flight.

During loading of the aircraft, the possibility that it may become necessary to jettison all, or a portion of the cargo should be considered. Whenever possible, cargo of a high priority or nonjettisonable nature should be placed forward of jettisonable items. If it becomes necessary to jettison cargo, the ramp and clamshell doors provide the only suitable exit. During jettisoning operations, the loadmaster must station himself at the ramp, clamshell doors and aft door control panel, and remain in interphone contact with the pilot. Due to the high noise level that exists in the cargo compartment when the clamshell doors are open, verbal communication between the loading crew members is impossible unless each man is equipped with a well-fitted headset. Instructions for operation of the ramp and clamshell doors are given in Section IV.

WARNING

Do not attempt to use the side cargo door as a jettisoning exit. The side cargo door must never be opened during flight.

WARNING

The aft door must not be opened during flight as this door supports part of the structural load of the aircraft.

Aircraft Control Prior to Door Operation.

Prior to opening the ramp and clamshell doors, any asymmetric power condition that exists must be corrected, as the structural loads that will be imposed upon the aft fuselage by this condition may cause the doors to bind. In the event one engine is inoperative, the power of the opposite engine should be reduced until minimum rudder force is required to maintain directional control. By reducing asymmetrical thrust in this manner, directional control can be maintained until the stall speed is reached. In the event both engines on the same side of the aircraft are inoperative, the minimum speed at which directional control can be maintained, at sea level with normal rated power and at gross weight of 190,000 pounds, is approximately 127 knots IAS.

The aircraft should be flown, in a zero sideslip attitude, at an airspeed between the minimum speed at which directional control can be maintained (127 knots IAS), and the maximum speed permissible for operation of the ramp and clamshell doors (150 knots CAS). To achieve a minimum rate of descent, a clean configuration should be maintained, if possible; however, a wing flap deflection angle not to exceed 15 degrees may be used to retain a reasonable margin of safety above the stall speed and to aid in controlling the attitude of the aircraft (see Attitude Adjustment by Flap Deflection chart, Part 5 of *T.O. 1C-133A-1-1*).

Aircraft Control During Door Operation.

Operation of the ramp and clamshell doors should not be attempted while the aircraft is in an asymmetric power condition as the structural load imposed upon the aft fuselage may cause the doors to bind. In the event one engine is inoperative, power of the opposite engine should be reduced until minimum rudder force is required to maintain directional control. If both engines on one side of the aircraft are inoperative, the throttles for the two remaining engines should be placed in the FLIGHT IDLE position during the door opening procedure. To maintain desired elevator control response, the aircraft should be flown at a speed of 145 to 150 knots IAS during operation of the doors (approximately 30 seconds). After the ramp and clamshell doors have been opened, the power of the operating engines can be restored to NORMAL RATED power. In the event both engines on one side of the aircraft are inoperative, a slight bank angle will aid in reducing the rudder force required to maintain directional control. Although elevator control forces are normal with the ramp and clamshell doors open, rudder control forces are somewhat reduced, due to the increased directional stability of the aircraft in the doors open configuration.

During opening or closing of the doors, wing flaps should be up unless it is necessary to provide a margin above stall speeds under high gross weight conditions. If necessary, flaps may be extended but not to more than 15 degrees. After the doors are open, flap deflection angle of 15 degrees is recommended, since this will result in the floor of the cargo compartment being nearly level, at gross weights of 200,000 to 240,000 pounds and airspeeds of 145 to 150 knots IAS.

WARNING

During jettisoning, and periods when the ramp and clamshell doors are open, do not exceed a wing flap deflection angle of 15 degrees or an airspeed of 150 knots IAS. Abrupt rolling maneuvers or directional changes which impose large structural loads upon the tail of the aircraft should be avoided.

Operation of Ramp and Clamshell Doors In Flight.

To Open Ramp and Doors:

CAUTION

Do not operate the ramp and clamshell doors with the cabin pressurized. The air conditioning system must be turned off and cabin pressure completely dumped before operating the doors. The manual control switch of the pressurization system should be kept in the DEPRESS position for a minimum of 45 seconds to ensure dumping of all cabin pressure.

a. Air Conditioning-Ram Ventilation Switch – OFF.

b. Hydraulic Pump Control Switch – UTILITY.

c. Aircraft – DEPRESSURIZE.

d. Asymmetric Engine Power – REDUCE TO MINIMIZE RUDDER TRIM.

CAUTION

The following sequences for opening and closing doors must be followed exactly to avoid damaging the aircraft.

e. Control Panel Cover – OPEN.

Seal control and ramp and clamshell door latch lights should come on.

CAUTION

Do not move any control handle unless the light above it is on, except as noted.

f. Seals – DEPRESSURIZE.

With the seal control light on, turn the seal control handle to DEPRESSURIZE.

CAUTION

In order to protect the clamshell door and ramp seals, do not actuate the latch control handle to the UNLATCH position until the seal pressure gage indicates zero.

g. Ramp and clamshell doors – UNLATCH.

With the ramp and clamshell door latch light on, turn the ramp and clamshell door handle to UNLATCH.

h. Ramp and clamshell doors – OPEN.

With the ramp and clamshell doors light on, turn the ramp and clamshell door control handle to DOWN.

The ramp may be stopped and held in any position above the cargo floor by placing the control handle in the HOLD position.

Note

The ramp will stop automatically when it is level with the cargo floor.

WARNING

Do not operate the ramp and clamshell doors by means of the emergency control handle during flight as the ramp will extend beyond the floor level position resulting in adverse flight characteristics.

WARNING

The aft door must not be opened during flight, as this door supports part of the structural load of the aircraft.

To Close Ramp and Doors:

a. Asymmetric Engine Power — REDUCE TO MINIMIZE RUDDER TRIM.

b. Ramp and clamshell doors — CLOSE.

With the ramp and clamshell door control light on, turn the ramp and clamshell door control handle to UP.

c. Ramp and clamshell doors — LATCH.

With the ramp and clamshell door latch control light on, turn the ramp and clamshell door latch handle to LATCHED.

d. Seals — TEST.

With the seal control light on, turn the seal control handle to PRESSURIZE. Check that the seal pressure gage stabilizes at 22 (±1) psi. Turn the seal control handle to TEST and hold for 1 minute. The pressure gage must remain above 19 psi.

CAUTION

Do not apply pressure to the seals until the doors are fully closed and latched to prevent damage to the seals.

e. Seals — PRESSURIZE.

With the seal control light and the ramp and clamshell door latch light on, return the seal control handle to PRESSURIZE. Place the ramp and clamshell door latch handle, ramp and clamshell door control handle, and the aft door control handle to NEUTRAL.

f. Aircraft — PRESSURIZE.

g. Air Conditioning-Ram Ventilation Switch — AIR CONDITIONING.

h. Hydraulic Pump Control Switch — OFF.

Aircraft Control During Jettisoning.

As the pallets move down the ramp during jettisoning, the momentary change in cg position will cause the aircraft to pitch up. During this pitch-up, the stalling angle of attack could be exceeded unless corrective action is taken by the pilot. Conversely, overcorrecting could slow down or even stop the pallet, leaving the aircraft with a dangerous cg position. However, reasonable care in monitoring the control during jettisoning should eliminate excessive changes in aircraft attitude. Any necessary adjustment to aircraft attitude should be accomplished gradually, avoiding abrupt control deflections. Large changes in cg position should be corrected, if necessary, by repositioning cargo after jettisoning operation is complete so that the most forward loading cg (17% MAC) is not exceeded.

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CARGO HANDLING — JETTISONING PROCEDURES.

The following procedures have been developed for jettisoning pallets IV and V (*figure 3-10*). In general, however, they apply to any situation which requires jettisoning of cargo. The cargo handling procedures are based on analysis, since flight test have only been accomplished on door opening and closing characteristics. Actual conditions may dictate that all or part of these procedures could not be followed. In any event, close cooperation and sound judgment are required of the entire crew.

(CONTINUED ON NEXT PAGE)

CARGO HANDLING — JETTISONING PROCEDURES. *(CONTINUED)*

Before Jettisoning.

PILOTS	***FLIGHT ENGINEER***	***LOADMASTER***
1. Loadmaster — INFORM. Inform loadmaster of cargo weight that must be jettisoned.		1. Pallet V — BLOCK. Direct cargo handling crew to block pallet V to prevent forward roll.
		2. Pallet V — REMOVE RESTRAINT NET. Direct cargo handling crew to remove restraint net from pallet V.
		3. Barrier Net — RELOCATE TO PALLET III. Direct cargo handling crew to relocate barrier net diagonal straps from forward restraint on pallet IV to rearward restraint of pallet III.
② Oxygen — AS REQUIRED. Direct crew to use oxygen if necessary.		④ Oxygen — AS REQUIRED. Direct cargo handling crew to use oxygen if necessary.
		5. Pilot — INFORM. Inform pilot when rear cargo doors and ramp are clear to open.
③ Air Conditioning-Ram Ventilation Switch — OFF; Hydraulic Pump Control Switch — UTILITY.	① Air Conditioning-Ram Ventilation Switch — OFF; Hydraulic Pump Control Switch — UTILITY. Set switches at pilot's command.	
④ Aircraft — DEPRESSURIZE. Direct engineer to depressurize aircraft when rear cargo doors and ramp are clear to be opened.	② Aircraft — DEPRESSURIZE. Depressurize at pilot's command; inform pilot when aircraft is completely depressurized.	
5. Asymmetric Engine Power — REDUCE TO MINIMIZE RUDDER TRIM.		
6. Airspeed — 150 KNOTS IAS (Do not exceed).		6. Cargo Handling Crew — MOVE FORWARD TO PALLET IV. Upon reduction of asymmetric engine power, direct cargo handling crew to move forward to pallet IV.
7. Wings — LEVEL.		
8. Wing Flaps — FLAPS UP. If necessary, flaps may be used to provide a margin above stall speed. Do not exceed 15 degrees.		7. Safety Harness — DON.

(CONTINUED ON NEXT PAGE)

CARGO HANDLING — JETTISONING PROCEDURES. *(CONTINUED)*

PILOTS

⑨ Rear Cargo Doors and Ramp — FULL OPEN (after aircraft is depressurized).

10. Asymmetric Engine Power — INCREASE.

Increase power on operating engines after doors are fully open.

FLIGHT ENGINEER

LOADMASTER

⑧ Rear Cargo Doors and Ramp — FULL OPEN.

Open rear cargo doors and ramp when directed by pilot; inform pilot when doors are fully open.

WARNING

On C-133B aircraft, the aft door must not be opened during flight, as this door supports part of the structural load of the aircraft.

CAUTION

On C-133B aircraft, do not unlatch the rear cargo doors and ramp until the door seal pressure gage indicates zero (+1, −0) psi to prevent damage to the seals.

WARNING

On C-133A aircraft, the ramp should not be allowed to extend beyond the TRAIL position, which is approximately 7 degrees below the floor plane. On C-133B aircraft, do not operate the ramp by means of the emergency system during flight, as the ramp will extend below the TRAIL position. Ramp extension below the TRAIL position will result in adverse flight characteristics.

(CONTINUED ON NEXT PAGE)

CARGO HANDLING — JETTISONING PROCEDURES. *(CONTINUED)*

Jettisoning Pallet V.

PILOTS

Note

> Expect nose-up pitch as Pallet V moves down the ramp, and nose-down pitch as it falls free.

① Aircraft Attitude — ADJUST.

Operate wing flaps to obtain floor attitude requested by loadmaster (see Attitude Adjustment by Flap Deflection chart in Part 5 of *T.O. 1C-133A-1-1)*.

LOADMASTER

① Aircraft Attitude Adjustment — REQUEST.

Request pilot to adjust aircraft attitude to obtain nose-up attitude until pallet begins to roll.

After Jettisoning Pallet V.

PILOTS

① Aircraft Attitude — ADJUST.

Operate wing flaps to obtain floor attitude requested by loadmaster (see Attitude Adjustment by Flap Deflection chart in Part 5 of *T.O. 1C-133A-1-1)*.

2. Airspeed — MAINTAIN 145 to 150 KNOTS IAS.

LOADMASTER

① Aircraft Attitude Adjustment — REQUEST.

Request pilot to adjust aircraft attitude to obtain level floor attitude.

2. Barrier Net — REMOVE FROM REAR OF PALLET IV.

3. Cargo Handling Crew — MOVE FORWARD OF PALLET III.

Jettisoning Pallet IV.

PILOTS

① Aircraft Attitude — ADJUST.

Operate wing flaps to obtain floor attitude requested by loadmaster (see Attitude Adjustment by Flap Deflection chart in Part 5 of *T.O. 1C-133A-1-1)*.

Note

> Expect nose-up pitch as pallet moves down ramp, and nose-down pitch as it falls free. Do not overcontrol for the pitchup. Overcontrolling may cause the rearward motion of the pallet to be slowed or stopped, leaving the aircraft with a dangerous cg position.

2. Aircraft — GRADUALLY RETURN TO TRIM POSITION.

3. Airspeed — MAINTAIN 145 to 150 KNOTS IAS.

LOADMASTER

① Aircraft Attitude Adjustment — REQUEST.

Request pilot to adjust aircraft attitude to obtain nose-up attitude when barrier net is removed and cargo handling crew is in a safe position.

Note

> If additional cargo is to be jettisoned, it will probably be necessary to reposition the remaining pallets to the rear of the cargo compartment. It is suggested that during repositioning, the pallets be moved only a short distance at a time, and that pallets be restrained at both ends to prevent uncontrolled movement.

(CONTINUED ON NEXT PAGE)

CARGO HANDLING — JETTISONING PROCEDURES. *(CONTINUED)*

After Jettisoning Is Completed.

PILOTS	***FLIGHT ENGINEER***	***LOADMASTER***
1. Wing Flaps — FLAPS UP.		
2. Asymmetric Engine Power — REDUCE TO MINIMIZE RUDDER TRIM. Reduce asymmetric engine power to minimize rudder trim prior to closing rear cargo doors and ramp.		
③ Rear Cargo Doors and Ramp — CLOSE.		① Rear Cargo Doors and Ramp — CLOSE. Check latch position and seal pressure on command of pilot. **CAUTION** On C-133B aircraft, to prevent damage to the door seals, do not pressurize the door seal until the door latches are closed, and ramp and clamshell latch control light is on.
④ Cargo — REPOSITION TO OBTAIN PROPER CG. Direct loadmaster reposition remaining cargo so that cg limits are not exceeded.		② Cargo — REPOSITION TO OBTAIN PROPER CG. At pilot's command, reposition the remaining cargo so that the most forward landing cg is not exceeded.
⑤ Aircraft — PRESSURIZE.	① Aircraft — PRESSURIZE. Pressurize the aircraft at pilot's command.	
⑥ Air Conditioning-Ram Ventilation Switch — AIR CONDITIONING; Hydraulic Pump Control Switch — OFF.	② Air Conditioning-Ram Ventilation Switch—AIR CONDITIONING; Hydraulic Pump Control Switch — OFF. Set switches at pilot's command.	
7. Driftdown — CONTINUE. Continue to selected altitude with NORMAL RATED power on all operating engines.		

AIRCRAFT SYSTEMS.

ENGINE OIL SYSTEM FAILURE.

The indications of engine oil system failure that may lead to engine failure are: loss of oil pressure, oil temperature increase or decrease, and low oil quantity. High or low oil temperatures may result from failure of the oil cooler door to function in AUTO. Position the oil cooler door switch to OPEN or CLOSE, hold it in the desired position, and make certain that the door will open or close and that the temperature returns to normal. In the event that low oil quantity is indicated, monitor the respective oil temperature and oil pressure indicators for readings beyond safe limits. Visually check for evidence of oil leakage. If oil leakage is excessive or if safe operating limits are exceeded, feather the propeller on the affected engine.

CAUTION

Due to the high rate of oil flow in the engine installation, impending engine failures are not necessarily preceded by gradual increase of oil temperature and/or loss of oil pressure.

FUEL SYSTEM MALFUNCTIONS.

Erratic fuel system operation will result from fuel system valve malfunction. The following paragraphs describe fuel system valve malfunctions and corrective actions that may be taken.

Boost Pump Failure.

In the event of a boost pump failure, fuel from the tank containing the failed boost pump may be utilized by permitting an engine-driven fuel pump to withdraw fuel from that tank by suction. Under this condition, it is recommended that the aircraft be flown at an altitude of 20,000 feet or less, to prevent cavitation of the engine-driven pump. Cavitation of an engine-driven pump will decrease the normal life of the pump, but erratic engine performance may not be experienced with inoperative boost pumps unless the aircraft is above 20,000 feet altitude.

H-Double Check Valve Malfunction.

In the event of an H-double check valve failure, the quantity of fuel in the tank containing the failed check valve may increase. If this condition occurs, close the tank outlet valve of the tank containing the suspected malfunctioning check valve. Open the tank outlet valve only when it is desired to use fuel from that tank.

GTU Fuel Pressure Relief Valve Malfunction.

When supplying engines No. 1 and 4 with fuel from tanks No. 1 and 8, approximately 400 pounds of fuel per hour may be returned to tanks No. 2 and 7 from each GTU. This return of fuel is a result of the GTU fuel pressure relief valves relieving excessive pressure, and may cause a slightly unbalanced fuel quantity condition. To correct this unbalanced condition, turn the auxiliary fuel boost pump switch for tank No. 2 and/or No. 7 ON until the fuel quantities in tanks No. 1, 2, 7, and 8 balance.

FUEL STOPPAGE DURING TAKEOFF.

If any engine fails during takeoff from sea level to 5000 feet because of fuel starvation, immediately perform the following steps with engine windmilling on NTC or above.

PILOTS	*FLIGHT ENGINEER*
a. Throttle — RETARD TO FLIGHT IDLE.	a. Investigate cause of fuel stoppage and eliminate if possible.

(CONTINUED ON NEXT PAGE)

FUEL STOPPAGE DURING TAKEOFF. *(CONTINUED)*

PILOTS	***FLIGHT ENGINEER***
b. Condition Lever — ACTUATE FROM RUN-FUEL ON to FUEL OFF then to RUN-FUEL ON.	
This will recycle ignition.	
c. Engine Relight — OBSERVE.	
d. Throttle — ADVANCE TO DESIRED POWER.	
If engine does not relight, follow steps under Fuel Stoppage in Flight.	

FUEL STOPPAGE IN FLIGHT.

If any engine fails in flight because of fuel starvation, immediately perform the following steps.

PILOTS	***FLIGHT ENGINEER***
a. Condition Lever — FEATHER. Refer to Engine Failure During Flight, this section.	a. After Feathering Propeller — Shut off fuel to affected engine.
	b. Tank Supplying Affected Engine — Check for adequate fuel.

If malfunction was due to insufficient fuel quantity, change tanks and restart engine.

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ELECTRICAL POWER SYSTEM FAILURE.

WARNING

If either a-c or d-c power, or both, are turned off, do not operate propeller reversing. If the throttles are placed in REVERSE without a-c and d-c electrical power, the forward thrust of the aircraft may be increased.

CAUTION

The following electrically operated instruments will fail, and may give no indication of electrical failure whenever there is an electrical failure in the respective circuits; fuel quantity indicators, fuel flow indicators, turbine inlet temperature indicators, hydraulic pressure indicator, and radar altimeter.

A generator malfunction chart *(figure 3-11)* is included to assist in identifying the various failures which may occur in the electrical systems, with a breakdown of power distribution under the various conditions outlined.

Circuit Breakers.

If a circuit breaker opens, disconnecting power to any circuit, it indicates an overload or short in that circuit. If the circuit breaker reopens after being reset, the circuit cannot be energized by holding the circuit breaker in as long as the fault exists. Exceptions to this are the propeller circuit breakers, which may be held in, in an emergency.

Figure 3-11 (Sheet 1 of 2) deleted.

Generator Malfunction Chart

A-C CHECK LIST AND D-C WARNING LIGHT INDICATION	GENERATOR CONDITION	AUXILIARY GENERATOR SWITCH POSITION	BUSES POWERED	BUSES NOT POWERED
CAUTION PRESS TO RESET	ON — Whenever Any Check List Light Comes On.			
LEFT GEN OUT RIGHT GEN TO AFT NON-ESS BUS	Loss of Left Generator.	NON-ESS BUS ON or AUTO	Battery Bus. All A-C Buses. All D-C Buses. Propeller Buses.	
RIGHT GEN OUT LEFT GEN TO FWD NON-ESS BUS	Loss of Right Generator.	NON-ESS BUS ON or AUTO	Battery Bus. All A-C Buses. All D-C Buses. Propeller Buses.	
LEFT GEN OUT RIGHT GEN OUT LEFT GEN TO FWD NON-ESS BUS AUX TO ALL BUSES	Loss of Left and Right Generators.	NON-ESS BUS ON	Battery Bus. All A-C Buses. All D-C Buses. Propeller Buses.	
LEFT GEN OUT RIGHT GEN OUT AUX TO FWD ESS BUS AUX TO AFT ESS BUS	Loss of Left and Right Generators.	AUTO	Battery Bus. All Essential A-C Buses. All Essential D-C Buses Propeller Buses. All Nonessential Buses Except Flight Deck	All Nonessential A-C Buses. All Flight Deck Nonessential D-C Buses
LEFT GEN OUT RIGHT GEN OUT AUX GEN OUT	Loss of Left and Right Generators and Auxiliary Generator. Note: Transformer-Rectifier Warning Lights are A-C Powered and Will Not Come On When All Generators are Out.		Battery Bus. Essential D-C Bus With Battery Switch ON. Note: Only Battery Bus With Battery Switch OFF.	All A-C Buses. All Nonessential D-C Buses.
Forward Transformer-Rectifier Warning Light — ON	Loss of Forward Transformer-Rectifier.		Battery Bus. Propeller Buses. All A-C Buses. All Essential D-C Buses. All Nonessential D-C Buses Not Listed in Next Column.	All Flight Deck Nonessential D-C Buses.
Aft Transformer-Rectifier Warning Light — ON	Loss of Aft Transformer-Rectifier.		Battery Bus. Propeller Buses. All A-C Buses. All Essential D-C Buses. All Nonessential D-C Buses Not Listed in Next Column	Right Fuselage Nonessential D-C Buses Aft D-C Radio Bus.
AIR DRIVEN GENERATOR	Extended Upon Failure of 2 Alternators or 2 Transformer-Rectifiers.		All D-C Buses (See Generator Condition Column For A-C Buses Powered)	A-C Buses, Refer To Generator Condition Column

NOTE: Generator-out lights come on only with generator switch ON; light goes out with switch OFF.

TRANSFORMER-RECTIFIER FAILURE

In the event of failure of one transformer-rectifier, reduce d-c electrical load until the air driven generator is extended and operating. If power is not available from the air driven generator maintain electrical load within the following limits:

200 Amps—Maximum for five minutes.

175 Amps—Maximum for continuous operation.

(See Transformer-Rectifier Failure, Section III).

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Figure 3-11 (Sheet 2 of 2)

Generator Bearing Out Warning.

A generator bearing out warning light coming on indicates that the generator mainshaft bearing has burned out or is excessively worn. This condition will not usually indicate a loss of electrical power. To prevent failure of the bearing or shaft which could cause possible damage to the accessory drive train, disconnect the affected engine driven generator and/or shut down the GTU on aircraft with T.C.T.O. 596. On aircraft without T.C.T.O. 596 it is recommended that the engine or GTU for the affected generator be shut down. In the event that one of the warning lights comes on perform the following:

a. Engine or GTU (for affected generator)—SHUT DOWN.

Shut down engine or GTU for affected generator and perform steps under Engine (or GTU) Failure in Flight, this section.

b. Electrical Load—MONITOR.

Perform steps under generator failure as applicable to the affected generator and monitor electrical load same as for generator failure.

(Aircraft with T.C.T.O. 596):

If failure is indicated on auxiliary generator, shut down GTU and perform steps under GTU Failure In Flight, this section. If failure is indicated on main generator, proceed as follows:

a. Generator Disconnect Switch (affected generator)—ON.

Place generator disconnect switch for affected generator in ON position and hold for 10 seconds to assure that drive mechanism disconnects.

CAUTION

To avoid possible damage to the generator drive disconnect solenoid do not hold switch in ON position for more than 25 seconds.

b. Electrical Load—Monitor

Perform steps under Failure of One Main Generator, this section, and monitor electrical load same as for generator failure.

Failure of One Main Generator—Auxiliary Generator Operating.

a. Turn and Slip Emergency Battery Power Switch — ALT. (Aircraft with T.C.T.O. 534.)

b. D-C Power — CHECK.

c. Turn and Slip Emergency Battery Power Switch — NORMAL. (Aircraft with T.C.T.O. 534.)

Failure of Both Main Generators—Auxiliary Generator Operating.

a. Turn and Slip Emergency Battery Power Switch — ALT.

(Aircraft with T.C.T.O. 534):

b. Air Driven Generator — EXTEND.

d. Electrical Load — AS REQUIRED.

Restore only the nonessential circuits considered to be necessary to continue flight. Monitor electrical load so as not to exceed the following values based on altitude.

(1) 35,000 feet altitude — 80 amperes.

(2) 25,000 feet altitude — 85 amperes.

(3) 20,000 feet altitude — 95 amperes.

(4) 15,000 to 0 feet altitude — 110 amperes.

On descent or landing approach, prior to extending the wing flaps, perform the following:

e. Auxiliary Generator Switch — AUTO.

f. Wing Flaps — EXTENDED AS REQUIRED.

g. Auxiliary Generator Switch — RESET, then NON-ESS BUS ON.

Note

Do not extend the wing flaps with the auxiliary generator switch in the NON-ESS BUS ON position.

(Aircraft with T.C.T.O. 519):

a. Turn and Slip Emergency Battery Power Switch — ALT.

(Aircraft with T.C.T.O. 534):

b. Air Driven Generator — EXTEND.

c. Transformer-Rectifier Circuit Breakers — OPEN. If voltages are not normal perform steps f and g.

d. D-C Power — CHECK.

e. Turn and Slip Emergency Battery Power Switch — NORMAL (T.C.T.O. 534).

f. Electrical Loads — REDUCE.

Reduce the nonessential a-c electrical load and monitor so as not to exceed the following values based on altitude.

35,000 feet altitude — 80 amperes

25,000 feet altitude — 85 amperes

20,000 feet altitude — 95 amperes

15,000 to 0 feet altitude — 110 amperes

On descent or landing approach, prior to reducing airspeed below 130 knots IAS, perform the following:

g. Auxiliary Generator Switch — RESET then NON-ESS BUS ON.

h. Forward Transformer-Rectifier — CLOSE.

Failure of Auxiliary Generator — Both Main Generators Operating.

If failure of the auxiliary generator should occur, the main generators must be kept on the line. The inboard engines should not be allowed to drop below HIGH GROUND IDLE rpm until there is no further need for electrical power on the aircraft.

Main and Auxiliary Generator Failure in Flight.

a. Turn and Slip Emergency Battery Power Switch — ALT **(Aircraft with T.C.T.O. 534).**

b. Battery Switch — OFF.

c. D-C Power — CHECK.

d. Air-Driven Generator — EXTEND.

e. Turn and Slip Emergency Battery Power Switch — NORMAL **(Aircraft with T.C.T.O. 534).**

f. Battery Switch — ON, if voltages are normal.

g. VFR — Maintain if possible.

Remain VFR if possible; if IFR, keep battery switch ON.

Note

Below 130 knots IAS, sufficient power is available from the air-driven generator for operation of the propeller circuits only.

On descent or landing approach, before reducing airspeed below 130 knots IAS, perform the following:

h. Circuit Breakers — AS REQUIRED.

Open all circuit breakers except propeller circuit breakers and those absolutely essential for flight. Monitor electrical load.

Note

In the event that both main and auxiliary generators fail in flight, no power will be available for operation of the landing lights.

Failure of One Transformer-Rectifier.

a. Turn and Slip Emergency Battery Power Switch — ALT **(Aircraft with T.C.T.O. 534).**

b. Failed Transformer-Rectifier Circuit Breaker — OPEN.

c. D-C Power — CHECK.

d. Turn and Slip Emergency Battery Power Switch — NORMAL **(Aircraft with T.C.T.O. 534).**

Failure of Both Transformer-Rectifiers.

a. Turn and slip Emergency Battery Power Switch — ALT **(Aircraft with T.C.T.O. 534).**

b. Air-Driven Generator — EXTEND.

c. D-C Power — CHECK.

d. Turn and Slip Emergency Battery Power Switch — NORMAL **(Aircraft with T.C.T.O. 534).**

Note

> On descent or landing approach, before reducing airspeed below 130 knots IAS, perform the following:

e. Circuit Breakers — AS REQUIRED.

Open all circuit breakers except propeller breakers and those absolutely essential for flight. Monitor electrical load.

COMMUNICATIONS AND/OR NAVIGATION EQUIPMENT FAILURE.

In the event of failure of any communications or navigation equipment, the nearest ATC facility will be notified immediately with information on capabilities or limitations of compliance with ATC instructions.

WING FLAP EMERGENCY OPERATION.

(Aircraft AF54-135 Through AF57-1615):

If the aircraft hydraulic system fails (loss of system pressure) position the emergency flaps switch to ON and operate the wing flaps by use of the normal wing flap lever.

Note

> The time required to completely extend or retract the wing flaps during emergency operation is 30 to 40 seconds.

CAUTION

> To avoid damage to the flap driving mechanism, do not move the wing flap control lever to reverse direction of wing flap travel while flaps are in motion.

To avoid overheat and possible damage to the flap driving motor, a cooling period of 5 minutes minimum is required after each continuous operation of 1½ minutes.

(Aircraft AF59-522 and Subsequent):

If the main hydraulic system fails, position the emergency flap switch to ON and operate the wing flaps by use of the normal wing flap lever. The hydraulic pressure switch on the engineer's panel must be in the OFF or UTILITY position, to prevent loss of hydraulic fluid through possible utility systems failure.

Note

> The time required to completely extend or retract the wing flaps during emergency operation is 18 to 24 seconds.

LANDING GEAR EMERGENCY EXTENSION.

If the aircraft hydraulic system fails, and the gear will not extend, reduce airspeed to 178 knots IAS, and proceed as follows:

a. Landing Gear Lever — GEAR DOWN.

Leave the landing gear lever in the GEAR DOWN position.

b. Landing Gear Control Valve Emergency Handle — PULL.

c. Main Landing Gear Emergency Release Handles — PULL (To extend main gear).

Note

> The approximate time required for main landing gear emergency extension is 5 seconds.

d. Nose Landing Gear Emergency Release Handle — PULL (To extend nose gear).

CAUTION

The nose landing gear emergency release handle must be held out after release to allow the locking mechanism to engage in the down position. Hold nose landing gear emergency release handle OUT until nose gear is down and locked.

Note

The approximate time required for nose landing gear emergency extension is 15 seconds.

e. Landing Gear — CHECK.

Have a crew member perform a visual inspection through the respective viewing windows to make certain that all gears are down and locked. If the red and white nose gear warning flag is not in the proper position, break the nose gear viewing window and insert the ground lockpin.

Nose Gear Emergency Extension (T.C.T.O. 614).

On aircraft with T.C.T.O. 614, in the event the nose gear does not extend, release the nose gear and extend as follows:

a. Pressurization Manual Control Switch — DEPRESSURIZE.

Make certain that cabin pressure is relieved.

b. Nose Gear Viewing Window — BREAK.

Break the nose gear viewing window with the hand ax.

c. Nose Gear Emergency Unlock Link — RELEASE. Engage hook end of nose gear safetypin with the end of unlock link and pull aft to pull nose gear latching mechanism overcenter.

CAUTION

Do not permit the ground safetypin to interfere with movement of the latching mechanism or draglink.

d. Nose Gear Emergency Release Handle — PULL and HOLD.

CAUTION

The nose gear emergency release handle must be held out after release to allow the latching mechanism to engage in the down position. Hold nose gear emergency release handle out during nose gear extension.

e. Nose Gear Ground Safetypin — INSTALLED.

Install nose gear ground safetypin to insure that gear is locked down.

Note

No provision is made for emergency extension of the tail bumper since it is not normally used during landings.

LOSS OF BOTH GTU'S IN FLIGHT.

a. GTU Pneumatic Selector Switches—NO LOAD.

b. Cabin Altitude—CHECK.

Use oxygen if necessary.

Note

Landing gear retraction time with the auxiliary hydraulic pump is approximately 14 to 30 seconds. Extension time with the auxiliary hydraulic pump only is 15 to 25 seconds.

CAUTION

To ensure electrical power upon landing, the rpm of an inboard engine should not be allowed to drop below high GROUND IDLE, until there is no further requirement for electrical power on the aircraft.

CAUTION

Caution should be exercised at all times when using the auxiliary pump for hydraulic power in the event of failure of both GTU's in flight. Operation should not exceed 30 minutes ON with 30 minutes OFF. If this duty cycle is not observed, the auxiliary pump will automatically shut off when overheated and cannot be restarted until it cools. No warning of shutoff is provided. If any two hydraulic units are operated at the same time, the operating time for the pump will be decreased.

BRAKE SYSTEM FAILURE.

If no hydraulic power is available to operate the brakes, the emergency airbrake system can be used to brake the aircraft as follows:

a. Emergency Airbrake Handle—PULL.

b. Brakes—Use brake pedals for braking.

Note

The supply of air is sufficient for at least three full applications, although the braking force will be less with each application.

Note

On aircraft AF59-522 and subsequent, auxiliary hydraulic pressure is not indicated on the hydraulic pressure indicator.

CAUTION

The antiskid system is inoperative with airbrakes. Care should be exercised to prevent skidding the tires. Taxiing should not be attempted when a brake malfunction has occurred.

c. Record use of airbrake system in Form 781.

WINDSHIELD OR WINDOW FAILURE.

In the event of windshield or window overheating, arcing, delamination, cracking or shattering occurs in flight, perform the following:

Front Center and Front Side Windshields and Clearview Windows (Aircraft without T.C.T.O. 589).

a. Windshield Anti-Ice Switch (affected windshield/window) — OFF.

b. 115 Volt Power Circuit Breaker (affected windshield/window) — OPEN.

c. Windshield Anti-Ice Switch — NORMAL.

Restore power as soon as possible to prevent failure of previously undamaged windshield/windows. If required for ice removal or birdproofing, switch may be turned to HIGH after windshield/window has first been warmedwith switch in NORMAL.

d. Failed Windshield/Window—HEAT ONLY IF REQUIRED FOR VISIBILITY.

CAUTION

Keep heat off failed windshield/windows unless required for visibility. Restore heat by closing applicable power circuit breaker for a period of 10 minutes or less, then open for 5 minutes to prevent damage to previously undamaged windshield/windows.

e. Window Pressure Barrier — INSTALL.

Install pressure barrier if pilot's or copilot's clearview window has failed.

f. Cabin Pressurization — AS REQUIRED.

Maintain cabin pressure as required depending on location of crack.

Note

Electrically heated windshield and clearview windows have thick inner glass panes and thin outer glass panes. All other cockpit and cabin windows have thick outer panes and thin inner plastic panes.

BRAKE SYSTEM FAILURE.

If no hydraulic power is available to operate the brakes, the emergency airbrake system can be used to brake the aircraft as follows:

a. Emergency Airbrake Handle—PULL.

b. Brakes—Use brake pedals for braking.

Note

The supply of air is sufficient for at least three full applications, although the braking force will be less with each application.

Note

On aircraft AF59-522 and subsequent, auxiliary hydraulic pressure is not indicated on the hydraulic pressure indicator.

CAUTION

The antiskid system is inoperative with airbrakes. Care should be exercised to prevent skidding the tires. Taxiing should not be attempted when a brake malfunction has occurred.

c. Record use of airbrake system in Form 781.

COCKPIT WINDOW FAILURE.

In the event the cockpit window overheat, arcing, delamination, cracking or shattering occurs in flight, perform the following:

Front Center and Front Side Windshields and Clearview Windows (Aircraft with T.C.T.O. 589).

a. Windshield Anti-Ice Switch (affected windshield/window) — OFF.

b. 115 Volt Power Circuit Breaker (affected windshield/window) — OPEN.

c. Windshield Heat Sense Source Switch — AS REQUIRED.

Position to operative windshield/window.

d. Windshield Anti-Ice Switch — NORMAL.

e. Failed Windshield/Window—HEAT ONLY IF REQUIRED FOR VISIBILITY.

CAUTION

If right-hand front windshield fails, do not reset windshield power circuit breaker while using jetblast rain removal with windshield heat sense source switch in the ALTERNATE position as further damage to the windshield may result.

f. Window Pressure Barrier — INSTALL.

Install pressure barrier if pilot's or copilot's clearview window has failed.

g. Cabin Pressurization — AS REQUIRED.

Maintain cabin pressure as required depending on location of crack.

Navigator's Sextant Windows.

a. Sextant Window Defog Switch — OFF.

Turn sextant defog switch OFF if not required for visibility.

b. Cabin Pressurization — AS REQUIRED.

Maintain cabin pressure as required depending on location of crack.

All Other Windows.

Cabin Pressurization — AS REQUIRED.

Maintain cabin pressure as required depending on location of crack.

Pressurization with Cracked or Shattered Windshields/Windows.

Electrically Heated Windshields/Windows (Outer Pane Failure):

With a crack in the outer pane, maintain full cabin pressurization with a maximum differential pressure not to exceed 6.55 psi.

Electrically Heated Windshields/Windows (Inner Pane Failure):

With a crack in the inner pane, immediately depressurize to a maximum differential pressure of ½ psi at a rate consistent with passenger safety. Maintain cabin pressure at a maximum differential pressure of ½ psi to offset external airloads.

Electrically Heated Windshields/Windows (Inner and Outer Pane Failure):

Failure of both inner and outer panes may result in large deflection of the window. Depressurize immediately at a rate consistent with passenger safety, to ½ psi differential pressure. Maintain ½ psi differential pressure to offset external airloads unless deflection of the window occurs. If deflection is noted, reduce differential pressure until no deflection is noted.

All Other Windows (Outer Pane Failure):

With a crack in the outer pane, immediately depressurize to a differential pressure of ½ psi at a rate consistent with passenger safety. Maintain cabin pressure at maximum differential pressure of ½ psi to offset external airloads.

All Other Windows (Inner Pane Failure):

With a crack in the inner pane, maintain normal cabin pressurization with maximum differential pressure not to exceed 6.55 psi.

All Other Windows (Inner and Outer Pane Failure):

Failure of both inner and outer panes may result in large deflection of the windows. Depressurize immediately at a rate consistent with passenger safety, to ½ psi differential pressure. Maintain ½ psi differential pressure to offset external airloads unless deflection of the window occurs. If deflection is noted, reduce differential pressure until no deflection is noted.

Window Crack Location.

To determine location of window cracks proceed as follows:

a. Hold finger to crack and move line of sight to a new angle. If crack appears to move relative to finger, crack is in the outer pane.

b. Cracks appearing to stop at the heat bus bar are in the outer pane.

c. Look for evidence of arcing across crack. This will locate outer pane cracks on front windshields and clearview windows.

Clearview Window Pressure Barriers.

Two window pressure barriers are stowed in the crew closet (Sta. 200) for use in the event of pilot's or copilot's clearview window failure. The barriers when installed, do not provide a perfect air seal, although the barrier is designed for pressures in excess of 6.8 psi differential. The primary purpose is to prevent explosive decompression following partial failure of the window panel.

Installation of Pilot's or Copilot's Clearview Window Pressure Barrier.

Outer Pane Failure.

Secure appropriate barrier from the crew closet and install in window frame. Pressurization need not be reduced.

Inner Pane Failure (Shatter).

Immediately depressurize to a differential pressure of ½ psi, at a rate consistent with passenger safety. Secure appropriate pressure barrier from the crew closet and install. If necessary, repressurize as required.

Note

> Depending upon the condition of the air conditioning system, 6.55 psi differential cabin pressure may or not be obtained. The pressure barrier is not intended to serve as a perfect air seal.

Total Fracture of Inner and Outer Panes and/or Loss From Aircraft.

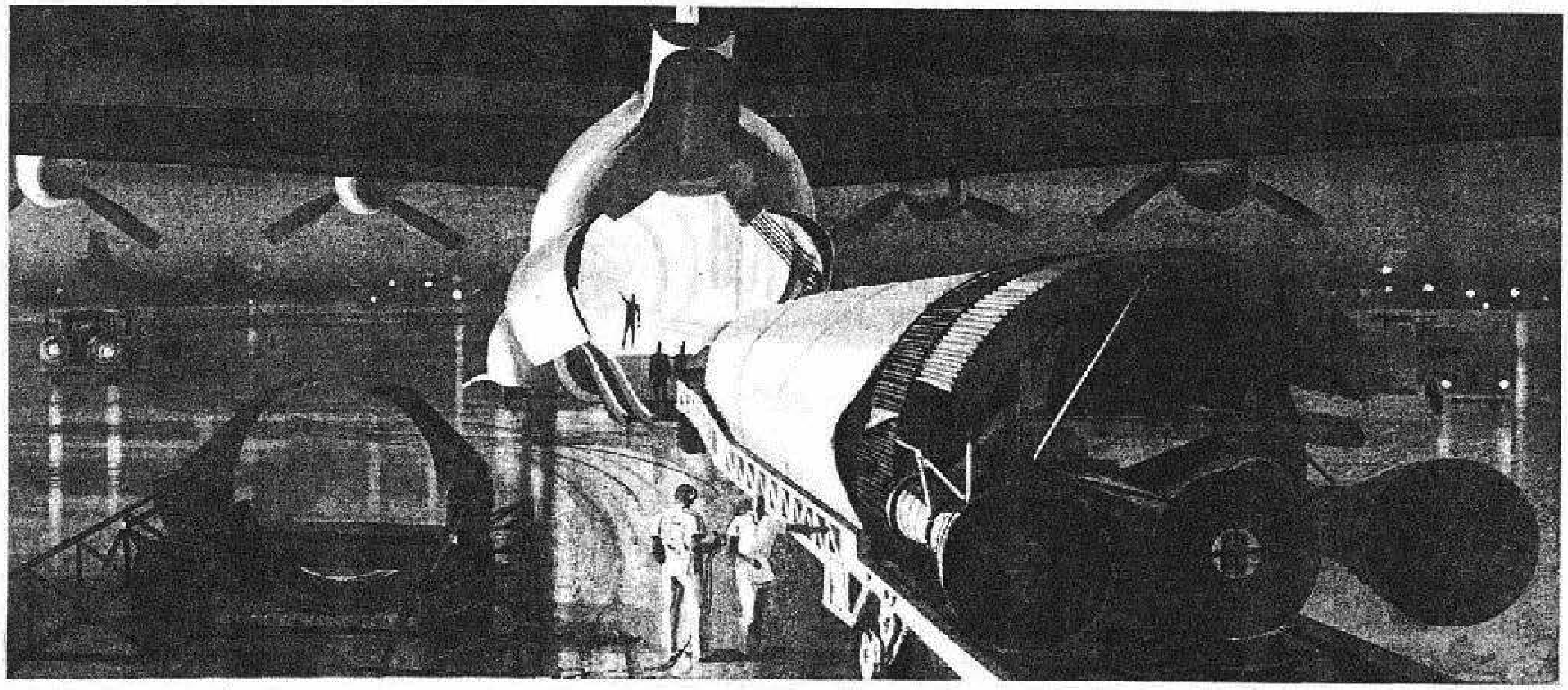
Immediately depressurize to a differential pressure of ½ psi, at a rate constant with passenger safety. Install pressure barrier. Do not repressurize above 1 psi.

EMERGENCY CABIN DEPRESSURIZATION.

If emergency cabin depressurization is required, don oxygen mask, if required and place the emergency depressurization control handle to DEPRESSURIZE.

MISCELLANEOUS EMERGENCY EQUIPMENT.

For locations of emergency equipment, see figure 3-1.



AUXILIARY EQUIPMENT SECTION IV

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PNEUMATIC SYSTEM.

The purpose of the pneumatic system is to provide bleed air for wing and empennage deicing, engine anti-icing, jet blast windshield rain removal, GTU augmentation, nacelle preheating, and engine starting. The main pneumatic manifold is located in the leading edge of the center wing section. An outer wing deicing, pressure regulating and shutoff valve at each end of the main pneumatic manifold connects the lateral terminals of this manifold to the outer wing deicing manifold in each outer wing. An extension of the main pneumatic manifold is routed down into the fuselage and along the left side of the main cabin. The jet blast windshield rain removal system is connected to the forward end of this ducting.

The air supply for GTU augmentation and the empennage deicing system is provided through the ducting which extends aft along the left side of the main cabin. Bleed air is supplied from two ports in the thirteenth compressor stage of each engine to the main pneumatic manifold. Two check valves at the firewall of each engine, prevent bleed air from the main pneumatic manifold from escaping into an engine that is not operating. Aft of the firewall in each nacelle, the ducts from the two check valves converge into a single duct which extends aft through a pneumatic manifold shutoff valve to the main pneumatic manifold. The engine starter valves are located forward of the firewalls between the engine starter and the pneumatic manifold shutoff valve. A branch of the duct aft of the firewall in each nacelle is connected to the nacelle preheat valve.

The GTU's are the normal pneumatic source used to start the engines. The engines starting, check and shutoff valve interconnects the GTU bleed air ducting and main pneumatic system. This valve is normally closed and opens only when an engine starter switch is energized, when a nacelle preheat switch is on, or when the jet blast windshield rain removal system is on. The check feature of the valve prevents air in the main pneumatic manifold from entering the air conditioning system ducting when the valve is open and the pressure in the main pneumatic manifold is greater than that in the air conditioning system. In the event both GTU's are inoperative and air conditioning is desired while the engines are operating, engine bleed air is utilized to provide ventilation, air conditioning, and cabin pressurization. During this condition, the emergency air conditioning valve opens automatically to interconnect the pneumatic system and the air conditioning ducting.

High temperature air for the main pneumatic manifold is controlled by four pneumatic manifold shutoff valves, one for each engine. When the valves are open, the pneumatic pressure in the pneumatic manifold will be indicated by a pneumatic pressure indicator at the flight engineer's station. Four pneumatic manifold switches are located at the flight engineer's station to individually control each pneumatic manifold shutoff valve. A continuous overheat detection system is installed to provide a warning at the flight engineer's station in the event of a manifold duct failure and subsequent overheating. The pneumatic manifold shutoff valves are connected with the engine fire control handles at the pilot's station so that actuation of an engine fire control handle will close the corresponding pneumatic manifold shutoff valve.

PNEUMATIC MANIFOLD SWITCHES.

Four, two-position, pneumatic manifold switches *(2, figure 4-2)* are installed on the flight engineer's instrument panel. The switches are placarded OPEN and CLOSE and control the flow of engine bleed air to the main pneumatic manifold. When a switch is placed in the OPEN position, a 28-volt d-c circuit, protected by four MANIFOLD OVERHEAT circuit breakers located on the flight deck left hand auxiliary bus, is energized to open the respective pneumatic manifold shutoff valve and admit high temperature bleed air to the pneumatic manifold. In the CLOSE position, the shutoff valve is closed to stop the flow of bleed air to the pneumatic manifold. During normal flight operations, the four pneumatic manifold switches should be in the OPEN position to allow the pneumatic manifold to be pressurized.

PNEUMATIC SYSTEM INDICATORS.

Pneumatic Manifold Overheat Warning Light.

A red, 28-volt d-c, manifold overheat warning light, and a test switch, powered from the flight deck left hand auxiliary bus, is located on the flight engineer's instrument panel, immediately below the pneumatic manifold switches *(2, figure 4-2)*. A continuous overheat detection element is installed in the leading edge of the wing adjacent to the pneumatic manifold. A temperature of 121°C in the area surrounding the manifold duct, will cause the detection element to energize the 28-volt d-c circuit and cause the overheat warning light to come on.

CAUTION

> If the overheat warning light comes on during pneumatic system operation, the pneumatic manifold valves should be closed by placing the four pneumatic manifold switches in the CLOSE position to prevent damage to the wing leading edge area.

Pneumatic Manifold Overheat Warning Test Switch.

A 3-position, pneumatic manifold overheat warning test switch, *(12, figure 4-2)* placarded LEFT WING — RIGHT WING, is located on the flight engineer's instrument panel, directly below the pneumatic manifold switches. The switch is spring loaded to the OFF, or, center position. Placing the switch in either the LEFT WING or RIGHT WING position, will complete a 28-volt d-c circuit between the manifold overheat detectors and the manifold overheat warning light, and cause the light to come on indicating that the circuit is functioning properly.

Pneumatic Pressure Indicator.

A 28-volt a-c pneumatic pressure indicator *(22, figure 4-2)*, is installed on the flight engineer's instrument panel. The pressure indicator is calibrated from zero to 200 psi and indicates the pressure in the pneumatic system. Power for the indicator and its transmitter is received from the 28-volt a-c flight deck right hand auxiliary bus.

JET BLAST WINDSHIELD RAIN REMOVAL SYSTEM.

A jet blast windshield rain removal system is installed in lieu of the windshield wiper for the pilot's front side windshield. The system allows either engine or GTU bleed air to be ducted from the pneumatic manifold through the jet blast windshield rain removal supply duct to a plenum at the base of the pilot's windshield. When all four engines are operating at high ground rpm or above, the rain removal system utilizes engine bleed air. During low ground idle operation, GTU bleed air is automatically selected to supply the system. When operating in this mode, air flow is reduced and may be ineffective in removing rain from the windshield. However, additional airflow for jet blast windshield rain removal may be obtained by shutting off the air conditioning system.

Jet Blast Windshield Rain Removal Switch.

A 2-position jet blast rain removal switch *(figure 4-8)*, powered from the flight deck overhead, 28-volt d-c, nonessential bus, is located on the pilots' overhead panel. The switch has the placarded positions ON and OFF. Placing the switch in the ON position completes a 28-volt d-c circuit to open the motor-actuated jet blast rain removal valve, located beneath the flight deck floor, and the engine starting and shutoff check valve. When the switch is in the ON position, electrical anti-icing of the pilot's front side windshield is automatically deenergized.

Rain Removal Operation Check.

With the aircraft engines operating at high ground idle rpm and the GTU's running and loaded, perform the following:

1. All Pneumatic Manifold Switches — OPEN.
2. Air Conditioning Ram Ventilation Switch—OFF.
3. Rain Removal Switch — ON.

Listen for indication of airflow through the exit nozzles.

4. Engines — LOW GROUND IDLE RPM.

Check for continuation of airflow.

CAUTION

When engine bleed air is supplied to the rain removal system during ground static conditions, the windshield is heated to a higher temperature than recommended for continuous duty. Repeated use of the rain removal system under these conditions will cause clouding or bubbling of the windshield vinyl layer. Therefore, it is recommended that system operation on the ground be limited to 6 minutes when main engines are operating above low ground idle.

CABIN PRESSURIZATION SYSTEM.

The source of pressure and airflow for pressurization is the air that has been conditioned by the air conditioning system *(figure 4-1)*. Cabin pressurization is accomplished by regulating the outflow of air from the main cabin to the atmosphere, through the cabin pressure outflow valve. The pressurization system allows flight up to approximately 16,000 feet with cabin altitude maintained at sea level pressure. Above this altitude the cabin altitude may be maintained at a pressure differential of 6.55 psi so that a cabin altitude of 10,000 feet will not be reached until the aircraft altitude is near the 35,000-foot level. The pressurization system consists of the following components: the cabin pressure controller, which provides for selection of cabin pressure altitude and rate of change of cabin pressure; the cabin pressure outflow valve, which opens and closes to regulate cabin pressure as selected by the cabin pressure controller; the cabin presure safety valve, which opens if cabin pressure reaches a pressure differential of 6.88 psi; the

Air Conditioning, Pneumatic and Pressurization Systems

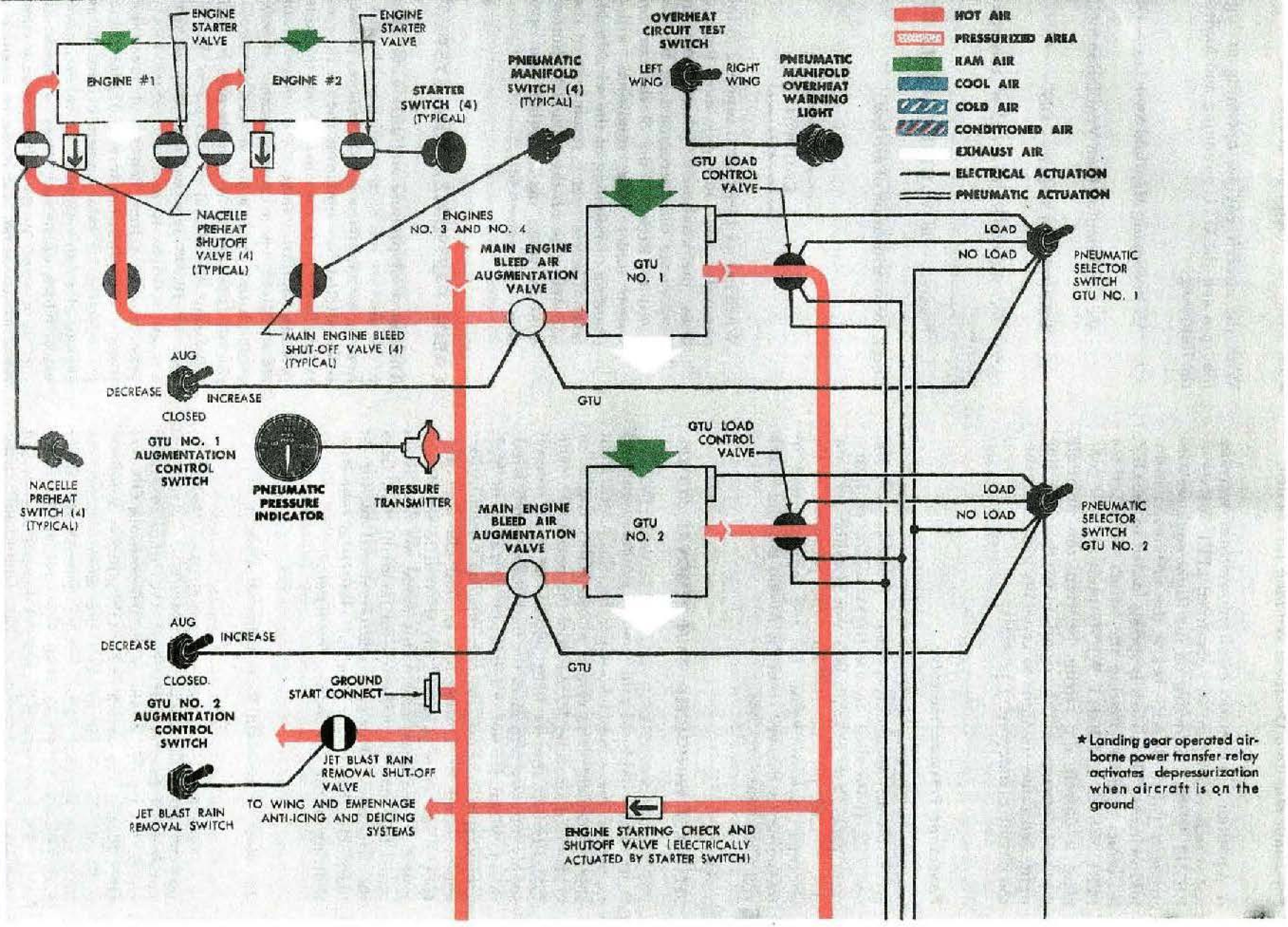


Figure 4-1 (Sheet 1 of 2)

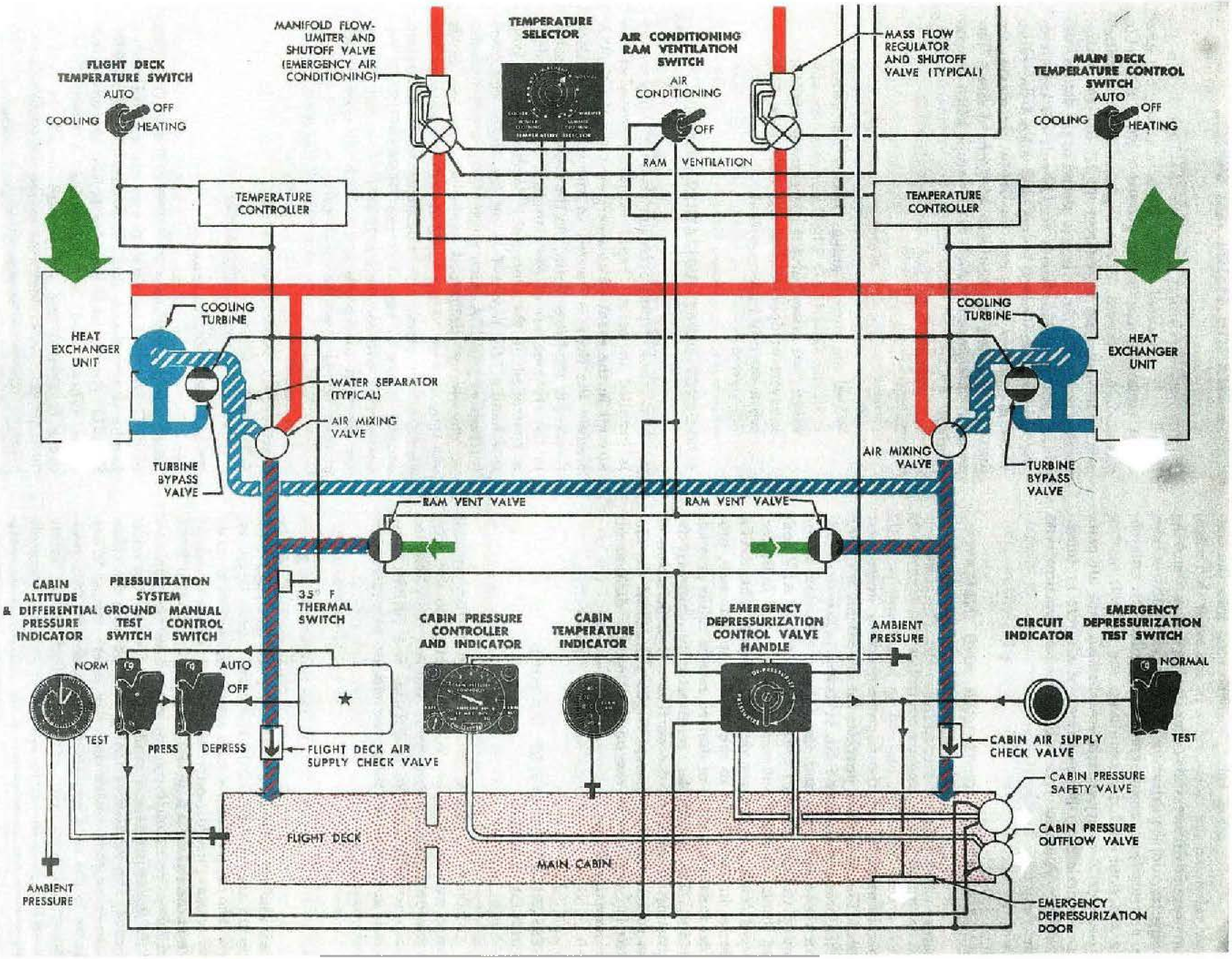


Figure 4-1 (Sheet 2 of 2)

cabin vacuum relief valve, incorporated into the outflow valve and the safety valve in the event that negative pressure differentials occur during descent; and the emergency depressurization door, which incorporates an electrically actuated explosive cartridge for unlatching the door and depressurizing the aircraft within 15 seconds. A safety switch, installed on each aft main gear, functions to depressurize the aircraft at touchdown by opening the cabin pressure outflow and safety valves.

CABIN PRESSURE CONTROLLER AND INDICATOR.

An automatic cabin pressure controller *(20, figure 4-2)* with a dial indicator, marked in increments of 1000 feet, is mounted on the flight engineer's instrument panel. The controller provides for the selection of any cabin pressure altitude from 1000 feet below to 10,000 feet above sea level, and also for the selection of the rate of change of cabin pressure. A CABIN ALT control knob, located to the right of the dial indicator, is provided to select the desired altitude. The RATE control knob, located to the left of the indicator, provides for the selection of desired rate of cabin pressure change. The controller pneumatically controls the actuating pressure of the outflow valve. Selection of the corresponding expected flight altitude of the aircraft is based on the maximum allowable differential pressure of 6.55 psi.

PRESSURIZATION SYSTEM MANUAL CONTROL SWITCH.

A guarded, 4-position, pressurization system manual control switch *(7, figure 4-2)* is installed on the pressurization system control panel and has the placarded positions AUTO, OFF, DEPRESS, and PRESS. This switch completes a 28-volt d-c circuit to control the pressurization system.

The switch is held in the AUTO position by a guard which must be lifted before manual control can be used. During automatic operation, the electrical actuator on the outflow valve and safety valve is driven to a neutral position, which allows the valves to open and close pneumatically to control cabin pressure. When the switch is held in the spring-loaded DEPRESS position, the manual control takes over the function of the cabin pressure controller by providing electrical signals to the actuators for opening of both the cabin pressure outflow valve and the safety valve. When the switch is held in the spring-loaded PRESS. position, the electrical actuator on the outflow and safety valves is driven to a neutral position which allows the valves to close pneumatically to control cabin pressure. The OFF position deenergizes the system leaving the electrical actuators in their last position.

PRESSURIZATION SYSTEM TEST SWITCH.

A guarded, 2-position pressurization test switch *(9, figure 4-2)* is located on the flight engineer's instrument panel. Its use is for ground testing the cabin pressurization system. The two positions of the switch are NORMAL and GROUND TEST. When ground testing is desired, the switch is placed in the GROUND TEST position. This opens the 28-volt d-c circuit to the landing gear safety switch and allows the cabin pressure outflow valve and the cabin pressure safety valve to function in their normal flight manner. The switch is positioned in NORMAL except when ground testing.

Note

> When the pressurization system test switch is in the GROUND TEST position, the side cargo door safety valve is energized to prevent inadvertent operation of the side cargo door while the cabin is pressurized.

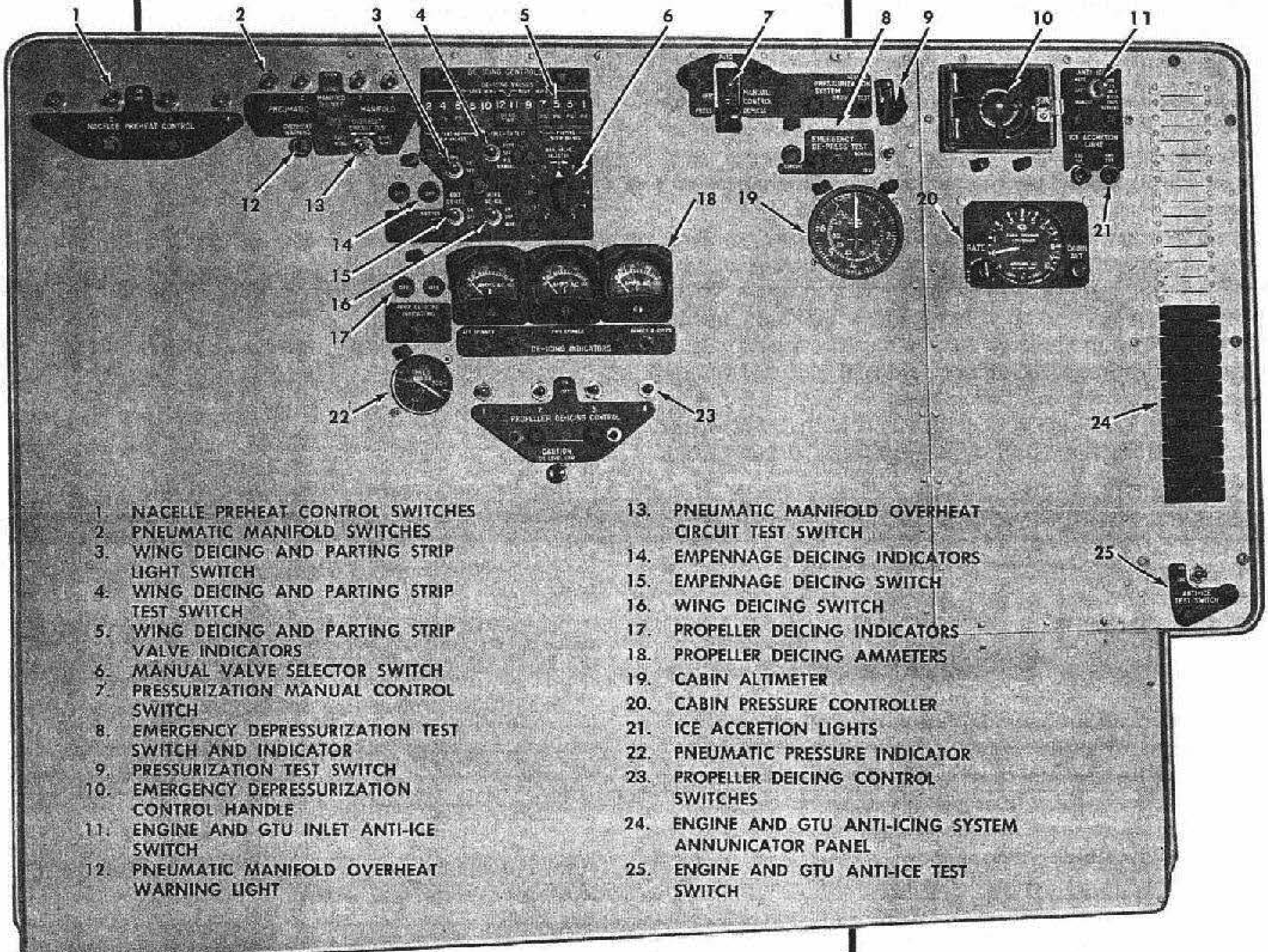
EMERGENCY DEPRESSURIZATION DOOR.

An emergency depressurization door *(19, figure 3-1)* is installed to permit rapid depressurization of the aircraft in the event of an emergency. On the C-133A aircraft the door is located in the rear cargo door forward of the hinge point. On the C-133B it is located in the aft door, aft of the clamshell doors. The door is controlled by the emergency depressurization control handle *(10, figure 4-2)* on the flight engineers instrument panel. A latch mechanism, which includes an electrically discharged explosive cartridge, holds the door closed. When rapid depressurization of the aircraft is desired, the emergency depressurization control handle is turned to the DEPRESSURIZE position. This will complete a 28-volt d-c circuit causing the cartridge to explode and unlatch the door, which is then forced open by cabin pressure.

EMERGENCY DEPRESSURIZATON CONTROL HANDLE.

An emergency depressurization control handle, *(10, figure 4-2)*, installed on the flight engineer's instrument panel, has the positions PRESSURIZE and DEPRESSURIZE. A cover is installed over the control with a handle clip to insure that the handle is in the PRESSURIZE (full closed) position before the cover will close. When rapid depressurization is required, the cover is opened and the control handle is rotated 90 degrees counterclockwise to the DEPRESSURIZE (open) position. In this position, a 28-volt d-c circuit is completed to open the cabin pressure outflow valve and safety valve, close the two GTU load control valves

Anti-Icing, Deicing, Pressurization and Pneumatic Manifold Controls—Typical



1. NACELLE PREHEAT CONTROL SWITCHES
2. PNEUMATIC MANIFOLD SWITCHES
3. WING DEICING AND PARTING STRIP LIGHT SWITCH
4. WING DEICING AND PARTING STRIP TEST SWITCH
5. WING DEICING AND PARTING STRIP VALVE INDICATORS
6. MANUAL VALVE SELECTOR SWITCH
7. PRESSURIZATION MANUAL CONTROL SWITCH
8. EMERGENCY DEPRESSURIZATION TEST SWITCH AND INDICATOR
9. PRESSURIZATION TEST SWITCH
10. EMERGENCY DEPRESSURIZATION CONTROL HANDLE
11. ENGINE AND GTU INLET ANTI-ICE SWITCH
12. PNEUMATIC MANIFOLD OVERHEAT WARNING LIGHT
13. PNEUMATIC MANIFOLD OVERHEAT CIRCUIT TEST SWITCH
14. EMPENNAGE DEICING INDICATORS
15. EMPENNAGE DEICING SWITCH
16. WING DEICING SWITCH
17. PROPELLER DEICING INDICATORS
18. PROPELLER DEICING AMMETERS
19. CABIN ALTIMETER
20. CABIN PRESSURE CONTROLLER
21. ICE ACCRETION LIGHTS
22. PNEUMATIC PRESSURE INDICATOR
23. PROPELLER DEICING CONTROL SWITCHES
24. ENGINE AND GTU ANTI-ICING SYSTEM ANNUNICATOR PANEL
25. ENGINE AND GTU ANTI-ICE TEST SWITCH

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Figure 4-2

and the mass flow valves, open the two ram ventilation valves, and energize the explosive cartridge to unlatch the emergency depressurization door. After the door is unlatched, cabin presure forces the door open to depressurize the aircraft within 15 seconds. For normal operation, the emergency depressurization control handle should be in the PRESSURIZE position with the cover plate closed and latched. In the PRESSURIZE position, the outflow valve is opened and closed pneumatically to maintain cabin pressure as selected by the cabin pressure controller.

EMERGENCY DEPRESSURIZATION CIRCUIT TEST SWITCH.

A 2-position, emergency depressurization circuit test switch *(8, figure 4-2)*, with the placarded positions NORMAL and TEST, is installed on the flight engineer's instrument panel. The switch, which is spring loaded from the TEST to the NORMAL position, is used to test the circuitry that detonates the cartridge which unlatches the emergency depressurization door. When the switch is held in the TEST position a 28-volt d-c circuit will be completed and a SAFE indication will appear on the emergency depressurization circuit test indicator, providing the detonating circuit for the emergency depressurization door unlatching cartridge is correct and a good cartridge is installed. When the switch is in the NORMAL position, the test circuit is deenergized.

WARNING

Make sure that all personnel are clear of the emergency depressurization door before placing the emergency depressurization circuit test switch in the TEST position to prevent injury in the event a malfunction causes the cartridge to detonate.

EMERGENCY DEPRESSURIZATION CIRCUIT TEST INDICATOR.

A 28-volt d-c emergency depressurization circuit test indicator *(8, figure 4-2)* is installed on the flight engineer's instrument panel. The indicator is used to indicate the condition of both the detonating circuit for the emergency depressurization door unlatching cartridge and the cartridge itself. If no malfunctions exist in either the detonating circuit or the cartridge, a SAFE indication will appear on the indicator when the emergency depressurization circuit test switch is held in the TEST position. If the indicator remains blank while the test switch is held in the TEST position, a malfunction is indicated in either the detonating circuit or the cartridge. The indicator remains blank whenever the test switch is in the NORMAL position.

CABIN PRESSURE DIFFERENTIAL INDICATOR.

A cabin pressure differential indicator installed with the cabin pressure controller *(20, figure 1-13)*, on the flight engineer's instrument panel, indicates on one dial the cabin altitude and the cabin pressure differential in psi. This indicator makes possible a direct reading of cabin pressure differential without resorting to calculation of cabin altitude versus aircraft altitude.

CABIN PRESSURIZATION — NORMAL OPERATION.

Before Takeoff.

Before takeoff, the following steps are taken to assure pressurization system operation after takeoff. The flight deck and cabin can be pressurized by the engineer performing the following steps.

1. GTU's — OPERATING and LOADED.
2. All Doors and Hatches — CLOSED and LATCHED.
3. Pressurization System Manual Control Switch— AUTO.
4. Pressurization System Test Switch—NORMAL.
5. Emergency Depressurization Control Handle — PRESSURIZE (cover on and latched).
6. Cabin pressure controller and indicator—SET.
    a. RATE knob — CENTERED.
    b. CABIN ALT knob — ADJUST.

Set so that the hand indicates approximately 1000 feet above the field elevation.

7. Air Conditioning-Ram-Ventilation Switch — AIR CONDITIONING.

Takeoff, Climb, and Cruise — With T.C.T.O. 584.

After the first power reduction following takeoff, turn the CABIN ALT knob until the number appearing in the AIRPLANE ALT AT MAX DIFF window corresponds with the cruise altitude that has been planned. After the altitude setting has been set on the controller, adjust the RATE knob as necessary so that the cabin altitude will reach the altitude indicated by the controller pointer before the aircraft reaches the actual flight altitude.

Takeoff, Climb, and Cruise — Without T.C.T.O. 584.

On aircraft without T.C.T.O. 584, the maximum allowable cabin differential altitude pressure is limited to 4.9 psi. Determine cabin altitude and set cabin pressure controller as follows:

1. Determine expected cruise altitude from mission planning data. Enter the ICAO Standard Atmosphere table, located in Part 1 of *T.O. 1C-133A-1-1,* to find pressure in inches Hg at that altitude.

2. Add 10 inches Hg to cruise pressure altitude to find cabin altitude.

3. Set cabin pressure controller to the cabin altitude determined.

Note

Disregard the figures that indicate airplane altitude at maximum differential pressure.

4. Using this procedure, a cabin altitude of 10,000 feet is reached when cruising a 26,000 feet mean sea level.

Descent.

When starting descent, rotate the CABIN ALT knob to set the pointer on the cabin pressure controller to indicate a cabin altitude setting approximately 1000 feet higher than the field elevation, and set the RATE knob to center. During descent, check that the cabin rate of descent is within comfortable limits which can be approximately maintained by adjusting the RATE knob. If cabin pressure is not depleted before landing, rapid depressurization will occur because the cabin outflow valve and the safety valves are automatically opened when the weight of the aircraft is on the landing gear. If necessary, release any excess pressure by use of the pressurization system manual control switch.

AIR CONDITIONING SYSTEM.

(See figure 4-1.)

The normal source of air used to air condition the aircraft is high-temperature bleed air from the GTU's. The design of the system provides ability to maintain flight deck temperatures at 21°C and cabin temperatures at 4°C when the ambient temperature is −54°C. With an ambient temperature of 38°C, it is possible to cool the flight deck to 27°C but the cabin will remain at ambient temperature. The air conditioning system includes the following: two refrigeration units, one in the forward end of each pod; two water separators; two temperature control systems, one for the cabin area and one for the flight deck; and the necessary valves and ducts that make up the operating system. Air is ducted from the GTU's through a mass airflow regulator to the two heat exchangers and to the hot side of the hot and cold mixing valves and turbine bypass valve. Air which is ducted to the heat exchangers, is cooled by heat transfer and then, depending upon the temperature required, is directed through the expansion turbine for further cooling, or is routed directly to the water separator by the turbine bypass valve. The air is then ducted to the cold side of the hot and cold mixing valves where it is mixed with the right quantity of hot air in accordance with the signal from the temperature control system. Airflow from the right mixing valve is ducted to the flight deck where floor level outlets and adjustable overhead outlets permit individual control of airflow. The normal flow requirement of the flight dcek is approximately 35 percent of the air ducted to the right refrigeration unit. The remaining 65 percent is ducted back across the aircraft to the cabin system. Airflow from the left mixing valves is divided into two ducts, one for each side of the aircraft, and released into the cabin through four outlets.

Variable Nozzle Control.

Each refrigerant unit is equipped with a pneumatically actuated variable area nozzle to provide adequate air cooling and air flows at all altitudes encountered. As the aircraft gains altitude the ambient pressure sensing actuator increases the nozzle area and as the aircraft descends the nozzle area is decreased.

The nozzle area and the actuation system are calibrated to maintain the most effective cooling pressure ratios across the turbine section for the required air flows at the different altitudes. Main engine bleed air from the pneumatic manifold is used for actuation of the nozzle control. Consequently operation of the variable area nozzle system is dependent on the pneumatic manifold being pressurized by engine bleed air.

FLIGHT DECK PRIORITY SYSTEM.

A priority system insures adequate temperature control on the flight deck during either automatic or manual temperature control when conditions require cool air to be supplied to the flight deck while warm air is being supplied to the cabin. The flight deck cooling priority system is in effect when the turbine bypass valve in the right pod is closed (in response to a demand for cold air to the flight deck) and the flight deck supply air temperature is above 4.4°C. The flight deck supply air temperature is sensed by a

Flight Deck and Main Cabin
Temperature Control Panel

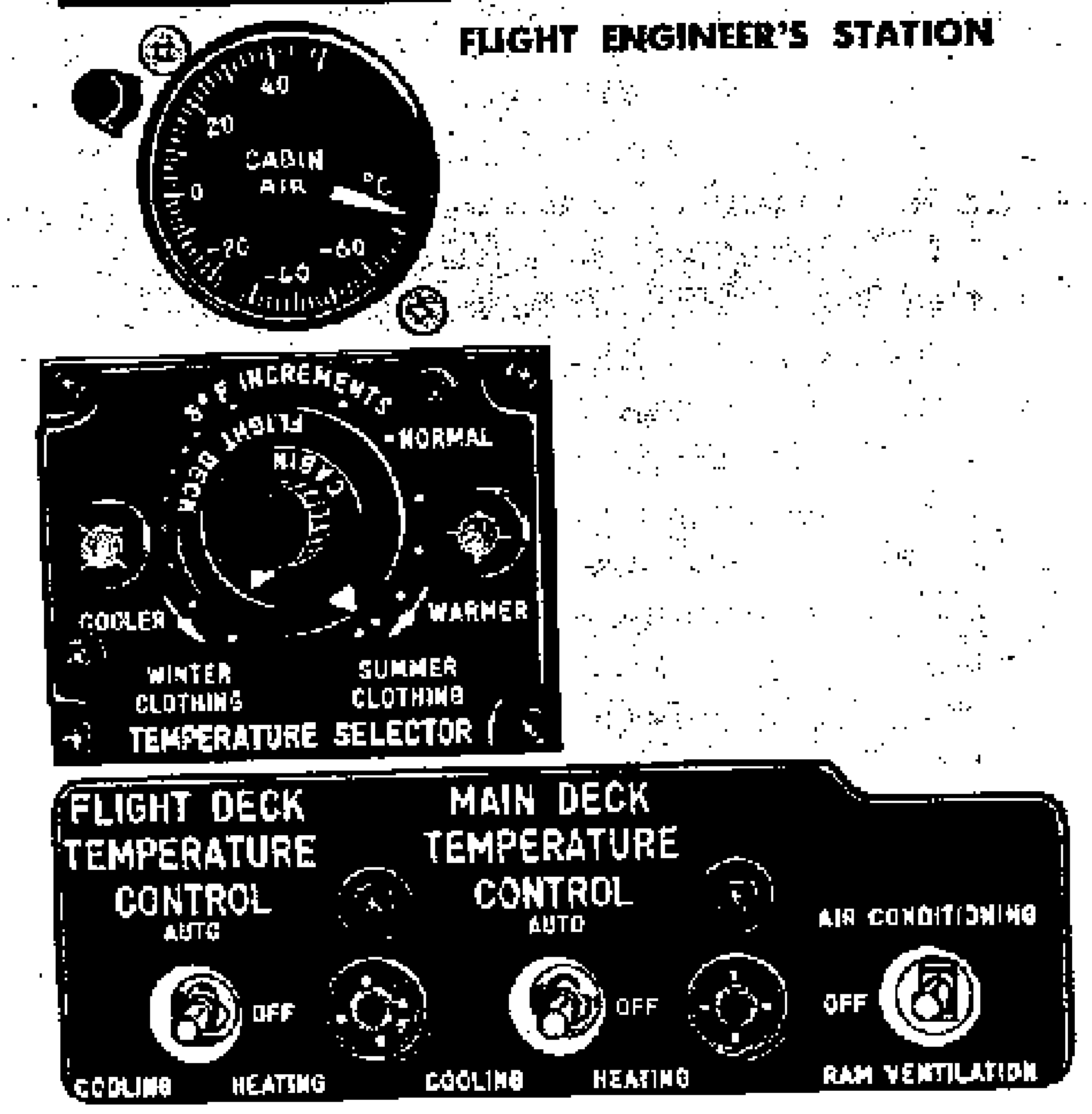

Figure 4-3

thermal switch which completes an electrical circuit to cause the left pod temperature control valves to provide cold air if duct temperatures are above 4.4°C. This change in circuitry occurs regardless of the previous demands from the cabin temperature control to position the left pod temperature control valves. Thus the distribution of airflow will be maintained to provide comfortable temperatures on the flight deck. When the right pod turbine bypass valve is closed, and the flight deck supply air temperature is below 4.4°C, the flight deck cooling priority system is not in effect. Thus the temperature control valves in the left pod can be positioned either automatically or manually with the cabin temperature control switch to provide any air temperature desired in the cabin.

Flight Deck and Cabin Temperature Control Switches.

Two 4-position temperature control switches *(figure 4-3)*, one for the flight deck placarded FLIGHT DECK TEMPERATURE CONTROL, and one for the cabin, placarded MAIN DECK TEMPERATURE CONTROL, are located on the flight deck and cabin temperature control panel. Each switch has the positions AUTO, COOLING, HEATING, and OFF (center) to permit selection of either automatic or manual temperature control, and are spring loaded from the COOLING and HEATING positions to OFF. When the switches are held in the spring loaded COOLING position, a 28-volt d-c circuit is completed to the air mixing valve motor to open the cold sides and close the hot sides of the mixing valves, until the valves are in the full cold position. If full cooling is necessary, the turbine bypass valves will then close to route air through the cooling turbine to the flight deck and cabin for maximum cooling. When the switches are held in the spring loaded HEATING position, a 28-volt d-c circuit is completed to the turbine bypass valves until the valves are open. If full heating is necessary, the cold sides will close and the hot sides of the air mixing valves will open to route heated air to the flight deck and cabin for maximum heating. When the switches are placed in the AUTO position, a 28-volt d-c circuit is completed to energize the 115-volt a-c flight deck and cabin temperature controllers to provide automatic temperature as selected by the temperature selector. The OFF (center) position deenergizes the circuits leaving the mixing and turbine bypass valves in the last selected position.

Note

> When the manual HEATING or COOLING positions are used, the switches must be held for approximately 100 seconds to move the air mixing valve and the turbine by-pass valve, through a complete cycle, from the full cold to the full hot position.

Note

> The flight deck and main deck temperature control switches are inoperative when the air conditioning-ram ventilation switch is in any position other than AIR CONDITIONING.

Flight Deck and Cabin Temperature Selectors.

Two temperature selectors *(figure 4-3)*, one for the flight deck and one for the cabin, are located on the flight deck and cabin temperature control panel. The selectors are mounted on concentric shafts and operate potentiometers which send signals to the temperature controllers (provided the temperature control switches are in AUTO). With the temperature selectors in NORMAL, the controllers provide automatic control of the air conditioning system and regulate the temperature to approximately 25°C. When the temperature selectors are moved toward WARMER or COOLER, the controllers will react accordingly. The cabin selector and the flight deck selector can be rotated through their full travel independently, in either direction.

Air Conditioning-Ram Ventilation Switch.

A three-position air conditioning-off-ram ventilation switch *(figure 4-3)* is located on the flight deck and cabin temperature control panel. When the switch is in the AIR CONDITIONING position the mass flow valve is open, and the air conditioning system is operating. When the switch is in the OFF position the mass flow valve and the ram vent valves are closed. When the switch is in the RAM VENTILATION position, the mass flow valve and the GTU load control valves are closed and the ram vent valves, the cabin pressure outflow valve, and the safety valve (Aircraft AF59-522 and subsequent) are open. The aircraft is then ventilated by ram air at ambient temperature and will slowly depressurize.

Cabin Air Temperature Indicator.

A 28-volt d-c cabin air temperature indicator *(figure 4-3)*, located on the flight deck and cabin temperature control panel and marked in degrees centigrade, indicates the cabin temperature.

AIR CONDITIONING SYSTEM — NORMAL OPERATION.

The flight deck and cabin can be air conditioned by the engineer performing the following steps.

1. GTU's — OPERATING and LOADED.
2. Emergency Depressurization Control Handle — PRESSURIZE (cover on and latched).
3. Flight Deck and Cabin Temperature Selectors — NORMAL.
4. Flight Deck and Cabin Temperature Switches — AUTO.
5. Air Conditioning Ram Ventilation Switch — AIR CONDITIONING.
6. GTU's — AUGMENT AS NECESSARY.

See GTU Operation, Section VII, for augmentation procedure.

If either temperature controller fails to function properly in the AUTO position, the temperature can be controlled manually with the flight deck and cabin temperature switches by holding them in the COOLING or HEATING position, as desired.

If the air conditioning system fails to function properly, the aircraft can be ventilated (but will depressurize) by placing the air conditioning-off-ram ventilation switch to RAM VENTILATION.

ANTI-ICING AND DEICING SYSTEMS.

The anti-icing systems *(figure 4-4)* are designed to prevent ice formation by maintaining the surface temperatures of the protected areas at a temperature which will prevent ice formation. The deicing system *(figure 4-4)* will remove accumulated ice by cyclic action of either thermal or pneumatic equipment. The anti-iced areas are heated by electric elements and/or by hot air from the pneumatic system. They are controlled either automatically by ice-sensing probes or by manual switch actuation. Deicing is accomplished by cyclic application of heat from the pneumatic system and the cyclic inflation of rubber boots on the leading edges of the horizontal and vertical stabilizers. Pneumatic power for both systems is supplied by engine bleed air. A relief valve, in each outer wing pneumatic manifold, is provided to relieve excessive pressure in the event the pressure regulators fail to maintain system pressure within limits.

ENGINE ANTI-ICING SYSTEM.

Electrically heated units and hot air from each individual engine are used to provide anti-ice protection for critical areas of the engines and nacelles. The pneumatic and electric units are electrically controlled and may be operated manually or automatically through an ice detector system. An ice detector probe is located in each engine air inlet. The power source for the ice detectors is from the 115-volt a-c center fuselage, nonessential bus.

The electrically heated units are the top and bottom struts between the cowl nosering and the spinner afterbody. The pneumatically heated units are the engine cowl nosering, the top four engine air inlet struts, and the compressor inlet guide vanes. Hot engine oil, passing through the lower two engine air inlet struts, heats the struts, providing anti-ice protection.

The nature of the automatic system is such that ice detection by any probe will actuate the engine and GTU anti-icing system if the engine and GTU anti-icing switch is in the AUTO position. The system is automatically deenergized by a timing device if the ice detectors do not sense ice for a period of 75 to 105 seconds. A disarm switch will interrupt an ice detector signal on any engine when its condition lever is in FEATHER or FUEL-OFF position.

Note

> Operation of the engine anti-icing system will result in approximately 2.5 psi torque pressure loss per engine. (See Torque Pressure Loss Due to Engine Airbleed charts in Part 5 of *T.O. 1C-133A-1-1*).

