Flight Manual

USAF SERIES KC-97L AIRCRAFT

THIS PUBLICATION IS INCOMPLETE WITHOUT T.O. 1C-97(K)L-1-1

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THIS PUBLICATION SUPERSEDES OPERATIONAL SUPPLEMENTS 1C-97(K)L-1S-16, -20, -23, AND -25.

SEE TECHNICAL ORDER INDEX T.O. 0-1-1-3 FOR CURRENT STATUS OF FLIGHT MANUALS, SAFETY AND OPERATIONAL SUPPLEMENTS, AND FLIGHT CREW CHECKLISTS.

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PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

AIR FORCE 3 Jan 74-2000

1 JUNE 1966
CHANGE 11 1 NOVEMBER 1973

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Boom Operator's	1C-97(K)L-1CL-4	1 Jun 66, Change 5 - 1 Nov 73
Ground Crewman's	1C-97(K)L-1CL-5	1 Jun 66

The above checklist dates are effective at the time of preparation of this page. Refer to T.O. 0-1-1-2 for date of the latest checklist.

Upon receipt of the second and subsequent changes to this technical order, personnel responsible for maintaining this publication in current status will ascertain that all previous changes have been received and incorporated. Action should be taken promptly if the publication is incomplete.

* The asterisk indicates pages changed, added, or deleted by the current change.

ADDITIONAL COPIES OF THIS PUBLICATION MAY BE OBTAINED BY USAF ACTIVITIES IN ACCORDANCE WITH T.O. 00-5-2.

USAF

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SAFETY SUPPLEMENTS SUMMARY

Safety Supplements are identified by the addition of "-SS-" and consecutive dash numbers to the basic publication number. A supplement number will never be used more than once. Supplements issued prior to 1 April 1963 are designated Safety of Flight Supplement, identified by "-SF-" instead of "-SS-", with no break in the numbering sequence. The supplements you receive should follow in sequence and if you are missing one, check the weekly index of Cargo Aircraft Safety Supplements, T. O. 0-1-1-3, to see if it was issued and, if so, is still in effect. That supplement may have been replaced or rescinded before you received your copy. If it is still active, see your Publication Distribution Officer and get your copy.

SAFETY SUPPLEMENTS IN THIS CHANGE

Number	Date	Short Title	Disposition

SAFETY SUPPLEMENTS STATUS

This portion to be filled in by you when you receive your Flight Manual and to be added to as you receive additional supplements. Refer to the weekly index of Cargo Aircraft Safety Supplements, T. O. 0-1-1-3, for latest information if any questions arise. Supplements outstanding at the time of preparation of this page have been listed below for your convenience.

Number	Date	Short Title	Disposition

OPERATIONAL SUPPLEMENTS SUMMARY

Operational Supplements are numbered by adding "S" and consecutive dash numbers to the basic publication number. Example: 1C-97(K)L-1S-1, -2, -3, etc. A supplement number will never be used more than once. The supplements you receive should follow in sequence and if you are missing one, check the Weekly Index of Cargo Aircraft Safety Supplements, T. O. 0-1-1-3, to see if it was issued and, if so, is still in effect. That supplement may have been replaced or rescinded before you received your copy. If it is still active, see your Publication Distribution Officer and get your copy.

OPERATIONAL SUPPLEMENTS IN THIS CHANGE

Number	Date	Short Title	Disposition
S-16	19 Apr 72	Copilot's Course Indicator	Section IV
S-20	17 Jul 72	Installation of AIMS/IFF System Mod	Section I, II, III, IV and VII
S-23	6 Dec 72	Aviation Gas Specification	Section I
S-25	10 Apr 73	Nacelle Heater Cavity Doors	Section II

OPERATIONAL SUPPLEMENTS STATUS

This portion to be filled in by you when you receive your Flight Manual and to be added to as you receive additional supplements. Refer to Weekly Index of Cargo Aircraft Safety Supplements, T. O. 0-1-1-3, for latest information if any questions arise. Supplements outstanding at the time of preparation of this page have been listed below for your convenience.

Number	Date	Short Title	Disposition
S-24	16 Jan 73	Central Oil Tank Mod (TCTO -506)	

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ALPHABETICAL INDEX-1

TIME COMPLIANCE TECHNICAL ORDERS

Note

- The following time compliance technical orders (TCTO's) are referred to in this publication.
- The TCTO dates listed are those from which information was extracted, and do not necessarily represent the current TCTO date.

AIRPLANE TCTO'S

T.O. 1C-97-505	Modification of Service Brake Hydraulic System, 15 May 1964
T.O. 1C-97-633	Modification of AN/ARC-65 to AN/ARC-65A, 21 Apr 1969
T.O. 1C-97(K)L-505	Modification of KC-97G to KC-97L Aircraft, 5 Oct 1970
T.O. 1C-97-634	Installation of AIMS Equipment C-97 aircraft, 15 Jul 1972
T.O. 1C-97-636	Installation of ID525 on Copilot's Instrument Panel - KC-97L, C-97G, C-97E Aircraft, 1 Mar 1972

A circled checklist number, such as (1.), appearing on a checklist means that this step must be coordinated with another crewmember.

The term "PLACES" preceded by a number, means the number of places in which the particular item appears on the illustration. It does not indicate the quantities of the particular item contained in the airplane.

C O D I N G

The following Air Force serial numbers are assigned to KC-97L airplanes:

52-833	52-905	52-2761	53-264	53-315
52-841	52-918	53-150	53-265	53-317
52-842	52-2603	53-200	53-276	53-319
52-844	52-2604	53-202	53-278	53-325
52-869	52-2605	53-205	53-280	53-327
52-870	52-2615	53-208	53-282	53-348
52-879	52-2630	53-218	53-283	53-350
52-883	52-2642	53-223	53-291	53-352
52-884	52-2656	53-224	53-292	53-354
52-892	52-2675	53-225	53-295	53-355
52-895	52-2680	53-230	53-296	53-357
52-900	52-2694	53-232	53-298	53-360
52-901	52-2695	53-237	53-304	53-361
52-902	52-2697	53-240	53-307	53-362
52-903	52-2698	53-243	53-310	53-363
52-904	52-2718	53-244		53-3816

Airplane code numbers used in this manual are taken from these Air Force serial numbers as outlined in the following example:

RELATION BETWEEN

	AIRPLANE CODE NO.	AF SERIAL NO.	AIRPLANE TAIL NO.
EXAMPLE 1	2833	52-833	20833
EXAMPLE 2	3147	53-147	30147

Information on all KC-97L airplanes is covered in this manual. Some of the information is applicable only to certain series or groups of airplanes. This information is identified by a code reflecting that group of airplanes. Each paragraph applicable only to certain airplanes is coded next to the title. Items in illustrations applicable only to some airplanes are generally coded alongside the nomenclature. When a paragraph, illustration, or item is not coded, it applies to all airplanes.

Information which is affected by incorporation of a TCTO modification is coded by the TCTO dash number. When this is used in conjunction with the airplane code, it adds to or subtracts from that group of airplanes on which the specific TCTO has been incorporated. The TCTO's which are reflected in this manual are listed on the preceding page.

EXAMPLES OF CODES

SYMBOL	
2833	Airplane code number. Number shown is for airplane AF52-833.
▶	Means "THRU" or "AND ON"
TCTO 505	T.O. 1C-97-505. Item applies only to airplanes having this numbered Time Compliance Technical Order (TCTO) incorporated.
G	To provide for flight crew standardization, this code is used in Sections II and VIII. The code identifies checklist items peculiar to C-97G airplanes assigned for support of air refueling operations.

The symbols are put together in various combinations to specify a group of airplanes. An example code is: 2833 ▶ 3141 less TCTO 292. This code means that the information applies to each airplane that has a serial number between AF52-833 and AF53-141 inclusive, except for those airplanes which have been modified by incorporation of T.O. 1C-97-292.

FOR A PROPER INTRODUCTION

READ THE INTRODUCTORY

SCOPE. This manual must be used in conjunction with T. O. 1C-97(K)L-1-1 to obtain all the necessary information for safe and efficient operation of the KC-97L airplanes. T. O. 1C-97(K)L-1-1 is an Appendix containing the performance data. These instructions provide you with a general knowledge of the airplane, its characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized and, therefore, basic flight principles are avoided.

SOUND JUDGMENT. Instructions in this manual are for a crew inexperienced in the operation of this airplane. 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 the Flight Manual Manager, OCAMA/MMEAF, before any questionable operation is attempted which is not specifically permitted in this manual.

HOW TO BE ASSURED OF HAVING LATEST DATA. Refer to T. O. 0-1-1-3 which is issued weekly and devoted solely to the listing of all current Flight Manuals, Safety and Operational Supplements, and Checklists. Its frequency of issue and brevity assure an accurate, up-to-date listing of these publications.

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.

SAFETY AND OPERATIONAL SUPPLEMENTS. Information involving flight crew safety and the KC-97L airplane will be promptly forwarded to you by Safety Supplements issued against the basic Flight Manual. Safety Supplements covering loss of life will get to you in 48 hours by TWX (called Interim Safety Supplements); those concerning serious damage to equipment within 10 days by mail (in a formal printed form). Operational information not involving safety but of an urgent nature will be forwarded to you by Operational Supplements issued against the basic Flight Manual. These will be forwarded by TWX (interim) or by mail (formal), depending upon the urgency of the information. Interim supplements are normally replaced by formal printed supplements at an early date. Formal printed supplements are identified by red letters "SS" for safety supplements and black letters "OS" for operational supplements printed around the borders of the pages. The currency of Safety and Operational Supplements can be determined by referring to T. O. 0-1-1-3, Cargo Aircraft Safety Supplements, which is issued weekly. The title block of each supplement and the title page of the Flight Manual should also be checked to determine the effect 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. As a further aid, supplement summaries for both Safety and Operational Supplements are included in the Flight Manual following the A pages; however, these summaries can be only as current as the manual.

PAGES

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. When a Safety or Operational 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 and Operational Supplement information in your checklist to a minimum.

HOW TO GET PERSONAL COPIES. Each flight crewmember is entitled to personal copies of the Flight Manuals, Safety and Operational 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 requests. Basically, you must order the required quantities on the Numerical Index and Requirement Table (T. O. 0-1-1-3). 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.

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.

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 on AF Form 847 through Tactical Air Command Headquarters (DO, Langley AFB, Va.) to OCAMA/MMEAF, Tinker Air Force Base, Oklahoma 73145.

ABBREVIATIONS AND DEFINITIONS

NOTE

It is not intended that this list include abbreviations used in decals and markings on the airplane.