Anti-Icing and Deicing System

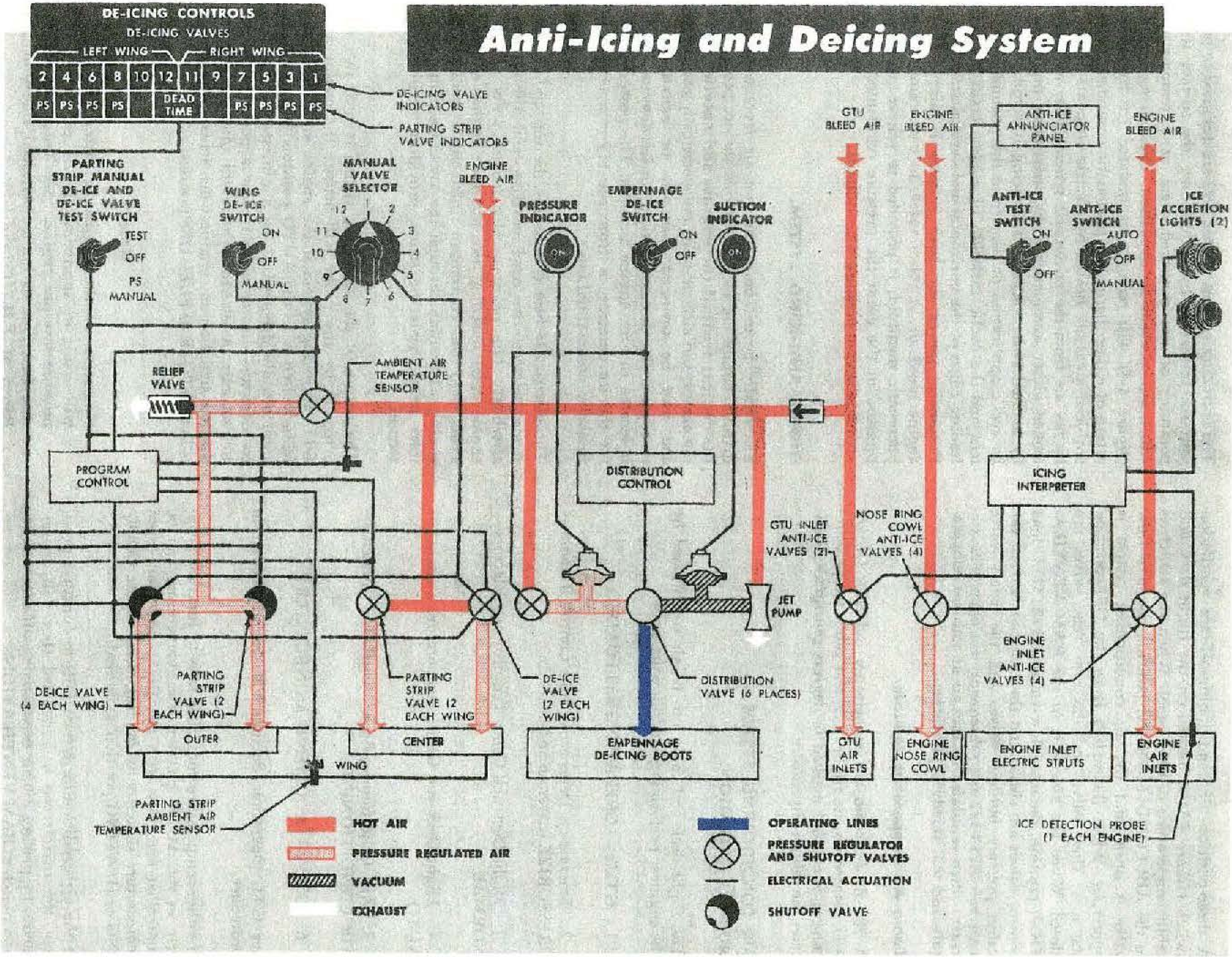

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Figure 4-4

Ice Accretion Lights.

Two amber, 28-volt d-c press-to-test ice accretion lights *(21, figure 4-2)* are located on the anti-ice control panel on the flight engineer's instrument panel. The lights are powered from the flight deck overhead, 28-volt, nonessential bus, and are connected to the engine inlet ice detection probes *(figure 4-4)* to warn of accumulation of ice in the engine inlets. The right-hand light is connected to the detector probes in engines No. 2 and 3, and the left-hand light is connected to the probes in engines No. 1 and 4. A light will come on whenever an icing condition is detected by any probe. When the anti-icing system is automatically energized both lights will come on.

Engine Inlet and GTU Inlet Anti-Ice Switch.

A 3-position engine inlet and GTU inlet anti-ice switch *(11, figure 4-2)*, placarded AUTO, OFF and MANUAL, is located on the anti-ice control panel. The function of this switch is to provide for manual or automatic control of the engine inlet and GTU inlet anti-ice system. During flight when the switch is placed in the AUTO position, a 28-volt d-c circuit is completed to the ice detector system and the automatic anti-icing feature of the system is ready to function. The OFF position breaks the holding circuit in the ice detector and deenergizes the system. The MANUAL position of the switch has a dual function of controlling the system for manual operation in the event of automatic system failure and of checking the system for malfunctioning. When the switch is placed in the MANUAL position, a 28-volt d-c circuit is energized which bypasses the ice detector and allows manual anti-icing. Both the AUTO position and the MANUAL position complete a 28-volt d-c circuit to the annunciator panels and any malfunction of the system will be indicated if the anti-ice test switch is actuated at the same time.

Aircraft with T.C.T.O. 506 are equipped with heating elements in the inlet struts which operate with reduced power with the anti-ice switch in the MANUAL POSITION to provide anti-ice protection on the ground. After takeoff, the airborne transfer relay will allow full electrical power to be applied to the struts to provide full ice protection.

Anti-Icing System Annunciator Panel.

An anti-ice system annunciator panel *(24, figure 4-2)*, consisting of 13 back-lighted press-to-test title strips, one for each engine and GTU anti-icing system component, is located on the flight engineer's instrument panel. The function of this panel is to present an indication of any malfunction of the electrical anti-icing elements and anti-icing valves of the system. The panel can be connected into the circuits by operation of the anti-ice test switch. When an individual circuit is functioning normally, the title strip light identifying that circuit will come on when the test switch is closed. Should a malfunction such as an open circuit exist, the title strip will not come on, indicating which portion of the system is unprotected for anti-icing. The annunciator panel lights receive power from the flight deck overhead nonessential d-c bus.

Anti-Ice Test Switch.

A 2-position, momentary-contact, anti-ice test switch *(25, figure 4-2)* is located on the flight engineer's instrument panel and has the placarded positions ON and OFF. With condition levers forward of FUEL OFF, placing the anti-ice switch in MANUAL will cause the annunciator strips for the top and bottom struts of each engine to come on. With the anti-ice switch still in MANUAL, placing the anti-ice test switch to ON will cause the GTU inlet valve strip and the anti-ice valve strips for each engine to come on. During flight, the operation of the engine and GTU anti-ice system is tested by placing the anti-ice switch to MANUAL and the anti-ice test switch to ON. All annunciator strips should come on. If the system has been automatically energized, the system may be tested by placing the test switch ON, providing the condition lever is forward of the FUEL-OFF position.

GTU ANTI-ICING SYSTEM.

The GTU air inlet scoop is anti-iced by heated air provided by the GTU bleed system. The air for this purpose is controlled by an electrically triggered, pneumatically operated valve and is automatically actuated by indication of ice at any of the four main engine ice detectors. The power source for this system is the 28-volt d-c center fuselage nonessential bus. The system is controlled by the engine anti-icing system.

ENGINE AND GTU ANTI-ICING SYSTEMS OPERATION AND TEST.

Test Procedures Ground — Engines and GTU Not Operating.

1. Ice Accretion Lights — PRESS-TO-TEST.

Lights should come on.

2. Anti-Ice Test Switch — ON.

3. Anti-Ice System Annunciator Strips — PRESS-TO-TEST each strip.

Both lights in each strip should come on.

4. Anti-Ice Test Switch — OFF.

5. Engine and GTU Anti-Ice Switch—MANUAL.

6. All Condition Levers — FUEL ON.

Top and bottom inlet strut annunciator strips for each engine should come on.

7. All Condition Levers — FUEL OFF.

8. Engine and GTU Anti-Ice Switch — AUTO.

9. No. 1 Condition Lever — ADVANCE FORWARD OF FUEL OFF POSITION.

Engine No. 1 and 4 ice accretion light should come on.

10. No. 1 Condition Lever — FUEL OFF.

Engine No. 1 and 4 ice accretion light should go off.

Note

Repeat steps 9 and 10 for each engine. Movement of No. 1 or No. 4 condition lever forward of the FUEL OFF position will cause ENG 1 & 4 ice accretion light to come on. Movement of No. 2 or No. 3 condition levers forward of the FUEL OFF position will cause ENG 2 & 3 ice accretion light to come on.

11. All Condition Levers — FUEL OFF.

12. Engine and GTU Anti-Ice Switch — OFF.

Test Procedures (Flight).

1. Engine and GTU Anti-Ice Switch—MANUAL.

2. Anti-Ice Test Switch — ON.

All annunciator strips should come on.

3. Anti-Ice Test Switch — OFF.

4. Engine and GTU Anti-Ice Switch — AUTO.

Operation.

1. Ground—Engine and GTU Anti-Ice Switch—MANUAL (if icing conditions exist.)

2. Takeoff — Anti-Ice System — RESET.

Reset after takeoff by placing engine and GTU anti-ice switch to OFF and then AUTO.

3. Flight — Engine and GTU Anti-Ice Switch — AUTO.

See Operation Under Icing Conditions, Section IX.

Note

When the manual system is energized prior to takeoff, the top and bottom strut annunciator strip light for each engines will come on. When the aircraft becomes airborne, the strut annunciator strip light will go off.

WING DEICING SYSTEM.

The wings are protected from ice by a hot air, double skin, cyclic deicing system which allows ice to accumulate and then loosens it by melting it at the airfoil surface.

Each wing is divided into six deicer equipped sections that are approximately 12 feet long. Each of the two inboard sections is supplied with hot air through a pressure regulating and shutoff valve (anchor valve) from the main pneumatic manifold. An outer wing pressure regulating and shutoff valve at each end of the pneumatic manifold supplies air to the outer wing deicing manifold. Each outer wing deicing manifold has a pressure relief valve and four air shutoff valves which allow hot air to flow through the four outer wing deicing sections.

Each of the deicer equipped sections has a heated parting strip located at the stagnation point of the leading edge of the wing to maintain it in an ice free condition. This strip aids in ice removal by unbalancng the icecap. The hot air for the four outboard parting strip ducts is supplied by the outboard manifold through two pneumatically actuated shutoff valves. The two inboard parting strip ducts are supplied by the main pneumatic manifold through two pneumatic pressure regulating and shutoff valves.

The system functions for either normal or manual deicing operation. When the wing deicing switch is in the ON position, the two pressure regulating and shutoff valves (anchor valve) in the main pneumatic

Wing Deicing – Time vs Temperature

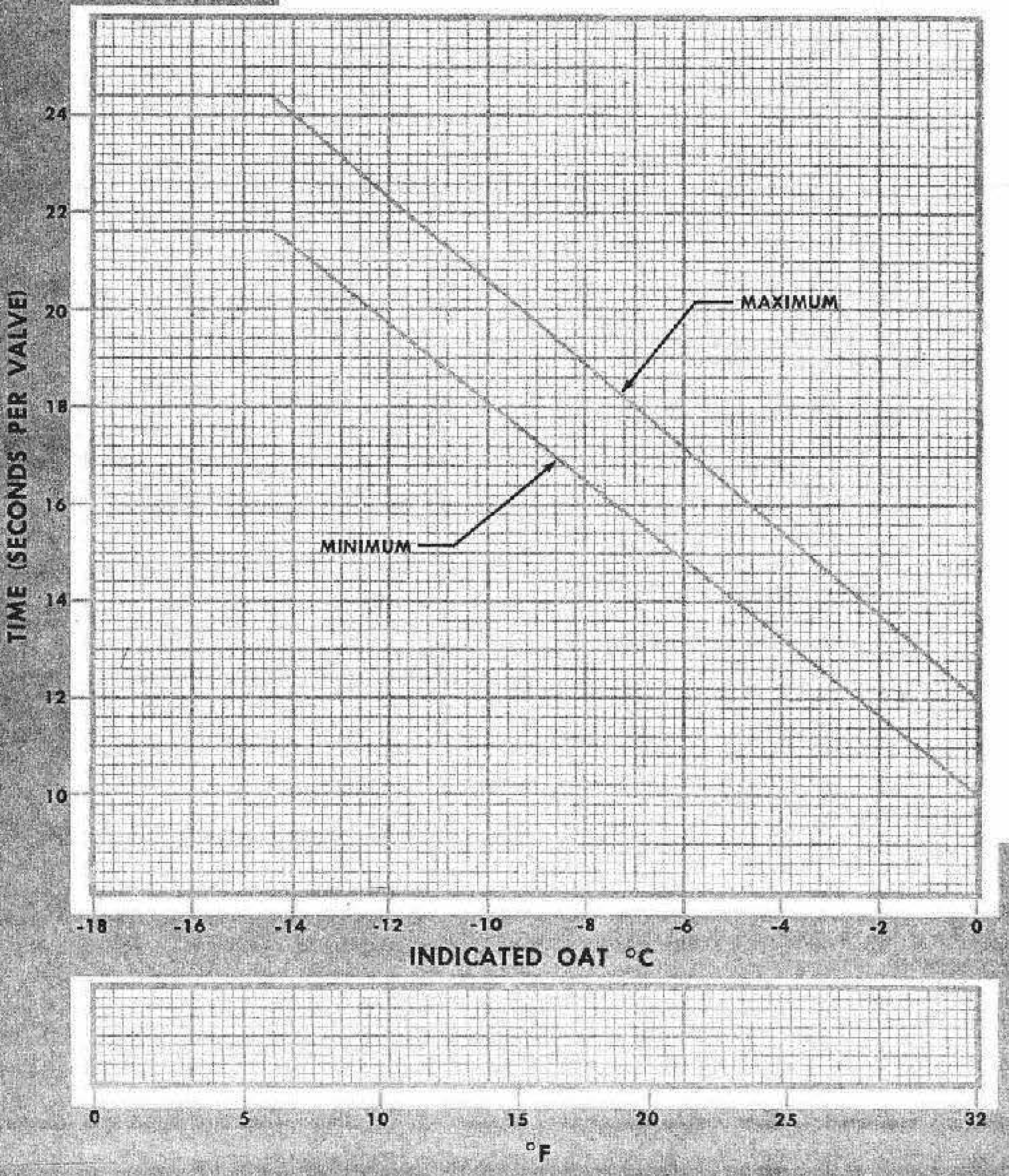

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Figure 4-5

manifolds are energized, the circuits to the 12 cyclic deicing valves are energized, and the wing deicing programmer is energized. The programmer actuates each of the deicing valves consecutively in a sequence outboard to inboard and alternately from the right to the left wing. The programmer cycle is started every 5 minutes. The length of time each wing deicing valve remains open is controlled by a temperature sensing element located in the outer skin aft of the right pod. At temperatures of 0°C and above, each valve will remain open from 10 to 12 seconds. The valves will stay open progressively longer to a maximum of 25 seconds at -18°C IOAT and below. See Wing Deicing —Time vs Temperature *(figure 4-5)*. The parting strip valves are controlled by a thermal switch and are energized when the temperature is below -4°C and the wing deicing switch is in the ON position.

Since the wing may be cold soaked when ice is encountered, some heat is dissipated in heating the ducting, insulation, etc. Therefore, the ice removal during the first cycle of operation may be somewhat uneven. Ice removal during subsequent cycles should be reasonably even for all sections. For this reason, the system should be allowed to operate for approximately 10 minutes before taking further action.

Note

Operation of the wing deicing system will result in approximately 1 psi torque pressure loss per engine. (See Torque Pressure Loss Due to Engine Airbleed, in Part 5 of *T.O. 1C-133A-1-1*).

Each of the 12 deicer equipped sections of the wing is protected from overheat by an overheat detector thermoswitch located on the lower surface inner skin approximately 6 inches from the wing deicing valves in the center of each section. The valve solenoids are connected in series with these switches, so that when the temperature of the structure to which the switch is attached rises above 60°C, the shutoff valve will close.

CAUTION

Do not operate the wing deicing system on the ground with the deicing valves open with the pneumatic manifold pressurized for longer than five seconds, otherwise damage to the wing area could result.

High temperature air to the main pneumatic manifold is controlled by four engine bleed air shutoff valves, one for each engine. When the valves are open, the pneumatic pressure gage at the flight engineer's station will indicate the pressure in the pneumatic duct system. The four pneumatic manifold switches at the flight engineer's station provide individual control of each bleed air shutoff valve. In the event of a manifold duct failure and subsequent overheating, the pneumatic manifold overheat warning light on the flight engineer's panel will come on to provide a warning to close the bleed air shutoff valves on all engines.

Manual control of the wing deicing valve is provided in the event the programmer becomes inoperative or fails to achieve the desired results. Each of the wing deicing valves may be individually opened by using the manual control.

Manual control of the parting strip valves is also provided. This allows all eight valves to be opened whether or not the programmer is in operation. The manual control also allows the valves to be opened at temperatures above -4°C when the wing deicing system is in operation, if anti-icing is desired at those temperatures.

CAUTION

The use of manual deicing is limited to 2 minutes ON for each section with a minimum of 2 minutes OFF before reapplication during flight.

Wing Deicing Switch.

A wing deicing switch *(16, figure 4-2)* with the placarded positions ON, OFF, and MANUAL (placarded MAN.), is located on the wing and empennage deicing control panel. The switch is spring loaded from the MAN. to the OFF position. When the switch is positioned to ON, a 28-volt d-c circuit is completed which opens two pressure regulating shutoff valves and energizes an electrical programmer. The programmer, in turn, actuates each of 12 cyclic deicing valves in an outboard-to-inboard, right wing-to-left wing alternating sequence. The switch also actuates the parting strip valves when the ambient temperature is below -4°C. For manual operation of the deicing valves, the switch must be held in the MAN. position. When the switch is in this position, the programmer is deenergized and a selected deicing valve may be kept open.

Manual Valve Selector Switch.

A rotary, manual valve selector switch *(6, figure 4-2)* is located on the wing and empennage deicing control panel. The selector has 12 positions for corresponding wing deicing valves. The selector switch permits oper-

Anti-Icing and Deicing Controls and Indicators — Flight Engineer's Station

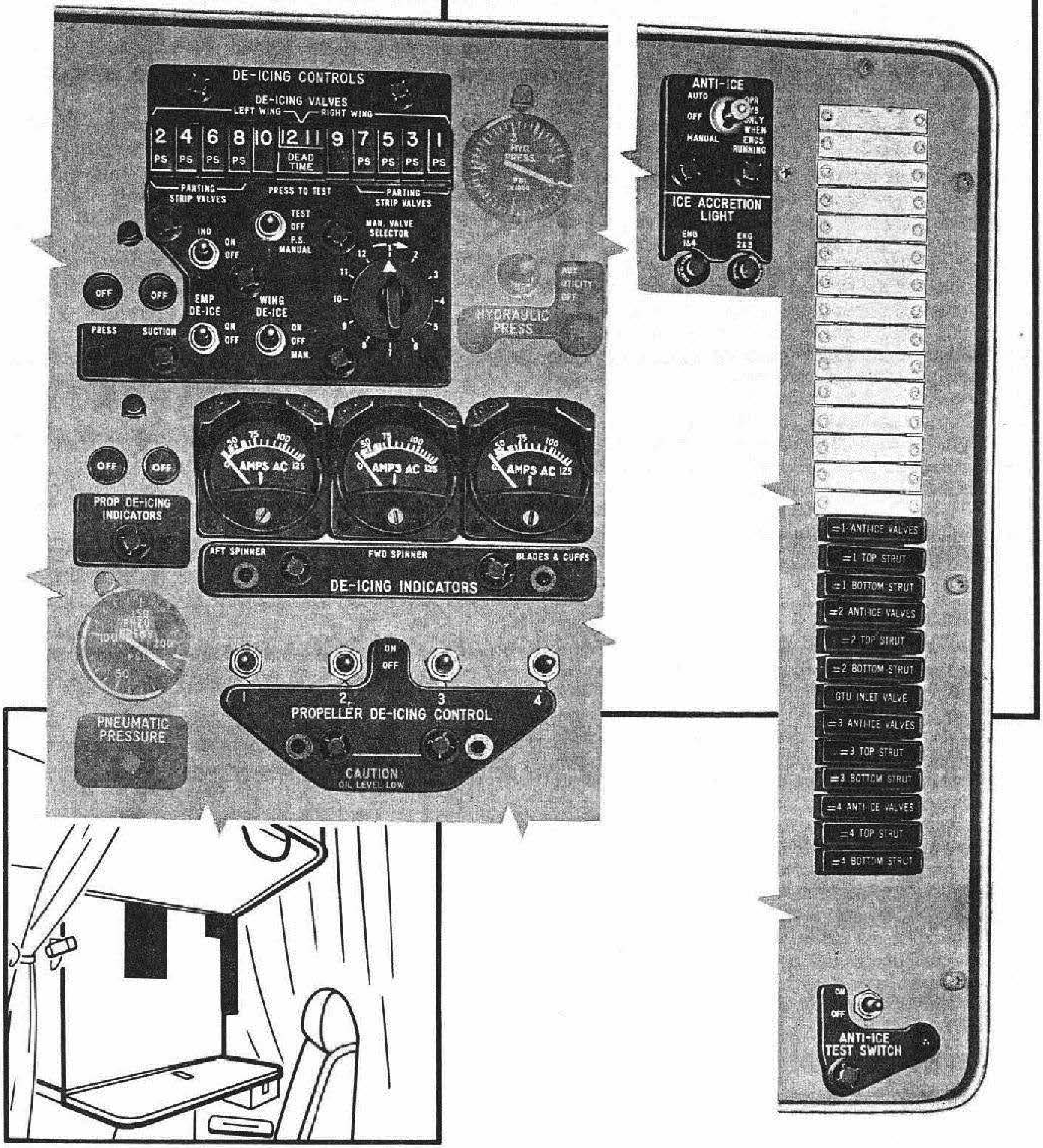

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Figure 4-6

ation of a particular deicing valve for as long as desired when the wing deicing switch is held in the MAN. position.

Wing Deicing and Parting Strip Valve Indicators.

Twelve indicators *(5, figure 4-2),* located near the top of the wing and empennage deicing control panel, provide visual indication of the cycling of the wing deicing system. Each indicator consists of a press-to-test 28-volt d-c light assembly powered from the flight engineer's instrument light circuit. Eight of the indicators are divided in half, the upper half indicating the cycling of wing deicing valves No. 1 through 8, and the lower half indicating the cycling of the respective parting strip valves. Two of the indicators indicate the cycling of wing deicing valves No. 9 and 10 only. The upper center indicator is divided in half, the right side indicating the cycling of wing deicing valve No. 11, and the left side indicating the cycling of wing deicing valve No. 12. The lower center indcator indicates dead time, or the time interval between cycles. The light behind each indicator will come on, in a programmed sequence, to indicate that its respective valve is open and functioning normally. The dead time indicator light will come on at the end of each complete cycle, and will remain on until the next cycle begins. In the event one or more of the indicator lights fail to come on at the proper time, or in the proper sequence, a malfunction of that particular valve or the system is indicated.

Indicator Light Switch.

A 2-position, indicator light switch, installed on the wing and empennage deicing control panel *(3, figure 4-2),* provides control of the wing deicing and parting strip indicator lights and the dead time indicator light. The switch, placarded IND, has the placarded positions ON and OFF. During wing deicing system checkout, placing the switch in the ON position permits the lamp filaments of each of the indicator lights to be tested when the individual indicator is pressed in. During normal operation of the system, placing the switch in the ON position will permit each individual indicator light to come on as it is selected by the wing deicing programmer. Placing the switch in the OFF position permits the indicator lights to be turned off during continuous cyclic operation of the wing deicing system when visual indication of system functioning is not desired.

Note

> The flight engineer's instrument panel lights must be on to permit the indicator light switch to turn the indicator lights on.

Wing Deice and Parting Strip Test Switch.

A 3-position (wing deice and parting strip test switch *(4, figure 4-2),* placarded TEST, OFF and PS MANUAL, is located on the wing and empennage deicing control panel. The switch is used to determine the satisfactory operation of the wing deicing valves and for manual operation of the parting strip valves.

WING DEICING SYSTEM — TEST PROCEDURES.

The wing deicing system should be ground checked with the pneumatic system pressurized by two engines operating at NORMAL RATED power. When the system is being checked using GTU air only, a recheck, using two engines, should be accomplished if any of the valves fail to operate or indicate normal operation before the system should be considered to have malfunctioned.

Deicing Valve Cycling Test.

1. Pneumatic System — PRESSURIZED.

Pressurize with two engines operating at NORMAL RATED power or with the GTU's.

2. Wing Deicing Valve Indicator Light Switch—ON.

3. Wing Deice and Parting Strip Test Switch—TEST.

Hold in TEST position for approximately 36 seconds. All parting strip indicator lights should come on simultaneously and the wing deicing valve indicator lights should come on in sequence. All 12 wing deicing valve indicators should come on within 36 seconds. At the completion of the valve test, the dead time indicator light will come on and remain on until the end of the 5-minute program time. The time span for the complete cycle (from the time No. 1 deicing valve indicator light comes on until the dead time light goes out) should be approximately 300 seconds.

Note

> Upon placing the test switch in TEST, a dead time indication may appear. This is caused by an interruption of power to the programmer on the preceding run. Allow the programmer to run out and then proceed with the cycling test.

4. Wing Deice and Parting Strip Test Switch—PS MANUAL.

All eight parting strip valve indicators should come on simultaneously.

5. Wing Deice and Parting Strip Test Switch — OFF.

6. Wing Deicing Valve Indicator Light Switch—OFF.

7. Pneumatic System — DEPRESSURIZED.

Depressurize the pneumatic system and shut down engines or GTU's as required.

Note

> During ground test on very hot days, when the wing deicing checkout system is energized more than one time, the overheat detector thermo-switches for the deicer equipped sections may prevent the wing deicing valves from opening.

WING DEICING SYSTEM OPERATION.

When necessary to use wing deicing, the pneumatic system must be pressurized, normally with engine bleed air. When icing conditions are anticipated, it is recommended that power be adjusted to compensate for the loss of power incurred. If engine power is critical it may be necessary to shut off any GTU augmentation (see Torque Pressure Loss Due to Engine Airbleed chart, Part 5 *T.O. 1C-133A-1-1*).

To achieve best results, turn on the deicing system prior to entering the icing area to allow the wing deiced sections to warm up. If icing conditions can not be anticipated and removal of ice is erratic during the first cycle of operation, allow the system to operate for at least 10 minutes before going to manual operation.

During normal operation, the deicing valve indicators will come on as each valve is actuated. At ambient temperatures below −4°C, the parting strip valve indicators will come on simultaneously to indicate operation of the parting strip valves. For detailed instructions on the operation of the deicing system under icing conditions, see Ice and Rain, Section IX.

Normal Operation.

Placing System In Operation:

1. Pneumatic Manifold Switches — OPEN.
2. GTU Augmentations — AS REQUIRED.
3. Wing Deice Switch — ON.

Observe deice indicators for proper cycling. Have a crew member check the wings to see that ice removal is proceeding normally.

To Turn System Off:

1. Wing Deice Switch — OFF.
2. GTU Augmentation — AS REQUIRED.
3. Pneumatic Manifold Switches — AS REQUIRED.

Manual Operation.

Manual operation of the wing deicing system is provided for use under conditions when desired results cannot be obtained by normal operation of the system. If the system malfunctions in flight, the malfunction may be due to failure of the wing deicing programmer.

Malfunctioning of the programmer is indicated by failure of the wing deicing valve indicators to come on or failure of any one of the indicators to remain on during the normal duty cycle of 12 to 25 seconds. If it is indicated that the programmer is not operating correctly, each wing deicing valve may be actuated manually and kept open as long as necessary to clear the ice by turning the manual valve selector switch to the desired valve and holding the wing deicing switch in the MAN. position.

CAUTION

> The use of manual deicing is limited to 2 minutes ON for each section, with a minimum of 2 minutes OFF, before reapplication during flight.

If it is indicated that a particular valve is not operating or is not operating properly, the valve in question may be held open by manual control.

Manual control of the wing deicing system also may be used in case large concentrations of ice are encountered and it is desired to keep the deicing valves open beyond the normal limits.

Manual control of the parting strip valves may be used (1) if the valves fail to open automatically at temperatures below −4°C when the deicing system is in operation, or (2) if it is desired to keep the valves open at temperatures above −4°C for anti-icing purposes, whether or not the deicing system is in operation.

Operating The System Manually:

1. Pneumatic Manifold Switches — OPEN.

2. GTU Augmentation — AS REQUIRED.

3. Manual Valve Selector Switch — AS DESIRED.

Position the manual valve selector for the valve to be operated.

Note

> To operate the valves in the proper outboard-to-inboard, right wing-to-left wing sequence, the selector switch should be turned clockwise starting with the No. 1 valve position and completing the cycle on the No. 12 valve position.

4. Wing Deicing Switch — MAN.

Hold the switch in the manual (MAN.) position. Do not exceed 2 minutes in any one position.

5. Wing Deice Switch — OFF.

6. Manual Valve Selector Switch — REPOSITION.

Select next section to be deiced.

CAUTION

> Do not rotate the manual valve selector switch while holding the wing deice switch in the MAN. position, to prevent burning of the switch contacts.

7. Repeat steps 4, 5, and 6 as required to effectively remove ice.

8. Parting Strip Valve Switch (if required) — PS MANUAL.

Place switch in PS MANUAL position if parting strip valves fail to operate or it is desired to keep them open when the deicing system is not in operation or operating at temperatures above −4°C.

To Turn System Off:

1. Parting Strip Valve Switch — OFF.

2. Wing Deice Switch — OFF.

3. Manual Valve Selector Switch — REPOSITION TO No. 1 VALVE.

4. GTU Augmentation — AS REQUIRED.

5. Pneumatic Manifold Switches — AS REQUIRED.

EMPENNAGE DEICING SYSTEM.

The empennage is deiced by pneumatically inflated boots on the leading edges of the horizontal and vertical stabilizers. Ice is allowed to accrete and then is mechanically loosened by cyclic inflation of the rubber boots. Aerodynamic forces effect the removal of the ice cap. The temperature of the engine bleed air used to operate the boots is lowered by cooling fins on the ducts leading to the boots. This system is energized when the empennage deicing switch is positioned to ON. It requires 60 seconds for a complete cycle of the system. Of the 60 seconds, only 48 seconds are required to complete the deicing cycle. Therefore, there are 12 seconds during the cycle when the boots are not actuated.

CAUTION

> The empennage deicing boots may be damaged if they are operated at a temperature of −43°C or below.

Empennage Deicing Switch.

A 2-position empennage deicing switch *(15, figure 4-2)*, placarded ON and OFF, is located on the wing and empennage deicing control panel on the flight engineer's instrument panel. When the switch is placed in the ON position, a 28-volt d-c circuit is completed which opens a pressure regulating shutoff valve and energizes an electrical distribution control. The distribution control, in turn, actuates six distribution valves in sequence to admit manifold bleed air under pressure for operation of the empennage deicing boots.

Note

> Approximately 60 seconds may elapse after the empennage deicing switch is turned ON before empennage deicing begins its first full cycle.

Empennage Deicing Indicators.

Two empennage deicing indicators *(14, figure 4-2)*, placarded PRESS and SUCTION, are located on the wing and empennage deicing control panel and indicate when there is sufficient pressure and suction in the empennage deicing manifolds for operation of the empennage deicing boots. The suction indicator indicates ON when there is sufficient negative pressure in the suction manifold.

Note

> The empennage deicing indicators will not present normal indications until the empennage deicing system begins its first full cycle.

Note

> The suction indicator will indicate ON whenever the pneumatic manifold is pressurized, regardless of the position of the empennage deicing switch.

The pressure indicator indicates ON when the pressure in the empennage deice manifold is above 17 psi. This condition exists when there is pressure in the pneumatic manifold and the empennage deicing switch is ON. The pressure indicator will fluctuate momentarily toward the OFF position when a distribution valve opens and permits pressure to inflate the boots; however, proper operation of the empennage deicing system can be determined only by observation of the boots themselves.

EMPENNAGE DEICING SYSTEM — NORMAL OPERATION.

Normal operation of the empennage deicing system is accomplished when the pneumatic manifold switches are in the OPEN position and the empennage deicing switch is in the ON position. The empennage suction and pressure indicators will indicate ON when the system begins to cycle.

Note

> The empennage deicing system should be turned ON at the same time the wing deicing system is turned ON to prevent the buildup of ice from becoming great enough to prevent its removal by the boots.

WINDOW AND WINDSHIELD ANTI-ICING AND DEFOG SYSTEMS.

The front center windshields and the front side windshields are anti-iced and defogged electrically. The pilot's and copilot's sliding clearview windows and the navigator's sextant windows are defogged but not anti-iced electrically. The laminated glass panels are heated electrically by current which passes through a transparent electrical conductive coating applied to the glass. Energy is dissipated in the form of heat when current is passed through the conductive coating. This is due to the resistance of the coating. Power to the electrically heated panels is 115-volt, single-phase a-c, from the 115-volt a-c, nonessential, flight deck overhead bus, stepped up to the appropriate voltage for each panel by an autotransformer. The side cockpit windows are laminated, contoured plastic panels, located above, aft of, and below the sliding clearview windows. The side cockpit windows are not anti-iced, but are defogged by air ducted across the interior surfaces of the windows. The air is ducted to each window from a blower, which is powered by an integral 200-volt 3-phase a-c blower motor, powered from the 115-volt nonessential flight deck overhead bus, and located below the cockpit floor.

Windshield Anti-Ice Switches.

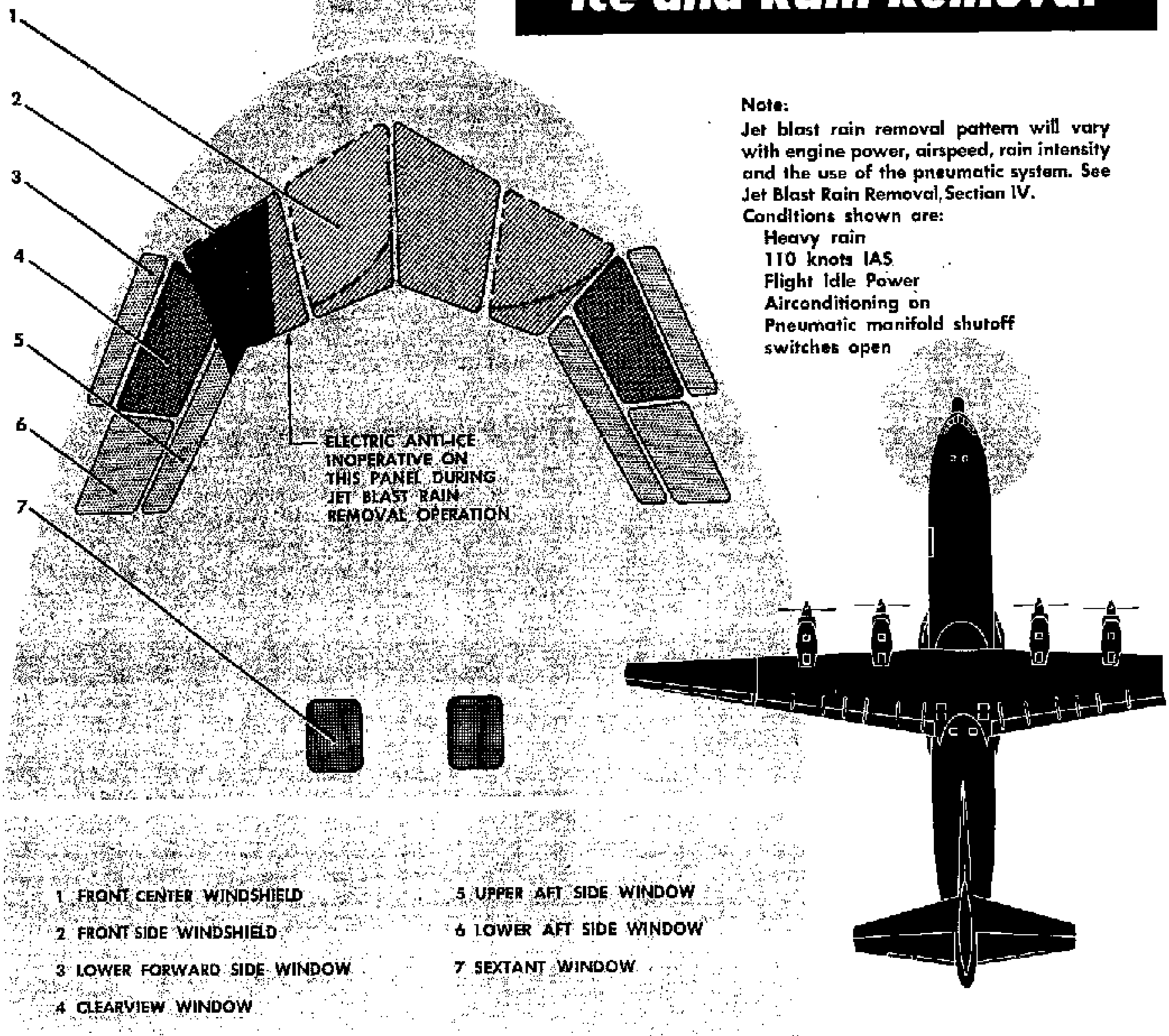
Two 3-position windshield anti-ice switches *(figure 4-8)* placarded WINDSHIELD ANTI-ICE are located on the pilot's overhead panel. The left switch is for the front side windshields and is placarded PILOT & COPILOT with the positions HIGH, OFF, and NORMAL. The NORMAL position completes a 28-volt d-c circuit to the relays and places the anti-icing and defogging system in operation. The HIGH position is for maximum heating. The OFF position deenergizes the system. The right switch is for the front center windshields and the pilot's and copilot's sliding clearview windows. The switch is placarded CLEARVIEW & FWD with the positions HIGH, OFF, and NORMAL. This switch selects the sliding clearview windows for defogging and the front center windshields for anti-icing and defogging. When the switch is positioned to HIGH, maximum heat is provided for the front center windshields. The sliding clearview windows remain at normal heat since no maximum heat circuit is provided for these windows.

Note

> The windshield anti-ice switches should be placed in NORMAL just before starting engines to provide sufficent preheating of the windshield to prevent the formation of frost or fog and to maintain the glass panels at maximum strength. The switches should remain in NORMAL for the duration of the flight. If severe icing conditions are encountered, the switches should be positioned to HIGH.

(See CAUTION on Page 4-23)

Windshield and Flight Deck Windows—Ice and Rain Removal



Note:
Jet blast rain removal pattern will vary with engine power, airspeed, rain intensity and the use of the pneumatic system. See Jet Blast Rain Removal, Section IV.
Conditions shown are:
Heavy rain
110 knots IAS
Flight Idle Power
Airconditioning on
Pneumatic manifold shutoff switches open

1 FRONT CENTER WINDSHIELD
2 FRONT SIDE WINDSHIELD
3 LOWER FORWARD SIDE WINDOW
4 CLEARVIEW WINDOW
5 UPPER AFT SIDE WINDOW
6 LOWER AFT SIDE WINDOW
7 SEXTANT WINDOW

▨ ELECTRIC ANTI-ICE
▓ ELECTRIC DE-FOG
░ AIR BLAST DE-FOG
■ JET BLAST RAIN REMOVAL PATTERN (PATTERN WILL VARY WITH CONDITIONS. SEE NOTE ABOVE)
☐ ELECTRIC WINDSHIELD WIPER CLEARED PATTERN

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Figure 4-7

Ice and Rain Protection Controls—Pilots' Station

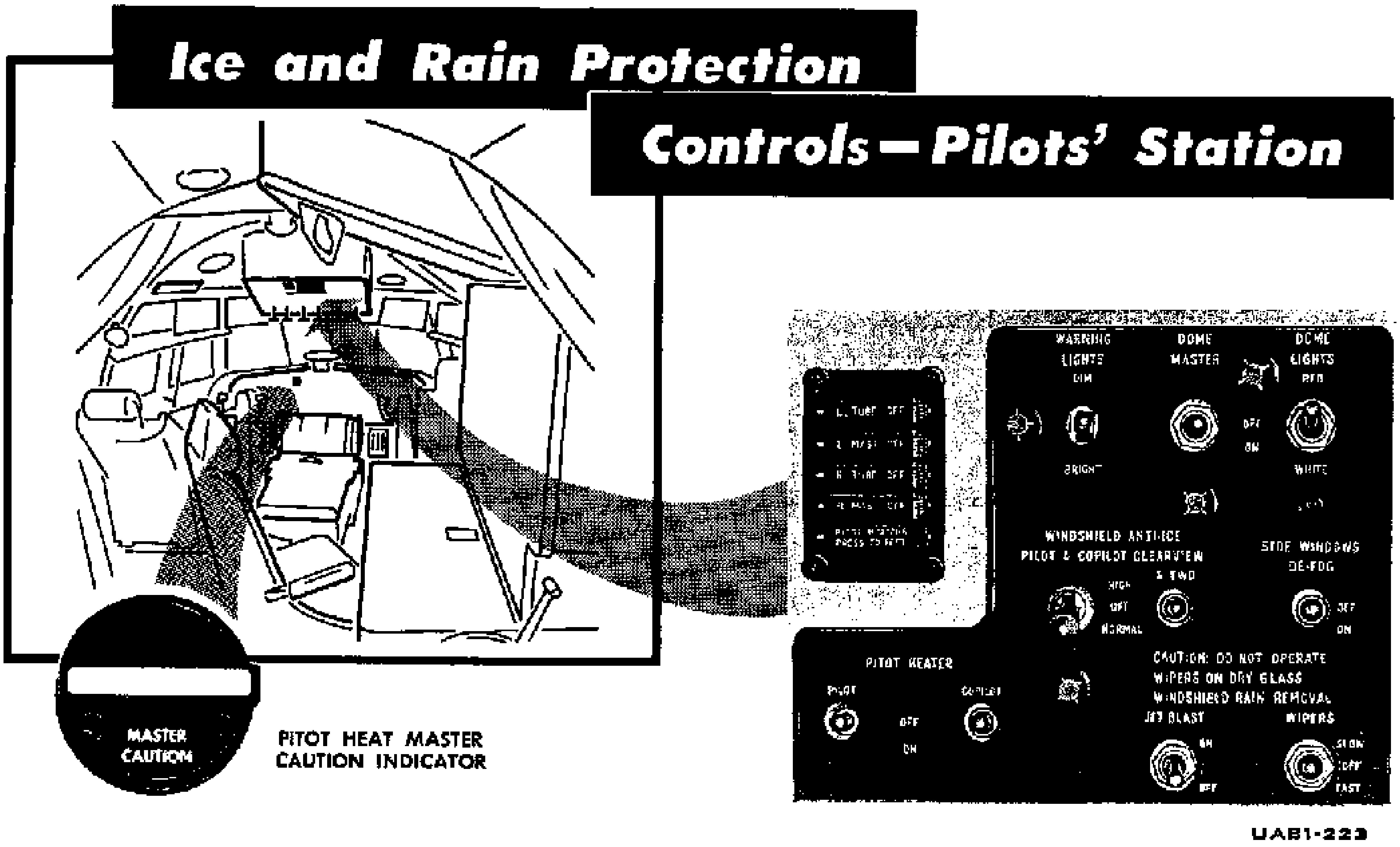


Figure 4-8

CAUTION

The NORMAL position provides sufficient heat to melt most ice. The HIGH position should be used only when the NORMAL position fails to melt the ice. To prevent cracking of the windshield, the switch must be placed in the NORMAL position before being placed in the HIGH position. Keep the switch in NORMAL for a reasonable length of time (approximately 5 minutes) to see if the ice or snow will melt, before placing it in HIGH. If it becomes necessary to use HIGH, return the switch to NORMAL when the ice or snow begins to melt.

Alternate Windshield Heat Sense Selection Switches (T.C.T.O. 589).

Three, 2-position, alternate windshield heat sense selection switches are installed on a panel placarded WINDSH HEAT SENSE SOURCE, located outboard of the pilot's station, at the lower aft corner of the side window. The switches are placarded FWD, SIDE and CLEAR WINDOW, with the placarded positions ALT and NORM. The switches provide a means of selecting an alternate heat sensing element in the event of failure of any of the sensing elements. With the switches in the NORM position, windshield heat will be sensed from the elements in the following windows: front center windshield — left side; front side windshield—right side; clearview window—left side. With the switches in the ALT position, windshield heat will be sensed from the respective windshield elements as follows: front center windshields — right side; front side windshields — left side; clearview window — right side.

Side Window Defog Switch.

A side window defog switch *(figure 4-8)* with the positions OFF and ON, is located on the pilots' overhead panel. When the switch is placed in the ON position, a circuit is completed to the 200-volt 3-phase a-c blower motor located below the cockpit floor, to provide air which is ducted to each set of side windows. The OFF position deenergizes the motor circuit.

Sextant Window Defog Switch.

A 2-position sextant window defog switch *(1, figure 4-14)* is located on the navigator's control panel to control the defogging of the sextant windows. The switch has the placarded positions ON and OFF. Placing the switch in the ON position completes a 115-volt single-phase a-c circuit, stepped up to the appropriate voltage by an autotransformer, to the heating elements of the windows for defogging. The OFF position deenergizes the circuit. Power for the defogging system is received from the 115-volt a-c nonessential, flight deck overhead bus.

WINDSHIELD ANTI-ICING SYSTEM OPERATION.

Normal Operation.

The windshield heater elements are placed in operation as follows:

1. Windshield Anti-Ice Switch — NORMAL.
2. Clearview and Forward Windshield Switch — NORMAL.
3. Alternate Windshield Heat Sense Selection Switches — NORM. **(Aircraft with T.C.T.O. 589).**

Emergency Operation.

If maximum heating is required, the following steps are taken.

1. Windshield Anti-Ice Switch — HIGH.
2. Clearview and Forward Windshield Switch — HIGH.

CAUTION

The switches must be placed in the NORMAL position before being placed in HIGH to prevent windshield cracking. Allow a reasonable time (approximately 5 minutes) in NORMAL to see if the ice or snow will melt before placing the switches in the HIGH position. Return the switches to NORMAL when the ice or snow begins to melt.

3. Alternate Windshield Heat Sense Selection Switches—AS REQUIRED **(Aircraft with T.C.T.O. 589).**

If a crack or defect (delamination, oil ring, apparent separation of panes, etc.) occurs in the pane of the left front center, the right front side windshield, or the left clearview window, place the switch for the respective set of windows in the ALT position. If malfunction of a heat sensing element is indicated by overheating or inadequate anti-icing of any pair of windows, place the selection switch for that pair of windows in the ALT position.

To Turn System Off.

1. Windshield Anti-Ice Switch — OFF.
2. Clearview and Forward Windshield Switch — OFF.

SIDE WINDOW DEFOG SYSTEM OPERATION.

To defog the side windows, position the side window defog switch to ON.

NAVIGATOR'S SEXTANT WINDOW DEFOG SYSTEM OPERATION.

The navigator's sextant window defogging system is placed in operation by positioning the sextant window defogging switch to ON.

PITOT HEATER SYSTEM.

The pitot head and mast of both the left and the right pitot installations are equipped with heaters. The pitot heads are heated by an integral heating element. The masts are heated by an element inside the leading edge of the mast. The power source for the pitot heads is the 115-volt a-c essential bus, and the power source for the pitot mast is the 115-volt a-c nonessential bus.

Pitot Heater Switches.

Two 2-position pitot heater switches *(figure 4-8)*, placarded ON and OFF, are located on the pilot's overhead panel. Each switch controls the heating elements (pitot mast and pitot head) for its respective pitot assembly, one on each side of the aircraft. The switches are connected to the 115-volt a-c essential bus for operation of the pitot heaters, and are connected to the 115-volt a-c nonessential bus for operation of the pitot mast heaters.

CAUTION

Do not operate the heaters for extended periods on the ground as the lack of cooling airstream will result in damage to the pitot heads and masts.

Pitot Heater Annunciator Panel.

The pitot heater annunciator panel *(figure 4-8)*, consists of four 28-volt d-c back-lighted annunciator strips, and a PRESS-TO-TEST switch, powered from the 28-volt d-c essential flight deck right hand auxiliary bus. The annunciator strips and master caution indicator are wired through the light dimming control switch located on the flight engineer's panel. When the PITOT-HEATERS — PRESS-TO-TEST switch is pressed, all annunciator strips and the master caution indicator will come on to indicate that the circuits and lights are functioning. When the pitot heater switches have been placed in the ON position and any of the heaters are off, the lights behind the annunciator strips will come on and remain on to indicate any of the following conditions.

1. Left pitot heaters.
   L TUBE OFF
   L MAST OFF
2. Right pitot heaters.
   R TUBE OFF
   R MAST OFF

Each of the annunciator strips have a press-to-reset switch to enable the master caution indicator light to be turned off after a malfunction occurs to warn of a subsequent malfunction.

Pitot Heater System Master Caution Indicator.

The 28-volt d-c pitot heater system master caution indicator *(figure 4-8)* is located on the left side of the pilots' instrument panel. The master caution indicator will come on if any heater in the system is off when the heater switches are in the ON position. The specific heater which is inoperative will be indicated on the annunciator panel. The annunciator panel PITOT HEATERS — PRESS-TO-TEST switch, when pressed, will cause all the annunciator strips and the master caution indicator to come on. Dimming of these lights is controlled by the flight engineer's light dimming control switch.

To reset the master caution indicator after a malfunction so that subsequent malfunctions will be noted, press the annunciator strip for the affected heater. The master caution indicator light will go off and remain off until another malfunction occurs. However, the annunciator strip light for the affected heater will remain on until the defective heater circuit is repaired.

PROPELLER DEICING SYSTEM.

The propellers and propeller spinners are deiced by means of external heating elements cemented to the leading edges of the blades and blade cuff assemblies and by a combination of cemented blankets and heating units on the inner surface of the propeller spinner components. The system is electrically powered from the 200-volt a-c essential center fuselage bus, and controlled by switches at the flight engineer's station.

The cycling sequence of the four propellers is controlled by an electrical timer powered from the 28-volt d-c nonessential flight deck overhead bus, and mounted behind the flight engineer's station which applies power to each propeller for a period of 30 seconds in each 120-second period. This permits accretion of ice on the propeller, after which the ice is loosened by heat and then removed by centrifugal forces without permitting runback ice to form on the blades or spinner.

Propeller Deicing Control Switches.

Four 2-position, propeller deicing control switches *(figure 4-6)*, placarded ON and OFF, are located on the flight engineer's instrument panel. Placing the switches in the ON position completes the 28-volt d-c circuits to a timer which closes relays to supply 200-volt a-c power to the heating elements in each propeller for a period of 30 seconds in each 120-second period to deice the propellers. When the switches are in the OFF position, the circuits are deenergized.

Propeller Deicing Ammeters.

Three propeller deicing ammeters *(18, figure 4-2)* are located on the flight engineer's instrument panel and indicate the ampere load of the heating elements for the aft spinner, forward spinner, and the blades and cuffs of the propeller being deiced, as indicated by the propeller deicing indicators.

Propeller Deicing Indicators.

Two 28-volt d-c propeller deicing indicators *(17, figure 4-2)*, one for each two propellers, are located on the flight engineer's instrument panel. When the propeller deicing system is turned on, numbers will appear in the indicators, indicating which propellers are being deiced. Deicing of the propellers may begin with any propeller, depending upon which propeller was being deiced when the system was last turned off. Halfway through each deicing cycle, an OFF indication may momentarily appear on the indicator. If one or more of the numbers fail to appear on the indicator during operation, a malfunction of the propeller deicing system is indicated.

PROPELLER DEICING SYSTEM OPERATION.

CAUTION

> The propeller deicing system should not be energized when the engines are not operating. During ground operation of the system, with engines running, each complete propeller deicing cycle should be followed by a 5-minute cooling period.

1. Propeller Deicing Control Switches — ON.
2. Propeller Deicing Ammeters—Check for proper amperage.
3. Propeller Deicing Indicators — Check for proper operation and indication.

Propeller Deicing Test — Ground.

1. All Propeller Deicing Control Switches — ON.
2. Propeller Deicing Indicators — Check for proper operation and indication.
3. Propeller Deicing Ammeters — Check for proper amperage.

CAUTION

> After a current value is read for each successive propeller, the deicing control switch for the respective propeller indicated by the deicing indicator, must be placed in the OFF position, to avoid possible damage to either the blade heating element, spinner heating element, or both.

4. Respective Propeller Deice Switch — OFF.
5. When ammeters again indicate a load, repeat steps 2, 3, and 4.

CAUTION

> If the amperage indicated on any one of the three propeller deicing ammeters is not within the normal operating range at any time during operation of the propeller deicing system, a malfunction of that particular propeller deicing circuit is indicated.

COMMUNICATION AND ELECTRONIC EQUIPMENT.

(See figures 4-9 through 4-15.)

INTERPHONE SYSTEM (AN/AIC-10A).

A 28-volt d-c, transistorized interphone system (AN/AIC-10A) is installed, which in addition to providing speech communication facilities between crew members within the aircraft, permits the transmission and reception of communications beyond the aircraft by integration with various radio equipment. Interphone control panels located on the pilots' control pedestal permit the pilot and the copilot to use the VHF and UHF command communication systems, the LIA 1 and LIA 2 liaison radios, VHF navigation equipment, the automatic radio compasses (ADF 1 and ADF 2), marker beacon equipment, and the public address system. An interphone control panel located at the navigator's station, permits the navigator to use all of these facilities, with the exception of the public address system. Interphone control panels located at the flight engineer's station and in the relief crew compartment, enable personnel at these locations to use the VHF and UHF command communication systems, and the LIA 1 and LIA 2 liaison radios. To facilitate maintenance and cargo handling, interphone control panels which limit the user to communications within the aircraft are also provided in the cabin near the side and rear cargo doors, in the nosewheel well, and in each of the pods. The interphone system is powered from the flight deck 28-volt d-c essential radio bus.

Interphone Control Panels.

Ten interphone control panels are installed in the aircraft to permit selection and control of communication facilities. The pilot's and copilot's control panels *(5 and 20, figure 4-12)* are located on the control pedestal. The flight engineer's control panel *(44, figure 1-13)* is located on the flight engineer's instrument panel. The navigator's interphone control panel *(7, figure 4-14)* is located on the navigator's control panel. The relief crew control panel *(7, figure 4-10)* is located on the forward bulkhead of the relief crew compartment, left of the flight deck doorway. The interphone control panels installed at each of these crew stations, permit transmission and reception of interphone communications within the aircraft as well as transmission and reception of communications beyond the aircraft. Five additional interphone control panels which permit communication only within the aircraft, are located in the nosewheel well *(45. figure 4-10)*, in the left and right pods *(32, figure 4-10)*, at the side cargo door *(38, figure 4-10)*, and at the rear cargo doors *(29, figure 4-10)*.

Interphone Control Panel Switches.

Each of the crew station interphone control panels is equipped with a 6-position, rotary, function selector switch, a volume control, a 2-position NORMAL — AUX LISTEN switch, and five 2-position radio selector switches. Both the function selector switch and the radio selector switches have positions placarded INPH, UHF COM, LIA 1, LIA 2 and VHF COM. The function selector switch has one additional position, placarded CALL. The function selector switch permits selection of the facility upon which transmission is to be made. Placing the function selector switch in the CALL position will override reception of all other communications at each of the other interphone control panels, permitting the transmission of urgent communications to each station, regardless of the switch positions at those stations.

The five radio selector switches permit selection of the facility upon which reception is desired. With the NORMAL — AUX LISTEN switch in the NORMAL position, all communications from the facilities selected by the radio selector switches will be heard simultaneously, regardless of the position of the function selector switch.

The AUX LISTEN position of the NORMAL — AUX LISTEN switch is used only in the event the interphone amplifier fails at a particular interphone station. In the AUX LISTEN position, only communications from the facility selected by the radio selector switch farthest to the left on the panel will be heard. For example, if both INPH and VHF COM have been selected by the radio selector switches, placing the NORMAL — AUX LISTEN switch in the AUX LISTEN position will permit only the interphone communication to be heard. If none of the facilities have been selected by the radio selector switches, priority then passes to the interphone control mixer switches, and only communications from the facility selected by the mixer switch farthest to the left on the panel will be heard.

Each of the five interphone control panels located in the nosewheel well, left and right pods, and at the side cargo door and rear cargo doors is equipped with a volume control, a rotary CALL switch, and a 2-position NORMAL — AUX LISTEN switch. A receptacle for a microphone and a headset is installed adjacent to each control panel. Actuating the CALL switch will interrupt any communication being received at any of the other interphone stations, to permit the transmission of urgent messages. With the NORMAL — AUX LISTEN switch in the NORMAL position, all communications being transmitted through the interphone system may be received. When the switch is placed in the AUX LISTEN position, only communications from the facility selected by the radio selector

Table of Radio, Communication and Navigation Equipment

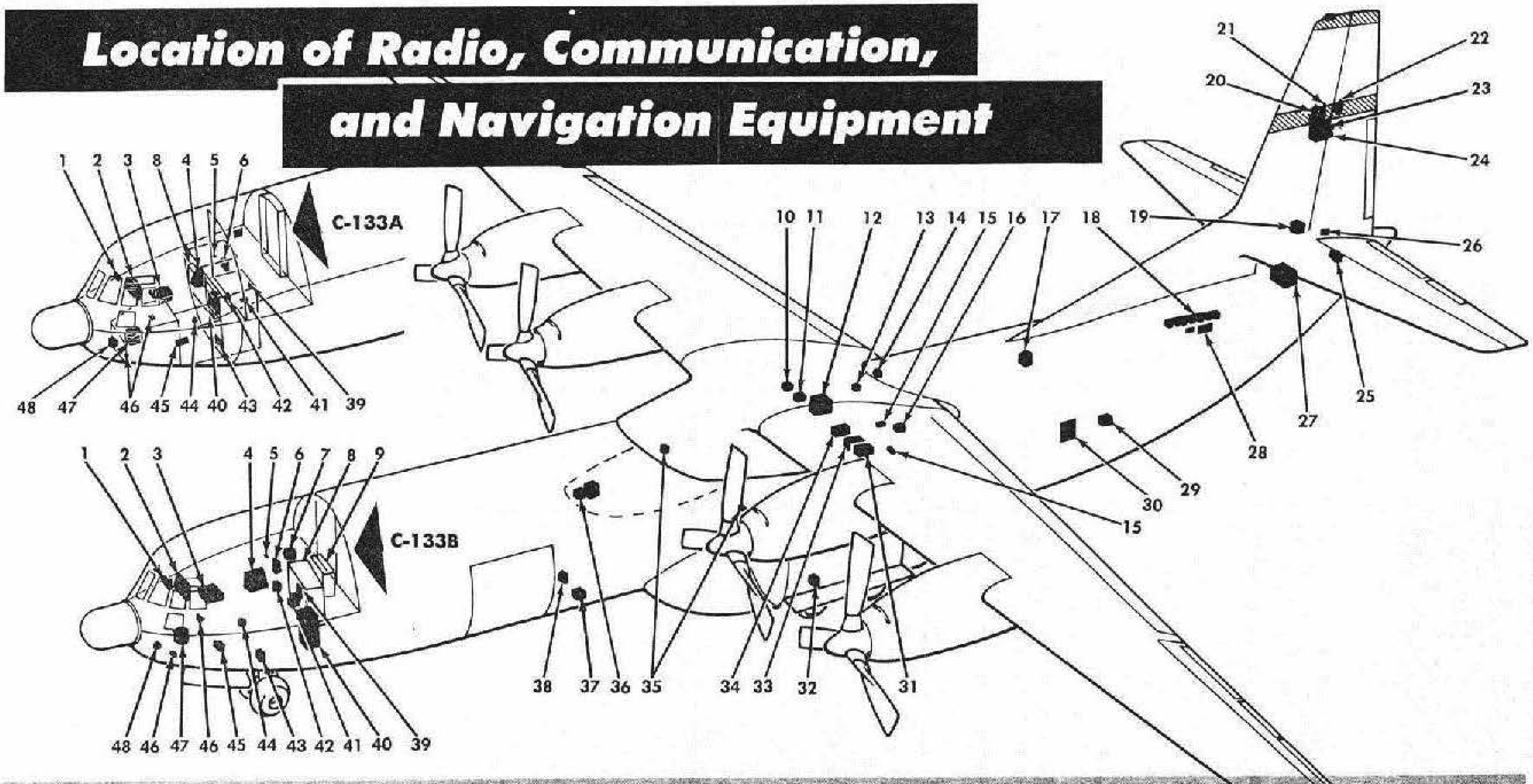
TYPE	DESIGNATION	USE	OPERATOR	RANGE	LOCATION OF CONTROLS
Remote Indicating Compass	N-1	Heading Indication, Directional Reference	Pilot Copilot Navigator		Navigator's Station
UHF Command	AN/ARC-34	2-Way Voice Communication	Pilot Copilot	Limited by Line of Sight Only	Control Pedestal
Liaison (2) HF Command	Collins 618S-1	Long Range 2-Way Voice Communication and Code Reception	Pilot Copilot	To 2000 Miles	Control Pedestal
Radio Compass (2)	AN/ARN-6	Reception of Voice or Code Communications; Position Finding, Homing	Pilot Copilot Navigator	To 200 Miles	Control Pedestal and Navigator's Station
Marker Beacon	AN/ARN-32	Reception of Location Signals from Instrument Approach Stations	Pilot Copilot	To 10,000 Feet Altitude	Sensitivity Control Pedestal
Emergency Transmitter	AN/CRT-3	Emergency Sea Rescue		100 Miles Low Frequency; 1000 Miles High Freq.	Stowed in Flight Crew Liferaft
VHF Command	★Collins VHF-101	2-Way Voice Communication	Pilot Copilot	Limited by Line of Sight Only	Control Pedestal
Interphone	AN/AIC-10A	Intercrew Communication and Radio Transmission	All Crew Members		Control Panel at Each Crew Member's Station
Tactical Air Navigation System (TACAN)	AN/ARN-21	Navigational Aid	Pilot Copilot	Line of Sight to Maximum of 195 Miles	Control Pedestal
Long Range Navigation (LORAN)	AN/APN-70	Reception of Radio Navigation Signals	Navigator	700 Miles Day; 450-1400 Miles Night	Navigator's Station
Glide Slope Receiver	AN/ARN-31	Reception of Glide Slope Signals on Indicator	Pilot Copilot		Control Pedestal (ARN-14 Controls)
VHF Omni Range Receiver	AN/ARN-14	Reception of VOR and Localizer Signals	Pilot Copilot	To 180 Miles (Line of Sight)	Control Pedestal
Public Address System	AN/AIC-13	1-Way Voice Communication	Pilot Copilot	Within the Aircraft, and Servicing Personnel	Control Pedestal
Search Radar	AN/APN-59	Navigational Aid (Search Radar)	Navigator	Line of Sight (To 200 Miles)	Navigator's Station
Homing Adapter	AN/ARA-25	Position Finding, Homing on UHF Frequencies	Pilot Copilot	Limited by Line of Sight Only	Control Pedestal
IFF	★★AN/APX-25	Identification	Pilot (C-133B) Navigator (C-133A)	Limited by line of sight only	Control Pedestal (C-133B) Navigator's Station (C-133A)
Radio Altimeter	SCR-718	High Altitude Altimeter	Navigator	0 to 50,000 Feet	Navigator's Station
Radar Altimeter	APN-22	Low Altitude Altimeter	Pilot	0 to 20,000 Feet Over Water 0 to 10,000 Feet Over Land	Pilot's Instrument Panel

★—AN/ARC-49 on aircraft with T.C.T.O. 756 not complied with
★★—Installed at navigator's station on C-133A and on control pedestal on C-133B

UAB1-224

Figure 4-9

Location of Radio, Communication, and Navigation Equipment



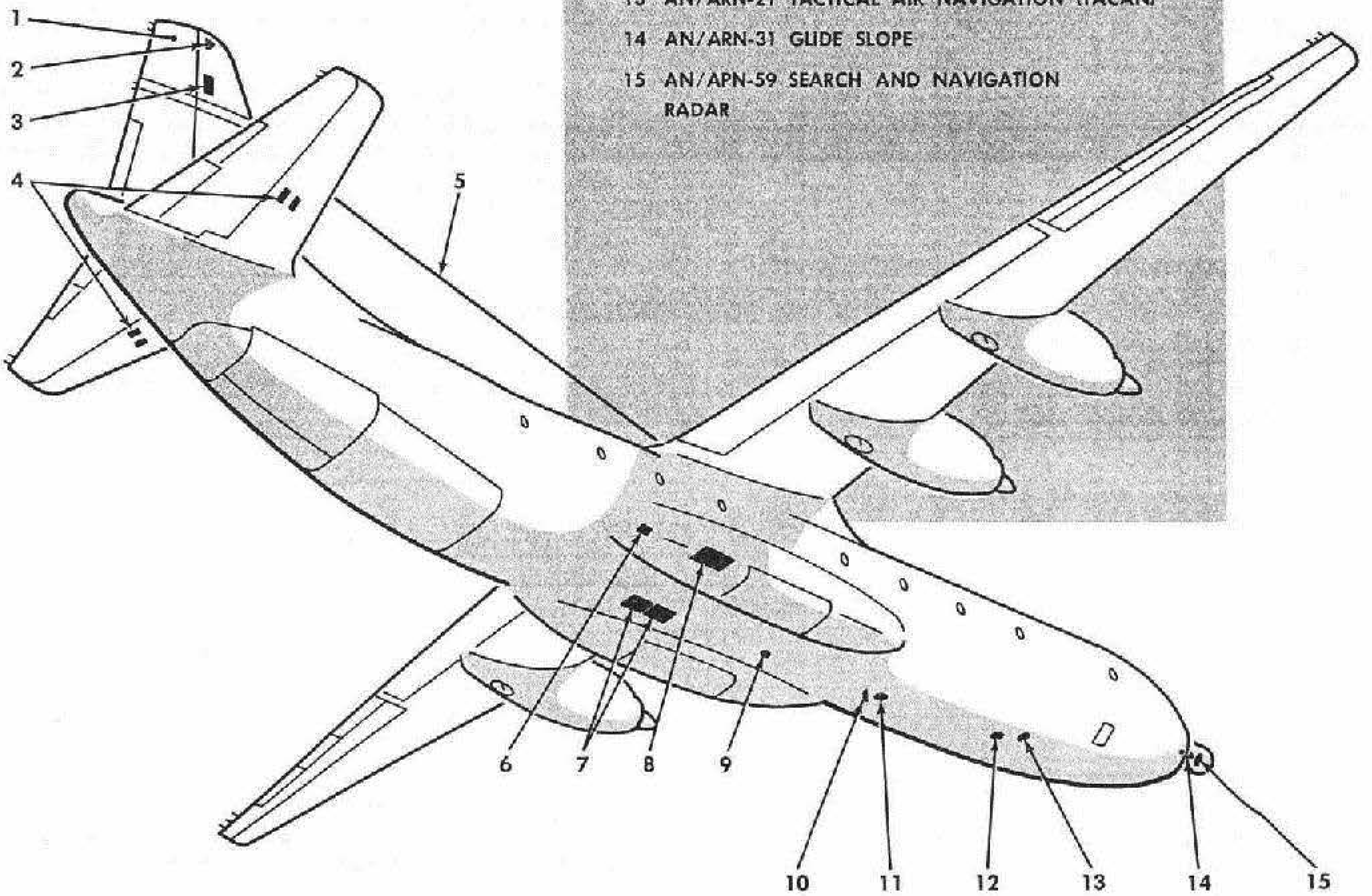
1. PILOT'S NAVIGATION-SEARCH RADAR
2. PILOT'S RADIO INSTRUMENTS
3. RADIO CONTROL PEDESTAL
4. NAVIGATOR'S RADIO CONTROL PANEL
5. RADIO TEST RECEPTACLE
6. NAVIGATOR'S RADIO AND RADAR INSTRUMENTS
7. INTERPHONE INSTALLATION — RELIEF CREW COMP.
8. FORWARD ELECTRONIC RACK
9. STATION 186 ELECTRONIC RACK (C-133B)
10. AUTOPILOT THREE-AXIS RATE CONTROL
11. AUTOPILOT ROLL AND PITCH CONTROL
12. LIAISON NO. 2 LONG WIRE ANTENNA TUNER
13. ELEVATOR TRIM TAB SERVO
14. AILERON SERVO
15. RADIO PRESSURE DISCONNECT — RIGHT POD — AFT (2)
16. RADAR ALTIMETER RECEIVER-TRANSMITTER
17. SPEAKER INSTALLATION — CABIN
18. RADIO PRESSURE DISCONNECT
19. RUDDER SERVO
20. ISOLATION UNIT — VHF RADIO
21. ISOLATION UNIT — OMNI NAV
22. LIAISON NO. 1 ANTENNA LIGHTNING ARRESTERS
23. LORAN ANTENNA COUPLER
24. LIAISON NO. 1 ANTENNA COUPLER
25. ELEVATOR SERVO
26. N-1 COMPASS TRANSMITTER DT-173 AJN
27. RADIO ALTIMETER RECEIVER-TRANSMITTER SCR 718
28. ELECTRONIC EQUIPMENT RACK (C-133A)
29. INTERPHONE INSTALLATION — REAR CARGO DOOR
30. ELECTRONIC EQUIPMENT RACK (C-133A)
31. RADIO COMPASS RECEIVER NO. 1 AND TUNING DRIVE (RIGHT POD)
32. INTERPHONE INSTALLATION (LEFT POD SHOWN, RIGHT TYPICAL)
33. RADIO COMPASS RECEIVER NO. 2 AND TUNING DRIVE (RIGHT POD)
34. RADAR ALTIMETER ELECTRONIC CONTROL AMPLIFIER (RIGHT POD)
35. RADIO PRESSURE DISCONNECTS — FWD PODS
36. IFF (APX-25) RECEIVER-TRANSMITTER AND TRANSPONDER INSTALLATION
37. UHF/DF DIRECTION FINDER RELAY
38. INTERPHONE INSTALLATION — SIDE CARGO DOOR
39. RADAR PRESSURIZATION SYSTEM DEHYDRATOR
40. FORWARD RADIO JUNCTION BOX
41. RADAR PRESSURIZATION SYSTEM AIR COMPRESSOR
42. N-1 COMPASS DIRECTIONAL GYRO
43. SPEAKER INSTALLATION — NOSEWHEEL WELL
44. PILOT'S NAVIGATION-SEARCH RADAR INDICATOR POWER SUPPLY
45. INTERPHONE INSTALLATION — NOSEWHEEL WELL
46. NAVIGATION-SEARCH RADAR BLOWER (2)
47. NAVIGATION-SEARCH RADAR RECEIVER-TRANSMITTER
48. RADAR PRESSURIZATION SYSTEM PRESSURE SWITCH

Figure 4-10

UAB1-249

Radio and Radar Antennas

1 AN/APN-70 LONG RANGE NAVIGATION (LORAN) AND 618S-1 LIAISON #1
2 VHF COMMAND — AN/ARC-49 OR VHF-101 (T.C.T.O. 756)
3 AN/ARN-14 VHF OMNI-RANGE
4 SCR-718 RADIO ALTIMETER
5 618S-1 LIAISON #2 (LONG WIRE)
6 AN/APN-22 RADAR ALTIMETER
7 AN/ARN-6 RADIO COMPASS
8 AN/APN-105 DOPPLER NAVIGATOR (SPACE ONLY)
9 AN/ARA-25 DIRECTION FINDER GROUP
10 AN/ARC-34 UHF COMMAND
11 AN/APX-25 IFF
12 AN/ARN-32 MARKER BEACON
13 AN/ARN-21 TACTICAL AIR NAVIGATION (TACAN)
14 AN/ARN-31 GLIDE SLOPE
15 AN/APN-59 SEARCH AND NAVIGATION RADAR



UAB1-250

Figure 4-11

switch farthest to the left on any of the interphone control panels may be heard.

Interphone Control Mixer Switch Panels.

Three interphone control mixer switch panels, containing switches which permit integration of the interphone with the navigation and communication systems, are installed in the aircraft. The pilot's and copilot's mixer switch panels *(1 and 4, figure 4-12)* are located on the control pedestal. The navigator's mixer switch panel *(8, figure 4-14)* is located on the navigator's control panel.

Interphone Control Mixer Switches.

Each mixer switch panel is equipped with five 2-position switches. Only four of the switches are used, and these are placarded ADF 1, ADF 2, MARKER, and TAC/VOR. Placing any of these switches in the ON position (up) will allow audio signals from the selected facility to be received at the respective interphone station, providing the facility selected is tuned and operating and the NORMAL — AUX LISTEN switch is in the NORMAL position. If the NORMAL — AUX LISTEN switch is in the AUX LISTEN position, only the audio signal from the facility selected by the mixer switch farthest to the left on the panel will be heard, and then only if all of the radio selector switches on the interphone control panel are in the OFF position (down).

Interphone Operation.

To Place Equipment In Operation:

1. Aircraft Power Supply — ON.

2. Interphone Circuit Breakers — CLOSED.

The interphone system equipment is ready for use when the aircraft power supply is on and the interphone circuit breakers are closed.

Normal Transmission:

1. Function Selector Switch — AS DESIRED.

2. Microphone Button — DEPRESS.

To transmit, under normal conditions, position the function selector switch to the mode of transmission desired, and depress the microphone button while transmitting.

Normal Reception:

1. Radio Selector Switches — AS DESIRED.

2. NORMAL—AUX LISTEN Switch—NORMAL.

3. Volume Control — AS DESIRED.

4. Interphone Control Mixer Switches — AS DESIRED.

To receive, under normal conditions, position the radio selector switches to the facility desired, place the NORMAL — AUX LISTEN switch in the NORMAL position, and adjust the volume control as desired. Signals from all facilities selected by the radio selector switches will be received simultaneously. If facilities have been selected by the mixer switches, signals will be received from these sources simultaneously with those selected by the radio selector switches.

Emergency Transmission:

1. Function Selector Switch — CALL.

2. Microphone Button — DEPRESS.

To transmit urgent messages, place the function selector switch in the CALL position and depress the microphone button. This will override reception of all other communications at each of the other interphone stations, regardless of the position of the interphone control panel switches at those stations.

Emergency Reception:

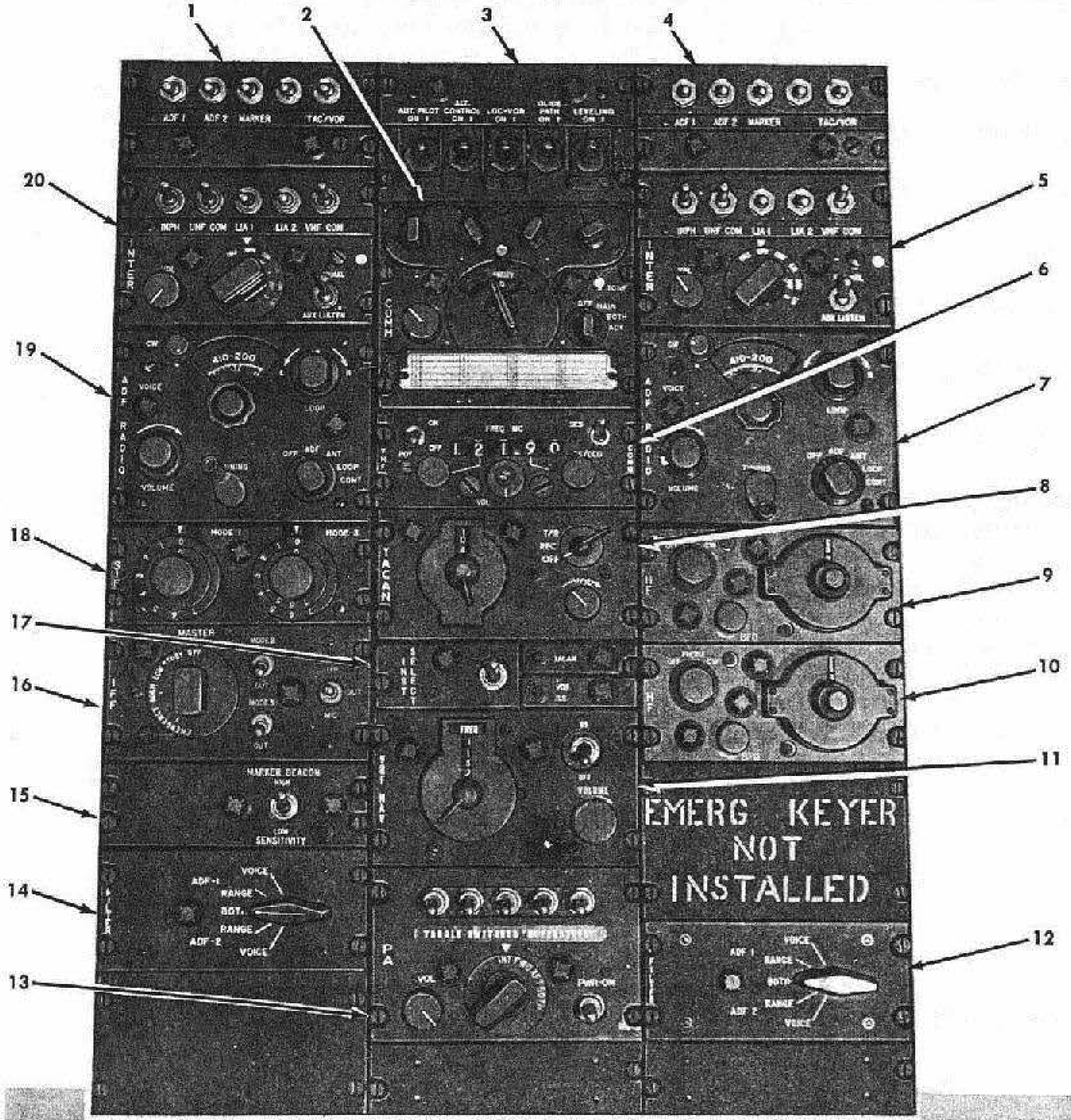
1. NORMAL — AUX LISTEN Switch — AUX LISTEN.

2. Radio Selector Switches — AS DESIRED.

3. Interphone Control Mixer Switches — AS DESIRED.

In the event of failure of the interphone amplifier at a particular interphone station, reception at that station may be obtained by placing the NORMAL — AUX LISTEN switch in the AUX LISTEN position. During this mode of operation, only communications from the facility selected by the radio selector switch farthest to the left on the interphone control panel will be received. If reception is desired from facilities selected by the interphone control mixer switches, place all radio selector switches in the off position (down). Communications will now be received only from the facility selected by the mixer switch farthest left on the interphone control mixer switch panel.

Communication and Navigation Equipment — Control Pedestal



1. PILOT'S INTERPHONE CONTROL MIXER SWITCHES
2. UHF COMMAND CONTROL PANEL
3. AUTOPILOT FUNCTION SELECTOR PANEL
4. COPILOT'S INTERPHONE CONTROL MIXER SWITCHES
5. COPILOT'S INTERPHONE CONTROL PANEL
6. VHF COMMAND CONTROL PANEL (AN/ARC-49 — VHF-101 WITH T.C.T.O. 756 COMPLIED WITH)
7. RADIO COMPASS (ADF) NO. 2 CONTROL PANEL
8. TACAN CONTROL PANEL
9. HF LIAISON NO. 1 CONTROL PANEL
10. HF LIAISON NO. 2 CONTROL PANEL
11. VHF NAVIGATION CONTROL PANEL
12. COPILOT'S RADIO COMPASS FILTER
13. PA SYSTEM CONTROL PANEL
14. PILOT'S RADIO COMPASS CONTROL PANEL
15. MARKER BEACON SENSITIVITY SWITCH
16. IFF CONTROL PANEL (C-133B, LOCATED ON NAVIGATOR'S PANEL ON C-133A)
17. VOR-ILS/TACAN SELECTOR SWITCH PANEL
18. SIF CONTROL PANEL (C-133B)
19. RADIO COMPASS (ADF) NO. 1 CONTROL PANEL
20. PILOT'S INTERPHONE CONTROL PANEL

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Figure 4-12

Note

The AUX LISTEN position of the NORMAL — AUX LISTEN switch is used only in the event of failure of the interphone amplifier at a particular interphone station.

To Turn Equipment Off — Normal:

1. Interphone Control Mixer Switches — OFF.
2. Radio Selector Switches — OFF.
3. Aircraft Power Supply — OFF.

To Turn Equipment Off — Emergency:

1. Interphone Circuit Breakers — OPEN.

PUBLIC ADDRESS SYSTEM (AIC-13).

A 28-volt d-c public address system (AIC-13) consisting of a speaker located in the nosewheel well and another speaker located in the aft fuselage near the rear cargo doors, is operated from the public address system control panel *(13, figure 4-12)* on the pilots' control pedestal. The public address system makes possible one-way communication from within the aircraft to servicing personnel inside or outside of the aircraft when the aircraft is on the ground and the engines are inoperative.

To Place Equipment In Operation:

1. Aircraft Power Supply — ON.
2. PA Switch — STBY (allow the equipment to warm up).
3. PA Speaker Selector Switch — LS.
4. Function Selector Switch — INPH.

To Turn Equipment Off:

1. PA Switch — OFF.

Note

All interphone control panels with the exception of the navigator's, are connected to the PA system when the PA switch is in the LS position.

LIAISON RADIOS (618S-1).

The Collins 618S-1 liaison equipment consists of two transceivers, associated power supplies, and antenna couplers. Only one system can transmit at a time; however, LIA 1, LIA 2, and LORAN can receive simultaneously. Each liaison transceiver has its own antenna and antenna coupler, the LIA 2 antenna being a wire antenna running from the center section of the wing to the vertical stabilizer. The coupler for this antenna is located in the upper section of the fuselage at the forward end of the antenna. The LIA 1 and LIA 2 control panels are located on the control pedestal *(9 and 10, figure 4-12)*. Either of the systems can be monitored from any of the flight deck interphone stations by operating the respective mixer switch and/or by rotating the microphone selector switch. To maintain radio security, the transmitter and antenna coupler sections of the liaison system do not tune or load until the microphone switch or key has been depressed momentarily. A 400-cycle tone will be heard in the headset and a red light on the control panel will come on until the respective system has completed tuning and is ready to transmit. The presence of sidetone also indicates transmission readiness.

Operating Either Radio:

1. Aircraft Power Supply — ON.

CAUTION

Allow transmitter to warm-up for a minimum of 10 minutes prior to use, to prevent damage to the transmitter.

2. Function Selector (desired radio control panel) — PHONE.
3. Interphone Selector Switch — ON (up).

Adjust the receiver volume.

4. To Transmit, Interphone Function Selector Switch — LIA 1 or LIA 2.

CAUTION

Do not attempt to transmit with the red light on as damage to the equipment may result.

5. Microphone Button — Depress.

Wait until the headset tone and the red light are off before speaking.

To Turn Either Radio Off:

1. Interphone Function Selector Switch (LIA 1 or LIA 2) — OFF.

PORTABLE EMERGENCY RADIO TRANSMITTER (AN/CRT-3).

Provisions are made for stowage of a portable radio transmitter in the crew liferaft. The radio is automatically ejected with the raft (see Emergency Equipment, Section III).

VHF COMMAND TRANSMITTER-RECEIVER

VHF-101 — (AIRCRAFT WITH T.C.T.O. 756).

The Collins VHF-101 command communications system is used for short range, line-of-sight, 2-way radio voice communications in the frequency range of 116.00 to 149.95 megacycles. The transmitter operates in increments of 50 kilocycles. There are 680 crystal-controlled channels available for selection by the control unit, located on the pilots' control pedestal. Frequency selection may be either single or double channel simplex. This function is controlled by a 2-position switch on the VHF command control panel *(6, figure 4-12)*, placarded SCS and DCS/DCD. When this switch is placed in the SCS (single channel simplex) position, all transmitting and receiving will be accomplished on the selected frequency. When double channel simplex (DCS) operation is desired (transmitting channel six megacycles higher than selected receiving channel), place the switch in the DCS/DCD position. Provision for this mode of operation is available between 124.00 and 126.95 megacycles. Output power of the VHF-101 system transmitter is approximately 30 watts.

Placing Equipment In Operation:

1. Aircraft Power Supply — ON.

2. Mixer (toggle) Switch (interphone control panel) — INTER.

3. VHF Power Switch — ON.

4. Interphone Function Selector Switch — COM VHF.

5. Frequency Selector Knobs — DESIRED FREQUENCY.

Rotate the megacycle and 50 kilocycle selector knobs until the desired frequency appears in the frequency indicator window.

6. SCS-DCS/DCD Switch — AS DESIRED.

7. Volume Control — AS DESIRED.

8. Squelch Control — AS DESIRED.

Note

> No transmissions should be made on emergency channels except for emergency purposes.

To Turn Equipment Off:

1. VHF Power Switch — OFF.

AN/ARC-49.

On aircraft without T.C.T.O. 756, the AN/ARC-49 command communication system *(6, figure 4-12)* is installed to provide short-range, 2-way communication with other aircraft or ground stations.

Placing Equipment In Operation:

1. Aircraft Power Supply — ON.

2. Mixer (toggle) Switch (interphone control panel) — INTER.

3. VHF Power Switch — ON.

4. Interphone Function Selector Switch — COM VHF.

5. Channel Selector Switches — DESIRED CHANNEL.

Rotate the two channel selector switches on the VHF control panel to the desired channel (A1 through D12), and allow approximately 30 seconds for the radio to warm up. When the audio tone heard in the headset stops, the radio is ready for operation.

6. Volume Control — AS DESIRED.

To Turn Equipment Off:

1. VHF Power Switch — OFF.

UHF COMMAND TRANSMITTER-RECEIVER (AN/ARC-34).

The AN/ARC-34 equipment is operated from the UHF command control panel *(2, figure 4-12)* located on the control pedestal, and is powered from the 28-volt d-c essential navigator's bus. This equipment provides short-range, line-of-sight, 2-way voice, and modulated code communications with other aircraft or ground stations. Signals received by the UHF command set are also used to provide bearing information for the AN/ARA-25 homing adapters and radio magnetic indicators.

The UHF command radio operates on a frequency range of 225.0 to 299.9 megacycles, with frequencies available in steps of one-tenth of a megacycle. Any 20 of these frequencies may be preset, in any order, at the control panel. The radio may be set manually to any frequency other than those which have been preset, without disturbing any of the preset channels. Tuning of the receiver and transmitter is automatic after a channel or frequency change.

To manually select a channel not already available on one of the preset channels, the MANUAL-PRESET-GUARD switch must be positioned to manual and the manual frequency selector knobs rotated until the frequency appears in the indicator window. Selection of the preset channels is accomplished by placing the MANUAL-PRESET-GUARD switch in the PRESET position and rotating the preset channel selector switch until the desired channel appears in the indicator window. Placing the MANUAL-PRESET-GUARD switch in the GUARD position will select a guard frequency whcih is set prior to installing the equipment and can be changed only by removal of the control panel. When operating in the GUARD position, only the main receiver and transmitter are operating, even though the OFF-MAIN-BOTH-ADF switch is in the BOTH position.

Presetting of channel is accomplished by first placing the MANUAL-PRESET-GUARD switch in the PRESET position and rotating the channel selector switch to obtain the desired preset drum position. The preset buttons on the drum are then positioned to the desired frequency by means of the presetting tool located under the drum cover. Preset channel can be changed or checked without disturbing the manually selected frequency.

Mode of operation is selected by the OFF-MAIN-BOTH-ADF switch. When the switch is in the MAIN position, the transmitter and main receiver are operating on the same frequency and the guard receiver is inoperative. When in the BOTH position, it is possible to transmit on a selected frequency and simultaneously receive both the main receiver frequency and the fixed, guard frequency. When the switch is positioned to ADF, bearing information from the station selected will be relayed by the homing adapter (AN/ARA-25) to the No. 1 pointers on both the pilot's and copilot's radio magnetic indicators *(40, figure 1-7).* **On aircraft with T.C.T.O. 517**, the navigator may select bearing information from the UHF command radio for presentation in No. 1 pointer of the radio magnetic indicator *(7, figure 4-13)* on the navigator's console, by means of the radio compass selector switches *(9, figure 4-13).*

Placing Equipment In Operation:

1. Aircraft Power Supply — ON.

2. Mixer (toggle) Switch (interphone control panel) — INTER.

3. OFF-MAIN-BOTH-ADF switch — MAIN.

4. Channel Frequency — AS DESIRED.

Select channel frequency either manually or by preset channel selection, and allow 30 seconds for radio to warm up as follows:

Manual Selection:

a. MANUAL-PRESET-GUARD Switch—MANUAL.

b. Manual Frequency Selector Knobs — ROTATE TO DESIRED FREQUENCY.

Preset Selection:

a. MANUAL-PRESET-GUARD Switch — PRESET.

b. Channel Selector Switch — ROTATE TO DESIRED CHANNEL.

5. Interphone Function Selector Switch — COM UHF.

6. Volume Control — AS DESIRED.

To Obtain Bearing Information — Pilots' Station:

1. UHF Command Radio — ON AND TUNED TO DESIRED STATION.

2. OFF-MAIN-BOTH-ADF Switch — ADF.

Read bearing information on No. 1 pointer of pilot's and copilot's radio magnetic indicators.

To Obtain Bearing Information — Navigator's Station **On Aircraft with T.C.T.O. 517 :**

1. UHF Command Radio — ON AND TUNED TO DESIRED STATION.

2. OFF-MAIN-BOTH-ADF Switch — ADF.

3. Radio Compass Selector Switch — TAC OR UHF/DF.

Read bearing information on No. 1 pointer of navigator's radio magnetic indicator.

Note

> No transmission will be made on emergency (distress) frequency channels except for emergency purposes in order to prevent transmission of messages that could be construed as actual emergency messages.

To Turn Equipment Off:

1. OFF-MAIN-BOTH-ADF Switch — OFF.

HOMING ADAPTER AND INDICATORS (AN/ARA-25).

The AN/ARA-25 homing adapter equipment is employed to indicate the relative bearing of radio signal sources extracted from signals received by the AN/ARC-34 radio receiver. The relative bearing of the signal source is indicated by the No. 1 pointers on two radio magnetic indicators *(40, figure 1-7)* located on the pilots' instrument panel. The homing adapter equipment is operated from the UHF command control panel *(2 , figure 4-12)* on the control pedestal. Power is supplied to the equipment from the 28-volt d-c nonessential, navigator's bus and from the 115-volt a-c nonessential navigator's bus. It should be noted that this equipment will give bearing indication only while the ground station is transmitting.

Placing Equipment In Operation:

1. Aircraft Power Supply — ON.

2. Mixer (toggle) Switch (interphone control panel) — COM UHF.

3. UHF Command Radio — ON AND TUNED TO DESIRED STATION.

4. OFF-MAIN-BOTH-ADF Switch — ADF.

Read bearing information on the No. 1 pointers of the pilot's and copilot's radio magnetic indicators or on the No. 1 pointer of the navigator's radio magnetic indicator.

To Turn Equipment Off:

1. OFF-MAIN-BOTH-ADF Switch — OFF.

MARKER BEACON RECEIVER (AN/ARN-32).

The AN/ARN-32 marker beacon receiver has no controls, but comes on automatically when power is supplied to the d-c bus. A marker beacon press-to-test indicator light is located on the pilot's and copilot's course indicators *(28 and 39, figure 1-7)*. Power for the marker beacon receiver and indicator lights, is supplied from the 28-volt d-c nonessential navigator's bus. When the aircraft is within the radiation pattern of a 75-megacycle marker beacon transmitter, the marker beacon indicator will indicate the identification code of the station, and if the MARKER switch on the interphone mixer panel is ON, an audio signal will be heard. Sensitivity of the unit may be selected to HIGH or LOW, as desired, by the marker beacon sensitivity switch *(15, figure 4-12)* on the control pedestal.

Note

> In a congested area, where marker beacons are in close proximity, multiple marker beacon signals may be received simultaneously at high altitudes. This condition may be minimized by positioning the marker beacon sensitivity switch to LOW.

RADIO AND RADAR ALTIMETER SYSTEMS.

WARNING

> Due to penetration of radio and radar waves in deep snow or ice, terrain clearance errors of as much as 1600 feet greater than actual clearance have been recorded when operating over deep snow or ice fields. Do not rely on the SCR-718 radio altimeter or the AN/APN-22 radar altimeter to provide accurate terrain clearance information when flying over areas covered by large depths of snow and ice.

Radio Altimeter System — High Range (SCR-718).

The SCR-718 high-altitude radio altimeter operates in the UHF band on a frequency of 440 megacycles. The SCR-718 radio altimeter indicator and controls *(5, figure 4-13)* are located at the navigator's station, and the receiver-transmitter *(27, figure 4-10)*, is located in the tail cone. Power for the altimeter is supplied from the 115-volt a-c, nonessential navigator's bus. The altimeter is of a pulse type, and is capable of indicating accurate terrain clearances up to an altitude of 50,000 feet. The altitude reading displayed on the indicator is accurate to within 50 feet on the 5000-foot scale, and to within 500 feet on the 50,000-foot scale. Basically, the equipment transmits pulses of radio 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 circular sweep on the face of the indicator tube. The circle on the face of the tube is calibrated in feet. When the toggle switch on the indicator is in the TIMES ONE position, the altimeter reads up to 5000 feet; when the toggle switch is in the TIMES TEN position, the altimeter reads up to 50,000 feet.

Radio Altimeter Preflight Check.

1. Radio Altimeter Circuit Breaker — CLOSED.
2. Radio Altimeter Power Switch — ON.

Turn the equipment on and allow it to warm up for at least three minutes.

3. Circle Size Control — ADJUST.

Adjust the circle size control so that the green circular trace is barely visible around the black circle of the calibrated scale.

4. Brilliance and Focus Controls (underside of I-152-D indicator) — ADJUST.

If circular trace fails to appear on the indicator screen within one minute after equipment is turned on, adjust the BRIL and FOCUS controls located on the underside of the I-152-D indicator. Recheck circle size control. If the circular trace still fails to appear, notify maintenance personnel.

5. Circular Trace — CENTER.

If the circular trace is not centered on the indicator screen, adjust the HORIZ and VERT CENTERING controls located on the underside of the I-152-D indicator. If circular trace cannot be centered, notify maintenance personnel.

6. REC GAIN Control — ADJUST.

If the circular trace appears to be blurred or fuzzy, reduce the REC GAIN to minimum before adjusting the BRIL and FOCUS controls. This removes the effect of noise or "grass" on sensitive equipment.

7. Receiver Gain — INCREASE.

Advance the REC GAIN control until the lobe is ¼ inch in height. If this height cannot be attained with control set near the maximum clockwise position, the sensitivity of the equipment is too low. Width of the lobe should be 250 feet. Notify maintenance personnel if sensitivity is low or the lobe width at base is greater than 300 feet.

8. TIMES ONE ZERO ADJ Control — CHECK.

Rotate the TIMES ONE ZERO ADJ control to check whether lobe can be moved to the left and right of zero by at lease 150 feet without appreciable change in circle size.

9. CIRCLE SIZE RATIO Control — ADJUST.

Place the SCALE switch in the TIMES TEN position. The lobe should become narrower and shorter. The circle decreases in size until it is located approximately ¼ inch inside the scale circle. The size of the circle may be adjusted by the CIRCLE SIZE control. However, this changes the size of both circles making it necessary to return the SCALE switch to the TIMES ONE position and adjust the CIRCLE SIZE RATIO control, located on top of the I-152-D indicator, until the trace is just visible around the edge of the scale circle. Recheck the TIMES TEN circle. Repeat the process until the exact circle sizes desired are obtained.

Radar Altimeter System — Low Range (AN/APN-22).

The AN/APN-22 radar altimeter system is a microwave altimeter which measures the terrain clearance of the aircraft through a transmitted and received frequency-modulated microwave carrier. The indicator *(7, figure 1-7)* is located on the pilot's instrument panel. The receiver-transmitter *(16, figure 4-10),* and the electronic control amplifier *(34, figure 4-10),* are located in the aft right pod. Power for the system is supplied from the 28-volt d-c, and 115-volt a-c, nonessential navigator's bus. The system is reliable from zero to 10,000 feet over land, and from zero to 20,000 feet over water. The indication accuracy is ±2 feet for an altitude of zero 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 radar altimeter indicator. The ON position of this switch applies power to the system; it is also used to set 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 checking that the red light on the face of the indicator is not on (when the red light comes on it indicates that the aircraft is below the set altitude). The indicator pointer will disappear behind a mask on the indicator if the system is inoperative or if a dropout altitude is reached. The dropout altitude is the altitude at which the return signal is too weak above 10,000 feet over land and above 20,000 feet over water, in banks of 60 degrees or more; and in climbs and dives of 70 degrees or more.

IFF RADAR (AN/APX-25).

The AN/APX-25 IFF radar *(16 and 18, figure 4-12 or 4, figure 4-14)* provides automatic radar identification of the aircraft in which it is installed, when challenged by surface or airborne radar sets using coded pulse transmissions. Three modes of interrogation are used in the IFF system and the IFF set will reply to any or all of these depending on how the mode switches are set. Modes 1, 2, and 3 are known as SI (Security Identification), PI (Personal Identification), and TI (Traffic Identification) respectively. The IFF set can also be used to send a distress signal or a prearranged intelligence message. The set incorporates an auxiliary coder group control panel which provides a more reliable identification through selectable pulse trains, the interval and number of which permit more coding combinations in the reply. The control panels are located on the control pedestal *(16 and 18, figure 4-12)* in C-133B aircraft, and on the navigator's control panel *(4, figure 4-14)* in C-133A aircraft. The equipment is powered from the 28-volt d-c nonessential navigator's bus.

RADIO COMPASS (ADF) (AN/ARN-6).

Two radio compass sets are installed to provide dual low-frequency direction-finding capabilities. The radio compass sets are designated as ADF-1 and ADF-2 and have two control panels *(7 and 19, figure 4-12)* located on the control pedestal. An additional control panel *(5, figure 4-14)* for the ADF-1 set is installed on the navigator's control panel. Power is supplied to the equipment from the 28-volt d-c and 115-volt a-c nonessential navigator's buses.

The bearing to the selected station from either ADF-1 or ADF-2 is indicated by the respective pointer on each of the pilots' ID-250A/ARN radio magnetic indicators *(31, figure 1-7)*, and on the navigator's radio magnetic indicator *(7, figure 4-13)*. A remote control system enables the navigator to assume command of the ADF-1 set, by momentarily positioning the function control switch on his radio compass control panel to CONT. Control of the ADF-1 may be returned to the pilots' station by positioning the function switch on the pilots' radio compass control panel momentarily to CONT.

Radio Magnetic Indicators (ID-250A/ARN).

Five ID-250A/ARN radio magnetic indicators are installed to provide visual bearing information from the radio compasses, UHF/DF (AN/ARC-34), VHF omnirange and TACAN receivers. Two of the indicators *(31, figure 1-7)*, located on the pilots' instrument panel, provide bearing information from the radio compasses only; No. 1 pointer indicating the bearing to the station selected by ADF-1 and the No. 2 pointer indicating the bearing for ADF-2.

Two of the indicators *(40, figure 1-7)*, located on the pilots' instrument panel, provide bearing information from the UHF/DF, VHF omnirange and TACAN receivers only. The indicator *(7, figure 4-13)*, located on the navigator's console, provides bearing information from all five sources previously mentioned, depending on the equipment in use and the positioning of the radio compass selector switches.

(Aircraft AF54-135 through AF59-525):

The No. 1 pointers on the TAC VOR-UHF/DF indicators at the pilots' station will provide UHF/DF bearing information providing the UHF command radio OFF-MAIN-BOTH-ADF switch is in the ADF position. The No. 2 pointer will provide bearing information from the TACAN or VOR receivers, depending on the position of the INST SELECT switch on the VOR-ILS/TACAN selector switch panel. Selection of the bearing information for presentation on the navigator's indicator is made by the radio compass selector switch *(9, figure 4-13)*. The No. 1 pointer will indicate bearing information from ADF-1 regardless of switch position. The No. 2 pointer will indicate TACAN or VOR bearing information when the switch is positioned to the left. Which of the two signals is received will depend on the position of the INST SELECT switch on the VOR-ILS/TACAN selector switch panel. The No. 2 pointer will indicate ADF-2 bearing information when the radio compass selector switch is positioned to the right.

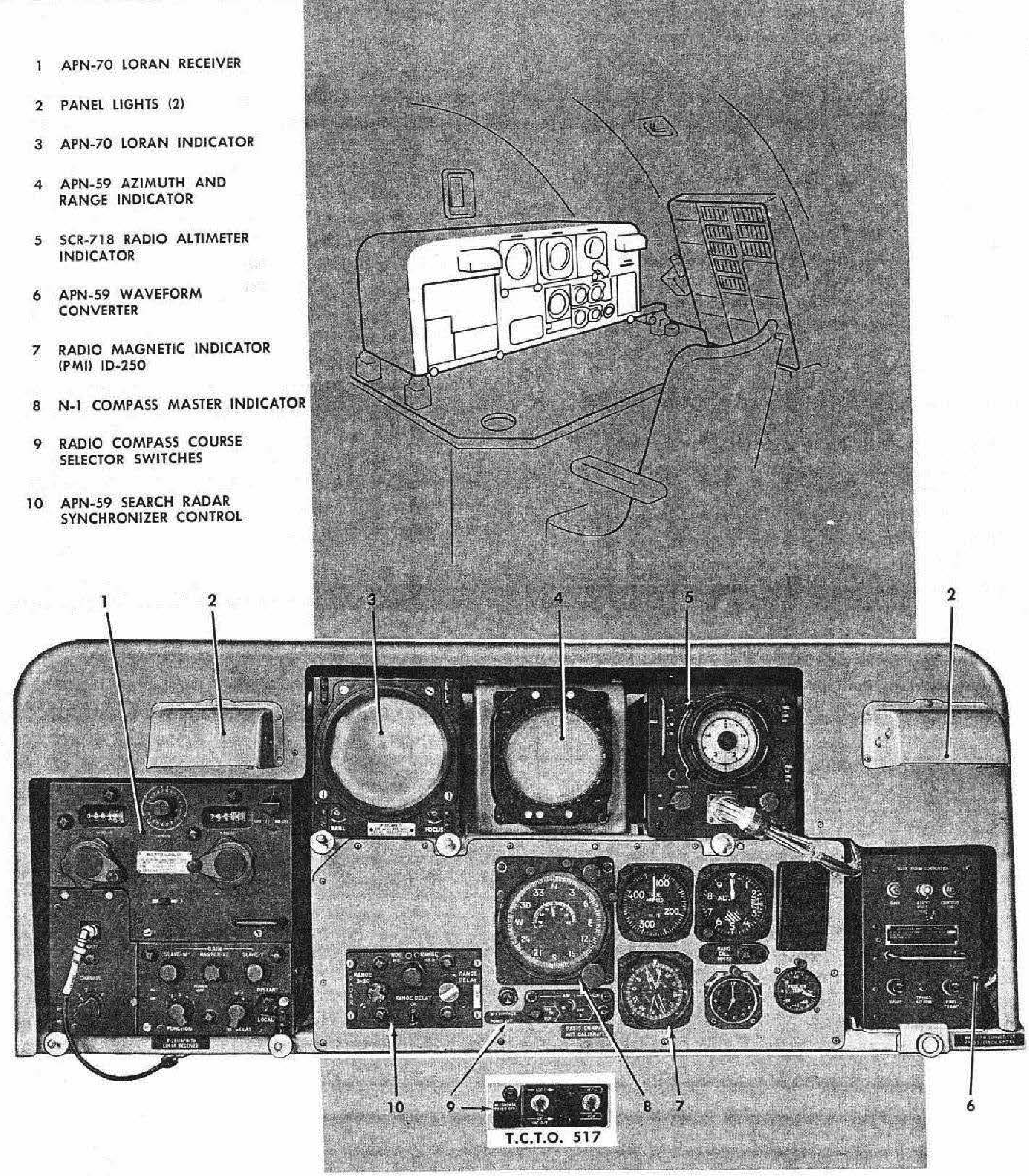
(Aircraft AF59-526 and Subsequent and Aircraft with T.C.T.O. 517):

Note

> Aircraft modified by T.C.T.O. 517 have been rewired to provide fail-safe display of TACAN and VOR information on the cross pointers of the course indicators and the pilot's and copilot's VOR-ILS/TACAN instrument selector switch is in the VOR position and power loss occurs through the TACAN/VOR relay power circuit breaker.

The No. 1 pointers on the TAC VOR-UHF/DF indicators at the pilots' station will indicate UHF/DF bearing information when the UHF command radio OFF-MAIN-BOTH-ADF switch is in the ADF position, or TACAN bearing information when the UHF command radio switch is in any position other than ADF the VOR-ILS/TACAN selector is in the TACAN position, and the TACAN equipment is in operation. The No. 2 pointer will show bearing information from the VHF omnirange receiver when the receiver is operating, regardless of the position of the VOR-ILS/TACAN INST SELECT switch.

Navigator's Console - Typical



1 APN-70 LORAN RECEIVER

2 PANEL LIGHTS (2)

3 APN-70 LORAN INDICATOR

4 APN-59 AZIMUTH AND RANGE INDICATOR

5 SCR-718 RADIO ALTIMETER INDICATOR

6 APN-59 WAVEFORM CONVERTER

7 RADIO MAGNETIC INDICATOR (PMI) ID-250

8 N-1 COMPASS MASTER INDICATOR

9 RADIO COMPASS COURSE SELECTOR SWITCHES

10 APN-59 SEARCH RADAR SYNCHRONIZER CONTROL

Figure 4-13

The navigator's radio magnetic indicator will present bearing information from the same sources and in the same modes as the pilots' TAC VOR-UHF/DF indicators, when the radio compass selector switches are placed in the down position. When the switches are placed in the up position the pointers will show bearing information from the ADF-1 and ADF-2 radio compass receivers on their respective pointers.

Radio Compass Selector Switches.

(Aircraft AF54-135 through AF59-525):

A 2-position, radio compass selector switch *(9, figure 4-13)* is installed on the navigator's console to enable the navigator to select the bearing information to be presented on the navigator's radio magnetic indicator. The switch has the placarded positions, ADF-1 and TAK OR VOR (left) and ADF-1, ADF-2 (right). When the switch is positioned to TAK OR VOR, bearing information from the radio compass ADF-1 will be selected for No. 1 pointer and TACAN or VOR information for pointer No. 2, depending on the position of the INST SELECT switch. When the switch is positioned to ADF-2, bearing information from both radio compass receivers will be selected and read on the respective pointers.

(Aircraft AF59-526 and Subsequent and Aircraft with T.C.T.O. 517):

Two, 2-position radio compass selector switches *(9, figure 4-13)* are installed on the navigator's console to enable the navigator to select the bearing information to be presented on the navigator's radio magnetic indicator. The left switch has the placarded positions ADF-1 and TAC OR UHF/DF and controls the input to the No. 1 pointer on the indicator. With the switch in the ADF-1 position, the indicator will receive bearing information from the radio compass (ADF-1) receiver. When the switch is in the TAC OR UHF/DF position, the indicator will receive UHF/DF bearing information when the UHF command radio OFF-MAIN-BOTH-ADF switch is in the ADF position, and TACAN bearing information when the command radio switch is in any other position than ADF, and the INST SELECT switch on the VOR-ILS/TACAN selector switch panel is in the TACAN position. The right switch has the placarded positions, ADF-2 and VOR, and controls the input to the No. 2 pointer. When positioned to ADF-2, the indicator will receive bearing information from the radio compass receiver. When the switch is in the VOR position, the indicator will receive bearing information from the VHF omnirange receiver.

Placing Equipment In Operation:

1. Aircraft A-c and D-c Power Supply — ON.
2. Mixer Switch — ADF-1 or ADF-2.
3. Radio Compass Function Switch — CONT (momentarily).

Position switch momentarily to CONT to obtain control of the radio compass receiver.

4. Radio Compass Function Switch — AS DESIRED.

Position function switch to COMP, ANT, or LOOP for desired mode of operation.

To Turn Equipment Off:

1. Radio Compass Function Switch — OFF.

VHF OMNIRANGE (VOR) (AN/ARN-14).

The VHF omnirange receiver is operated from the VHF NAV control panel *(11, figure 4-12)* and is powered from the 28-volt d-c nonessential navigator's bus. Visual bearing information from the receiver is presented on the No. 2 pointer of each of the TAC, VOR-UHF/DF radio magnetic indicators on the pilots' instrument panel, and on the No. 2 pointer of the radio magnetic indicator at the navigator's station. Visual bearing information is also presented on the pilot's course indicator (ID-351/ARN or ID-387/ARN) *(29, figure 1-7)*, and on the copilot's ID-525/ARN course indicator *(39, figure 1-7)*. When an ILS frequency has been selected, ILS course information will be present on the two course indicators. The system will also provide signals to the automatic flight control system during an automatic approach when the INST SELECT switch is positioned to VOR ILS.

Glide Slope Receiver (AN/ARN-31).

The glide slope receiver is used to provide visual indication of the aircraft position relative to the glide slope during an ILS approach. The receiver is operated from the VHF NAV control panel *(11, figure 4-12)*, and is tuned automatically when an ILS frequency is selected on the AN/ARN-14 frequency selector. The receiver is powered from the 115-volt a-c nonessential navigator's bus. Visual indication is presented on the pilot's and copilot's course indicators *(29, and 39, figure 1-7)*. The system also provides signals to the automatic flight control system during automatic approach when the INST SELECT switch is in the VOR ILS position.

Placing Equipment In Operation:

1. A-c Power — ON.
2. VHF NAV Power Switch — ON.
3. Frequency Selector (on VHF NAV control) — ROTATE TO DESIRED FREQUENCY.
4. Desired Course — SELECT.

Rotate the course set knob on the ID-351 indicator to set desired course in course window.

Note

> During an ILS approach, the course set knob has no effect on the operation of the CDI. However, course information set in the window may be desirable as a reference to course heading.

To Turn Equipment Off:

1. VHF NAV Power Switch — OFF.

TACTICAL AIR NAVIGATION (TACAN) EQUIPMENT (AN/ARN-21).

The AN/ARN-21 (TACAN) equipment is mounted in the forward electronic rack *(8, figure 4-10)*, and is controlled from the TACAN control panel *(8, figure 4-12)* on the pilots' control pedestal. This equipment provides continuous indications of the aircraft bearing, and the distance from any TACAN surface beacon in a line-of-sight range up to 195 nautical miles. Power is supplied to the equipment from the 28-volt d-c and 115-volt a-c nonessential navigator's busses. The receiver operates in the frequency range of 962 to 1024 megacycles and 1151 to 1213 megacycles. The transmitter operates in the frequency range of 1025 to 1144 megacycles. Any one of 126 preset channels can be selected by the channel selectors on the control panel when the TACAN/VOR-ILS selector switch is in the TACAN position. Course information furnished by the system is read as vertical bar deviation on the course indicators *(29, and 39, figure 1-7)* on the pilots' instrument panel, and as a bearing to the selected station on the radio magnetic indicators *(40, figure 1-7)*, on the pilots' instrument panel, and *(7, figure 1-13)*, on the navigator's console. **On Aircraft AF54-135 through AF59-525** bearing information is read on the No. 2 pointer of the pilots' radio magnetic indicators and on the No. 1 pointer of the navigator's indicator. **On aircraft AF59-526 and subsequent and aircraft with T.C.T.O. 517,** TACAN bearing information is read on the No. 1 pointer of the pilot's and copilot's and navigator's indicators.

The distance to the TACAN beacon is read from the ID-307/ARN range indicator *(18, figure 1-7)* on the pilot's instrument panel. When the TACAN set is operating, the red bar on the TACAN range indicator will remain hidden, and the range indicator will continue to operate from the TACAN receiver, regardless of the position of the INST SELECT switch. The TACAN equipment measures straight-line between the aircraft and the TACAN transmitter. Minimum indication at any fixed altitude will appear when the aircraft is directly over the transmitter, and will be equal to the aircraft altitude in nautical miles over the station. The equipment also provides signals to the automatic flight control system.

TACAN Equipment Control Switches.

Switches for control of the TACAN equipment are located on the TACAN control panel *(8, figure 4-12)* and on the VOR-ILS/TACAN selector switch panel *(17, figure 4-12)*. The TACAN receiver switch is a 2-position, rotary-type selector switch with the placarded positions T/R and REC. OFF, and is located on the TACAN control panel. Positioning the switch to T/R turns the receiver on and placing the switch to REC. OFF, turns off the power to the receiver. Receiver volume is controlled by a rheostat knob on the TACAN control panel. The channel selector is a rotary-type switch and is also located on the TACAN control panel. Rotating the switch will select any one of 126 preset channels when the VOR-ILS/TACAN selector switch is in the TACAN position. There are no placarded positions on the channel selector switch, the channel selected being indicated in a window on the top of the selector.

The VOR-ILS/TACAN selector switch *(17, figure 4-12)*, is a 2-position, toggle switch and is placarded INST. SELECT., with the positions TACAN and VOR-ILS. Lights adjacent to the switch placards indicate which mode of operation has been selected. With the switch in the TACAN position and the set operating, TACAN information is displayed on the pilot's and copilot's course indicator cross pointers as vertical bar deviation, and bearing information if displayed on the No. 1 pointers of the pilot's and copilot's radio magnetics indicators.

With the switch in the VOR-ILS position, either VOR or ILS information (as selected by the OMNI receiver) is displayed on the cross pointers. TACAN signals to the pilot's and copilot's No. 1 pointers is cut off when the switch is in the VOR-ILS position.

Note

UHF/DF signals to the No. 1 pointers are not affected by the VOR-ILS/TACAN selector switch. With the TACAN set operating, DME information is also available regardless of position of the VOR-ILS/TACAN selector switch.

Placing Equipment In Operation:

1. Aircraft A-C and D-C Power Supply — ON.
2. VOR-ILS/TACAN Selector Switch — TACAN.
3. TACAN Receiver Switch — T/R.

WARNING

Occasionally TACAN equipment will "Lock-On" to a false bearing which will be 40 degrees or a multiple of 40 degrees 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

A false lock-on does not effect the DME display provided by the TACAN equipment.

When using TACAN crosscheck for false lock-on with ground radar, airborne radar, VOR, dead reckoning, or other available means. These checks are especially important when switching channels or when turning the set on. When false lock-on is suspected check as follows:

1. Switch to another channel, check for correct bearing, then switch back to desired channel.
2. Check for correct lock-on to desired channel.
3. If false lock-on is still suspected, turn set off and then ON.
4. Recheck for correct lock-on.
5. If false lock-on still persists, utilize other equipment or navigational aids available.

Note

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

Navigator's Control Panel – Typical

1. SEXTANT WINDOW DE-FOGGING SWITCH
2. CV-402/AP ISO-ECHO SWITCH (APN-59)
3. NAVIGATOR'S RADIO CIRCUIT BREAKER PANEL
4. IFF CONTROL PANEL (ON C-133A ONLY – LOCATED ON CONTROL PEDESTAL ON C-133B)
5. RADIO COMPASS (ADF) NO. 1 CONTROL PANEL
6. OXYGEN REGULATOR
7. INTERPHONE CONTROL PANEL
8. NAVIGATOR'S INTERPHONE CONTROL MIXER SWITCHES
9. LIGHT CONTROL PANELS
10. APN-59 RADAR CONTROL PANEL
11. RADAR PRESSURIZATION CONTROL PANEL

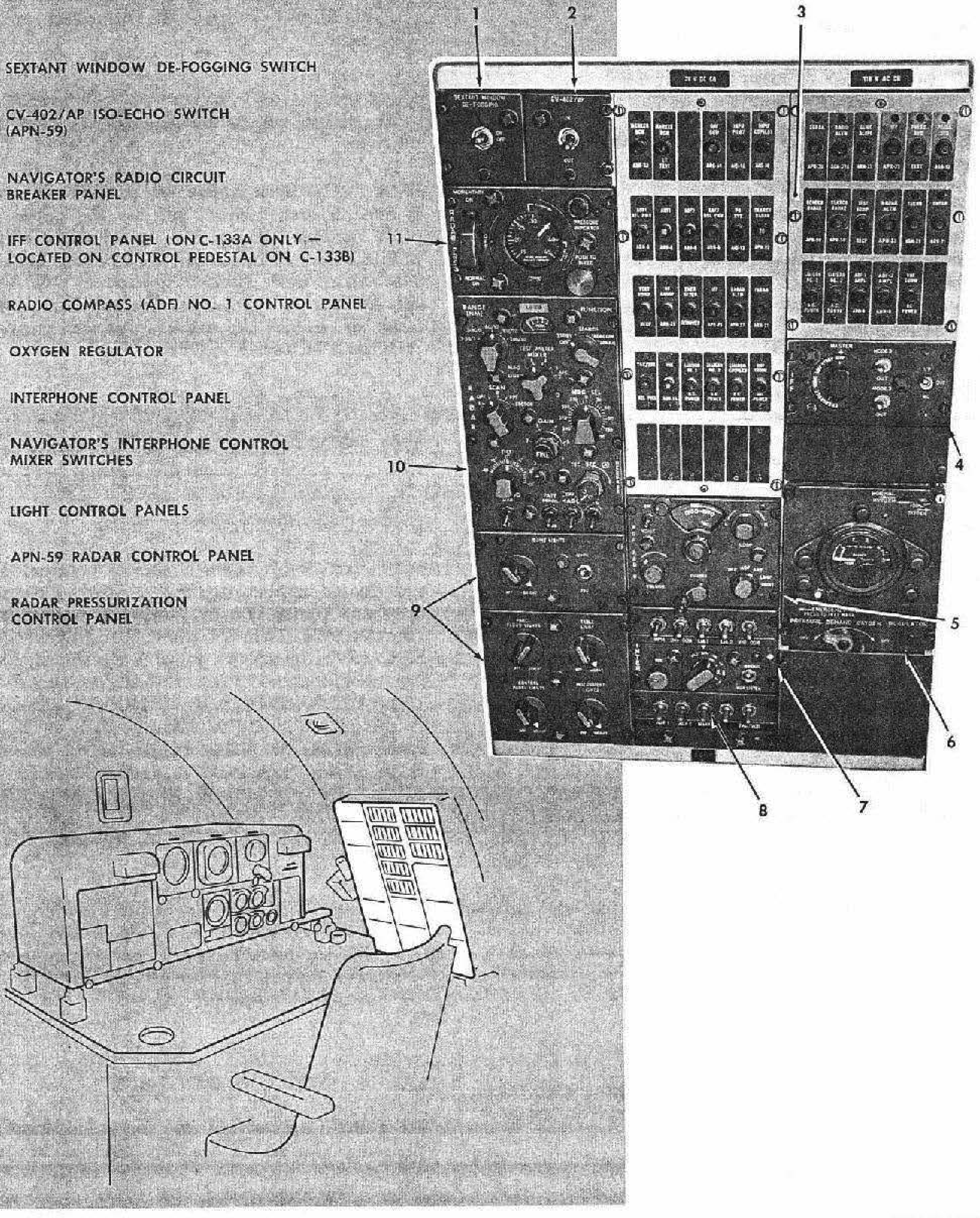


Figure 4-14

4. Channel Selector Switch — SET AS REQUIRED.

5. Volume Control — AS DESIRED.

To Turn Equipment Off:

1. TACAN Receiver Switch — OFF.

LONG-RANGE NAVIGATION (LORAN) EQUIPMENT (AN/APN-70).

The AN/APN-70 equipment *(1 and 3, figure 4-13)*, is operated from the navigator's station and is used for long-range navigation. Power is supplied to the equipment from the aircraft 28-volt d-c and 115-volt a-c nonessential navigator's busses and the 28-volt d-c aft radio bus.

Placing Equipment In Operation:

1. Aircraft A-c and D-c Power Supply — ON.

2. MASTER-XZ GAIN Control — ON.

Set gain control at midpoint. Allow one minute for warmup.

Note

> Make sure the d-c LORAN APN-70 circuit breaker on the aft circuit breaker panel *(figure 1-27)* is CLOSED to energize the LORAN antenna coupler.

3. LOCAL-DISTANT Switch — DISTANT (unless flying very close to a LORAN transmitter).

4. CHANNEL Selector Switch — AS DESIRED.

Set switch to desired R-F channel.

5. R-RATE Switch — SET.

Set to correct PRR.

6. FUNCTION Switch — 1.

Set FUNCTION switch on No. 1 position. Two traces should appear on the scope with a pedestal on each trace.

7. Signal Height — ADJUST.

Set H-F DELAY switch on W; adjust MASTER-XZ and SLAVE-W gain controls until the signals are of the desired height.

Note

> The MASTER-XZ gain controls the upper trace, and the SLAVE-W gain the lower trace. With the H-F DELAY switch on W, the SLAVE-Y gain has no effect on the scope.

8. Pulses — ADJUST FOR POSITION AND DRIFT.

With the L-R switch, position the pulses so that there is one on each trace. Then set the upper (master) pulse on the leading edge of the master pedestal. Kill the drift with the drift control and turn the ADC (Automatic Drift Control) switch to ON. The ADC should lock the pulse in this position. If excessive noise or erratic sky wave reception prevents this, turn the ADC switch to OFF.

9. Slave Pedestal — SET.

With the W-DELAY crank pushed in (1,000 ms per turn), set the slave pedestal under the slave pulse.

10. FUNCTION Switch — 2.

Set FUNCTION switch on No. 2 position. Both signals should appear on the left third of the scope. If only one signal appears, adjust the individual gain controls (MASTER-XZ controls the upper trace and SLAVE-W controls the lower trace). If adjustment of the gain does not cause the other pulse to appear, recheck FUNCTION 1. The ADC will keep the signals to the far left side of the scope. With the W-DELAY crank pulled out (100 ms per turn), set the slave pulse directly under the master pulse. With the two appropriate gain controls, adjust the two pulses to the same height.

Note

> In FUNCTION 1 with ADC ON, it is possible to lock in on a large split of a one-hop-E pulse. To prevent this possible lock, use the following procedures:

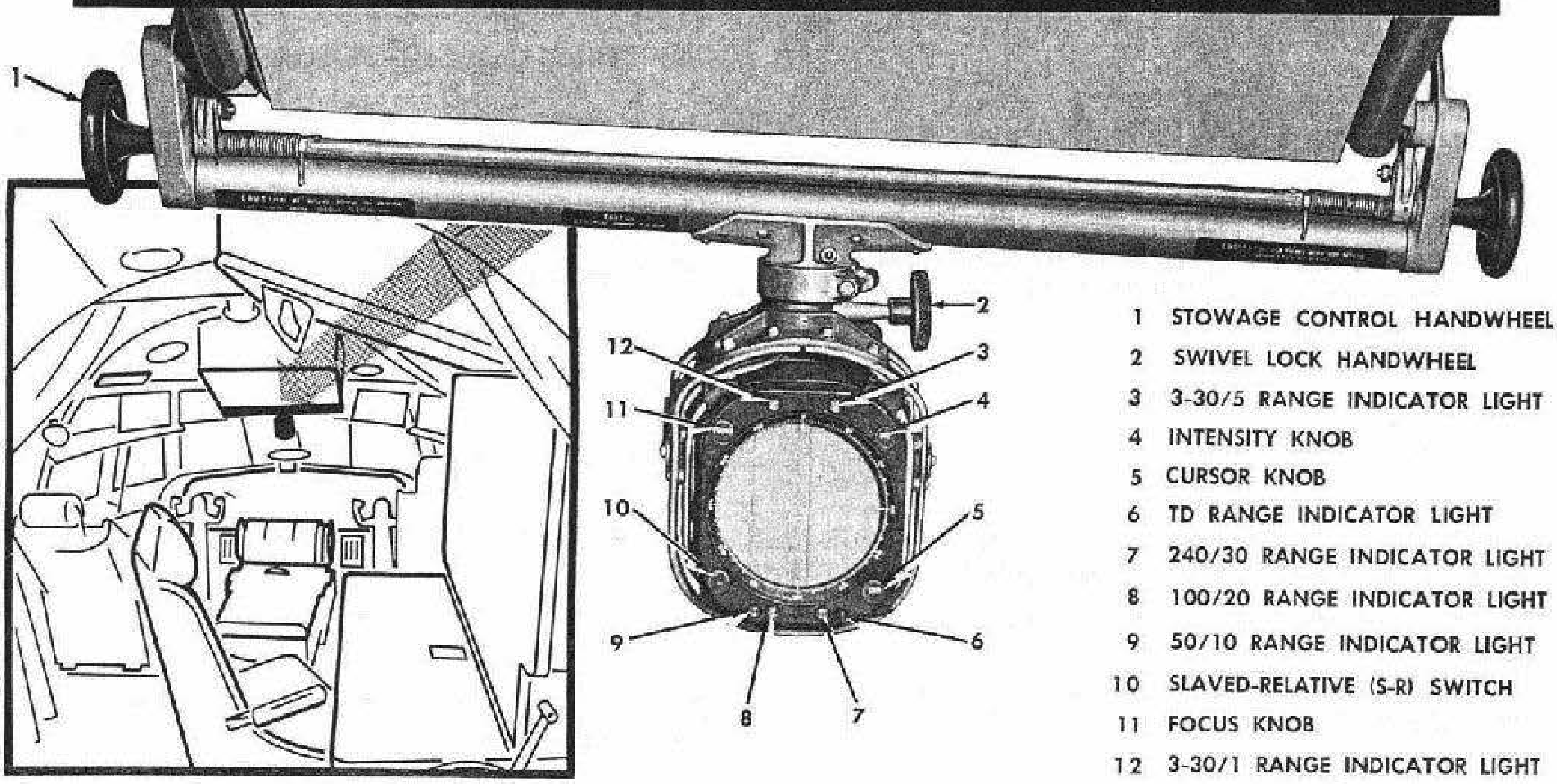
a. FUNCTION Switch — 1.

Set FUNCTION switch to No. 1 and position both desired pulses on the leading edges of the pedestals.

b. FUNCTION Switch — 2.

Set FUNCTION switch to No. 2. Use the L-R switch to move the pulses to the right, in order to assure

Pilot's AN/APN—59, Indicator



1 STOWAGE CONTROL HANDWHEEL
2 SWIVEL LOCK HANDWHEEL
3 3-30/5 RANGE INDICATOR LIGHT
4 INTENSITY KNOB
5 CURSOR KNOB
6 TD RANGE INDICATOR LIGHT
7 240/30 RANGE INDICATOR LIGHT
8 100/20 RANGE INDICATOR LIGHT
9 50/10 RANGE INDICATOR LIGHT
10 SLAVED-RELATIVE (S-R) SWITCH
11 FOCUS KNOB
12 3-30/1 RANGE INDICATOR LIGHT

UAB1-253

Figure 4-15

that the desired pulse is portrayed on the scope, and is not off the trace to the left. When the pulses are moved to the right, ADC is lost and the pulses may drift to the right. Keep the manual drift control in the extreme left position. If ADC loses the pulses when they are moved to the right, the manual drift will move them to the left and ADC will lock them automatically.

11. FUNCTION Switch — 3.

Set the FUNCTION switch to No. 3 position; the two signals will appear on a single trace slightly to the left of center on the scope, and be locked in this position by the ADC. Width of the signals will remain the same regardless of their location on the scope. With the W-DELAY crank pulled out, superimpose the pulses, adjusting the MASTER-XZ gain if needed, to make them the same height. The time of the LOP is the time of matching, and the time difference may now be read from the W-DELAY counter. No correction to this reading is necessary.

12. Second Reading — OBTAIN.

To obtain the second reading, turn the H-F DELAY switch to Y and follow steps 3 through 11, substituting SLAVE-Y gain for SLAVE-W gain and Y-DELAY for W-DELAY crank. This procedure will allow the first reading to be retained while the second is being taken.

13. Position Fix — PLOT.

With the readings obtained, interpolate between hyperbolas on the chart and plot the LOP's. Resolve to common time for fix.

To Turn Equipment Off:

1. MASTER-XZ GAIN Control — OFF.

SEARCH RADAR (AN/APN-59).

The search radar equipment is mounted in the nose and is controlled from the APN-59 radar control panel *(10, figure 4-14),* located on the navigator's control panel. Two indicators are provided, one for the pilot and copilot *(figure 4-15),* located at the forward end of the pilots' overhead panel and one for the navigator *(4, figure 4-13),* located on the navigator's console. The equipment is powered from the 28-volt d-c and 115-volt a-c nonessential navigator's busses. The equipment is designed for use as a navigational and search radar, weather radar, or a RACON (radar beacon) interrogator-receiver.

CAUTION

The ANTENNA STAB switch should be moved to the OFF (down) position when it is anticipated that a bank angle of 30 degrees is to be exceeded.

Search Radar Preparation.

Before placing the equipment in operation, the control panel (*10, figure 4-13)* and the APN-59 azimuth and range indicators (PPI scopes) *(4, figure 4-13; and 8, figure 1-5)* should be set as follows:

Control Panel (Navigator's Station):

1. FUNCTION Switch — OFF.
2. RANGE (NM) Switch — 50/10.
3. TEST METER Switch — LINE.
4. SCAN Switch — OFF.
5. HDG SEL Control — 0.
6. GAIN Control — Full counterclockwise.
7. TILT Control — 0.
8. ANTENNA STAB Switch — Off (down position).
9. STC Control (both knobs)—Full counterclockwise.
10. BEARING Switch — REL.
11. PATT Switch — FAN.
12. IAGG Switch — Off (down position).
13. FTC Switch — Off (down position).

PPI Scope (IP268, Navigator's Station):

1. DIAL DIM Control — Full counterclockwise.
2. RANGE DELAY Control — Full counterclockwise.
3. RANGE DELAY Switch — Off (down position).
4. FOCUS Control — Full counterclockwise.
5. RANGE 3-30 Control — Full counterclockwise.
6. INT Control — Full counterclockwise.
7. RANGE MKS Control — Full counterclockwise.

PPI Scope (IP268, Pilot's Station):

1. INT Control — Full counterclockwise.
2. FOCUS Control — Full counterclockwise.
3. STAB (S) — RELATIVE (R) Control — Relative (R).

Search Radar Operation.

1. Aircraft Power Supply — ON.
2. If voltages are within tolerance:
    a. FUNCTION Switch — STDBY.
    b. TEST METER Switch — LINE. Meter should read 0.6(±0.05).
3. After 3 minute warmup period:
    a. SCAN Switch — PPI.
    b. FUNCTION Switch — SEARCH.
    c. TEST METER Switch — Position as follows and note readings:
        (1) LINE — 0.6(±0.05).
        (2) MAG — 0.6(±0.2) and steady.
        (3) MIXER 1 — 0.7(±0.2).
        (4) MIXER 2 — 0.7(±0.2).
        (5) AFC 1 — 0.7(±0.2).
        (6) AFC 2 — 0.7(±0.2).

Short Range Search:

1. TEST Meter Switch — MAG.

2. FUNCTION Switch — SEARCH.

3. RANGE (NM) Switch — 50/10, 3-30/5, or 3-30/1.

4. INT Control (scope) — Clockwise until faint sweep appears.

5. FOCUS Control (scope) — Adjust for well-defined sweep.

6. SCAN Switch — PPI.

7. GAIN Control — Adjust clockwise for optimum presentation.

8. ANTENNA STAB Switch — ON (up position).

9. PATT Switch — FAN.

10. BEARING Switch — As desired.

11. HDG SEL Control — 0.

12. TILT Control — Adjust for optimum presentation.

13. RANGE MKS Control — Clockwise as desired.

14. DIAL DIM Control — As desired.

15. To receive presentation on pilot's indicator IP268:

   a. INT Control — Adjust clockwise until faint sweep appears.

   b. FOCUS Control — Adjust for well-defined sweep.

   c. STAB (S) — RELATIVE (R) Control — As desired.

Note

When the bearing switch on the radar control is in the REL position, the pilot's S/R switch on the indicator should be in the R position.

CAUTION

For optimum performance, the AN/APN-59 radar set should be in operation for at least 20 minutes prior to switching to long range search.

Long and Medium Range Search:

1. TEST METER Switch — MAG.

2. FUNCTION Switch — SEARCH.

3. RANGE (NM) Switch — 100/20 or 240/30.

4. INT Control (scope) — Clockwise until faint sweep appears.

5. FOCUS Control (scope) — Adjust for well-defined sweep.

6. SCAN Switch — PPI.

7. GAIN Control — Adjust clockwise for optimum presentation.

8. ANTENNA STAB Switch — ON (up position).

9. PATT Switch — FAN.

10. BEARING Switch — As desired.

11. HDL SEL Control — 0.

12. TILT Control — Adjust clockwise.

13. RANGE MKS Control — Clockwise as desired.

14. DIAL DIM Control — As desired.

Weather Reconnaissance:

1. TEST METER Switch — MAG.

2. FUNCTION Switch — WARN.

3. RANGE (NM) Switch — As desired.

4. INT Control — Adjust clockwise until faint sweep appears.

5. FOCUS Control — Adjust for well-defined sweep.

6. SCAN Switch — PPI.

7. ANTENNA STAB Switch—ON (up position).

8. PATT Switch — PENCIL.

9. BEARING Switch — REL or STAB.

10. HDG SEL Control — 0.

11. GAIN Control — Adjust as necessary.

12. TILT Control — 0.

13. RANGE MKS Control — Clockwise as desired.

14. DIAL DIM Control — As desired.

15. ISO-ECHO or CV-402/AP Switch *(2, figure 4-12)* on Navigator's Control Panel — IN.

Note

The ISO-ECHO switch connects the CV-402/AP waveform converter into the indicator circuit, altering the indicator display to provide easily interpreted images of storm areas. The areas of heaviest rainfall and greatest turbulence will be readily identifiable as small holes within each target return from heavy storm concentrations.

Note

With bearing switch set to STAB and HDG SEL control set to 0, the flashing marker on PPI scope will indicate aircraft magnetic heading. With bearing switch set to STAB and HDG SEL switch set to aircraft heading, the flashing marker will appear at zero degrees relative to the aircraft. Subsequent deviation of the aircraft from the compass bearing at the time HDG SEL control is set will deflect the flashing marker from zero by the amount of the aircraft heading change. After storm concentrations have been observed, set the bearing switch to REL, and concentrations ahead will appear ahead and flashing marker on PPI scope will be at zero degrees.

RACON (Radar Beacon) Operation:

1. TEST METER Switch — MAG.

2. FUNCTION Switch — BEACON.

3. RANGE (NM) Switch — As necessary.

4. INT Control (scope) — Clockwise until faint sweep appears.

5. FOCUS Control (scope) — Adjust for well-defined sweep.

6. SCAN Switch — PPI.

7. GAIN Control — As necessary.

8. ANTENNA STAB Switch — On (up position).

9. PATT Switch — PENCIL or FAN.

10. BEARING Switch — STAB or REL.

11. HDG SEL Control — 0.

12. TILT Control — Adjust clockwise.

13. RANGE MKS Control (scope) — Clockwise as desired.

14. DIAL DIM Control — As desired.

Note

Range of beacon is from center of scope to first return of beacon. Magnetic bearing of RACON is read under the cursor on the azimuth ring.

To Turn Equipment Off:

1. STAB Switch — Off (down position).

2. SCAN Switch — OFF.

3. Return all controls and switches to positions as follows:

    a. PPI Scope (IP268, Navigator's Position):

        (1) DIAL DIM Control — As desired.

        (2) RANGE DELAY Control — Full counterclockwise.

        (3) RANGE DELAY Switch — Off (down position).

        (4) FOCUS Control — Full counterclockwise.

(5) RANGE 3-30 Control — Full counterclockwise.

(6) INT Control — Full counterclockwise.

(7) RANGE MKS Control — Full counterclockwise.

b. PPI Scope (IP268, Pilot's Position):

(1) INT Control — Full counterclockwise.

(2) FOCUS Control—Full counterclockwise.

(3) STAB (S) — RELATIVE (R) Control — Relative (R).

c. Control Panel:

(1) ANTENNA STAB Switch — Off (down position).

(2) SCAN Switch — OFF.

(3) RANGE (NM) Switch — 50/10.

(4) TEST METER Switch — LINE.

(5) HDG SEL Control — 0.

(6) GAIN Control — Full counterclockwise.

(7) TILT Control — 0.

(8) STC Control (both knobs) — Full counterclockwise.

(9) IAGC Switch — Off (down position).

(10) FTC Switch — Off (down position).

(11) BEARING Switch — RELATIVE.

(12) PATT Switch — FAN.

(13) FUNCTION Switch — OFF.

LIGHTING EQUIPMENT.

EXTERIOR LIGHTING.

Navigation and anticollision lights are wired to the 28-volt d-c power supply through their respective circuit breakers and switches. The landing lights are operated through a stepdown transformer by 30 volts a-c, and the formation lights, scanning lights, and taxi lights are operated by 28 volts a-c. The exterior lights are operated from the pilots' overhead panel and the control pedestal.

Taxi Lights and Switch.

Two 28-volt sealed beam, taxi lights *(figure 4-16)* are installed on the steerable portion of the nose gear shock strut. The lights receive 28-volt power from a 115-volt/28 — 30-volt stepdown transformer located at station 135. Power for the transformer is received from the 115-volt a-c nonessential bus on the flight engineer's overhead circuit breaker panel. The lights are controlled by the taxi light switch *(35, figure 1-11)*. Placing the switch in the ON position completes a 28-volt a-c circuit to a control relay, which in turn completes the 28-volt a-c circuit to the lights.

Landing Lights and Switches.

A 30-volt sealed-beam, electrically actuated wing landing light *(figure 4-16)* is installed on the underside of each wing, outboard of the outboard nacelle. Power for the lights is obtained from a 115-volt/28 — 30-volt stepdown transformer located in the left hand center fuselage area which is powered from the 115-volt a-c nonessential bus on the flight engineer's overhead circuit breaker panel. The extend/retract actuating motor is powered from the 28-volt a-c nonessential bus on the left hand center fuselage circuit breaker panel. Each light is controlled by a 3-position switch placarded EXTEND and RETRACT, and an ON-OFF switch *(32, figure 1-11)* located on the left forward side of the control pedestal. The EXTEND-RETRACT switch energizes a 28-volt d-c circuit to the motor to actuate the landing light extend/retract mechanism. The center position of this switch provides for intermediate positioning of the landing lights, and for stopping the motor. A 28-volt d-c ON-OFF switch, when placed in the ON position, energizes a relay to supply 30-volt a-c power for illumination of the landing lights, regardless of position of the wing landing lights.

A nosewheel landing light is rigidly attached to the fixed portion of the nose gear shock strut. The light is controlled by an ON-OFF nose landing light switch *(35, figure 1-11)* located adjacent to the wing landing light switches. When the nose gear is retracted, the nose landing light is rendered inoperative.

CAUTION

Operation of the nosewheel landing light at speeds below 30 knots for periods exceeding 2 minutes, will result in overheating and decreased life of the landing light bulb.

(See CAUTION on Page 4-49)

Location of Exterior Lights—Typical

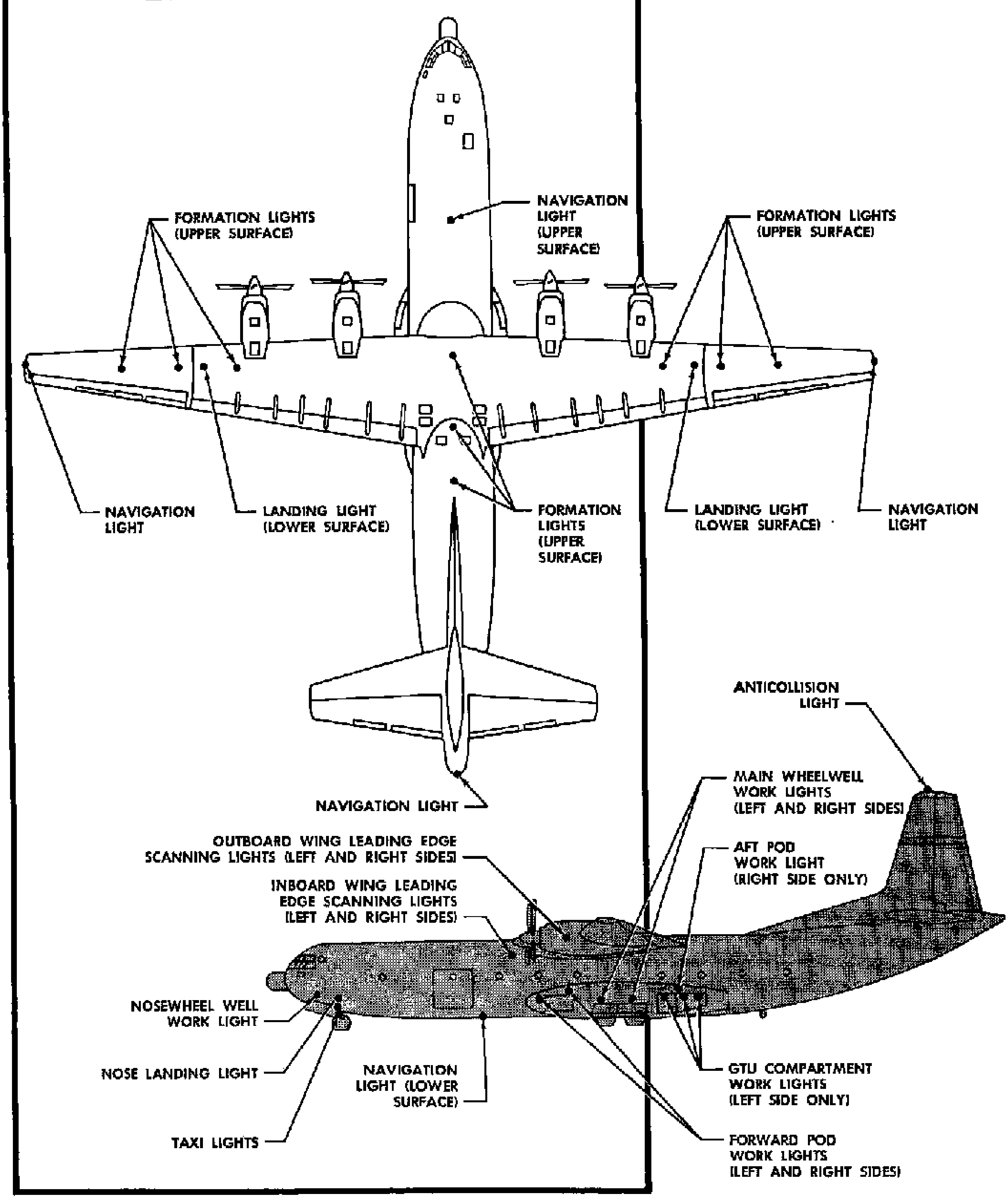


Figure 4-16

CAUTION

Do not extend the wing landing lights at airspeeds in excess of 178 knots IAS.

Wing Leading Edge Scanning Lights and Switch.

Four 28-volt a-c wing leading edge scanning lights *(figure 4-16)* are installed, one on each side of the fuselage and one on the outboard side of each outboard nacelle. The wing leading edge scanning lights illuminate the leading edge of the wing for the detection of ice formation. The lights are powered from the 28-volt a-c nonessential bus on the left hand center fuselage circuit breaker panel. They are controlled by two 2-position switches located on the pilots' overhead panel *(figure 1-6)*, through a control relay which is powered from the 28-volt d-c essential bus on the flight deck left hand auxiliary circuit breaker panel.

Navigation Lights and Switches.

The navigation lights *(figure 4-16)* consist of a green light on the right wing tip, a red light on the left wing tip, a yellow light and a white light on the tail cone tip, and two white lights, one on the top fuselage centerline forward section and one on the bottom fuselage centerline forward section. The lights and the flasher are powered from the 28-volt d-c nonessential bus on the flight engineer's overhead circuit breaker panel and are wired through the pilots' dim control switch. The navigation lights are controlled by a 3-position switch *(figure 1-6)*, placarded FLASH, OFF, and STEADY, and located on the pilots' overhead panel. When the switch is in the FLASH position, the wing tip lights and the white taillight flash on and off together; the yellow taillight and the top and bottom fuselage lights flash on and off alternately with the wing lights and white taillight. When the switch is in the STEADY position, all the lights will remain on without flashing. A DIM-BRIGHT switch *(figure 1-6)*, located adjacent to the STEADY-FLASH switch, is incorporated in the circuit to control light intensity.

Formation Lights and Switch.

Nine 28-volt a-c formation lights *(figure 4-16)*, three on the top of each wing and three along the top of the fuselage. The lights are powered from the 28-volt a-c nonessential flight deck right hand auxiliary bus, and are controlled by a 3-position formation light switch located on the pilots' overhead panel *(figure 1-6)*. The switch has the placarded positions, DIM, OFF, and BRIGHT.

Anticollision Lights and Switches.

A red, 28-volt d-c rotating anticollision light *(figure 4-16)* is installed on top of the vertical stabilizer. The light is powered from the 28-volt d-c nonessential bus on the flight engineer's overhead panel and is controlled by an ON-OFF switch located on the pilots' overhead panel *(figure 1-6)*.

On aircraft with T.C.T.O. 583, an additional anticollision light is installed on the bottom of the fuselage, midway between the forward end of the pods. The light is powered from the 28-volt d-c nonessential bus located on the flight deck left hand auxiliary circuit breaker panel. The light is controlled by a 2-position switch located on the pilots' overhead panel *(figure 1-6)*. The switch is placarded LOWER and has the placarded positions ON and OFF.

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 is could not be observed by pilots of other aircraft.

Work Lights and Switches.

Fourteen 28-volt d-c work lights *(figure 4-16)* are installed throughout the aircraft to provide lighting for work areas. The lights are powered from the 28-volt d-c nonessential bus located on the right hand center fuselage circuit breaker panel. ON-OFF switches are located adjacent to the lights. The lights are located as follows: one in the nosewheel area, two in the right forward pod area, two in the right wheel well area, one in the right aft pod area, two in the left forward pod area, two in the left wheel well area, two in the No. 1 GTU compartment, and two in the No. 2 GTU compartment. All three wheel well areas and both GTU's also have auxiliary ON-OFF switches and viewing windows located inside the aircraft, adjacent to the area their respective lights come on.

CAUTION

Do not leave the work lights in the main wheel wells on during flight. When the landing gear is retracted, the tires are close enough to the lights to cause blistering if the lights are left on for extended periods of time.

INTERIOR LIGHTING.

The interior lights receive their power from 28-volt d-c, 28-volt a-c, and 115-volt a-c busses. The power is supplied through their respective circuit breakers, switches, and variable autotransformers. The variable autotransformer is used for several purposes: it reduces the voltage from 115 volts a-c to 28 volts a-c, turns the lights on or off, and by varying the voltage, incorporates the dimming feature. All lights are powered by 28 volts except the side cargo door floodlights and the cargo ramp floodlights, which are powered by 115 volts a-c.

Instrument Rim Lighting and Switches.

All instruments in the cockpit, at the flight engineer's station, and at the navigator's station, are equipped with individual red rim lighting fixtures and receive power from the 115-volt a-c bus. All of the red rim lights are controlled by variable autotransformers placarded OFF and BRIGHT. The pilot's rim light controls are located on the pilot's overhead side panel (*1, figure 1-5*). The copilot's rim lights are controlled at the copilot's overhead side panel. The flight engineer's rim lights are controlled at the flight deck light control panel (*53, figure 1-13*), the navigator's rim lights are controlled at the navigator's light control panel (*9, figure 4-14*), and the engine instrument rim lights are controlled at the copilot's overhead side panel.

Pilot's Instrument Panel Edge Lighting and Switches.

The pilots' instrument panels are provided with edge lighting which illuminates only the markings of the various panel masks. The pilot's panel lights are powered from the 115-volt a-c essential bus on the flight engineer's overhead panel through a variable autotransformer placarded OFF and BRIGHT, which is located on the pilot's overhead side panel (*1, figure 1-5*). The copilot's instrument illumination is controlled in a similar manner at the copilot's overhead side panel.

Pilot's Overhead Side Panel and Overhead Panel Edge Lighting and Switch.

The pilots' overhead side panels and overhead panel are provided with edge lighting which illuminates only the markings of the switch controls. The lights are powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel through a variable autotransformer placarded OFF and BRIGHT which is located on the pilot's overhead panel (*1, figure 1-5*).

Control Pedestal Edge Lighting and Switch.

The control pedestal is provided with edge lighting which illuminates only the markings of the various control panels. The control pedestal panel edge lights are powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel, through a variable autotransformer placarded OFF and BRIGHT, which is located on the pilots' overhead panel (*figure 1-6*).

Flight Engineer's Instrument Panel Edge Lighting and Switch.

The flight engineer's instrument panel is provided with edge lighting which illuminates the markings of the switch controls and various masks. The instrument panel edge lights are powered from the 115-volt a-c essential bus on the flight engineer's overhead panel, through a variable autotransformer placarded OFF and BRIGHT, which is located on the flight deck light control panel (*53, figure 1-13*).

Navigator's Panel Edge Lighting and Switch.

The navigator's panel is provided with edge lighting which illuminates the markings of the switch controls and various masks. The panel edge lights are powered from the 115-volt a-c essential bus on the flight engineer's overhead panel, through a variable autotransformer placarded OFF and BRIGHT (*9, figure 4-14*) located on the navigator's electrical control panel.

Pilots' Instrument Panel Floodlights and Switches.

Red and white floodlights are installed just below the pilot's and copilot's glare shield to provide illumination for the instrument panel. The lights are powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel, through a variable autotransformer placarded OFF and BRIGHT, located on the pilots' overhead side panel (*1, figure 1-5*).

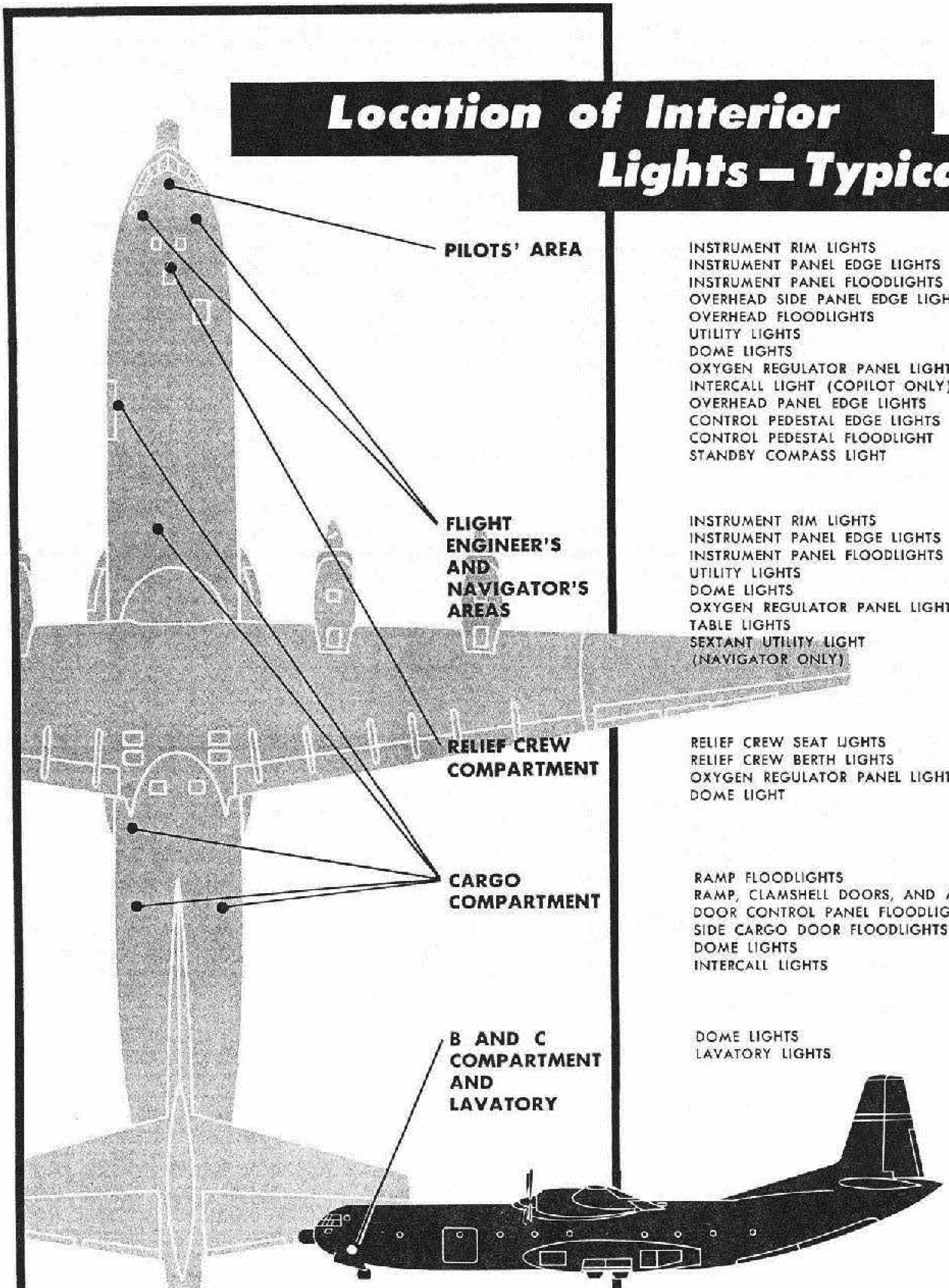
Cockpit Overhead Floodlights and Switch.

Two red floodlights (*figure 4-17*) are installed in the cockpit, one above the pilot's station and one above the copilot's station. The lights are powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel, through a variable autotransformer placarded OFF and BRIGHT, located on the pilots' overhead panel (*figure 1-6*).

Control Pedestal Floodlight and Switch.

A red floodlight (*figure 4-17*) is provided for the control pedestal, and is located above the pilots' over-

Location of Interior Lights — Typical



PILOTS' AREA

INSTRUMENT RIM LIGHTS
INSTRUMENT PANEL EDGE LIGHTS
INSTRUMENT PANEL FLOODLIGHTS
OVERHEAD SIDE PANEL EDGE LIGHTS
OVERHEAD FLOODLIGHTS
UTILITY LIGHTS
DOME LIGHTS
OXYGEN REGULATOR PANEL LIGHTS
INTERCALL LIGHT (COPILOT ONLY)
OVERHEAD PANEL EDGE LIGHTS
CONTROL PEDESTAL EDGE LIGHTS
CONTROL PEDESTAL FLOODLIGHT
STANDBY COMPASS LIGHT

FLIGHT ENGINEER'S AND NAVIGATOR'S AREAS

INSTRUMENT RIM LIGHTS
INSTRUMENT PANEL EDGE LIGHTS
INSTRUMENT PANEL FLOODLIGHTS
UTILITY LIGHTS
DOME LIGHTS
OXYGEN REGULATOR PANEL LIGHTS
TABLE LIGHTS
SEXTANT UTILITY LIGHT (NAVIGATOR ONLY)

RELIEF CREW COMPARTMENT

RELIEF CREW SEAT LIGHTS
RELIEF CREW BERTH LIGHTS
OXYGEN REGULATOR PANEL LIGHTS
DOME LIGHT

CARGO COMPARTMENT

RAMP FLOODLIGHTS
RAMP, CLAMSHELL DOORS, AND AFT DOOR CONTROL PANEL FLOODLIGHT
SIDE CARGO DOOR FLOODLIGHTS
DOME LIGHTS
INTERCALL LIGHTS

B AND C COMPARTMENT AND LAVATORY

DOME LIGHTS
LAVATORY LIGHTS

UAB1-261

Figure 4-17

head panel. The light is powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel, through a variable autotransformer placarded OFF and BRIGHT, which is located on the pilots' overhead panel.

Standby Compass Light and Switches.

A light is provided for the pilots' standby compass (*12, figure 1-7*). The light receives its power from the 115-volt a-c essential bus on the flight engineer's overhead panel, through the pilot's instrument panel edge lighting variable autotransformer. Circuit protection is through the pilot's instrument light circuit breaker. The light is controlled by a 2-position ON-OFF switch located on the pilots' overhead panel (*figure 1-6*).

Thunderstorm Lights and Switch.

Two thunderstorm lights (*figure 4-17*) are provided for the pilot and copilot. One light is located above the pilot's station and one light is located above the copilot's station. The thunderstorm lights are both powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel, through a variable autotransformer placarded OFF and BRIGHT, located on the pilots' overhead panel (*figure 1-6*).

Intercall Lights and Switches.

Three amber 28-volt a-c press-to-test intercall lights, with respective momentary-contact pushbutton switches that energize all three lights simultaneously, are installed in the aircraft. The cockpit intercall light and switch (*24, figure 1-7*) is located on the pilot's main instrument panel. A second intercall light and switch is located on the side cargo door interphone control panel (*38, figure 4-10*). A third intercall light and switch is located on the rear cargo door interphone control panel (*29, figure 4-10*). The intercall lights are powered from the 28-volt a-c essential bus on the flight deck right hand auxiliary circuit breaker panel. The lights are wired through the warning lights dimming circuit so that they will be dimmed whenever the warning light dimming switches are positioned to DIM.

Warning Lights Dimming Switches.

Two 3-position warning lights dimming switches with the two placarded positions of DIM and BRIGHT, are installed. The switches are located, one on the pilots' overhead panel (*figure 1-6*), and one on the flight engineer's light control panel (*53, figure 1-13*). The switch is spring loaded to the center position and need only be held momentarily in the DIM or BRIGHT positions. The dimming of the indicator lights is accomplished by a dimming relay. When the dimming relay is energized, the circuits for all the indicator lights are switched through resistors to dim the lights. The dimming relays are energized by placing the two indicator lights dimming switches in the DIM position, which energize the holding coil in the relays. The dimming circuit is so designed that, if the lights are dimmed (relay energized), they can be returned to bright (relay deenergized) by three separate methods: positioning the dimming switches to BRIGHT, turning the pilots' or flight engineer's engine instrument lights variable autotransformer to OFF, then approximately one-quarter turn toward BRIGHT, or removing the power from the 28-volt d-c nonessential bus.

Crew Utility Lights and Switches.

Five 28-volt a-c crew utility lights, each controlled by a built-in ON-OFF switch contained in the unit, are installed in the flight compartment. The lights are located, one each, at the following stations: pilot's, copilot's, engineer's, navigator's, and naviagor's sextant. The lights are powered from the 28-volt a-c essential bus on the flight deck right hand auxiliary circuit breaker panel.

Oxygen Panel Lights and Switches.

Oxygen panel lights are provided for each of the ten oxygen regulators installed in the aircraft. The oxygen panel lights at each of the four flight crew stations are powered from the 115-volt a-c essential bus on the flight engineer's overhead panel, through the instrument panel edge lighting variable autotransformer at the respective crew station. The panel lights on the six regulators in the relief crew compartment are powered from the 28-volt d-c nonessential bus on the flight engineer's overhead panel, and are controlled by a 2-position ON-OFF switch located adjacent to the relief crew radio control panel.

Table Lights and Switches.

Two table lights (*figure 4-17*), one for the flight engineer and one for the navigator, are located in the flight compartment. The lights are powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel, through the variable autotransformers at the respective crew station. One table light is installed above the flight engineer's table and is controlled by the variable autotransformer, placarded OFF and BRIGHT, located on the flight deck control panel (*53, figure 1-13*). Rotating the autotransformer knob clockwise increases the brightness of the light. The remaining table light is installed above the navigator's table and is controlled in a similar manner at the navigator's light control panel *(9, figure 4-14).*

Flight Engineer's Panel Floodlights and Switch.

Two red floodlights (*figure* 4-17) are installed at the flight engineer's station. The lights are powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel through a variable autotransformer, placarded OFF and BRIGHT, located on the flight deck light control panel (*53, figure 1-13*).

Navigator's Panel Floodlight and Switch.

A red floodlight (*figure* 4-17) is installed at the navigator's station and is powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel through a variable autotransformer, placarded OFF and BRIGHT, located on the navigator's light control panel (*9, figure 4-13*).

Side Cargo Door Floodlights and Switch.

Two floodlights (*figure* 4-17) are installed at the side cargo door. One light is mounted on the fuselage wall, over the center of the door opening, and the other is mounted on the door in such a manner that it will focus down on the area immediately outside the door opening when the door has been raised. The lights are controlled by an ON-OFF switch located on the fuselage forward interphone control panel just aft of the side cargo door. The lights are powered from the 115-volt a-c nonessential bus on the center fuselage left hand circuit breaker panel.

Rear Cargo Door Hydraulic Control Panel Floodlight and Switch.

A floodlight (*figure* 4-17) is installed on the bulkhead just forward of the rear cargo door hydraulic control panel for illumination of the panel. The floodlight is controlled by an ON-OFF switch, located on the rear cargo door interphone control panel. The light is powered from the 28-volt a-c nonessential bus on the center fuselage left hand circuit breaker panel.

Cargo Ramp Floodlights and Switch.

Four floodlights (*figure* 4-17), installed above the cargo loading ramp area at the rear of the aircraft, are controlled by an ON-OFF switch located on the rear cargo door interphone control panel. The lights are powered from the 115-volt a-c nonessential bus on the center fuselage left hand circuit breaker panel.

Cabin Dome Lights and Switches.

The cabin is equipped with 32 dome lights (*figure* 4-17). Twelve of the lights are installed along the upper sides of each of the cabin walls in a staggered arrangement from the crew entrance door to the rear cargo ramp. Seven of the lights are installed in the tail area, and one is installed over the area between the crew lavatory and the left side of the cabin. Either of the two ON-OFF switches, one adjacent to the right side of the crew entrance door and the other located on the rear cargo door interphone control panel, may be used to control the lights. The right center, left forward, right aft, and left aft dome lights are powered from the 28-volt a-c nonessential bus on the center fuselage left hand circuit breaker panel. The right forward lights are powered from the 28-volt a-c nonessential bus on the flight deck right hand auxiliary circuit breaker panel. The lights are controlled through two 28-volt d-c control relays which are powered from the 28-volt d-c nonessential bus on the flight engineer's overhead panel.

Stairway Lights and Switches.

Two 28-volt a-c stairway lights are installed, one over the crew entrance door and the other over the flight deck ladder. The lights are powered from the 28-volt a-c nonessential bus on the flight deck right hand auxiliary circuit breaker panel, through the right forward dome light circuit breaker. The lights are controlled through the dome light control relay by ON-OFF switches located adjacent to the crew entrance door and the relief crew compartment door.

Forward Cabin Dome Lights and Switch.

Six 28-volt a-c dome lights (*figure* 1-17) are installed in compartment B, three on each side of the nosewheel well. The lights are powered from the 28-volt a-c nonessential bus, through the lower forward dome light circuit breaker on the flight deck right hand auxiliary circuit breaker panel. The lights are controlled through the dome light control relays by a 2-position ON-OFF switch located at the entrance to the B compartment.

Lavatory Lights and Switch.

Two tubular-type lights are mounted on the wall of the crew's lavatory and are controlled by an ON-OFF switch located on the same wall. The lights are powered from the 28-volt a-c nonessential bus on the flight deck right hand auxiliary circuit breaker panel.

Flight Deck Dome Lights and Switches.

Three dome lights (*figure 4-17*) are installed in the aft section of the flight deck; one in the relief crew compartment, one at the navigator's station and the other at the flight engineer's station. The light in the relief crew compartment is powered from the 28-volt a-c nonessential bus on the flight deck right hand auxiliary circuit breaker panel. The light is controlled by a built-in 3-position switch placarded WHITE, OFF and RED. The dome light at the navigator's station is powered from the 115-volt a-c nonessential bus on the flight engineer's overhead panel, through a variable autotransformer. It is controlled by the variable autotransformer and a 2-position switch (*9, figure 4-13*), both of which are located on the navigator's control panel. The light at the flight engineer's station is powered from the 115-volt a-c nonessential bus, through a variable autotransformer. It is controlled by the autotransformer and a 2-position switch located on the flight deck light control panel (*53, figure 1-13*). The switches at both stations are placarded RED and WHITE and the autotransformers are placarded OFF and BRIGHT. Normally the switches are operated individually, however, the lights may be turned ON or OFF as a group by the dome light master control switch located on the pilots' overhead panel (*figure 1-6*), providing the autotransformers are not OFF. The flight deck right hand auxiliary circuit is illuminated by a light controlled by the pilot's master dome light switch and a 2-position switch placarded RED and WHITE located adjacent to the light.

Cockpit Dome Lights and Switches.

The two dome lights (*figure 4-17*) installed in the cockpit are controlled by a 2-position switch mounted on the pilots' overhead panel (*figure 1-6*). The switch positions are RED and WHITE. The brightness of each of the lights is controlled by its respective variable autotransformer, placarded OFF and BRIGHT, one located on the pilot's overhead side panel (*1, figure 1-5*) and one located on the copilot's overhead side panel. The lights are powered from the 115-volt a-c bus on the flight engineer's overhead panel, through the variable autotransformers.

Relief Crew Reading Lights.

Five 28-volt a-c lights (*figure 4-17*) are installed in the relief crew compartment, three on the right side above the crew bunk, and two on the left side above the reclining seats. The lights are powered from the 28-volt a-c nonessential bus on the flight deck right hand auxiliary circuit breaker panel, and controlled by ON-OFF switches mounted in the light fixtures. Each light can be adjusted by loosening the lock screws on the face of the light assembly and rotating the ball to position the light beam as desired.

OXYGEN SYSTEM.

A liquid oxygen system (*figure 4-18*) is installed which supplies oxygen at a pressure of approximately 300 psi to the ten diluter-demand type oxygen regulators. It is a constant-pressure type system which supplies gaseous oxygen, on demand, by converting the liquid oxygen into gaseous oxygen through a regulated evaporation process.

WARNING

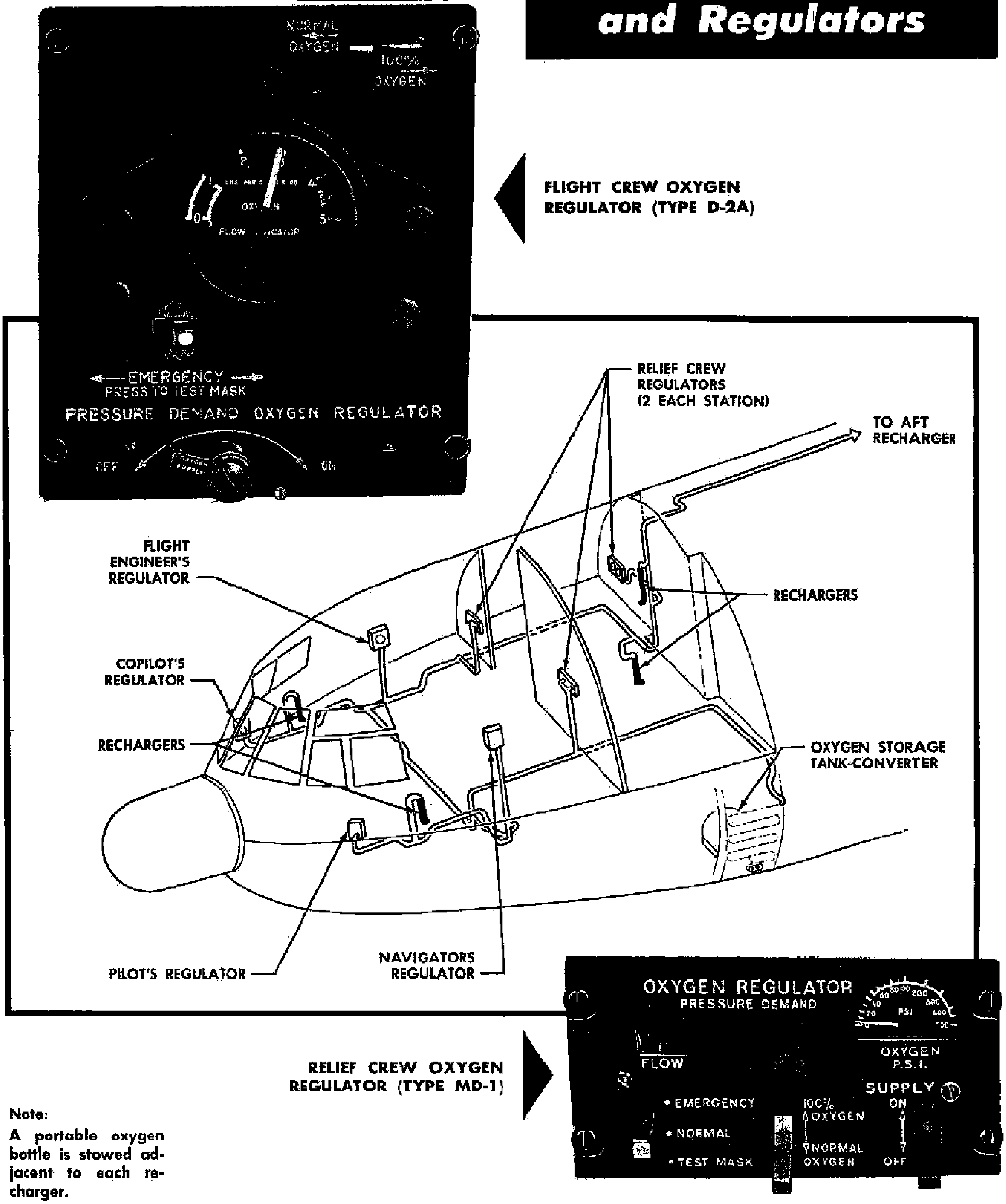
Liquid oxygen should be handled only by authorized personnel familiar with its properties and skilled in its use. Skin contact with liquid oxygen will result in severe burns. Liquid oxygen, in contact with combustible material such as clothing, grease, or oil, may explode.

OXYGEN DURATION TABLE.

The oxygen duration table (*figure 4-19*) shows a greater oxygen duration at higher altitude. This is due to the oxygen expansion to a greater volume at altitude than at sea level. This expansion is seven times greater at 40,000 feet than at sea level, therefore, more oxygen is available for breathing. With the oxygen diluter lever in NORMAL, the black figures show a progressive decrease in duration up to 25,000 feet because the D-2A regulator is feeding an increasing amount of oxygen to compensate for increase of altitude. Above 25,000 feet, the duration begins to increase because the increase in expansion of oxygen is greater than the increase in demand. At 28,000 to 32,000 feet, the D-2A regulator automatically starts to feed 100 percent oxygen, therefore, the red (100%) and black (NORMAL) figures are the same above this altitude.

The D-2A regulator automatically starts pressure-feeding of oxygen at 38,000 feet to offset the decrease of

Oxygen Supply System and Regulators



Note:
A portable oxygen bottle is stowed adjacent to each recharger.

Figure 4-18

oxygen pressure. Additional oxygen used during pressure-feeding accounts for the duration at 40,000 feet being the same as at 35,000 feet.

CREW OXYGEN SUPPLY.

The crew oxygen supply is contained in a 25-liter storage tank-converter *(figure 4-18)* located on the left side of the cabin below the relief crew compartment. The oxygen supply filler valve (*figure 1-44*) is located on the outside of the fuselage, forward of the side cargo door. A buildup and vent valve is located adjacent to the filler valve and is designed so that the filler valve access door cannot be closed unless the buildup and vent valve is in the BUILDUP position. When the aircraft is to be left standing for an extended period of time, especially during hot weather, the buildup and vent valve should be placed in the VENT position to prevent buildup of excessive pressures in the system.

Liquid Oxygen Quantity Indicator.

A liquid oxygen quantity indicator (*28, figure 1-7*) is located on the pilot's instrument panel. The indicator receives the indication of the oxygen level in the tank converter from a capacitance-type sensing element installed in the tank-converter. The indicating system is powered from the 115-volt a-c essential bus on the flight engineer's overhead panel.

Note

> Under normal operation, the oxygen pressure in the liquid oxygen system will not decrease with usage until the liquid oxygen supply is almost completely exhausted. Therefore, the liquid quantity indicator is the primary indication of oxygen depletion.

Liquid Oxygen Low-Level Warning Light.

A 28-volt d-c oxygen low-level warning light (*41, figure 1-7*) is located on the pilot's instrument panel. The light will come on to warn when the oxygen supply is less than 2½ liters. The light is powered from the 28-volt d-c essential bus on the flight deck left hand auxiliary circuit breaker panel.

Liquid Oxygen System Test Switch.

A push-button type liquid oxygen test switch (*41, figure 1-7*) is located on the pilot's instrument panel, below the liquid oxygen quantity indicator, to provide a means of checking the operation of the indicator. When the switch is pushed in, the pointer on the indicator will rotate counterclockwise, toward empty (allow about 15 to 20 degress of rotation). When the switch is released, the pointer should return to its original position.

FLIGHT CREW OXYGEN REGULATORS.

Four type D-2A diluter-demand oxygen regulators (*figure 4-18*) are installed, one of which is located at each flight crew station. Each regulator is equipped with a combination oxygen flow and oxygen pressure indicator, an oxygen supply lever, an oxygen diluter lever, and a combination emergency oxygen and mask test lever.

Oxygen Flow and Oxygen Pressure Indicator.

Each flight crew station oxygen regulator is equipped with a combination oxygen flow and oxygen pressure indicator. The pressure indicator occupies the upper half of the indicator dial, and consists of a movable pointer and a dial graduated in increments of 100 psi. The range of the pressure indicator is from zero psi to 500 psi. At the 450 psi graduation, the dial is placarded FULL. The blinker-type oxygen flow indicator occupies the lower half of the indicator dial. Black and luminescent segments alternately appear in slots in the indicator dial with each breath taken by the crew member, giving a visual indication that he is receiving oxygen from the regulator.