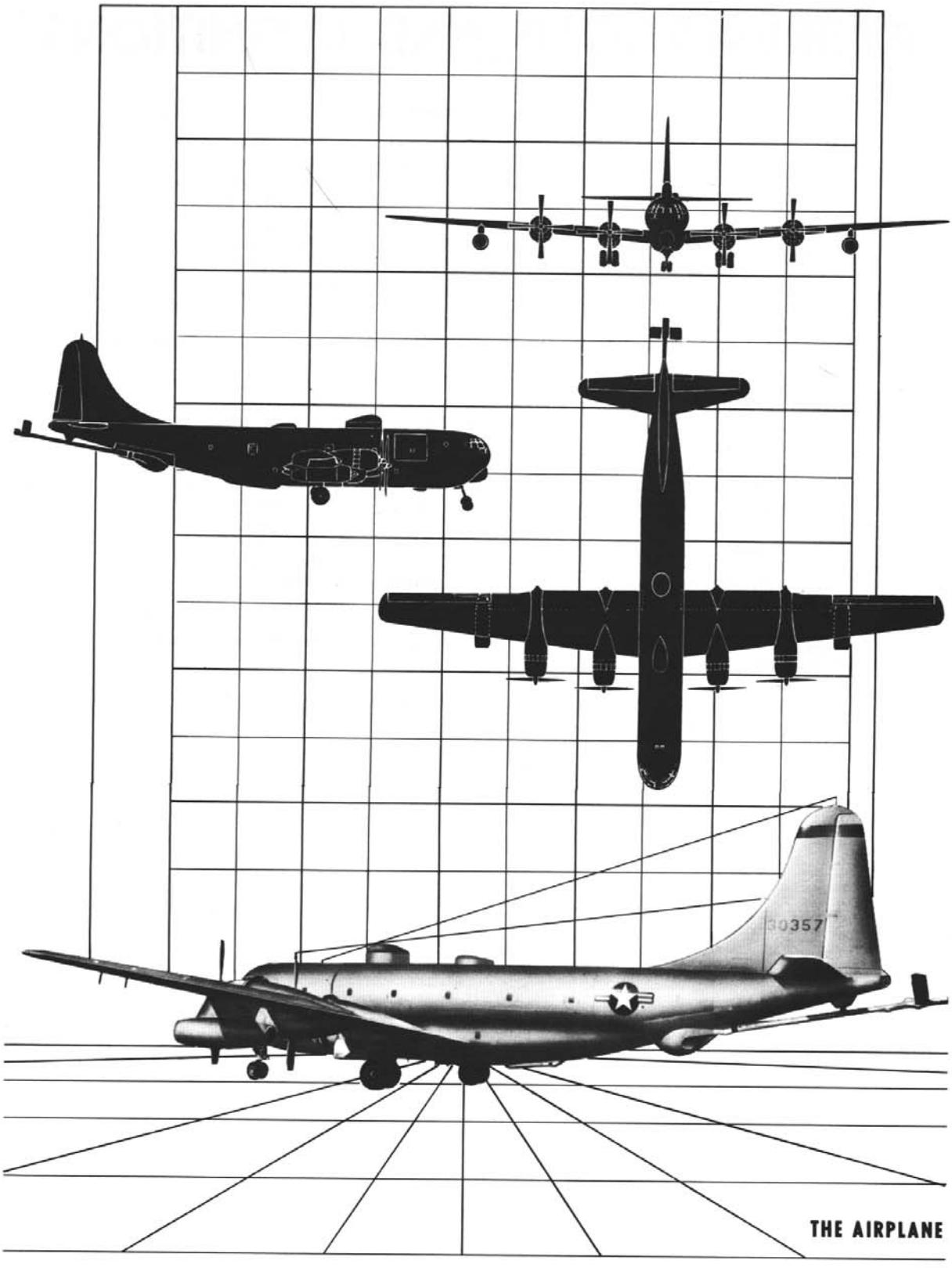
ABBREVIATIONS	DEFINITIONS
AC, ac	Alternating Current
ACCEL	Acceleration
ACP	Allied Communications Publication
ADF	Automatic Direction Finding
ADI	Anti-Detonation Injection System
ADIZ	Air Defense Identification Zone
ALT	Altitude
AM	Amplitude Modulation (Communication Radios)
AME	Equivalent AM
amp	Ampere
APU	Auxiliary Power Unit
AR	Auto Rich
A/R	Air Refueling
ATA	Actual Time of Arrival
BHP	Brake Horsepower
BMEP	Brake Mean Effective Pressure
(BO)	Boom Operator
°C	Degrees Centigrade
CAS	Calibrated Airspeed (Indicated Airspeed Corrected for Position Error)
CAT.	Carburetor Air Temperature (Degrees Centigrade)
CB	Circuit Breaker
CCW	Counterclockwise
CFG	Cowl Flap Gap (Inches)
CG, cg	Center of Gravity
CHT	Cylinder Head Temperature (Degrees Centigrade)
COMP	Compressibility
CONT	Continue or Continued
CORR	Correction or Corrected
(CP)	Copilot
C/R	Climb Rate (Feet per Minute)
CW	Clockwise
(CW)	Continuous Wave
CWG	Closed Wastegate
CWT	Center Wing Tank
CYL	Cylinder
DC, dc	Direct Current
D/F	Direction Finding
DIST	Distance
DN	Down
DR	Dead Reckoning
(E)	Engineer

ABBREVIATIONS	DEFINITIONS
EAS	Equivalent Airspeed (Calibrated Airspeed Corrected for Compressibility)
EBP	Exhaust Back Pressure
ENG	Engine
EPW	Equivalent Performance Weight
EST	Estimated
ETA	Estimated Time of Arrival
°F	Degrees Fahrenheit
FAA	Federal Aviation Agency
FF	Fuel Flow
fps	Feet per Second
FT, ft	Feet
FWD	Forward
G	Acceleration of Gravity
GAL	Gallons
(GC)	Ground Crew
GCA	Ground Controlled Approach
GMT	Greenwich Mean Time
GPM, gpm	Gallons per Minute
GR	Gross
HF	High Frequency
Hg	Mercury, in Inches (1 Inch Mercury Equals Approximately 0.49 Pounds per Square Inch)
HR	Hour
IAS	Indicated Airspeed (Instrument Reading Corrected for Instrument Error Only)
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
IN., in.	Inches
INST	Instrument
K	Knots
LB	Pounds
LOP	Line of Position
LRC	Long Range Cruise
M	Mach Number
MAC	Mean Aerodynamic Chord
MACH	The Ratio of TAS to the Local Speed of Sound
MAX	Maximum
MCW	Modulated Continuous Wave
ME	Manifold to Engine
METO	Maximum Except Takeoff
MH	Magnetic Heading

ABBREVIATIONS AND DEFINITIONS

ABBREVIATIONS	DEFINITIONS
MI	Miles
MIN	Minutes
MP	Manifold Pressure (Inches of Mercury)
(N)	Navigator
NMI	Nautical Miles
NMPP	Nautical Miles per Pound
No.	Number
OAT	Outside Air Temperature
OWE	Operating Weight Empty
P	Static Pressure in Atmosphere
(P)	Pilot
ph	Pounds per Hour
pm	Pounds per Minute
POS	Position
PPI	Plan Position Indicator
PRESS.	Pressure
PSI	Pounds per Square Inch
R/C	Rate of Climb
RCR	Runway Condition Reading
R/D	Rate of Descent
RPM, rpm	Revolutions per Minute
SIF	Selective Identification Feature
SL	Sea Level
SPR	Single Point Refueling
SQ	Square
SSB	Single Side Band
STD	Standard
T	Absolute Temperature
t	Temperature °F or °C

ABBREVIATIONS	DEFINITIONS
TAS	True Airspeed (Equivalent Airspeed Corrected for Temperature and Pressure ($EAS \times \frac{1}{\sqrt{\sigma}} = TAS$))
TBS	Turbo Boost Selector
TDC	Top Dead Center
TE	Tank to Engine
TEMP	Temperature
TME	Tank to Manifold to Engine
TO.	Takeoff
TPSI	Torque Pressure in Pounds per Square Inch
TRPM	Turbosupercharger Revolutions per Minute
UHF	Ultra High Frequency
V	Velocity
VFO	Variable Frequency Oscillator
VHF	Very High Frequency
VOR	Visual Omni Range
VW	Wind Velocity (Knots)
WT	Weight (Pounds)
XTAL	Crystal
Δ (delta)	Increment
ρ (rho)	Air Density (Slugs per Cubic Foot)
σ (sigma)	Air Density Ratio (ρ/ρ_0)


THE AIRPLANE

SECTION I
DESCRIPTION

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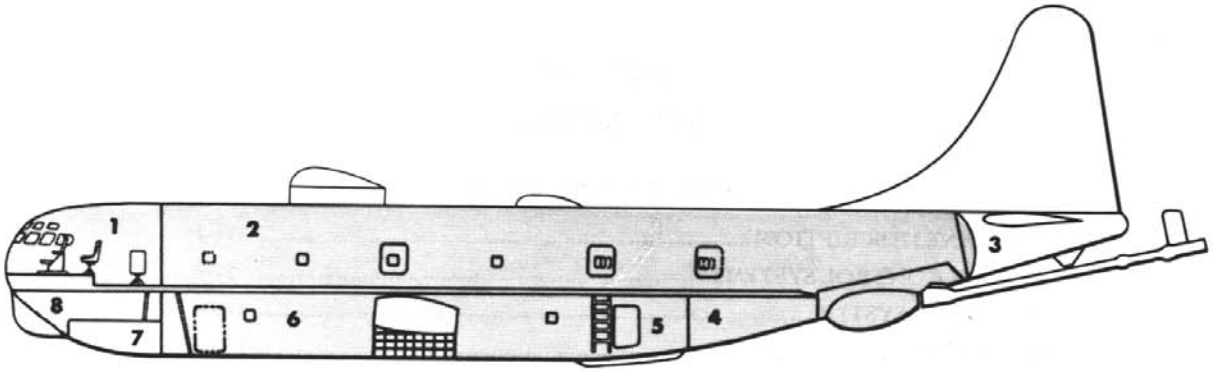
ITEM	KC-97G	KC-97L
EXTERNAL FUEL TANKS	One droppable tank under each wing	None
ENGINES	Four P&W R-4360-59B	Four P&W R-4360-59B Two J-47-25 or -25A

MAIN DIFFERENCES

Figure 1–1



PRESSURIZED AREA

1 CONTROL CABIN
2 MAIN COMPARTMENT
3 TAIL COMPARTMENT (UNPRESSURIZED)
4 STOWAGE COMPARTMENT
5 LOWER AFT COMPARTMENT
6 LOWER FORWARD COMPARTMENT
7 NOSE WHEEL WELL (UNPRESSURIZED)
8 LOWER NOSE COMPARTMENT

COMPARTMENTS

Figure 1–2

AIRPLANE DESCRIPTION

The KC-97L airplane is a jet-augmented, four-engine, long-range, high-altitude, high-speed transport equipped for use primarily as a flying boom tanker for the in-flight refueling of other airplanes. The arrangement of the A/R equipment is such that the airplane is usable either as a tanker or an extremely long range cargo and/or troop carrier without the removal of any A/R equipment.

These airplanes are powered by four Pratt and Whitney R-4360-59B reciprocating engines and two General Electric J-47-25 or -25A axial-flow jet engines. Each reciprocating engine drives a Hamilton Standard Hydromatic constant-speed propeller with full feathering and reversible pitch features. The fuselage is furnished with complete heating, ventilating, and pressurizing equipment for use either in flight or on the ground.

The control surfaces are mechanically operated and have servo tabs to provide aerodynamic boost which lightens the control forces. The rudder can also be operated by means of a hydraulic boost system. The main hydraulic supply system provides hydraulic pressure for the operation of the following; service brake system, nose wheel steering system, windshield wipers, rudder boost system, and on 22737 ▶ the A/R boom hydraulic system. The airplanes also have an independent engine-driven hydraulic system which operates the A/R fuel pumps and on 17260 ▶ 22736 operates the A/R boom hydraulic system. All other equipment in the airplane is electrically operated. For main differences, see figure 1–1.

The normal crew consists of the pilot, copilot, engineer, navigator, and boom operator.