Oxygen Supply Lever.

Each flight crew station oxygen regulator is equipped with an oxygen supply lever. The supply lever has two positions, one of which is placarded OFF, and the other placarded ON. Turning the supply lever to the right turns the supply of oxygen on. Turning the supply lever to the left shuts off the supply of oxygen. The supply lever should be left in the OFF position whenever the oxygen regulator is not in use.

Oxygen Diluter Lever.

Each flight crew station oxygen regulator is equipped with an oxygen diluter lever. The diluter lever has two positions, one of which is placarded NORMAL OXYGEN, and the other placarded 100% OXYGEN. Moving the diluter lever to the left selects NORMAL OXYGEN for all normal usage. Moving the diluter lever to the right selects 100% OXYGEN for emergency use.

Emergency Oxygen and Mask Test Lever.

Each flight crew station oxygen regulator is equipped with a 3-position, combination emergency oxygen and mask test lever, placarded EMERGENCY and PRESS TO TEST MASK. Moving the lever either to the left or right of the center position permits oxygen to flow from the regulator under positive pressure for emergency use. Placing the lever in the center position shuts off the flow of oxygen under positive pressure and returns the oxygen regulator to normal diluter-demand operation. Pressing the lever in when it is in the center position permits oxygen to flow from the regulator under a positive pressure, which is greater than that obtained with the lever in either of the two emergency positions. The PRESS TO TEST MASK position is used to test the crew members oxygen mask and oxygen mask hose for leakage. When the lever is released from the PRESS TO TEST MASK position, it returns to the off position.

Note

When positive pressures are required, it is mandatory that the oxygen mask be well fitted to the face. Unless special precautions are taken to insure against leakage, continued use of positive pressures will result in the rapid depletion of the oxygen supply, and can also result in extremely cold oxygen flowing to the mask.

RELIEF CREW OXYGEN REGULATORS.

Six type MD-1 diluter-demand oxygen regulators (*figure 4-18*) are installed, two of which are located at each relief crew station. Each regulator is equipped with an oxygen flow indicator, an oxygen pressure indicator, an oxygen supply lever, an oxygen diluter lever, and a combination emergency oxygen and mask test lever.

Oxygen Flow Indicator.

Each relief crew station oxygen regulator is equipped with a blinker-type oxygen flow indicator, placarded FLOW. Black and luminescent segments alternately appear in the flow indicator window with each breath taken by the crew member, giving a visual indication that he is receiving oxygen from the regulator.

Oxygen Pressure Indicator.

Each relief crew station oxygen regulator is equipped with an oxygen pressure indicator, placarded OXYGEN P.S.I. The pressure indicator consists of a movable pointer and a dial graduated in increments of 10 psi from zero psi to 100 psi, and in increments of 100 psi from 100 psi to 500 psi.

Oxygen Supply Lever.

Each relief crew station oxygen regulator is equipped with a 2-position oxygen supply lever, placarded SUPPLY, which has the placarded positions ON, and OFF. Moving the supply lever up turns the supply of oxygen on. Moving the supply lever down shuts off the supply of oxygen. The supply lever should be left in the OFF position whenever the oxygen regulator is not in use.

Oxygen Diluter Lever.

Each relief crew station oxygen regulator is equipped with a 2-position oxygen diluter lever which has the placarded positions 100% OXYGEN and NORMAL OXYGEN. Moving the lever down selects NORMAL OXYGEN for all normal usage. Moving the diluter lever up selects 100% OXYGEN for emergency use.

Emergency Oxygen and Mask Test Lever.

Each relief crew station oxygen regulator is equipped with a 3-position, combination emergency oxygen and mask test lever, which has the placarded positions EMERGENCY, NORMAL, and TEST MASK. During normal operation, the lever is placed in the center, or NORMAL position. Moving the lever up, to the EMERGENCY position permits oxygen to flow from the regulator under positive pressure for emergency use. Moving the lever back to the NORMAL position shuts off the flow of oxygen under positive pressure and returns the oxygen regulator to normal diluter-demand operation. Moving the lever down, to the TEST MASK position, permits oxygen to flow from the regulator under a positive pressure, which is greater than that obtained with the lever in the EMERGENCY position. The TEST MASK position is used to test the crew member's oxygen mask and oxygen mask hose for leakage. After this test is made, the lever should be returned to the NORMAL position.

Note

When positive pressures are required, it is mandatory that the oxygen mask be well fitted to the face. Unless special precautions are taken to insure against leakage, continued use of positive pressures will result in the rapid depletion of the oxygen supply, and can also result in extremely cold oxygen flowing to the mask.

Oxygen Duration Table

MAN HOURS

BLACK FIGURES — NORMAL

RED FIGURES — 100%

CABIN ALTITUDE (FEET)	LITERS OF LIQUID OXYGEN								
	25	20	15	10	5	4	3	2	1
10,000	150.0	120.0	90.0	60.0	30.0	24.0	18.0	12.0	6.0
	42.9	34.2	25.6	17.1	8.5	6.8	5.1	3.4	1.7
15,000	150.0	120.0	90.0	60.0	30.0	24.0	18.0	12.0	6.0
	53.4	42.4	31.8	21.2	10.6	8.4	6.3	4.2	2.1
20,000	123.3	98.6	73.9	49.3	24.6	19.7	14.7	9.8	4.9
	66.5	53.2	39.9	26.6	13.3	10.6	7.9	5.3	2.6
25,000	109.2	87.2	65.4	43.6	21.8	17.4	13.0	8.7	4.3
	87.9	70.2	52.6	35.1	17.5	14.0	10.5	7.0	3.5
30,000	115.9	92.6	69.4	46.3	23.1	18.5	13.8	9.2	4.6
	114.1	91.2	68.4	45.6	22.8	18.2	13.6	9.1	4.5
35,000 & Above	156.1	124.8	93.6	62.4	31.2	24.9	18.7	12.4	6.2
	156.1	124.8	93.6	62.4	31.2	24.9	18.7	12.4	6.2

Figure 4-19

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OXYGEN SYSTEM PREFLIGHT CHECK.

The following should be accomplished prior to flight.

1. Oxygen Supply Lever — ON.

The pressure gage should read approximately 300 psi.

2. Oxygen Regulator — Check.

With the diluter lever first at NORMAL OXYGEN position and then at the 100% OXYGEN position as follows: Blow gently into the oxygen regulator hose as during normal exhalation. If there is slight resistance to blowing, the system is satisfactory. Little or no resistance indicates a faulty demand diaphragm or diluter valve.

3. Oxygen Diluter Lever — 100% OXYGEN.

4. Emergency Oxygen and Mask Test Lever — PRESS TO TEST MASK.

The oxygen flow indicator should indicate a continuous flow.

5. Flow Indicator — Check.

With the emergency oxygen and mask test lever depressed, block the end of the regulator hose with the hand. The flow indicator should indicate no flow.

6. Oxygen Mask — Connect to hose.

Check for 10- to 20-pound pull for disconnection. Recheck hose and check for breathing on both NORMAL OXYGEN and 100% OXYGEN.

7. Emergency Oxygen and Mask Test Lever — PRESS TO TEST MASK.

With mask in place, press the emergency oxygen and mask test lever and hold breath; the oxygen flow indicator should indicate no flow.

8. Emergency Toggle Lever — Release.

9. Oxygen Diluter Lever — NORMAL OXYGEN. The system is now ready for use.

PORTABLE OXYGEN BOTTLES.

Five type MA-1 pressure-demand portable oxygen bottles are provided. One portable oxygen bottle is located at the pilot's station, one at the copilot's station, one at the side of the buffet in the relief crew compartment, one in the lavatory, and one on the right wall of the cargo compartment, just forward of the power distribution panel. Each portable oxygen bottle is equipped with a clip for attaching the bottle to the clothing of the crew member using it, a type A-21 regulator containing a pressure indicator and pressure regulating knob, and an adapter for recharging the bottle.

Portable Oxygen Bottle Rechargers.

Five portable oxygen bottle rechargers *(figure 4-18)* are provided, one adjacent to each portable oxygen bottle location. One recharger is located at the pilot's station, one at the copilot's station, one at the side of the buffet in the relief crew compartment, one in the lavatory, and one on the right wall of the cargo compartment, just forward of the power distribution panel.

OXYGEN SYSTEM — NORMAL OPERATION.

The oxygen supply lever should be ON and the oxygen diluter lever should be at the NORMAL OXYGEN position.

OXYGEN SYSTEM EMERGENCY OPERATION.

If 100 percent oxygen is desired, set the oxygen diluter lever to the 100% OXYGEN position. If an oxygen regulator at a flight crew station becomes inoperative, move the emergency oxygen and mask test lever either to the left or right of the center position, or press the lever IN, in the center position and hold it, for maximum pressure. If an oxygen regulator at a relief crew station becomes inoperative, move the emergency oxygen and mask test lever up, to the EMERGENCY position, or down, to the TEST MASK position for maximum pressure.

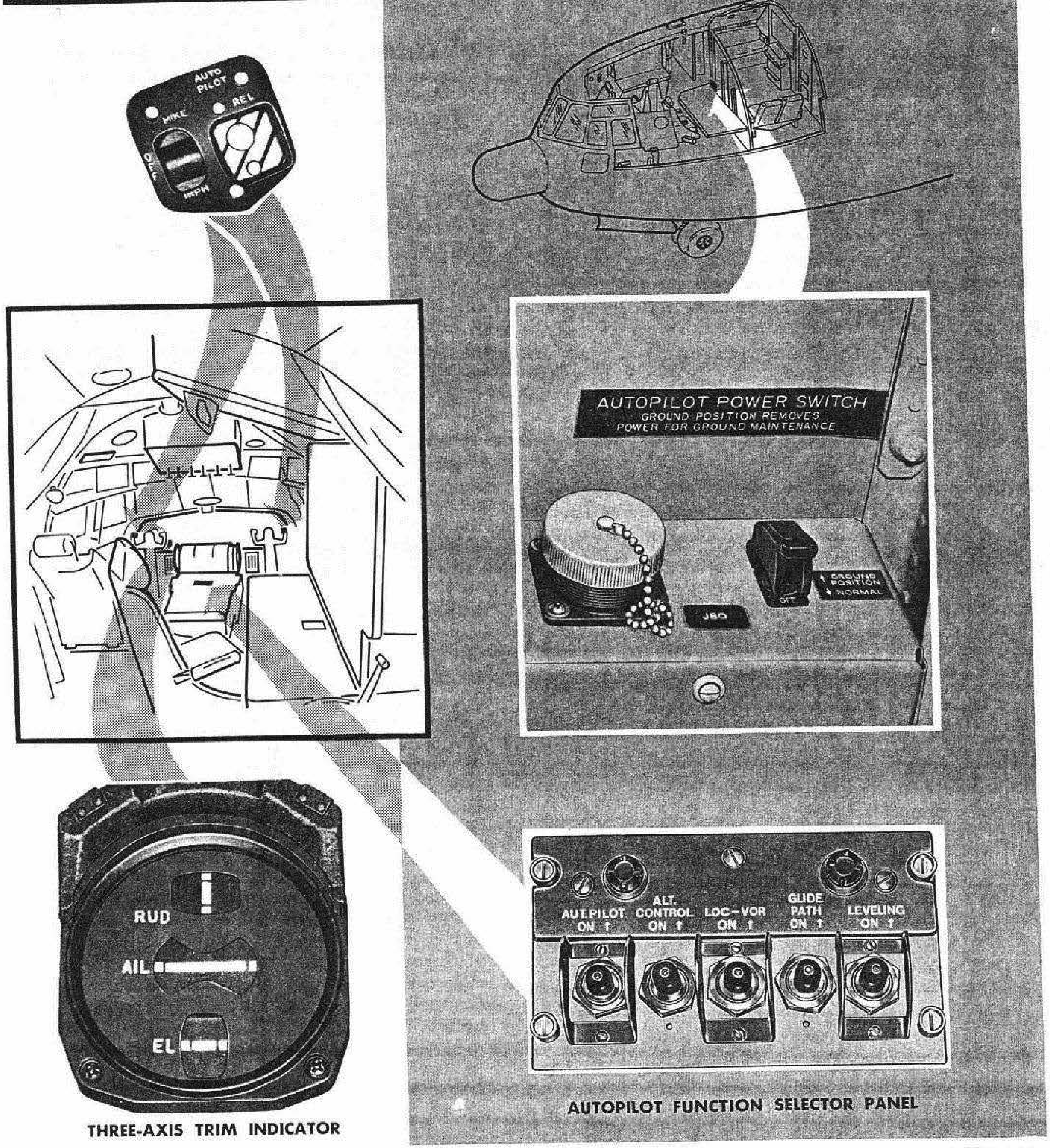
Note

When use of 100% OXYGEN or the use of the emergency toggle lever becomes necessary, the pilot should be informed of this action. Use of 100% OXYGEN or use of the emergency toggle lever will reduce oxygen duration of the aircraft. After the emergency is over, set the oxygen diluter lever to NORMAL OXYGEN and, if the emergency toggle lever was used, close the emergency valve by moving the emergency toggle lever to the center position.

AUTOPILOT (AIRCRAFT AF59-528 AND SUBSEQUENT AND AIRCRAFT WITH T.C.T.O. 518).

The MB-7 autopilot is a gyroscopically controlled, electrically actuated system which automatically operates the flight controls to maintain a stabilized attitude and a selected flight path. The modes of autopilot operation are as follows: Standby, Autopilot Engage, Altitude Control, Localizer-VOR, Glide Slope and Leveling. In addition, the system provides stick steering, automatic pitch trim, and TACAN beam tracking. The autopilot may be engaged when the aircraft is in any normal flight attitude, and may be used, during climbs, descents, in the power approach configuration (25 degrees flap), and in the cruise configuration at speeds up to 274 knots and a Mach of 0.56 (see Airspeed Limitations, Section V). However, it is recommended that the autopilot not be used when making jet penetrations since the autopilot is limited in its ability to maintain trim requirements during this maneuver. The electrical controls for selecting the desired mode of operation are located on the autopilot function selector panel (*figure 4-20*) on the control pedestal. Stick steering functions on only the pitch and roll axes, however, the autopilot will control the rudder to provide coordinated flight. If miscoordination is desired, the rudder servo must be overpowered manually. The autopilot limits are 20-degrees pitch and 30-degrees bank. Should stick steering control exceed these limits or if the autopilot is engaged in excess of these limits, the aircraft will return to approximately the specified limits when the control wheel is released. When the control wheel is released at any pitch angle within 20 degrees and a bank angle between 8 and 30 degrees, this attitude will be maintained. When roll is introduced by gusts, with the leveling switch engaged, the aircraft will automatically level so that heading control is maintained. When a roll of less than 8 degrees is induced through bank stick steering, the aircraft will automatically return to level flight and any new heading reference existing at the instant the control wheel is released. Power is supplied to the autopilot equipment from the nonessential 200-volt, 3-phase a-c bus through a 3-phase

Autopilot Controls and Indicators



AUTOPILOT FUNCTION SELECTOR PANEL

THREE-AXIS TRIM INDICATOR

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Figure 4-20

circuit breaker on the flight engineer's overhead panel and by the autopilot power switch on the autopilot J-box.

WARNING

When climbing at speed for best rate of climb or when cruising at at constant true airspeed, the stall margin decreases with increasing altitude. In the event of an autopilot nose-up hardover during climbs, or while cruising at altitudes above 26,000 feet, recovery should be initiated immediately since the aircraft may reach stall in less than the normal 3-second response time. For cruise at altitudes of 26,000 feet or less, 3 seconds or more are available prior to reaching stall.

AUTOPILOT POWER SWITCH.

A 2-position, guarded autopilot power switch (*figure 4-20*) is located on top of the autopilot junction box, to the left of the navigator's table. The switch positions are placarded NORMAL (guard down) and GROUND POSITION. This switch must be in the NORMAL position any time the engines are operating to prevent damage to vertical gyros. However, the switch should be in the GROUND POSITION whenever the engines are not operating, to prevent excess wear on the equipment.

AUTOPILOT ENGAGE SWITCH.

A 2-position, solenoid-held autopilot engage switch (placarded AUT.PILOT) is located on the autopilot function selector panel (*figure 4-20*). When the switch is positioned to ON, automatic control of the aircraft about its three axes, automatic pitch trim, and heading control are provided. Through an interlock system all modes of operation except STANDBY are inoperable when this switch is in the OFF position.

Note

If power to the autopilot is interrupted during flight, the aircraft should be flown in a level attitude, power applied to the autopilot, and level flight maintained for at least 3 minutes to allow proper erection of the vertical gyro. The autopilot may then be reengaged.

AUTOPILOT RELEASE SWITCHES.

Two autopilot release switches (*figure 4-20*), one located on each control column wheel, permit either pilot to disengage the autopilot system from the flight controls.

ALTITUDE SWITCH.

A 2-position, solenoid-held altitude switch (placarded ALT-CONTROL) is located on the autopilot function selector panel (*figure 4-20*). When the switch is positioned to ON, it selects the existing barometric altitude and controls the aircraft to maintain this altitude during turns or straight and level flight. An interlock system prevents operation of the altitude conrol when the autopilot engage switch is OFF. Another interlock disengages the altitude control when the glide slope switch is positioned to ON. However, if a change of alitude is made through control stick steering, the altitude control switch will remain in the ON position and a new reference altitude will result upon release of the control wheel. Altitude control may be engaged during normal rates of climbs or descents, however, an initial overshoot will result before the aircraft returns to the altitude at which the switch was engaged.

Note

During flap extension (with the ALT CONTROL switch ON), a ballooning effect will be noted, followed by aircraft return to reference altitude. The reverse is true on flap retraction.

Note

After sustained period of flight with the altitude control ON, a ballooning effect may be experienced. The altitude will gradually increase to approximately 20 to 30 feet above the reference altitude and then return to the reference altitude. This condition is recurrent and may be corrected in flight by draining the static system. The autopilot air data control is on the copilot's secondary static system and the drain valve for the air data control is located at station 135 on the right hand side. Drain the static line only.

CAUTION

Place the altitude control switch in the OFF position before draining the static lines to prevent erratic operation of the autopilot while the drain valve is open.

LOC-VOR CONTROL SWITCHES.

LOCALIZER-VOR/TACAN Control Switch.

A 2-position, solenoid-held LOCALIZER-VOR/TACAN control switch (placarded LOC-VOR) is located on the autopilot function selector panel (*figure 4-20*). Positioning of the switch selects TACAN or VOR-ILS modes of operation depending on the position of the VOR-ILS/TACAN selector switch.

VOR-ILS/TACAN Selector Switch.

A 2-position VOR-ILS/TACAN selector switch (*figure 4-20*) (placarded INST. SELECT.) is located on the pilots' control pedestal. The switch has the placarded positions TACAN and VOR-ILS. Lights adjacent to the switch placards indicate the mode of operation selected. Placing the switch in the VOR-ILS position selects course information from the VOR receiver for presentation on the course indicators and for beam tracking. Placing the switch in TACAN position selects course information from the TACAN receiver.

VOR/TACAN Operation.

Placing the LOC-VOR switch in the ON position will disengage the LEVELING switch and engage the VOR or TACAN coupler. The autopilot will intercept the desired course of the VOR or TACAN station selected, providing the desired course is set in the course window of the ID-351 indicator. The tracking information for the ID-351 indicator for autopilot command is selected with the VOR-ILS/TACAN radio selector switch (*17, figure 4-12*) located on the pilots' control pedestal.

Note

The appearance of a red flag on the CDI (ID-351) will indicate to the pilot that automatic flight control to the selected station is no longer reliable.

Engagement can be made at any bank angle up to the limits of the autopilot. An interlock system will disengage VOR or TACAN switch if LEVELING switch is positioned to ON. (Engagement of LOC-VOR switch will disengage LEVELING switch; engagement of LEVELING switch will disengage LOC-VOR switch.) Course interception will result from:

1. A 60-degree intercept angle to the selected course, 30 miles from the station.

2. A 90-degree intercept angle to the selected course, 50 miles from the station.

3. A 135-degree intercept angle to the selected course, 125 miles from the station.

When engaging VOR and TACAN in all the preceding intercepts, the pointer should normally be approximately one and one-half dots from the center of the indicator (ID-351). On engagement, the autopilot will turn toward the station which may be away from the CD1, until heading and course displacement signals cancel. The autopilot then will turn the aircraft to intercept the beam.

When station passage is imminent, disengage the LOC-VOR switch. When a stable indication on the CDI is observed, reengage the LOC-VOR switch to intercept desired outbound course. If the preceding disengagement is not accomplished, bank angles up to 25 degrees and undesirable heading changes may be experienced during over-the-station operation.

LOC-ILS Operation.

Placing the LOC-VOR switch to ON will disengage the leveling switch, and automatic interception of the localizer course of the selected ILS station will then be accomplished. Engagement can be made at any bank angle up to the limits of the autopilot. Automatic ILS back course approaches are not possible. The interlock system will disengage the LOC-VOR switch if the leveling switch is positioned to ON. Localizer course intercepts will result from:

1. A 45-degree intercept angle to the localizer, 8 miles from the station.

2. A 50-degree intercept angle to the localizer, 12 miles from the station.

3. A 90-degree intercept angle to the localizer, 20 miles from the station.

4. A 135-degree intercept angle to the localizer, 25 miles from the station.

ID-351 Turn Procedure.

The course set knob on the ID-351 indicator may be used for small increments of turn as follows:

1. VOR and TACAN — OFF.

2. Autopilot — ENGAGED.

3. ID-351 Course Set Knob —SET AT DESIRED HEADING IN ID-351 WINDOW.

4. LOC-VOR Switch — ON.

   a. If the heading set in the ID-351 window is the same as the aircraft heading the aircraft will continue on approximately the same course.

b. If ID-351 and aircraft headings are different, the aircraft will fly approximately the same course as set in the ID-351 window.

c. The course set knob may be adjusted to make desired changes in headings.

d. Errors of up to ±5 degrees between the ID-351 window heading and the N-1 compass repeater indicator heading are possible, therefore, the N-1 compass headings should be used for navigation of the aircraft.

Polar Grid Navigation.

Polar grid navigation techniques, using the ID-351 heading control, are the same as normal heading control operations.

GLIDE SLOPE SWITCH.

A 2-position, solenoid-held glide slope switch (placarded GLIDE PATH) is located on the autopilot selector panel (*figure 4-20*). When the switch is positioned to ON, the autopilot controls pitch attitude of the aircraft to hold the aircraft on the glide slope, control stick steering is locked out, and altitude hold switch is disengaged. An interlock prevents engagemen of the glide slope switch unless the LOC-VOR switch is ON and the ARN-14 radio is tuned to a localizer frequency. It is recommended that engagements to the glide slope be made at the published fix and altitude. This will generally result in engagements 1100 and 3000 feet above field elevation. If the glide slope is engaged above 3000 feet, the glide slope switch may be turned OFF, and then ON at intervals of approximately every 1500 feet of descent, to obtain more positive control by starting the altitude compensation on a new cycle. Oversensitive operation on the glide slope will be obtained when engaging below 1100 feet because of high gain settings of the autopilot in the final phases of the approach. Disengagement of the autopilot at minimum approach altitude is accomplished by either of the autopilot release switches (*figure 4-20*) on both control column wheels or by the autopilot engage switch.

LEVELING SWITCH.

A 2-position, solenoid-held leveling switch is located on the autopilot function selector panel (*figure 4-20*). This switch should be used during flight in turbulent air when it is desired to maintain a constant heading. In the ON position, this switch maintains heading during gust displacements in excess of an 8-degree bank angle. An interlock system disengages the leveling switch when pilot effort is applied in the roll axis and the bank angle exceeds 8 degrees, or if the LOC-VOR switch is positioned to ON. The interlock system will also disengage the LOC-VOR switch when the leveling switch is positioned to ON. The leveling switch may be used to roll out of a turn. However, several oscillations in heading may occur before stabilization. If the leveling switch is disengaged prior to heading and wings level stabilization, the airplane may assume a new bank angle and continue to turn depending upon conditions at the moment of disengagement.

AUTOPILOT THREE-AXIS TRIM INDICATOR.

The three-axis trim indicator (*figure 4-20*) is located on the lower right-hand corner of the pilot's instrument panel. Prior to engagement of the autopilot, the three-axis trim indicator indicates the synchronized condition of the autopilot. If the indices are not aligned, a malfunction exists and the autopilot should not be engaged. After engagement of the autopilot, the indicator shows the trim condition between the autopilot and the aircraft. If the rudder or aileron indices are not aligned, they may be centered by manual trimming, using the rudder or aileron trim wheels (the elevator is automatically trimmed). It is recommended that manual trimming should only be accomplished with autopilot disengaged. With the autopilot engaged, a cross check of the turn and slip indicator should be made as a further indication of an out of trim condition of the aircraft. Disengagement of the autopilot in an out of trim condition will result in a disengage transient.

CONTROL STICK STEERING OPERATION.

After the autopilot is engaged, changes in pitch or bank can only be made by the use of stick steering. During pitch or bank angle changes, the autopilot pitch axis or roll axis will be disengaged until the control wheel is released. During VOR, ILS and glide slope operation, bank stick steering is inoperative. During glide slope operation, pitch stick steering is also inoperative.

Hardover Recovering Techniques.

Aileron and elevator hardovers should be recovered by use of control stick steering. The autopilot should be disengaged whenever a hardover is experienced; disengagement may be accomplished either before, after, or during the recovery.

Rudder hardovers should be manually overpowered and the rudder returned to neutral position before disengaging the autopilot.

CAUTION

To preclude the possibilty of the autopilot subsequently malfunctioning and introducing a hardover signal which may exceed structural limits, do not re-engage the autopilot after a hardover has been experienced.

AUTOPILOT — NORMAL OPERATION.

1. Aircraft — Trim.

2. Autopilot Three-axis Trim Indicator — Pointers centered.

3. AUT-PILOT Switch — ON.

4. Altitude Control Switch — ON (if desired).

5. Leveling Switch — ON (if desired, to maintain heading during turbulent air operation).

CAUTION

On those aircraft equipped with rudder vortex generators, structural protection throughout the speed range is provided by the rudder stops. If airspeed is above 168 knots IAS and the 18½ degrees rudder warning strip comes on, the autopilot should not be operated. This is to preclude the possibility of the autopilot subsequently malfunctioning and introducing a hardover signal into the rudder and exceeding structural limits.

Disengaging Autopilot.

1. AUT-PILOT Switch — OFF.

This will release all modes of operation except standby (control wheel autopilot release switches may also be used).

NAVIGATION EQUIPMENT.

N-1 COMPASS SYSTEM.

The N-1 compass system is a remote indicating, directional reference system consisting of the following units.

1. A master indicator located on the navigator's console (*8, figure 4-13*).

2. Two repeater indicators located on the main instrument panel (*14 and 51, figure 1-7*).

3. A compass transmitter located in the tail cone (*26, figure 4-10*).

4. A compass signal amplifier (ME-1A) and a N-1 compass amplifier, both located in the forward electronic rack (*8, figure 4-10*).

5. A slaving control, also located in the forward electronic rack.

6. N-1 compass directional gyro located below the navigator's table.

It may be operated in either of two modes: as a gyro-stabilized magnetic compass, responding to the influence of the earth's magnetic field; or as a gyro-controlled directional indicator deslaved from the earth's magnetic field and incorporating a servo mechanism which automatically corrects for gyro precession and apparent gyro drift due to the earth's rotation. This automatic correction of the apparent gyro drift enables the aircraft to fly a TRUE heading relative to the earth's surface (describe a great circle route). Selection of either mode of operation is made by means of the latitude correction knob on the face of the master indicator (*figure 4-21*) installed at the navigator's station. When the latitude correction pointer is in the OFF position, the system functions as a gyro stabilized magnetic compass. When the latitude correction pointer is in any position other than OFF (latitude correction set in), the system functions as a gyro-controlled directional indicator, which is extremely valuable in high altitudes and areas of weak or distorted magnetic signals.

The N-1 compass system also provides directional reference for the autopilot and, through the master indicator, supplies directional signals to operate the pilot's and copilot's directional repeater indicators, which reflect the mode of operation selected by the navigator on the master indicator. The N-1 compass system is powered from 28-volt d-c and 115-volt, 3-phase a-c essential busses located on the flight engineer's overhead panel. (See N-1 Compass System, Section VII for principles of operation.)

N-1 Compass Master Indicator.

The N-1 compass master indicator (*figure 4-21*) is installed at the navigator's station. The master indicator has a compass card, heading pointer, annunciator pointer and dial, synchronizer knob, latitude correction pointer and dial, latitude correction knob, and a servo dot. The annunciator dial is marked L-R, and the annunciator pointer will indicate whether the heading pointer is left or right of the correct magnetic heading when the N-1 is operating in the magnetic function. The synchronizer knob has two purposes: (1) when operating in the magnetic function, it is used to reset the heading pointer when the annunciator pointer indicates that the heading pointer has drifted off the correct magnetic heading, and (2) when operating in the gyro controlled function, it is used to rotate the heading pointer to the desired true heading. The latitude correction dial in the center of the instrument face is graduated from 90 degrees N on the left up to zero degrees and then down to 90

N-1 Compass Master Indicator

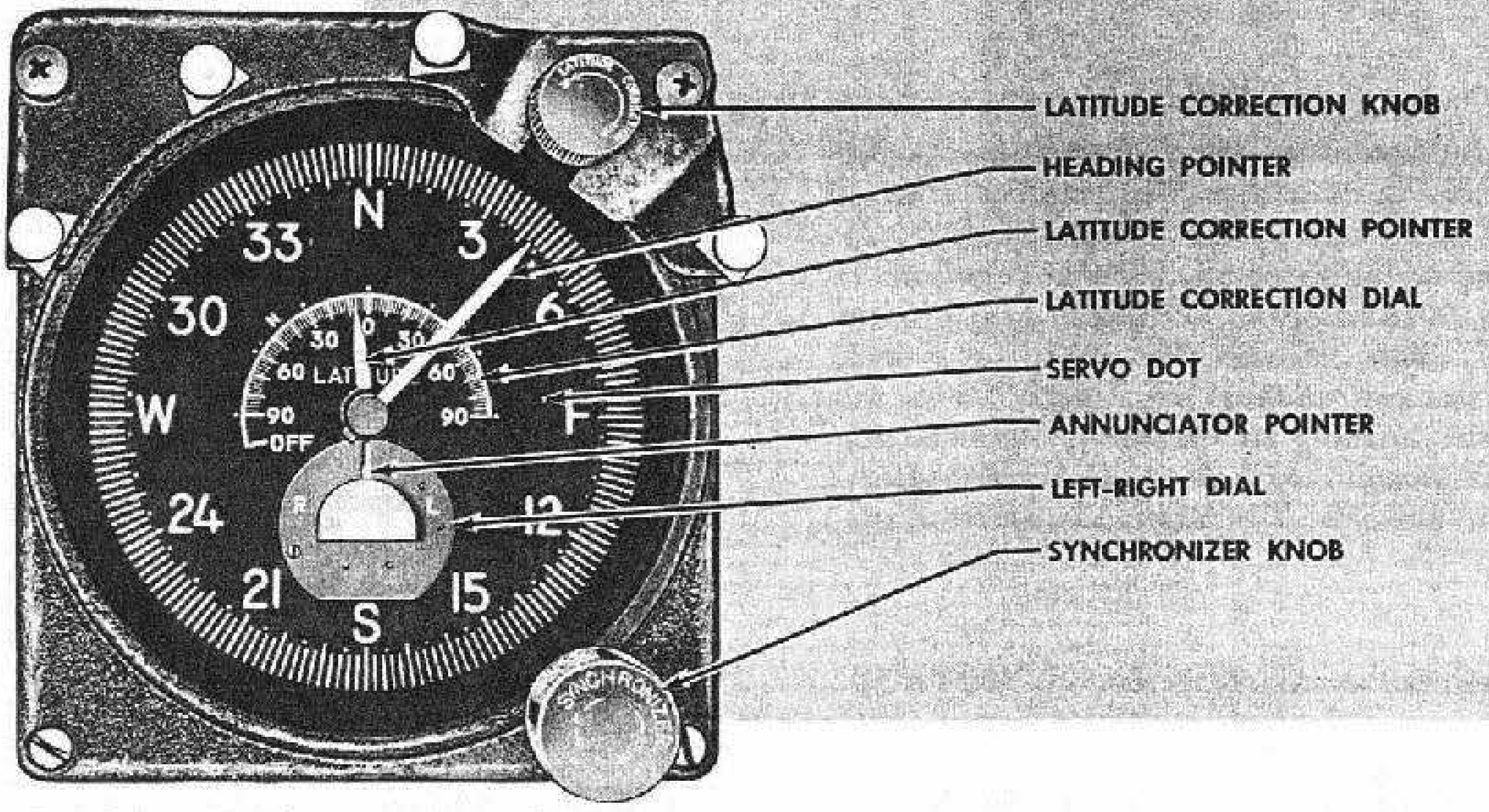

Figure 4-21

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degrees S on the right. The latitude correction pointer is controlled by the latitude correction knob at the upper right corner of the instrument. When the proper latitude correction (corresponding to the area of aircraft operations) is set in, the heading pointer reflects this correction of apparent gyro drift due to the earth's rotation, and indicates the true heading. The servo dot is located next to the E marker on the instrument face, and oscillates or rotates when the instrument is correcting itself for error.

Note

> The autopilot relies on signals from the N-1 compass master indicator; therefore the pilot should be notified before any changes are made to the indicated headings of the master heading pointer.

Repeater Indicators.

Two repeater indicators *(14 and 51, figure 1-7)* are located on the pilots' instrument panel, one for the pilot and one for the copilot. Both indicators have knobs installed which may be used to rotate the compass card and heading pointer around to place the desired heading under the instrument index. Both indicators repeat the heading and mode of operation selected by the master indicator.

N-1 Compass Power-Off Warning Lights.

Two 28-volt a-c compass power-off warning lights will come on if power is not being supplied to the N-1 compass system. One is located adjacent to the master indicator (*8, figure 4-13*) on the navigator's console and the other (*12, figure 1-7*) is located on the pilot's instrument panel. The lights are powered from the 28-volt a-c essential bus on the flight deck right hand auxiliary circuit breaker panel. Control is through the d-c power relay which is powered from the 28-volt d-c essential bus on the flight engineer's overhead panel.

ME-1A Compass Signal Amplifier.

The ME-1A compass signal amplifier is installed as a part of the N-1 compass system, to enable the repeater indicator output of the N-1 system to be capable of driving more than the normal four repeater indicators. The signal amplifier provides 26- and 36-volt synchro excitation in addition to the power to drive a maximum of 20 synchro repeaters from the single source in the N-1 compass master indicator. All of the RMI cards plus the localizer deviation indicator are driven through the ME-1 amplifier to provide azimuth reference.

N-1 COMPASS SYSTEM PREFLIGHT.

1. Power Supply — ON (power-off warning light — OFF).

2. Latitude Correction Pointer — OFF.

3. Master Indicator Heading — SYNCHRONIZED.

Synchronize the master indicator heading with the DT-173 AJN remote compass transmitter.

Note

> Synchronization is accomplished by engaging and rotating the synchronizer control knob, thus rotating the heading pointer on the master indicator until the annunciator is zeroed. The master indicator heading pointer should then indicate the correct magnetic heading; any serious divergence from the magnetic heading should be investigated for possible local magnetic disturbances affecting the DT-173 AJN remote compass transmitter.

4. Synchronizer Control Knob — ROTATE.

Engage control knob and rotate the master indicator in a clockwise direction.

Note

> The master indicator heading pointer should follow clockwise.

5. Master Indicator Heading Pointer — SET.

Set pointer 3 to 5 degrees to the right of the magnetic heading.

Note

> The annunciator pointer should move to the right of center (approximately 30 degrees) into the area marked L. The position of the annunciator pointer in the L area indicates that the synchronizer control knob and the master indicator heading pointer are to be rotated to the left (counterclockwise) to synchronize the instrument.

6. Servo Correction Indicator (white dot seen through the opening near the E mark on the master indicator dial) — ROTATING COUNTERCLOCKWISE.

Note

> The servo correction indicator should rotate counterclockwise (during rotation of the synchronizer control knob to the left) to indicate that the correction servo motor is rotating in that direction, and is returning the master indicator heading pointer to the correct magnetic heading. The heading pointer should return slowly to its original heading and the annunciator should approach the center position.

7. Synchronizer Control Knob — ROTATE.

Engage and rotate in a counterclockwise direction. The master indicator heading pointer should follow in the same direction. Set the heading pointer 3 to 5 degrees to the left of the magnetic heading. The annunciator pointer should move to the left of center (approximately 30 degrees) into the area marked R. The position of the pointer in the R area indicates that the synchronizer control knob and the master indicator are to be rotated to the right (clockwise) to synchronize the instrument.

8. Servo Correction Indicator — ROTATING CLOCKWISE.

Note

> This indicates that the system is correcting in the proper direction to return the master indicator pointer to the correct magnetic heading. The heading pointer should return slowly to its original heading and the annunciator should approach the center position.

9. Latitude Correction Control Knob — ROTATE TO 90 DEGREES N.

Rotate the latitude correction pointer to 90 degrees N. and observe that the latitude correction pointer rotates clockwise.

10. Latitude Correction Control Knob — ROTATE SLOWLY TO ZERO DEGREES.

Slowly rotate the latitude correction pointer to zero degrees. Observe that the speed of the correction servo indicator gradually diminishes and stops completely when the 0- degree position of the latitude correction pointer is reached.

11. Latitude Correction Control Knob — ROTATE TO 90 DEGREES S.

Continue to rotate the latitude correction pointer to 90 degrees S. Observe that the servo correction indicator rotates counterclockwise with speed of rotation reaching a maximum at 90 degrees S.

12. Latitude Correction Control Knob — SET.

Set latitude correction pointer on local latitude.

13. Directional Gyro — ROTATE MANUALLY.

Manually rotate the directional gyro in a horizontal plane about its vertical axis, first clockwise, then counterclockwise, as far as its shock mounts will permit (about 2 degrees). The master indicator heading pointer should follow accordingly. This is an indication that the azimuth signal circuit is functioning.

14. Repeater Indicator (pilot's station) — CHECK.

Check indicator by rotating the synchronizer control knob on the master indicator 360 degrees, first clockwise, then counterclockwise. The pointer should follow the master indicator heading smoothly, without sticking or lagging.

15. Magnetic Slaved Operation — CHECK SYNCHRONIZATION.

For magnetic slaved operation, proceed as follows: Place the latitude control knob in the OFF position and check that the system is synchronized by observing that the master indicator pointer is indicating the correct magnetic heading, and that the annunciator is at the center position.

16. Latitude Correction and Master Indicator Heading Pointers — SET FOR DIRECTIONAL INDICATION (GYRO) OPERATION.

a. Latitude Correction Control Knob — Set the latitude correction pointer to the local latitude.

b. Synchronizer Control Knob — Engage and adjust the master indicator heading pointer to the desired heading.

NORMAL OPERATION — MAGNETIC SLAVED.

1. N-1 Compass Power-Off Warning Light — OFF.

Note

Allow 10 minutes for warmup.

2. Master Indicator — SYNCHRONIZE (see N-1 Compass System Preflight this Section).

3. Master Indicator Heading — CHECK.

Check against some known heading reference (such as runway heading, etc.) for approximate agreement of magnetic heading.

Note

During magnetic slaved operation the following procedures should be observed.

a. Check that the correction servo indicator is rotating.

b. The annunciator pointer may oscillate R (right) and L (left) as a result of yaw of aircraft. This indicates proper operation of the correction servo.

c. Do not attempt to synchronize the system during or immediately after a turn.

NORMAL OPERATION — DIRECTIONAL INDICATOR (GYRO).

1. Latitude Correction Pointer — SET.

Set on latitude of aircraft position.

2. Correction Servo Indicator — CHECK FOR CORRECT ROTATION.

The indicator rotates clockwise in north latitudes and counterclockwise in south latitudes.

3. Master Indicator Heading Pointer — SET TO DESIRED GYRO HEADING.

Note

During directional indicator (gyro) operation, the following procedures should be observed.

Note

The autopilot relies on signals from the N-1 compass master indicator, therefore the pilot should be notified before any changes are made to the indicated heading of the heading pointer.

a. The latitude correction pointer should indicate ±1 degree of the aircraft position at all times.

b. The latitude correction pointer should be changed to mid-latitude for each 2 degrees change in latitude.

c. Observe that the correction servo indicator is rotating to indicate proper operation of the correction servo: clockwise for north latitudes and counterclockwise for south latitudes.

STANDBY COMPASS.

The standby compass (*9, figure 1-5*) is a conventional magnetic compass that may be used in determing the magnetic heading of the aircraft. The compass is located on the centerline of the aircraft directly above the pilots' instrument panel, and is shock mounted to a bracket. A light and shield assembly is installed to provide indirect illumination. Since this unit is a simple magnetic device, its accuracy will be affected by changes or variations in the electromagnetic flux of nearby electrical wiring. It is therefore used only under emergency conditions as a standby source of directional information.

Deviation can be reduced in the standby compass while in flight by changing position of the small compensating magnet screws in the face of the compass case; however, it is usually not possible to remove all the deviation on all headings. Remember to use a non-magnetic screwdriver when making any adjustments.

PERISCOPIC SEXTANT.

A periscopic sextant (*10, figure 1-2*) is provided in the aircraft for celestial navigation purposes. A mount provided for the periscopic sextant is located on the centerline of the fuselage, overhead, between the navigator's two sextant windows. When not in use, the periscopic sextant is stowed under the navigator's table.

Note

> The periscopic sextant may be used to visually check the engines and upper portions of the wing and fuselage by pushing the sextant mount cover handle forward and inserting the sextant into the mount until the safety latch catches. The wing leading edge scanning lights must be turned on for night viewing.

Installation of Periscopic Sextant.

The following installation procedures are accomplished with a SLIGHT upward pressure on the sextant:

1. With the azimuth locking lever in the left or unlocked position, insert the sextant into the mount with the arrows of the sextant tube and index in alignment.

2. Slip the tube up into the mount as far as possible and rotate the lower ring of the mount clockwise until the lug on the tube enters the slot in the mount.

3. Pull the retractable plunger, placarded TO INSERT — REMOVE PULL and rotate the lower ring of the mount counterclockwise until the sextant is free to rise vertically. Withdraw the shutter by moving the lever of the mount to the open position. Push the sextant up into the mount until the knob, placarded TO RETRACT SEXTANT PULL, snaps into place. When pressurized, do not permit sextant to snap into locked position when shutter is withdrawn.

CAUTION

> Do not force the sextant against the shutter of the mount.

4. To lower or remove the sextant, release the knob, placarded TO RETRACT SEXTANT PULL, and gently lower the sextant so that it remains suspended in the mount in the retracted position.

CAUTION

> Do not remove the sextant from the mount until the shutter is closed. When flying in turbulent air the sextant should not be allowed to remain in the retracted position.

Mount Alignment Check.

1. Set 180° into the azimuth dial window.

2. Sight on the center of the Grimes light. The true heading scale should read 000°.

3. If the vertical crosshair does not align the zero:

   a. Sight on the stabilizer and lock the sextant in this position with the clamping lever.

   b. Loosen the lock ring of the true heading scale objective lens and turn the adjusting ring until the vertical crosshair shifts to the zero true heading reading. Tighten the lock ring.

   c. If the full adjustment of the true heading scale objective lens does not correct the true heading to zero, the mount has been improperly installed. Maintenance personnel should be called upon to make further mount alignment corrections. The sextant mount is usable even if this condition exists; however, a correction must be applied to all true heading checks.

CARGO LOADING EQUIPMENT.

The aircraft is equipped to handle diversified types of cargo and a variety of loading equipment by means of hydraulically actuated rear cargo doors and ramp and a side cargo door. On the C-133A, the rear cargo doors consist of an aft door (*29, figure 1-2*) which is raised upward within the fuselage aft section, and a ramp (*30, figure 1-2*). On the C-133B, the rear cargo doors consist of two clamshell doors (*28, figure 1-2*) which swing outward from the side of the fuselage, a ramp (*30, figure 1-2*), and an aft door (*29, figure 1-2*), located directly aft of the clamshell doors, which is raised upward into the fuselage.

On both the C-133A and the C-133B, the ramp may be positioned at floor lever to permit truck bed height loading, or lowered to ground level to permit vehicular access. Treadways, 41 inches in width, extend along either side of the cabin and are rated to carry a single axle load of 22,000 pounds. The aircraft is equipped with a rapid cargo loading system to facilitate loading and unloading of palletized or crated items. The system utilizes conveyor sections running fore and aft, each section consisting of roller conveyors and magnesium rails and braces. The complete system comprises 48 10-foot sections, six 8-foot sections, and six 5-foot sections. The sections are held in position by quick-disconnect tiedown fittings which attach to seat studs on the cargo compartment floor. A transfer dolly is provided to permit lateral movement of pallets or crates. Refer to figure 4-22 for Cargo Loading and Dimensional Limitations. Refer to the *Technical Manual, Loading Instructions, T.O. 1C-133A-9*, for details of cargo loading.

CARGO TIEDOWN FITTINGS.

Tiedown fittings for securing cargo are provided in the cabin as follows: 79 fittings, rated at 5000 pounds, are located on the aft end of the cargo ramp and along the juncture of the floor and side wall of the aircraft; 402 fittings, rated at 10,000 pounds, are located on a 20-inch grid pattern over the entire floor of the aircraft; 24 fittings, rated at 25,000 pounds, are located symmetrically about the aircraft centerline on each transverse bulkhead; 24 fittings, rated at 35,000 pounds, are located at the juncture of the floor and main frames of the aircraft. The tiedown fittings are the ring and hinge type, and are permanently installed in a recess in the aircraft floor. The aircraft is equipped with a net-type cargo tiedown system to provide rapid tiedown and restraint of various types of cargo. The complete tiedown system comprises six 20 x 15-foot nets for lateral and vertical restraint of cargo movement, six 8 x 12-foot barrier nets to restrain forward and aft cargo movement, support provisions for stowing the nets and the necessary ropes, blocks, and pulleys for operating the system.

Note

> Certain limitations must be observed in the simultaneous use of the 10,000-pound capacity fittings in any one compartment. Refer to the *Technical Manual, Loading Instructions, T.O. 1C-133A-9.*

SIDE CARGO DOOR.

The side cargo door is located on the left side of the fuselage, forward of the left pod, and has an opening 100 inches high by 106 inches wide. The door width permits trucks or trailers to be positioned at the entrance for unloading directly into the aircraft. The door is hinged at the top and is hydraulically opened and closed by an actuating cylinder. The door opens outward and is held open by the extended position of the actuating cylinder. The door is latched closed by eight mechanical latches, six along the bottom of the door and one on each side of the door, approximately halfway up. The latches are mechanically linked to a torque tube on the door. A hydraulically actuated latch cylinder is also linked to the torque tube. As the latch cylinder extends or retracts, it rotates the torque tube which in turn acts upon the latches to latch or unlatch the door.

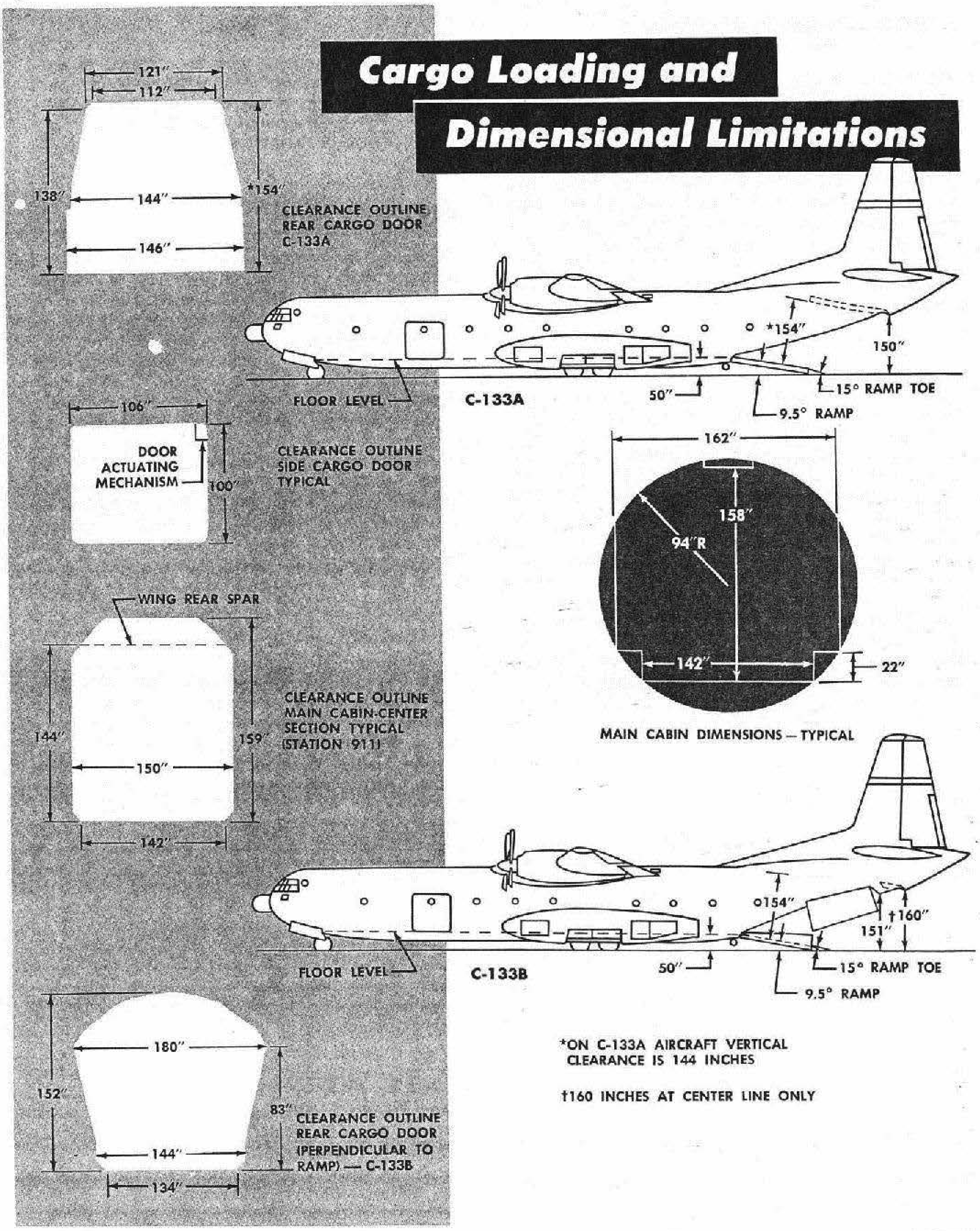
Side Cargo Door Safety Valve and Switches.

A 28-volt d-c solenoid-operated safety valve, spring loaded to the open position, is installed in the fluid circuit of the side cargo door normal operation system, ahead of the door control panel (*figure 4-24*). The function of this valve is to prevent the door from being hydraulically opened during flight, or from being opened on the ground if the cabin is being pressurized through use of the test switch. When the aircraft weight is supported by the landing gear and the fuselage is depressurized, the safety valve is opened by two 28-volt d-c switches, one located on each rear main landing gear. When the valve is open, the side cargo door can be operated hydraulically. A shutoff valve manual override (*figure 4-24*), operated by pushing down on a spring-loaded plunger, is installed behind the side cargo door control panel. A plugged access is provided for the plunger. The access is located in the control panel. The function of the manual override is to manually override the inflight safety valve and allow normal operation of the side cargo door when the aircraft is on the ground, supported by jacks, and the gear is extended. A placard with operating instructions is provided for the valve and is located on the door control panel.

Side Cargo Door Control Handle.

The side cargo door is normally operated by hydraulic pressure distributed from the main landing gear

Cargo Loading and Dimensional Limitations



*ON C-133A AIRCRAFT VERTICAL CLEARANCE IS 144 INCHES

†160 INCHES AT CENTER LINE ONLY

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Figure 4-22

Side Cargo Door Hydraulic System

CAUTION

To avoid damage to the door and latch mechanism, do not operate door controls with latch safety pins installed.

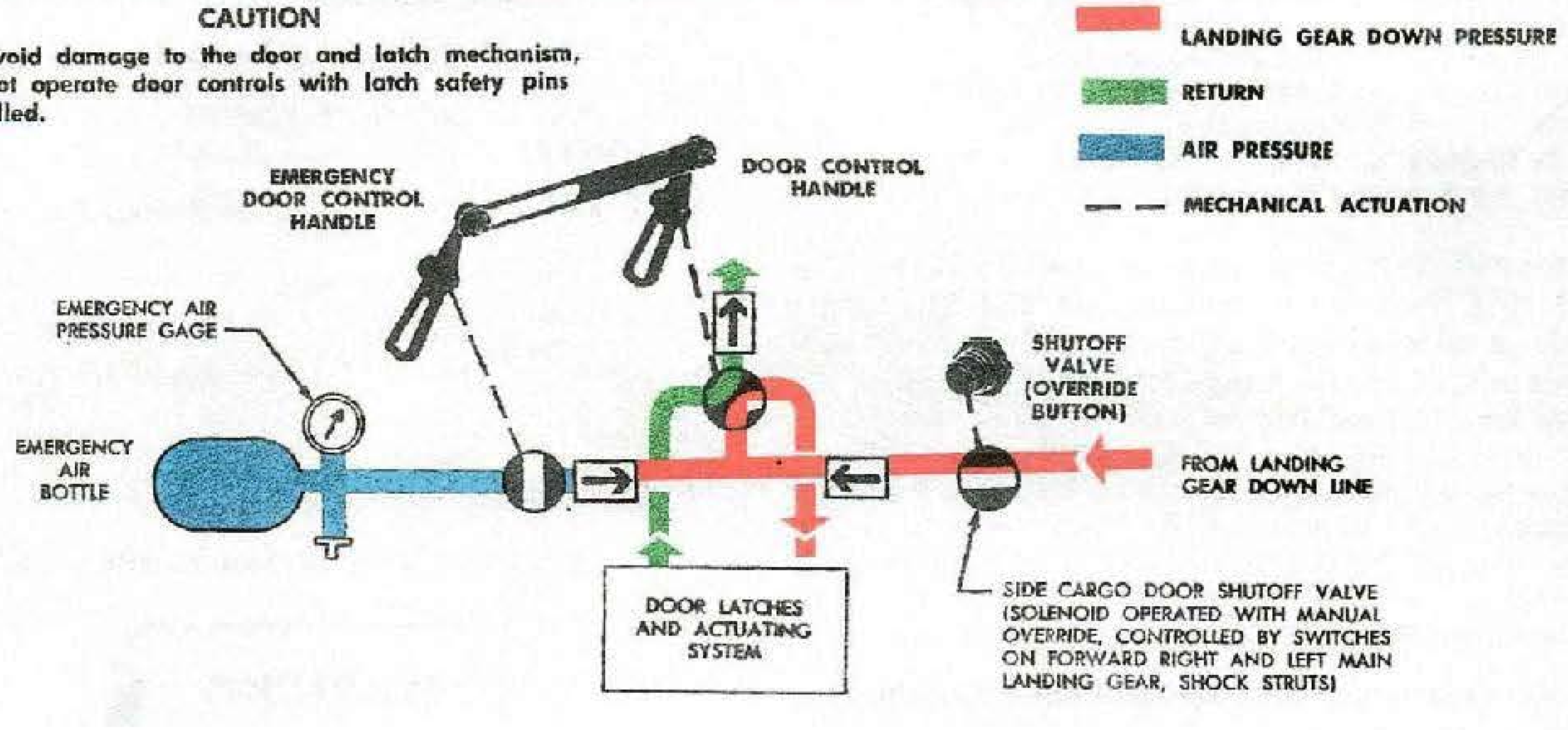

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Figure 4-23

downline to the side cargo door control panel and supplied by the aircraft hydraulic system. The manual control handle (*figure 4-24*) for the side cargo door normal operation is located on the door control panel. The three positions of the control handle are OPEN, HOLD, and CLOSED IN FLIGHT position. When the handle is in the OPEN position, hydraulic pressure is supplied to the retract side of the side cargo door latch actuating cylinder, which rotates the torque tube. As the torque tube rotates, the eight latches which are connected to the torque tube unlatch. The latch actuating cylinder is held in the retracted position by an overcenter mechanism. After unlatching occurs, fluid pressure is applied to the door operating cylinder, which opens the door. When the door is opened to the desired angle, the door control valve handle is placed in the HOLD position, trapping the fluid in the pipes. This serves as a door open lock. When the side cargo door control handle is in the CLOSED IN FLIGHT position, fluid pressure is applied to the closing side of the door operating cylinder, which closes the door. Fluid is then ported to the latch actuating cylinder, which rotates the torque tube. As the torque tube rotates, the eight latches are actuated to latch and seal the door against the jamb.

Side Cargo Door Emergency Handle.

An emergency operation system is provided for the side cargo door. High-pressure air is supplied for the system by an air bottle, located behind the side cargo door control panel (*figure 4-24*). An air filler valve is provided for the air bottle and is located behind the control panel. An access for the air filler valve is provided in the panel. A direct-reading air pressure gage is located on the panel to indicate the air pressure of the emergency system air bottle. A pressure versus temperature chart is also installed on the panel for air bottle filling. An emergency air valve control handle with the positions EMER OPEN and CLOSED is located on the panel for actuation of the air bottle to open the side cargo door in an emergency. The handle is mechanically connected by a sliding link to the hydraulic door control valve, so that opening of the air valve will also open the hydraulic door control valve, porting high-pressure air into the door opening system. The actuation of the latches and cylinders is then sequenced as in normal operation, and the door will open to a partially extended position, permitting personnel entrance or exit. A second emergency handle is located on the outside of the aircraft, adjacent to the door (*figure 3-4*), for emergency entrance. The air pressure is restrained from going into the hydraulic system by a check valve in the hydraulic pressure line to the hydraulic control valve. The side cargo door hydraulic system is self-bleeding, and should be operated through several cycles after using the air bottle for emergency opening.

WARNING

The side cargo door must never be used during flight.

(See CAUTION on Page 4-72)

CAUTION

The aircraft should be depressurized before emergency operation of the side cargo door.

Side Cargo Door Latch Safety Pins (Aircraft With T.C.T.O. 509 and 509A).

Two side cargo door latch safety pins *(figure 4-25)* are installed to prevent the door latches from unlatching and allowing the door to open in flight. The pins are inserted in the forward and aft latches through holes in the latch covers, and are fitted with streamers which are fastened together to prevent the pins from falling out of place in flight. Inspection windows are installed in the latch covers to permit checking of the latches to insure that they are fully latched.

Side Cargo Door Lock (Aircraft with T.C.T.O. 594)

A side cargo door lock is installed to prevent the door latches from unlatching and allowing the door to open in flight. The lock is installed on the door latch torque tube and prevents the torque tube from rotating to the unlatched position when the locking arm is in place. The lock is held in the LOCKED position with a retaining pin which is inserted in holes in the locking arm. A placard is inserted in holes in the locking arm. A placard installed on the torque tube cover indicates the LOCKED and UNLOCKED positions of the locking arm.

WARNING

Do not attempt to open the side cargo door during flight.

CAUTION

Do not attempt to open the side cargo door with the door latch safety pins or the door lock pin installed.

SIDE CARGO DOOR — NORMAL OPERATION.

To Open Door.

CAUTION

Do not attempt to open the door until it is positively determined that the cabin is depressurized. Hydraulic power must be available before the door can be normally operated.

1. Side Cargo Door Latches — UNLOCKED.

Remove the side cargo door latch safety pins (T.C.T.O. 509A) or the side cargo door lock pin (T.C.T.O. 594) as applicable.

2. Auxiliary Hydraulic Pump Switch — ON.
3. Side Cargo Door Control Handle — OPEN, then HOLD.

Place handle in HOLD when the desired door position is obtained.

Note

To fully open the side cargo door, 120 seconds are required. To close and latch requires 60 seconds.

To Close Door.

1. Auxiliary Hydraulic Pump Switch — ON.
2. Side Cargo Door Control Handle — CLOSE.

WARNING

Operating the auxiliary hydraulic pump by any one of the four control switches will pressurize the entire hydraulic system. Before operating this pump, make certain that all hydraulic controls are in a safe position and that personnel and equipment are clear of hydraulically operated units. Damage to the aircraft or injury to personnel may result if this care is not exercised.

CAUTION

Do not operate or leave the side cargo door open when ground winds are in excess of 43 knots (50 miles per hour), as structural damage may occur.

REAR CARGO LOADING SYSTEM — C-133A.

Two hydraulically actuated rear cargo loading doors *(29, and 30, figure 1-2),* one of which incorporates an integral ramp, form the lower aft contour of the fuselage when closed. The two doors are hinged to the fuselage structure so that, when opened, the aft door swings up into the fuselage, and the forward ramp moves down. The ramp may be stopped at any intermediate position to correspond with various truck or trailer bed heights. Two removable toe sections, each 30 inches wide and laterally adjustable to accommodate any vehicle wheel tread width (from outside wheel rim to outside wheel rim) up to approximately 136 inches, are provided to form a continuous ramp from the ground up into the fuse-

Side Cargo Door Control Panel

LOCATED AFT OF SIDE CARGO DOOR

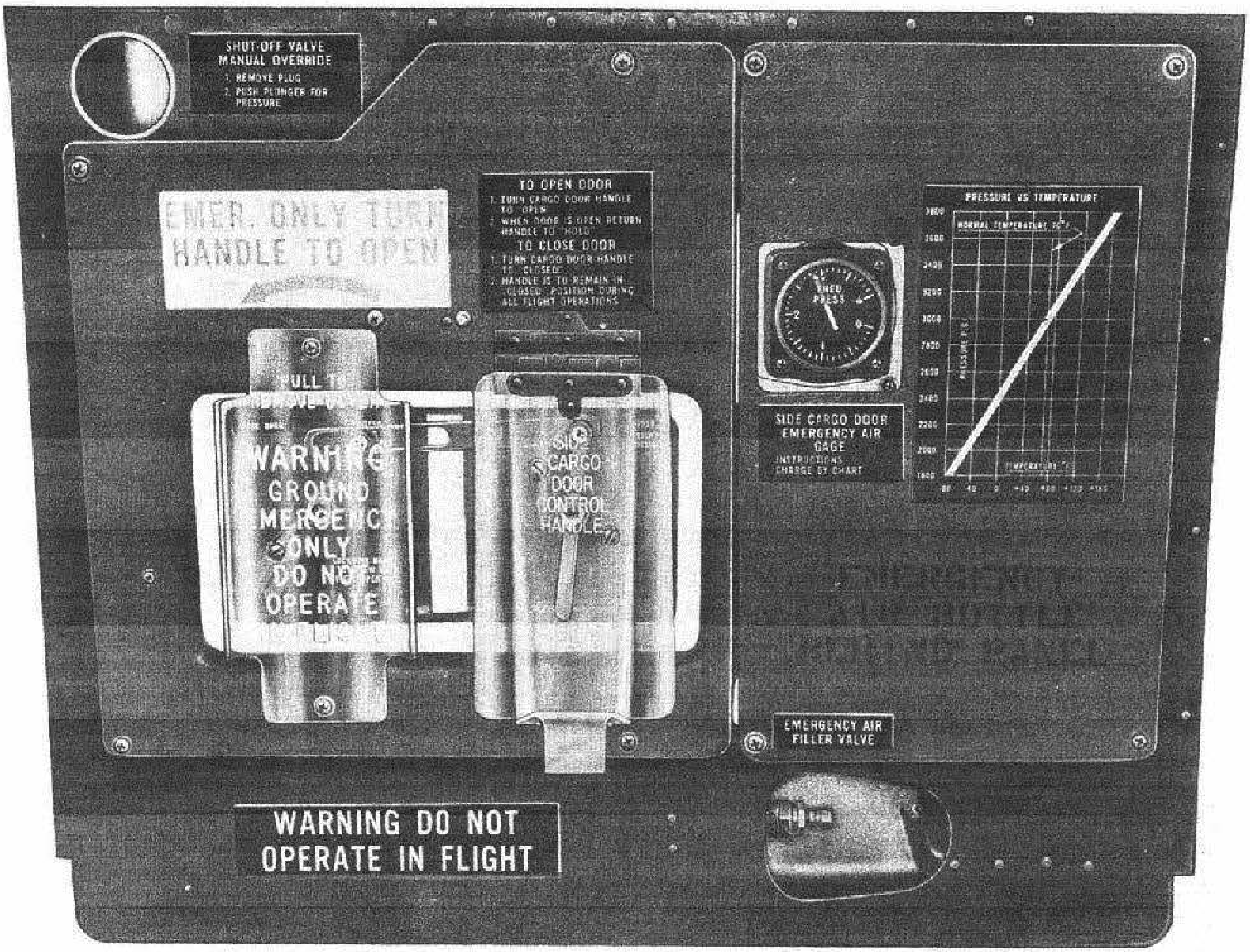

Figure 4-24

UAB1-268

lage. When fully extended to the ground rest position, the ramp will support 50,000 pounds, and is capable of supporting 25,000 pounds uniformly distributed or 13,000 pounds on the end of the ramp; or it may be raised from the ground with a 10,000-pound load stowed on the forward 8 feet of the ramp. The controls for the aft cargo loading system are located on a panel on the left side of the main cabin, just forward of the ramp hinge point. The door and ramp are normally operated by the aircraft hydraulic system (*figure 4-26*), but the door may be pneumatically operated in the event that an alternate method is required. The rear door has eight hydraulically actuated latches that lock the door to the fuselage structure when in the closed position. The ramp is held in the closed position by 18 similar latches. All door and ramp latches can be visually checked for proper latch engagement. Four shear fittings are provided on the mating ends of the cargo door and ramp to insure a proper alignment when the doors are closed and to minimize side loads. When the fuselage is pressurized, a solenoid-operated valve in the hydraulic pipe to the control panel closes as a safety measure against opening the doors in flight. The controls for actuating the ramp and door are arranged in such a manner that it is impossible to operate the doors in any but the proper sequence. Instruction placards are mounted on the control panel (*figure 4-28*), and lights, located over each valve control handle, give the operator the sequence in which to operate the valves and also indicate completion of each function.

Side Cargo Door Latch Safety Pins

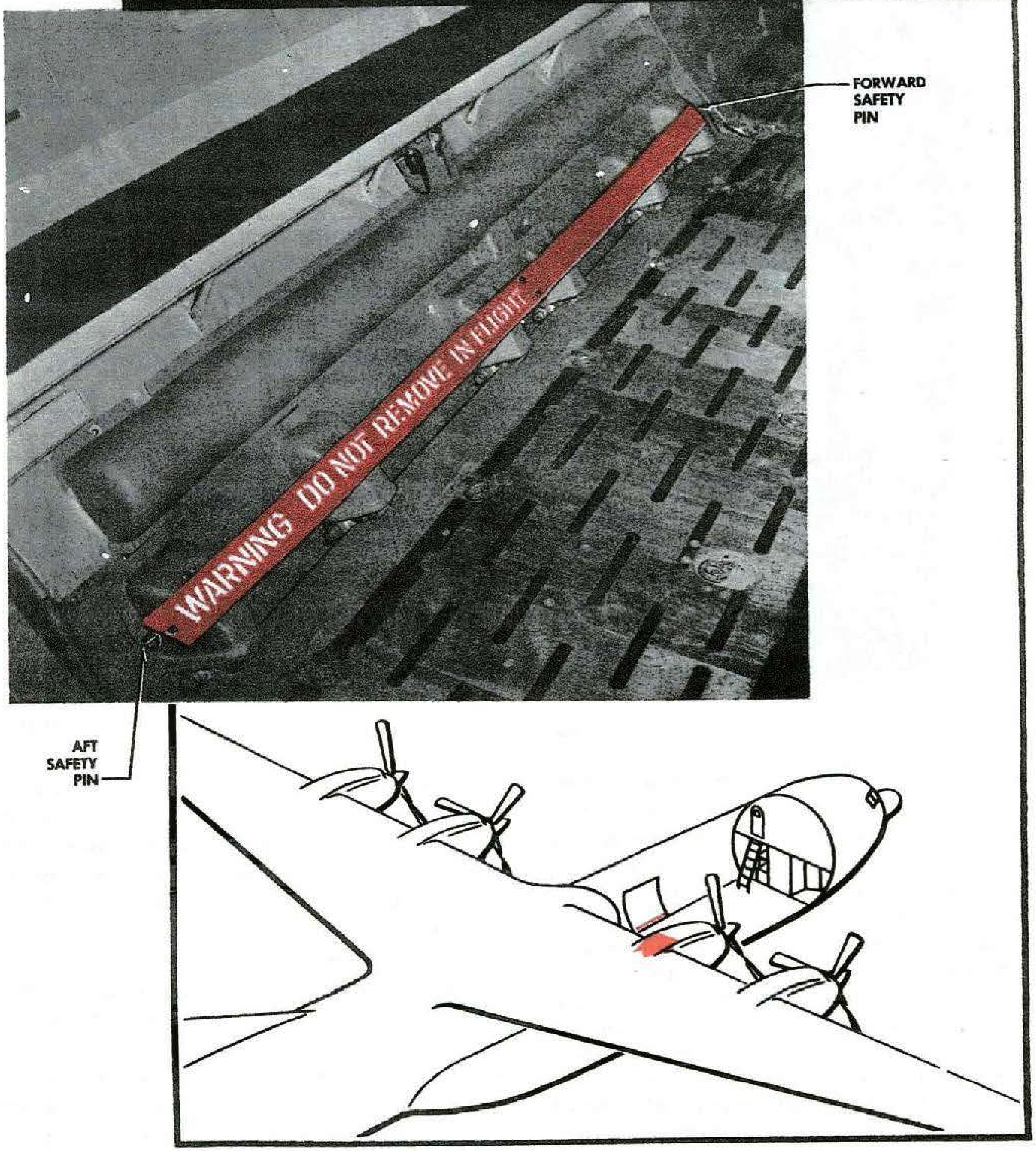

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Figure 4-25

Loading Door Latch Valve Handle No. 1.

The rear cargo loading door is provided with locking latches to prevent inadvertent opening in flight and to aid in forming a pressure-tight seal. They are controlled by loading door latch valve handle No. 1, located on the rear cargo door control panel (*figure 4-28*). The valve handle has the following positions: OPEN, NEUTRAL, and CLOSED. In the OPEN position, hydraulic pressure is directed through the latch valve to the door latch cylinders to unlatch the door. The NEUTRAL position locks the pressure in the cylinders. When the handle is in the CLOSED position, pressure is ported to the latching cylinders to close and lock the door latches.

Loading Door Control Valve Handle No. 2.

The rear cargo loading door is controlled by loading door valve No. 2, located on the rear cargo control door panel (*figure 4-28*). A double-end hydraulic cylinder, connected to a cable system, operates the aft door inward to open it and outward to close it, when actuated by the loading door valve handle No. 2. The valve handle has the following positions: OPEN, NEUTRAL, and CLOSED. In the OPEN position of the handle, hydraulic pressure is ported through the loading door valve to the actuating cylinder to retract the loading door. The NEUTRAL position locks the pressure in the actuating cylinder. In the CLOSED position, pressure is ported to the opposite end of the door cylinder, through the control valve, and the door is lowered to the closed position.

Loading Ramp Latch Valve Handle No. 3.

The rear cargo loading ramp is provided with locking latches to prevent inadvertent opening in flight and to aid in forming a pressure-tight seal. They are controlled by loading ramp latch valve handle No. 3, located on the rear cargo door control panel (*figure 4-28*). Valve handle has the following positions: OPEN, NEUTRAL, and CLOSED. When the valve handle is placed in the OPEN position, hydraulic pressure is ported to the latch cylinders to release the ramp latches. The NEUTRAL position locks the pressure in the cylinders. In the CLOSED position, the valve ports pressure to the latching cylinders to close and lock the ramp latches.

Loading Ramp Control Valve Handle No. 4.

The rear cargo loading ramp is controlled by ramp control valve handle No. 4, located on the rear cargo door control panel (*figure 4-28*). Two hydraulically actuated cylinders raise or extend the ramp and are capable of stopping the ramp at intermediate positions. The valve handle has the following positions: OPEN, NEUTRAL, CLOSED, FLIGHT DOWN, and HOLD. In the OPEN position, the ramp control valve opens both cylinder ports to return and allows the ramp to lower by its own weight. A restrictor in the line prevents the ramp from lowering rapidly. The CLOSED position of the valve handle ports pressure to the actuating cylinders to raise the ramp. The FLIGHT DOWN position ports hydraulic pressure to the actuating cylinders to force the ramp down against airloads encountered during flight. The HOLD position blocks all ports, and pressure is locked in the lines to lock the ramp in place. The ramp also may be stopped in any position between closed and fully extended by positioning the valve handle to NEUTRAL when the ramp is in the desired position.

Loading Door and Ramp Indicator lights.

Four 28-volt d-c indicator lights are located, one above each valve handle, to indicate the proper sequence for operating the valve handles, and also to indicate completion of each function. The operating instruction placard shown on the rear cargo door and ramp control panel (*figure 4-28*) indicates the sequence of illumination of the indicator lights for operation of the valve handles. The lights are powered from the 28-volt battery bus on the right hand center fuselage circuit breaker panel.

REAR CARGO LOADING SYSTEM — NORMAL OPERATION — C-133A.

Note

Electrical and hydraulic power are required for operation of the system. Use the electric hydraulic pump when ground power is available.

WARNING

Operating the auxiliary hydraulic pump by any one of the four control switches will pressurize the entire hydraulic system. Before operating this pump, make certain that all hydraulic controls are in a safe position and that personnel and equipment are clear of hydraulically operated units. Damage to the aircraft or injury to personnel may result if this care is not exercised.

(See CAUTION on Page 4-79)

Rear Cargo Door and Ramp Hydraulic System

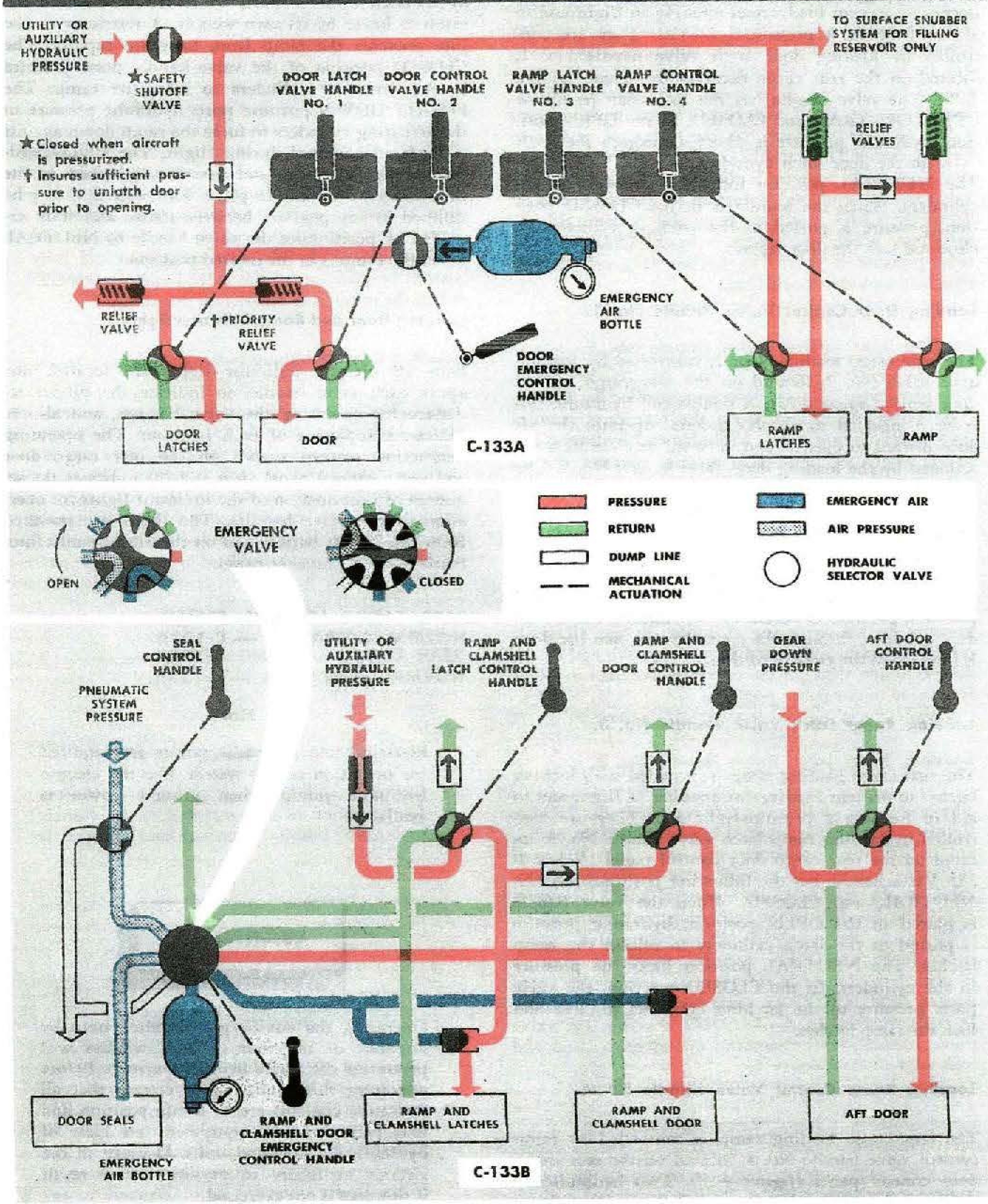

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Figure 4-26

Ramp and Clamshell Door Bleeder Lights

C-133B

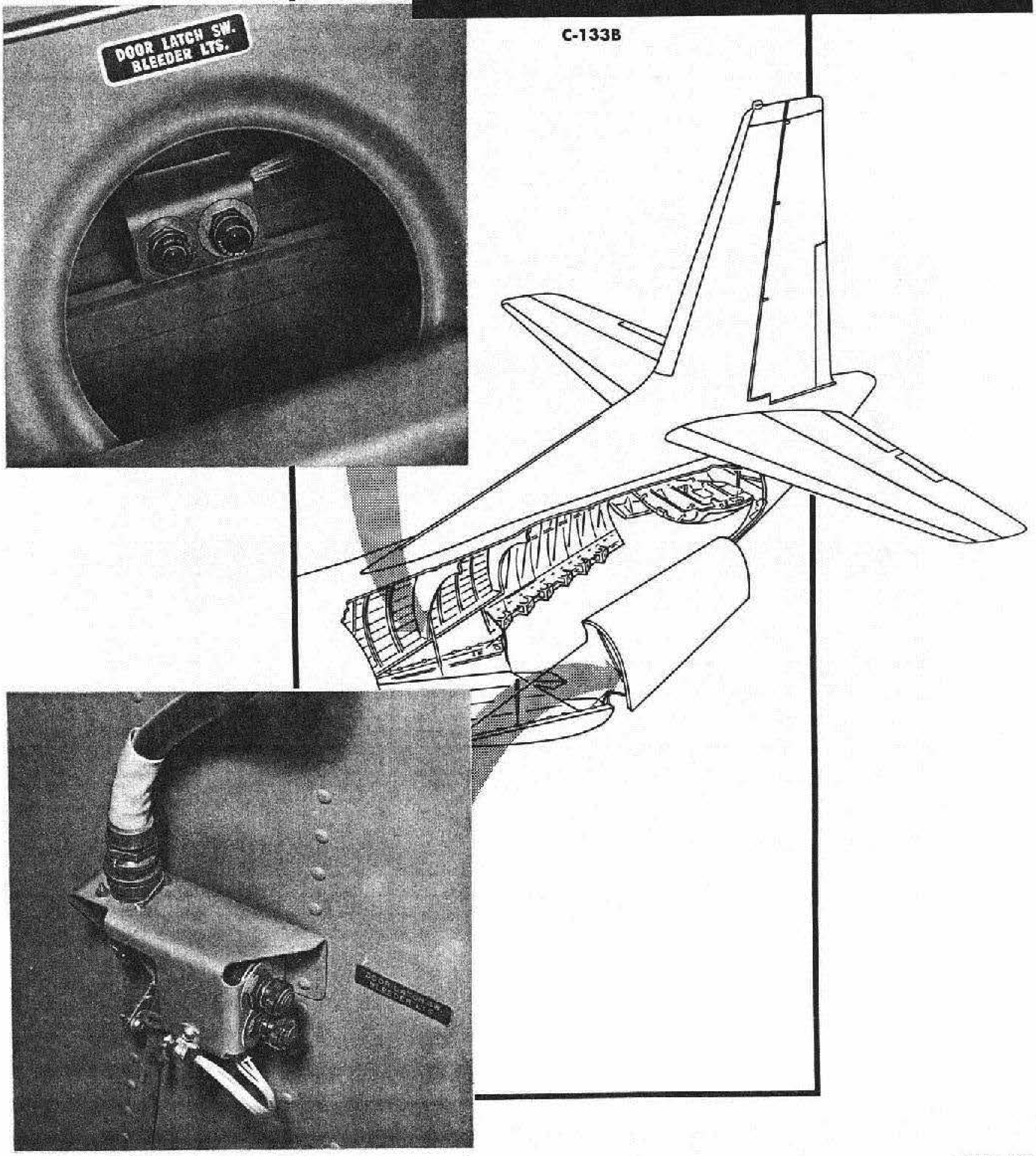
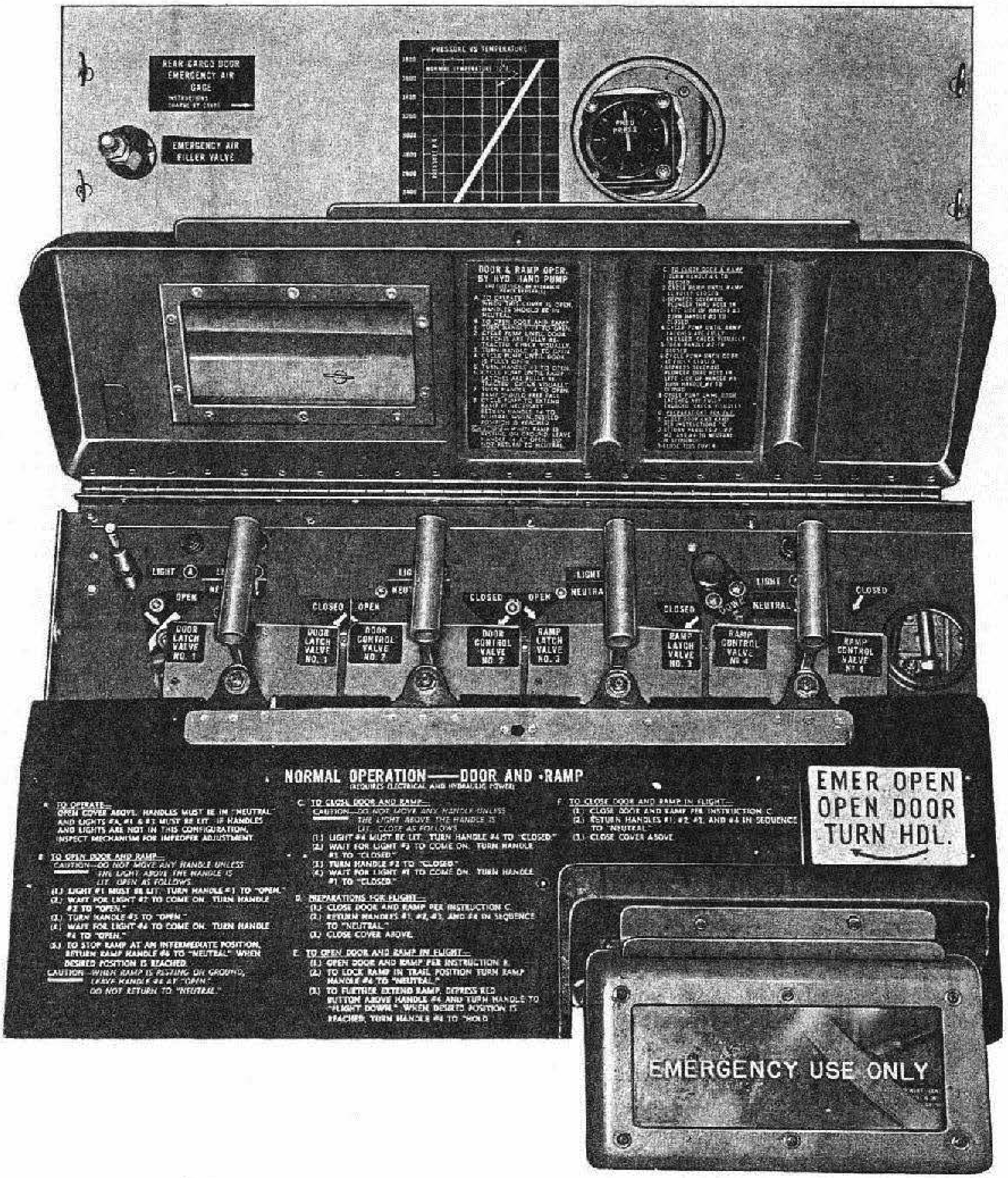


Figure 4-27

Rear Cargo Door and Ramp Control Panel - Interior

C-133A



NORMAL OPERATION——DOOR AND RAMP
(REQUIRES ELECTRICAL AND HYDRAULIC POWER)

A. TO OPERATE—
OPEN COVER ABOVE. HANDLES MUST BE IN "NEUTRAL" AND LIGHTS #A, #1 & #3 MUST BE LIT. IF HANDLES AND LIGHTS ARE NOT IN THIS CONFIGURATION, INSPECT MECHANISM FOR IMPROPER ADJUSTMENT.

B. TO OPEN DOOR AND RAMP—
CAUTION—DO NOT MOVE ANY HANDLE UNLESS THE LIGHT ABOVE THE HANDLE IS LIT. OPEN AS FOLLOWS.
(1.) LIGHT #1 MUST BE LIT. TURN HANDLE #1 TO "OPEN."
(2.) WAIT FOR LIGHT #2 TO COME ON. TURN HANDLE #2 TO "OPEN."
(3.) TURN HANDLE #3 TO "OPEN."
(4.) WAIT FOR LIGHT #4 TO COME ON. TURN HANDLE #4 TO "OPEN."
(5.) TO STOP RAMP AT AN INTERMEDIATE POSITION, RETURN RAMP HANDLE #4 TO "NEUTRAL" WHEN DESIRED POSITION IS REACHED.
CAUTION—WHEN RAMP IS RESTING ON GROUND, LEAVE HANDLE #4 AT "OPEN." DO NOT RETURN TO "NEUTRAL."