OVERALL DIMENSIONS

Approximate overall dimensions of the airplane are as follows:

Wing Span	141 feet 3 inches
Fuselage Length	110 feet 4 inches
Height (to top of fin)	38 feet 3 inches
Height (fin folded)	26 feet 7 inches
Tread (between struts)	28 feet 6 inches
Tread (between outboard wheels)	32 feet (approx)
Overall Length	
(boom retracted)	117 feet 5 inches
(boom extended)	136 feet 10 inches

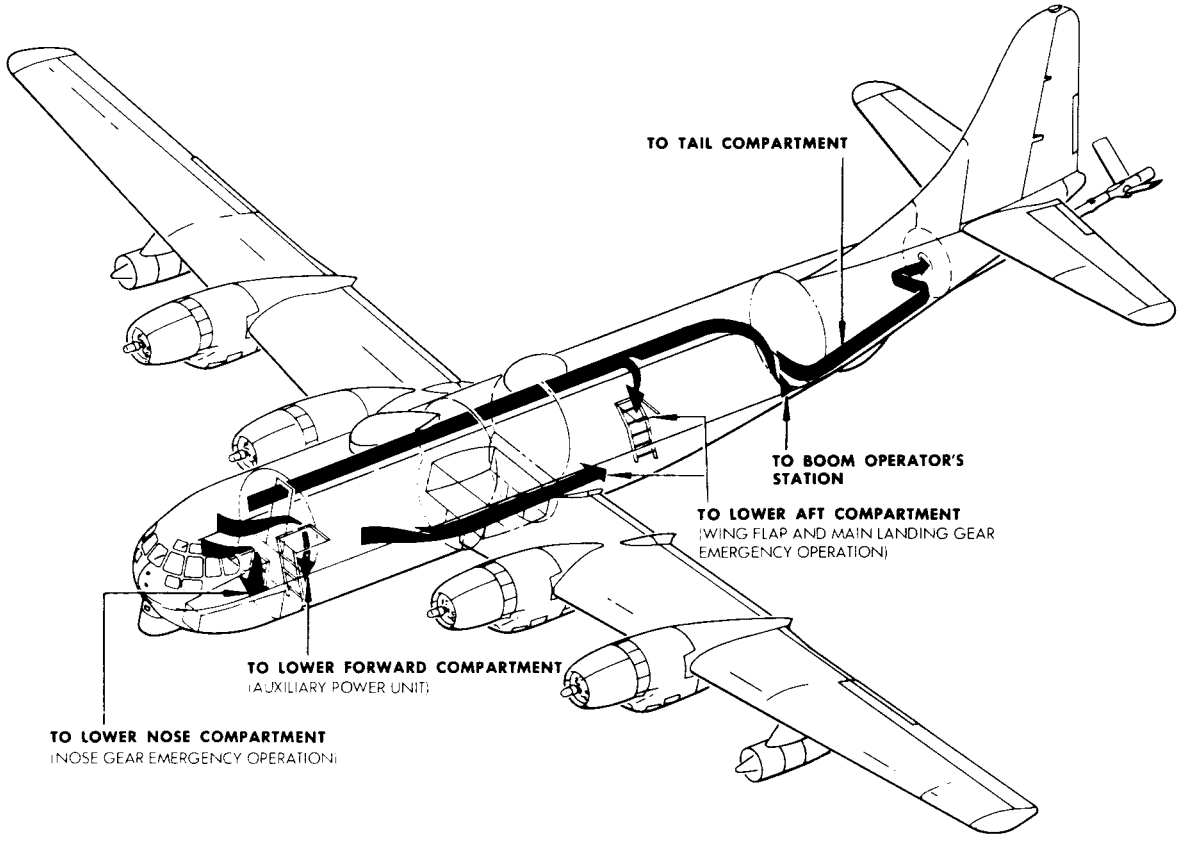
See figure 2–3 for minimum turning radius and minimum ground clearance.

GROSS WEIGHT

The design gross weight of this airplane is 153,000 pounds. For additional gross weight information, refer to Section V.

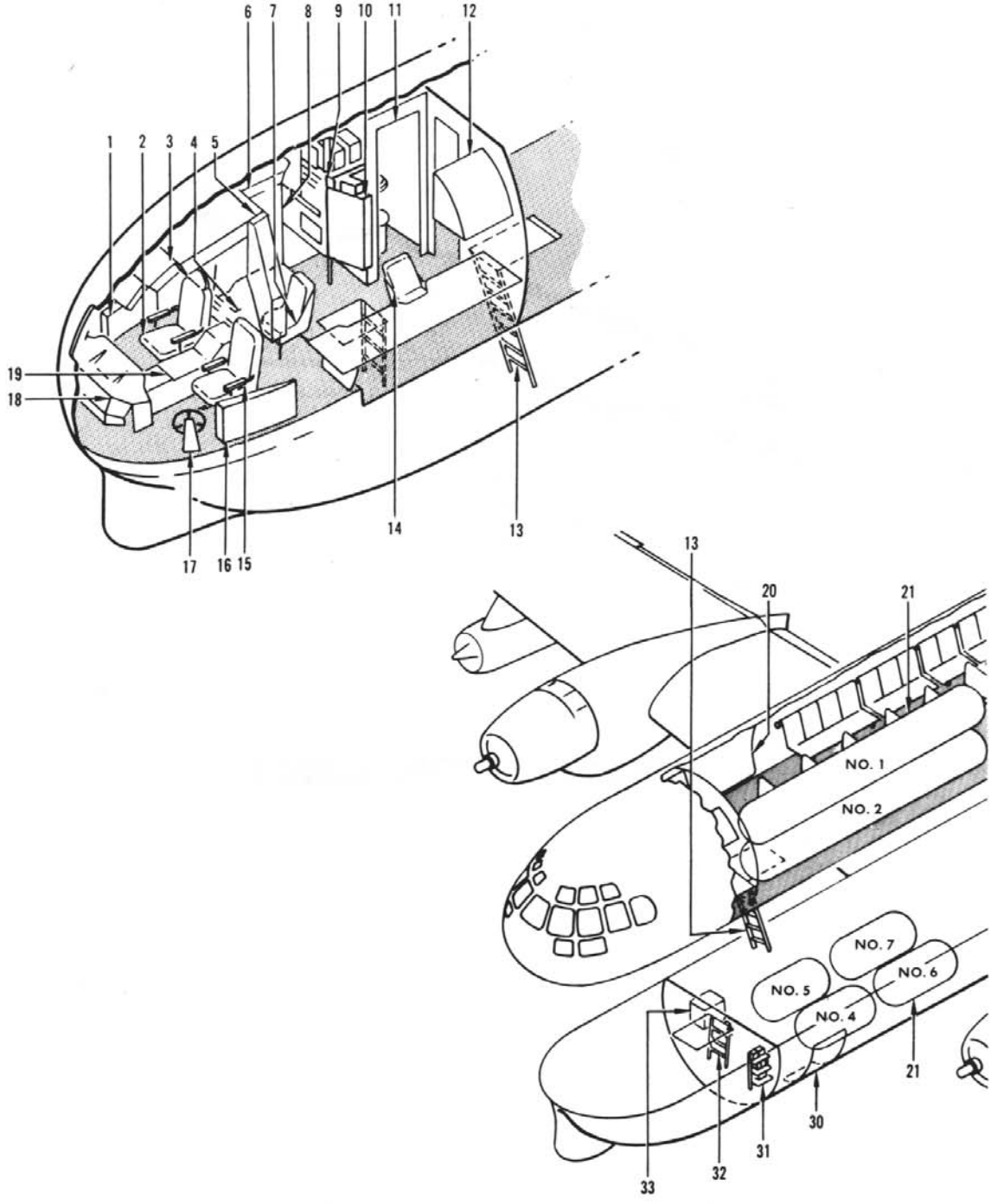
INTERIOR ARRANGEMENT AND CREW MOVEMENT

The fuselage is divided into six pressurized and two unpressurized compartments as shown in figure 1–2. Hatches and ladders are provided for extensive crew movement between compartments as shown in figure 1–3.



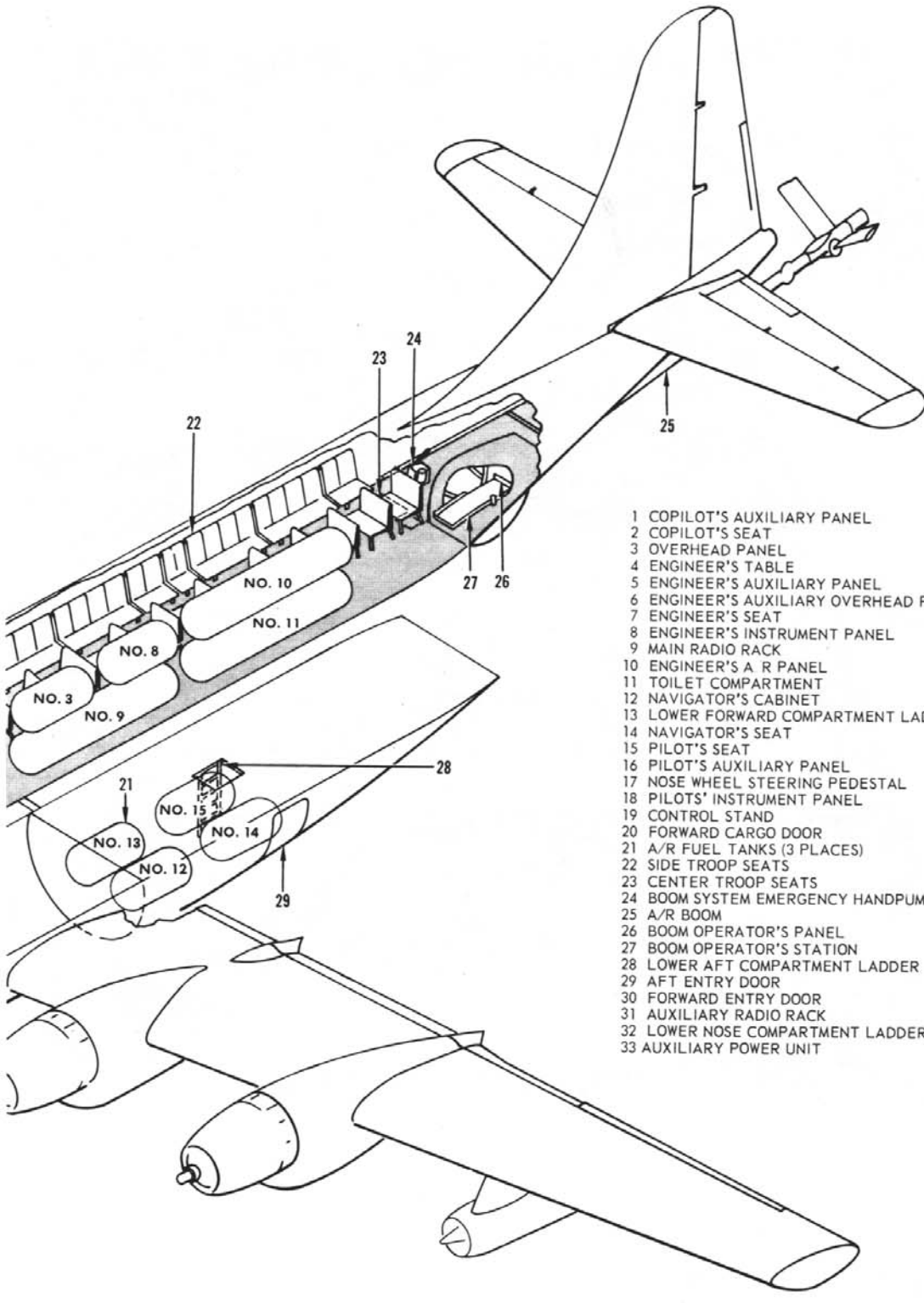
CREW MOVEMENT

Figure 1–3



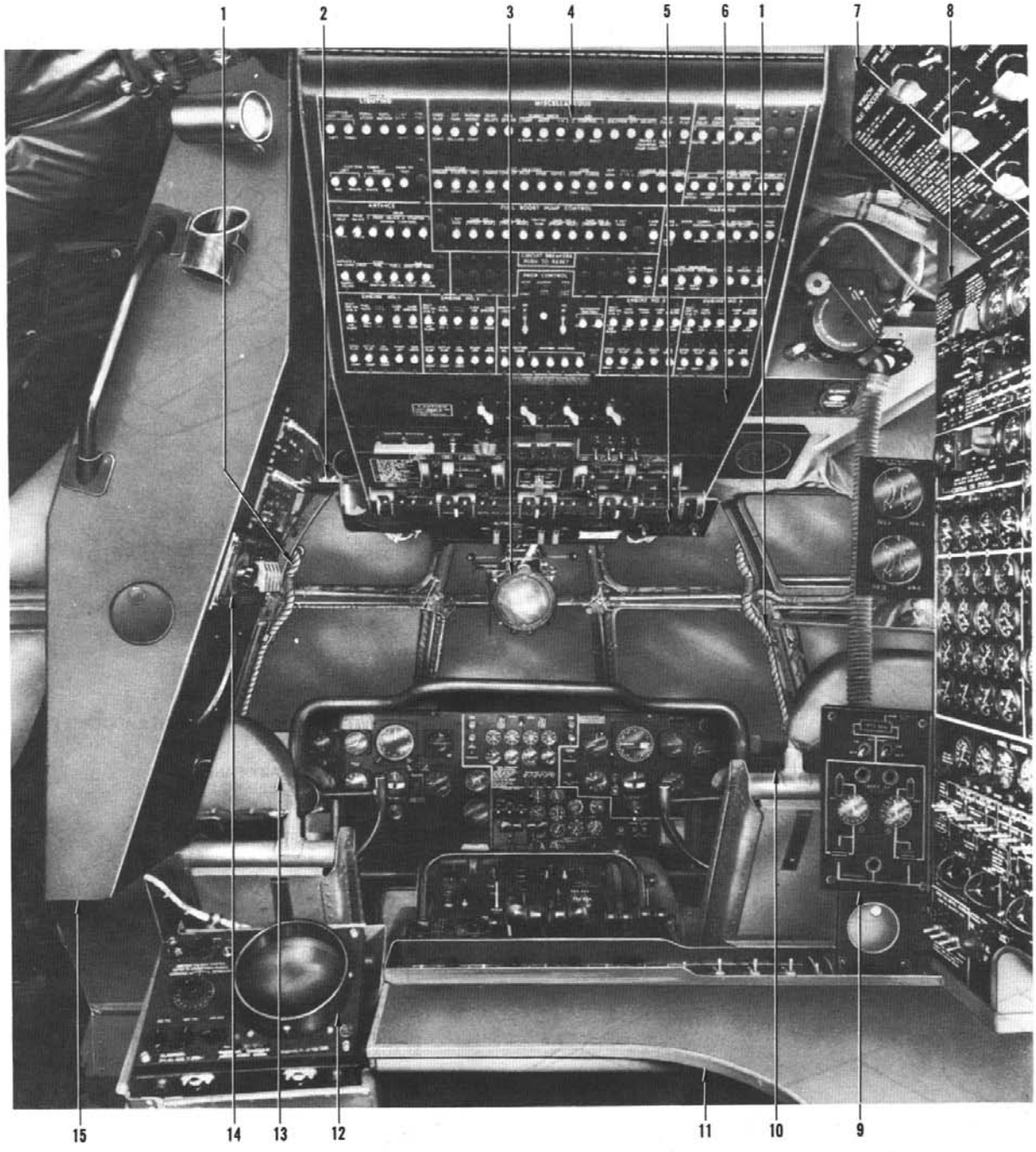
GENERAL ARRANGEMENT

Figure 1–4 (Sheet 1 of 2)



1 COPILOT'S AUXILIARY PANEL
2 COPILOT'S SEAT
3 OVERHEAD PANEL
4 ENGINEER'S TABLE
5 ENGINEER'S AUXILIARY PANEL
6 ENGINEER'S AUXILIARY OVERHEAD PANEL
7 ENGINEER'S SEAT
8 ENGINEER'S INSTRUMENT PANEL
9 MAIN RADIO RACK
10 ENGINEER'S A R PANEL
11 TOILET COMPARTMENT
12 NAVIGATOR'S CABINET
13 LOWER FORWARD COMPARTMENT LADDER (2 PLACES)
14 NAVIGATOR'S SEAT
15 PILOT'S SEAT
16 PILOT'S AUXILIARY PANEL
17 NOSE WHEEL STEERING PEDESTAL
18 PILOTS' INSTRUMENT PANEL
19 CONTROL STAND
20 FORWARD CARGO DOOR
21 A/R FUEL TANKS (3 PLACES)
22 SIDE TROOP SEATS
23 CENTER TROOP SEATS
24 BOOM SYSTEM EMERGENCY HANDPUMP
25 A/R BOOM
26 BOOM OPERATOR'S PANEL
27 BOOM OPERATOR'S STATION
28 LOWER AFT COMPARTMENT LADDER
29 AFT ENTRY DOOR
30 FORWARD ENTRY DOOR
31 AUXILIARY RADIO RACK
32 LOWER NOSE COMPARTMENT LADDER
33 AUXILIARY POWER UNIT

Figure 1–4 (Sheet 2 of 2)



1 ESCAPE ROPE (2 PLACES)
2 EMERGENCY BRAKE LEVERS
3 SEARCH RADAR INDICATOR
4 OVERHEAD CIRCUIT BREAKER PANEL
5 JET ENGINE CONTROL PANEL
6 OVERHEAD PANEL
7 ENGINEER'S AUXILIARY OVERHEAD PANEL
8 ENGINEER'S INSTRUMENT PANEL
9 JET ENGINE FUEL MANAGEMENT PANEL
10 COPILOT'S STATION
11 ENGINEER'S STATION
12 IGNITION ANALYZER
13 PILOT'S STATION
14 IGNITION ANALYZER SWITCH PANEL
15 ENGINEER'S AUXILIARY PANEL

CONTROL CABIN (TYPICAL)

Figure 1–5

ENGINE CONTROL SYSTEMS

The airplane is powered by four Pratt and Whitney R-4360-59B, 28-cylinder, aircooled engines. The engines are equipped with a low-tension ignition system and a torquemeter indicating system. Each engine is equipped with a single-stage, single-speed internal supercharger, and an exhaust-driven turbosupercharger. Water injection is provided for high power settings. Each engine is capable of developing a maximum (at sea level) of 3250 bhp dry (without water injection) or 3500 bhp wet (with water injection).

CARBURETOR

Each engine is equipped with a Stromberg injection carburetor. The carburetor is a rectangular-barrel, downdraft unit incorporating a throttle-actuated accelerating pump. It is equipped with a fuel enrichment valve to supply adequate fuel at high power settings, and an automatic mixture control unit to compensate for altitude and carburetor air temperature variations. Mixture control to the engine is regulated by a rotary-type idle mixture control, actuated by the throttle in idle range, and a rotary-type manual mixture control, actuated by the mixture control lever through a cable system. For details on the carburetor preheat valve, supercharger, and sheltered air door assembly, refer to INDUCTION SYSTEM and TURBOSUPERCHARGER, this section.

THROTTLES

Throttle-Actuated Equipment

Two sets of throttles (30 and 39, figure 1–15) are on the control stand. One set near the forward end of the stand is for the pilots' use and is interconnected to the other set near the aft end of the stand for the engineer's use. Movement of the throttles automatically actuates the propeller reversing switches, wing flap warning switches, and landing gear warning switches. Movement of the throttles will actuate the respective carburetor controls through a cable system. A reverse throttle lock solenoid prevents propeller reversing during flight. A propeller reverse throttle lock plate (38, figure 1–15) prevents inadvertent reversing of the propellers. A throttle lock lever (12, figure 1–15) to the right of the pilots' throttles, provides a friction braking force to hold the throttles in any desired position. With the water injection (ADI) pump switch (10, figure 1–15) ON, the water injection (ADI) system operates automatically when the throttles are opened beyond 45 inches manifold pressure, and shuts off when the throttles are closed below 41 inches manifold pressure. Refer to WATER INJECTION (ADI) SYSTEM, this section.

Throttle Operation

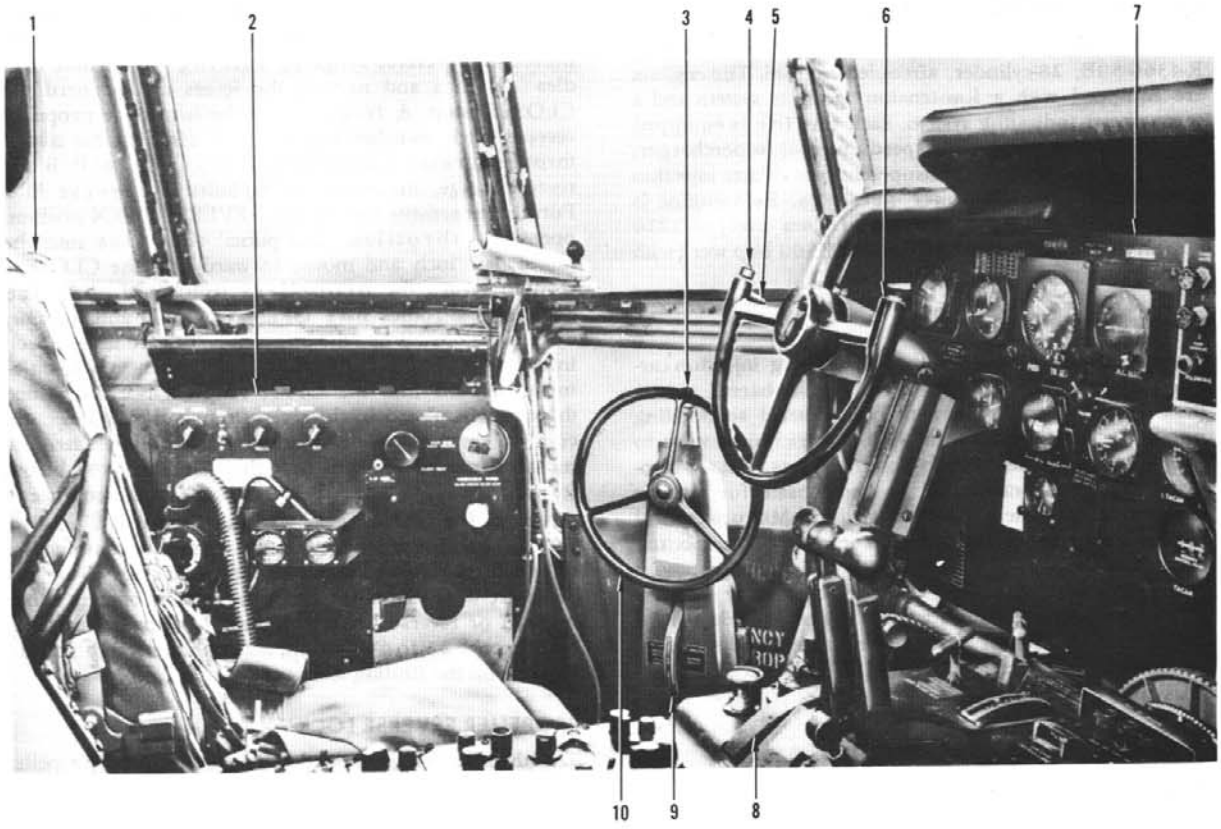
The pilots' throttles have OPEN-CLOSED-REVERSE OPEN and intermediate positions. The pilots' throttle operation is conventional in the OPEN-CLOSED range. Holding the throttles aft against the CLOSED stop maintains the throttles in forward idle. The throttles can be moved into reverse range by raising the throttle handles 1/4 inch and moving the levers aft beyond the CLOSED stop. A friction can be felt as the propeller reverse pitch switches are actuated. Holding the pilots' throttles forward against the CLOSED stop, while in the reverse range, maintains the throttles in reverse idle. Further movement toward the REVERSE OPEN position opens the throttles. The pilots' throttles must be raised 1/4 inch and moved forward over the CLOSED stop to return the propellers to forward pitch. The engineer's throttles have OPEN-CLOSED and intermediate positions. When the pilots' throttles are moved back into the REVERSE OPEN range, the engineer's throttles move forward into the OPEN range. Once the pilots' throttles are placed in the reverse range, the engineer can control reverse power operation. The pilots' throttles must be moved forward over the CLOSED stop before forward power control is restored to the engineer's throttles. The landing gear warning light will illuminate and the warning horn will sound when any combination of two throttles for engines on opposite sides of the airplane are advanced more than three-fourths open in either forward or reverse thrust with the wing flaps in any position, except 22 to 44 percent, and with the weight of the airplane on the landing gear.