C. TO CLOSE DOOR AND RAMP—
CAUTION—DO NOT MOVE ANY HANDLE UNLESS THE LIGHT ABOVE THE HANDLE IS LIT. CLOSE AS FOLLOWS.
(1.) LIGHT #4 MUST BE LIT. TURN HANDLE #4 TO "CLOSED."
(2.) WAIT FOR LIGHT #3 TO COME ON. TURN HANDLE #3 TO "CLOSED."
(3.) TURN HANDLE #2 TO "CLOSED."
(4.) WAIT FOR LIGHT #1 TO COME ON. TURN HANDLE #1 TO "CLOSED."

D. PREPARATIONS FOR FLIGHT—
(1.) CLOSE DOOR AND RAMP PER INSTRUCTION C.
(2.) RETURN HANDLES #1, #2, #3, AND #4 IN SEQUENCE TO "NEUTRAL."
(3.) CLOSE COVER ABOVE.

E. TO OPEN DOOR AND RAMP IN FLIGHT—
(1.) OPEN DOOR AND RAMP PER INSTRUCTION B.
(2.) TO LOCK RAMP IN TRAIL POSITION TURN RAMP HANDLE #4 TO "NEUTRAL."
(3.) TO FURTHER EXTEND RAMP, DEPRESS RED BUTTON ABOVE HANDLE #4 AND TURN HANDLE TO "FLIGHT DOWN." WHEN DESIRED POSITION IS REACHED, TURN HANDLE #4 TO "HOLD."

F. TO CLOSE DOOR AND RAMP IN FLIGHT—
(1.) CLOSE DOOR AND RAMP PER INSTRUCTION C.
(2.) RETURN HANDLES #1, #2, #3, AND #4 IN SEQUENCE TO "NEUTRAL."
(3.) CLOSE COVER ABOVE.

LOCATED FORWARD OF RAMP ON LEFT SIDE OF FUSELAGE

CAUTION Do not operate control handles with the cabin pressurized

UAB1-271

Figure 4-28

CAUTION

Do not operate the rear cargo door and ramp with the cabin pressurized. The air conditioning system must be turned off and cabin pressure completely dumped before operating the rear cargo door and ramp. The manual control switch of the pressurization system should be kept in the DEPRESS position for a minimum of 45 seconds to insure dumping of all cabin pressure. Do not move any handle unless the light above the handle is lit.

To Operate.

Open the cover. The handles must be in NEUTRAL and lights No. A, No. 1 and No. 3 must be lit. If they are not, inspect adjustment of the electrical switches and the mechanical linkage.

To Open Door and Ramp on Ground.

1. No. 1 Door Indicator Light — ON; Door Latch Valve No. 1 — OPEN.
2. No. 2 Door Indicator Light — ON; Door Control Valve No. 2 — OPEN.

If the rear cargo door does not open, proceed with steps 3 and 4. The door should open after the ramp starts to open.

3. No. 3 Door Indicator Light — ON; Ramp Latch Valve No. 3 — OPEN.
4. No. 4 Door Indicator Light — ON; Ramp Control Valve No. 4 — DOWN.

If the ramp does not open, turn handle No. 4 to FLIGHT DOWN position to start the ramp down only. After ramp has started down (cleared the door seals), return handle No. 4 to DOWN.

5. Ramp — ADJUST AS DESIRED.

To stop ramp in an intermediate position, return handle No. 4 to NEUTRAL when the desired position is reached.

CAUTION

When the ramp is resting on the ground, leave handle No. 4 at OPEN. Do not return it to NEUTRAL.

To Close Door and Ramp on Ground.

1. No. 4 Door Indicator Light — ON; Ramp Control Valve No. 4 — CLOSED.
2. No. 3 Door Indicator Light — ON; Ramp Latch Valve No. 3 — CLOSED.
3. No. 2 Door Indicator Light — ON; Door Control Valve No. 2 — CLOSED.
4. No. 1 Door Indicator Light — ON; Door Latch Valve No. 1 — CLOSED.
5. Control Valve Handles — NEUTRAL.

Return control valve handles No. 1, 2, 3, and 4 to the NEUTRAL position in sequence. Close cover.

RAMP CLAMSHELL AND AFT DOORS — C-133B.

Hydraulically actuated ramp and clamshell cargo doors and an aft door *(28, 29, and 30, figure 1-2)* form the lower aft contour of the fuselage when closed. The two clamshell doors are hinged to the fuselage structure so that, when opened, the doors swing out to each side of the fuselage. The aft door is hinged to open inward, and the ramp is hinged to allow the aft end of the ramp to move down and is mechanically linked to the clamshell doors. The ramp may be stopped at any intermediate position below floor level to correspond with various truck or trailer bed heights. Two removable toe sections, each 30 inches wide and laterally adjustable to accommodate any vehicle wheel tread width (from outside wheel rim to outside wheel rim) up to approximately 125 inches, will form a continuous ramp from the ground up into the fuselage. When fully extended to the ground rest position, the ramp will support 50,000 pounds. When not resting on the ground it is capable of supporting 25,000 pounds, uniformly distributed, or 13,000 pounds on the end of the ramp. It may be raised or lowered with a 10,000 pound load stowed on the forward 8 feet of the ramp. The exterior and interior controls *(figures 4-29 and 4-30)* for the doors are located on the exterior and interior sides of a panel on the left side of the cabin, just forward of the ramp hinge point. The ramp, clamshell doors and aft door are normally operated by the utility hydraulic system but may be operated by means of the auxiliary hydraulic pump if electrical power is available or by the utility system hand pump. The ramp and clamshell doors may be pneumatically opened (on the ground only) for emergency operation. The aft (inward opening) door is operated by gear down pressure and has four hydraulically actuated latches that lock the door to the fuselage structure when in the closed position. The ramp is held in the closed position by 18 latches. The clamshell doors are latched closed by three shear latches and eight strut latches on each door and 10 hook latches on the left door. All door and ramp latches can be visually checked for proper latch engagement. The controls for actuating the ramp and doors are interlocked so that it is impossible to operate the doors in the wrong sequence. Instruction placards are mounted on the control panel *(figure 4-29)*, and lights, located over each valve control handle, give the operator the sequence in which to operate the valves and also indicate the completion of each function.

Ramp and Clamshell Door Seals.

The ramp and clamshell doors are equipped with inflatable seals to insure a pressure-tight seal when the doors are closed. Air pressure to inflate the seals is obtained from the pneumatic system. An air reservoir is installed to insure a supply of air sufficient to maintain seal pressure for an extended period in the event of reduced pneumatic manifold pressure. An air pressure indicator is installed on the ramp and clamshell door control panel (*figure 4-29*) to indicate the air pressure being applied to the seals.

Seal Control Handle.

The seal control handle (*figure 4-29*), is used to actuate a 3-position pneumatic valve which controls inflation and deflation of the door seals. The handle positions are placarded PRESSURIZE, DEPRESSURIZE, and TEST. The PRESSURIZE position opens a pressure port and allows the ramp and door seals to inflate. The DEPRESSURIZE position blocks the pressure port and opens a vent to dump the seal pressure. However, the handle cannot be turned to the DEPRESSURIZE position unless the fuselage pressurization system outflow valves and safety valves are both in the full open position, thus retracting a solenoid lock. The TEST position blocks the pressure and vent ports, trapping pressure in the seals, thus allowing any depletion of seal pressure to be checked on the seal pressure gage.

Ramp and Clamshell Latch Control Handle.

The ramp and clamshell latch control handle (*figure 4-29*) is used to actuate a 3-position hydraulic valve which controls operation of the door latches. The handle positions are placarded LATCH, NEUTRAL, and UNLATCH. The LATCH position allows pressure to close the clamshell doors the last 4 degrees of travel and also to latch the clamshell doors and ramp. The NEUTRAL position blocks the pressure port of the valve isolating the rear door system from the utility system pressure line. The UNLATCH position allows pressure to unlatch the clamshell doors and ramp and also to open the clamshell doors the first 4 degrees of travel.

Ramp and Clamshell Door Control Handle.

The ramp and clamshell door control handle (*figure 4-29)* is used to actuate a hydraulic valve which controls operation of the ramp and clamshell doors. The handle positions are placarded UP, NEUTRAL, DOWN, HOLD, and FREEFALL. The UP position allows hydraulic pressure to simultaneously raise the ramp to the full up position and start to close the clamshell doors to within 4 degrees of the closed position. All ports are blocked when the handle is in either the NEUTRAL or HOLD position, hydraulically locking the clamshell doors and ramp in any desired position. The DOWN position allows hydraulic pressure to open the clamshell doors fully and lower the ramp to the floor-level position. The FREEFALL position ports hydraulic pressure to hold the clamshell doors open while connecting the ramp cylinder ports to system return, allowing the ramp to lower under its own weight.

Aft Door Control Handle.

The aft door control handle (*figure 4-29*) is used to actuate a 3-position hydraulic valve which controls operation of the aft door. The handle positions are placarded CLOSED, NEUTRAL, and OPEN. The CLOSED position allows hydraulic pressure to close and latch the aft door. The NEUTRAL position blocks the pressure port, isolating the aft door system from the gear-down pressure line. The OPEN position allows hydraulic pressure to unlatch and open the aft door. When fully opened, the aft door is held open without hydraulic system pressure by an internal lock in the actuating cylinder. If not fully opened, the door will drift closed when hydraulic pressure is shut off.

Ramp, Clamshell Doors, and Aft Door Indicator Lights.

Four green, 28-volt d-c indicator lights are located one above each valve handle, to indicate the proper sequence for operating the valve handles and also to indicate completion of each function. The operating instruction placard shown on the ramp, clamshell doors and aft door control panels (*figures 4-29 and 4-30*) indicates the sequence the indicator lights will come on for operation of the valve handles. The lights are powered from the 28-volt d-c battery bus on the right hand center fuselage circuit breaker panel.

Ramp and Clamshell Door Bleeder Lights

Four green, 28-volt d-c bleeder lights (*figure 4-27*) are installed in the ramp and clamshell door warning circuit to aid in breaking down contact resistance of the door latch switches. Two of the lights are installed in the torque box, on the right side, above and behind the ramp latch torque tube, and two are installed on the forward end of the left clamshell door. The lights are connected in series with the ramp and door latch switches and will remain ON whenever the door warning circuit is energized. Each light has a PRESS-TO-TEST feature for checking the continuity of the lamp. The lights serve as a resistor in the door latch switch circuit, and by breaking down the contact resistance of the switches, reduce erosion of the switch contacts. The lights are powered through the ramp and door warning circuit from the 28-volt d-c battery bus on the right hand center fuselage circuit breaker panel.

RAMP AND CLAMSHELL DOOR EMERGENCY CONTROL SYSTEM — GROUND OPERATION ONLY — C-133B.

An emergency operation system is provided for the ramp and clamshell doors. High-pressure air is supplied for the system by an air bottle located aft of the ramp and clamshell door control panel. The filler valve for emergency air bottle is located above the control panel and the pressure gage and pressure versus temperature correction chart are located on the control panel.

Ramp and Clamshell Door Emergency Control Handle.

The ramp and clamshell door emergency control handle is located under a hinged cover on the ramp and cargo door control panel (*figure 4-29*) for operation from inside the aircraft. A control handle placarded EMERGENCY ONLY REAR CARGO DOOR RELEASE, is located on the outside of the fuselage, aft of the exterior ramp and cargo door control panel (*figure 4-30*). To operate the control valve from outside the aircraft, the handle is released from a recess by means of a pushbutton.

Positioning the emergency control valve handle to OPEN, dumps the air pressure from the ramp and clamshell door seals, ports the high-pressure air to the door opening system and ports the lines on the retract side of the ramp and clamshell door actuating cylinders to the return lines, allowing the doors to open and the ramp to fall to the free-fall position. Air is prevented from entering the hydraulic system by a check valve in the hydraulic line to the control valve. The ramp and clamshell door hydraulic system is self-bleeding and should be operated through several cycles after using the air bottle for emergency opening.

Emergency operation of the ramp and clamshell doors may be accomplished regardless of the position of the hydraulic control valve handles. No emergency operation is provided for the aft door.

CAUTION

The aircraft should be depressurized before emergency operation of the ramp and clamshell doors.

RAMP, CLAMSHELL DOORS, AND AFT DOOR — NORMAL OPERATION — C-133B.

WARNING

Operating the auxiliary hydraulic pump, by any one of the four control switches, will pressurize the entire hydraulic system. Before operating this pump, make certain that all hydraulic controls are in a safe position and that personnel and equipment are clear of hydraulically operated units. Damage to the aircraft or injury to personnel may result if this care is not exercised.

CAUTION

Do not operate the ramp and clamshell doors with the cabin pressurized. The air conditioning system must be turned off and cabin pressure completely dumped before operating the doors. The manual control switch of the pressurization system should be kept in the DEPRESS position for a minimum of 45 seconds to insure dumping of all cabin pressure.

To Open Doors and Ramp on Ground.

CAUTION

The following sequences for opening and closing the doors must be followed exactly to avoid damaging the aircraft.

1. Control Panel Cover — OPEN.

Seal control and ramp and clamshell door latch lights should come on.

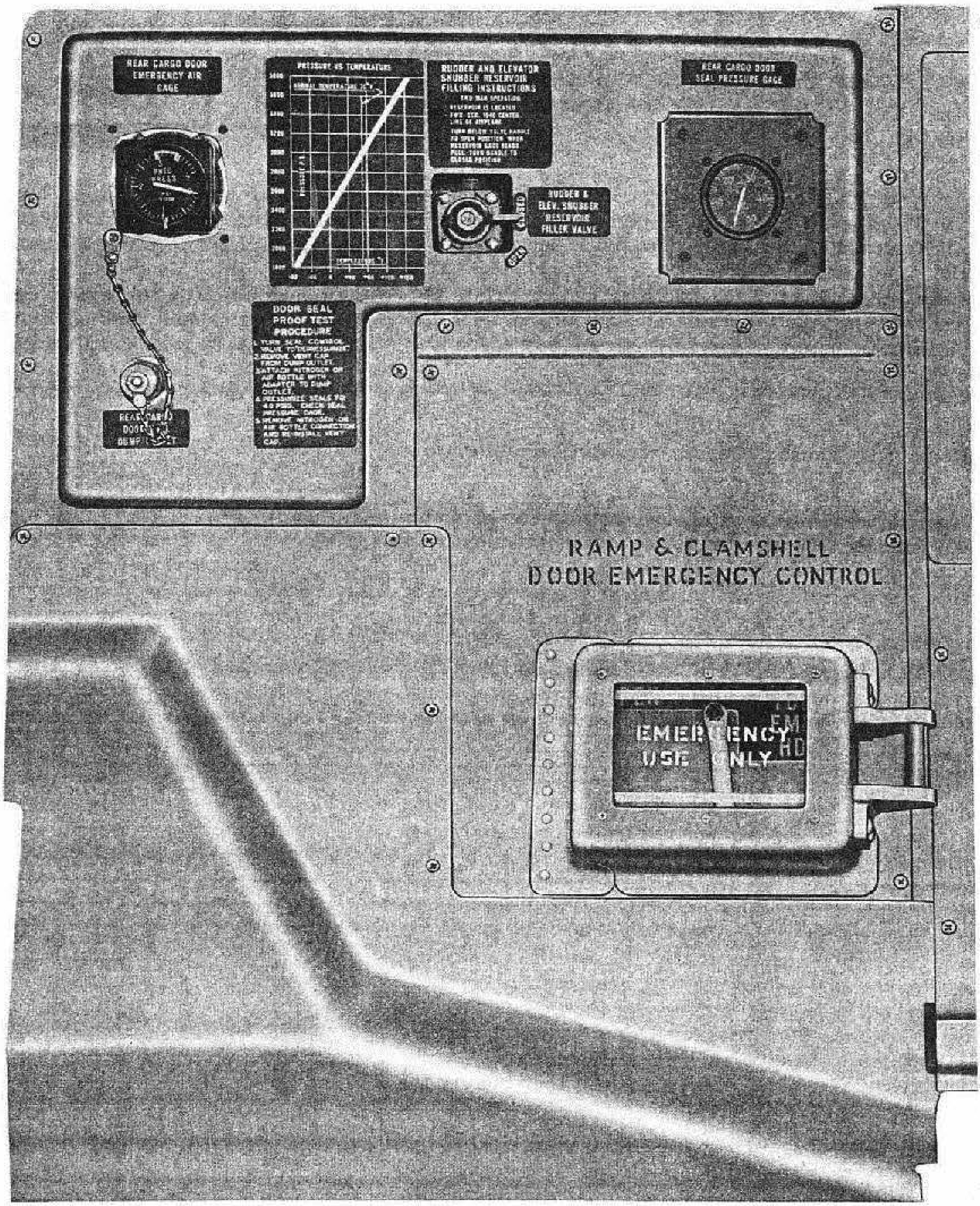
(See CAUTION on Page 4-84)

Ramp, Clamshell Doors, and Aft Door

LOCATED FORWARD OF RAMP ON LEFT SIDE OF FUSELAGE

CAUTION

DO NOT OPERATE HANDLES WITH THE CABIN PRESSURIZED



UA81-272

Figure 4-29 (Sheet 1 of 2)

Control Panel—Interior

C-133B

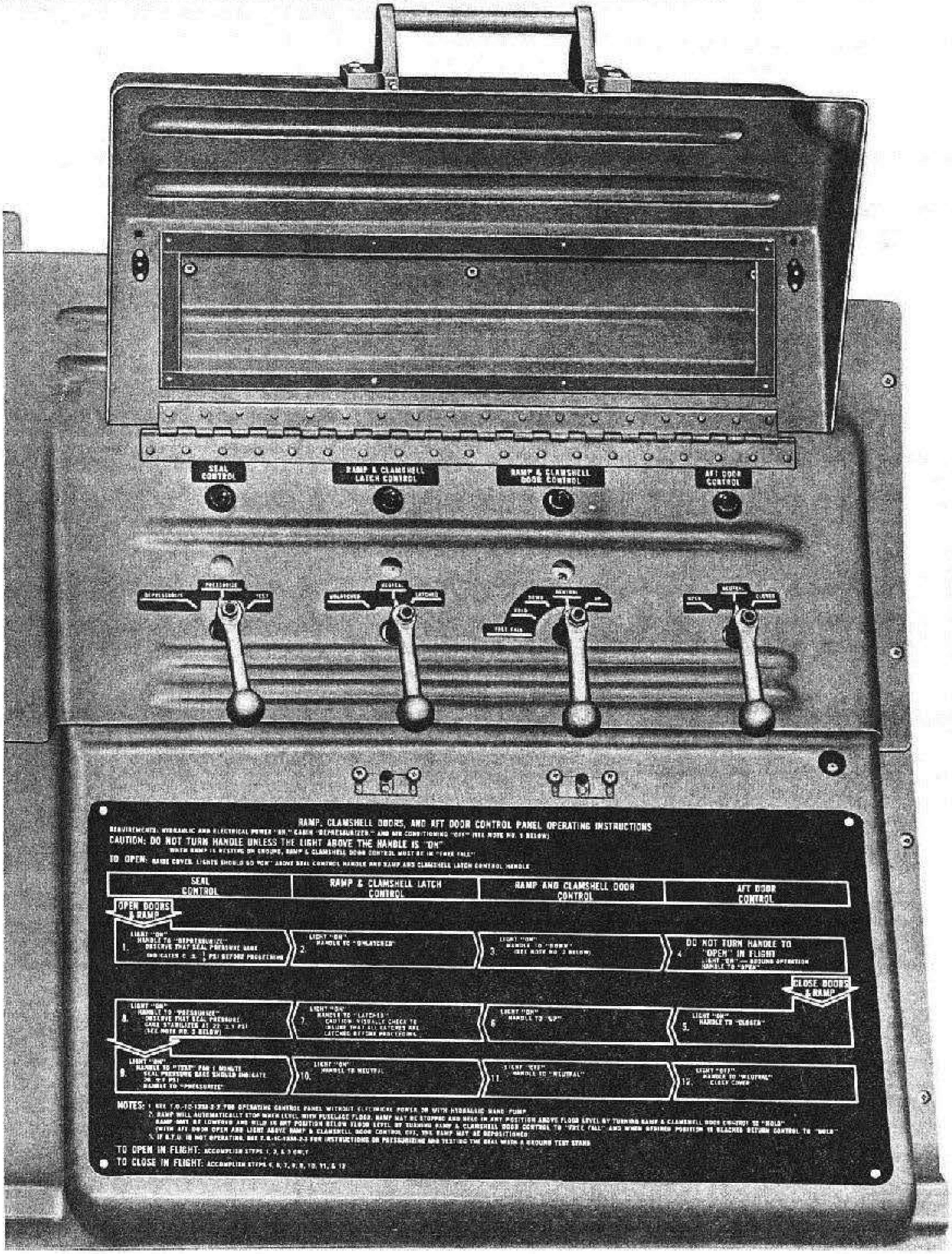


Figure 4-29 (Sheet 2 of 2)

UAB1-273

CAUTION

Do not move any control handle unless the light above it is on, except as noted.

2. Seals — DEPRESSURIZE.

With the seal control light on, turn the seal control handle to DEPRESSURIZE.

CAUTION

In order to protect the clamshell door and ramp seals, do not actuate the latch control handle to the UNLATCH position until the seal pressure gage indicates zero.

3. Ramp and clamshell doors — UNLATCH.

With the ramp and clamshell door latch light on, turn the ramp and clamshell door handle to UNLATCH.

4. Ramp and clamshell doors — OPEN.

With the ramp and clamshell doors light on, turn the ramp and clamshell door control handle to DOWN. The ramp may be stopped and held in any position above the cargo floor by placing the control handle in the HOLD position.

Note

The ramp will stop automatically when it is level with the cargo floor.

5. Ramp — LOWER.

Lower ramp below floor level by turning the ramp and clamshell door control handle to FREEFALL. When the desired position is reached, turn the control handle to HOLD.

Note

If it is desired to allow the ramp to rest on the ground, leave the ramp and clamshell door control handle in the FREEFALL position.

6. Aft door — OPEN.

With the aft door light on, turn the aft door control handle to OPEN.

Note

The aft door cannot be operated with the landing gear retracted.

CAUTION

The aft door must be fully opened, or hydraulic pressure maintained to prevent the door from drifting closed during cargo loading operations.

7. Ramp — ADJUST AS DESIRED.

The ramp is repositioned by turning the ramp and clamshell door control handle to the desired position (UP or DOWN). The ramp and clamshell door light need not be on. When the desired position is obtained, return the control handle to HOLD.

To Close Doors and Ramp on Ground.

Insure that ramp and door area is clear of all foreign objects prior to closing doors.

1. Aft door — CLOSE.

With the aft door light on, turn the aft door control handle to CLOSED.

2. Ramp and clamshell doors — CLOSE.

With the ramp and clamshell door control light on, turn the ramp and clamshell door control handle to UP.

3. Ramp and clamshell doors — LATCH.

With the ramp and clamshell door latch control light on, turn the ramp and clamshell door latch handle to LATCHED.

4. Seals — TEST.

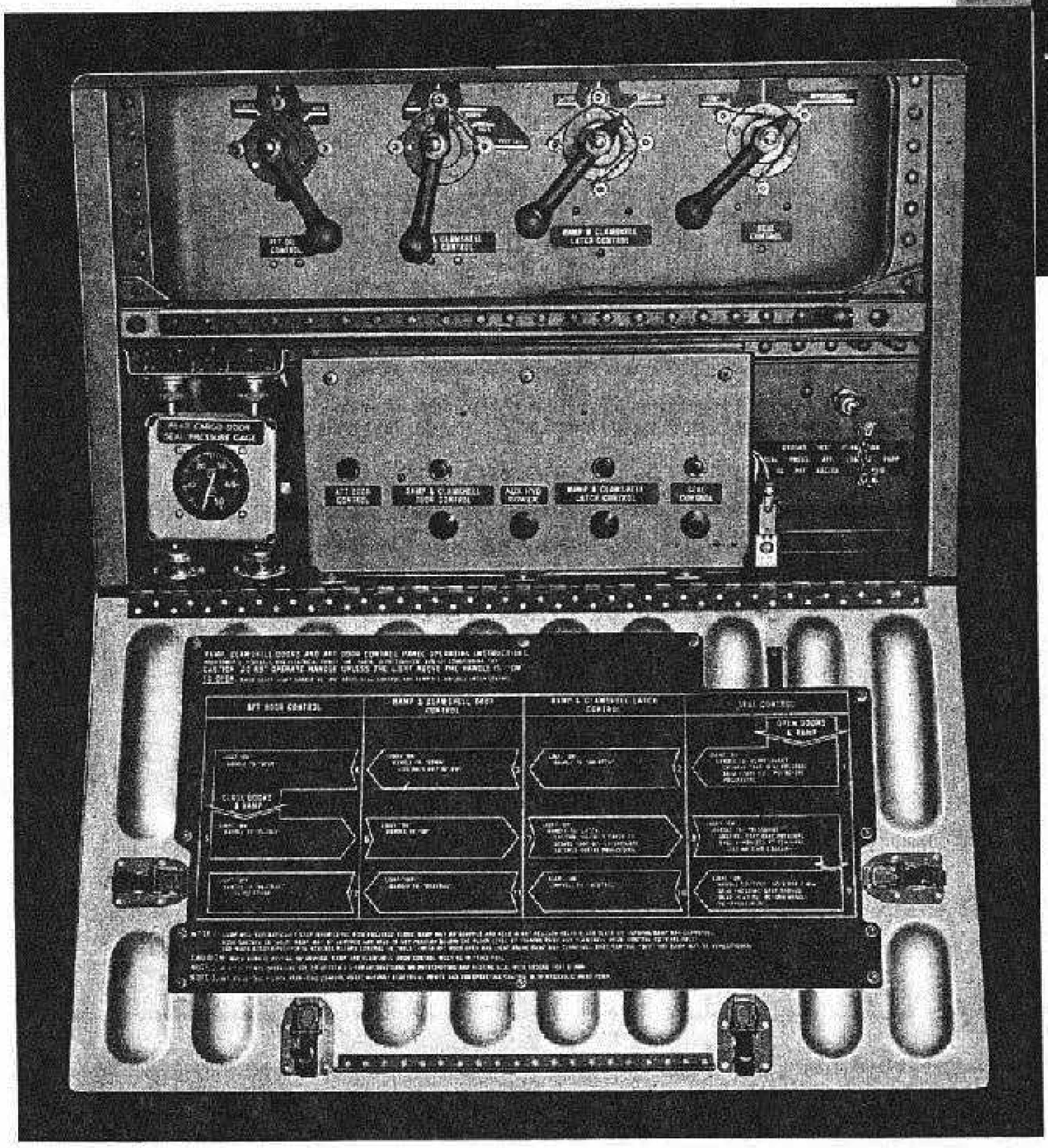
With the seal control light on, turn the seal control handle to PRESSURIZE. Check that the seal pressure gage stabilizes at 22 (±1) psi. Turn the seal control

Ramp, Clamshell Doors, and Aft Door Control Panel — Exterior

C-133B

EMERGENCY REAR CARGO DOOR RELEASE

CONTROL PANEL



UAB1-275

Figure 4-30

handle to TEST and hold for 1 minute. The pressure gage must remain above 19 psi.

CAUTION

Do not apply pressure to the seals until the doors are fully closed and latched to prevent damage to the seals.

5. Seals — PRESSURIZE.

With the seal control light and the ramp and clamshell door latch light on, return the seal control handle to PRESSURIZE. Place the ramp and clamshell door latch handle, ramp and clamshell door control handle, and the aft door control handle to NEUTRAL.

Note

The pneumatic manifold must be pressurized by engine bleed air prior to takeoff. This will assure that sufficient pressure is trapped in the seal reservoir to maintain seal pressure during extended flight at altitudes where the pneumatic manifold pressure may be lower than normal seal pressure.

TROOP CARRYING PROVISIONS.

No provisions are made for troop carrying in the aircraft.

PASSENGER CARRYING PROVISIONS.

No passenger accommodations are provided in the aircraft.

CASUALTY CARRYING PROVISIONS.

No facilities for carrying of casualties are provided in the aircraft.

SINGLE-POINT REFUELING EQUIPMENT.

See Section VII for details of the Single-Point Refueling System.

MISCELLANEOUS EQUIPMENT.

WINDSHIELD WIPERS AND SWITCHES.

Two electrically actuated windshield wiper units are installed, one on the pilot's front center windshield and one on the copilot's front side windshield. The windshield wipers are controlled by a 3-position switch located on the pilot's overhead panel (*figure 1-6*). The switch has the placarded positions SLOW, OFF, and FAST.

BUFFET.

A buffet (*12, figure 1-2*), consisting of two electrically heated 37-ounce hot cups, four electrically heated 2-gallon liquid containers, two waste containers (one for liquid and one for paper), storage space for eight box lunches, and a cup dispenser, is located on the forward side of the aft bulkhead of the relief crew compartment. Each hot cup is provided with an electrical connector, a control knob, an automatic timer, and a power indicating light, all located on the hot cup mount. A recess with a built-in electrical outlet and latch is provided in the buffet cabinet to accommodate each liquid container. A toggle switch and latch release for each container is mounted on the face of the cabinet, adjacent to its respective container space. The hot cups and liquid containers are powered from the 115-volt a-c nonessential bus on the flight deck left hand auxiliary circuit breaker panel. This bus is deenergized when one main generator is inoperative and the propeller deicing switches are turned ON.

OVEN AND ICEBOX.

An electrically heated oven is mounted in the aft bulkhead of the relief crew compartment. A dry-ice box is mounted on the floor directly below the oven. The dry-ice box has a capacity for 26 precooked meals in containers of size 1⅛ x 6½ x 9¼ inches. When loaded with 5 pounds of dry ice, it will keep the food at a nonspoiling temperature for a minimum period of 20 hours under all but the most severe conditions. The oven is provided to heat the food and is powered from the 200-volt a-c nonessential bus on the flight deck left hand auxiliary circuit breaker panel. The oven will not operate when one main generator is inoperative and the propeller deicing switches are turned ON.

FLIGHT DECK LADDER.

A ladder (*40, figure 1-2*) is located in the cabin on the left side, just forward of the side cargo door to provide access to the flight deck.

BLACKOUT CURTAINS.

Blackout curtains (*7, figure 1-2*) are installed for all crew compartment windows except those in the cockpit enclosure. A full-length blackout curtain is installed on the flight deck, just aft of the pilots' stations, and separates the pilots' area from the remainder of the flight deck. The relief crew's quarters and navigator's station are provided with a similar type of curtain.

RELIEF CREW PROVISIONS.

Accommodations for a relief crew are provided in the aft portion of the flight deck. Seating is available for six relief crew members. Four bunks provide sleeping accommodations. Two of the bunks are located in the relief crew compartment; the other two bunks *(11, figure 1-2)* are located in the forward end of the cabin directly below the relief crew compartment.

LAVATORY.

A lavatory *(43, figure 1-2)* is installed in the cabin opposite the crew's entrance. The lavatory contains a wash basin, a mirror, a paper towel dispenser, a chemical toilet, a toilet paper holder, a trash container, an electric razor outlet, and a urinal. A 5-gallon tank is provided to supply water for the wash basin. A walk-around oxygen bottle is stowed in a bracket on the wall of the lavatory. The lavatory is equipped with lighting facilities.

MAP CASES.

Three map cases are provided in the aircraft. One map case *(2, figure 1-2)* is attached to the flight deck floor at the outboard side of both the pilot's and the copilot's seats. The navigator's map case *(16, figure 1-2)* is attached to the flight deck floor at the outboard side of the navigator's seat.

FLIGHT ENGINEER'S DATA CASE.

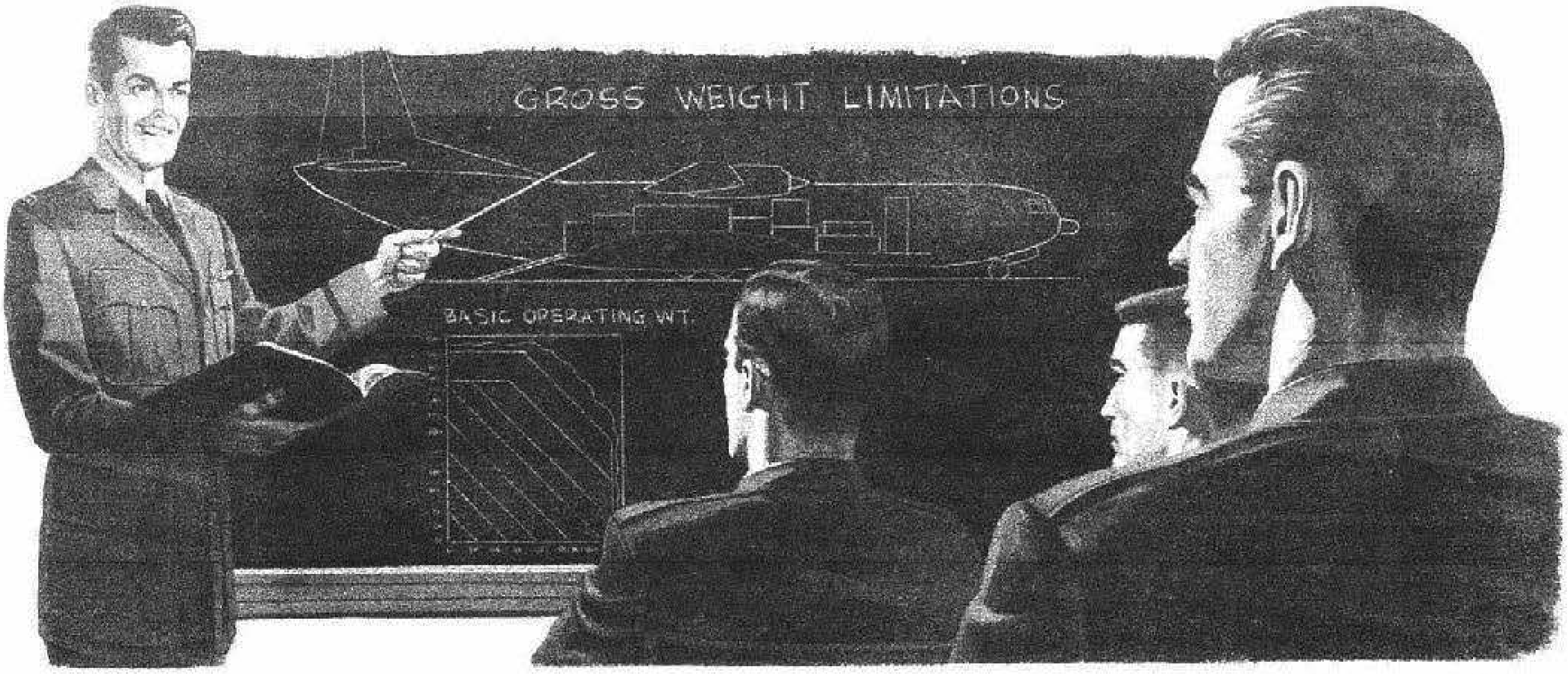
A flight engineer's data case *(6, figure 1-2)* is installed on the aft side of the copilot's seat.

LOAD ADJUSTER.

A load adjuster *(9, figure 1-2)* is stowed in a mounting bracket at the aft end of the flight engineer's table, below the fuel dump lever.

FLIGHT INFORMATION PUBLICATIONS (FLIP) HOLDERS.

Two Flight Information Publications, (Flip) holders *(18, figure 1-2)* are installed on top of the glareshield. One of the holders is located in front of the pilot's station, and the other in front of the copilot's station. When not in use, the holders lie flat against the glareshield. In use, each of the Flip holders may be individually raised to a vertical position.



OPERATING LIMITATIONS SECTION V

UA81-309

TABLE OF CONTENTS

Instrument Limit

FUEL GRADE JP-4

EXHAUST GAS TEMPERATURE INDICATOR (T34-P-7WA)

🟩 400°C to 505°C Continuous Operation

🟨 505°C to 545°C Caution (Continuous Operation)—Operation in this range dependent upon ambient conditions (see Power Setting curves).

🟨 545°C to 760°C Caution (Starting—10 seconds maximum).

🟥 400°C Maximum Starting Below 41 Percent RPM.

🟥 760°C Maximum Starting Above 41 Percent RPM.

620°C Maximum Continuous Permissible in Low Ground Idle

ENGINE TURBINE INLET TEMPERATURE INDICATOR (T34-P-9W)

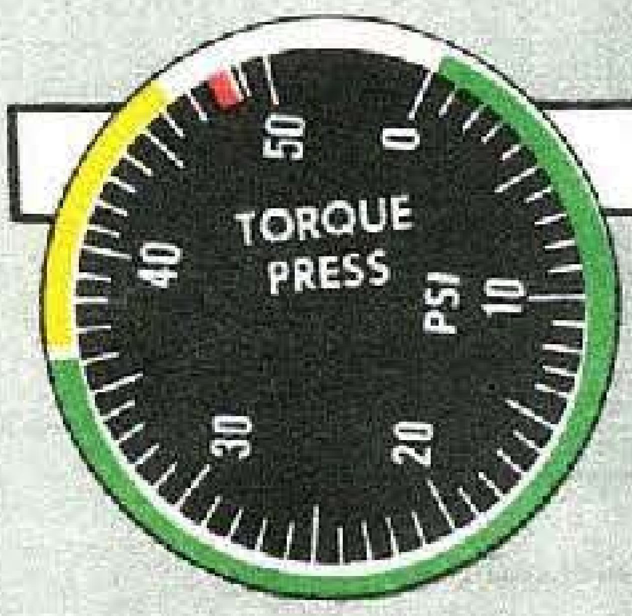
🟩 660° C to 890° C Continuous Operation

🟨 890° C to 955° C Caution (Time and Temperature Limited by Power Setting).

🟥 760°C Maximum Starting Below 50 Percent RPM

🟥 850°C Maximum Starting Above 50 Percent RPM (10 Seconds)

🟥 955°C Maximum



ENGINE TORQUE PRESSURE INDICATOR (T34-P-7WA)

🟩 0 to 36.6 PSI Continuous Operation at 97.7 Percent RPM

🟨 36.6 to 46.5 PSI Caution (Consult Power Curves for Applicable Limits).

🟥 48.9 PSI Maximum (absolute) at 95 Percent RPM

ENGINE TORQUE PRESSURE INDICATOR (T34-P-9W)

🟩 0 to 40.2 PSI Continuous Operation at 97.7 Percent RPM

🟨 40.2 to 52.5 PSI Caution (Consult Power Curves for Applicable Limits).

🟥 52.5 PSI Maximum (absolute) at 95 Percent RPM

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Figure 5-1 (Sheet 1 of 6)

Markings

FUEL GRADE JP-4

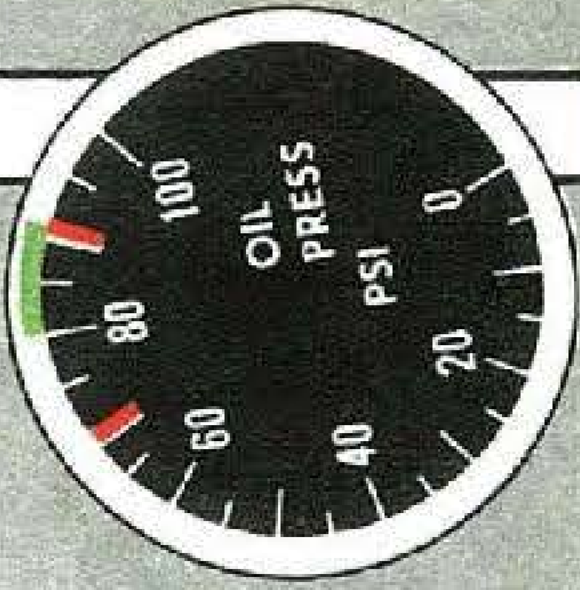
ENGINE TACHOMETER

94.5 to 100 Percent RPM Continuous Operation 🟩

100.0 to 107 Percent RPM Transient Condition 🟨

107 Percent RPM Maximum 🟥

ENGINE OIL PRESSURE INDICATOR



70 PSI Minimum at Low Ground Idle 🟥

80 to 90 PSI Continuous Operation 🟩

90 PSI Maximum 🟥

ENGINE FUEL FLOW INDICATOR (T34-P-7WA)

700 to 4250 PPH Normal Operating Range 🟩

4250 PPH Maximum 🟥

ENGINE FUEL FLOW INDICATOR (T34-P-9W)

700 to 4300 PPH Normal Operating Range 🟩

4300 PPH Maximum 🟥

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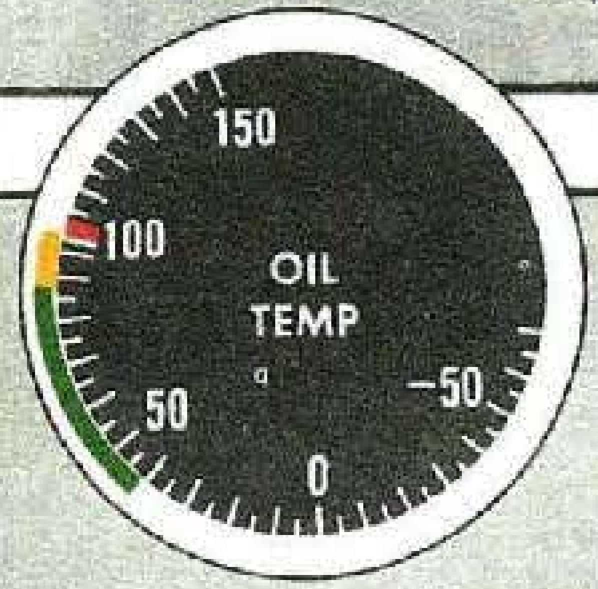
Figure 5-1 (Sheet 2 of 6)

Instrument Limit

FUEL GRADE JP-4

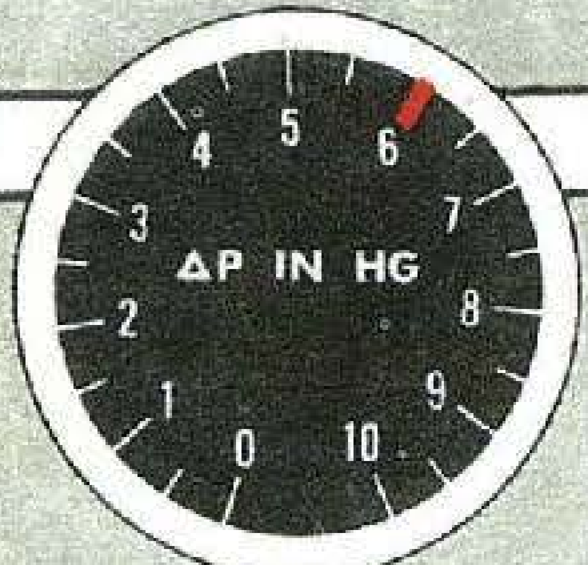


ENGINE OIL TEMPERATURE INDICATOR

🟩 40°C to 87°C Continuous Operation

🟨 87°C to 100°C Caution

🟥 100°C Maximum



GTU AIRFLOW DIFFERENTIAL PRESSURE (ΔP) INDICATOR

🟥 6 inches Hg Maximum

NOTE: 6 inches Hg maximum limit with either one or two GTU'S operating.

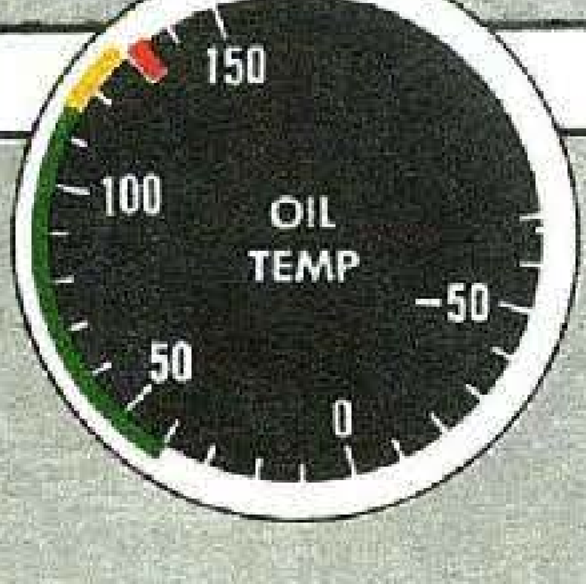
GTU EXHAUST GAS TEMPERATURE INDICATOR

🟩 300°C to 600°C Continuous Operation

🟨 600°C to 670°C Caution: Continued operation in this range will adversely affect life of turbine section

🟥 670°C Maximum

CAUTION: Any time temperature exceeds 670°C the temperature and duration must be noted in form 781. Operation from 670°C to 700°C longer than 10 Sec. or from 700°C to 750°C longer than 5 Sec. or any operation above 750°C requires GTU shut down and inspection in accordance with applicable technical orders.



GTU OIL TEMPERATURE INDICATOR

🟩 40°C to 115°C Continuous Operation

🟨 115°C to 130°C Caution (Monitor Continuously)

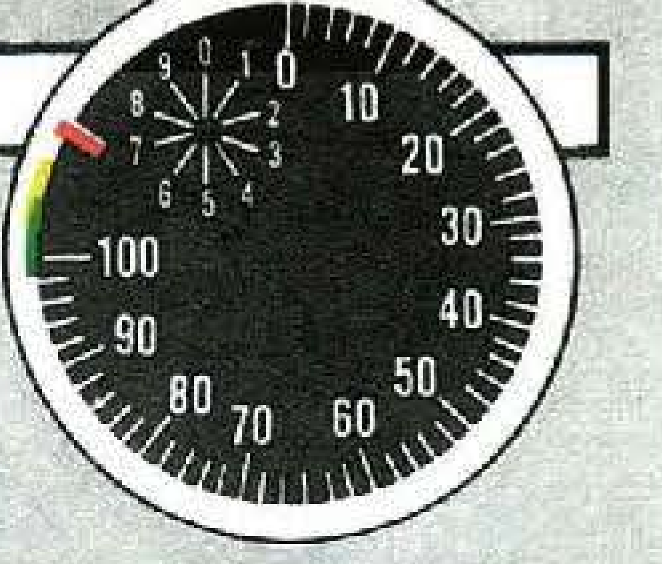
🟥 130°C Maximum

UAB1-312

Figure 5-1 (Sheet 3 of 6)

Markings

GTU TACHOMETER



98.5 to 105 Percent RPM Continuous Operation 🟩

105 to 110 Percent RPM Caution (Monitor Continuously) 🟨

110 Percent RPM Maximum 🟥

GTU OIL PRESSURE INDICATOR

95 to 120 PSI Continuous Operation in Flight 🟩

45 to 95 PSI Caution (Monitor Continuously) 🟨

120 PSI Maximum 🟥

AIRSPEED INDICATOR

Airspeed Limited to:

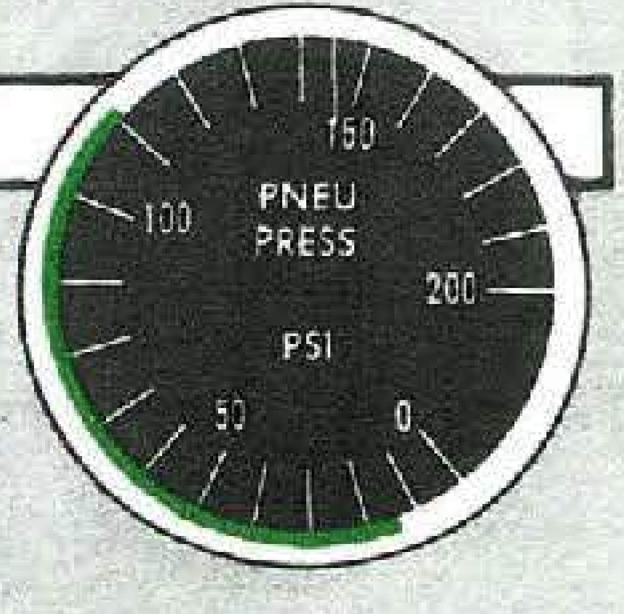
267 Knots from Sea Level to 5000 feet
261 Knots from 5000 feet to 10,000 feet
255 Knots from 10,000 feet to 15,000 feet
248 Knots from 15,000 feet to 20,000 feet 🟥

Airspeed Limited to M.55 above 20,000 feet ▥

178 Knots IAS Maximum for Extension of Landing Gear or Landing Lights 🟨

140 Knots IAS Maximum for Full Flap Extension 🟨

PNEUMATIC PRESSURE INDICATOR



15 to 110 PSI Normal 🟩

Figure 5-1 (Sheet 4 of 6)

UAB1-313

Instrument Limit

AILERON LOCK ACCUMULATOR PRESSURE INDICATOR

🟩 1000 to 1050 PSI Normal Preload Pressure

🟥 3750 to 3800 PSI Maximum

FREQUENCY METER

🟥 380 CPS Minimum

🟩 381 to 419 CPS Normal

🟥 420 CPS Maximum

PROPELLER DEICING AMMETER

🟥 42 Amps Minimum

🟩 43 to 59 Amps Normal

🟥 60 Amps Maximum

NOTE:
Forward spinner, aft spinner, and blades and cuffs ammeters should indicate within 3 amps of each other.

HYDRAULIC PRESSURE INDICATOR

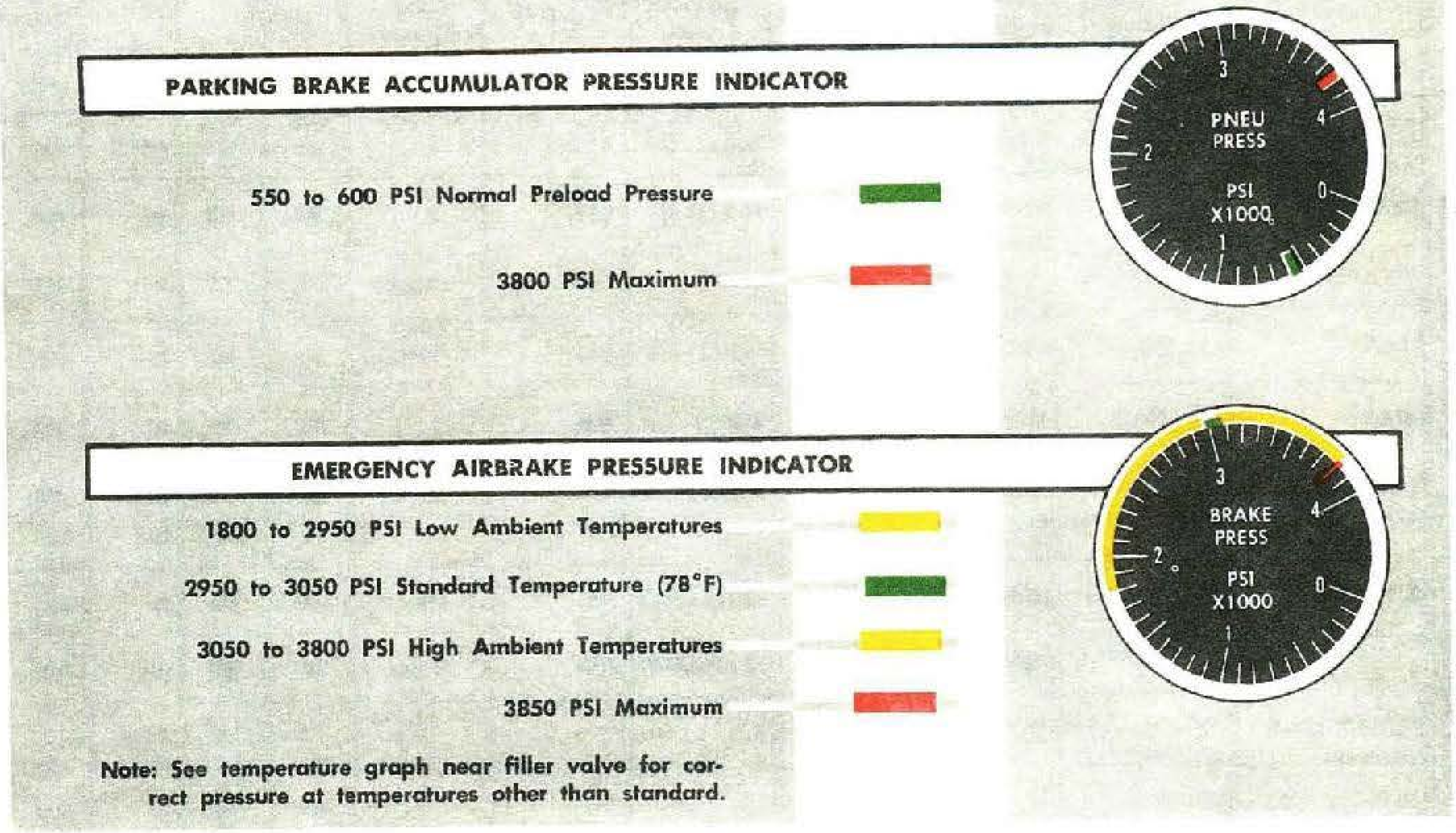
🟩 2600 to 3000 PSI Normal

🟥 3400 PSI Maximum (Relief Valve Cracking Pressure)

UAB1-314

Figure 5-1 (Sheet 5 of 6)

Markings



UA81-315

Figure 5-1 (Sheet 6 of 6)

INTRODUCTION.

This section includes the limitations that must be observed during normal operation of the C-133A and C-133B aircraft, and the T34-P-7WA and T-34-P-9W engines. The instrument limit markings *(figure 5-1)* form a part of these limitations and must be referred to, since these limitations are not necessarily repeated in the text.

MINIMUM CREW REQUIREMENTS.

The minimum crew consists of a pilot, a copilot, a flight engineer, and a scanner. Additional crew members, as required, will be added at the discretion of the commander.

INSTRUMENT MARKINGS.

Refer to figure 5-1 for Instrument Limit Markings.

ENGINE LIMITATIONS.

Close observance and adherence to engine limitations is necessary for efficient and safe engine operation. The maximum limits for starting, ground operation, acceleration, and cruise apply regardless of outside air or compressor inlet temperatures.

ENGINE OPERATING POWERS.

The following engine powers, as defined, are used in this section and in the performance data throughout *T.O. 1C-133A-1-1.*

MAXIMUM power — The greatest amount of power (wet or dry) to be used for a limited time period during takeoff or emergency operation.

Engine Operating Limitations — T34-P-7WA and T34-P-9W

Operating Condition	Schedule Percent Rpm*	T34-P-7WA		T34-P-9W		Time Limit (Minutes)	Oil Pressure (Psi)		Oil Temperature (°C)	
		Maximum Allowable Torque Pressure (Psi)** (3)	Maximum Exhaust Gas Temperature (°C)	Maximum Allowable Torque Pressure (Psi)** (3)	Maximum Turbine Inlet (°C)		Min	Max	Minimum	Maximum (10)
MAX	(S) 100	46.5 (2) (3) (4)	(12)	49.8 (2) (3) (4)	955	2	80	90	40	100
(Wet)***	(M) 97.7	47.6 (3) (4)	(12)	50.9 (3) (4)	955	2 (5 min. emerg.)	80	90	40	100
MAX	(S) 100	46.5 (2) (3)	(12)	49.8 (2) (3) (4)	940	5	80	90	40	100
(Dry)	(M) 97.7	47.6 (3)	(12)	50.9 (3) (4)	940	5	80	90	40	100
MILITARY	(S) 100 (13)	46.5 (5)	(12)	46.5 (5)	925	30	80	90	40	100
RATED	(M) 97.7 (13)	47.6	(12)	47.6	925	30	80	90	40	100
NORMAL	(S) 97.7 (1) (13)	36.6 (6) (16)	(12)	40.2 (6) (16)	890	Cont.	80	90	40	100
RATED	(M) 97.7 (13)	36.6 (6) (16)	(12)	40.2 (6) (16)	890	Cont.	80	90	40	100
FLIGHT IDLE (Airborne)	(S) 94.5 (13)					Cont.	80	90	40	100
	(M) 97.7 (above 120 Knots)					Cont.	80	90	40	100
(Static)	90.9—92.5 (15)					Cont.	80	90	40	100
GROUND IDLE										
High	90.9—92.5 (15)		(11)		705 (11)	Cont.	80	90	40	100
Low	53.5—57.0 (14)		(11)		705 (11)	Cont.	80	90	40	100
FULL REVERSE	92.5—103 (15)		460		750		80	90	40	100
STARTING	(9)		400 Below 41% Rpm 760 Above 47% Rpm (10 Seconds)		760 Below 50% Rpm 850 Above 50% Rpm (10 Seconds)	(7)	(8)	(8)		

(S) Synchronous governing. (M) Mechanical reference governing.

For numbers in parentheses, see applicable numbered notes, sheets 2 of 3 and 3 of 3.

*The maximum overspeed limit is 107 percent rpm for 5 seconds.

**Gear box limit or ram limit.

***Do not use water-alcohol injection at ambient temperatures below 0°C, or at altitudes above 8,000 feet.

Figure 5-2 (Sheet 1 of 3)

Engine Operating Limitations—T34-P-7WA and T34-P-9W

(1) Scheduled rpm for NORMAL RATED power is 97.7 percent, however, rpm up to 100 percent is permissible. The minimum rpm which can be obtained with the rpm trim lever in the full decrease position is also permissible at NORMAL RATED power at ambient temperatures of 10°C and below.

(2) T34-P-7WA
A maximum of 48.5 psi torqure pressure at 100 percent rpm (6675 SHP) is allowed for 1 minute during the initial power reduction following takeoff. If this value is exceeded, the engine must be shut down or an immediate landing made, using the minimum power required to sustain flight.

T34-P-9W
A maximum of 50.8 psi torque pressure at 100 percent rpm (7100 SHP) is allowed for 1 minute during the initial power reduction following takeoff. If this value is exceeded, the engine must be shut down or an immediate landing made, using the minimum power required to sustain flight.

(3) T34-P-7WA
The engine will develop more than 46.5 psi torque pressure at 100 percent rpm (6500 SHP) for takeoff at low ambient temperatures (see MAX Dry Power Check Curve — 100 Percent Rpm, in Part 2 of *T.O. 1C-133A-1-1*). Where the engine will develop more than 6500 SHP, a takeoff at less than full throttle will be necessary. The following percent rpm and torque pressure combinations reflect 6500 SHP:

Tachometer Reading (Percent Rpm)	*Maximum Allowable Torquemeter Pressure (Psi)*
100	46.5
99	47.0
98	47.4
97	47.9
96	48.4
95	48.9

T34-P-9W
The engine will develop more than 49.8 psi torque pressure at 100 percent rpm (6950 SHP) for takeoff at low ambient temperatures (see MAX Dry Power Check Curve — 100 Percent Rpm, Part 2 of *T.O. 1C-133A-1-1*). Where the engine will develop more than 6950 SHP, a takeoff at less than full throttle will be necessary. The following percent rpm and torque pressure combinations reflect 6950 SHP.

Tachometer Reading (Percent Rpm)	*Maximum Allowable Torquemeter Pressure (Psi)*
100	49.8
99	50.4
98	50.9
97	51.3
96	51.9
95	52.5

(4) Compute maximum power from MAX Wet or MAX Dry Power Check Curves, Part 2 of *T.O. 1C-133A-1-1*, as applicable.

(5) To be computed from the Torque Pressure Determination - MILITARY RATED Power chart in Part 2 of *T.O. 1C-133A-1-1*, or from the Climb Torque Pressure — Military Rated Power chart in Part 4 of *T.O. 1C-133A-1-1*. If any of these limits are exceeded, the 5 minute time limit for MAX (dry) power will apply.

(6) To be computed from Torque Pressure — Climb-NORMAL RATED Power chart, Part 4, of T.O. 1C-133A-1-1. If operating torque pressure limit is exceeded, the 30 minute time limit for MILITARY RATED power will apply. If the 30 minute limit is exceeded, either the engine should be shut down or a landing should be made using the minimum power required to sustain flight. When operating below NORMAL RATED power, do not exceed the torque pressure computed for NORMAL RATED power.

(7) To ensure adequate propeller reduction gear lubrication and to avoid overheating of the turbine or turbine seals, starting time from engaging the starter to attaining ground idle rpm should not be less than 30 seconds nor more than 60 seconds. In no case should the starting time exceed 2 minutes.

(8) During cold starting, engine oil pressure may vary from 90 to 150 psi, but should not exceed 150 psi for more than 10 minutes. After warmup, oil pressure should stabilize within limits (80 to 90 psi).

(9) Do not exceed HI GROUND IDLE rpm with oil temperature below 40°C.

Figure 5-2 (Sheet 2 of 3)

Engine Operating Limitations — T34-P-7WA and T34-P-9W

(10) To increase the service life of the engine, 87°C is the recommended maximum oil-in temperature for normal operation. An oil-in temperature up to 100°C is permitted in the event that normal oil temperature cannot be maintained.

(11) T34-P-7WA
Acceleration exhaust gas temperature limit from LOW to HI GROUND IDLE is 620°C. When accelerating to powers above HI GROUND IDLE, the maximum allowable exhaust gas temperature of the power condition to which the acceleration is being made, will also be the acceleration temperature limit.

T34-P-9W
The turbine inlet temperature limit for acceleration from LOW to HI GROUND IDLE rpm is 760°C below 50 percent rpm and 850°C above 50 percent rpm (10 seconds). Acceleration to higher power settings are limited to steady state limit for that power.

(12) To be computed from the appropriate power check curves in Part 2 of *T.O. 1C-133A-1-1*. Do not exceed these curve limits.

(13) A fluctuation of ±0.5 percent with an occasional ±1.0 percent rpm on synchronous governing, and a fluctuation of ±0.75 percent rpm with an occasional ±1.5 percent rpm on mechanical reference, is acceptable. These variations are predicted on a rhythmic cycle of one to three seconds. In general rapid fluctuations (several cycles per second) will be of small amplitude and may be contributed to instrumentation. If a propeller operational check at a fixed blade angle does not eliminate the fluctuation, the engine fuel control should be checked. When a fluctuation is observed, closely monitor the extent of fluctuation. A definite trend toward an increase in amplitude beyond the above stated tolerances coupled with the approximate frequency as previously stated, may be an indication of the bearings sticking and binding in the propeller governor. Such a malfunction is reason for engine shutdown.

(14) A slow random fluctuation of ±5.0 percent rpm can be occasionally expected with the throttle in LOW GROUND IDLE and the aircraft in a static condition.

(15) A slow random fluctuation of ±1.0 percent rpm may be occasionally expected with the throttle in FLIGHT IDLE, HI GROUND IDLE, or FULL REVERSE, and the aircraft in a static condition.

(16) A torque pressure fluctuation of ±2 psi is permissible during NORMAL RATED operating conditions and below.

Figure 5-2 (Sheet 3 of 3)

MILITARY RATED Power. —The maximum power allowable during flight under specified operating conditions for periods of 30 minutes duration.

NORMAL RATED Power. —The maximum power allowable for continuous operation under specified conditions.

ENGINE OPERATING LIMITATIONS.

The engine operating limits for the various operating conditions are given on figure 5-2. For shaft horsepower limitations at NORMAL RATED, MILITARY RATED, and MAXIMUM power, see figure 5-4. Shaft horsepower limitations for a given takeoff condition are shown on the MAX Power Check Curves in Part 2 of *T.O. 1C-133A-1-1*. Maximum allowable torque pressures for takeoff, climb, and cruise are to be computed from the appropriate curves in *T.O. 1C-133A-1-1*. For torque pressure characteristics during cold weather operation, see section IX.

Maximum Allowable Turbine Inlet/Exhaust Gas Temperatures.

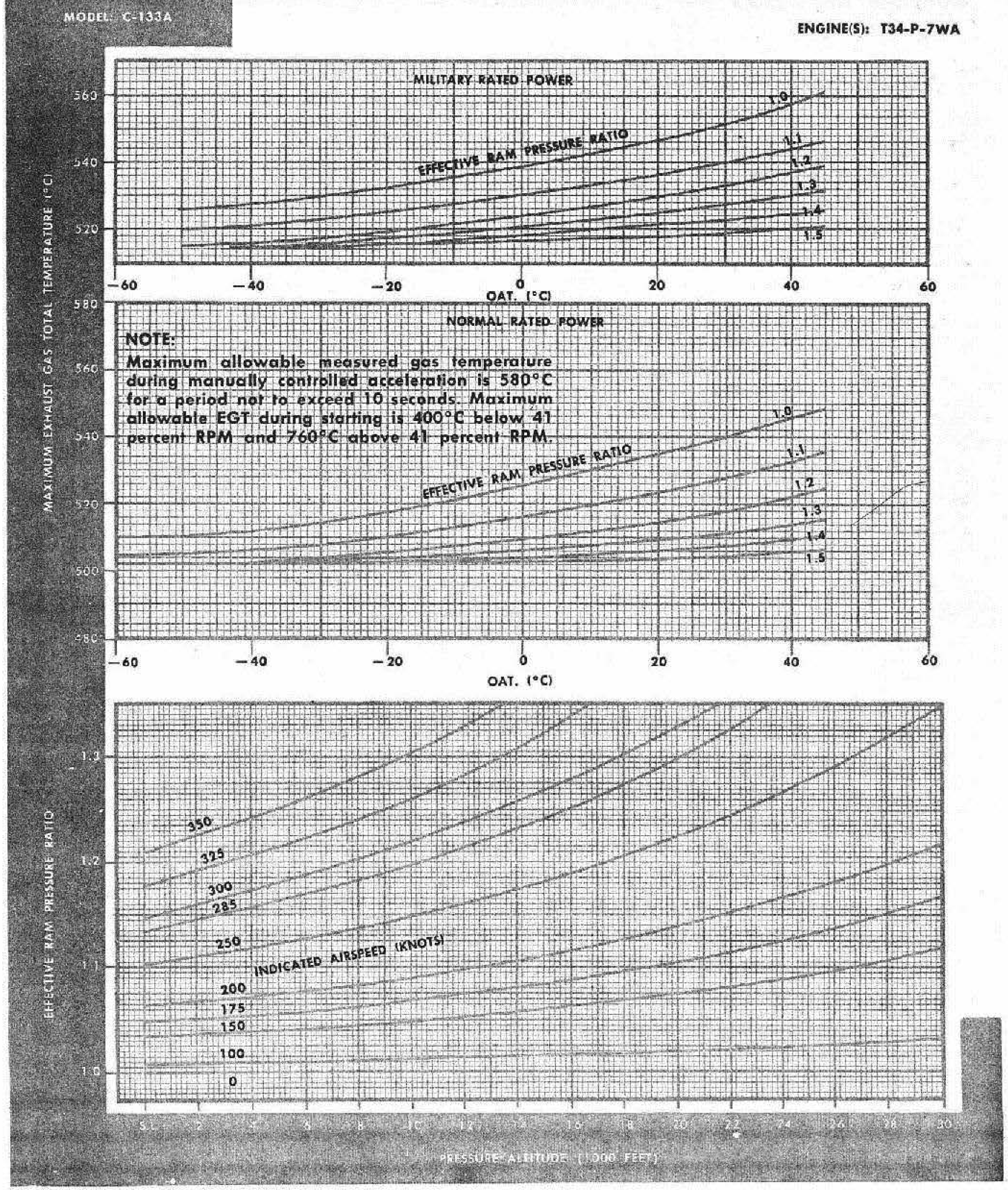
CAUTION

Turbine inlet/exhaust gas temperature and torque pressure control is of the utmost importance to the life of the engines; therefore, it is necessary that the limiting temperature for any given condition be strictly observed, both on the ground and during flight. If the turbine inlet/exhaust gas temperature and torque pressure limits cannot be maintained, either the engine should be shut down or a landing should be made as soon as practicable, using the minimum power required to sustain flight. Any overspeed, overtemperature, or overtorque will be noted in Form 781 by stating rpm, temperature, or torque experienced and duration.

Takeoff—Use the MAX Power Check Curves in Part 2 of *T.O.* 1C-133A-1-1 to determine the maximum allowable turbine inlet/exhaust gas temperature for a given takeoff condition. This maximum allowable turbine inlet/exhaust gas temperature must be limited to 5 minutes dry and 2 minutes wet.

(See Note on Page 5-14)

Maximum Allowable Exhaust Gas Temperatures



NOTE:
Maximum allowable measured gas temperature during manually controlled acceleration is 580°C for a period not to exceed 10 seconds. Maximum allowable EGT during starting is 400°C below 41 percent RPM and 760°C above 41 percent RPM.

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Figure 5-3

Shaft Horsepower Limitations — Maximum,

MODEL: C-133A

ENGINE(S): (4) T34-P-7WA

Note: Limitations specified are gearbox limits.

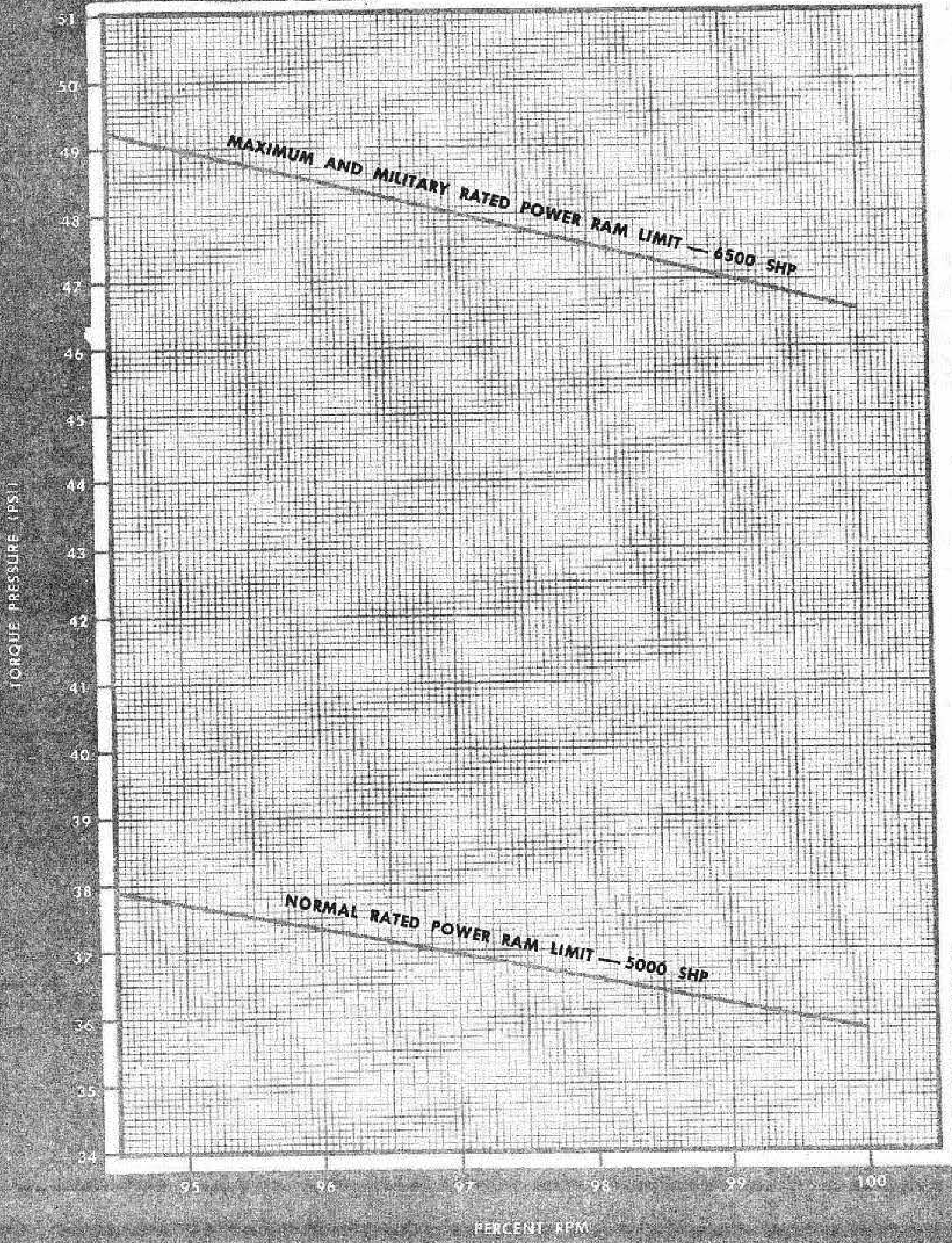

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Figure 5-4 (Sheet 1 of 2)

Military Rated, and Normal Rated Power

ENGINE(S): (4) T34-P-9W

MODEL: C-133B

Note: Limitations specified are gearbox limits.

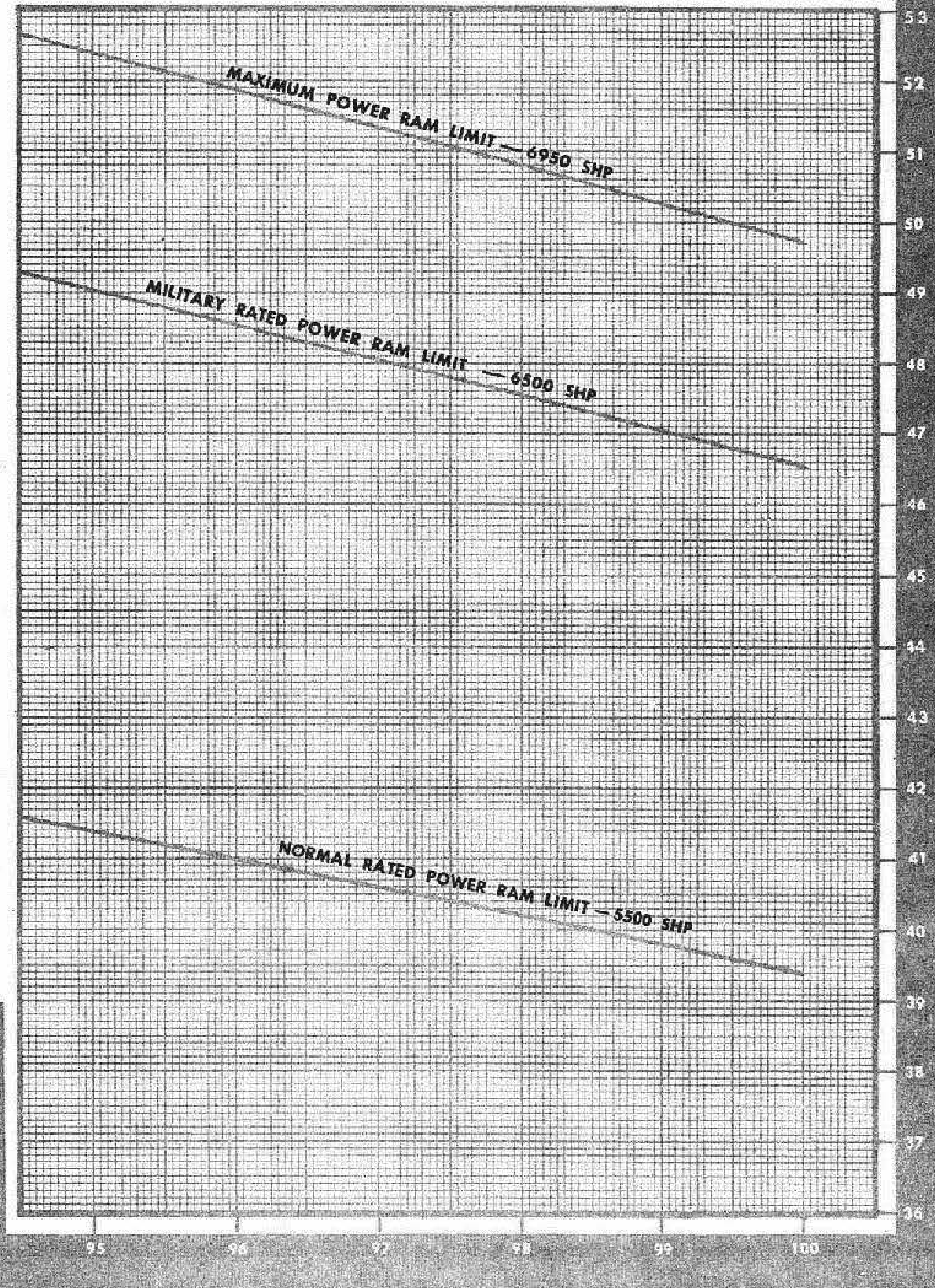

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Figure 5-4 (Sheet 2 of 2)

Note

In an emergency, water injection may be used until the supply of water-alcohol mixture is exhausted.

Starting — T34-P-7WA — The exhaust gas temperature limit is 400°C below 41 percent rpm, and 760°C above 41 percent rpm, for a period not to exceed 10 seconds. When accelerating to engine powers above high ground idle rpm, the temperature limit for the power condition to which the acceleration is being made will also be the acceleration temperature limit.

Starting — T34-P-9W — The turbine inlet temperature limit for starting acceleration is 760°C below 50 percent and 850°C above 50 percent rpm, not to exceed 10 seconds. When accelerating to engine powers above high ground idle rpm, the temperature limit for the power condition to which the acceleration is being made will also be the acceleration temperature limit.

Steady State — The maximum allowable TIT/EGT during steady state operations may be determined from the applicable charts in Parts 2 and 4 of *T.O. 1C-133A-1-1.*

Water-Alcohol Injection.

CAUTION

The use of water-alcohol injection is restricted to a maximum of 6500 SHP for the T34-P-7WA and 6950 SHP for the T34-P-9W engines. Use is limited to ambient temperatures above 0°C and altitudes below 8000 feet.

STARTING FUEL FLOW SCHEDULE.

During engine starting, check for an indication of fuel flow at the same time the condition lever is placed in the RUN-FUEL ON position. At sea level, with standard day conditions, the desired fuel flow schedule is as follows:

Percent Rpm	*Fuel Flow (Pounds Per Hour)*
15	300 to 380
20	340 to 420
25	440 to 520
30	580 to 640
35	700 to 760
40	820 to 900
45	960 to 1020
50	1100 to 1180

Note

When the condition lever is placed in the RUN-FUEL ON position, the fuel flow will momentarily surge to approximately 550 psi prior to stabilizing. If starting fuel flow exceeds the desired fuel flow schedule, turbine inlet temperature will be high. If fuel flow is low, a false start may be experienced. See figure 5-2 for maximum turbine inlet temperature for engine starting.

NORMAL FUEL GRADE OPERATING LIMITS.

The normal fuel grade operating limits are those specified under the paragraphs on Engine Operating Limitations, this section. When the specified JP-4 fuel grade is not available, service the aircraft with alternate fuels listed in order of preference under Military Aviation Turbine Fuels *(figure 5-5).*

ALTERNATE FUEL GRADES.

JP-5 Fuel.

Engines tested with this fuel indicated no significant power changes. High altitude relight characteristics with JP-5 fuel are not as good as with JP-4 fuel. JP-5 fuel can freeze at a −48°C temperature which is considerably above the −59°C capability of the aircraft. JP-5 fuel is not stocked by the Air Force, but it may be available at some Naval bases.

JP-1 Fuel.

Fuels with the NATO symbol F-30, F-32, F-33, and F-34 have similar properties of JP-1 fuel, the principal variation being the freezing point. Performance changes with these fuels have not been determined, therefore, careful monitoring of the engine instruments is necessary.

JP-3 Fuel.

Performance changes on the engine due to the use of JP-3 fuel have not been determined; therefore, careful monitoring of the engine instruments is necessary.

Aviation Gasoline.

In the event that an aircraft is serviced with gasoline, engine performance from NORMAL RATED to MAXIMUM power will change as follows:

Fuel flow, PPH	7 percent decrease
Shaft horsepower	10 percent decrease
Turbine inlet temperature	Slight decrease
Exhaust gas temperature	33°C decrease
Equivalent specific fuel consumption	2½ percent increase

Military Aviation Turbine Fuels

SPECIFIED FOR C-133A/B AIRCRAFT — T34-P-7WA/9W ENGINES

Order of Preference	*NATO Symbol*	*UNITED STATES*		*GREAT BRITAIN*	*BELGIUM*	*CANADA*	*FRANCE*	*ITALY*
		Grade	*Specification*	*Specification*	*Specification*	*Specification*	*Specification*	*Specification*
1	F-40	JP-4	MIL-F-5624	DERD 2486-AVTAG	DSM-70b	3-GP-22c	Air 3407	AM-C-142b
KEROSENE ALTERNATE								
2	F-42	JP-5	MIL-F-5624	DERD 2488-AVCAT		3-GP-24b	Air 3404	
3	F-30			DERD 2482-AVTUR	DSM-58a			AM-C-141a
4	F-32	JP-1	MIL-F-5616					
5	F-33							
6	F-34					3-GP-23a	Air 3405/2	
7		JP-3	MIL-F-5624					
GASOLINE ALTERNATE								
8	F-12	80/87	MIL-G-5572					
9	F-15	91/96	MIL-G-5572					
10	F-18	100/130	MIL-G-5572					
11	F-22	115/145	MIL-G-5572					

Figure 5-5

Aviation gasoline varies in each country. The significant variation is in the tetraethyl lead content. If aviation gasoline must be used as an alternate fuel, NATO specification aviation gasoline of the lowest grade available is preferred.

General Instructions For Use of Any Alternate Fuel.

1. Do not exceed engine limits specified for JP-4 fuel.

2. Avoid icing conditions.

3. Service aircraft with minimum quantity of fuel to permit flight to nearest base where JP-4 fuel is available.

4. If possible, climb should be performed at NORMAL RATED power.

5. Draining of alternate grade fuel from tanks after flight is not mandatory but is recommended to assure aircraft performance as specified in *T.O. 1C-133A-1-1.* If tanks are not drained of alternate grade fuel, entry should be made in the Form 781 of the approximate amount of alternate grade fuel remaining in the tanks, to alert the next crew that normal performance will not be attained until that fuel is consumed. No special inspections are required after use of any of the specified alternate grade fuel.

TABLE OF TOLERANCES.

A table of tolerances *(figure 5-6)* is provided as a supplement to the instrument limit markings *(figure 5-1).*

PROPELLER LIMITATIONS.

RPM FLUCTUATION.

When an rpm fluctuation is encountered in flight, care must be taken in judging the seriousness of the

Table of Tolerances

GTU TOLERANCES.

Starting and No-Load Limits.

Rpm — Ground	99 — 101 Percent
Rpm — Flight	99 — 102.5 Percent
*Rpm — Transient	105 — 110 Percent Caution 110 Percent Maximum
EGT — Ground and Flight	300 — 600°C 600 — 670°C Caution
*EGT — Transient	670 — 700°C, 10 Seconds 700 — 750°C, 5 Seconds
Oil Pressure — Ground	105 — 115 Psi
Oil Pressure — Flight	95 — 120 Psi
Oil Temperature	130°C Maximum
Airflow ΔP	0.0 Inches Hg

Loaded and Unaugmented.

Rpm — Ground	98.5 — 99.5 Percent
Rpm — Flight	98.5 — 105 Percent
*Rpm — Transient	105 — 110 Percent Caution 110 Percent Maximum
EGT — Ground	580 — 590°C
EGT — Flight	580 — 600°C 600 — 670°C Caution 670 — 700°C, 10 Seconds 700 — 750°C, 5 Seconds
Airflow ΔP — Ground	1.5 — 2.5 Inches Hg
Airflow ΔP — Flight	1.0 — 2.5 Inches Hg
Oil Pressure — Ground	105 — 115 Psi
Oil Pressure — Flight	95 — 120 Psi
Oil Temperature	130°C Maximum

Loaded and Augmented.

Rpm — Ground	98.5 — 101 Percent
Rpm — Flight	98.5 — 105 Percent Caution
*Rpm — Transient	105 — 110 Percent Caution 110 Percent Maximum
EGT — Ground and Flight	510 — 540°C Minimum 570 — 600°C Continuous 600 — 670°C Caution 670 — 700°C, 10 Seconds 700 — 750°C, 5 Seconds
Oil Pressure — Ground	105 — 115 Psi
Oil Pressure — Flight	95 — 120 Psi
Oil Temperature	130°C Maximum
Airflow ΔP (Manual Selection)	6.0 Inches Hg Maximum

* Transient conditions occur during changes in GTU operational procedures. For example, unloaded to loaded or unaugmented to augmented operation.

PROPELLER TOLERANCES.

All rpm tolerance limitations are predicated on the use of an accurate tachometer system. Inaccuracies in the tachometers can usually be determined by across the board comparison of rpm indicators. For allowable rpm oscillation, see Rpm Fluctuation, this section. The following tolerances are applicable to both B-100 and B-300 series propellers:

Synchronous Reference Governing.

MAXIMUM Power	100(±0.5) Percent
MILITARY RATED Power	100(±0.5) Percent
NORMAL RATED Power	97.7(±0.5) Percent
FLIGHT IDLE (Airborne)	94.5(±0.5) Percent

Mechanical Reference Governing.

Powers Above FLIGHT IDLE	97.7(±0.5) Percent

Note

If time does not permit adequate propeller pitch change system warmup, a tolerance of 97.7(±1.0) percent is acceptable.

FLIGHT IDLE — Static	90.9 — 92.5 Percent
High GROUND IDLE	90.9 — 92.5 Percent
FULL REVERSE	95.5 — 100.5 Percent
Low GROUND IDLE	53.5 — 57.0 Percent

Error Switch Settings.

High Error	103.0(±1.0) Percent
Low Error	92.5(±1.0) Percent

Rpm Trim (see Propeller Synchronizer Rpm Trim Operation Envelope, *figure 7-1*).

Upper Limit	99.5 — 100.5 Percent
Lower Limit	94.0 — 95.0 Percent

Figure 5-6

Warning and Caution Light Settings

BRAKE SYSTEM.

Antiskid Warning Light.

Light ON..........Landing gear is not down and locked, *or* continuity does not exist in antiskid system.

Light OFF.........Landing gear is down and locked, weight of aircraft is resting on gear, and continuity exists in antiskid system.

ELECTRICAL SYSTEMS.

A-C Checklist Annunciator Panel.

LEFT GEN OUT
Light ON..........Voltage is less than 100 volts to ground on any line, *or* voltage exceeds 139 ±10 volts to ground on any line.

RIGHT GEN OUT
Light ON..........Voltage is less than 100 volts to ground on any line, *or* voltage exceeds 139 ±10 volts to ground on any line.

N-1 Compass Power-Off Light.

Light ON..........Voltage to N-1 Compass system is 90 volts or less.

Light OFF.........Voltage to N-1 Compass system is 105 volts or more.

Transformer-Rectifier Warning Lights.

Light ON..........A-C input voltage to applicable transformer-rectifier is less than 72 to 83 volts for a period of 4 seconds or more, *or* d-c output voltage from applicable transformer-rectifier is less than 16 to 18 volts.

Light OFF.........D-c output voltage from applicable transformer-rectifier is 25 to 30 volts, *or* a-c power is not available.

ENGINE SYSTEMS.

Engine Overheat and Fire Warning Lights.

Flashing
Light ON..........Sensing element ambient temperature is 300°F or more (overheat).

Flashing
Light OFF.........Sensing element ambient temperature is 280°F or less.

Steady
Light ON..........Sensing element ambient temperature is 500°F or more (fire).

Steady
Light OFF.........Sensing element ambient temperature is 475°F or less.

Ice Accretion Lights.

Lights ON.........Detector probe in any engine is sensing a free airstream impact pressure of .007 psi or less at sea level.

Lights OFF........Detector probes in all engines are sensing a free airstream impact pressure of .008 psi or more, at sea level.

NTC Indicator (Warning) Lights.

Light ON..........Negative torque of respective engine exceeds 2000 foot/pounds for a period of .015 seconds or more.

Light OFF.........When NTC warning light reset switch is moved to RESET position.

Oil Low-Pressure Warning Light.

Light ON..........Oil pressure of any engine is descreasing and has reached 33 to 37 psig.

Light OFF.........Oil pressure of all operating engines is above 40 to 44 psig and condition lever of inoperative engine is in the FUEL OFF or FEATHER position.

Pneumatic Manifold Overheat Warning Light.

Light ON..........Sensing element ambient temperature is 300°F or more.

Light OFF.........Sensing element ambient temperature is 280°F or less.

Starter Disengage Warning Lights.

Light ON..........Pressure in respective starter air inlet duct is 20 psi or more.

Light OFF.........Light should go off when speed of respective engine is between 48 and 64 percent rpm, depending upon the type of starter installed.

Water-Alcohol Injection Pressure Indicators.

ON....................Water-alcohol injection pressure is between 170 and 185 psi and is increasing.

OFF..................Water-alcohol injection pressure is between 160 and 170 psi and is decreasing.

ENGINE OIL SUPPLY SYSTEM.

Oil Low-Level Warning Lights.

Lights ON.........Volume of oil in any tank is from 3.3 to 4.3 gallons, or less.

Lights OFF........Volume of oil in all tanks exceeds 4.3 gallons, *or* volume of oil in a specific tank is from 3.3 to 4.3 gallons or less, and condition lever for engine being supplied by that tank is in the FUEL OFF or FEATHER position.

FUEL SUPPLY SYSTEM.

Fuel Low-Pressure Warning Lights.

Light ON..........Respective fuel boost pump pressure is between 8.25 and 9.75 psig and is decreasing.

Light OFF.........Respective fuel boost pump pressure is between 9 and 12 psig and is increasing.

Figure 5-7 (Sheet 1 of 2)

Warning and Caution Light Settings

GTU SYSTEMS.

GTU Fire Warning Lights.

Flashing
Light ON..........Sensing element ambient temperature is 300°F or more (overheat).

Flashing
Light OFF..........Sensing element ambient temperature is 280°F or less.

Steady
Light ON..........Sensing element detects light at a temperature of 2500° K, modulated at a frequency of 16 cycles per second or less (fire).

Steady
Light OFF..........Sensing element detects light either at a temperature above 2550°K, or modulated at a frequency greater than 16 cycles per second, or both.

GTU Low-Oil Pressure Warning Lights.

Light ON..........Oil pressure of respective GTU is decreasing and has reached 43 to 47 psig.

Light OFF..........Oil pressure of respective GTU is increasing and has reached 45 to 49 psig.

Low EGT Caution Lights.

Light ON..........Exhaust gas temperature of respective GTU is between 510°C and 540°C.

Light OFF..........Exhaust gas temperature of respective GTU is above 540°C or below 510°C.

LANDING GEAR SYSTEMS.

Landing Gear Warning Light.

Light ON..........Any landing gear not up and locked or down and locked, regardless of the position of any throttle, *or* any landing gear, except the tail bumper, not down and locked and the throttle for any engine retarded to a position of 65.5° or less (as indicated on the fuel control unit protractor).

Light OFF..........All landing gears up and locked or down and locked and the throttles for all engines advanced to a position of 67.5° or more (as indicated on the fuel control unit protractor).

OXYGEN SYSTEM.

Liquid Oxygen Low-Level Warning Light.

Light ON..........Volume of liquid oxygen is from 2.75 to 2.25 litres, or less.

Light OFF..........Volume of liquid oxygen is greater than 2.75 litres.

PROPELLER SYSTEM.

Propeller Beta Warning Lights.

Light ON..........Blade angle of respective propeller is less than 10.5°.

Light OFF..........Blade angle of respective propeller exceeds 11.0°.

RUDDER SYSTEM.

Two-Position Rudder Stop Caution Indicator Lights.

18½ DEG.
RUDDER
Light ON..........Airspeed between 165 and 170 knots IAS, or more, and 7-degree rudder stop is inoperative.

18½ DEG.
RUDDER
Light OFF..........Airspeed between 165 and 170 knots IAS or more, and rudder control limited to 7-degrees.

7 DEG.
RUDDER
Light ON..........Airspeed between 165 and 170 knots IAS or less, and only 7-degrees of rudder control available.

7 DEG.
RUDDER
Light OFF..........Airspeed between 165 and 170 knots IAS or less, and 18½-degrees of rudder control is available.

WING FLAP SYSTEMS.

Emergency Wing Flap Hydraulic Pressure Indicating Light.

Light ON..........Emergency flap switch is in ON position, and auxiliary hydraulic pump pressure is between 600 and 750 psi and is increasing.

Light OFF..........Emergency flap switch is in ON position, and auxiliary hydraulic pump pressure is between 600 and 750 psi and is decreasing, *or* emergency flap switch is in the OFF position.

Wing Flap Takeoff Warning Index Panel Light.

Light ON..........Wing flaps not set at 15 ±1°, landing gear down and locked, weight of aircraft on gear, and throttles for engines No. 1 and 3 advanced to a position of 70° or more (as indicated on fuel control unit protractor).

Light OFF..........Wing flaps set at 15 ±1°, landing gear down and locked, weight of aircraft on gear, and throttles for engines No. 1 and 3 advanced to a position of 70° or more, *or* wing flaps not set at 15 ±1°, landing gear down and locked, weight of aircraft on gear, and throttles for engines No. 1 and 3 retarded to a position of 67½° or less (as indicated on fuel control unit protractor).

Figure 5-7 (Sheet 2 of 2)

discrepancy. To avoid unnecessary engine shutdown or continued operation of a faulty propeller governing system, note the following tolerances. Rpm fluctuation on synchronizer of ±0.5 percent, with occasional (every 1 to 3 seconds) fluctuation to ±1.0 percent, is acceptable. A fluctuation of ±0.75 percent with an occasional increase to ±1.5 percent is acceptable on mechanical reference governing. Rapid fluctuation (several cycles per second) of small amplitude is also acceptable. Once noted, an rpm fluctuation should be carefully monitored for a definite trend toward an increase in amplitude beyond the preceding tolerances. If any of the tolerances are exceeded, the engine should be shut down, if not essential to safe flight.

AIRSPEED LIMITATIONS.

The Maximum Flight Speed vs Altitude Chart *(figure 5-8)* shows the maximum allowable level flight indicated airspeed for any gross weight up to the design gross weight versus altitude. Reduced maximum allowable level flight speeds are shown for use at alternate gross weights.

MAXIMUM SPEED FOR WING FLAP EXTENSION.

The maximum indicated airspeeds for various degrees of wing flap extension at gross weights less than 210,000 pounds and greater than 210,000 pounds are shown on figure 5-9. The maximum recommended airspeed for full extension of the wing flaps (35 degrees) is 140 knots IAS at gross weights below 210,000 pounds, and 155 knots IAS at gross weights above 210,000 pounds.

MAXIMUM SPEED FOR LANDING GEAR EXTENSION.

The landing gear should not be extended at airspeeds above 178 knots IAS.

MAXIMUM SPEED FOR LANDING LIGHT EXTENSION.

The landing lights should not be extended at airspeeds above 178 knots IAS.

MAXIMUM GROUNDSPEED LIMITED BY TIRE STRENGTH.

Groundspeed in excess of 140 knots may cause portions of the tread to separate from the tires. The Maximum Groundspeed (IAS) Limited by Tire Strength chart *(figure 5-10)* shows the maximum allowable groundspeed in knots IAS for various temperature and altitude conditions. The chart is based on a maximum groundspeed of 140 knots. The following example explains how the chart is used.

Example.

Given:

Outside Air Temperature = 25°C.
Pressure Altitude = 2000 feet.

Enter the chart at an outside air temperature (OAT) of 25°C (A). Read up to the 2000 feet pressure altitude curve (B). Read across to find the tire strength limit IAS is 129.5 knots. Do not exceed a groundspeed of 129.5 knots IAS for these conditions.

CREW ENTRANCE DOOR.

Do not open the crew entrance door in flight, except for bailout. The door can be removed before flight, and the aircraft operated up to permissible speeds without damage to the aircraft. At speeds above 200 knots IAS, straight and level flight must be maintained.

SIDE CARGO DOOR.

The side cargo door must not be operated during flight.

RAMP AND REAR CARGO OR CLAMSHELL DOORS.

The maximum indicated airspeed for operation of the ramp and doors is 150 knots IAS. When the ramp and doors are unlatched or open, the maximum allowable flap deflection is limited to 25 degrees due to structural limitations. Abrupt rolling or directional manuever which result in high tail loads should be avoided. A load limit factor of 1.5g should not be exceeded with ramp and doors unlatched or open.

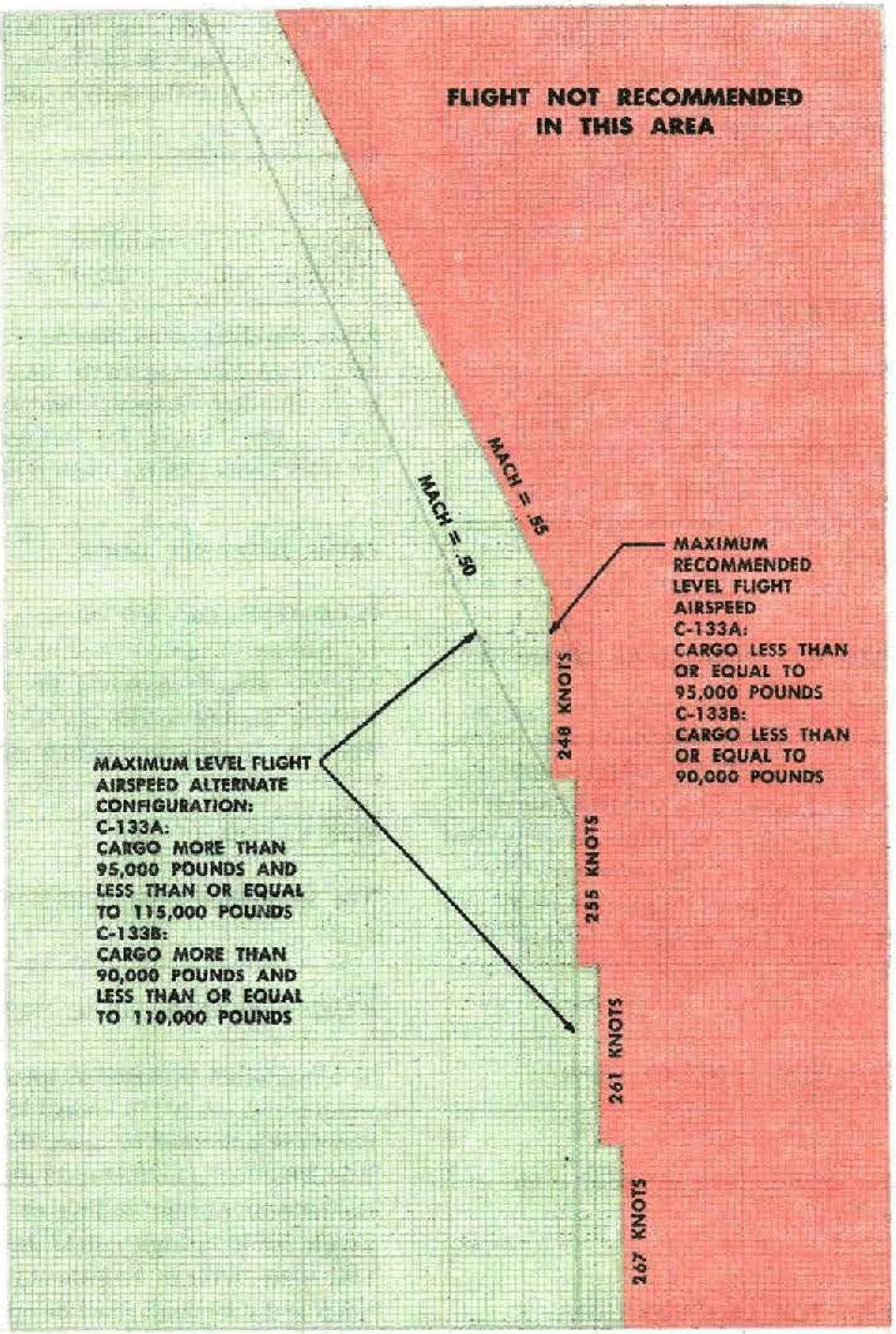
Ramp and Rear Cargo Doors — C-133A.

The ramp should not be allowed to extend below the TRAIL position which is approximately 7 degrees below

Maximum Flight Speed vs Altitude Chart

ENGINE(S): (4) T34-P-7WA/9W

STANDARD DAY



UAB1-333

Figure 5-8

floor level. The maximum allowable sideslip, for any condition with ramp and doors open, is ±10 degrees. No restriction is placed on operation of the wing flaps up to the structural limitation of 25 degrees.

Ramp and Clamshell Doors — C-133B.

The ramp should not be allowed to extend below the floor level position. Maximum allowable sideslip for any condition with the ramp and doors open is ±5 degrees. Wing flap deflection with the ramp and doors open is limited to 15 degrees due to adverse flight characteristics.

MANEUVERS.

The maneuvering flight limitations of the aircraft are indicated in the following paragraphs.

PROHIBITED MANEUVERS.

The aircraft is restricted to normal maneuvers. No acrobatic flight is permitted.

ALLOWABLE AILERON DEFLECTION.

Maximum pilot force can be applied throughout the speed range of the aircraft. Structural protection is provided by a spring force limiter built into the aileron control system.

WARNING

To avoid high vertical tail loads during rolling maneuvers, coordinated rudder must be used to maintain as little sideslip as possible.

ALLOWABLE ELEVATOR DEFLECTION.

Abrupt elevator deflections should be avoided whenever possible. Abrupt wheel forces in excess of 150 pounds and sustained deflections at these forces should also be avoided. When abrupt elevator deflections are necessary, the elevators must be returned to the trim position as soon as possible. See Operating Flight Strength Diagram *(figure 5-11)* for allowable load factor limits at various gross weights.

CAUTION

Abrupt reversal of the elevators will develop loadings in excess of structural design, resulting in deformation and possible structural failure. Abrupt elevator deflections are prohibited in the landing configuration.

ALLOWABLE RUDDER DEFLECTION — CLEAN CONFIGURATION

Maximum pilot force can be applied throughout the speed range of the aircraft. Structural protection is provided by the 2-position rudder stops. Rudder travel is limited to 7 degrees in each direction at airspeeds above approximately 168 knots IAS and to 18.5 degrees in each direction at airspeeds below approximately 168 knots IAS.

WARNING

To prevent development of excessive loads on the vertical tail and the aft fuselage, avoid returning the rudder abruptly to trim position from a steady sideslip maneuver. At low airspeeds in sideslip, rudder buffet will be encountered accompanied with force roundover which also could develop into a rudder lock.

ALLOWABLE FLAP DEFLECTION.

With the flaps in the extended position, longitudinal flight control push forces are light and force reversal will occur if aircraft load factor is reduced appreciably below lg. Although the aircraft is unstable when force reversal occurs, aircraft response to control movement is normal. This unstable condition is proportionately more pronounced with increased flap angles, lower gross weights, and higher airspeeds with wing flaps extended. The force reversal is also more easily attained at aft cg than at forward cg. The airspeed gross weight restrictions *(figure 5-9)* are designed to minimize this unstable condition; however, tuckunder can occur within the speed-weight-flap angle restrictions if pushovers are prolonged. This flaps-down instability can occur from a long period of "hands off" oscillation. In the event the aircraft does progress into the region of stick force reversal, recovery can be attained by pulling back on the control column. The aircraft is responsive and care must be taken not to exceed the positive limit load factor. Do not fly "hands off" with the flaps extended more than 25 degrees. Do not use more than 15 degrees flap above 10,000 feet in normal operation. The maximum recommended airspeed for operation with full flaps is 140 knots IAS at gross weights less than 210,000 pounds, and 155 knots IAS at gross weights greater than 210,000 pounds. The structural limit for operation with full flaps is 187 knots IAS.

Allowable Flap Extension Schedule

MODEL: C-133A/B
DATA BASIS: FLIGHT TEST DATA
DATE: 6-15-61

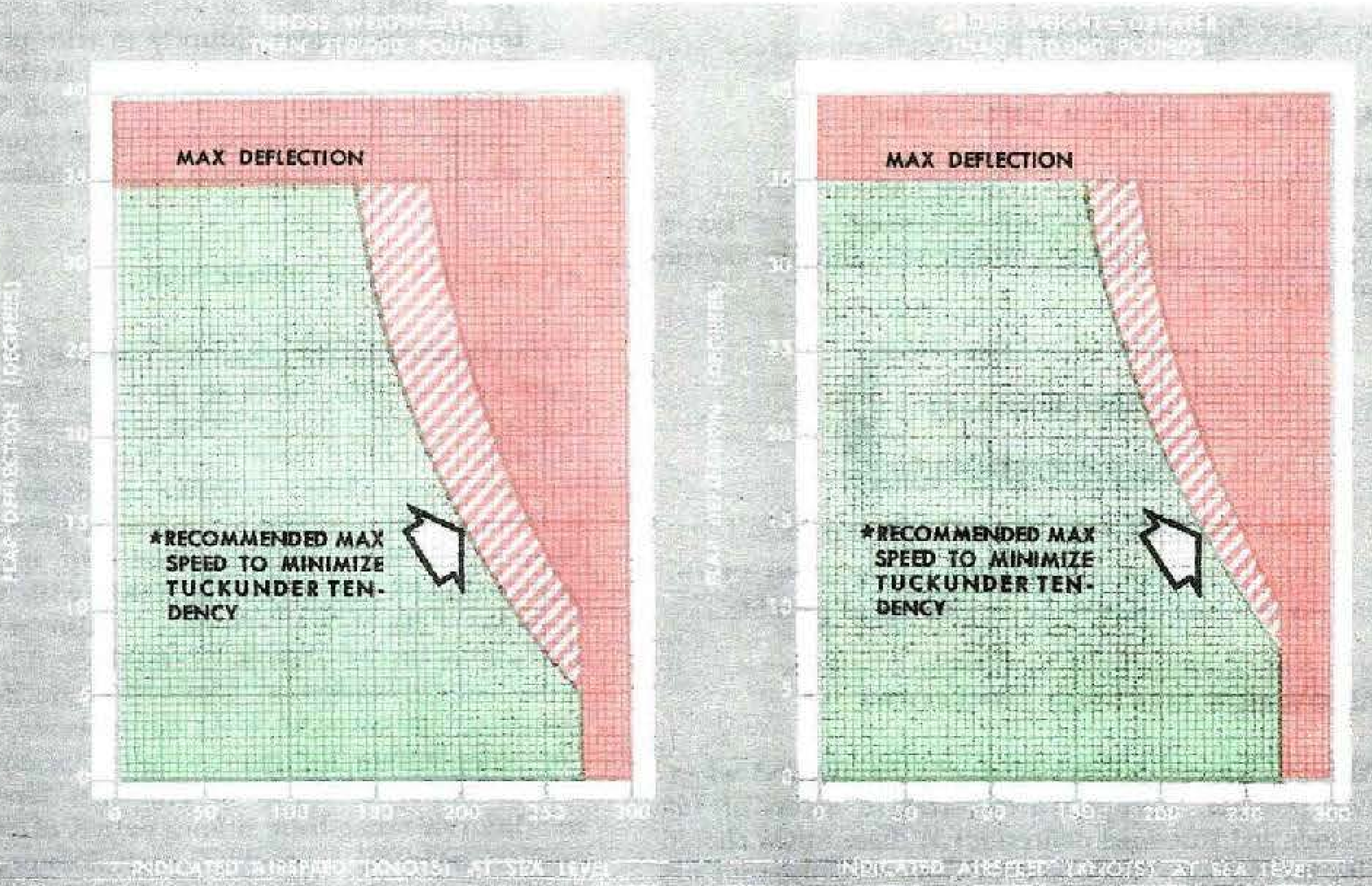
WARNING

During pushover maneuvers with the flaps extended there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.

🟩 NORMAL OPERATION — *SEE TUCKUNDER, SECTION VI

▨ UNSAFE OPERATION — TUCKUNDER PROBABLE

🟥 UNSAFE OPERATION — STRUCTURAL LIMITATIONS



CAUTION

Flap settings greater than 15 degrees above 10,000 feet are not recommended for normal operation. Do not fly "HANDS OFF" with flaps down more than 25 degrees.

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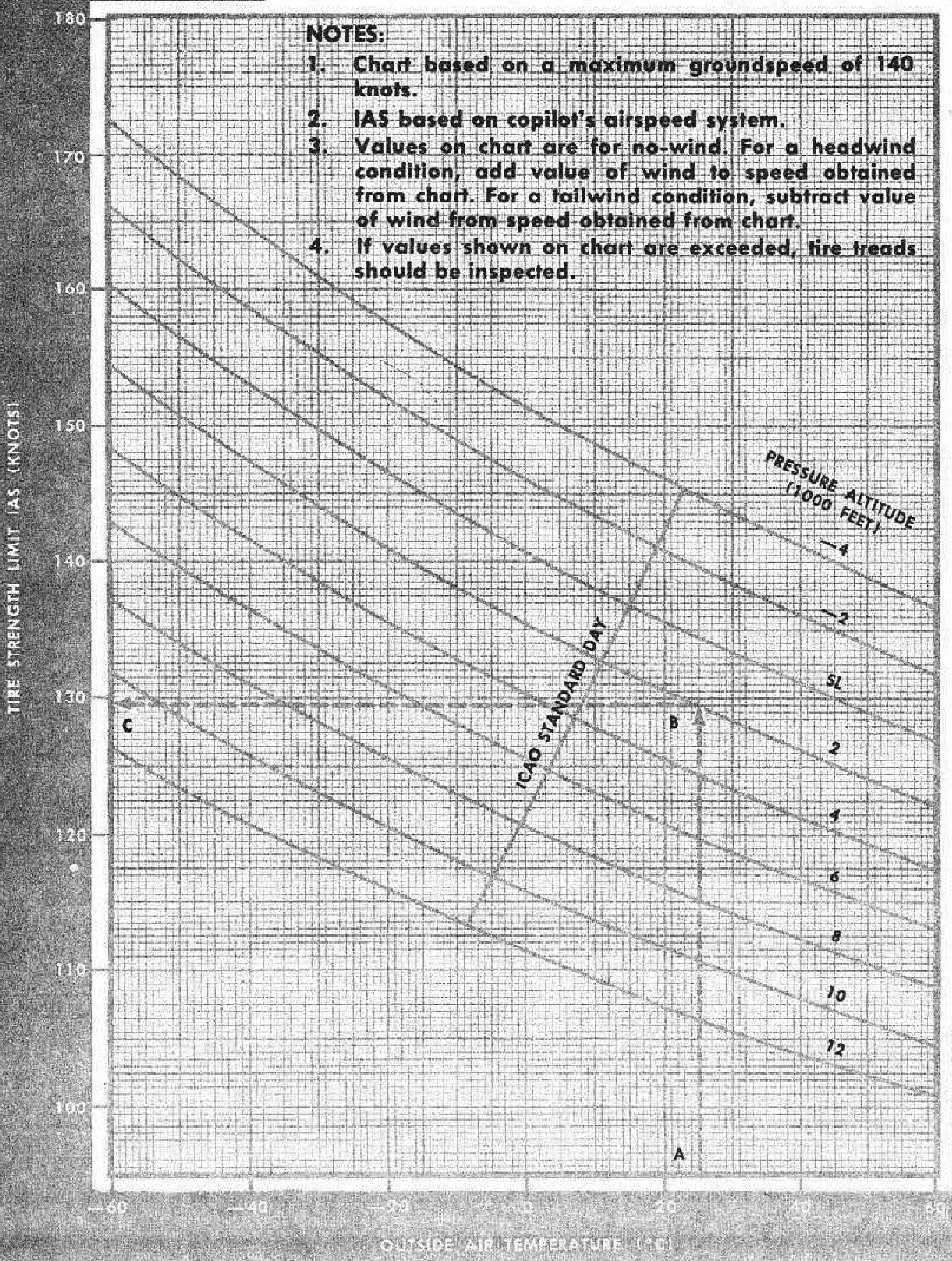
Figure 5-9

Maximum Groundspeed (IAS) Limited by Tire Strength

MODEL: C-133A/B
DATA BASIS: CALCULATED DATA
DATE: 6-15-61



NOTES:

1. Chart based on a maximum groundspeed of 140 knots.
2. IAS based on copilot's airspeed system.
3. Values on chart are for no-wind. For a headwind condition, add value of wind to speed obtained from chart. For a tailwind condition, subtract value of wind from speed obtained from chart.
4. If values shown on chart are exceeded, tire treads should be inspected.

Figure 5-10

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OPERATING FLIGHT STRENGTH DIAGRAM.

The Operating Flight Strength Diagrams *(figure 5-11)* are a strength envelope showing allowable load factor as a function of speed for various gross weights. When the zero fuel gross weight is in excess of 215,000 pounds, it is considered an alternate weight configuration.

Normal and Alternate Gross Weights — C-133A.

The design gross weight of the C-133A is 275,000 pounds with a cargo weight less than or equal to 95,000 pounds. The maximum alternate gross weight is 282,000 pounds with a cargo weight greater than 95,000 pounds and less than or equal to 115,000 pounds.

Normal and Alternate Gross Weights — C-133B.

The design gross weight of the C-133B is 286,000 pounds with a cargo weight less than or equal to 90,000 pounds. The maximum alternate gross weight is 300,000 pounds with a cargo weight greater than 95,000 pounds and less than or equal to 110,000 pounds.

LIMIT MANEUVER LOAD FACTOR

C-133A.

Gross Weight (Normal) Cargo Less Than 95,000 Pounds	*Maximum Flight Load Factor (All Speeds)*	
	Positive	*Negative*
275,000	2.5	0
265,000	2.5	0
245,000	2.5	0
215,000	2.5	0
175,000	2.5	0
120,000	2.5	0

Gross Weight (Alternate) Cargo Greater Than 95,000 Pounds	*Maximum Flight Load Factor*			
	Level Flight Speed		*Maximum Speed*	
	Positive	*Negative*	*Positive*	*Negative*
282,000	2.18	0	2.15	0
265,000	2.18	0	2.15	0
235,000	2.18	0	2.15	0

C-133B.

Gross Weight (Normal) Cargo Less Than 90,000 Pounds	*Maximum Flight Load Factor (All Speeds)*	
	Positive	*Negative*
286,000	2.5	0
265,000	2.5	0
250,000	2.5	0
215,000	2.5	0
175,000	2.5	0
125,000	2.5	0

Gross Weight (Alternate) Cargo Weight 90,000 to 100,000 Pounds	*Maximum Flight Load Factor*			
	Level Flight Speed		*Maximum Speed*	
	Positive	*Negative*	*Positive*	*Negative*
300,000	2.32	0	2.25	0
286,000	2.32	0	2.25	0
265,000	2.32	0	2.25	0
235,000	2.32	0	2.25	0
Cargo Weight 100,000 to 110,000 Pounds				
300,000	2.18	0	2.15	0
286,000	2.18	0	2.15	0
265,000	2.18	0	2.15	0
235,000	2.18	0	2.15	0

Load Factor Restrictions During Emergency Fuel Jettisoning.

According to the emergency fuel jettisoning schedule, fuel is jettisoned from those portions of the wing that may cause overloading of the wing structure at high gross weights. Therefore, the following load factor restrictions must be observed during emergency fuel jettisoning.

C-133A.

Gross Weight Before Jettisoning (Pounds)	*Cargo Load (Pounds)*	*Load Factor Restriction*	*Restriction To Be Maintained Until GW Reduced To*
218,000 to 275,000	Less than 95,000	2.24	218,000
218,000 to 282,000	Greater than 95,000	2.00	Landing or 218,000

C-133B.

Gross Weight Before Jettisoning (Pounds)	*Cargo Load (Pounds)*	*Load Factor Restriction*	*Restriction To Be Maintained Until GW Reduced To*
218,500 to 286,000	Less than 90,000	2.24	218,500
218,500 to 300,000	90,000 to 100,000	2.15	Landing or 218,500
228,500 to 300,000	100,000 to 110,000	2.00	Landing or 228,500

CENTER OF GRAVITY (CG) LIMITATIONS.

On aircraft with a gross weight of 215,000 pounds and below, the cg limits are as follows:

Gear Up or Down (Level Flight)	*Percent MAC*
Forward	17
Aft	32

CAUTION

Caution should be exercised when landing with the center of gravity forward of 23 percent MAC because of the limited elevator control available at low airspeeds with the engines at idle power. Power should be carried throughout the flare and touchdown.

For gross weights above 215,000 pounds, refer to the Center of Gravity (Cg) Limitations Chart — Structural (*figure 5-12*) and the *Handbook of Weight and Balance Data, T.O. 1-1B-40.*

GROUND TURNING RADIUS VS VELOCITY LIMITATIONS.

The minimum ground turning radius is 50 feet from the aircraft centerline as limited by the nose gear steering angle. The maximum permissible aircraft velocity at the minimum radius is 10 knots. Higher velocities result in a tipover tendency.

It is permissible to use light braking on the main gears on one side to assist in turning. Hard braking on one side which causes sliding of the nose gear and a shorter turning radius must not be used as this may cause structural damage to the main gears. See figure 2-7 for Minimum Turning Radius.

WEIGHT LIMITATIONS.

Weight, more than any other single factor, will determine the capability and performance of the aircraft. In designing, 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. Weight and balance limitations, therefore, are necessarily involved in the operation of the aircraft. If these limitations are exceeded, a loss in performance is inevitable, and structural failure is probable. When the 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. The takeoff and landing rolls increase appreciably with an increase in gross weight. Likewise, the brakes may be insufficient to brake the forward momentum of the aircraft, and the wings will become more vulnerable to airloads during maneuvers or flight through turbulent air. These resultant effects can reach serious proportions when the weight limitations are disregarded. For specific weight information, refer to the *Handbook of Weight and Balance Data, T.O. 1-1B-40.*

AIRCRAFT WEIGHT LIMITS.

The following are the aircraft weight limits for the indicated conditions.

Condition	*Weight (Pounds)*		*Maximum Allowable Sinking Speed*
	C-133A	*C-133B*	
Maximum Alternate	282,000	300,000	
Maximum Takeoff	282,000	300,000	
Maximum Landing	282,000	300,000	300 feet per minute
Design	275,000	286,000	
Normal Landing	245,000	250,500	540 feet per minute
Maximum Alternate (Zero Fuel)	235,000	235,000	
Design Zero Fuel	215,000	215,000	
Operating	120,000	125,000	

LANDING GEAR LIMITATIONS.

The landing gear structure is designed for landing during routine operation at a gross weight of 245,000 pounds for the C-133A, and 250,500 pounds for the C-133B with a maximum contact sinking speed of 540 feet per minute limit. At a maximum landing weight

(Continued on Page 5-38)

Operating Flight Strength

MODEL: C-133A
DATA BASIS: FLIGHT TEST DATA
DATE: 6-15-61

STANDARD CONFIGURATION = Cargo less than or equal to 95,000 pounds

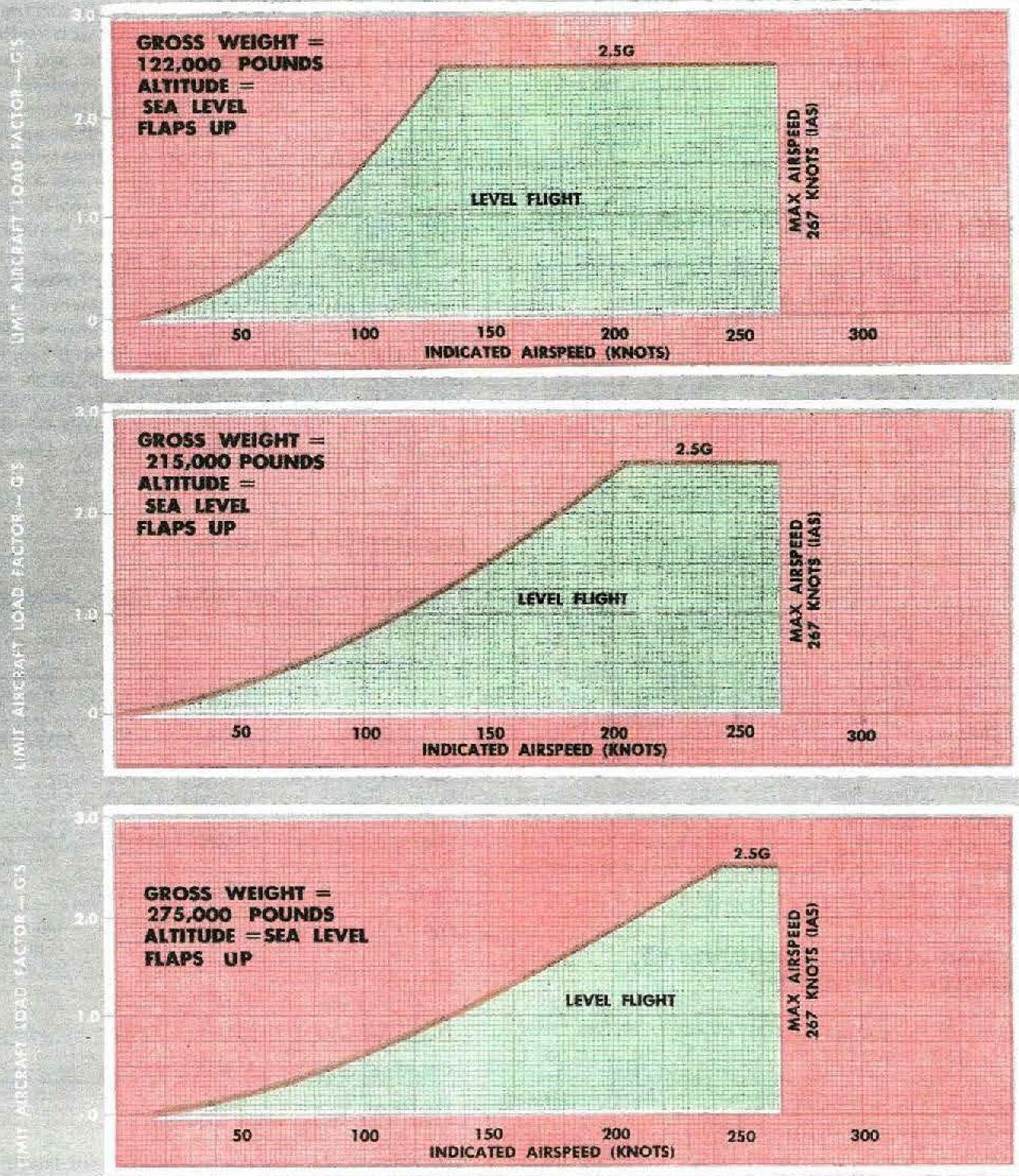

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Figure 5-11 (Sheet 1 of 4)

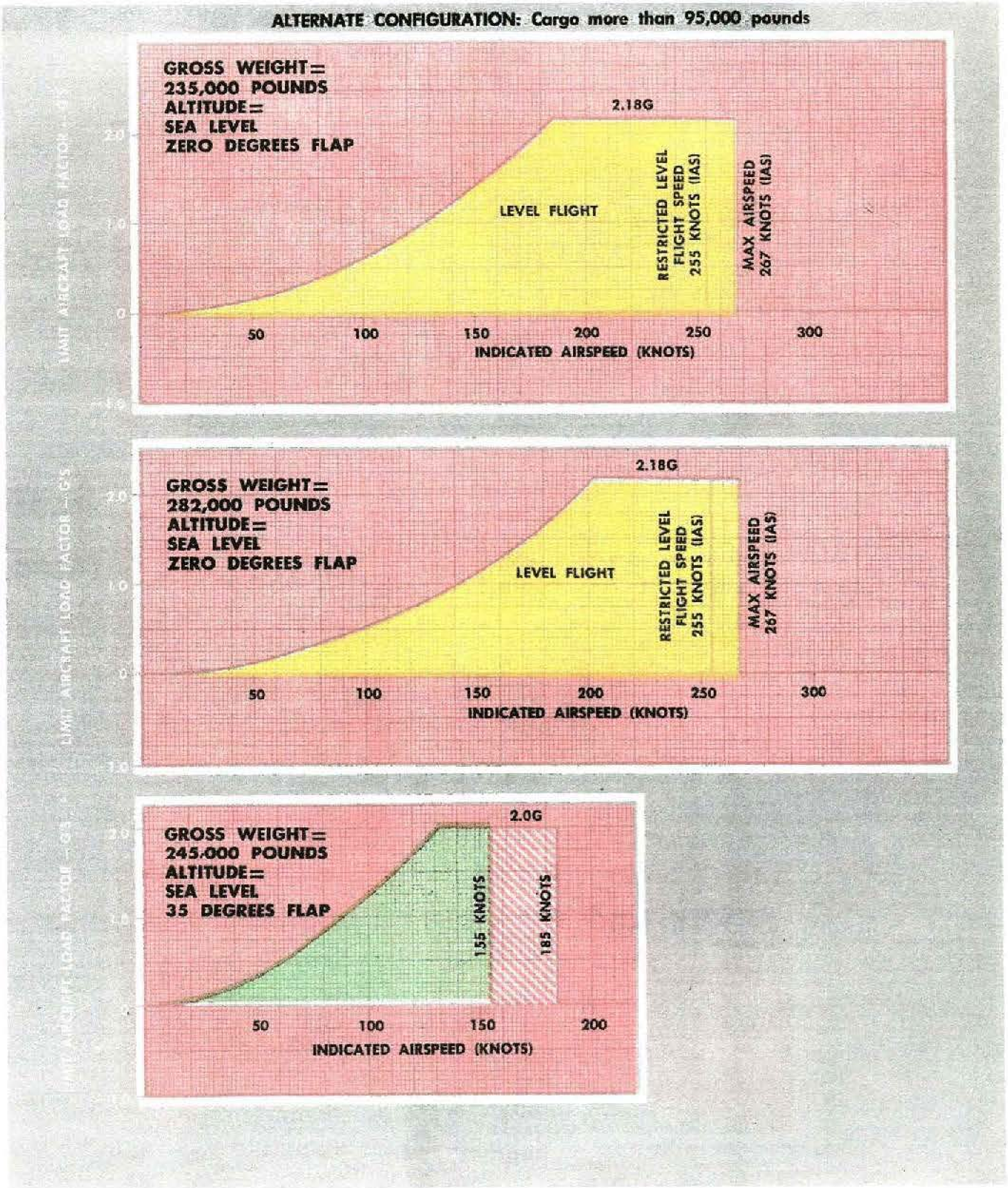
Diagram

🟩 SAFE OPERATION

🟥 UNSAFE OPERATION — STRUCTURAL LIMITATION

▨ TUCKUNDER TENDENCY

🟨 ALTERNATE CONFIGURATION



ALTERNATE CONFIGURATION: Cargo more than 95,000 pounds

Figure 5-11 (Sheet 2 of 4)

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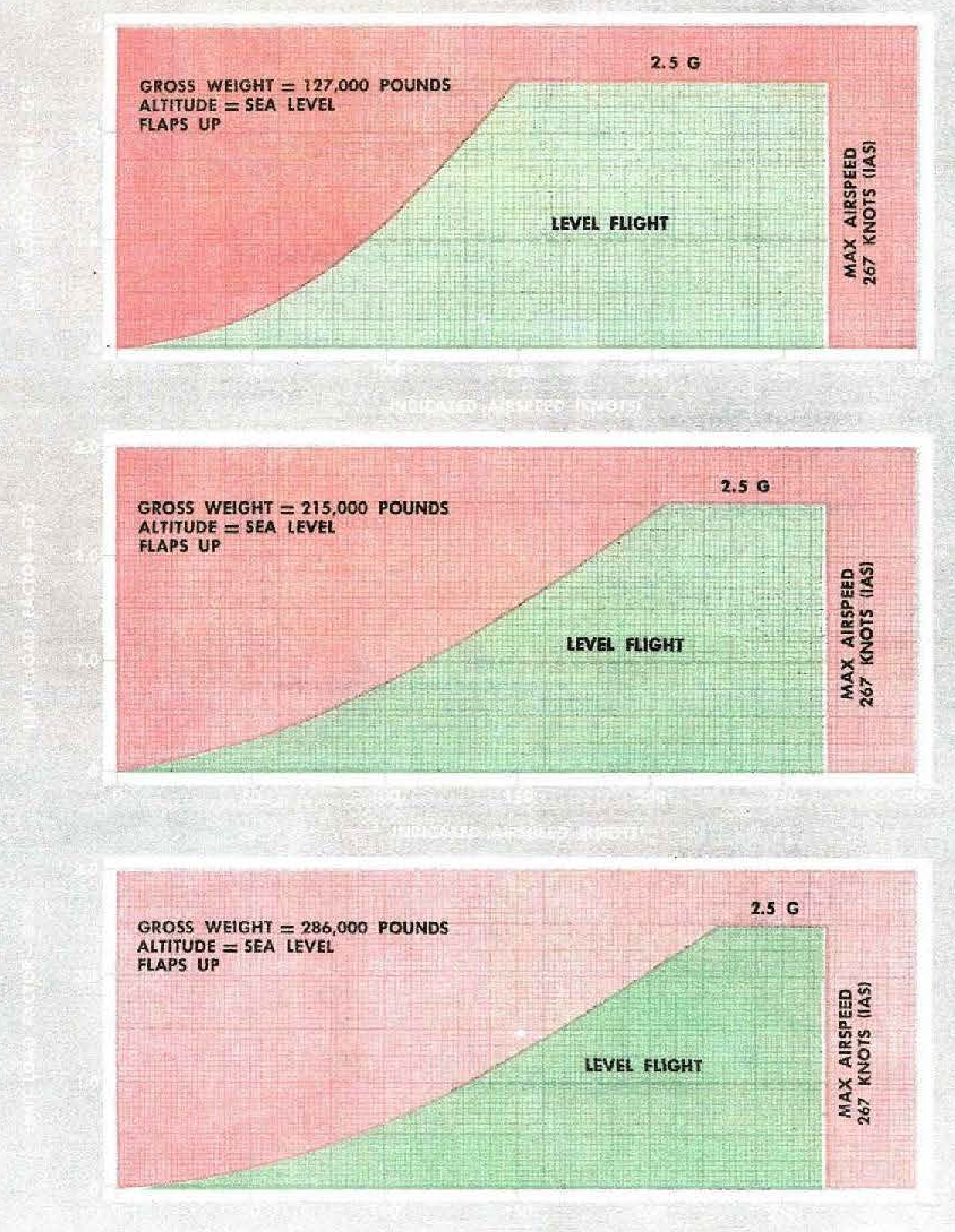
Operating Flight Strength

STANDARD CONFIGURATION

CARGO LESS THAN OR EQUAL
TO 90,000 POUNDS

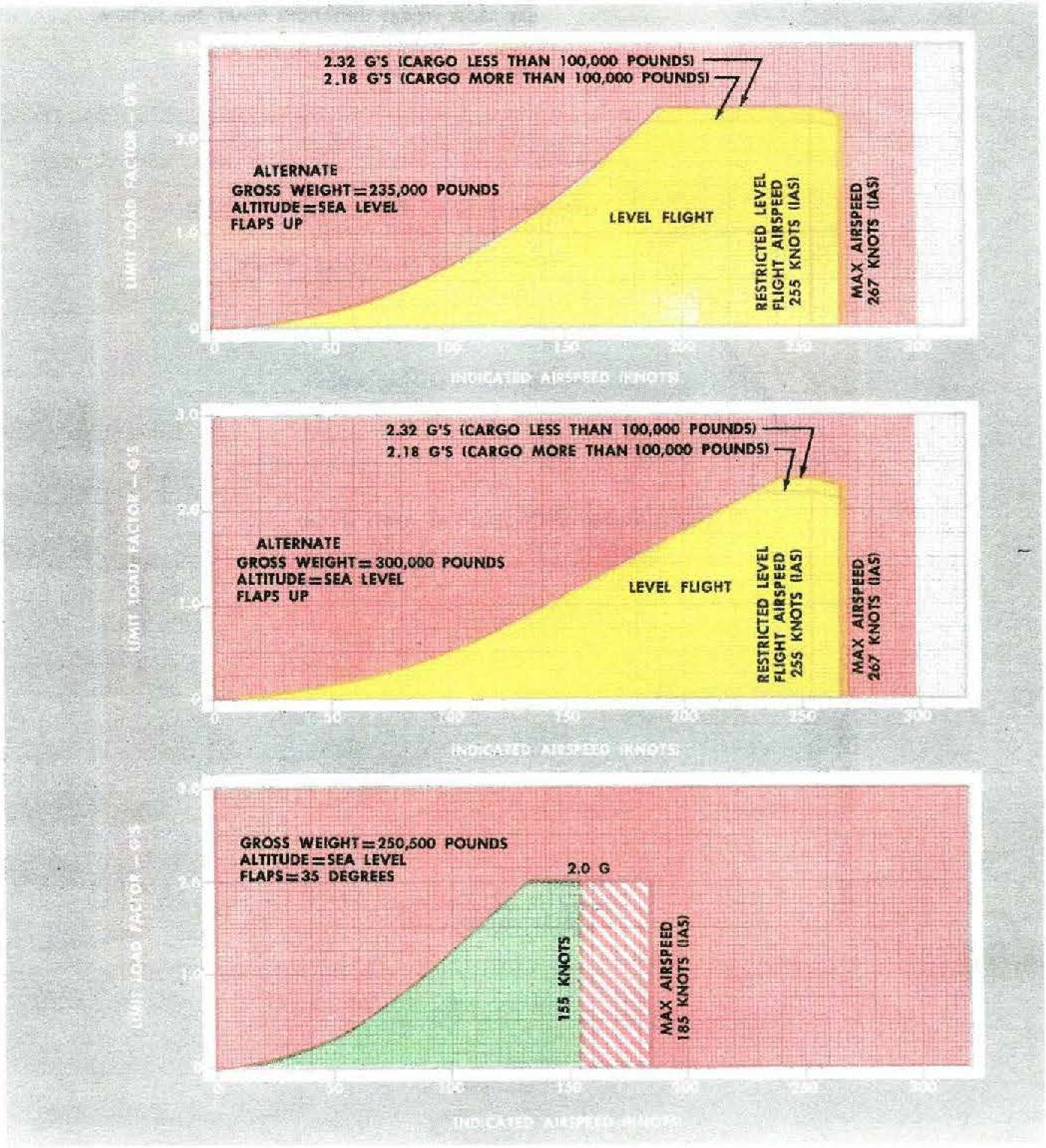


UAB1-326

Figure 5-11 (Sheet 3 of 4)

Diagram

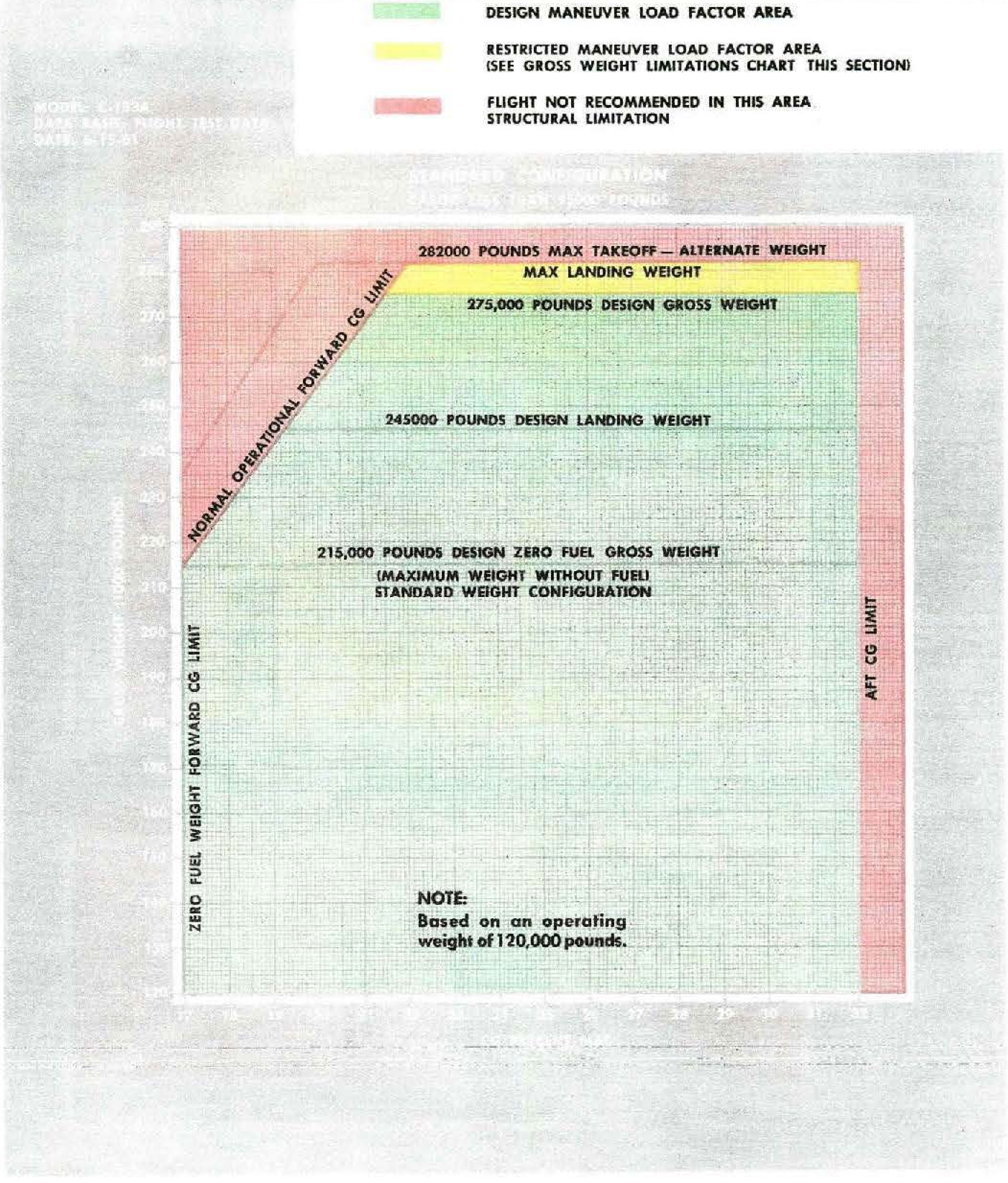
- 🟩 STANDARD CONFIGURATION— SAFE OPERATION
- 🟨 ALTERNATE CONFIGURATION — SAFE OPERATION
- 🟥 UNSAFE OPERATION — STRUCTUAL LIMITATION
- ▨ TUCKUNDER TENDENCY PROBABLE



UAB1-334

Figure 5-11 (Sheet 4 of 4)

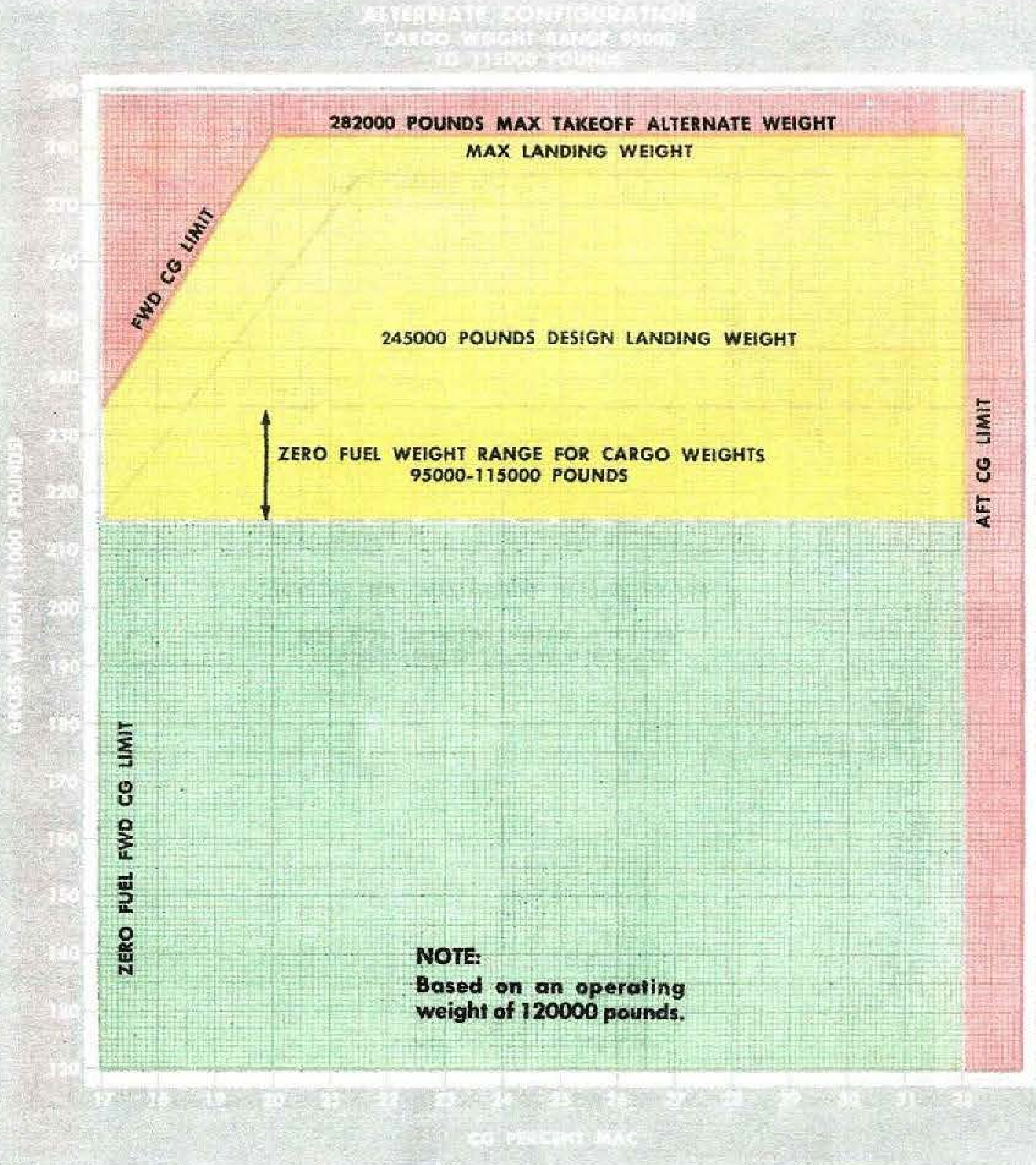
Center of Gravity (CG)



NOTE:
Based on an operating weight of 120,000 pounds.

Figure 5-12 (Sheet 1 of 4)

Limitations Chart — Structural



NOTE:
Based on an operating weight of 120000 pounds.

UAB1-328

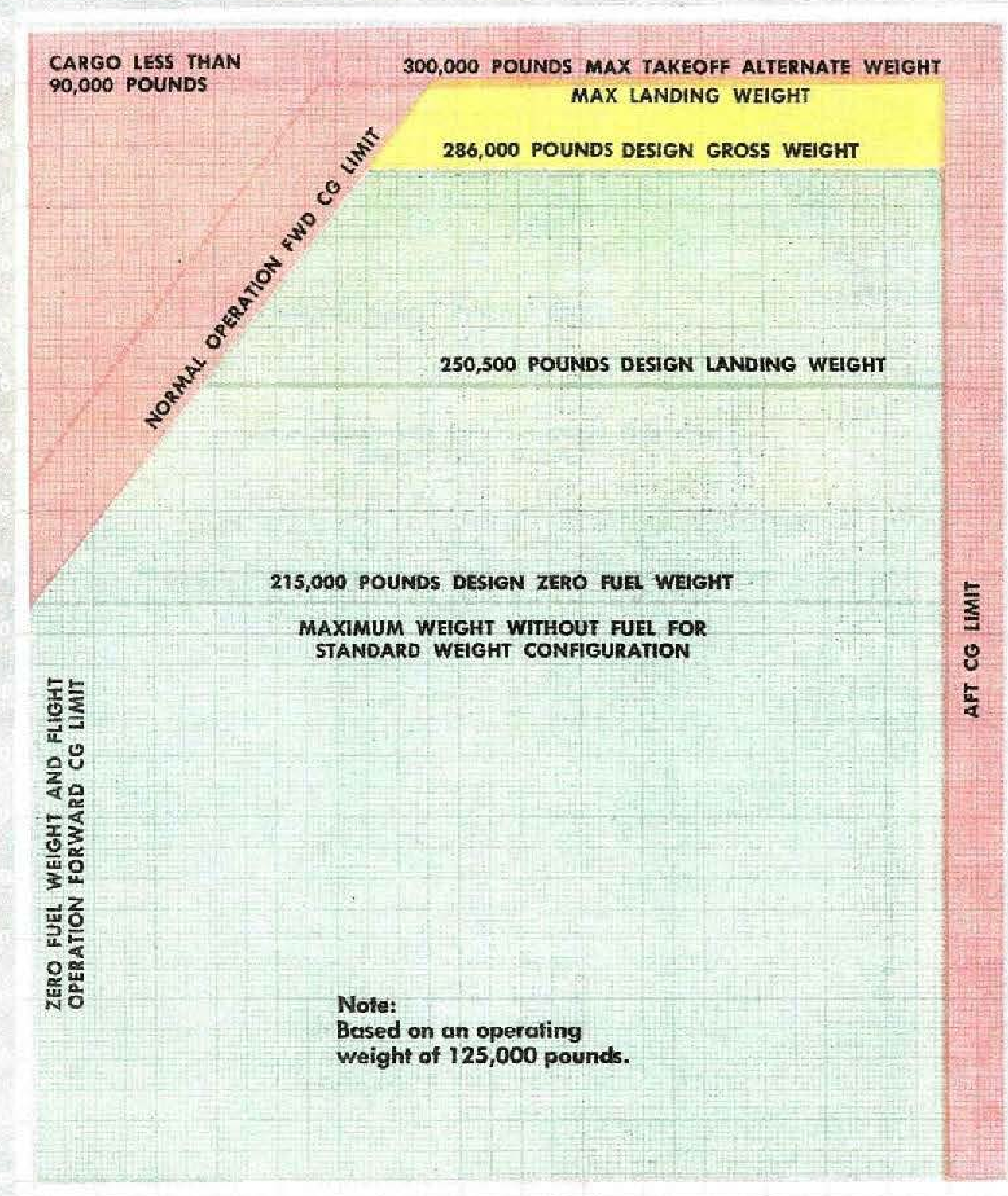
Figure 5-12 (Sheet 2 of 4)

Center of Gravity (CG)

🟩 DESIGN MANEUVER LOAD FACTOR AREA

🟨 RESTRICTED MANEUVER LOAD FACTOR AREA (SEE GROSS WEIGHT LIMITATIONS CHART, THIS SECTION)

🟥 FLIGHT NOT RECOMMENDED IN THIS AREA STRUCTURAL LIMITATION

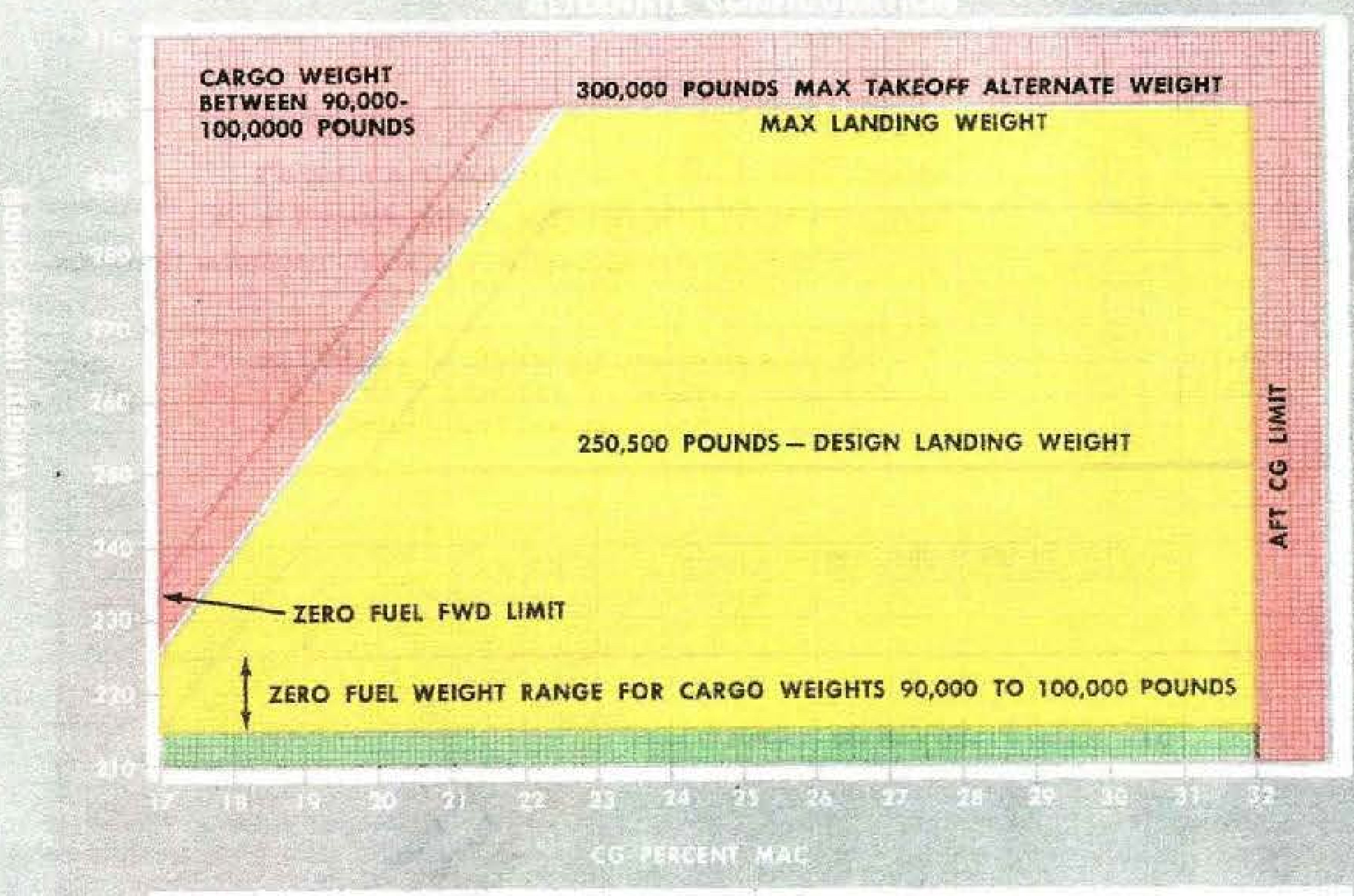


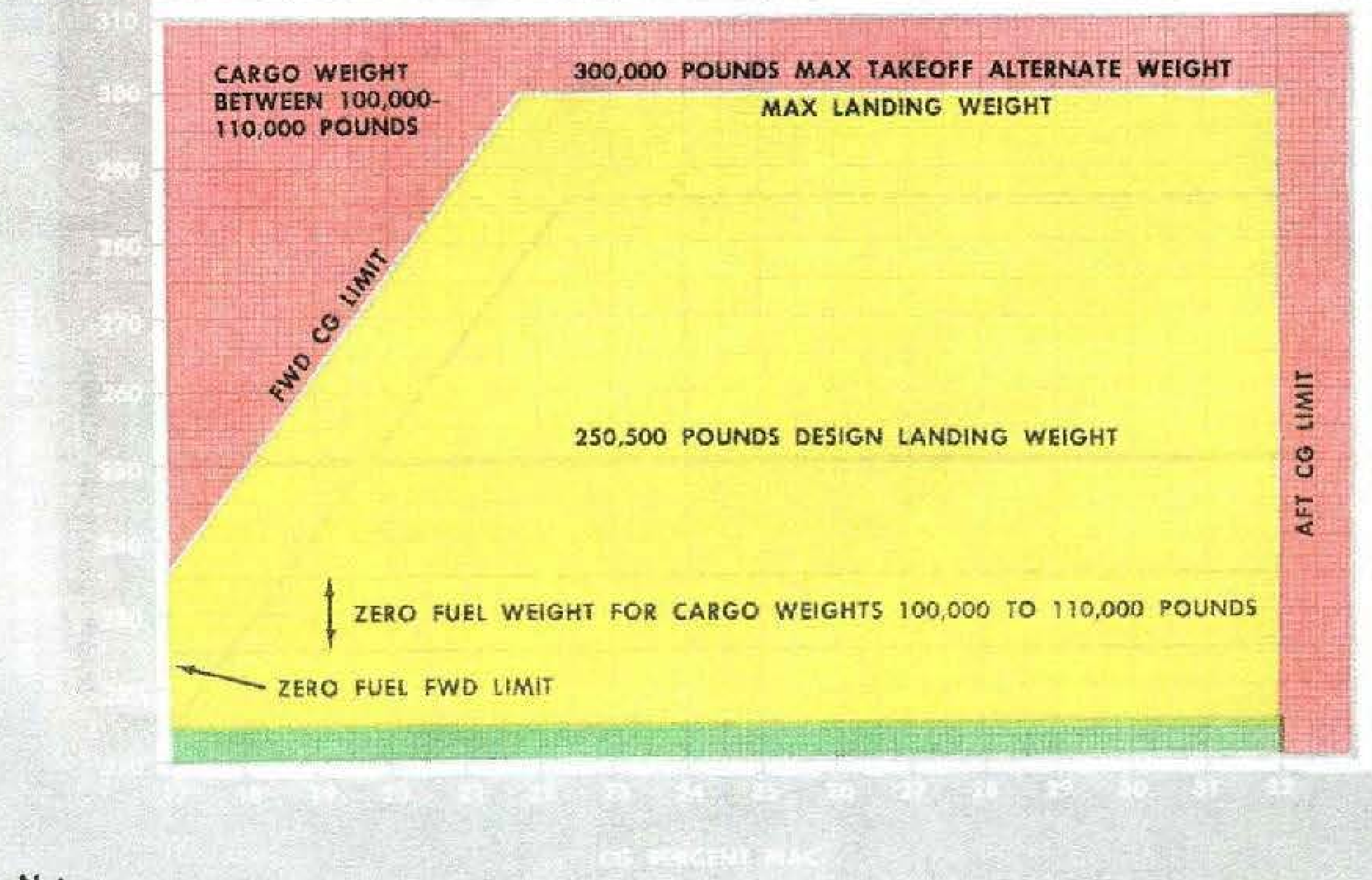
Note:
Based on an operating weight of 125,000 pounds.

UAB1-329

Figure 5-12 (Sheet 3 of 4)

Limitations Chart – Structural





Note:
Based on an operating weight of 125,000 pounds.

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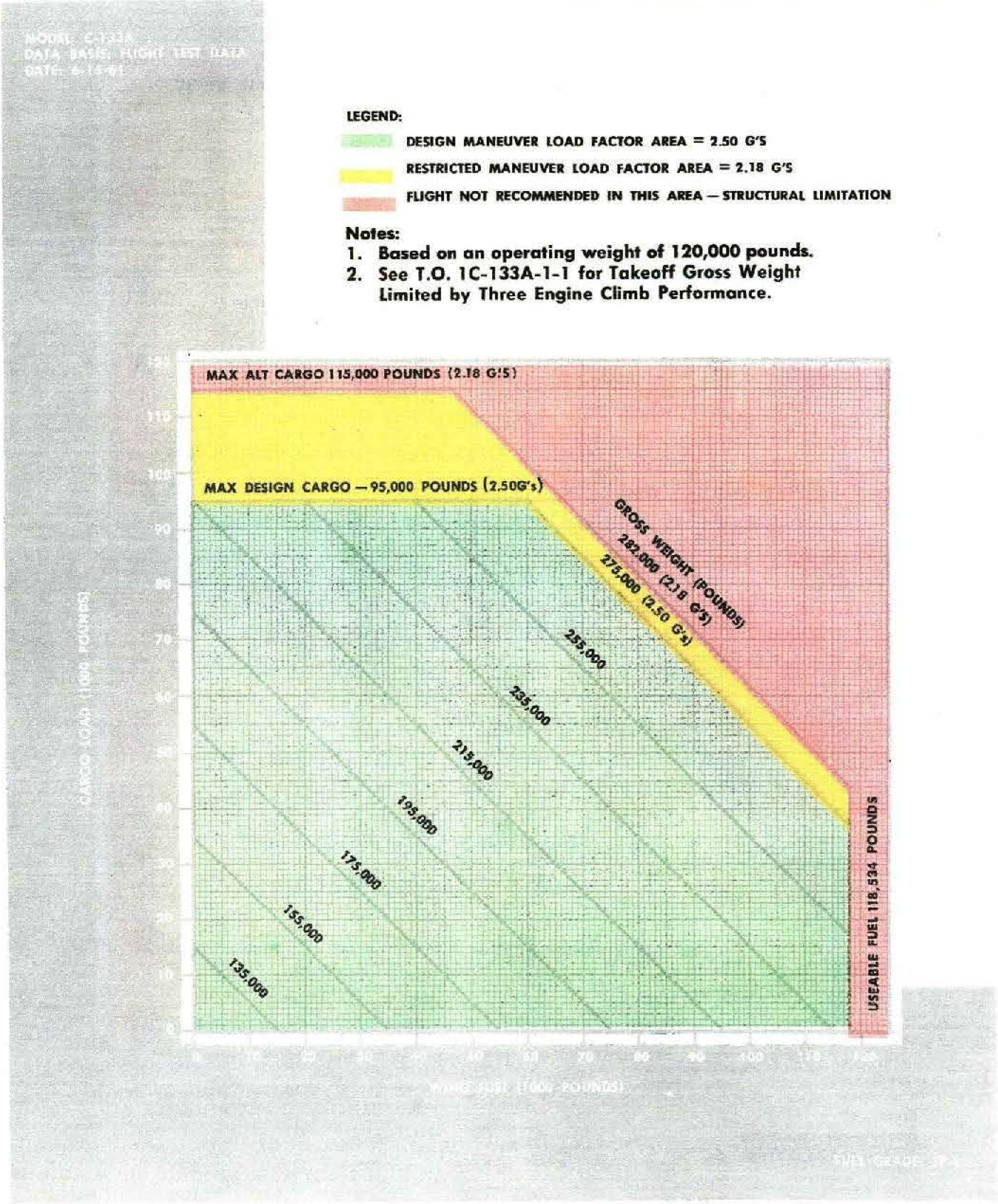
Figure 5-12 (Sheet 4 of 4)

Gross Weight



LEGEND:

- 🟩 DESIGN MANEUVER LOAD FACTOR AREA = 2.50 G'S
- 🟨 RESTRICTED MANEUVER LOAD FACTOR AREA = 2.18 G'S
- 🟥 FLIGHT NOT RECOMMENDED IN THIS AREA — STRUCTURAL LIMITATION

Notes:

1. Based on an operating weight of 120,000 pounds.
2. See T.O. 1C-133A-1-1 for Takeoff Gross Weight Limited by Three Engine Climb Performance.

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Figure 5-13 (Sheet 1 of 4)

Limitation Chart

EXAMPLE 1

Assume a mission calls for 80,000 pounds of cargo load and 50,000 pounds of usable fuel. With a normal operating weight of 120,000 pounds this take off gross weight would be 250,000 pounds. The chart is used to determine if any special operating restrictions are necessary. Enter chart at "0" and proceed along vertical axis to 80,000 pounds cargo. The gross weight would be 200,000 pounds at this point with no usable fuel. Next at "0" proceed along the horizontal axis to 50,000 pounds of fuel and project a line vertically to intersect with the horizontal projection of the 80,000 pound cargo line. By interpolation the intersection of the fuel and cargo line will be the 250,000 pound gross weight. The chart indicates that from take-off and throughout the mission, the aircraft will remain in the green area — no special operating restrictions are necessary.

EXAMPLE 2

Assume a mission calls for 80,000 pounds of cargo load and 80,000 pounds of usable fuel. With a normal operating weight of 120,000 pounds the take-off gross weight would be 280,000 pounds. Enter the chart at "0" and proceed along the vertical axis to 80,000 pounds cargo. The gross weight would be 200,000 pounds at this point with no usable fuel (same as example 1). Next proceed along the horizontal axis to 80,000 pounds of fuel and project a line vertically to intersect with the horizontal projection of the 80,000 pound cargo line. By interpolation the intersection of the fuel and cargo line will be at 280,000 pound gross weight. This intersection is in the yellow area, showing that until 5000 pounds of fuel are used, caution must be exercised while taxiing and braking and the flight load factor for maneuvering reduced from 2.5 to 2.18 g's. After the 5000 pounds of fuel are used the gross weight is 275,000 pounds, and the remainder of the flight is in the green area — no special operating restrictions necessary.

EXAMPLE 3

When the operating weight is in excess of the operating weight used to develop the chart the excess must be added to the cargo weight in order to effectively use the chart. Assume the operating weight has been determined to be 126,000 pounds (due to additional fixed equipment carried in the aircraft). Assume a mission calls for 64,000 pounds of cargo load and 85,000 pounds of usable fuel (mission requirement plus adequate reserves). The take off gross weight would be 275,000 pounds. The operating weight in excess of the one noted on the chart (in this example 6000 pounds) must be added to the cargo weight. Enter the chart at "0" and proceed along the vertical axis to (64,000 plus 6,000) 70,000 pounds cargo. The gross weight at this point would be 190,000 pounds in the green area. Next at "0" proceed along the horizontal axis to 85,000 pounds of fuel and project a line vertically to the intersection of the horizontal projection of the 70,000 pound cargo line. The gross weight at this point is 275,000 pounds in the green area. The chart indicates that throughout the mission the aircraft will remain in the green area — no special operating restrictions are necessary.

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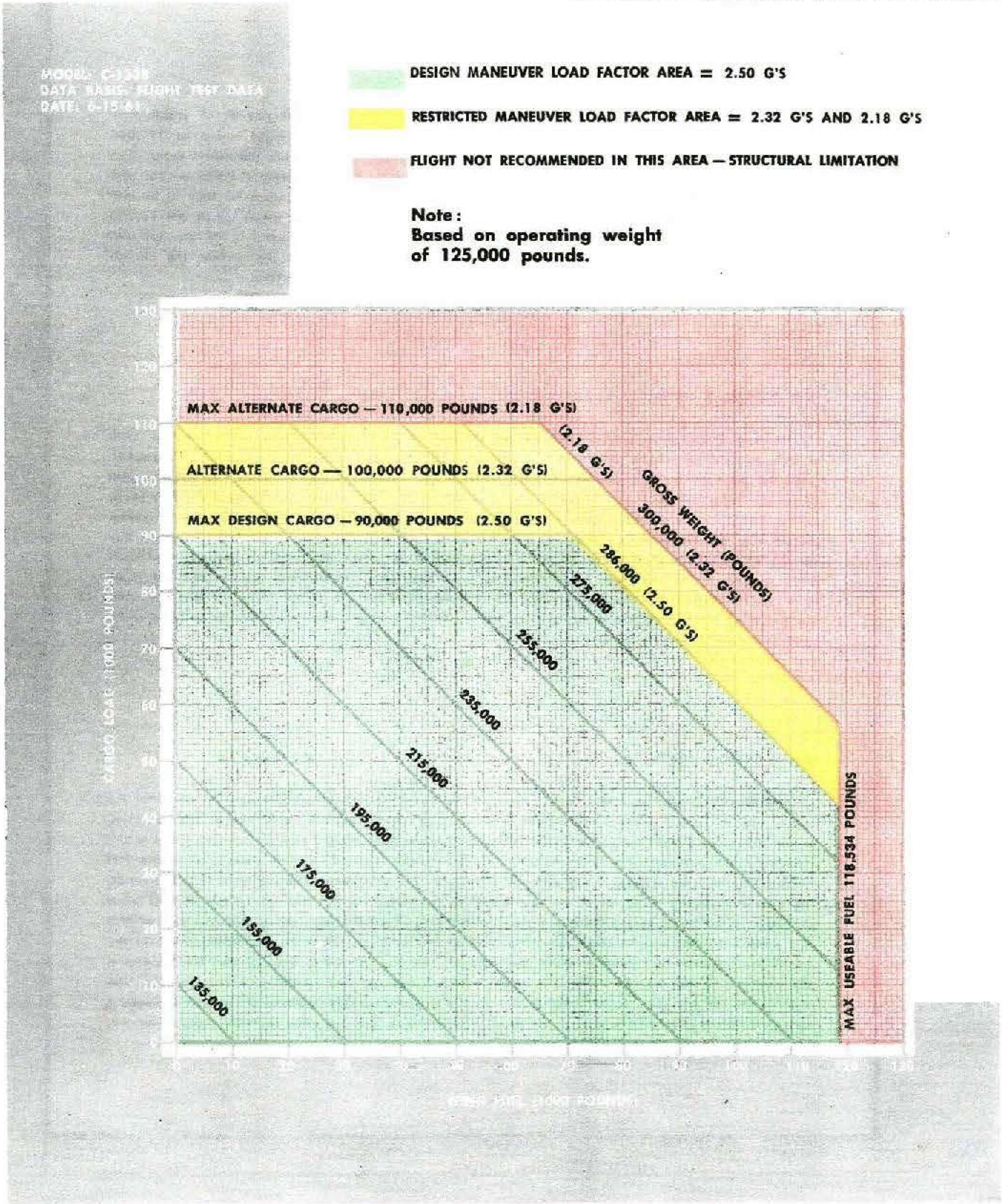
Figure 5-13 (Sheet 2 of 4)

Gross Weight



Note:
Based on operating weight of 125,000 pounds.

Figure 5-13 (Sheet 3 of 4)

UA81-336

Limitations Chart

EXAMPLE 1

Assume a mission calls for 65,000 pounds of cargo and 90,000 pounds of usable fuel (mission requirement plus adequate reserves). With a normal operating weight of 125,000 pounds the takeoff gross weight would be 280,000 pounds. The chart is used to determine if any special operating restrictions are necessary. Enter the chart at "0" and proceed along the vertical axis to the 65,000 pound cargo. The gross weight would be 190,000 pounds at this point with no usable fuel and in the green area. Next at "0" proceed along the horizontal axis to the 90,000 pounds of fuel and project a line vertically to intersect with the horizontal projection of the 65,000 pound cargo line. By interpolation the intersection of the fuel and cargo line is at 280,000 pounds, in the green area. The chart indicates that throughout the mission the aircraft will remain in the green area — no special operating restrictions are necessary.

EXAMPLE 2

Assume a mission calls for 96,000 pounds of cargo load and 72,000 pounds of usable fuel (mission requirement plus adequate reserves). With a normal operating weight of 125,000 pounds the takeoff gross weight is 293,000 pounds. Enter the chart at "0" and proceed along the vertical axis to 96,000 pounds cargo. The gross weight at this point is 221,000 pounds in the yellow area. Next at "0" proceed along the horizontal axis to 72,000 pounds of fuel and project a line vertically to intersect with the horizontal projection of the 96,000 pound cargo line. By interpolation the gross weight is 293,000 pounds in the yellow area. The chart indicates that throughout the mission the aircraft will be operating in the yellow area showing that restrictions on maneuvering the aircraft to less than normal should be followed as well as caution exercised while taxiing and braking.

EXAMPLE 3

When the operating weight is in excess of the operating weight used to develop this chart the difference must be added to the cargo weight in order to effectively use the chart. Assume the operating weight is 132,000 pounds (additional equipment not normally carried in aircraft, etc.,). Assume a mission calls for 85,000 pounds of cargo load and 80,000 pounds of fuel (mission requirement plus adequate reserves). The takeoff gross weight would be 297,000 pounds.

The operating weight in excess of the one noted in the chart is 7000 pounds and must be added to the cargo weight. The cargo weight used to enter the chart should be 85,000 plus 7000 or 92,000 pounds. The example then becomes similar to Example 2. Without the excess operating weight the takeoff gross weight for this example would be 290,000 pounds. Enter the chart at "0" and proceed along the vertical axis to 85,000 pounds cargo (normal operating weight). The gross weight at this point is 210,000 pounds with no usable fuel and in the green area of the chart. Next at "0" proceed along the horizontal axis to 80,000 pounds fuel and project a line vertically to intersect with the horizontal projection of the 85,000 pound cargo line. By interpolation the intersection of the fuel and cargo line is 290,000 pounds in the yellow area. Until the gross weight is reduced 4000 pounds caution must be exercised in taxi and braking and maneuvering maximum reduced from 2.5 to 2.32 g's. After 4000 pounds of fuel have been used the gross weight is 286,000 pounds, the remainder of the mission is in the green area — no special operating restrictions necessary.

UAB1-332

Figure 5-13 (Sheet 4 of 4)

(Continued from Page 5-25)

of 282,000 pounds for the C-133A or 300,000 pounds for the C-133B, the maximum contact sinking speed is 300 feet per minute. Under normal conditions, landings should not be scheduled for weights in excess of 245,000 pounds for the C-133A or 250,500 pounds for the C-133B. Prolonged ground handling (towing, taxiing, turning and braking) at high gross weights should be avoided because of the reduced fatigue life associated with high loading conditions.

SPACE LIMITATIONS.

In order that cargo of various sizes may be accommodated, the cargo compartment is of such proportions that space is not a restrictive factor; consequently, overloading is possible. 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.

MANEUVER LOADS.

During maneuver 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. These forces 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. The maximum weight which the aircraft can safely carry is dependent upon distribution of the weight throughout the aircraft, and its capability of sustaining airloads in accelerated flight.

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 attitude of static equilibrium. The load factor denotes the magnitude of the forces acting on the aircraft because of sudden changes in air currents and manipulation of the controls and is expressed by the term g, which is a gravitational force. Therefore, 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 loads on the aircraft resulting from these forces are expressed in relation to the gravitational forces and are referred to as 0.5g, 1.0g, 2.0g, etc., which means that the forces exerted on the aircraft structure and its members are one-half, one, or two times the force exerted by gravity. For example, if the weight of the aircraft is 275,000 pounds and the load factor at some given moment of accelerated flight is 2.0g's, the total load which the aircraft must sustain is 550,000 pounds.

MARGIN OF SAFETY.

The margin of safety is the range of forces which exists between two points, one of which is the load factor the aircraft is sustaining at any given moment, and the other is 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's and during flight through turbulent air is subjected to a force of 1.5g's, the margin of safety at this particular moment is 100 percent. When 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 aircraft to maintain a margin of safety which will never be exceeded during any period of flight.

GROSS WEIGHT LIMITATION CHART.

The Gross Weight Limitation Chart *(figure 5-13)* graphically presents the weight-carrying capabilities of the aircraft, as defined by the various criteria which provide limits for safe and efficient operation. Through the use of this chart and the data contained in the *Handbook of Weight and Balance, T.O. 1-1B-40,* the flight planner is aided in recognizing the weight limitations of a specific mission and in completing the Weight and Balance form (Form 365F). The chart represents the loading conditions that present no particular problem in regard to the strength or performance of the aircraft. These conditions should not be exceeded.

CAUTION

> The operating weight should never exceed that required for the mission, otherwise unnecessary risk and equipment wear will result. In addition, the takeoff weight must also be considered in the light of available runways, altitude, terrain, temperatures, mis-

sion requirements, and the urgency of the mission. Although the chart indicates the limitations involved in 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 reflected in the Gross Weight Limitation Chart *(figure 5-13)* 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 axis represents the operating weight. This value is an approximate weight which includes the aircraft basic weight shown on Chart C, ***Handbook of Weight and Balance**, T.O. 1-1B-40,* plus standard crew and full oil capacity. Since individual aircraft weights vary, it will be necessary to adjust the chart for specific aircraft. The operating weight plus the fuel and cargo, as required for a specific mission, are shown by the gross weight lines which slope at a 45-degree angle to the axis of the chart. These diagonal lines indicate various structural limitations and can be used in aiding performance calculations. 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.

Wing Fuel Load.

At the base of the Gross Weight Limitation Chart *(figure 5-13)*, along the horizontal axis, the fuel weight is indicated in thousands of pounds. The ability of the wing to safely withstand the airloads imposed is inescapably allied with the weight of the fuel present, and the distribution of the fuel along the span. Therefore, it is important to adhere to the recommended fuel loading and consumption schedules by proper fuel system management (see Section VII). The fuel management schedule is designed to keep the remaining fuel as far outboard as possible. This causes the greatest possible down-bending moment from a given quantity of fuel and thereby provides the maximum relief from the upward wing bending moment from airloads. Each design condition for the wing is analyzed assuming the optimum fuel distribution. If fuel is placed inboard of the proper location, wing loads will be higher than normal for that condition. Repeated wing overloading will reduce its fatigue life and improper fuel location, coupled with certain critical maneuvers, could cause structural damage.

Minimum Fuel Requirements.