PROPELLER REVERSE LOCK

The throttles are equipped with an automatic propeller reverse lock to restrict propeller reversing to ground operation only. The lock, actuated by a solenoid, consists of four mechanical latches which engage the pilots' throttle levers. The throttle lock solenoid is energized by an oleo-actuated relay. The lock is actuated to the UNLOCKED position when any of the landing gear is in contact with the ground. A time delay relay in the solenoid circuit prevents the lock from being actuated to the LOCKED position for a period of 8 seconds after the airplane is airborne. This propeller reverse lock operates in conjunction with a propeller reverse warning flag (4, figure 1–15) on the forward end of the control stand. The propeller reverse lock may be manually unlocked while the airplane is airborne or on the ground by pressing the warning flag. During normal operation, this flag serves as a position indicator for the reverse lock. The circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37). For more information concerning this flag, refer to PROPELLER SYSTEM, this section.

PROPELLER REVERSE THROTTLE LOCK PLATE

A metal propeller reverse throttle lock plate (38, figure 1–15) on the aft side of the pilots' throttle quadrant prevents the throttle from being moved inadvertently into the propeller reverse range. The lock is hinged on the aft edge and must be opened when the throttles are to be operated in the propeller reverse range.



1 PILOT'S SEAT
2 PILOT'S AUXILIARY PANEL
3 NOSE WHEEL STEERING EMERGENCY DISCONNECT BUTTON
4 PILOT'S MICROPHONE SWITCH
5 AUTOPILOT RELEASE SWITCH
6 PILOT'S CONTROL WHEEL
7 PILOTS' INSTRUMENT PANEL
8 CONTROL STAND
9 PARKING BRAKE HANDLE
10 NOSE GEAR STEERING WHEEL

PILOT'S STATION (TYPICAL)

Figure 1–6

MIXTURE CONTROLS AND MIXTURE LOCK LEVER

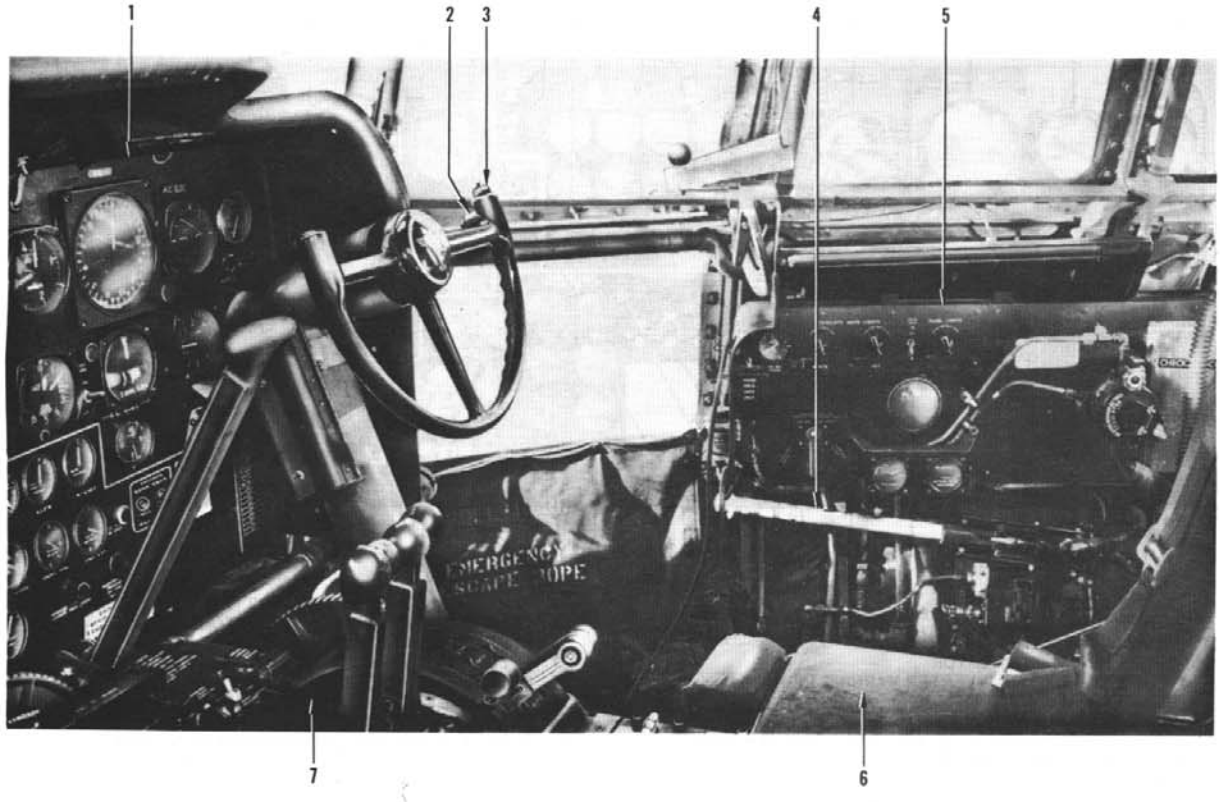
Four mixture controls (23, figure 1–15) are on aft end of the control stand. The levers have FUEL CUTOFF-AUTO LEAN-AUTO RICH and intermediate positions. Placing a lever in FUEL CUTOFF shuts off fuel flow at the carburetor. The AUTO LEAN and AUTO RICH carburetor mixture settings are obtained by placing the mixture levers in the appropriate detent position. Manual mixture control may be obtained at intermediate positions using the procedures outlined under MANUAL LEAN FUEL CONTROL, Section VII. A mixture lock lever (22, figure 1–15), adjacent to the mixture control levers, provides a friction braking force to hold the mixture control levers at any desired position.

INDUCTION SYSTEM

The induction system (figure 1–9) consists of an entry scoop, a sheltered air door, sheltered air inlet, turbosupercharger, intercooler, carburetor preheat valve, and connecting ducting. Either ram air or supercharged air may be supplied to the carburetor through a bypass door controlled by differential pressure. Supercharged carburetor air temperature is controlled by positioning of the carburetor preheat valve and intercooler flap. For details on turbosupercharger and turbosupercharger controls, refer to TURBOSUPERCHARGER, this section.

Sheltered Air Door

An electrically operated sheltered air door and sheltered air inlet are located aft of the entry scoop on the bottom of the air intake duct. This door enables either ram air or sheltered air to be supplied to the induction system. With the door in the sheltered position, ram air is shut off from the induction system and sheltered air is supplied through the sheltered air inlet. This causes a rapid change of direction in the flow of air as it enters the induction system, which aids in separating moisture particles from the induction air. An air filter is provided in the inlet to filter dust particles from the air.



1 PILOTS' INSTRUMENT PANEL
2 AUTOPILOT RELEASE SWITCH
3 COPILOT'S MICROPHONE SWITCH
4 HYDRAULIC HANDPUMP
5 COPILOT'S AUXILIARY PANEL
6 COPILOT'S SEAT
7 CONTROL STAND

COPILOT'S STATION (TYPICAL)

Figure 1–7

Carburetor Preheat Valve

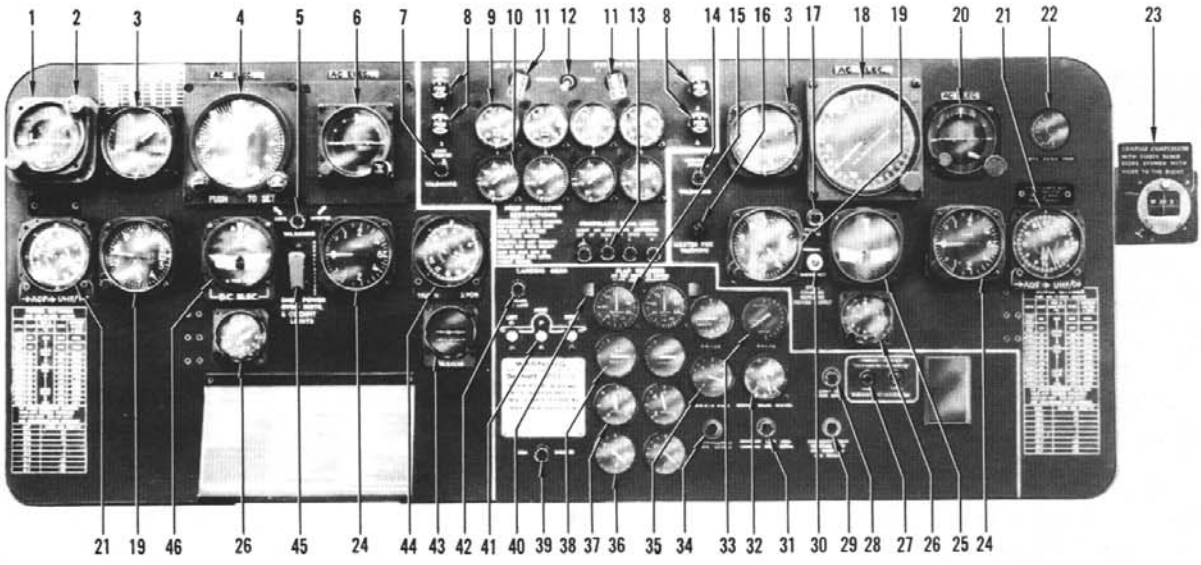
An electrically operated, gate-type carburetor preheat valve (figure 1–9) is located downstream from the compressor. It is used to preheat supercharged carburetor air. When the valve is in the closed position, all of the supercharged air is directed through the induction system. In the open position, a portion of the supercharged air is bled off and allowed to recirculate through the compressor. This results in higher carburetor air temperature.

Carburetor Air Switches

Four carburetor air switches (41, figure 1–21) on the engineer's instrument panel control operation of the sheltered air doors. The switches have RAM–SHELT positions. Gang bars permit actuation of all four switches to either position at the same time. In the RAM position, air enters the air intake scoop and passes directly into the induction system. In the SHELT position, the sheltered air door closes the air intake scoop and allows air to enter the induction system through a filter in the bottom of the air scoop. The circuit is supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel and the main circuit breaker panel (1 and 8, figure 1–37).

Carburetor Preheat Switches

Four OPEN–OFF–CLOSE carburetor preheat switches (38, figure 1–21) on the engineer's instrument panel control the carburetor preheat valves. The switches are spring-loaded only from the OPEN position to the OFF position. Gang bars permit actuation of all four switches to any position at the same time. The supercharger must be operating before preheat is possible. The circuit is supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).