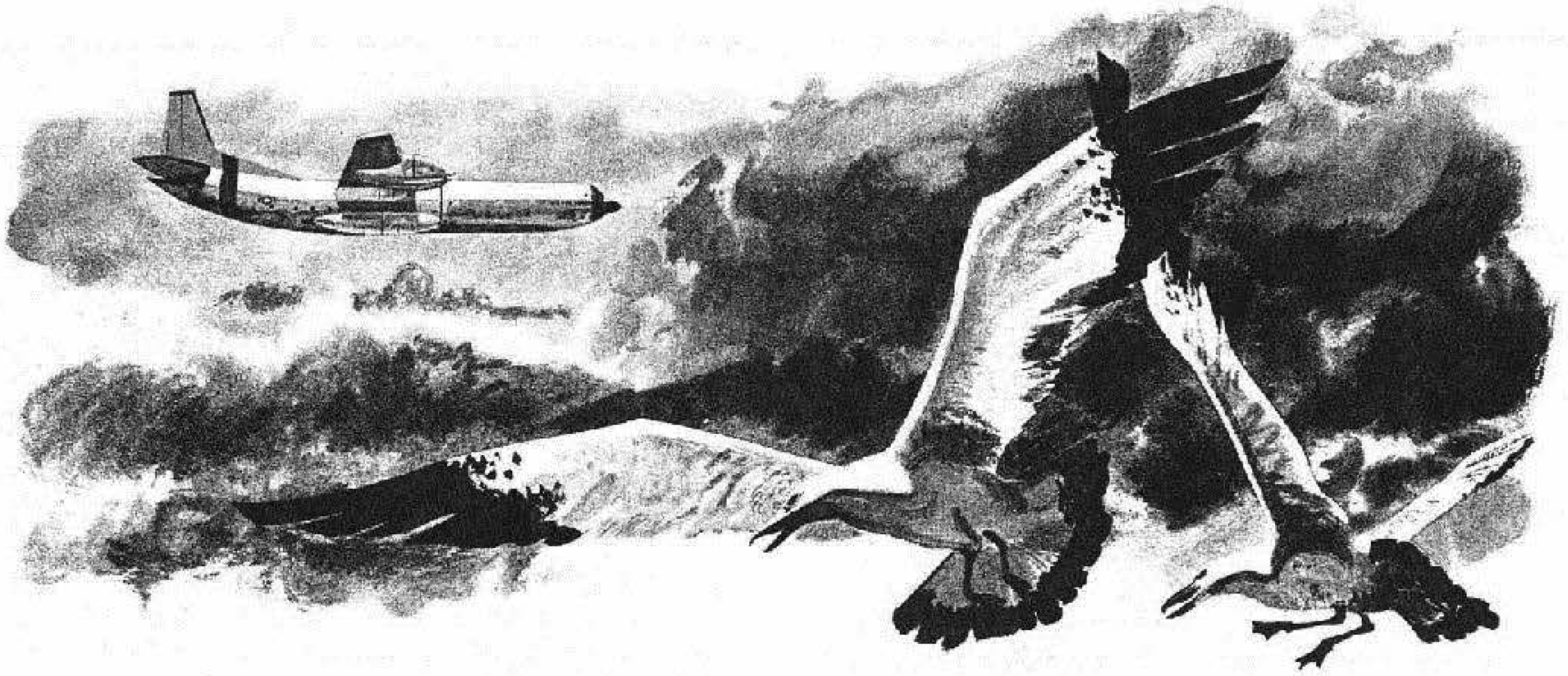
Configuration	*Gross Weight (Pounds)*	*Minimum Fuel Required (Pounds)*
C-133A.		
Normal Landing	245,000	30,000
Design	275,000	60,000
Alternate	282,000	47,000
C-133B.		
Normal Landing	250,500	35,500
Design	286,000	71,000
Alternate	300,000	65,000

Cargo Load.

In any mission, range and fuel consumption directly determine the fuel which must be carried and, indirectly, the cargo which 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 pounds along the vertical axis of the Gross Weight Limitation Chart *(figure 5-13).*

PERFORMANCE LIMITATIONS.

The aircraft gross weight is limited by various performance considerations such as the number of engines operating, landing gear and wing flap positions, altitude and temperature. Complete instructions and data are contained in the performance charts in *T.O. 1C-133A-1-1,* with which the effect of these conditions may be determined.



FLIGHT CHARACTERISTICS SECTION VI

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GENERAL FLIGHT CHARACTERISTICS.

The general flight characteristics of the aircraft are excellent. Control and response are good, especially when considering the bulk and weight of the aircraft. The aircraft possesses negative dihedral stability at airspeeds of approximately 110 knots IAS or less. In other words, at the lower airspeeds, the rudder is relatively ineffective for the purpose of picking up a wing down condition. As in other large, straight wing aircraft, this condition is not unusual and does not present a control problem. The available roll at low airspeeds is of a slow rate, although during low gross weight approaches (low airspeed), the time required to correct rolling errors is necessarily slow, and therefore should be considered.

With the rudder-aileron interconnect system, the adverse yaw accompanying the rolling of the airplane is of a low enough magnitude to allow rudder free rolls of large deflections and bank angles without problem. The control force harmony is also improved with the interconnect system.

In all areas of the flight envelope, stability of all axes is positive and the control forces associated are comparable to other aircraft of this type. Abrupt aileron movements, at all airspeeds, produce a lateral nose oscillation which is extremely uncomfortable, but which is not of any structural or control consequence. The oscillation is caused by the flexible wing bending in various modes which couple with the bending modes of the fuselage.

During normal crosswind takeoff and landing, there is a tendency of the aircraft to roll and turn downwind. This characteristic is due to the relative wind side load on the upwind side of the fuselage, causing the aircraft to heel over, and compares to the usual characteristics of aircraft possessing a high wing and bicycle type landing gear. The aileron power to correct this condition is positive and adequate. Nose gear steering further aids ground control under most conditions, and the crosswind characteristics are comparatively good.

The cg location, as in other aircraft, affects the longitudinal force gradients with lighter forces in the aft locations and heavier forces in the forward locations.

The normal takeoff configuration of the aircraft is with four engines operating at maximum power and with 15-degrees flap deflection at gross weights above 160,000 pounds. Below 160,000 pounds, the flaps-up configuration should be used to prevent takeoff at ground attitude before reaching the minimum control speed.

Elevator power is adequate for takeoff throughout the entire gross weight and cg range of the aircraft with elevator trim set at zero. However, to maintain elevator pull force in a comfortable region, a setting of approximately 4 degrees noseup elevator trim is recommended for all takeoffs.

During landing, the cg location affects the amount of elevator required. The aircraft will be unstable if loaded aft of the aft cg limit. Elevator power is marginal to hold the aircraft off to stall with cg locations forward of 23 percent MAC if normal techniques are used. The trim changes with power for a go-around are negligible. For this reason, power-off approaches at the forward cg locations are not recommended.

STALLS.

In all configurations, the stall is characterized by airframe buffet (increased level with increased gross weight), and a wing roll off accompanied with yaw which is adverse to the roll. The rolloff is usually in the left wing down direction with yaw to the right, but rolloff has been experienced in either direction. In all configurations, especially flaps down, aircraft response to aileron deflections for roll correction is relatively low. If the stall is not immediately broken, the yaw and rolloff increase proportionately and mild noseup trim change and extreme yawing may occur. Under these conditions lateral control of the aircraft may be lost. Power-on configurations reduce the stall airspeed a marked amount, and therefore decrease the control effectiveness for recovery. With power required for level flight in all configurations, a reduction in stalling airspeed of as much as 18 knots has been experienced. Stall recovery normally results in a sideslipping dive with a loss of from 500 to 1500 feet of altitude.

Accelerated stalls are characterized with an abrupt rolloff and a mild noseup trim change. Lateral control prior to and during the stall is marginal. The rolloff in the case of stalls in turns is nearly always in the wing down direction, and excessive bank angles usually occur prior to recovery.

CAUTION

Intentional power-off unaccelerated stalls should not be performed because of marginal lateral control for recovery. Accelerated and power-on stalls are prohibited because of ineffective lateral control for recovery. At the first indication of a stall, immediately apply forward control column movement, and if rolloff exists, apply full aileron against the rolloff.

SPINS.

Intentional spins are prohibited. In the event of an unintentional spin, use normal recovery technique for this type aircraft, that is, apply full rudder against the spin and full forward control column, holding ailerons approximately neutral. If the rotation does not decrease appreciably after two turns, continue to hold full rudder against the spin and pull column full back until the rotation stops, then full forward.

Power-Off Stalling Speeds

MODEL: C-133A/B
DATE: 6-15-61
DATA BASIS: FLIGHT TEST DATA

CONDITIONS:
GEAR UP OR DOWN
THROTTLES — FLIGHT IDLE

ENGINES: (4) T34P-TWA/9W

NOTE:

1. Power-on stall speed is approximately 10 knots lower than power-off stall speed.
2. Correct CAS to IAS by use of the Airspeed Position Error Charts in Part 2 of, T.O. 1C-133A-1-1

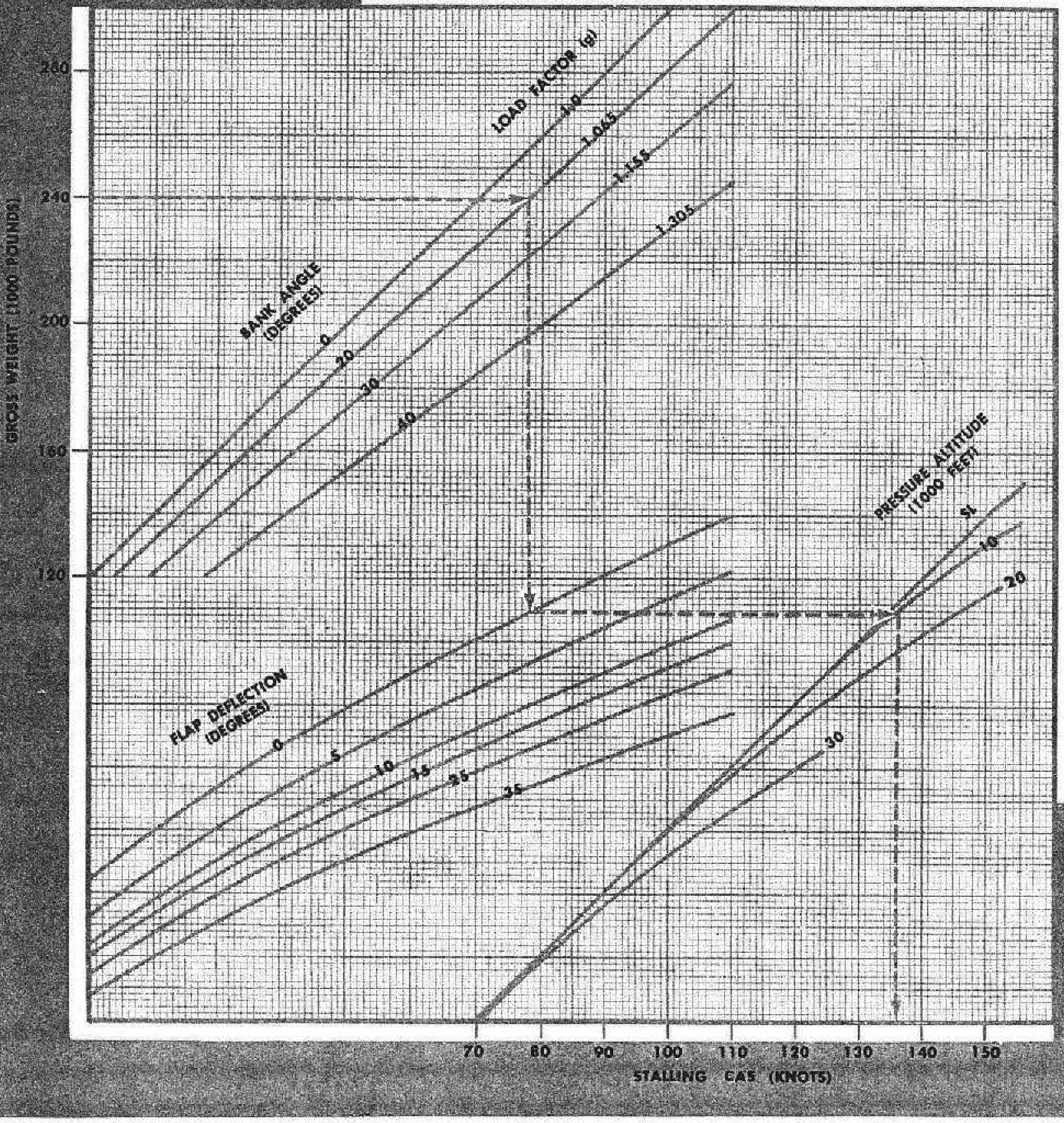

Figure 6-1

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FLIGHT CONTROLS.

All the control surfaces are actuated by linked control tabs. This type of control is equivalent in pilot force to a hydraulic boost system of approximately 15 to 1 ratio, but it has the inherent reliability of a direct control system. Surface response to control movements is rapid, although the large amount of inertia involved often causes some lag in aircraft response. The lateral (aileron) control surfaces have an aerodynamic seal and are pressure balanced. To increase the aileron effectiveness, vortex generators, mounted at angles to each other, are installed along the 50 percent chord line on the upper wing surface and along the 75 percent chord line on the lower wing surface. These vortex generators act to increase the roll rate by providing a more aerodynamically efficient airflow over the aileron surfaces. Aileron deflection is 23 degrees up and 15 degrees down

The rudder-aileron interconnect system aids in making coordinated turns. The interconnect system simply connects the main aileron surface to the rudder control tab. The control harmony in forces is therefore improved, and in most cases, turns are coordinated with the use of lateral controls only.

The 2-position rudder stop system is an integral part of the rudder snubber. Without the 2-position rudder stop, an inherent characteristic of the directional control system known as rudder overbalance, and light rudder forces could easily allow the pilot to exceed the structural limits of the vertical tail. Full deflection of rudder (18.5 degrees in each direction) is available at the lower airspeeds (168 knots IAS and below) which is within the structural envelope. The 7-degree rudder stop allows only 7 degrees of rudder travel at the higher airspeeds (above approximately 168 knots IAS). Adequate rudder deflection is provided in both positions to maintain directional control at minimum control speed, during asymmetrical power conditions.

MANEUVERING FLIGHT.

The elevator forces required to maneuver the aircraft are a function of loading (gross weight and cg), wing flap deflection, landing gear position, and airspeed. Most of the maneuvering requirements involve the takeoff and landing operations, and for these configurations the control forces are satisfactory.

DIVING.

The flight envelope of this aircraft, as presented, does not limit the design mission capability. Dive angles required to exceed this envelope are steep and are considered excessive for this type aircraft. Within the limits shown in the Operating Flight Strength Diagram *(figure 5-9)*, the aircraft is satisfactory in all stability requirements.

TUCKUNDER.

With the flaps extended, longitudinal flight control push forces are light and force reversal will occur if aircraft load factor is reduced appreciably below 1g. Although the aircraft is unstable when force reversal occurs, aircraft response to control movement is normal. This unstable condition is proportionately more pronounced with increased flap angles, lower gross weights, and higher airspeeds with wing flaps extended. The force reversal is also more easily attained at aft cg than at forward cg. The airspeed and gross weight are restricted (see Section V) to minimize this unstable condition; however, tuckunder can occur within these speed-weight-flap angle restrictions if pushovers are prolonged. This flaps down instability can also occur from the long period "hands off" oscillation. In the event the aircraft does progress into the region of stick force reversal, recovery can be attained by pulling back on the control column. The aircraft is responsive and care must be taken not to exceed the positive limit load factor.

SYSTEMS OPERATION SECTION VII

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ENGINE.

ENGINE PREOILING AND PROPELLER FEATHERING CHECK.

If engines have been idle for a period of 24 hours or longer, prior to starting, preoil the engines and check the propeller feathering circuits as follows:

1. Firewall shutoff valve switches — NORMAL.
2. Condition lever — FUEL OFF.
3. Throttles — GROUND IDLE.
4. Engine brake switch — OFF.

Note

Prior to pushing the starter switch IN, insure that air supply to the starter is available.

5. Starter switch — PUSH TO START; rotate the propeller with the starter for 10 seconds, and check for a rise in oil pressure.

6. Starter Switch — PULL TO RESET.

Note

Perform the following feathering circuit checks as propeller is coasting to a stop.

7. Auxiliary Feathering Switch — FEATHER.

Actuate to FEATHER (momentarily). Beta light should go off.

8. Auxiliary Feathering Switch — NORMAL.

Beta light should come on.

9. Condition Lever — FEATHER.

Move the condition lever to FEATHER (momentarily). Beta light should go off.

10. Condition Lever — FUEL OFF.

Beta light should come on.

11. Engine brake Switch — ON.

Allow engine to coast to a stop prior to activation of engine brake switch.

TORQUE PRESSURE CHECK — T34-P-7WA.

MILITARY RATED and NORMAL RATED Power.

1. Set power to achieve torque pressure values shown on the applicable chart in Part 2 of *T.O. 1C-133A-1-1.*

2. Do not exceed maximum allowable EGT.

3. If EGT is excessive, or if indicated torque presure is less than charted value, check fuel flow on applicable charts in Parts 4 and 5 of *T.O. 1C-133A-1-1.*

TORQUE PRESSURE CHECK — T34-P-9W.

MILITARY RATED Power.

1. Set TIT at 915°C; indicated torque pressure should be the value charted on figure B2-5 of *T.O. 1C-133A-1-1.*

2. If indicated torque pressure is below charted vlaue, advance throttle until charted value or MILITARY RATED power TIT limit of 925°C is reached. Do not exceed TIT of 925°C.

3. If indicated torque pressure is above charted value, perform the following:

a. Determine indicated fuel flow on affected engines.

b. Determine MILITARY RATED power fuel flow values from applicable charts in Part 4 of *T.O. 1C-133A-1-1.*

c. If indicated fuel flow exceeds charted fuel flow (±100 lbs. per hour), error may exist in the torque pressure indicating system. Maintain TIT at 915°C.

d. If indicated fuel flow exceeds charted fuel flow (±100 lbs. per hour), the TIT indicating system may be in error. Set torque pressure to charted values.

NORMAL RATED Power.

Use same procedure for checking indicated torque pressure as for MILITARY RATED power. TIT should be set at 885°C, and not to exceed 890°C. Fuel flow values for NORMAL RATED power are determined from charts in Parts 4 and 5 of *T.O. 1C-133A-1-1.*

ENGINE VIBRATION MONITORING SYSTEM (AIRCRAFT WITH T.C.T.O. 612).

The engine vibration monitoring system is installed to enable readings to be made of the vibration level of various sections of the engine.

Note

Comparative readings are not made between like pickup locations on different engines, or between different pickup locations on the same engine. All data is recorded at specific time intervals during flight to determine whether progressive vibration changes are occurring over a period of time or between flights.

Systems Test—Engine Not Operating

The following test is accomplished with electrical power on the line and engines not operating.

tion. Reading for ACCESSORY, TURBINE, and PROP positions should be 3 to 4 with not more than 0.5 spread between engines.

Operation.

Monitor engine vibration indicator during flight and record vibration levels for each engine at each selector switch position at specified time intervals. Note changes in vibration level during steady state operating conditions. If malfunction of the vibration system is suspected, system may be checked with engines operating at FLIGHT IDLE or above as outlined in System Test. Indicator readings may differ from those obtained during preflight check due to different vibration input from the pickups.

Postflight Check.

1. Repeat steps 2 through 4 of System Test after engines have been shut down.
2. System Power Switches — OFF.

Turn off both a-c and d-c power switches.

PROPELLER SYNCHRONIZER RPM TRIM SYSTEM.

At temperatures below 10°C OAT maximum down trim (94.5 percent rpm) is recommended for all powers not exceeding NORMAL RATED. Operation at 94.5 percent rpm reduces aircraft and internal engine vibration amplitude, improves engine compressor efficiency and specific fuel consumption under conditions of low ambient temperatures, and provides additional crew comfort through the reduction in noise levels. Use of the rpm trim above NORMAL RATED power, or at temperatures above 10°C OAT, is limited to bringing the rpm on schedule as FULL DECREASE rpm at high ambient temperatures may result in excessive EGT/TIT or torque values (see Propeller Synchronizer RPM Trim Operation Envelope, figure 7-1).

PROPELLER SYNCHRONIZER RPM TRIM OPERATION.

Climb.

1. Set climb power (see Part 4, *T.O. 1C-133A-1-1*).

1. System Power Switches — A-C and D-C ON.

Turn on both a-c and d-c power and allow 1 minute for warmup.

2. Vibration Pickup Selector Switch — INLET.

3. Vibration Test Switch — Press.

Press vibration test switch and note readings on vibration indicator scales. Indicator reading should be 0.2 to 1.5 wth no more than 0.5 spread between engines.

4. Repeat steps 2 and 3 for ACCESSORY, TURBINE, and PROP positions. Note reading at each position. Reading for ACCESSORY, TURBINE, and PROP positions should be 3 to 4 with not more than 0.5 spread between engines.

Operation.

Monitor engine vibration indicator during flight and record vibration levels for each engine at each selector switch position at specified time intervals. Note changes in vibration level during steady state operating conditions. If malfunction of the vibration system is suspected, system may be checked with engines operating at FLIGHT IDLE or above as outlined in System Test. Indicator readings may differ from those obtained during preflight check due to different vibration input from the pickups.

Postflight Check.

1. Repeat steps 2 through 4 of System Test after engines have been shut down.

2. System Power Switches — OFF.
Turn off both a-c and d-c power switches.

PROPELLER SYNCHRONIZER RPM TRIM SYSTEM.

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PROPELLER SYNCHRONIZER RPM TRIM OPERATION.

Climb.

1. Set climb power (see Part 4, *T.O. 1C-133A-1-1*).

2. At temperatures above 10°C OAT and/or power above NORMAL RATED, use trim to bring rpm on schedule.

3. When OAT temperature decreases to 10°C, apply FULL DECREASE rpm, providing power does not exceed NORMAL RATED.

4. Readjust power as required (see Part 4, *T.O. 1C-133A-1-1*, for setting climb power at 94.5 percent rpm).

Cruise

1. Maintain FULL DECREASE rpm and adjust power as required (see Part 5, *T.O. 1C-133A-1-1*).

Note

> As long as OAT remains below 10°C and power does not exceed NORMAL RATED, maximum downtrim should be maintained for initial and subsequent climb and cruise power settings.

PROPELLER CHECKS.

A complete engine and propeller check is required after periodic inspection, propeller or engine change, or if maintenance has been performed on the propeller, engine, or engine accessories. When an engine or propeller malfunction is suspected, a complete check will be accomplished on that engine.

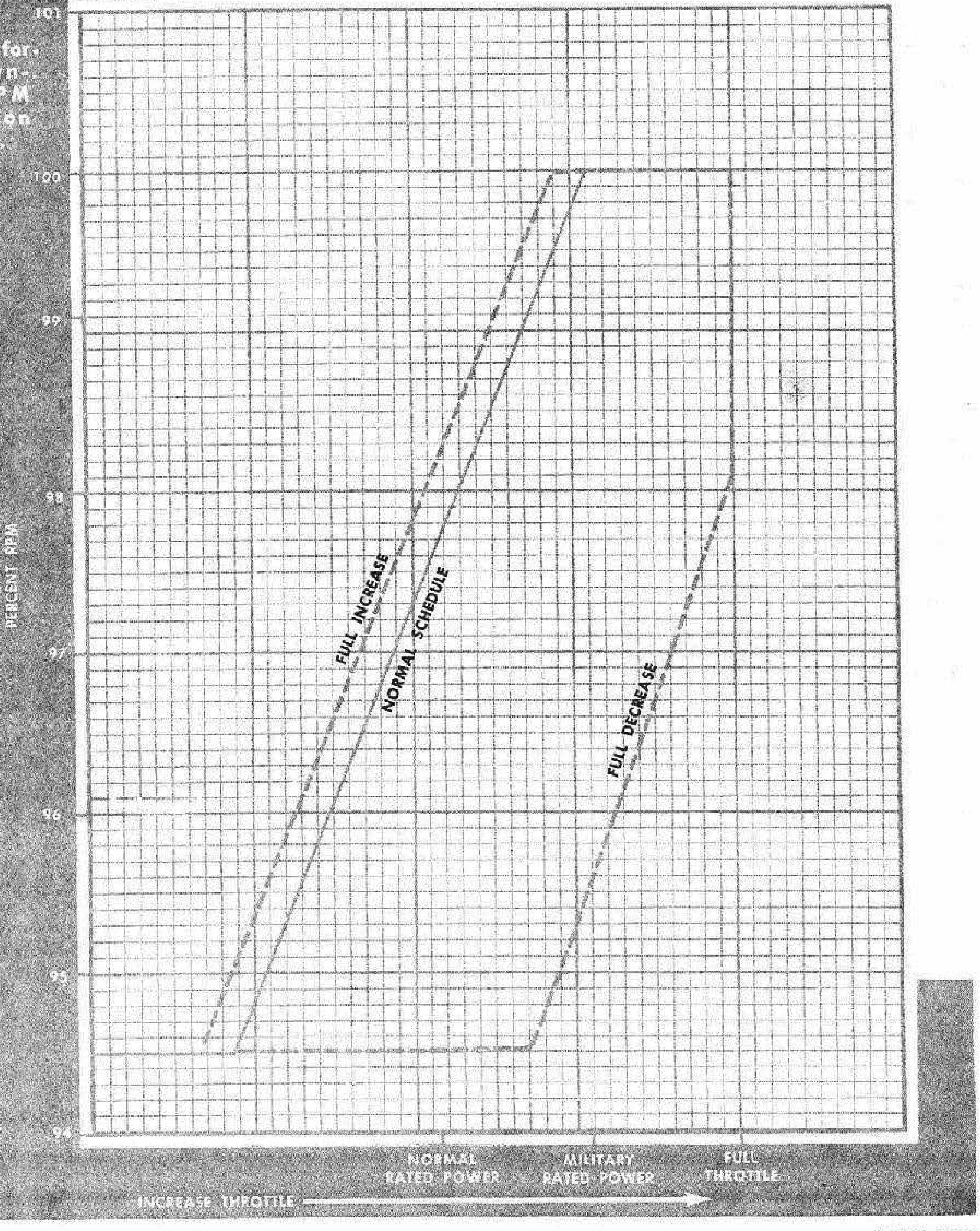
On aircraft not modified by T.O. 3E3-2-558, a propeller static check shall be performed prior to the first flight of the day, before starting engines. The static check need not be performed at enroute stations unless propeller malfunction has been experienced or maintenance has been performed on the engine or the propeller. (See Section IX for Cold Weather Operation.)

CAUTION

> To prevent overload and inducement of current limiter failure, move only one throttle at a time when power is applied to the aircraft and engines are not operating.

Propeller Synchronizer RPM Trim Operation Envelope

NOTE:
See Section V for Propeller Synchronizer RPM Trim limitation and tolerances.



UAB1-22B

Figure 7-1

PROPELLER STATIC CHECK (AIRCRAFT NOT MODIFIED BY T.O. 3E3-2-558).

1. All Propeller Circuit Breakers — CLOSED.

Close pitch lock circuit breakers first; then close all other propeller circuit breakers.

2. Throttles — GROUND IDLE.

Beta light should come on.

3. Propeller Overspeed Pitch Lock Test Light — PRESS-TO-TEST.

Light should come on when pressed and go out when released.

4. Propeller Overspeed Pitch Lock Test Engine Selector Switch — Turn to each engine position.

Propeller overspeed pitch lock test light must come on in each engine position.

CAUTION

> Discontinue the propeller static check immediately and open all propeller circuit breakers if the light does not come ON, for each engine position. Serious damage to the feather (air start) motor will result if static decrease pitch blade angle changes are attempted with the pitch lock mechanism engaged.

CAUTION

> When throttle movement requires a blade angle decrease and the blade angle does not decrease, the pitch lock mechanism may be engaged. Discontinue the propeller static check immediately, and open all propeller circuit breakers to prevent damage to the feather (air start) motor.

5. Propeller Overspeed Pitch Lock Test Engine Selector Switch — NO. 1 ENGINE.

Propeller overspeed pitch lock test light must come ON.

6. Engine Brake Switch — ON.

7. Throttle — FLIGHT IDLE.

Blade angle increases to flight idle, propeller overspeed pitch lock test light should go off momentarily. Beta light should remain on.

8. Condition Lever — FEATHER.

Check that propeller blades go to feather angle and Beta light goes off.

9. Condition Lever — FUEL OFF.

Check for slight blade angle decrease.

10. Static Pitch Control Switch — INCREASE (hold).

No blade angle change should occur.

11. Static Pitch Control Switch — RELEASE TO NORMAL.

12. Condition Lever — AIR START.

No blade angle change should occur. Propeller low oil pressure light should come on.

13. Engine Brake Switch — OFF.

Check that blade angle changes to air start position.

14. Condition Lever — FUEL OFF.

Check for slight blade angle increase. Propeller low oil pressure light should go off.

15. Throttle — GROUND IDLE.

Blade angle should decrease to ground idle. Beta light should come on.

16. Throttle — REVERSE.

Check blade angle to reverse.

17. Throttle — GROUND IDLE.

Check that blade angle increases to ground idle.

18. Condition Lever — AIR START (hold).

19. Throttle — FLIGHT IDLE.

Propeller overspeed pitch lock test light should go off.

20. Condition Lever — FUEL OFF.

Check that propeller blades increase to NORMALIZING angle. Beta light should stay on. Propeller overspeed pitch lock test light should come on.

21. Throttle — GROUND IDLE.

Blade angle should increase to ground idle.

22. Perform steps 5 through 21 for engines No. 2, 3, and 4, if applicable.

23. Propeller Pitch Lock Overspeed Test Engine Selector Switch — OFF.

All data deleted from page 7-6.

PROPELLER OPERATIONAL CHECKS (ENGINES OPERATING).

Propeller Synchronizer System Check.

The propeller synchronizer and rpm trimmer check should be performed after periodic inspection, if a malfunction has been experienced or is suspected, or if maintenance has been performed on the propeller synchronizer or synchronizer trimmer.

1. Throttles — SET.

Set at approximately 95 percent rpm.

2. All Propeller Synchronizer Buttons—PUSH IN.

3. Propeller Synchronizer Rpm Trim Lever — NEUTRAL.

4. Throttles — ADVANCE.

Advance on synchronous governing to 98.5 percent rpm.

5. Propeller Synchronizer Rpm Trim Level—FULL INCREASE.

Engine rpm should increase a minimum of 0.5 percent.

6. Propeller Synchronizer Rpm Trim Lever—FULL DECREASE.

The engine rpm must decrease to 94.5 percent.

7. Throttle — ADVANCE ONE THROTTLE TO MAX POWER.

The rpm must be 98 percent for all engines.

8. Propeller Synchronizer Rpm Trim Lever — NEUTRAL.

The rpm must increase to 100 percent for all engines.

9. Throttles — GROUND IDLE.

NTC and Pitch Lock System Check (Engines Operating).

Note

On all aircraft modified by T.O. 3E3-2-558 delete item 1.

1. No. 1 Auxiliary Feathering Switch—FEATHER (momentarily) with engine at HIGH GROUND IDLE rpm.

Check for decrease in engine rpm and propeller Beta warning light OFF (momentarily). Repeat for engines No. 2, 3, and 4, if applicable.

2. Throttle — FLIGHT IDLE.

Beta light should come on.

3. Propeller Normal Control Circuit Breaker — OPEN.

4. Propeller Overspeed Pitch Lock Test Engine Selector Switch — NO. 1 ENGINE.

Test Light should come on.

5. Throttle — 95 PERCENT RPM.

6. Propeller Synchronizer Button — PUSH IN.

7. Throttle — Advance (slowly).

Advance throttle slowly until propeller synchronizer button pops out and propeller pitch lock test light goes off, at approximately 103 percent rpm.

CAUTION

Do not exceed 105 percent rpm.

8. Throttle — RETARD (slowly).

Retard throttle slowly, propeller overspeed pitch lock test light should come on at 101.5 percent rpm minimum.

Note

Propeller overspeed pitch lock test light may flicker at or near actuation points. Take readings at rpm where light is steady.

9. Throttle — FLIGHT IDLE.

Beta light should come on.

10. Condition Lever — FUEL OFF, then RUN-FUEL ON (accomplish action rapidly).

Beta light should go OFF and NTC warning indicator light should come on.

CAUTION

If engine rpm drops to a low value during this check, start the throttle to ground idle and close the propeller normal control circuit breaker to avoid high engine EGT/TIT and possible loss of engine due to excessive blade angle.

Note

> Moving the condition lever beyond FUEL OFF toward the FEATHER position will give a false NTC indication.

11. NTC Indicator Light Switch — RESET.

NTC warning indicator light should go OFF.

12. Throttle — 95 PERCENT RPM.

13. Propeller Synchronizer Button — PUSH IN.

14. Throttle — RETARD (slowly).

Synchronizer button should pop out at approximately 92.5 percent rpm.

15. Propeller Normal Control Circuit Breaker — CLOSE.

16. Throttle — GROUND IDLE.

Beta should come on.

17. Propeller Clutch Solenoid Circuit Breaker — OPEN.

18. Condition Lever — AIR START (HOLD).

19. Throttle — FLIGHT IDLE.

Position throttle approximately 1 inch above FLIGHT IDLE, then return to FLIGHT IDLE.

20. Condition Lever — FUEL OFF, then RUN-FUEL ON (accomplish rapidly).

Beta light should go off.

Note

> The NTC indicator light is not operative during this check because the propeller clutch solenoid circuit breaker is open.

Note

> Moving the condition lever beyond the FUEL OFF position will give a false NTC indication.

21. Propeller Clutch Solenoid Circuit Breaker — CLOSED.

22. Propeller Pitch Lock Circuit Breaker — OPEN.

Propeller pitch lock test light should go off.

23. Throttle — ADVANCE.

Advance throttle to 25 psi torque pressure.

24. Throttle — RETARD (slowly).

Retard throttle slowly to get 2 to 3 percent rpm decrease.

25. Propeller Pitch Lock Circuit Breaker — CLOSED.

Propeller pitch lock test light should come on. Rpm should increase to approximately 97.7 percent.

Note

> If rpm does not increase, advance throttle to 26 psi torque pressure.

26. Throttle — FLIGHT IDLE.

Note that torque pressure and rpm are normal.

27. Throttle — GROUND IDLE.

Beta light should come on.

WARNING

The aircraft should not be flown if any light fails to function as specified in steps 1 through 27.

28. All Propeller Circuit Breakers — CLOSED.

Perform steps 2 through 27 for engines No. 2, 3, and 4, if applicable.

29. Throttle — ADVANCE TO 20-25 PSI TORQUE PRESSURE.

30. Rpm — CHECK.

Check for 97.7 percent rpm after EGT/TIT and rpm have stabilized (mechanical reference check).

31. Synchrophase — CHECK.
    a. Synchronizer Buttons — PUSH IN.
    b. Synchrophase Switch ON, observe normal operation.
    c. Synchrophase Switch — OFF.

32. Throttles — GROUND IDLE.

33. No. 1 and 4 Throttles — FULL REVERSE.

34. Generators and Transfer Relays — CHECKED.

While No. 2 and 3 engines are operating in HIGH GROUND IDLE RPM, the pilot will clear the engineer to conduct the generator and transfer relays check by stating "Check generators." The engineer will acknowledge and upon completion will report, "Generators checked" (see generator and non-essential load transfer relay check procedures, this Section).

35. Water-Alcohol Injection Switch — AS REQUIRED.

If water-alcohol is to be used for takeoff, while the inboard engines are at HIGH GROUND IDLE RPM, the pilot will turn the switch ON, and check that the indicator reads ON. After check, turn the switch OFF.

36. No. 1 and 4 Ground Speed Control Switch — LO-IDLE (momentarily).

37. No. 2 and 3 Throttles — FULL REVERSE.

38. No. 2 and 3 Ground Speed Control Switch — LO-IDLE (momentarily).

Note

If APN-59 radar is required immediately after takeoff, leave No. 3 engine at HIGH GROUND IDLE RPM.

39. Runup Check — COMPLETED.

Rapid Throttle Movement.

Rapid throttle movement is permissible in either direction in the FLIGHT range or the GROUND range; however, when moving throttles from GROUND IDLE to REVERSE, a slow movement is required to avoid possible engine stall. The time it takes to move the throttle from MAX POWER position to full REVERSE should be approximately 2 seconds. In any case, the acceleration turbine inlet temperature limit should not be exceeded.

FUEL SYSTEM OPERATION.

FUEL MANAGEMENT PROCEDURE.

Fuel System Preflight Check.

1. Tank Outlet Valve Switches — ALL OPEN.

2. No. 1, 2, 7, and 8 Fuel Boost Pump Switches — ON.

3. Fuel Pressure Warning Lights — OUT.

4. No. 1, 2, 7, and 8 Fuel Boost Pump Switches — OFF.

5. Fuel Pressure Warning Lights — ON.

6. No. 2 and 7 Auxiliary Fuel Boost Pump Switches — ON.

7. No. 1 and 4 Fuel Pressure Warning Lights — OUT.

8. No. 2 and 7 Auxiliary Fuel Boost Pump Switches — OFF.

9. No. 1 and 4 Fuel Pressure Warning Lights — ON.

10. Manifold-To-Engine Valve Switches — ALL OPEN.

11. No. 3 and 6 Fuel Boost Pump Switches — ON.

12. Fuel Pressure Warning Lights — OUT.

13. No. 3 and 6 Fuel Boost Pump Switches — OFF.

14. Fuel Pressure Warning Lights — ON.

15. No. 4 and 5 Fuel Boost Pump Switches — ON.

16. Fuel Pressure Warning Lights — OFF.

17. Manifold-To-Engine Valve Switches — ALL CLOSE.

18. No. 2 and 7 Inlet Valve Switches — OPEN.

19. High-Level Float Test — CHECK.

20. No. 4 and 5 Fuel Boost Pump Switches OFF.

21. Fuel Presure Warning Lights — ON.

Taxiing and Engine Runup.

Asymmetrical fuel loading does not present a serious problem during ground operations. However, to insure lateral stability in a turn, and when taxiing in cross winds, the following fuel management provisions should be met.

1. Fuel quantity differential between tanks No. 1 and 8 must not exceed 1000 pounds.

2. Fuel quantity differential between tanks No. 2 and 7 must not exceed 2000 pounds.

3. Total fuel quantity differential between tanks of the left wing and tanks of the right wing must not exceed 4000 pounds.

Takeoff and Climb.

For takeoff and climb, use fuel from tank No. 2 to supply engines No. 1 and 2, and fuel from tank No. 7 to supply engines No. 3 and 4.

Cruise.

For cruise operation, the following procedure should be used. Monitor fuel consumption and GTU return flow to assure symmetrical loading.

Note

> Always select a new fuel supply for the engines before shutting off the old supply. Shut off the fuel boost pump for the respective tank when that tank is empty.

1. During Cruise — Use Takeoff and Climb procedure until tanks No. 2 and 7 indicate 9000 pounds.

2. No. 4 and 5 Fuel Boost Pump Switches — ON.

3. Float Test Light —Check to insure fuel transfer into tanks No. 2 and 7.

4. Fuel Transfer — Transfer fuel into tanks No. 2 and 7 until indicators read 12,000 pounds (or light comes on).

5. When Tanks No. 4 and 5 are Empty, No. 4 and 5 Tank-To-Manifold Switches—CLOSE; No. 4 and 5 Fuel Boost Pump Switches—OFF.

6. Repeat steps 2 through 4 for tanks No. 3 and 6.

7. When Fuel Quantity in Tanks No. 1, 2, 7, and 8 Is Equal, No. 1 and 8 Fuel Boost Pump Switches — ON; No. 2 and 7 Auxiliary Fuel Boost Pump Switches — OFF.

8. Monitor symmetrical use of remaining fuel until landing and engine shutdown.

Note

> When all fuel tanks are not full at takeoff, the same procedure described in the previous eight steps will apply, except that the empty tanks should be omitted from the fuel management procedure.

Descent.

Check for balanced fuel to ensure even distribution during landing, and transfer as required.

Landing.

For landing, use fuel from tank No. 1 to supply engine No. 1, tank No. 2 to supply engine No. 2, tank No. 7 to supply engine No. 3, and tank No. 8 to supply engine No. 4.

SINGLE-POINT REFUELING SYSTEM OPERATION.

The single-point refueling system allows ground refueling from a connection in the right landing gear pod. During refueling operation (refueling valve switches and crossfeed valve switch OPEN), the fuel rises through the pod and fuselage and flows into a common fuel manifold extending through the left and right wing tank areas. Each of the eight tanks is supplied from the manifold, and as each tank is filled, the high-level float control is activated. This causes the inlet control valve to close and stop the flow of fuel to the tank.

CAUTION

To prevent seal damage and fuel leakage, the pressure output of the refueling source must not exceed 60 psi.

Note

The fuel quantity indicators should be monitored for partial filling of tanks. See figures 1-17 and 1-18 for correction of indicated fuel to actual usable fuel.

CAUTION

After the aircraft is refueled, the refueling riser should be drained to prevent seal damage and fuel leakage caused by thermal expansion of fuel.

Before draining the refueling riser, the tank inlet, crossfeed, and refueling valves should be closed. The riser is drained by holding the fuel vent valve switch IN and repositioning the ground fueling unit to defuel until all riser fuel is drained. If the refueling equipment does not have provisions for reversing flow, the riser may be drained through a manual drain valve located on the aft side of the forward wheel pod bulkhead.

OVERWING REFUELING OPERATION.

The aircraft may also be refueled through the filler-caps in tanks No. 4 and 5, and by use of normal fuel transfer to the other tanks. The transfer rate is approximately 250 pounds per minute per pump.

ELECTRICAL SYSTEMS LOAD DISTRIBUTION.

The electrical power system is basically an a-c system. The electrical system converts only enough a-c power to d-c to support the d-c requirement of the aircraft; therefore, no d-c power is available to support missiles or other equipment requiring d-c power during transportation. The d-c power system may be utilized during ground loading operations if necessary.

Sufficient a-c electrical power is available to support equipment during flight, providing the main a-c generators are operating normally. In the event of failure of one or both main a-c generators, follow procedure under Main Generator Failure, Section III.

D-C ELECTRICAL POWER SYSTEM CHECK.

The flight engineer will perform the D-C Electrical Power System Check (*figure* 7-2), as a part of the Electrical Power-On Check (see Section II).

GENERATOR AND TRANSFER RELAY CHECK.

The flight engineer will perform the Generator and Transfer Relays Check during ground runup, with No. 2 and 3 engines operating at HIGH GROUND IDLE rpm.

1. Left Generator Switch — ON.
2. AC Check List Annunciator Panel — CHECKED.

LEFT GEN TO FWD NON-ESS BUS annunciator strip should come on.

3. Left Generator — CHECK VOLTAGE and FREQUENCY.
4. Right Generator Switch — ON.
5. AC Check List Annunciator Panel — CHECKED.

All annunciator strips go out.

6. Left Generator Switch — OFF.
7. AC Check List Annunciator Panel — CHECKED.

RIGHT GEN TO AFT NON-ESS BUS annunciator strip should come on.

8. Right Generator — CHECK VOLTAGE AND FREQUENCY.
9. Left Generator Switch — ON.

AIR-DRIVEN GENERATOR.

The air-driven generator is installed to provide emergency d-c power during flight in the event of failure of the main and auxiliary a-c generators. The air-driven generator has sufficient capacity to supply continuous power for all normal d-c power requirements at airspeeds above 150 knots. In the event of multiple a-c generator failure or failure of one or more transformer-rectifiers, follow procedures under Electrical Power System Failure, Section III.

Air-Driven Generator Extension.

To extend the air-driven generator in flight, proceed as follows:

1. Air-Driven Generator Emergency Release Handle — PULL.

D-C Power System Check

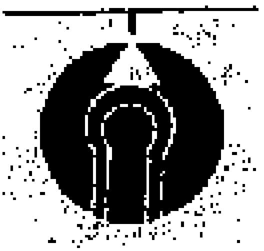
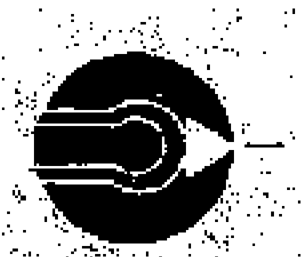
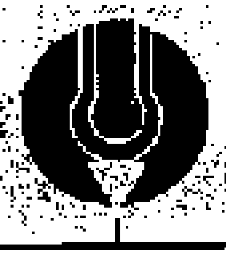
VOLTMETER SELECTOR SWITCH POSITION	CIRCUIT BREAKER AND BATTERY SWITCH POSITIONS	CHECK VOLTMETER AND WARNING LIGHTS
AUX. GENERATOR BATTERY 	a. Forward Transformer-Rectifier Circuit Breaker — OFF. b. Battery Switch — OFF. c. Battery Switch — ON.	a. Forward Transformer-Rectifier Warning Light — ON. b. Check Voltage. c. Check for Slight Voltage Increase.
RIGHT GEN FWD T.R. 	a. Forward Transformer-Rectifier Circuit Breaker — ON.	a. Check for Voltage Increase Above Battery Voltage. Forward Transformer-Rectifier Warning Light — OFF.
FLIGHT DECK ESS 	a. Battery Switch — OFF. b. Auxiliary Generator Switch — Momentarily to AUTO. c. Forward Transformer-Rectifier Circuit Breaker — OFF.	a. Check Voltage. b. Check for Continuous Voltage and Aft Transformer Rectifier Warning Light — ON. c. Check Voltage.
CENTER FUS ESS 	a. Battery Switch and Forward Transformer-Rectifier Circuit Breaker — OFF.	a. Check Voltage.
AC OFF DC 	a. Battery Switch and Forward Transformer-Rectifier Circuit Breaker — OFF.	a. Check for Zero Voltage.
CENTER FUS NON ESS 	a. Battery Switch and Forward Transformer-Rectifier Circuit Breaker — OFF.	a. Check Voltage.
FLIGHT DECK NON ESS 	a. Battery Switch and Forward Transformer-Rectifier Circuit Breaker — OFF.	a. Check Voltage.
LEFT GEN AFT T.R. 	a. Battery Switch and Forward Transformer-Rectifier Circuit Breaker — ON.	a. Check Voltage.
AUX. GENERATOR BATTERY 	a. Battery Switch and Forward Transformer-Rectifier Circuit Breaker — ON.	a. Pilot Checks Aft Radio Bus With VHF or OMNI. Navigator Checks Navigators Bus.

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Figure 7-2

Figure 7-2 (Sheet 2 of 2) deleted.

2. Aircraft Electrical System — CHECK.

Check d-c electrical system as outlined under Main Generator Failure, Section III. Monitor electrical load as required.

Note

Once extended, the air-driven generator cannot be retracted while in flight.

Extending Air-Driven Generator From Inside Aircraft While On Ground:

1. Generator Door Area — CLEAR.

Check that area around the air-driven generator door is clear of personnel and equipment.

2. Air-Driven Generator Emergency Release Handle — PULL.

Extending Air-Driven Generator From Outside Aircraft:

1. Generator Door Area — CLEAR.

Check that area around the air-driven generator door is clear of personnel and equipment.

2. Latch Control Handle (Handle A) — UNLOCKED.

Air-Driven Generator Door Retraction.

1. Hydraulic Power — ON.

Turn on hydraulic power; either utility system or auxiliary hydraulic pump if GTU's are not operating.

2. Generator Door Unlatching Handle (Handle B) — UNLOCKED.

Pull handle outboard to the UNLOCKED position to release the inner door latches and hold until door starts to close.

3. Retraction Control Handle (Handle C) — RETRACT.

Turn handle to retract position and hold until door is retracted. Handle will return to NORMAL position when released. Emergency release handle inside the cabin will be pulled into its socket as the door is retracted.

4. Hydraulic Power — OFF.

5. Generator Door Control Access Cover — CLOSED.

6. Emergency Release Handle — SAFETIED.

GTU OPERATION.

GTU AUGMENTATION.

Augmentation extends the capabilities of the air conditioning system. For each pound of augmentation air that enters the turbine section of the GTU, approximately 1 pound of bleed air flows through the load control valve and into the pneumatic system. As the augmentation valve is opened further, more air enters the turbine; thus, more air is bled from the GTU compressor through the load control valve. A point will be reached, however, where either the load control valve or air conditioning system (either the cooling turbine nozzle or the mass flow valve) cannot accept additional airflow. An increase in augmentation airflow beyond this point will not result in more bleed airflow from the GTU. Any additional augmentation airflow will result in an excess of turbine exhaust flow, which will tend to decrease EGT.

When the EGT reduces to 525° C, the low EGT warning light will come on, warning the operator that the GTU is overaugmented. During ground operation, the maximum airflow for the air conditioning system will depend on whether the system is in full HEATING or full COOLING. During operation of both GTU's, the air conditioning system maximum regulated flow will be obtained at approximately 3.5 to 6.0 inches Hg airflow when in full HEATING.

During modulated operation with both GTU's operating (intermediate operation between full HEATING and full COOLING), the air conditioning system will obtain its maximum flow requirements between 3.5 inches Hg airflow and the red line (6.0 inches Hg airflow). During single GTU operation, the maximum regulated flow condition will not be reached in either full HEATING or full COOLING.

NORMAL GROUND START.

Each GTU unit may have its own air and normal starting characteristics. The operator should become familiar with the starting procedure techniques for each unit and the GTU tolerances (*figure 5-5*).

CAUTION

A qualified operator must be at the flight engineer's station whenever the GTU's are operating.

Note

When starting the GTU's on battery power, it is recommended that No. 1 GTU be started first.

Flight Engineer.

1. GTU Overheat and Fire Control Handles — IN.

2. No. 1 and 2 GTU Start and Load Control Circuit Breakers — Check IN.

3. Battery Switch — OFF (to start on aircraft power).

4. Jet Blast Rain Removal Switch — OFF.

5. Air Conditioning Switch — OFF.

6. GTU Augmentation Switch — CLOSED.

7. GTU Pneumatic Selector Switches — NO LOAD.

8. Nacelle Preheat Switches — OFF.

9. GTU Start Selector Switch (GTU being started) — NORMAL.

10. GTU Air Doors Switch — OPEN.

11. GTU Start-Run-Stop Switch — Hold in START.

12. GTU Ignition and Fuel Switch — Push IN above 3 to 5 percent rpm.

13. GTU Start-Run-Stop Switch — Release to RUN at 95 percent rpm.

CAUTION

If EGT does not increase within 5 seconds after pushing in the ignition and fuel switch, pull the ignition and fuel switch out and continue to motor the unit by holding the GTU start-run-stop switch in START for 30 seconds before allowing the unit to stop. Another start may be attempted. Do not exceed the starter duty cycle which is 1 minute on and 4 minutes off. The starter may be engaged only when the GTU is completely stopped. Maximum allowable starting time is 60 seconds.

Note

If the GTU speed exceeds 110 percent rpm, the unit will automatically shut down.

CAUTION

The GTU low-oil pressure warning light should go out at approximately 45 psi. If the light comes on during GTU operation, and low oil pressure is observed, it is recommended that the affected GTU be shut down to prevent possible damage to the unit.

14. Airflow — Zero inches Hg.

CAUTION

If a GTU is operated in excess of the operaing limits (see Section V), the unit should be shut down to prevent damage to the unit. The operating excess should be noted on Form 781.

ALTERNATE STARTING PROCEDURES.

If either GTU is operating, the other unit may be started by utilizing bleed air from the operating unit. An operating aircraft engine, or ground air supply unit can also be utilized.

Augmentation Start (GTU Bleed Air) — Ground Start Only.

1. Jet Blast Windshield Rain Removal Switch— OFF.

2. Pneumatic Manifold Switches — CLOSE.

3. Air Conditioning Switch — OFF.

4. Any Nacelle Preheat Control Switch — ON.

5. Operating GTU Pneumatic Selector Switch — LOAD.

6. Operating GTU Augmentation Switch — CLOSED.

7. Pneumatic Manifold Pressure Gage — Check for pressure indication.

8. Inoperative GTU Pneumatic Selector Switch — NO LOAD.

9. Inoperative GTU Start Selector Switch — AIR

10. Inoperative GTU Start-Run-Stop Switch — Hold in START.

(See Note on Page 7-16)

Note

The starter motor circuit is bypassed but electrical power is applied to the GTU.

11. Inoperative GTU Augmentation Switch — Hold in INCREASE until 25 to 30 percent rpm is indicated.

12. Inoperative GTU Ignition and Fuel Switch — Push in at 25 to 30 percent rpm; release AUG switch when a rise in EGT is noted.

Note

If the rpm tends to hang and EGT is near the transient limits, momentarily reposition the GTU augmentation switch to INCREASE to assist the unit to accelerate to operational speed.

CAUTION

If EGT does not increase within 5 seconds, pull the GTU ignition and fuel switch OUT and continue to motor the unit at 25 to 30 percent rpm for 30 seconds before allowing the unit to stop. Do this by intermittently positioning the GTU augmentation switch to INCREASE. Another start may be attempted after the unit has stopped. Do not exceed the ignition duty cycle or attempt light-offs above 80 percent rpm. Ignition duty cycle is 2 minutes on, 3 minutes off; 2 minutes on and 23 minutes off.

13. GTU Start-Run-Stop Switch — Release to RUN at 95 percent rpm.

14. GTU Start Selector Switch — NORMAL.

15. Limits — Observe normal starting and operating limits (see Section V).

16. Nacelle Preheat Control Switch — OFF.

17. Augmentation Switch — CLOSED.

Augmentation Start (Engine Bleed Air).

Note

This is the preferred inflight starting procedure.

With two or more aircraft engines operating at high GROUND IDLE or above, perform the following:

1. Jet Blast Rain Removal Switch — OFF.

2. Pneumatic Manifold Switches — OPEN.

3. GTU Pneumatic Selector Switch — NO LOAD.

4. GTU Start Selector Switch — AIR.

5. GTU Air Doors Switch — OPEN.

6. Inoperative GTU Start-Run-Stop Switch — Hold in START.

Note

The starter motor circuit is bypassed but electrical power is applied to the GTU.

7. GTU Augmentation Switch — Hold in INCREASE until GTU speed is 25 to 30 percent rpm.

8. GTU Ignition and Fuel Switch — Push IN at 25 to 30 percent rpm.

Release the GTU augmentation switch when a rise in EGT has been noted.

Note

If the rpm tends to hang and EGT is near the transient limits, momentarily reposition the GTU augmentation switch to INCREASE to assist the unit to accelerate to operational speed.

CAUTION

If EGT does not increase within 5 seconds, pull the GTU ignition and fuel switch OUT and continue to motor the unit at 25 to 30 percent rpm for 30 seconds before allowing the unit to stop. Do this by intermittently positioning the GTU augmentation switch to INCREASE. Another start may be attempted after the unit has stopped. Do not exceed the ignition duty cycle or attempt light-offs above 80 percent rpm. Ignition duty cycle is 2 minutes on, 3 minutes off; 2 minutes on and 23 minutes off.

9. GTU Augmentation Switch — CLOSED.

10. GTU Start-Run-Stop Switch — Release to RUN above 95 percent rpm.

11. GTU Start Selector Switch — NORMAL.

12. Limits — Observe the normal starting and operating limits (see Section V).

Windmill Start (Inflight).

Note

The windmill start procedure may be used if an augmentation valve has malfunctioned (will not open). A windmill start will normally be obtained by using the following technique.

1. GTU Overheat and Fire Control Handles — Check IN.

2. GTU Pneumatic Selector Switch — NO LOAD.

3. GTU Windmilling Speed — Check for desired 12 to 20 percent rpm.

Note

A windmill start can be obtained with a GTU windmilling speed greater than 20 percent rpm, but not normally with a windmilling speed of less than 12 percent rpm.

4. GTU Start Selector Switch — AIR.

5. GTU Air Doors Switch — OPEN.

6. GTU Start-Run-Stop Switch — Hold in START.

7. GTU Ignition and Fuel Switch — Push IN.

CAUTION

If EGT does not rise within 10 seconds, pull the GTU ignition and fuel switch OUT and allow unit to rotate for 60 seconds prior to another attempted start. Do not exceed ignition and coil duty cycle.

Note

If three unsuccessful starts have been attempted, return start controls to shutdown positions.

8. GTU Start-Run-Stop Switch — Release to RUN above 95 percent rpm.

9. GTU Start Selector Switch — NORMAL.

10. Limits — Observe starting and operating limits (see Section V).

LOADING AND AUGMENTATION PROCEDURES.

Loading Procedure — Unaugmented (One or two GTU's).

1. GTU Augmentation Switch — CLOSED.

2. GTU Pneumatic Selector Switch — LOAD.

3. Air Conditioning Switch — AIR CONDITIONING.

Note

Observe that the low EGT light is extinguished as EGT reaches 525° C when changing from a no-load to a load condition.

4. Main and Flight Deck Temperature Controls — NORMAL.

Note

If a GTU exceeds the EGT limit for continuous operation during flight (600°C), use augmentation to reduce EGT to within operating limits.

5. Airflow — 2.0 inches Hg (ground), 1.5 inches Hg (flight).

Augmentation Procedure (One GTU).

1. GTU — LOADED.

See Loading Procedure — Unaugmented

2. Pneumatic Manifold Switches — OPEN.

3. GTU Augmentation Switch — INCREASE.

Note

Hold the GTU augmentation switch in INCREASE until desired airflow for air conditioning requirements is obtained (not to exceed 6.0 inches Hg). If 6.0 inches Hg differential pressure airflow is exceeded during augmentation, erratic operation of the GTU may result. (See Section V for operating limits).

(See Note on Page 7-18)

Note

The low EGT caution light will come on at an EGT of approximately 525° C to indicate that the unit is overaugmented.

Augmentation Procedure (Two GTU's).

1. GTU's — Loaded.

See Loading Procedure — Unaugmented.

2. Pneumatic Manifold Switches — OPEN.

3. GTU Augmentation Switches — Alternately toggle to INCREASE until the desired air conditioning requirements are met and airflow readings for both GTU's are equal.

Note

For maximum ventilation, increase the augmented airflow to both GTU's slowly by alternately toggling each augmentation switch to INCREASE, and note the readings when the differential pressure stops increasing (do not exceed 6.0 inches Hg). Reduce the augmented airflow until the airflow readings decrease slightly. This is the maximum ventilation airflow. With the air conditioning system in full HEATING, the airflow differential pressure should be 4.5 to 6 inches Hg. With the air conditioning system in full COOLING, the airflow differential pressure should be 3.5 to 4.5 inches Hg. If 6.0 inches Hg is exceeded during augmentation, erratic operation of the GTU may result.

NORMAL SHUTDOWN PROCEDURE.

1. GTU Augmentation Switch —CLOSED.
2. GTU Pneumatic Selector Switch — NO LOAD.
3. EGT — STABILIZED.
4. GTU Start-Run-Stop Switch — STOP.

BRAKE SYSTEM.

WHEEL BRAKE OPERATION.

The wheel brakes stop the wheels of the aircraft from turning, but stopping the aircraft is dependent upon the frictional force between the tires and the runway. As the load on the tires becomes greater, this frictional force increases, resulting in more efficient braking action. During a skid, the frictional force is reduced, thus requiring more distance to stop. Extreme care should be used when applying the brakes immediately after touchdown or at any time when there is considerable lift on the wings, to prevent skidding. Heavy brake pedal pressure will lock the wheels much easier, immediately after touchdown, than if the same pressure is applied after the full weight of the aircraft is on the tires. Once locked in this manner immediately after touchdown, a wheel will not become unlocked when the load on the tire increases, as long as brake pedal pressure is maintained. If maximum wheel braking is required, lift should be decreased as much as possible by raising the flaps before applying the brakes. This procedure will improve the braking action, since the load on the tires will be increased, thus increasing the frictional force between the tires and the runway. When a short landing roll is required, a single, smooth application of the brakes with constantly increasing pedal pressure will result in optimum braking. This procedure is also applicable whenever the emergency airbrake system is utilized.

Note

To minimize brake wear, the full length of the runway should be taken advantage of, and aerodynamic braking should be utilized to stop the aircraft. Reverse thrust should be used, whenever possible, in lieu of wheel brakes.

ANTISKID SYSTEM.

The antiskid system is designed to prevent skidding, and is not intended to perform as a completely automatic braking system. Utilizing the antiskid system, the wheel brakes may be applied immediately after touchdown, but this should be done only when absolutely necessary. Heavy, continuous braking from touchdown may result in locked brakes and tire failure if a malfunction of the antiskid system should occur.

Note

The antiskid system is inoperative whenever the emergency airbrake system is used.

BRAKE OVERHEATING.

Temperature rise within the brake assembly after stopping is such that failure of the brake components may result if hard braking applications are repeated without adequate cooling periods. To prevent brake overheating, the brakes should not be dragged while taxiing, and should be used as little as possible for turning the aircraft on the ground. During a series of successive landings, a minimum of 15 minutes should elapse between landings where the landing gear is allowed to remain in the slipstream, and a minimum of 30 minutes between landings where the landing gear has been retracted after each takeoff, to allow adequate cooling time between brake applications. During touch-and-go landings, where no brake application is involved, this time restriction does not apply.

WARNING

At the first indication of brake malfunction, or if the brakes are suspected to be in an overheated condition after excessive use, the aircraft should be maneuvered off the active runway and stopped. The aircraft should not be taxied into a crowded parking area, and the parking brakes should not be set. Overheated wheels and brakes should be allowed to cool before the aircraft is subsequently towed or taxied. Maximum temperatures in the wheel and brake carrier assembly are not attained until some time after a maximum braking operation is completed (the time required may vary from 5 to 30 minutes). In extreme cases, heat buildup can cause the wheel and tire to fail with explosive force or be destroyed by fire if proper cooling is not effected. Taxiing at low speeds to obtain air cooling of overheated brakes will not reduce temperatures adequately, and can actually cause additional heat buildup.

Note

Overheated wheel and brake assemblies may be cooled by means of an air blast from any source available, such as a fan, blower, air compressor (except ground starting unit compressor), ground heater (utilizing blower only, with the heating cycle turned off), etc. Cooling may be accelerated by parking the aircraft perpendicular to any surface wind. Cooling periods, however, should not be reduced.

In the event of fire in the wheel and tire assembly, the fire should be extinguished with a minimum quantity of CB (bromochloromethane).

WARNING

The use of CO_2, water spray, foam, or any similar extinguishing agent, to cool or to extinguish a fire in the wheel and tire assembly is not recommended, as thermal shock can cause the wheel to fail with explosive force. This failure can occur as long as 15 minutes after the use of the above extinguishing agents.

AIR CONDITIONING SYSTEM.

AIR CONDITIONING — NORMAL OPERATION.

The air conditioning system maintains comfortable temperatures in the flight compartment and cabin under most ambient temperature conditions in flight, or on the ground with unaugmented airflow provided by the two GTU's. Automatic or manual control is available. Normally, automatic control should be used to maintain the most satisfactory temperature conditions. Water separators are provided in the ducting systems to the flight deck and cabin which remove up to 50 percent of the entrained free moisture. Water traps are located in the ducting to remove additional moisture. This results in the ventilating airflow containing a minimum of free water.

When the system is turned on, the temperature control switches should be positioned to AUTO and the temperature selectors to NORMAL. This mode of control will stabilize the compartment temperatures at approximately 25°C. If the stabilized temperature is considered too high or too low due to humidity, sunshine, compartment wall temperatures, etc., it may be necessary to reposition the selector. This should be done by rotating the selector knobs in increments of 5°F as marked on the face of the unit. Allow the control system enough time to stabilize (approximately 15 minutes) before determining whether any further adjustment of the selector should be made.

When initially operating the system and rapid cooling or warmup is desired, the temperature control valves should be placed in the maximum heating or cooling positions by using manual control. This can be done by holding the temperature control switches in the manual HEATING or COOLING positions for approximately 2 minutes and then switching to AUTO. During a warmup period, the flight deck temperature may overshoot the desired temperature by several degrees. This is a normal characteristic of the automatic temperature control system during initial operation under severe ambient temperature until sufficient time has elapsed for temperatures to stabilize. The automatic control system will correct this temperature overshoot. However, if the overshoot is unreasonably high, manually correct it by placing the control switches in COOLING for several seconds, and then switch back to AUTO.

AIR CONDITIONING — EXTREME TEMPERATURE OPERATION.

The air conditioning temperature control system will normally provide comfortable compartment temperatures when using the airflow from the GTU's without augmentation. However, during taxiing and while airborne under some extreme ambient temperature conditions, the amount of airflow from the two GTU's, without augmentation, may be insufficient to maintain comfortable temperatures. It will then be necessary to increase the airflow through the air conditioning system by augmenting the GTU's.

During augmented operation, main engine bleed air is allowed to flow into the GTU turbine to sustain combustion. This permits a greater amount of airflow from the GTU compressors to be used in the air conditioning system. Thus, the heating and cooling capacity of the system can be increased. With the system set in AUTO and NORMAL, the cabin temperature indicator should be monitored and GTU augmentation operation established when cabin temperatures are less than 20°C or greater than 30°C. This applies on the ground as well as in flight.

The airflow differential pressure indications for both GTU's should be increased in 2-inch Hg increments at intervals of approximately 20 minutes until the cabin air temperature stabilizes at approximately 25°C, as indicated on the cabin temperature indicator.

Note

> Total airflow indications during augmented GTU operations should not be allowed to exceed 6 inches Hg at any time. Above 6 inches Hg, unstable operation of the GTU may result.

Excessive augmentation airflow can result during augmented GTU operations even though the indicated total airflow from the GTU is less than 6 inches Hg. Excessive augmentation, at any time, is indicated by an EGT of 540°C or below and/or the low EGT caution light which should come on at 525°C. Excessive augmentation can be alleviated by positioning the GTU augmentation control switches to DECREASE until the EGT indication increases above 525°C and the low EGT caution light goes out.

During augmented GTU operations, an increase in cabin pressure of approximately 0.1 psi may occur because of the increased airflow in the air conditioning system. This is a normal condition due to greater airflow through the pressure control valve.

Air Conditioning System Operation — Single GTU.

During air conditioning operations while airborne and with only one GTU as the source of air, maximum augmented GTU operation (4 to 6 inches Hg differential pressure airflow indication) should be utilized for sufficient airflow to provide for temperature control, ventilation, and cabin pressurization. Operation above 6 inches Hg may result in unstable GTU operation.

Air Conditioning System — Emergency.

Airflow for the air conditioning system is provided automatically by main engine bleed air in the event both GTU's become inoperative when the air conditioning system is in operation. There is less airflow available to provide temperature control; however, the pressurization schedule may be maintained with this type of operation.

Note

> An odor may be noticed during operation of the emergency air conditioning system. This odor, a characteristic of main engine bleed air, is nontoxic.

EMERGENCY AIR CONDITIONING CHECK.

Make the emergency air conditioning check as follows:

1. Make certain one or more main engines and both GTU's are operating, the pneumatic manifold switches are open, and the air conditioning system is on.

2. Place the pneumatic selector switch for each GTU in the NO LOAD position. Continued airflow from the air conditioning ducts indicates satisfactory operation of the emergency air conditioning system.

Note

Emergency air conditioning should start automatically through the main engine pneumatic system if both GTU's fail in flight.

N-1 COMPASS SYSTEM.

The information contained in this section is an addition to that contained in Section IV.

MAGNETIC SLAVED OPERATION.

To illustrate the principle of magnetic slaved operation, assume the following conditions.

1. The aircraft is flying a steady course.

2. Latitude Correction Pointer — OFF (system to be functioning in magnetic slaved operation).

3. The master indicator to be set to the correct magnetic heading of the aircraft.

By such assumptions, a change in aircraft heading will result in a change in the azimuth reference signal from the directional gyro. This signal is amplified and fed into the azimuth servo loop, causing the azimuth servo motor of the master indicator to position the master indicator heading pointer to the new heading. This change in heading also results in a change of signal from the DT-173 AJN remote compass transmitter. However, the signals from the directional gyro and the DT-173 AJN remote compass transmitter have been changed an equal amount; therefore, they remain in step and the master indicator heading pointer will indicate the new magnetic heading. The apparent gyro drift (due to the earth's rotation) is an actual factor that must be considered. Its correction is accomplished by slaving the N-1 compass system to the DT-173 AJN remote compass transmitter when in magnetic slaved operation. Now, assume a small change in azimuth of the gyro due to apparent gyro drift, with no actual change in aircraft heading. There will be a change in the directional gyro azimuth reference signal to the azimuth servo loop and motor in the master indicator, resulting in a corresponding movement of the master indicator heading pointer. However, the signal from the DT-173 AJN remote compass transmitter, no longer changing equally with the directional gyro, now incorporates an error signal since the heading pointer of the master indicator no longer indicates the correct magnetic heading of the aircraft. This error signal is transmitted to the motor of the correction loop through the amplifier. The correction servo motor then corrects the signal from the azimuth servo loop and causes the heading pointer of the master indicator to return to its original position, thus indicating the correct magnetic heading of the aircraft once more. The same correction is transmitted to the autopilot signal. Theoretically, with the aircraft maintaining a steady magnetic course, the master indicator heading pointer will not move, since a state of equilibrium will be reached where the drift rate of the gyro spin axis is exactly counteracted by the output rate of the correction servo. The maximum speed of the correction servo loop is ample to compensate for the total gyro drift, which in a properly operating system cannot exceed 15 degrees per hour, yet is sufficiently low to be unresponsive to the effects of shock, vibration and rapid changes in course and speed of the aircraft. To summarize, when the N-1 compass system is in magnetic slaved operation, the master indicator heading pointer is slaved to the DT-173 AJN remote compass transmitter and the system operates as remote indicating magnetic compass with the stability of a directional indicator.

DIRECTIONAL INDICATOR OPERATION.

Assume that the aircraft is flying a steady course. In areas where the magnetic field is unreliable, the method of operation may be changed to directional indicator operation. To accomplish this, manually rotate the latitude correction knob clockwise from the OFF position and set the latitude correction pointer at the latitude of the aircraft's position. This will isolate the DT-173 AJN remote transmitter signal and introduce the latitude correction mechanism signal into the system. The desired gyro heading reference is set by engaging and rotating the synchronizer control knob on the master indicator. The azimuth signal from the directional gyro follows through the azimuth servo loop in the same manner as previously described. Because of the rotation of the earth, the directional gyro spin axis will appear to drift in azimuth. Unless this is corrected, the azimuth pointer on the master indicator will move in the same direction and at the same rate as the apparent drift. An aircraft following a constant gyro heading reference thus will continuously turn away from the great circle course which it is desired to follow. To correct this apparent error, a signal is generated in the latitude correction mechanism which is proportional to the latitude at which the latitude correction pointer has been set. A special electronic circuit uses this signal to regulate the speed of the correction servo motor, causing the azimuth servo loop and the master indicator heading pointer to compensate at the apparent drift rate of the gyro. To summarize, when the N-1 compass system is in directional indicator operation, the system operates as a directional indicator with an arbitrary gyro heading reference, selected by the operator. With the proper latitude setting on the latitude correction indicator, a correction is incorporated equal and opposite to the apparent drift in azimuth of the directional gyro. Assuming a no-wind condition, maintaining a constant gyro reference heading (as indicated by the master indicator heading pointer) will result in the aircraft's flight approximating that of a great circle.

EFFECTS OF ELECTRICAL POWER FAILURE ON THE K-4B ATTITUDE INDICATING SYSTEM.

If a-c power to the K-4B attitude indicating system is interrupted for less than 3 minutes without interruption in d-c power, the errors after reapplication of a-c power normally should not exceed 3 degrees. Such errors will be compensated for within approximately 1 minute by normal erection of the gyro. Changes in aircraft attitude during a-c power interruption will not induce additional errors if d-c power is not interrupted. If d-c power is interrupted at any time, a snubber brake will drop against the roll gimbal, holding it stationary at its position at the time of d-c power loss. If the aircraft attitude is changed, especially about the roll axis, the roll gimbal cannot follow due to the snubber brake; therefore, a precession is forced in the pitch axis. When power is reapplied, the K-4B control will go through a start cycle of 2 minutes (±30 seconds). However, because of the high angular momentum of the gyro wheel, except under conditions described following, the torque motors cannot erect the gyro within the 2-minute (±30 seconds) start cycle. After the starting cycle is complete, the K-4B control will switch to normal erection and the power-off warning flag on the B-1A attitude indicator will disappear, indicating to the pilot that the attitude displayed is correct. However, the pitch indication may be as much as 60 degrees in error at this time, and could result in incorrect indication for as long as 20 minutes. If a-c power to the K-4B gyro is lost for longer than 5 minutes without a d-c power loss, the PILOT VERT GYRO and CO-PILOT VERT GYRO circuit breakers should be positioned to OPEN for at least 20 seconds, then to CLOSE. Then, when a-c power is reapplied, the K-4B gyro will go through its initial erection cycle and the power-off warning flag on the B-1A attitude indicator will disappear within the 2-minute (±30 seconds) start cycle. The indication of the B-1A attitude indicator should be cross-checked with the altimeter, vertical velocity, and turn and slip indicators to determine the accuracy of the indication. If a-c power is lost for period of 3 to 5 minutes without a d-c power loss, the errors should not be excessive; however, when the power-off warning flag on the B-1A attitude indicator goes down, the indication should be cross-checked with the other instruments to determine that the indication is accurate.

Note

As a check, the normal indications achieved by rotation of the horizontal adjustment knob do not assure that roll axis circuitry of the system is also functioning properly.

Note

See Electrical Power-On Check, Section II for daily preflight requirements.

CREW DUTIES SECTION VIII

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TABLE OF CONTENTS

INTRODUCTION.

Except for some repetition necessary for emphasis, clarity, or continuity of thought, this section contains only those duties and procedures that are in addition to the normal operating instructions, Section II, and emergency procedures, Section III. Discussion relative to the operation of certain systems and equipment is covered in Section VII. The duties listed in this section are only a part of those which may be required of the crew members. Special missions will necessitate additional duty assignments which will be detailed during the mission briefing.

INTERPHONE PROCEDURES AND PHRASEOLOGY.

Use of the interphone will be at the pilots' discretion. Circumstances will dictate when the transmission of verbal instructions and/or responses are best satisfied with or without the use of interphone. To implement standard interphone precedures and phraseology, the following will be used during all ground and air operations.

NOMENCLATURE.

In the interest of standardization of crew member identification the following terms will be used.

1. Pilot: The occupant of the left seat in the cockpit, regardless of his position on the crew.

2. Copilot: The occupant of the right seat in the cockpit, regardless of his position on the crew.

Note

> Frequently, during training, the instructor pilot or the student pilot will occupy the right seat; regardless, he will be referred to as copilot.

3. Flight Engineer: The crew member seated at the flight engineer's station.

4. Scanner/Ground Controller: The crew member(s) delegated the responsibility to maintain continuous watch from the cabin of the aircraft and adjacent area during taxiing, runup, and flight, also to maintain continuous watch from outside the aircraft during starting and securing operations. A scanner/ground controller will be stationed in the crew escape hatch during taxiing operations in congested areas.

IDENTIFICATION.

The crew member who is being called will be identified first, followed by the identification of the crew member making the call, for example: Flight engineer from pilot.

SEQUENCE.

Crew members will always state the unit to be actuated first, then followed by the action to be taken, for example: gear — UP; flaps — FIFTEEN DEGREES; torque — TWO ONE.

TERMINOLOGY.

In the interest of clarity and comprehension, the terminologies contained in this publication will be used as applicable.

ACKNOWLEDGEMENT.

Prior to execution, every command will be repeated by the receiver to insure proper understanding of the transmission. An exception to the above rule may be made during the final approach on a GCA letdown; here, the pilot may direct the other crew members not to acknowledge his commands in order to prevent interphone transmissions from interfering with the GCA controller's transmissions. In this situation, if the command is not clearly understood, the copilot will request that the command be repeated, stating, "Say again;" the pilot will then repeat his original transmission. After initial contact has been established, it is not necessary during subsequent transmissions (in the same conversation) to identify the crew member being called.

PILOT.

It will be the responsibility of the pilot to insure that a thorough inspection of the aircraft and all equipment is properly conducted in sufficient time prior to departure in order to permit correction of any discrepancies without incurring delays. The pilot will ascertain that all items of bailout, ditching, and survival equipment are aboard.

COPILOT.

The copilot will assist the pilot, as directed, in order to accomplish the assigned mission.

FLIGHT ENGINEER.

The flight engineer will perform the complete aircraft visual inspection prior to departure and determine if the aircraft condition is satisfactory for the assigned mission. The flight engineer will report the condition of the aircraft and the equipment to the pilot.

NAVIGATOR.

The navigator will complete the following preflight duties and report readiness of his equipment to the pilot. He will aid the pilot in all matters pertaining to flight planning and will perform any other duties assigned.

PREFLIGHT CHECK.

Power Off.

1. Form 781 — CHECKED.

Check Form 781 for write-ups pertaining to navigation equipment, navigator's station, etc.

2. Navigation and Radio Publications — CHECKED.

Check for currency, completeness, and condition of FLIP's. Check Air Almanac, HO 249's, appropriate maps and charts, and route briefing material, as required.

3. Periscopic Sextant — CHECKED.

Check periscopic sextant for cleanliness and general condition. (See Section IV.)

4. Altimeter — CHECKED.

Set altimeter to field barometric pressure and check for field elevation (±75 feet).

5. Standby and N-1 Compasses — CHECKED.

Check for presence of calibration cards. (See Section IV.)

6. Clocks — SET.

Set pilots' and navigator's clocks to correct time (Greenwich or Local, as appropriate).

7. Circuit Breakers — CHECKED.

Check navigation equipment circuit breakers for being in the CLOSED position.

Power On.

1. Oxygen Equipment —CHECKED.

Connect oxygen mask and check for operation, pressure, and illumination of indicator.

2. N-1 Compass — CHECKED.

See N-1 Compass System Preflight, Section IV.

3. LORAN — CHECKED.

See Long-Range Navigation (LORAN) Equipment, Section IV.

4. Table and Dome Lights — CHECKED.

Check table and dome lights for proper operation.

5. Radio Altimeter — CHECKED.

See Radio Altimeter System — High Range, Section IV.

6. Search Radar (AN/APN-59) — CHECKED.

If Form 781 indicates that preflight has not been accomplished on search radar equipment, perform an operational check in accordance with Section IV.

7. Periscopic Sextant and Mount — CHECKED.

Check installation of periscopic sextant and alignment of mount in accordance with Section IV.

8. Navigator's Preflight Check — COMPLETED.

BEFORE STARTING ENGINES.

① Oxygen Equipment — CHECKED.

2. Lights — AS REQUIRED.

BEFORE TAXIING.

① Altimeter and Flight Instruments — (State Altimeter Setting) SET & CHECKED.

② IFF —STANDBY.

BEFORE TAKEOFF.

① Altimeter — STATE SETTING.

2. Radio Altimeter and Radar — ON & SET.

   a. Radio Altimeter — ON.

   b. Search Radar (AN/APN-59) — AS REQUIRED.

③ Seat Belt — "FASTENED."

④ IFF — NORMAL.

Set to proper mode and code as briefed.

⑤ Navigator's Report — "NAVIGATOR'S BEFORE TAKEOFF CHECK COMPLETED."

AFTER TAKEOFF-CLIMB.

1. IFF — CHECKED.

Note

As soon after takeoff as flight conditions permit, positive operation of the IFF should be established with an Air Traffic Control Facility if the route will require an operative IFF. Consult appropriate FLIP documents for IFF/SIF traffic control requirements and procedures.

DESCENT.

① Altimeter — STATE SETTING.

2. Radio Altimeter — ON.

3. Search Radar (AN/APN-59) — AS REQUIRED.

4. Periscopic Sextant — STOWED.

⑤ Seatbelt — "FASTENED."

⑥ Approach Minimums — CHECKED.

Check appropriate FLIP for planned approach minimums.

6A. IFF — CHECKED.

⑦ Navigator's Report — "NAVIGATOR'S DESCENT CHECK COMPLETED."

AFTER LANDING.

1. Radio Compass — OFF.

2. LORAN — OFF.

3. Radios, Radio Altimeter, Radar, and IFF — OFF.

4. Navigation Equipment and Publications — STOWED.

5. Form 781 — COMPLETED.

Enter equipment discrepancies in Form 781-2.

6. Lights — OFF.

⑦ Navigator's Report — "NAVIGATOR'S AFTER LANDING CHECK COMPLETED."

BAILOUT.

For bailout information, see Section III.

LOADMASTER.

The degree of cargo load preplanning necessary will vary with the amount and variety of cargo to be loaded. There are, however, certain factors which must be considered in preplanning all cargo loads. These factors are: aircraft center of gravity, unit load on the cargo floor, cargo physical characteristics, cargo restraint, cargo loading aids, loading sequence, and aircraft preparation. For specific loadmaster duties, refer to *T.O. 1C-133A-9.*

PRIOR TO LOADING.

In addition to those duties outlined in *T.O. 1C-133A-9,* the loadmaster will perform the following:

1. Load Jacks — IN PLACE.

2. Form 781 — CHECKED.

3. Emergency Equipment — CHECKED.

Check against fleet service issue slip.

4. Survival Equipment — CHECK.

Check condition, adequacy for mission, and proper stowage.

5. Galley — CHECKED.

Check cleanliness of hotcups, beverage containers, oven, and waste containers.

6. Latrine — CHECK FOR CLEANLINESS.

7. Water Tank — CLIMATIC.

8. Safety Nets — STOWED.

9. Tiedown Equipment — CHECKED.

Check straps, cables, chains, and tiedown rings for condition and quantity.

10. Winching Equipment — CHECK.

Check general condition and proper installation.

11. Special Loading Equipment — CHECK; as required.

12. Loadmaster Kit — COMPLETE.

13. Prior To Loading Check — COMPLETED.

AFTER LOADING.

1. Ramp Toes — STOWED IN PROPER POSITION.

2. Aft Cargo Door — CLOSED and LOCKED.

3. Rear Cargo Doors and Ramp — CLOSED and LOCKED.

4. Rear Cargo Door and Ramp Control Panel — CHECKED.

Observe normal operation placard adjacent to panel.

5. Side Cargo Door Control Panel — CHECKED.

Observe placarded instructions located on panel.

6. Side cargo door – CLOSED, LOCKED, AND PINS INSTALLED.

7. Sheaves — STOWED.

8. Loose Equipment — SECURED.

9. Cargo and Manifest — LOADED and CHECKED.

10. Inflight Lunches and Beverages — ABOARD.

Check that sufficient quantity are aboard and stowed.

11. Sanitary Bags, Paper Towels, Cups and Spoons — CHECK THAT SUFFICIENT QUANTITY IS ABOARD.

12. Cabin Escape Ladder — INSTALLED.

13. Load Jacks — PROPERLY STOWED.

14. After Loading Check — COMPLETED.

BEFORE TAKEOFF.

1. Cargo Tiedown — CHECKED SECURE.

2. Smoking — PROHIBITED DURING GROUND OPERATION AND TAKEOFF.

Inform passengers and/or loading crew that smoking is prohibited during ground operation and takeoff.

3. Loose Equipment — SECURED.

4. Oxygen Equipment — CHECKED.

5. Seat Belt — FASTENED.

Assume position for takeoff.

6. Before Takeoff Check — COMPLETED.

DURING FLIGHT.

Prepare precomputation sheet if aircraft is to be loaded at next point of landing, and perform other duties as directed by the pilot.

DESCENT.

1. Cargo Tiedown — CHECKED SECURE.

2. Latrine — CHECKED FOR CLEANLINESS.

3. Aircraft — CHECKED FOR CLEANLINESS.

4. Precomputation Sheet — COMPLETE.

Brief pilot on precomputation sheet if aircraft is to be loaded.

5. Seat Belt — FASTENED.

Assume position for landing.

6. Descent Check — COMPLETED.

LANDING — INTERMEDIATE STOP.

1. Mission Report — COMPLETED.

2. Manifests — COMPLETED.

LANDING — DESTINATION.

1. Preplanning Of Off-Loading — COMPLETE.

2. Manifests — COMPLETE.

Retain a signed copy of the manifests.

3. Cargo Off-Loading — CHECKED.

Check that all cargo is off-loaded, as required.

4. Inventory of Equipment — COMPLETED.

After off-loading of cargo is completed, check equipment for condition and quantity.

5. Aircraft — CHECKED FOR CLEANLINESS.

6. Form 781 — COMPLETED AS REQUIRED.

7. Loadmaster Forms — COMPLETED AS REQUIRED.

8. Landing Check — COMPLETED.

BAILOUT.

For bailout information, see Section III.

SCANNER/GROUND CONTROLLER.

Normally, the flight engineer not making the takeoff will act as scanner/ground controller. While on the ground, he will be referred to as the ground controller. When in the aircraft, he will be called the scanner. The scanner/ground controller will accomplish the following:

a. Assist the flight engineer in a complete preflight inspection prior to starting engines.

b. Act as ground controller during engine starts, clearing engines; removing chocks and removing and stowing landing gear safety pins when directed by the pilot.

c. Observe engine runup and report any evidence of engine malfunction to the pilot or flight engineer.

d. Observe aircraft and engines for evidence of fuel leaks or malfunctions before takeoff and during climb. Report observations to the pilot or flight engineer.

e. Maintains periodic observation of the wings, engines, and control surfaces throughout the flight.

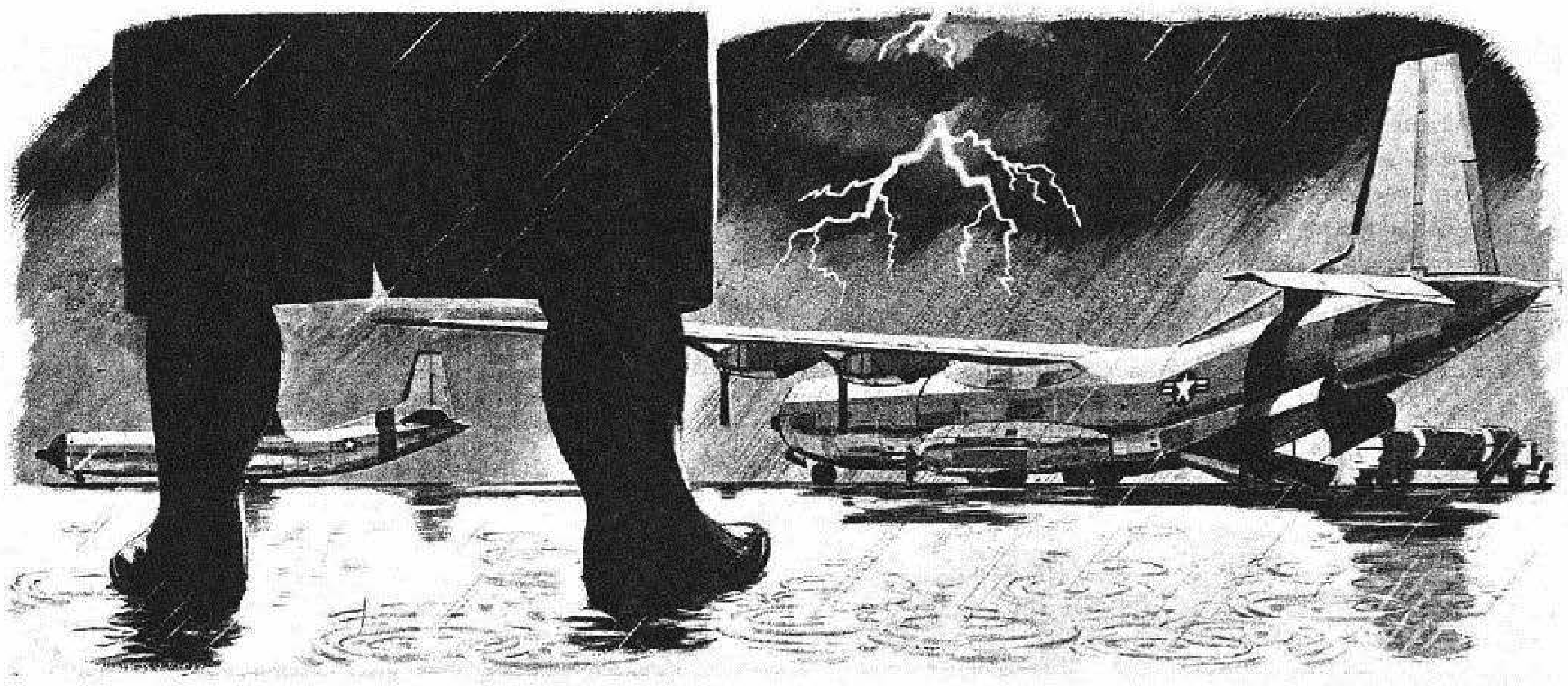
f. Assist the loadmaster to insure that passengers, cargo, and equipment are secure prior to takeoff and landing.

g. Act as ground controller during securing of aircraft.

h. Perform other duties as directed by the pilot.