1 COURSE INDICATOR
2 MARKER BEACON LIGHT
3 AIRSPEED INDICATOR (2 PLACES9
4 PILOT'S HEADING INDICATOR
5 PILOT'S INSTRUMENT INVERTER WARNING LIGHT
6 PILOT'S ATTITUDE INDICATOR
7 MAIN INVERTER WARNING LIGHT
8 MANIFOLD PRESSURE PURGE VALVE BUTTONS (2 PLACES)
9 MANIFOLD PRESSURE GAGES
10 TACHOMETERS
11 JET ENGINE FUEL-OIL EMERGENCY SHUTOFF VALVE T-HANDLE (2 PLACES)
12 JET ENGINE FIRE DETECTION TEST SWITCH
13 RPM LIMIT LIGHTS
14 AUTOPILOT INVERTER WARNING LIGHT
15 JET ENGINE TACHOMETERS
16 MASTER FIRE WARNING LIGHT
17 HEADING INDICATOR REPEATER WARNING LIGHT
18 HEADING INDICATOR REPEATER
19 ALTIMETER (2 PLACES)
20 COPILOT'S ATTITUDE INDICATOR
21 RADIO MAGNETIC INDICATOR (RMI) (ADF/UHF/DF) (2 PLACES)
22 OUTSIDE AIR TEMPERATURE GAGE
23 MAGNETIC COMPASS
24 VERTICAL VELOCITY INDICATOR (2 PLACES)
25 COPILOT'S TURN AND SLIP INDICATOR
26 CLOCK (2 PLACES)
27 WHEEL WELL OVERHEAT WARNING LIGHTS
28 DOOR WARNING LIGHT
29 EMERGENCY BRAKE LOW-PRESSURE WARNING LIGHT
30 HEADING INDICATOR REPEATER EMERGENCY POWER SWITCH
31 SERVICE BRAKE LOW-PRESSURE WARNING LIGHT
32 HYDRAULIC PRESSURE GAGE (SERVICE BRAKE SYSTEM)
33 WING FLAP POSITION INDICATORS
34 MAIN HYDRAULIC LOW-PRESSURE WARNING LIGHT
35 HYDRAULIC PRESSURE GAGE (MAIN HYDRAULIC SYSTEM)
36 JET ENGINE OIL PRESSURE GAGES
37 JET ENGINE FUEL FLOWMETERS
38 JET ENGINE EXHAUST GAS TEMPERATURE GAGES
39 BOOM ENGAGED INDICATOR LIGHT
40 JET ENGINE INSTRUMENT LIGHTS
41 LANDING GEAR POSITION INDICATORS
42 LANDING GEAR WARNING LIGHT
43 RANGE INDICATOR
44 RADIO MAGNETIC INDICATOR (RMI) (TACAN/VOR)
45 PILOT'S INSTRUMENT INVERTER EMERGENCY POWER SWITCH
46 PILOT'S TURN AND SLIP INDICATOR

PILOTS' INSTRUMENT PANEL (TYPICAL)

Figure 1–8

Carburetor Air Temperature Gages

A resistance bulb-type carburetor air temperature gage (76, figure 1–21) for each engine induction system is located on the engineer's instrument panel. The gages indicate carburetor inlet air temperature in degrees centigrade. The circuits are supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Intercooler

An intercooler (figure 1–9), located downstream from the turbocompressor, is used to provide cooling of supercharged air to the carburetor. Intercooler operation is controlled electrically by positioning of the intercooler flap switch. The flap limits the amount of ram air passing through the intercooler.

Intercooler Flap Switches. Four OPEN–OFF–CLOSED intercooler flap switches (39, figure 1–21) on the engineer's instrument panel control the intercooler flaps. The switches are spring-loaded to the OFF position from both the OPEN and the CLOSED positions. Holding the switch in the OPEN position increases the amount of flap opening, allowing cool air to pass through the intercooler. Holding the switch in the CLOSED position decreases the amount of flap opening. Gang bars permit actuation of all four switches to either position at the same time. The circuit is supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Intercooler Flap Position Indicators. Four intercooler flap position indicators (73, figure 1–21) on the engineer's instrument panel show intercooler flap positions in inches of opening. The reading is taken from the flap screw driving mechanism. The indicator circuits are supplied with 26-volt ac power through the four engine instrument fuses on the ac power panel (15, figure 1–37).

Turbosupercharger

The turbosupercharger (figure 1–9) is an exhaust-driven, centrifugal air compressor which is used to maintain carburetor inlet pressure at altitude by compressing intake air above the existing atmospheric pressure. This results in greater power output, fuel economy, and better performance of the engine during high altitude cruising operation. The output of the compressor is increased or decreased by closing or opening the wastegate. Closing the wastegate directs more exhaust gases against the turbine which causes the compressor to rotate at higher speeds, resulting in a higher manifold pressure. The wastegate is controlled by an automatic control system or a manual control system. A small percentage of the compressor output is used to pressurize the cabin. A solenoid brake is incorporated in the wastegate motor which locks the motor when it is not receiving power. An integral oil pump provides lubrication to the turbosupercharger from a separate oil tank mounted inside the engine oil tank.

Turbosupercharger Automatic Control System

The turbosupercharger automatic control system (figure 1–12) regulates the wastegate position to maintain approximately constant carburetor inlet pressure within the limits set by the governor. It is composed of an independent wastegate control and bridge circuit for each engine, all connected to a single turbo control unit. The turbo control unit consists of the TBS lever (31, figure 1–15) and the turbo calibrating knobs (32, figure 1–15) for each of the wastegate bridge circuits.

Each of the wastegate bridge circuits consists of a calibrating potentiometer, a pressuretrol-actuated potentiometer, a governor-actuated potentiometer, and a wastegate-actuated potentiometer. The calibration potentiometers adjust the bridge circuits to provide equal compressor output for each engine. The pressuretrol senses carburetor inlet pressure, the governor limits maximum turbine rpm, and the wastegate potentiometer feeds back a signal to balance the bridge circuit. The turbo amplifier and the wastegate motor complete the wastegate control circuit.

The turbo amplifier senses unbalance in the bridge circuit and sends a power signal to the wastegate motor. The wastegate potentiometer rebalances the bridge circuit and the power signal ceases. The action of this control system is nearly instantaneous. With turbo amplifiers RG-7002A-5, or with late model turbo amplifier EG51A-1, the wastegate will automatically open when there is a discontinuity in the amplifier circuit (figure 1–12). Each control circuit is separately fused with a 2-ampere slow-blow fuse located in the turbo amplifier main junction box near the turbo amplifiers in the lower nose compartment. The automatic control system is supplied with 115-volt ac power through the SUPCHG CONTR fuse on 17260▶ 22700 or circuit breaker on 22701▶ on the ac power panel (15, figure 1–37).

Turbosupercharger Manual Control System

The turbosupercharger manual control system is provided in case of automatic system malfunction. A separate power source, transformer, and override switches (figure 1–12) permit the manual control system to transmit power directly to the wastegate motor. The separate power source transformer is supplied with 115-volt ac power through TURBO BOOST fuse on 17260▶ 22700 or circuit breaker on 22701▶ on the ac power panel (15, figure 1–37).

Turbosupercharger Overboost Limiting System

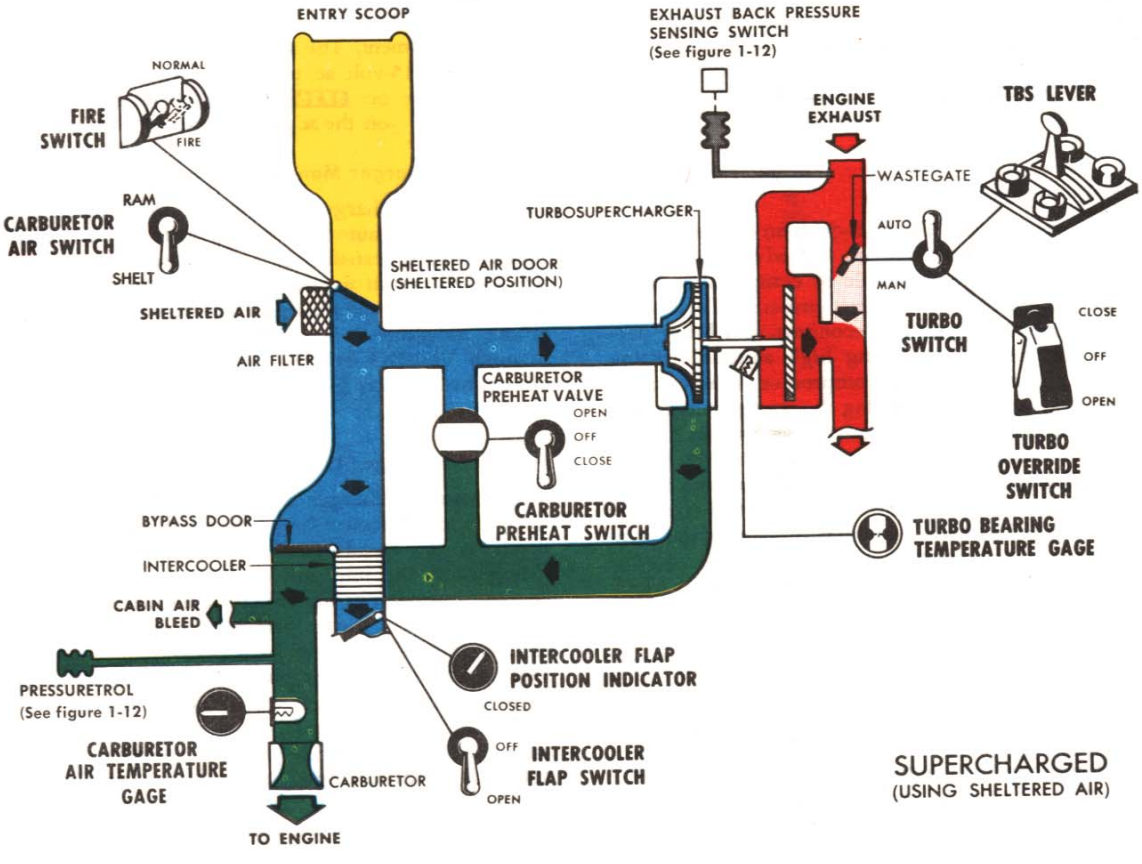
The turbosupercharger overboost limiting system is a safety device to protect the power plant from the effects of overboost due to an accidental wastegate closure by overriding either the automatic control system or the manual control system. The system consists of an exhaust back pressure sensing switch and a relay (figure 1–12) for each engine. The exhaust back pressure sensing switch, sensing an exhaust back pressure in excess of the maximum operating pressure, will cause the relay to connect the wastegate motor directly to the 230-volt ac open signal of the manual override system transformer. The wastegate will be driven open until the maximum operating pressure is reached. The exhaust back pressure sensing switch will then cause the relay to return the turbosupercharger to its previous control. The circuit breakers for the exhaust back pressure sensing switch and the relay are on the overhead circuit breaker panel (1, figure 1-37). If the circuit breaker is tripped, the wastegate will be driven to the full open position. The separate power source transformer is supplied with 115-volt ac power through the TURBO BOOST fuse on 17260▶ 22700 or circuit breaker on 22701▶ on the ac power panel (15, figure 1–37).

TBS Lever

As the TBS lever (31, figure 1–15) is advanced from ZERO toward 10, the wastegate control bridge circuits are unbalanced so that each exhaust wastegate is moved toward the closed position. When the lever is moved toward the ZERO position, the bridge circuits are unbalanced so that the wastegates are driven toward the open position. The output of each compressor is regulated by the turbosupercharger automatic control system once the initial carburetor inlet pressure has been established by positioning the TBS lever.

Turbo Calibrating Knobs

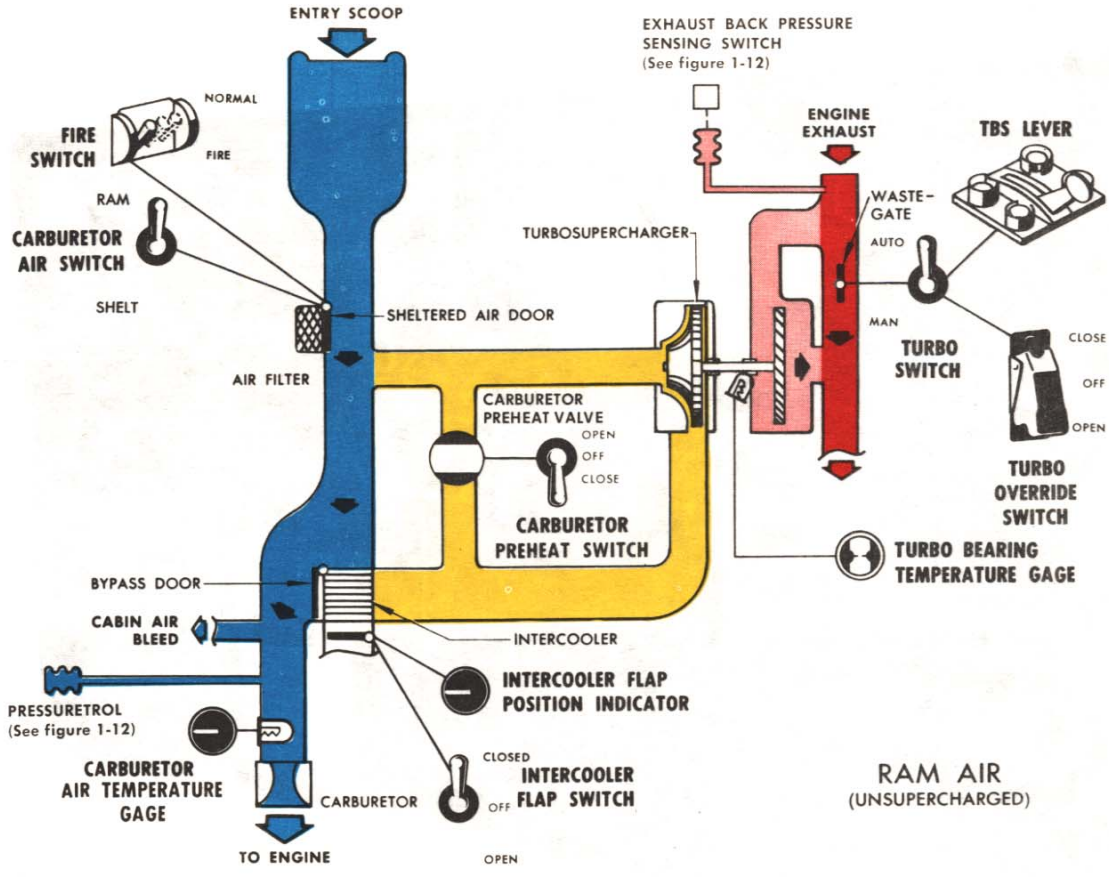
Each of the four turbo calibrating knobs (32, figure 1–15) permits adjustment of its wastegate control



EXHAUST BACK PRESSURE
UNSUPERCHARGED AIR
SUPERCHARGED AIR
ENGINE EXHAUST
STATIC AIR
ELECTRICAL

INDUCTION SYSTEM

Figure 1-9 (Sheet 1 of 2)



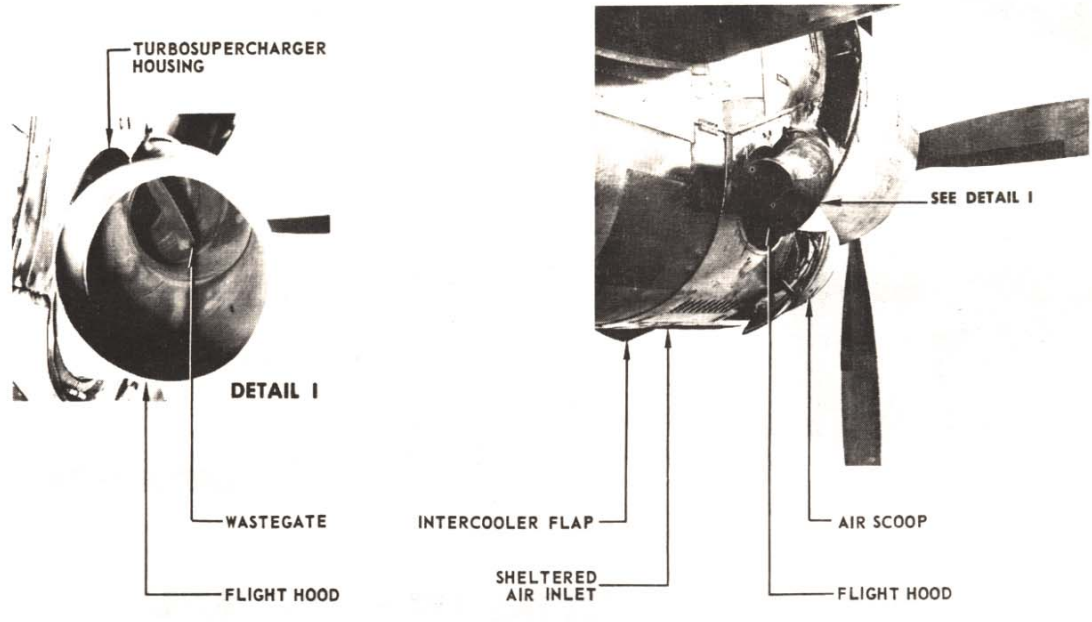
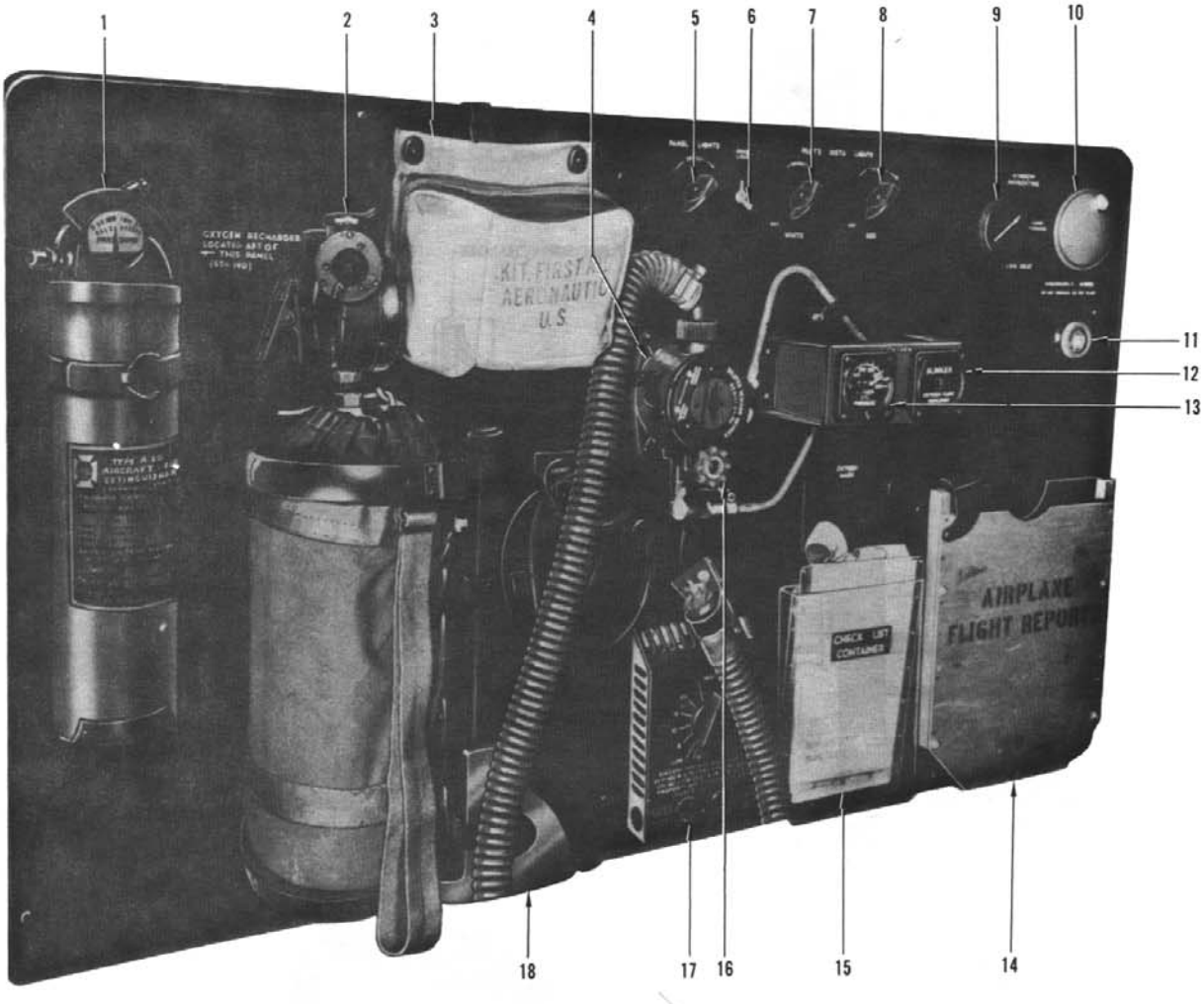
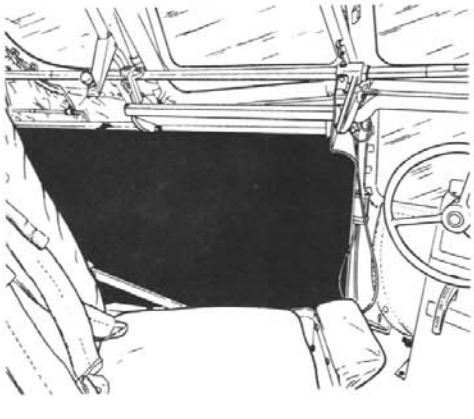


Figure 1-9 (Sheet 2 of 2)





1 FIRE EXTINGUISHER
2 OXYGEN BOTTLE
3 FIRST AID KIT
4 OXYGEN FLOW REGULATOR
5 PILOT'S AUXILIARY PANEL LIGHT RHEOSTAT
6 DOME LIGHT SWITCH
7 PILOTS' INSTRUMENT PANEL LIGHT RHEOSTAT (LEFT SIDE WHITE)
8 PILOTS' INSTRUMENT PANEL LIGHT RHEOSTAT (LEFT SIDE RED)
9 WINDOW DEFROSTING CONTROL KNOB
10 ASH TRAY
11 WINDSHIELD WIPER SPEED CONTROL KNOB
12 OXYGEN FLOW INDICATOR
13 OXYGEN PRESSURE GAGE
14 AIRPLANE FLIGHT REPORT CONTAINER
15 PILOT'S CHECKLIST CONTAINER
16 OXYGEN REGULATOR EMERGENCY VALVE KNOB
17 PILOT'S HEATED SUIT CONTROL PANEL 17260 ▶ 2859
18 CRASH AXE

PILOT'S AUXILIARY PANEL

Figure 1–10

bridge circuit to set a uniform manifold pressure for all engines. They provide a means of compensating for small variations in the individual engine and turbosupercharger control characteristics (figure 1–12). Each calibrating knob is shielded by a barrier to prevent accidental repositioning. Each barrier has an index mark. Each calibration potentiometer is protected by a 1/16-ampere fuse located in the junction box in the floor under the engineer's seat.

Turbo Switches

The turbo switches (29, figure 1–15) have AUTO–MAN positions. When these switches are placed in the AUTO position, the turbosuperchargers are controlled by the automatic control system. When placed in the MAN position, the turbosupercharger wastegates are controlled by means of the manual control system (turbo override switches).