BAILOUT.

For bailout information, see Section III.



ALL WEATHER OPERATION SECTION IX

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TABLE OF CONTENTS

INTRODUCTION.

This section contains only those procedures that are in addition to the normal operating instructions contained in Section II, and emergency procedures in Section III, except where repetition is necessary for emphasis, clarity, or continuity of thought. Operation of the various aircraft systems is covered in Sections IV and VII. Basic information concerning instrument techniques is not covered in this manual. This manual contains only special information applicable to the aircraft.

INSTRUMENT FLIGHT PROCEDURES

The handling of the aircraft and all flight characteristics are normal and satisfactory while being flown under instrument conditions. The aircraft is provided with normal instrumentation and navigational equipment allowing the use of such navigational aids as radio range, ADF, VOR, TACAN, ILS, and automatic autopilot approach. Equipment is available for DF, radar surveillance and ground controlled approach procedures.

There is no effect on range during operation under instrument conditions other than the decrease that may be expected when necessary to use ice protection measures or reduced speed as outlined in the following procedures for ice and rain or turbulence and thunderstorms.

INSTRUMENT TAKEOFF.

Preflight Planning For Takeoff.

Preplanning for an instrument takeoff should include the possibility of return to field, and suitable precautions should be taken, including the monitoring of departure by radar. Special attention should be paid to checking all radios and flight instruments for proper operation and aligning the aircraft on the centerline of the runway to insure that the directional indicator coincides with the runway heading. If channelization to departure control has not been initiated before takeoff, do not accomplish until 1000 feet of altitude is attained.

Taxiing

Complete the Taxiing check, Section II, paying particular attention to the operation of the magnetic compass, N-1 compass, directional indicators and turn and slip indicators during turns.

Takeoff.

1. On receiving clearance for takeoff, align the aircraft on the centerline of the runway.
2. Check and set attitude indicators.
3. Cross check directional indicators with magnetic compass and set pointers.
4. Reset altimeter and note instrument error.
5. Set aircraft configuration for normal takeoff.
6. After release of brakes, maintain directional control with rudder pedal steering and proceed as for normal takeoff. Heading is maintained by use of directional indicator, however, a cross check of the runway lights should be made to assist in maintaining a heading.

INSTRUMENT CLIMB.

Normal climbing turns should be limited to 30-degrees bank angle.

CRUISING DURING INSTRUMENT FLIGHT CONDITIONS.

The aircraft should be handled in the same manner under instrument conditions as under VFR conditions.

WARNING

Due to penetration of radio and radar waves in deep snow or ice, terrain clearance errors of as much as 1600 feet greater than actual clearance have been recorded when operating over deep snow or ice fields. Do not rely on the SCR-718 radio altimeter or the AN/APN-22 radar altimeter to provide accurate terrain clearance information when flying over areas covered by large depths of snow and ice.

DESCENT PROCEDURE.

To descend from altitude, use the same procedure as for Descent, Section II, plus the necessary precautions during icing conditions. Charts showing descents are included in Part 7 of *T.O. 1C-133A-1-1.*

HOLDING.

Holding will normally be accomplished in a clean configuration at 140 percent of power off stall. For maximum endurance, see Maximum Endurance Summary charts, part 6 of *T.O. 1C-133A-1-1.*

Note

Maximum endurance airspeeds are not recommended for holding patterns due to incresaed power required in turns.

INSTRUMENT APPROACHES.

WARNING

On aircraft without T.C.T.O. 517, turn the TACAN set OFF during a VOR or ILS approach. This will prevent automatic switchover to TACAN in the event of VOR or ILS power failure.

Penetration Procedure.

The recommended penetration procedure *(figure 9-1)* is to maintain initial penetration altitude and complete the Descent check, Section II, while approaching the fix. When over the fix, retard power to FLIGHT

IDLE and establish descent at the desired airspeed, keeping the configuration clear. Observe Mach number and airspeed limitations. Start penetration turn as published. At approximately 1500 feet above minimum altitude inbound, reduce the rate of descent to 500 feet per minute, descend to published minimum altitude inbound, reduce airspeed to 1.4 V_S, and prepare for desired approach.

Note

Care should be taken when operating at penetration airspeeds to avoid sideslipping maneuvers which could exceed the design limits of the aircraft.

VOR, ADF or Range Approach Procedure.

For typical VOR, ADF or Range approach procedure, see figures 9-2 and 9-3. For operation of the autopilot on VOR approach proceed as follows:

1. Omni (VHF NAV) Power Switch — ON.
2. AN/ARN-14 Receiver—Desired range frequency.
3. VOR-ILS/TACAN Selector Switch — VOR/ILS.
4. AUT. PILOT Switch — ON.
5. Altitude Control Switch — ON (if desired).
6. ID-351 Widow — Set heading of radial to be tracked.
7. LOC-VOR Switch — ON (bank stick steering inoperative).
8. Over Station Operation—Turn LOC-VOR switch off during pointer oscillations over station.

The autopilot may be disengaged and manual approach continued at the discretion of the pilot. To discontinue autopilot VOR operation:

1. LOC-VOR Switch — OFF.

TACAN Approach Procedure.

WARNING

Accasionally TACAN equipment will "Lock-On" to a false bearing which will be 40 degrees or a multiple of 40 degrees 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.

When using TACAN, cross check for false lock-on with ground radar, airborne radar, VOR, dead reckoning or other available means. These checks are especially important when switching channels or when turning the set on. When false lock-on is suspected follow procedure outlined in TACAN Operation, section IV, for recycling the TACAN search mode.

Note

A false lock-on does not affect the DME display provided by the TACAN equipment.

For typical TACAN approach procedures see figures 9-4 and 9-5. Operation of the autopilot for TACAN approach is the same as for VOR approach except that the AN/ARN-21 receiver is set to the desired frequency and the VOR-ILS/TACAN selector switch is positioned to TACAN.

GCA Approach Procedures.

For typical GCA approach procedures see figures 9-6 and 9-7.

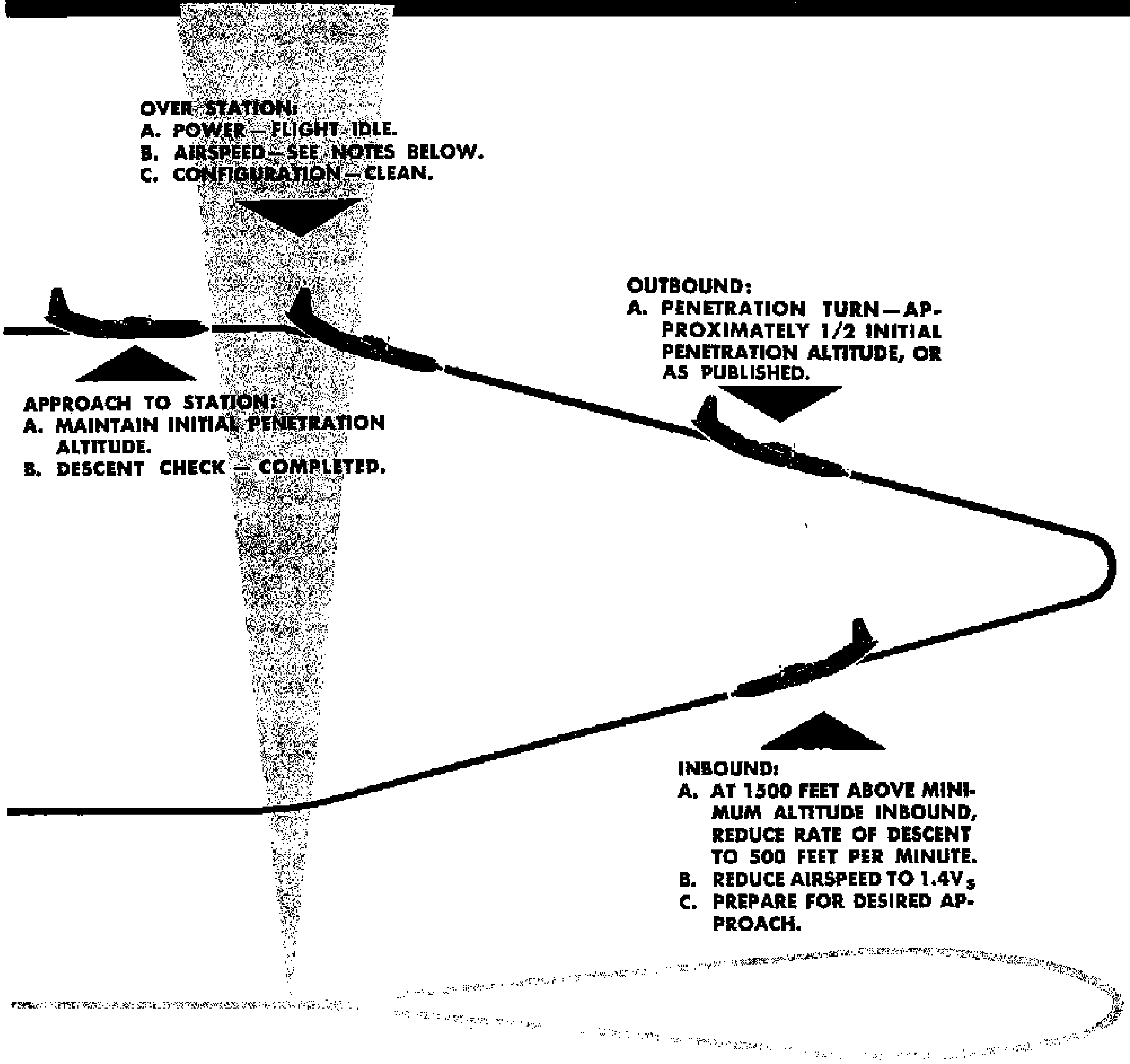
ILS Approach Procedures.

For typical ILS approach procedures, see figures 9-8 and 9-9. For a normal four- or three-engine manual ILS approach proceed as follows:

1. Inbound.
    a. AN/ARN-14 Power Switch — ON.
    b. AN/ARN-14 Receiver — Desired ILS frequency.
    c. ID-351 Window — Set published heading of ILS.
    d. Altitude—Cruising or minimum enroute instrument altitude, whichever is higher.
    e. Descent Checks — Completed.
2. Approaching Outer Marker.
    a. Airspeed — Reduce. Approximately 3 minutes prior to crossing outer marker, start reducing airspeed to 1.4V_S.

(Continued on Page 9-14)

Recommended Penetration Procedure



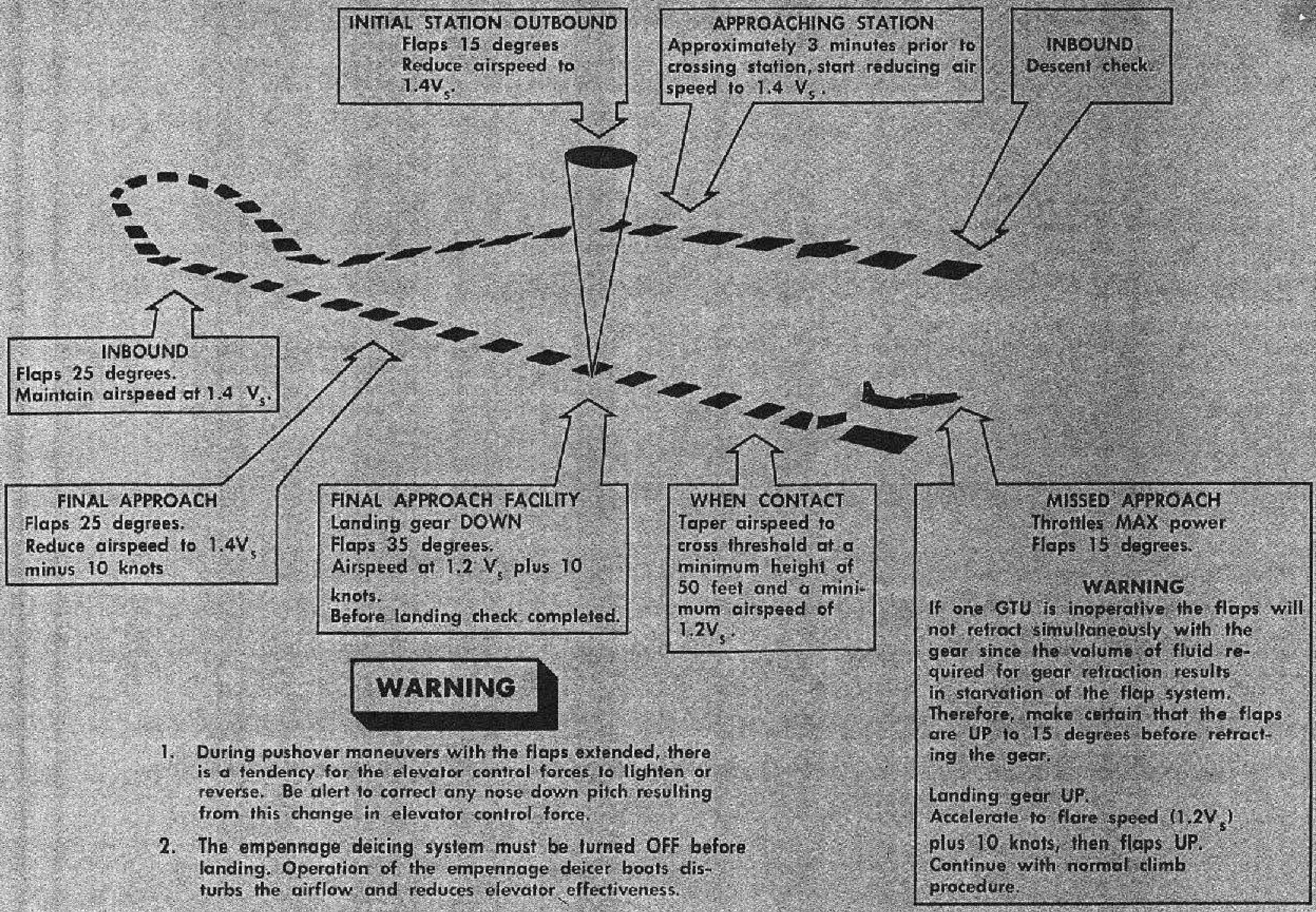
Notes:

1. Do not exceed maximum dive speed (see Section V).
2. See Part 7 of T.O. 1C-133A-1-1 for variations in the descent performance.
3. Due to present aircraft limitations, a Standard Jet Penetration of 250 knots and 4000 feet per minute rate of descent cannot be accomplished; therefore, modification of initial penetration altitude and/or procedure turn clearance limits will be coordinated with Air Traffic Control.

UA81-195

Figure 9-1

ADF, VOR, or Range Procedures — Four or Three-Engine — Typical



INITIAL STATION OUTBOUND
Flaps 15 degrees
Reduce airspeed to $1.4V_s$.

APPROACHING STATION
Approximately 3 minutes prior to crossing station, start reducing air speed to $1.4\ V_s$.

INBOUND
Descent check.

INBOUND
Flaps 25 degrees.
Maintain airspeed at $1.4\ V_s$.

FINAL APPROACH
Flaps 25 degrees.
Reduce airspeed to $1.4V_s$ minus 10 knots

FINAL APPROACH FACILITY
Landing gear DOWN
Flaps 35 degrees.
Airspeed at $1.2\ V_s$ plus 10 knots.
Before landing check completed.

WHEN CONTACT
Taper airspeed to cross threshold at a minimum height of 50 feet and a minimum airspeed of $1.2V_s$.

MISSED APPROACH
Throttles MAX power
Flaps 15 degrees.

WARNING

If one GTU is inoperative the flaps will not retract simultaneously with the gear since the volume of fluid required for gear retraction results in starvation of the flap system. Therefore, make certain that the flaps are UP to 15 degrees before retracting the gear.

Landing gear UP.
Accelerate to flare speed ($1.2V_s$) plus 10 knots, then flaps UP.
Continue with normal climb procedure.

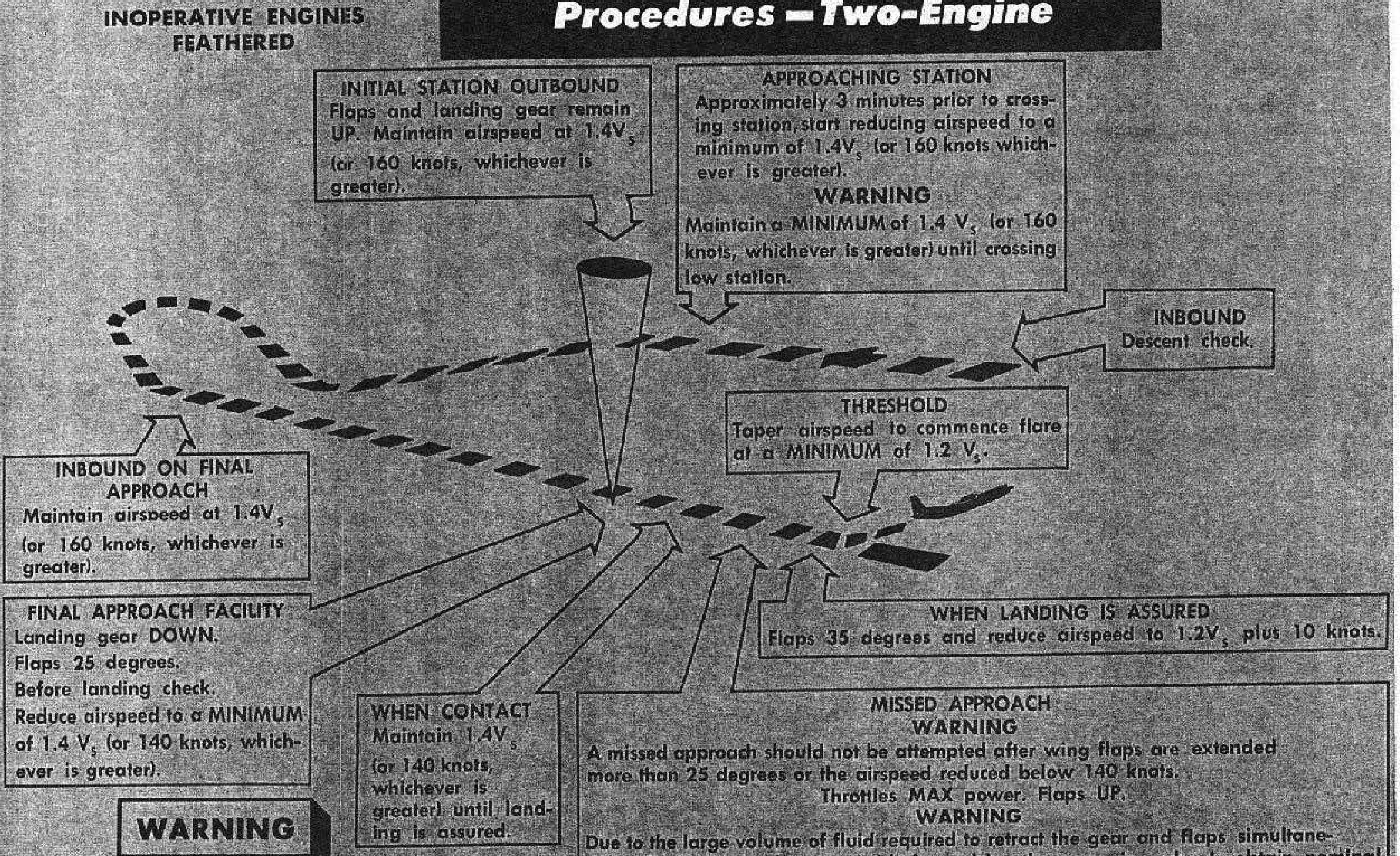
WARNING

1. During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.
2. The empennage deicing system must be turned OFF before landing. Operation of the empennage deicer boots disturbs the airflow and reduces elevator effectiveness.

UAB1-131

Figure 9-2

ADF, VOR, or Range Emergency Procedures — Two-Engine



INOPERATIVE ENGINES FEATHERED

INITIAL STATION OUTBOUND
Flaps and landing gear remain UP. Maintain airspeed at 1.4V$_s$ (or 160 knots, whichever is greater).

APPROACHING STATION
Approximately 3 minutes prior to crossing station, start reducing airspeed to a minimum of 1.4V$_s$ (or 160 knots whichever is greater).

WARNING

Maintain a MINIMUM of 1.4 V$_s$ (or 160 knots, whichever is greater) until crossing low station.

INBOUND
Descent check.

THRESHOLD
Taper airspeed to commence flare at a MINIMUM of 1.2 V$_s$.

INBOUND ON FINAL APPROACH
Maintain airspeed at 1.4V$_s$ (or 160 knots, whichever is greater).

FINAL APPROACH FACILITY
Landing gear DOWN.
Flaps 25 degrees.
Before landing check.
Reduce airspeed to a MINIMUM of 1.4 V$_s$ (or 140 knots, whichever is greater).

WHEN CONTACT
Maintain 1.4V$_s$ (or 140 knots, whichever is greater) until landing is assured.

WHEN LANDING IS ASSURED
Flaps 35 degrees and reduce airspeed to 1.2V$_s$ plus 10 knots.

MISSED APPROACH

WARNING

A missed approach should not be attempted after wing flaps are extended more than 25 degrees or the airspeed reduced below 140 knots.

Throttles MAX power. Flaps UP.

WARNING

Due to the large volume of fluid required to retract the gear and flaps simultaneously, the flaps must be retracted before raising the gear, in order to obtain nominal flap retraction time.

Landing gear UP. Maintain airspeed at 140 knots

NOTE: 140 knots is a nominal flaps up best climb speed for a gross weight range of 160,000 to 200,000 pounds, and is based on a compromise between the best climb speed and the speed for the best angle of climb.

WARNING

1. During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.
2. The empennage deicing system must be turned OFF before landing. Operation of the empennage deicer boots disturbs the airflow and reduces elevator effectiveness.

UAB1-132

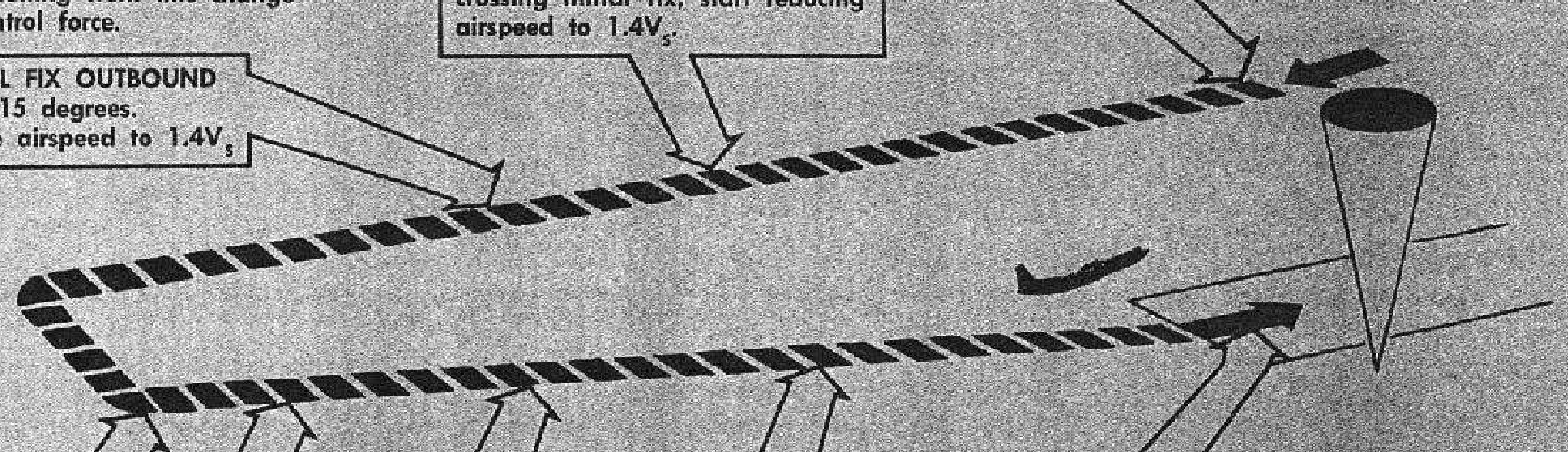
Figure 9-3

TACAN Approach Procedure

FOUR-OR THREE-ENGINE—TYPICAL

WARNING

During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.



INITIAL FIX OUTBOUND
Flaps 15 degrees.
Reduce airspeed to $1.4V_s$

APPROACHING INITIAL FIX
Approximately 3 minutes prior to crossing initial fix, start reducing airspeed to $1.4V_s$.

INBOUND
Descent check.

INBOUND
Flaps 25 degrees.
Maintain airspeed at $1.4V_s$.

FINAL APPROACH
Flaps 25 degrees.
Reduce airspeed to $1.4V_s$ minus 10 knots.

GATE
Landing gear DOWN.
Flaps 35 degrees.
Airspeed at $1.2V_s$ plus 10 knots.
Before landing check completed.

WARNING

The empennage deicing system must be turned OFF before landing. Operation of the deicer boots disturbs the airflow and reduces elevator effectiveness.

WHEN CONTACT
Taper airspeed to cross threshold at a minimum height of 50 feet and a minimum airspeed of $1.2V_s$.

MISSED APPROACH
Throttle MAX power.
Flaps 15 degrees.

WARNING

If one GTU is inoperative the flaps will not retract simultaneously with the gear since the volume of fluid required for gear retraction results in starvation of the flap system. Therefore, make certain that the flaps are UP to 15 degrees before retracting the gear.

Landing gear UP.
Accelerate to flare speed ($1.2V_s$) plus 10 knots, then flaps UP.
Continue with normal climb procedure.

UAB1-137

Figure 9-4

TACAN Approach Emergency Procedure — Two-Engine

WARNING

During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.

INOPERATIVE ENGINES FEATHERED

APPROACHING INITIAL FIX

Approximately 3 minutes prior to crossing initial fix, start reducing airspeed to a minimum of $1.4V_s$ (or 160 knots, whichever is greater).

WARNING

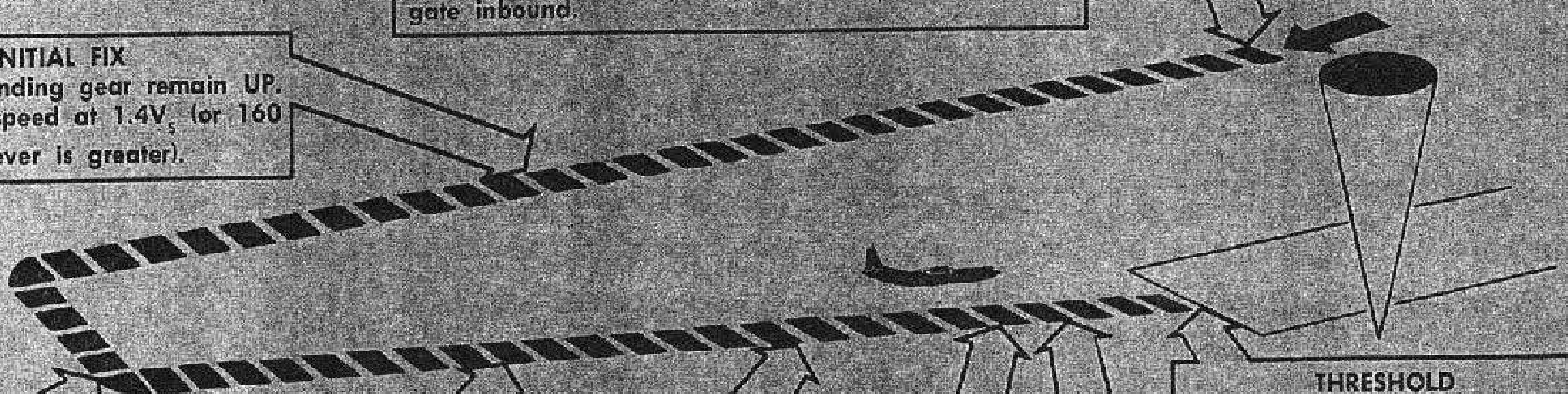
Maintain a MINIMUM airspeed of $1.4V_s$ (or 160 knots, whichever is greater) until crossing the gate inbound.

INBOUND

Descent check.

INITIAL FIX

Flaps and landing gear remain UP. Maintain airspeed at $1.4V_s$ (or 160 knots, whichever is greater).



THRESHOLD

Taper airspeed to commence flare at a MINIMUM airspeed of $1.2V_s$.

INBOUND ON FINAL APPROACH

Maintain airspeed at $1.4V_s$ (or 160 knots, whichever is greater).

WHEN CONTACT

Maintain airspeed at $1.4V_s$ (or 140 knots, whichever is greater) until landing is assured.

WHEN LANDING IS ASSURED

Flaps 35 degrees and reduce airspeed to $1.2V_s$ plus 10 knots.

GATE

Landing gear DOWN. Flaps 25 degrees. Before Landing check. Reduce airspeed to a minimum of $1.4V_s$ (or 140 knots, whichever is greater).

WARNING

The empennage deicing system must be turned OFF before landing. Operation of the empennage deicer boots disturbs the airflow and reduces elevator effectiveness.

MISSED APPROACH

WARNING

A missed approach should not be attempted after wing flaps are extended more than 25 degrees or the airspeed reduced below 140 knots.

Throttles MAX power.

Flaps UP.

WARNING

Due to the large volume of fluid required to retract the gear and flaps simultaneously, the flaps must be retracted before raising the gear, in order to obtain nominal flap retraction time.

Landing gear UP. Maintain airspeed at 140 knots.

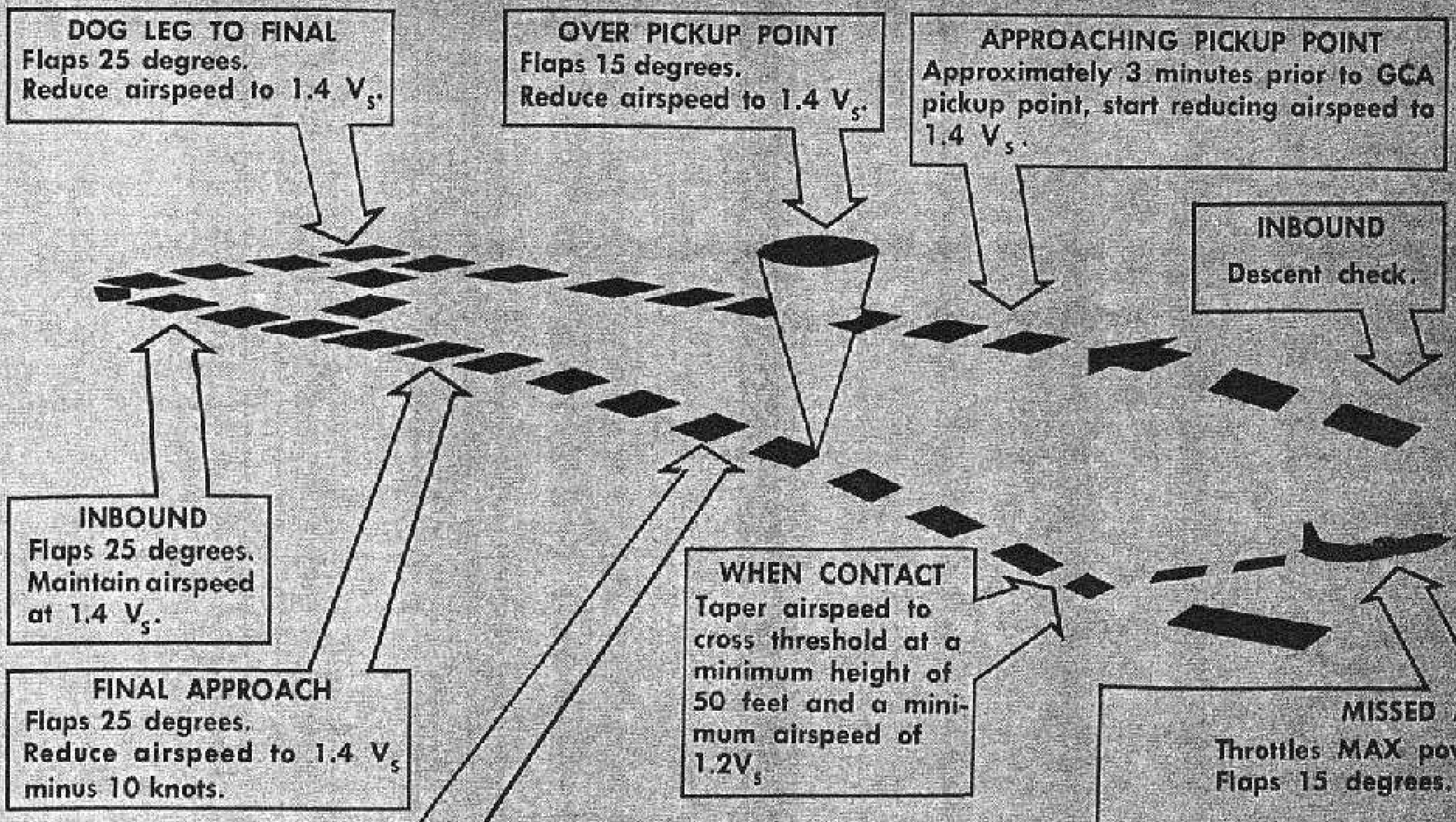
NOTE

140 knots is a nominal flaps up best climb speed for a gross weight range of 160,000 to 200,000 pounds, and is based on a compromise between the best climb speed and the speed for the best angle of climb.

UAB1-13B

Figure 9-5

GCA Procedure-Four-or Three-Engine — Typical



DOG LEG TO FINAL
Flaps 25 degrees.
Reduce airspeed to 1.4 V_s.

OVER PICKUP POINT
Flaps 15 degrees.
Reduce airspeed to 1.4 V_s.

APPROACHING PICKUP POINT
Approximately 3 minutes prior to GCA pickup point, start reducing airspeed to 1.4 V_s.

INBOUND
Descent check.

INBOUND
Flaps 25 degrees.
Maintain airspeed at 1.4 V_s.

FINAL APPROACH
Flaps 25 degrees.
Reduce airspeed to 1.4 V_s minus 10 knots.

WHEN CONTACT
Taper airspeed to cross threshold at a minimum height of 50 feet and a minimum airspeed of 1.2V_s

PRIOR TO ENTERING GLIDESLOPE
(Approximately 10 seconds)
Landing gear DOWN.
Flaps 35 degrees
Airspeed at 1.2V_s plus 10 knots.
Before landing check completed.

WARNING

1. During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.
2. The empennage deicing system must be turned OFF before landing. Operation of the empennage deicer boots disturbs the airflow and reduces elevator effectiveness.

MISSED APPROACH
Throttles MAX power.
Flaps 15 degrees.

WARNING

If one GTU is inoperative the flaps will not retract simultaneously with the gear since the volume of fluid required for gear retraction results in starvation of the flap system. Therefore, make certain that the flaps are UP to 15° before retracting the gear.

Landing gear UP.

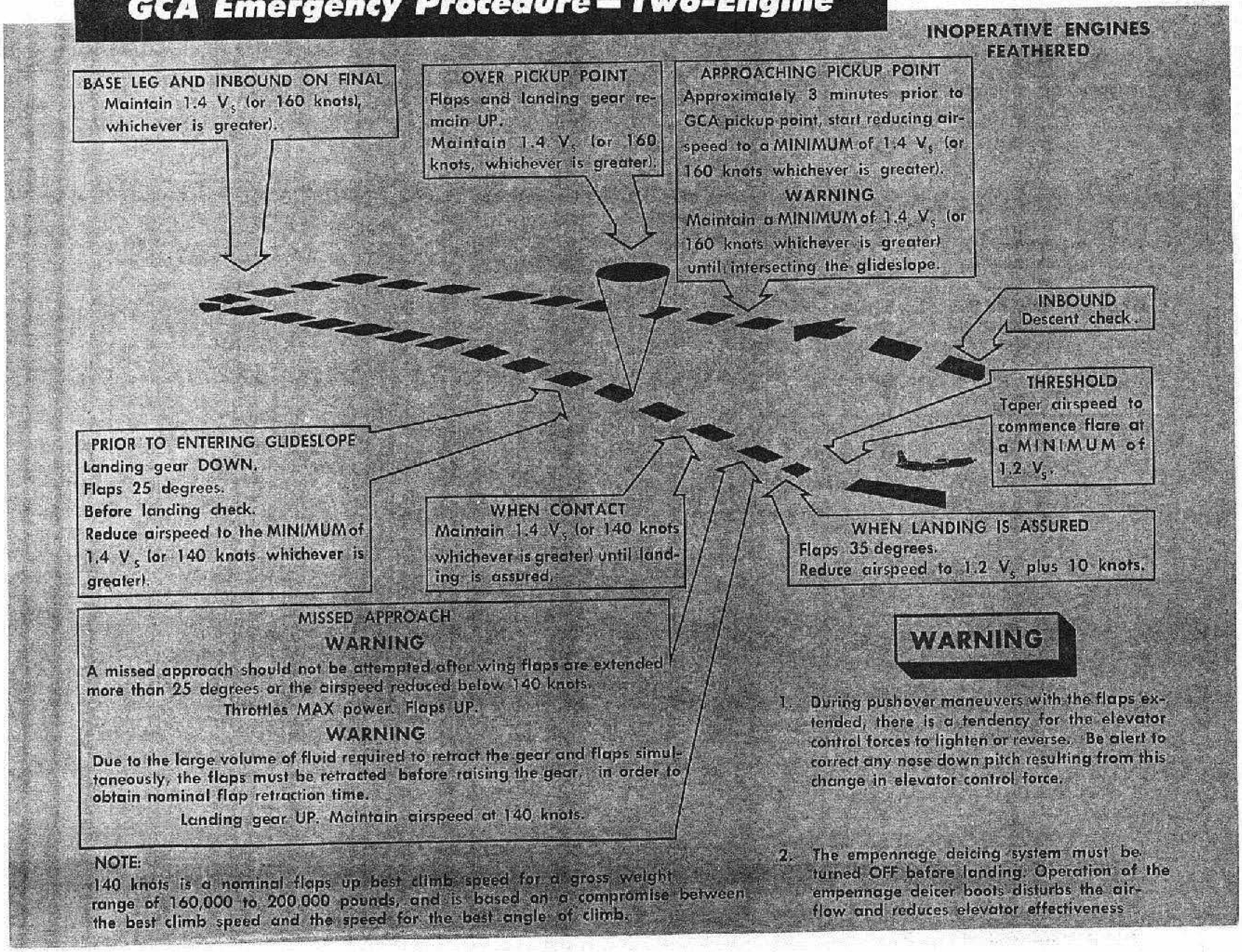
Accelerate to flare speed (1.2V_s) plus 10 knots, then flaps UP.

Continue with normal climb procedures.

Figure 9-6

UAB1-133

GCA Emergency Procedure — Two-Engine



BASE LEG AND INBOUND ON FINAL
Maintain 1.4 V_s (or 160 knots), whichever is greater).

OVER PICKUP POINT
Flaps and landing gear remain UP.
Maintain 1.4 V_s (or 160 knots, whichever is greater).

APPROACHING PICKUP POINT
Approximately 3 minutes prior to GCA pickup point, start reducing airspeed to a MINIMUM of 1.4 V_s (or 160 knots whichever is greater).

WARNING

Maintain a MINIMUM of 1.4 V_s (or 160 knots whichever is greater) until intersecting the glideslope.

INBOUND
Descent check.

THRESHOLD
Taper airspeed to commence flare at a MINIMUM of 1.2 V_s.

PRIOR TO ENTERING GLIDESLOPE
Landing gear DOWN.
Flaps 25 degrees.
Before landing check.
Reduce airspeed to the MINIMUM of 1.4 V_s (or 140 knots whichever is greater).

WHEN CONTACT
Maintain 1.4 V_s (or 140 knots whichever is greater) until landing is assured.

WHEN LANDING IS ASSURED
Flaps 35 degrees.
Reduce airspeed to 1.2 V_s plus 10 knots.

MISSED APPROACH

WARNING

A missed approach should not be attempted after wing flaps are extended more than 25 degrees or the airspeed reduced below 140 knots.

Throttles MAX power. Flaps UP.

WARNING

Due to the large volume of fluid required to retract the gear and flaps simultaneously, the flaps must be retracted before raising the gear, in order to obtain nominal flap retraction time.

Landing gear UP. Maintain airspeed at 140 knots.

WARNING

1. During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.

2. The empennage deicing system must be turned OFF before landing. Operation of the empennage deicer boots disturbs the airflow and reduces elevator effectiveness

NOTE:
140 knots is a nominal flaps up best climb speed for a gross weight range of 160,000 to 200,000 pounds, and is based on a compromise between the best climb speed and the best angle of climb.

UAB1-134

Figure 9-7

ILS Procedure

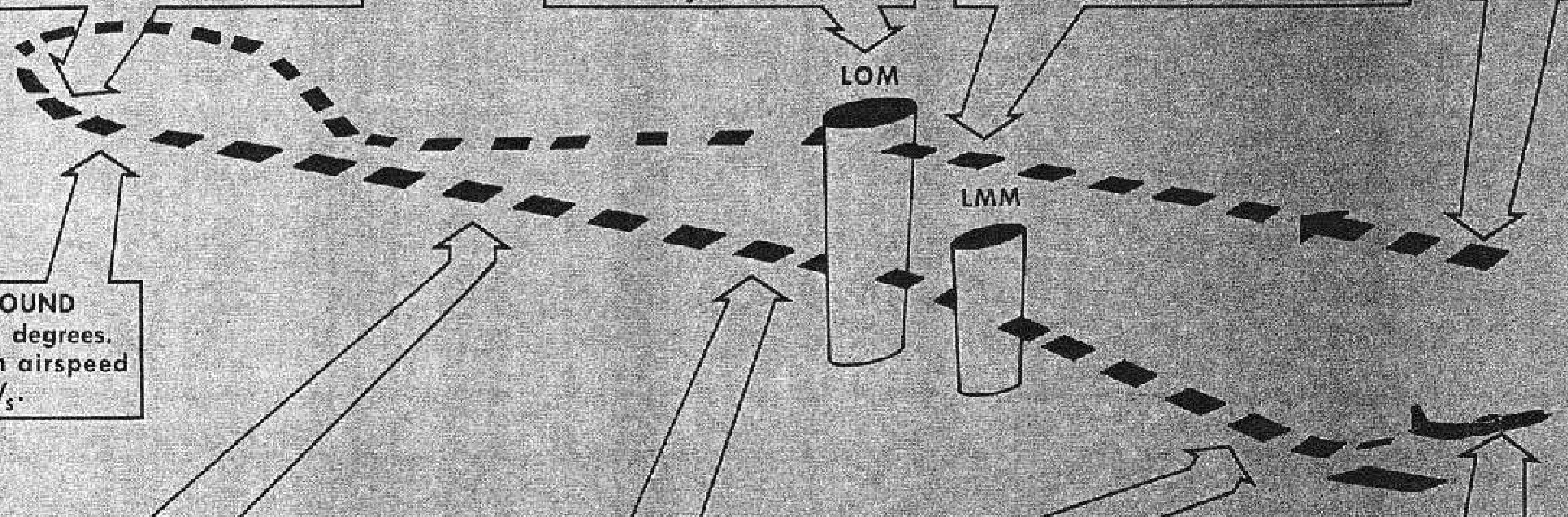
Four or Three-Engine — Typical

PROCEDURE TURN
When the course deviation indicator (vertical pointer) starts to move, turn to localizer heading.

OUTER MARKER OUTBOUND
Flaps 15 degrees.
Reduce airspeed to 1.4 V_S.

APPROACHING OUTER MARKER
Approximately 3 minutes prior to crossing outer marker, start reducing airspeed to 1.4 V_S.

INBOUND
Descent check



INBOUND
Flaps 25 degrees.
Maintain airspeed at 1.4 V_S.

FINAL APPROACH
Flaps 25 degrees.
Reduce airspeed to 1.4 V_S minus 10 knots.

APPROACHING GLIDESLOPE
When glideslope indicator is one dot above center:
Landing gear DOWN.
Flaps 35 degrees
Airspeed at 1.2V_S plus 10 knots.
Before landing check completed.

WHEN CONTACT
Taper airspeed to cross threshold at a minimum height of 50 feet and a minimum airspeed of 1.2V_S.

MISSED APPROACH
Throttles MAX power.
Flaps 15 degrees.

WARNING

If one GTU is inoperative the flaps will not retract simultaneously with the gear since the volume of fluid required for gear retraction results in starvation of the flap system. Therefore, make certain that the flaps are UP to 15 degrees before retracting the gear.

Landing gear UP.
Accelerate to flare speed (1.2V_S) plus 10 knots, then flaps UP.
Continue with normal climb procedure.

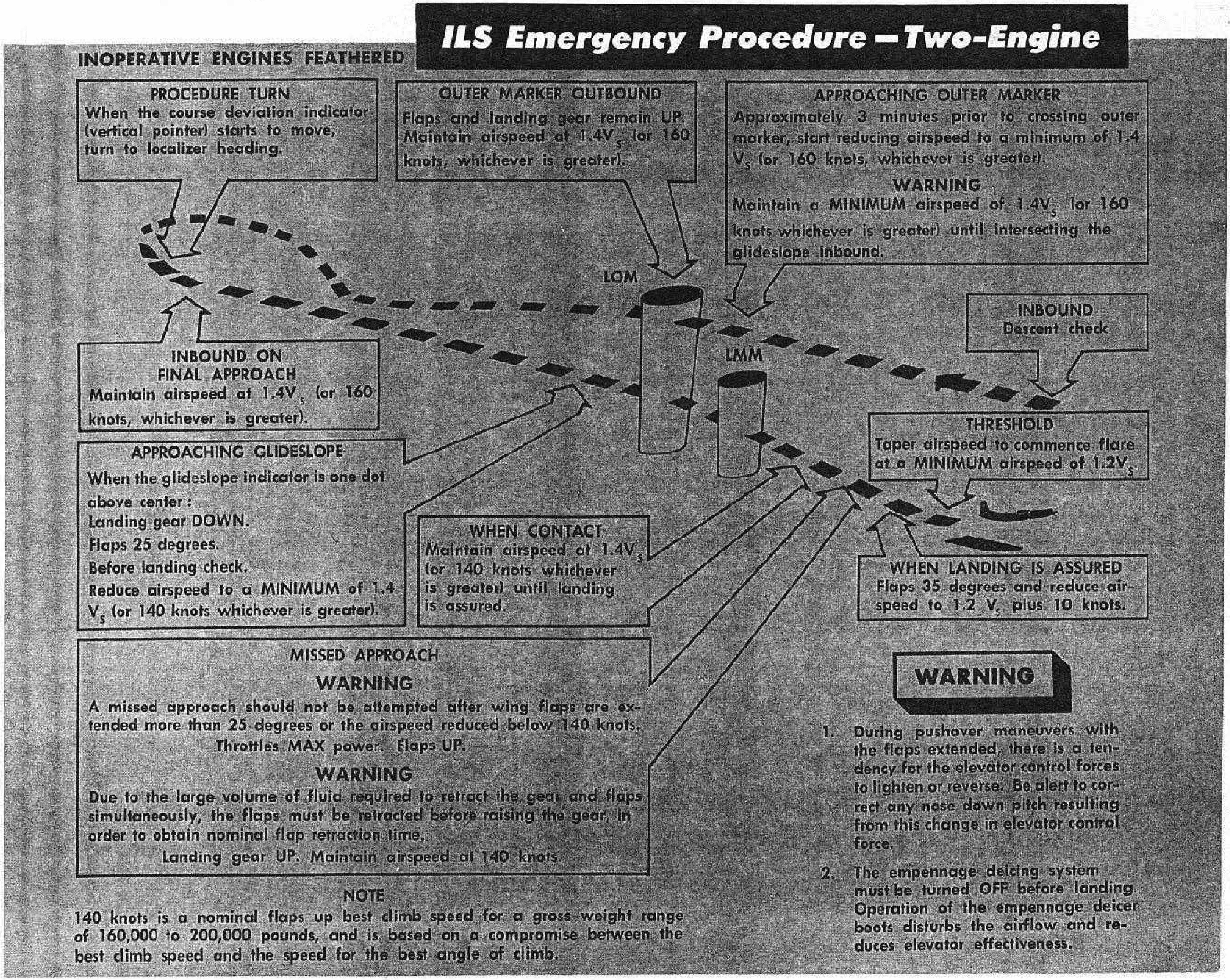
WARNING

1. During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.
2. The empennage deicing system must be turned OFF before landing. Operation of the empennage deicer boots disturbs the airflow and reduces elevator effectiveness.

UAB1-135

Figure 9-8

ILS Emergency Procedure—Two-Engine



INOPERATIVE ENGINES FEATHERED

PROCEDURE TURN
When the course deviation indicator (vertical pointer) starts to move, turn to localizer heading.

OUTER MARKER OUTBOUND
Flaps and landing gear remain UP. Maintain airspeed at 1.4V_s (or 160 knots, whichever is greater).

APPROACHING OUTER MARKER
Approximately 3 minutes prior to crossing outer marker, start reducing airspeed to a minimum of 1.4 V_s (or 160 knots, whichever is greater).

WARNING

Maintain a MINIMUM airspeed of 1.4V_s (or 160 knots whichever is greater) until intersecting the glideslope inbound.

INBOUND
Descent check

INBOUND ON FINAL APPROACH
Maintain airspeed at 1.4V_s (or 160 knots, whichever is greater).

APPROACHING GLIDESLOPE
When the glideslope indicator is one dot above center :
Landing gear DOWN.
Flaps 25 degrees.
Before landing check.
Reduce airspeed to a MINIMUM of 1.4 V_s (or 140 knots whichever is greater).

WHEN CONTACT
Maintain airspeed at 1.4V_s (or 140 knots whichever is greater) until landing is assured.

THRESHOLD
Taper airspeed to commence flare at a MINIMUM airspeed of 1.2V_s.

WHEN LANDING IS ASSURED
Flaps 35 degrees and reduce airspeed to 1.2 V_s plus 10 knots.

MISSED APPROACH

WARNING

A missed approach should not be attempted after wing flaps are extended more than 25 degrees or the airspeed reduced below 140 knots.

Throttles MAX power. Flaps UP.

WARNING

Due to the large volume of fluid required to retract the gear and flaps simultaneously, the flaps must be retracted before raising the gear, in order to obtain nominal flap retraction time.

Landing gear UP. Maintain airspeed at 140 knots.

NOTE

140 knots is a nominal flaps up best climb speed for a gross weight range of 160,000 to 200,000 pounds, and is based on a compromise between the best climb speed and the speed for the best angle of climb.

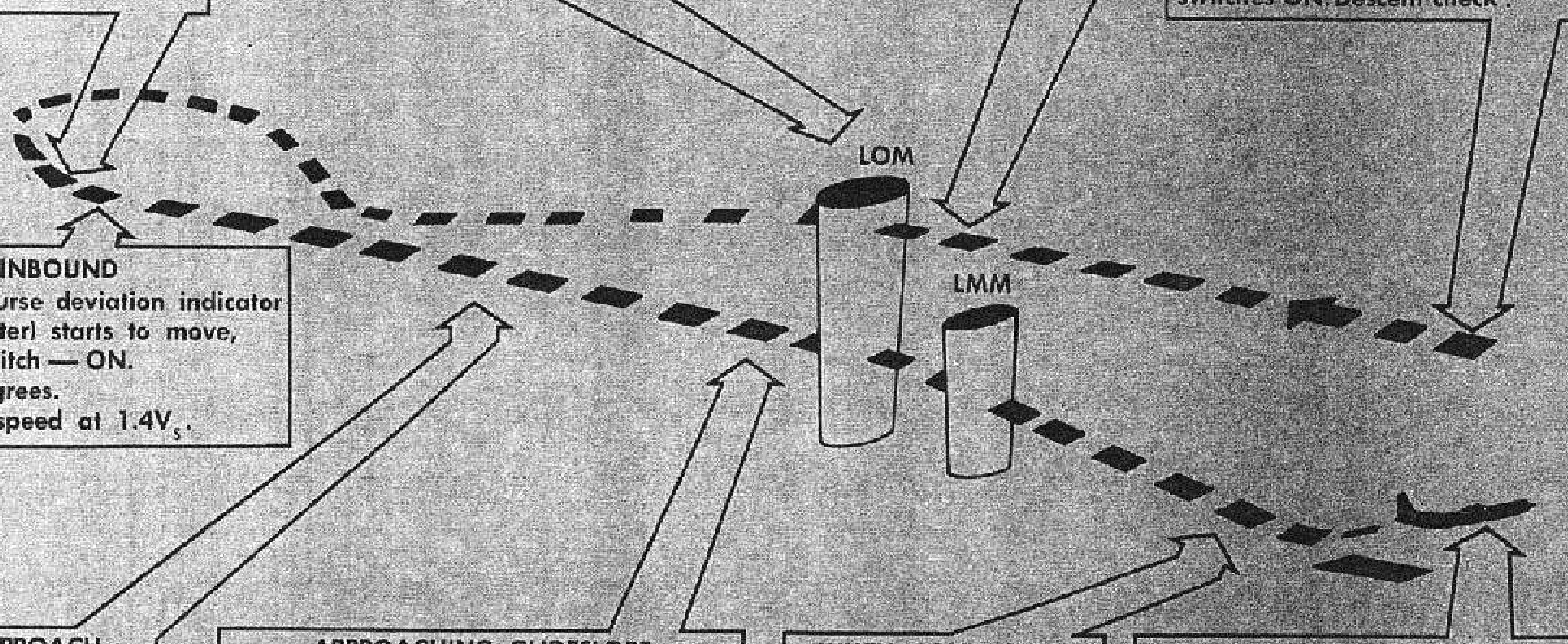
WARNING

1. During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.
2. The empennage deicing system must be turned OFF before landing. Operation of the empennage deicer boots disturbs the airflow and reduces elevator effectiveness.

UAB1-136

Figure 9-9

Automatic Approach Procedure — Typical



PROCEDURE TURN
One minute after crossing outer marker outbound, execute procedure turn, using stick steering.

OUTER MARKER OUTBOUND
Flaps 15 degrees.
Reduce airspeed to 1.4V_s.

APPROACHING OUTER MARKER
Approximately 3 minutes prior to crossing outer marker, start reducing airspeed to 1.4V_s.

INBOUND
AN/ARN-14 ON and tuned to ILS frequency. ID351 — ILS heading.
Auto pilot and altitude control switches ON. Descent check.

INBOUND
When the course deviation indicator (vertical pointer) starts to move, LOC-VOR switch — ON.
Flaps 25 degrees.
Maintain airspeed at 1.4V_s.

FINAL APPROACH
Flaps 25 degrees.
Reduce airspeed to 1.4V_s. minus 10 knots.

APPROACHING GLIDESLOPE
When pointer indicates glideslope intersection, turn glideslope switch ON.
Landing gear DOWN. Flaps 25 degrees.
Airspeed at 1.2V_s plus 10 knots.
Before landing check complete.

WHEN CONTACT
Disengage Autopilot.
Flaps 35 degrees.
Taper airspeed to cross threshold at a minimum height of 50 feet and a minimum airspeed of 1.2V_s.

MISSED APPROACH
Disengage autopilot.
Throttles MAX power.
Flaps 15 degrees.

WARNING

If one GTU is inoperative the flaps will not retract simultaneously with the gear since the volume of fluid required for gear retraction results in starvation of the flap system. Therefore, make certain that the flaps are UP to 15 degrees before retracting the gear.

Landing gear UP.
Accelerate to flare speed (1.2V_s) plus 10 knots, then flaps UP.
Continue with normal climb procedure.

WARNING

1. During pushover maneuvers with the flaps extended, there is a tendency for the elevator control forces to lighten or reverse. Be alert to correct any nose down pitch resulting from this change in elevator control force.
2. The empennage deicing system must be turned OFF before landing. Operation of the empennage deicer boots disturbs the airflow and reduces elevator effectiveness.

UAB1-139

Figure 9-10

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3. Outer Marker Outbound.
   - a. Wing Flaps — 15 degrees.
   - b. Airspeed — Reduce to $1.4V_S$.
   - c. ALT. CONT. Switch — OFF (if desired).

4. Procedure Turn.
   - a. One minute after crossing the outer marker, execute a standard procedure turn using stick steering.

5. Inbound.
   - a. When intercept heading is within limits of the localizer heading specified for intercept angle, turn the LOC-VOR switch ON as the course deviation indicator starts to move towards center (bank stick steering will become inoperative).
   - b. Wing Flaps — 25 degrees.
   - c. Airspeed — Maintain at $1.4V_S$.

6. Final Approach.
   - a. Wing Flaps — 25 degrees.
   - b. Airspeed — Reduce to $1.4V_S$ minus 10 knots.
   - c. ALT. CONT. Switch — ON (if desired).

7. Approaching Glide Slope.
   - a. When steady on the localizer, monitor the glide slope pointer. When the pointer indicates glide slope intersection — Glide Slope Switch — ON. The altitude control switch will be automatically disengaged and pitch stick steering will be inoperative.
   - b. Landing gear — DOWN.
   - c. Wing Flaps — 25 degrees.
   - d. Airspeed — $1.2V_S$ plus 10 knots (for 25 degree flaps).
   - e. Before Landing Check — Complete.

8. When Contact.
   - a. Autopilot — Disengage.
   - b. Wing Flaps — 35 degrees.
   - c. Airspeed — Taper to minimum of $1.2V_S$.
   - d. Threshold — Cross at minimum height of 50 feet.
   - e. Commence Flare.

9. Missed Approach.
   - a. Autopilot — Disengage.
   - b. Throttles — MAX POWER, continue standard Missed Approach Procedure.

Circling Approach — Three- and Four-Engine.

For a circling approach, follow normal approach procedures except maintain $1.4V_S$ and flaps 25 degrees until the final approach. Extend the wing flaps to 35 degrees and continue with the landing procedures outlined in the normal VFR traffic pattern depicted in Section II.

Circling Approach — Two-Engine.

Conduct a two-engine approach in the same manner as a two-engine straight-in approach, except keep the gear and flaps up. Maintain 1.4 V_S or 160 knots IAS (whichever is highest), until descent on final approach. On final approach, landing gear down, wing flaps 25 degrees, maintain a minimum of 1.4 V_S (or 140 knots IAS, whichever is higher). When landing is assured, extend wing flaps to 35 degrees and taper airspeed to cross threshold at 1.2 V_S minimum.

ICE AND RAIN

Recommended aircraft mission flight planning, ice protection system operation, and flight characteristics under icing conditions are described in the following paragraphs.

Note

> When using the secondary static sources for approach conditions see Airspeed Position Error Correction charts, Part 1 of *T.O. 1C-133A-1-1* for airspeed correction.

EFFECT OF ICING CONDITIONS.

Note

> The aircraft should not be flown in areas of known or forecasted severe icing conditions.

During icing conditions in flight, a torque pressure decay of 2½ to 3 psi can normally be expected when deicing and anti-icing systems are operating. Loss of torque pressure for each system is shown on the MAX Power Check Curves in Part 2 of *T.O. 1C-133A-1-1.* Torque pressure decay in excess of this cited normal will occur when the ice blockage occurs in the compressor. Accretion of ice on the compressor stator, rotor, and guide vanes will narrow the engine stall margin to the extent that relatively small pieces of ice, when ingested, will cause the compressor to surge. These surges, when severe enough to be noted, will be evidenced by momentary torque pressure drop, momentary NTC, release of propeller synchronization, or possible flameout. Engine surges may release the compressor ice blockage resulting in recovery of torque pressure.

Note

> When engine compressor stall has been experienced in flight, notation will be made in the Form 781 in order that a visual inspection for damage will be conducted at the next station of landing with particular attention given to the compressor section and the tailpipe.

FLIGHT PLANNING FOR ICING CONDITIONS.

It is essential that the capabilities and the operational procedures for the ice protection systems be thoroughly understood. Recommended procedures should be followed to assure a feasible flight plan.

WARNING

> Depending upon the weight of snow and ice accumulated, takeoff distances and climb out performances can be seriously affected. The roughness and distribution of the ice and snow could vary stall speeds and characteristics to an extremely dangerous degree. Loss of an engine shortly after takeoff is a serious enough problem without the added, and avoidable, hazard of snow and ice on the wings. In view of the unpredictable and unsafe effects of such a practice, the ice and snow must be removed before flight is attempted.

Engine bleed air required to operate the pneumatic systems will present some penalties to speed, power, and performance of the aircraft. When icing conditions are predicted enroute or at destination, a flight plan for lower than cruise ceiling should be prepared to assure enough reserve power to maintain the desired airspeed. Airspeed losses of 10 to 15 knots IAS may be experienced during icing conditions. To prevent this loss of airspeed, additional power should be applied prior to encountering ice.

When planning a flight through forecasted icing conditions, the following steps should be taken.

1. Plan to penetrate the icing condition at NORMAL RATED power, approximately 2000 feet below the cruise ceiling for the aircraft.

2. Schedule extra fuel to provide for that quantity of fuel which will be consumed due to flight below cruise ceiling and for operation of the ice protection system.

3. Assure that all the ice protection systems are operating properly prior to takeoff.

OPERATING PROCEDURES UNDER ICING CONDITIONS.

Approaching The Icing Area.

1. Ascertain that the pitot heat is on.

2. Turn the parting strip on at least 15 minutes prior to contacting the icing conditions. Satisfactory parting strip operation is essential to satisfactorily remove ice from the wing.

Entering The Icing Area.

1. Immediately turn on the propeller deicing system.

2. Advance the throttles to recover the power lost when the anti-icing and deicing systems are energized.

Note

> When it can be anticipated that the engine and/or wing ice protection system will be turned on, it is advantageous to advance power prior to energizing these systems. Care must be exercised to assure that the throttles are not advanced beyond the point which will cause the EGT/TIT limit for NORMAL RATED power to be exceeded. In extreme emergency, throttles may be advanced to the EGT/TIT limits for MILITARY RATED power for periods not to exceed 30 minutes.

3. Ascertain that the engine and GTU anti-icing system has been turned on automatically. If not, set

the engine and GTU anti-ice switch to the MANUAL position.

4. Observe the wing leading edge closely and when it is determined that ice is building up in this region, set the wing and empennage deicing switches to the ON position.

Note

> If the removal of ice from the wing is not complete after the first cycle, it will usually be fairly well removed after the second cycle. Subsequent cycles should show improvement in ice removal.

When In The Icing Area (Light To Moderate Icing).

1. If engine power becomes critical, the GTU augmentation may be shut off. This may result in lower cabin temperatures but may be advisable under the circumstances.

WARNING

> If the normal static system becomes inoperative the secondary static source should be selected immediately. Monitor the static source instruments and select the secondary source whenever any erratic operation of the instruments is noted.

2. Scanning of each engine inlet, as well as the wing and tail surfaces, is advisable during the icing encounter. Ice will be visible on the wing leading edge and in the unheated areas at the wing joints, tips, and adjacent to the nacelles. Residual ice will be visible on the leading edge of the tail surfaces. The engine inlets should be generally clear of ice; however, ice may be noted on the outer skin of the nacelles, around the propeller spinner risers, and on the leading edge of the spinner afterbody.

WARNING

> An increase of approximately 15 knots IAS power off stall speed should be expected for each inch of ice buildup on the wing surfaces.

3. All ice protection systems are to be allowed to operate without interruption during icing conditions.

4. For extreme conditions, where ice removal is not proceeding normally, the procedures for operation When In Moderate To Heavy Icing conditions, may be used. These instructions cover manual operation of the wing deicing system; however, the wing deicing system should be allowed to cycle twice in order to allow the ducts, valves, and skin to be heated, and the normal cycle to perform its function.

When In Moderate To Heavy Icing.

Note

> The following procedures are in addition to the steps outlined for Light to Moderate Icing conditions.

If temperatures are below −10°C and the amount of residual ice remaining on the wings after normal cyclic action appears to seriously affect airspeed, power, or performance, all of the ice may be removed from the wing deicing sections by operating the manual deicing system in the following manner.

Note

> When 94.5 percent rpm does not provide sufficient heat to the wings, an increase in rpm may improve deicing effectiveness. The higher rpm increases bleed air volume and temperature, and improves aircraft stability.

1. Place the manual valve selector switch in the desired position.

2. The wing deicing switch must be placed in the MANUAL position and held in this position while each section of the wing is being manually deiced.

CAUTION

> Use of the manual control of the deicing system should be limited to 2 minutes ON for each position, with a minimum of 2 minutes OFF before reapplication.

3. Before proceeding to the next section to be manually deiced, release the wing deicing switch. After placing the valve selector in the desired position, return the deicing switch to the MANUAL position.

When it is no longer necessary to utilize the manual deicing system, the valve selector should be returned to the No. 1 position.

Removal of ice from the wing panels outboard of the outboard nacelles is relatively more important than removal of ice from the panels inboard of the outboard nacelles.

High ice collection rates may cause engine compressor stall. These compressor stalls may be evidenced by a loud sharp noise, sometimes accompanied by a loss of synchronizer and actuation of NTC on the affected engine. When this occurs, synchronizer operation should be restored and the NTC light should be reset.

If torque pressure decay continues in excess of the cited normal, depart the icing area as soon as possible. The following additional steps will be taken as conditions warrant.

1. Immediately feather the respective propeller if engine speed falls below 92 percent rpm.

2. Observe EGT/TIT and adhere to all engine operating limits as given in Section V.

3. If a propeller was feathered or if an engine flameout occurred and an air start is attempted, employ caution during air start procedure and carefully observe engine instruments.

WARNING

Scan engine prior to attempting a restart for possible collapsed tailpipe.

4. After landing, note in Form 781 that icing was encountered and that surges were experienced. List all pertinent information of the encounter as well as action taken, in order that appropriate maintenance action can be accomplished.

Upon Leaving Icing Conditions.

Upon leaving icing conditions, the flashing amber ice accretion lights will cease to flash and will remain off. The engine and GTU ice protection systems will automatically deenergize. After all visible ice on heated areas is removed from the wings, take the following action.

1. Wing deicing switch — OFF.
2. Empennage deicing switch — OFF.
3. Parting strip manual switch — OFF.
4. Propeller deicing control switches — OFF.
5. Windshield anti-ice switches — NORMAL.
6. Throttles — Adjust to obtain desired airspeed.
7. GTU — Augmentation as desired.
8. Static source selectors — PRIMARY.

CHARACTERISTICS OF ICE PROTECTION SYSTEMS.

The wing deicing system is capable of removing moderate ice from the wings at temperatures down to −10° C by means of the normal cyclic system. At lower temperatures, ice removal will be somewhat slower and residual ice may remain on the heated areas aft of the leading edge and on the unheated areas between the wing deicing sections. Any accumulation of ice in the heated areas not removed by normal cyclic system operation may be removed by the manual control system. The empennage boot system will be effective during all encounters of ice.

Note

Longitudinal trim changes may be noticed when empennage deicing boots are operating.

The engine and GTU anti-icing system will be automatically operated in response to the first ice or freezing rain sensed by any one of the ice detector probes in each of the engine inlets. One of the two ice warning lights on the flight engineer's panel will respond to icing of any one of the engine ice detectors. When flying through the tops of icing clouds or departing icing conditions, the engine ice protection system will be automatically deenergized within 75 to 105 seconds after cessation of icing signals from the ice detector probes.

Propeller ice protection consists of an electrical cyclic type deicing system. Electrically heated elements on each propeller blade, spinner, and blade cuff assemblies will remove all ice formations, except some residual ice. In order to prevent large pieces of ice from ingesting into the engine inlets, heavy concentration of ice should not be permitted to accumulate on the propeller deicing sections.

The windshield anti-icing systems will remove ice and frost from the windshield and clearview heated areas under most icing conditions. If severe ice is experienced, the windshield, clearview, and forward windshield anti-icing switches may be placed in the HIGH position long enough to remove the ice or snow and then in the NORMAL position when the ice is removed.

Note

> If delamination of an anti-iced windshield exists, the outside layer of glass of that windshield may crack when the anti-ice switch is placed in HIGH. Vision may be obscured, but there is no immediate danger of windshield blowout.

INFLIGHT USE OF NACELLE PREHEAT.

In the event erratic fuel control operation is encountered during flight when the OAT is below freezing, the following procedures are recommended:

1. Control engine power with the throttle.

2. Apply nacelle preheat to the affected engine or engines until fuel control operation returns to normal. Use of nacelle preheat in this manner is not to exceed 15 minutes, maximum.

WINDSHIELD JET BLAST RAIN REMOVAL SYSTEM.

The windshield jet blast rain removal system *(figure 4-7)* will prevent rain from contacting the pilot's windshield over more than 50 percent of the glass area. As higher speeds are obtained after takeoff, the windshield clear area will narrow. Air is supplied to the windshield nozzles from the pneumatic system. When the main engine pneumatic duct pressure is lower than the GTU pneumatic pressure, the GTU system will automatically supply air. Maximum rain removal can be attained only by placing the four engine pneumatic manifold switches in the OPEN position. Under these conditions, a decrease in torque pressure of approximately 1 psi per engine may be expected. To avoid this loss of power, limited rain removal may be obtained from the GTU pneumatic system, but only if the pneumatic manifold switches are in the CLOSED position and the air conditioning system is turned off.

During landing approaches in rain, the jet blast rain removal system should be used as desired. Visibility through the pilot's windshield will be satisfactory. However, when taxiing in low ground idle, airflow will be insufficient to clear the windshields unless the air conditioning system is turned off.

TURBULENCE AND THUNDERSTORMS

Note

> Flight through thunderstorms should be avoided, if possible. However, should circumstances force a flight into a zone of severe turbulence, the recommended turbulence penetration speed of **60 knots above the power off stall speed** for the weight and configuration being flown must be observed (see Power Off Stalling Speeds chart, *figure 6-1*).

The power setting and pitch attitude should be established before entering the thunderstorm, and if maintained throughout the storm, will result in an approximate average airspeed, regardless of airspeed indicator readings.

APPROACHING THE STORM.

Prepare the aircraft prior to entering a zone of turbulent air. If the storm cannot be seen visually, its proximity can be detected through the use of radar. "Soft spots" can be located and an appreciable reduction in gust loads can be achieved by circumnavigation or by penetrating the areas of least return. Normal preparatory procedures should be employed when there is a possibility of encountering thunderstorm activity.

CAUTION

> Do not lower the landing gear and wing flaps, as they merely decrease the aerodynamic efficiency of the aircraft. Lowering the wing flaps may also compromise the design load factor.

Note

> Altitudes between 10,000 and 30,000 feet are usually the most turbulent areas in a thunderstorm. Therefore, altitudes below 10,000 feet or above 30,000 feet are recommended for thunderstorm penetration.

NIGHT FLYING

Night flying in this aircraft requires no special procedures or precautions. Interior and exterior lighting, including navigation, landing, and taxilights, should be checked and adjusted as required before starting engines. Adjust blackout curtains as desired to eliminate glare. Check flashlight accessibility and proper operation.

Note

Instrument takeoff (ITO) procedures are recommended for all night takeoffs to avoid flying back into the ground when visual outside references are lost immediately after takeoff.

COLD WEATHER OPERATION

The following cold weather procedures are in addition to the normal procedures in Section II, and should be complied with when cold weather conditions are encountered.

PREPARATION FOR FLIGHT.

1. Fuel Vents, Pitot Tubes, Static Ports, Fuselage Wing Drainage Holes, and Ventilation Openings — Inspect and remove any ice that may be present.
2. Shock Struts and All Exposed Actuating Cylinders — Check for freedom from dirt and ice.
3. Fuselage, Wings, Empennage, and Control Surfaces — Remove all ice and snow.

CAUTION

Loose snow and frost may be removed with long-handled pushbrooms. Removal of ice and encrusted snow may require the direct application of heat from an external heater or the use of deicing fluids. Care must be taken to prevent water from accumulating in control hinge areas or other critical areas where refreezing may cause damage or impair proper movement of surfaces.

WARNING

Depending upon the weight of snow and ice accumulated, takeoff distances and climbout performances can be seriously affected. The roughness and distribution of the ice and snow could vary stall speeds and characteristics to an extremely dangerous degree. Loss of an engine shortly after takeoff is a serious enough problem without the added, and avoidable, hazard of snow and ice on the wings. In view of the unpredictable and unsafe effects of such a practice, the ice and snow must be removed before flight is attempted.

4. All Flight Control Surfaces, Hinges and Limit Switches — Check for frozen runback water.
5. Complete the normal Preflight checks, Section II.

ON ENTERING THE AIRCRAFT.

Use external power for operating and ground checking all electrical and radio equipment. Perform the checks required for normal procedures, Section II, and make a visual and "feel" check of all flight controls and trim tabs for freedom and full movement.

STARTING GTU'S.

GTU's should be started according to procedures outlined in GTU Operation, Section VII.

BEFORE STARTING ENGINES.

If the aircraft is on ice or snow, check that the wheels are well chocked to prevent slippage when the engines start. Make certain that all ground support equipment is located at a safe distance from the aircraft to prevent possible damage in case of slippage when the engines start. Check the brakes for proper operation, and set the parking brake when OAT is below freezing, make use of the nacelle preheat provisions, as applicable, to preheat the fuel control unit and the general nacelle area.

CAUTION

> Use of nacelle preheat is restricted to a duty cycle of a maximum of 15 minutes ON, followed by a minimum of 5 minutes OFF. This procedure should be followed to prevent possible overheating of the engine mounts and fuel control units.

Attempt to pull the propellers through by hand when icelock is suspected. The engine rotor may be ice locked as a result of frozen condensation. If any indication of a locked rotor or unusual noise is noted, blow hot air through the engine for a period of 10 to 15 minutes.

Note

> When ambient temperatures are below −40° C, the engines should be preheated with a ground heating unit to ensure adequate lubrication before starting. If, after starting one engine, any of the remaining engines fail to light up, pneumatic manifold pressure may be increased by running an operating engine at high ground idle rpm, after the oil temperature and oil pressure are within limits. This procedure will generally result in a satisfactory start of the remaining engines.

STARTING ENGINES.

Start engines in normal manner (See Section II).

TAXIING.

Exercise caution when taxiing on ice or snow. The taxiing speed should be slower than normal so that the aircraft is under complete control at all times. Use nose gear steering for turning and directional control. Nose gear steering is effective on snow-covered surfaces, although some skidding may be encountered at moderate taxi speeds, especially when temperatures are near freezing. Steam caused by snow or ice in the brakes may be mistaken for smoke from a brake fire. Scanner/ground controllers should be especially careful in observing the wheels under these conditions. Make sure wheels are turning. Use the brakes (see Wheel Brake Operation, Section VII) only when necessary to aid in turning or to slow the taxi speed. Use caution when applying brakes on ice or snow-covered areas. Do not taxi through snow drifts or windrows of plowed snow, especially after a thaw and freeze.

WARNING

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

CAUTION

> If an engine runup is required, avoid surfaces recently jetblasted by jet aircraft since these areas are usually covered with glazed or clear ice. Wheel slippage will occur during a runup on such a surface. Choose a dry area or compacted snow-covered surface for the runup.

BEFORE TAKEOFF.

Recheck all flight controls for freedom of movement and full travel. Turn ON anti-icing and deicing systems, as required.

Note

> A power check may not be possible, due to slippage on ice and snow; therefore, it will be necessary to make the power check in conjunction with the takeoff. Power should be applied as rapidly as possible to provide use of the maximum amount of runway in the event the takeoff is discontinued.

TAKEOFF.

Make a normal takeoff, particularly observing the torque pressure indicators. At low ambient temperatures, engine torque values may be considerably higher than predicted and care must be taken not to exceed the limits. Under slush and wet runway conditions in cold weather, leave the landing gear down approximately 30 seconds after takeoff to allow moisture to be blown away from the landing gear prior to retraction.

Takeoff Procedure.

To obtain the accuracy required for computing MAX power for takeoff and takeoff performance, the following procedures will apply.

1. When predicted MAX power (static) at 100 percent rpm is within 1.5 psi of the maximum allowable, takeoff will be made on mechanical reference governing, using the values shown on the MAX Power Check Curves — 97.7 Percent Rpm, in Part 2 of *T.O. 1C-133A-1-1.*

Note

This procedure is necessary due to part throttle effect on synchronizer rpm and the resulting inability to predict maximum allowable torque pressure during the takeoff run.

2. Push synchronizer buttons IN, above 1000 feet, after completion of the After Takeoff — Climb checklist. Readjust throttles as required. Do not exceed the limits specified in Section V.

AFTER TAKEOFF — CLIMB.

At temperatures below approximately —30°C, as power is reduced to climb power after takeoff, a torque increase may be experienced. If such an increase occurs, the throttles should be quickly retarded to a point where torque values decrease to normal.

CRUISE, DESCENT, AND APPROACH TO PATTERN.

Cruising flight is made in the normal manner. Use the anti-icing and deicing systems, as required. For flight, erratic operation of the engine fuel control at temperatures below 0°C may be alleviated by the use of nacelle preheat. Unnecessary use of nacelle preheat is not recommended due to the resulting increase in fuel consumption.

CAUTION

Use of nacelle preheat is restricted to a duty cycle of a maximum of 15 minutes ON followed by a minimum of 5 minutes OFF. This procedure should be followed to prevent possible overheating of the engine mounts and fuel control units.

LANDING.

Analyses of fuel system icing probabilities in long-range aircraft using jet fuels have indicated that fuel icing potentials are greatly intensified by conditions that arise during low-altitude operations following prolonged cruise at altitude. Tank wall frost, condensation, water precipitation, and suspended ice particles are all intensified by descent from high-altitude cruise conditions. These contaminants will tend to enter the fuel system through agitation of fuel in the tanks. Aircraft engine and aircraft fuel system components have sufficient tolerance to accept the water formed, but winter operations (ambient surface temperatures below freezing and/or bulk fuel temperatures below freezing) create icing conditions which can be dangerous. Prolonged high fuel flows at low altitudes following descent from high altitude, and under the temperature conditions described, can overload the filters and screens with ice. The bypass feature of the fuel system provides only temporary relief when the quantity of ice is great since it passes downstream and ices other vital components, thus creating a power loss. Therefore, touch-and-go landings or other low-altitude operations after prolonged cruise at altitude, and where surface ambient temperatures are less than 0°C are prohibited except for emergency situations. These operations may be conducted regardless of temperatures providing the aircraft has not descended from high-altitude cruise conditions. **On aircraft with T.C.T.O. 502,** the probability of fuel icing is minimized.

Landing on icy or slippery runways requires no special technique other than that used in normal landings except that it should be borne in mind that braking and nose gear steering will be less effective. Ailerons and rudder may be used effectively to assist directional control.

Note

When reverse thrust is used after landing on a snow-covered runway, forward and side visibility may be obscured by blowing snow as forward speed decreases. The pilot may anticipate this condition by observing to the side, and then may control reverse thrust to minimize it.

ENGINE SHUTDOWN.

Stop the engines and complete the Before Leaving Aircraft check, Section II.

BEFORE LEAVING AIRCRAFT.

After the chocks are in place, release the parking brake. In addition to the Before Leaving Aircraft checks, Section II, ensure the following are accomplished.

1. Shock Struts — Check.

Clean dirt and ice from all shock struts and exposed actuating cylinders; wipe with a rag soaked in the same type of hydraulic oil used in the system.

2. Covers — Install.

Install covers and dust plugs, as required. Allow sufficient time for engine cooling before installing intake and exhaust covers.

3. Aircraft — Secure.

Tie down aircraft securely.

4. Battery — Remove (if required).

If an extended layover is anticipated, or if the ambient temperature is −6°C or lower and the layover is expected to exceed 6 hours, remove and store the battery in a warm area.

DESERT OPERATION

Many of the malfunctions that occur during desert operations may be the result of improper care of the aircraft. Since most of the procedures in Section II also apply to desert operations, only those additional procedures that specifically apply to desert operations are covered in this section. When operating under desert conditions, perform the normal operating procedures, and in addition insure that air filters, instrument filters, and oil filters, have been cleaned before each flight. Close and cover all openings to keep out sand; cover the windshield and cockpit windows for protection from the sun and blowing sand; space the aircraft when parking in sandy areas to avoid the possibility of blowing sand on other aircraft, equipment, or personnel during runup; and avoid wash from other aircraft when taking off from sandy or dusty runways.

CAUTION

Avoid flying through dust storms or sandstorms, as grit or dust will damage the engines.

BEFORE ENTERING AIRCRAFT, ENTERING AIRCRAFT, AND BEFORE STARTING ENGINES.

When operating under desert conditions, certain additional precautions should be taken. Gloves should be worn when working around metal surfaces exposed to the sun, landing gear struts should be wiped free of sand and dust with a dry cloth, all protective covers should be removed, and a check should be made to determine if there are leaking seals caused by expansion. The flight and cargo compartments should be cooled with a ground cooling unit, if available; the instrument panel should be wiped with a lint-free cloth to remove any dust or sand; the flight controls and wing flaps should be operated; and all possible ground checks should be completed before starting the engines.

STARTING ENGINES, GROUND TESTS, AND TAXIING.

Start engines using the starting procedures, Section II. (Keep ground test to the minimum required time.) Do not ride the brakes while taxiing.

CAUTION

Use brakes only when necessary, as high ambient temperatures retard cooling.

BEFORE TAKEOFF.

Keep ground operation to an absolute minimum. Check takeoff performance by referring to Part 3 of *T.O. 1C-133A-1-1*, and compare takeoff distance required with runway length available.

TAKEOFF AND CLIMB.

Make a normal takeoff, using all available runway. After liftoff, be alert to any settling of the aircraft due to the instability of hot air and loss of ground effect. Maintain best climb speed (see Part 3 of *T.O. 1C-133A-1-1*) or, if necessary, climb at an airspeed higher than normal.

CRUISE, DESCENT, AND APPROACH TO PATTERN.

Cruise, descent, and approach to the pattern are normal, except that turbulence may be expected on descent. Refer to Parts 5 and 6 of *T.O. 1C-133A-1-1* to determine the effect of abnormal temperatures on range and endurance.

LANDING.

Make a normal approach and landing, using caution on the final approach and touchdown. If the approach is over water or a green field, a change in altitude may be expected as the end of the runway is crossed, due to the difference in temperatures and instability of the air directly over the two areas. Allowance should be made for a longer landing roll due to the faster (4 to 7 knots) touchdown speed on a hot day.

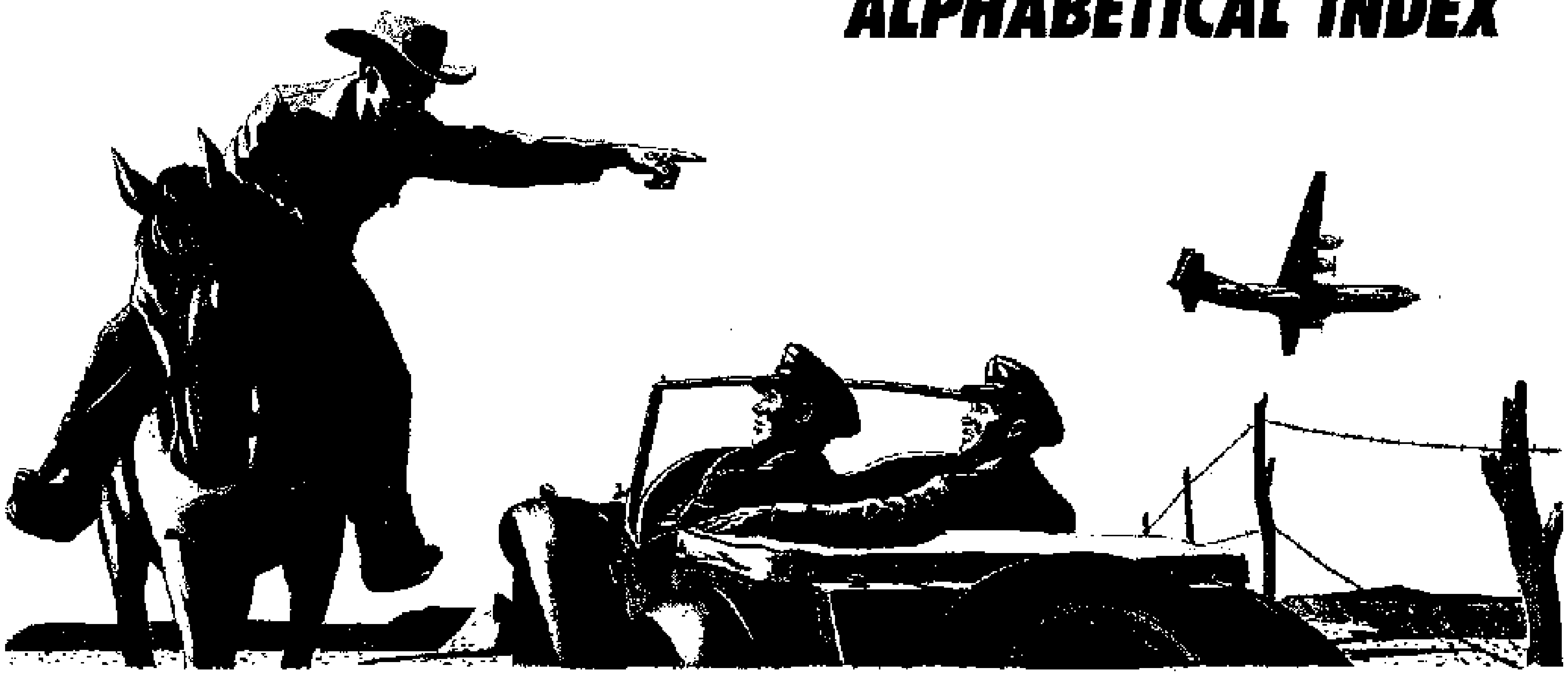
WARNING

After maximum performance landings or aborted takeoff, do not approach the main landing gears until the brakes have cooled. During extremely high temperatures, it is essential that more strict adherence to the normal landing procedures and the normal approach and landing speeds be observed than at other times. This is due to the fact that the higher the temperature, the higher the true airspeed for a given indicated airspeed; thus, a faster touchdown speed results.

ENGINE SHUTDOWN AND BEFORE LEAVING THE AIRCRAFT.

Perform the shutdown procedures, Section II, and install pitot covers and pilot's enclosure covers; install engine covers after engines have cooled; leave windows and hatches slightly open to aid air circulation but close during sand or dust storms; close or cover all openings to keep out sand; and secure the aircraft.

ALPHABETICAL INDEX



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