Turbo Override Switches

The turbo override switches (28, figure 1–15) have CLOSE–OFF–OPEN positions. When the turbo switches are at MAN, nudging the override switches to the CLOSE position causes the wastegates to close, which results in a rise in manifold pressure. When the turbo switches are at MAN, nudging the override switches to the OPEN position causes the wastegates to open, which results in a drop in manifold pressure. The turbo override switches are spring-loaded from the OPEN and CLOSE positions to the OFF position, and may be guarded to the OPEN position. The manual control system is supplied with 230-volt ac power from the separate power source transformer.

CAUTION

- The turbo override switches should be operated with caution because of the fast action of the wastegate motors and the lack of governor overspeed control in the manual system. Refer to TURBOSUPERCHARGER SYSTEM, Section VII.

- Do not energize all four wastegate motors with the manual override switches for more than 5 minutes continuous operation to avoid overheating the transformer.

Turbo Bearing Temperature Gages

Two dual turbo bearing temperature gages (75, figure 1–21) are installed on the forward side of the engineer's instrument panel. These gages show turbo bearing temperature in degrees centigrade. The gages provide the capability to detect impending turbo bearing failure and nozzle box cracks prior to reaching the disintegration and fire stages. Turbo bearing failures can also be detected by properly monitoring these gages. Power for the gages is 28-volt dc through circuit breakers on the ENGINE NO. 2 and ENGINE NO. 3 sections of the overhead circuit breaker panel (1, figure 1–37).

WATER INJECTION (ADI) SYSTEM

The water injection system (figure 1-13) is used to increase the power output of the engine. The system consists of two 30-US gallon water injection fluid tanks and two water injection pumps, one water injection pump and one water injection fluid tank located on the front spar in each wheel well, a water injection regulator unit on each engine, a gate-type shutoff valve on the front wing spar for the outboard engines, a gate-type shutoff valve on the aft side of the firewall in the wheel well for the inboard engines, and a manifold pressure switch on each engine. With the water injection pump operating, the system is automatically controlled by the regulator unit above 45 inches manifold pressure. The manifold pressure switch automaticallly opens the shutoff valve at 45 inches manifold pressure, allowing water injection fluid to flow to the pressure regulator, which controls the flow of fluid to the carburetor. The shutoff valve closes automatically when manifold pressure drops below 41 inches. Each water injection tank contains a water-alcohol mixture, described in figure 1-53, and supplies the two engines on that side of the airplane. Duration of the supply at 3500 BHP per engine is approximately 10 minutes.

Water Injection (ADI) Pump Switch

An ON–OFF water injection (ADI) pump switch (10, figure 1–15) on the forward end of the control stand energizes the water injection pump circuit. When the water injection pump switch is ON, both pumps supply pressure to a gate-type shutoff valve. Operation is then initiated by manifold pressure. The circuit is supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel and the main circuit breaker panel (1 and 8, figure 1–37).

Water Injection (ADI) Low-Pressure Warning Lights

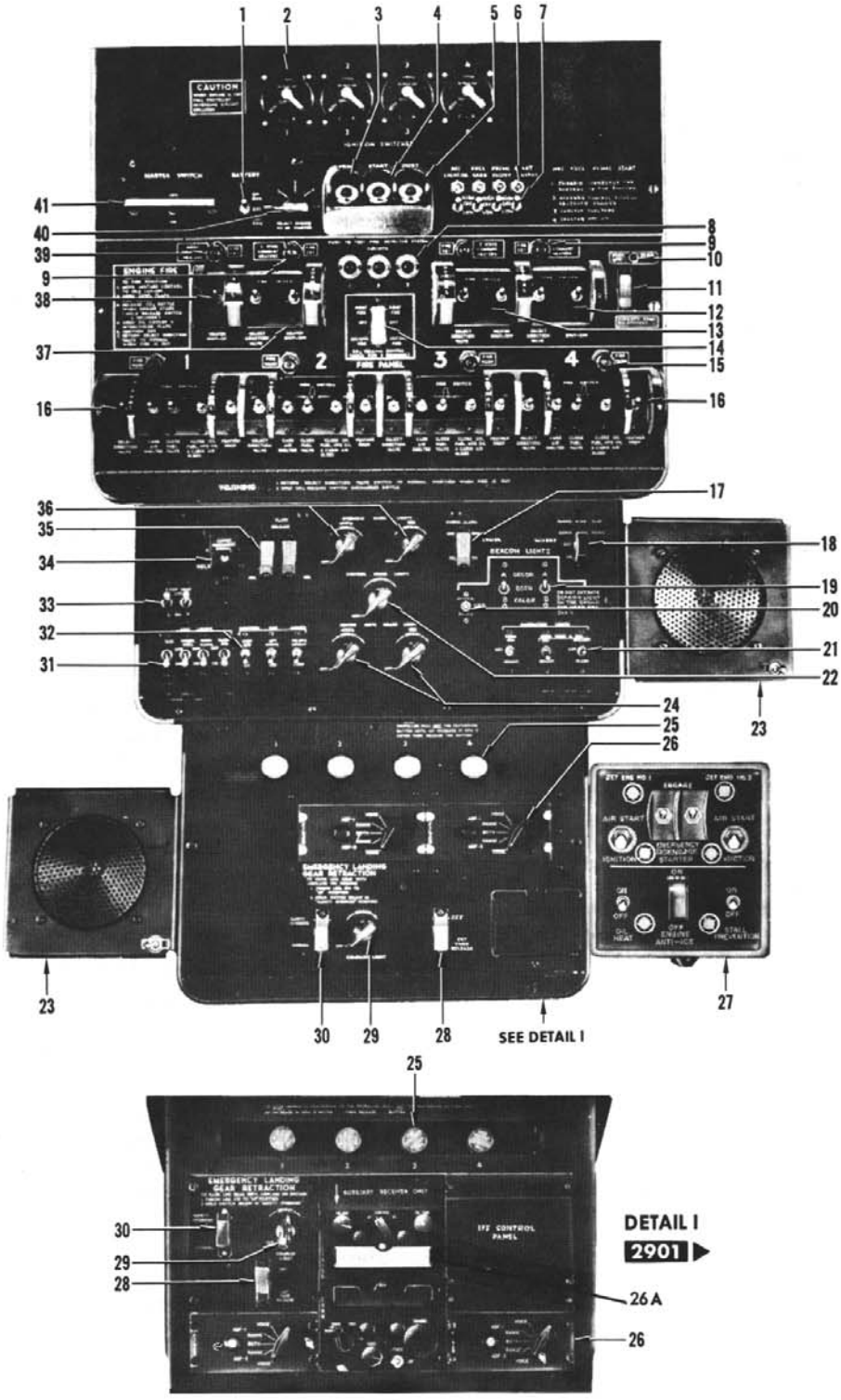
Four amber water injection (ADI) low-pressure warning lights (5, figure 1–15) are on the forward end of the control stand. Water injection fluid low pressure at the regulator is indicated if a light remains illuminated at power setting above 45 inches manifold pressure, with the water injection pump switch ON. The circuit is supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

ENGINE COOLING SYSTEM

The flow of cooling air for each engine is controlled by two ground-adjustable and seven electrically operated, flight-adjustable, cowl flaps. The cowl flaps are actuated by seven jackscrews driven by a single electric motor through a flexible drive shaft system.

Cowl Flap Switches

Four cowl flap switches (31, figure 1–21) are on the engineer's instrument panel. These switches electrically



OVERHEAD PANEL (TYPICAL)

Figure 1–11 (Sheet 1 of 2)

1 BATTERY SWITCH
2 IGNITION SWITCHES
3 PRIMER SWITCH
4 STARTER SWITCH
5 IGNITION BOOST SWITCH
6 HOT FUEL PRIME INDICATOR LIGHTS (INOPERATIVE)
7 HOT FUEL PRIME SWITCHES (INOPERATIVE)
8 FIRE DETECTOR SYSTEM TEST BUTTONS
9 ANTI-ICING HEATER FIRE WARNING LIGHTS (2 PLACES)
10 APU FIRE WARNING LIGHT
11 APU CO_2 RELEASE SWITCH
12 EMPENNAGE ANTI-ICING HEATER FIRE GANG SWITCH
13 RIGHT WING ANTI-ICING HEATER FIRE GANG SWITCH
14 CO_2 RELEASE SWITCH
15 POWER PACKAGE FIRE WARNING LIGHTS
16 POWER PACKAGE FIRE GANG BAR SWITCHES (2 PLACES)
17 EMERGENCY ALARM BELL SWITCH
18 EMERGENCY WING FLAP SWITCH
19 ANTI-COLLISION LIGHT COLOR SELECT SWITCHES
20 ANTI-COLLISION LIGHT SWITCH
21 NAVIGATION LIGHT SWITCHES
22 CONTROL STAND LIGHTS RHEOSTAT
23 LOUDSPEAKER (2 PLACES)
24 PILOT'S INSTRUMENT PANEL LIGHT RHEOSTAT
25 PROPELLER FEATHERING BUTTONS (2 PLACES)
26 RADIO COMPASS FILTER PANELS (2 PLACES)
26A UHF RADIO CONTROL PANEL
27 JET ENGINE CONTROL PANEL
28 EXTERNAL TANK RELEASE SWITCH (INOPERATIVE) (2 PLACES)
29 COMPASS LIGHT RHEOSTAT (2 PLACES)
30 LANDING GEAR EMERGENCY RETRACTION SWITCH (2 PLACES)
31 MISCELLANEOUS LIGHT SWITCHES
32 CONTROL CABIN LIGHT SWITCHES
33 PITOT HEAT SWITCHES
34 CARGO DISCHARGE SIGNAL SWITCH
35 FLARE RELEASE SWITCHES
36 OVERHEAD PANEL LIGHTS RHEOSTAT
37 LEFT WING ANTI-ICING HEATER FIRE GANG SWITCH
38 BODY HEATER FIRE SWITCH
39 BODY HEATER FIRE DETECTOR LIGHT
40 ENGINE STARTING SELECTOR SWITCH
41 ELECTRICAL MASTER SWITCH

Figure 1–11 (Sheet 2 of 2)

control the opening and closing of the cowl flaps. The switches have OPEN–OFF–CLOSE positions and are spring-loaded from the OPEN and CLOSE positions to the OFF position. Gang bars permit simultaneous actuation of all four switches to either position. The cowl flaps will remain stationary when the switch is released to OFF. The circuit is supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel and the main circuit breaker panel (1 and 8, figure 1–37).

Cowl Flap Position Indicators

The position of the cowl flaps is indicated in inches of opening by four cowl flap position indicators (78, figure 1–21) on the engineer's instrument panel. The reading is taken from the flap screw driving mechanism. The indicator circuits are supplied with 26-volt ac power through the four engine instrument fuses on the ac power panel (15, figure 1–37).

IGNITION SYSTEM

Four magnetos provide low tension ignition for each engine. The magnetos supply low voltage current through the primary ignition leads to 56 transformer coils which are mounted near the spark plugs. This low voltage is converted into higher voltage and is fed through short leads to the spark plugs. Magnetos are designated L1, L2, R1, and R2, and each magneto furnishes ignition to the left or right spark plug in two rows of cylinders. For example: Rows B and D by the L1 magneto.

NOTE

The right spark plugs are on the exhaust side of the cylinders and the left spark plugs are on the intake side of the cylinders. Cylinder rows are designated A, B, C, and D, from rear to front.

Two starting vibrators are incorporated into the right magneto circuit of each engine ignition circuit to boost magneto input at low starting rpm until the magneto output is sufficient to operate the ignition.

Ignition Switches

Four rotary-type engine ignition switches (2, figure 1–11) are on the overhead panel. Each switch has BOTH–LEFT–RIGHT–OFF positions for the right- and left-hand magneto circuits.

Ignition Boost Switch

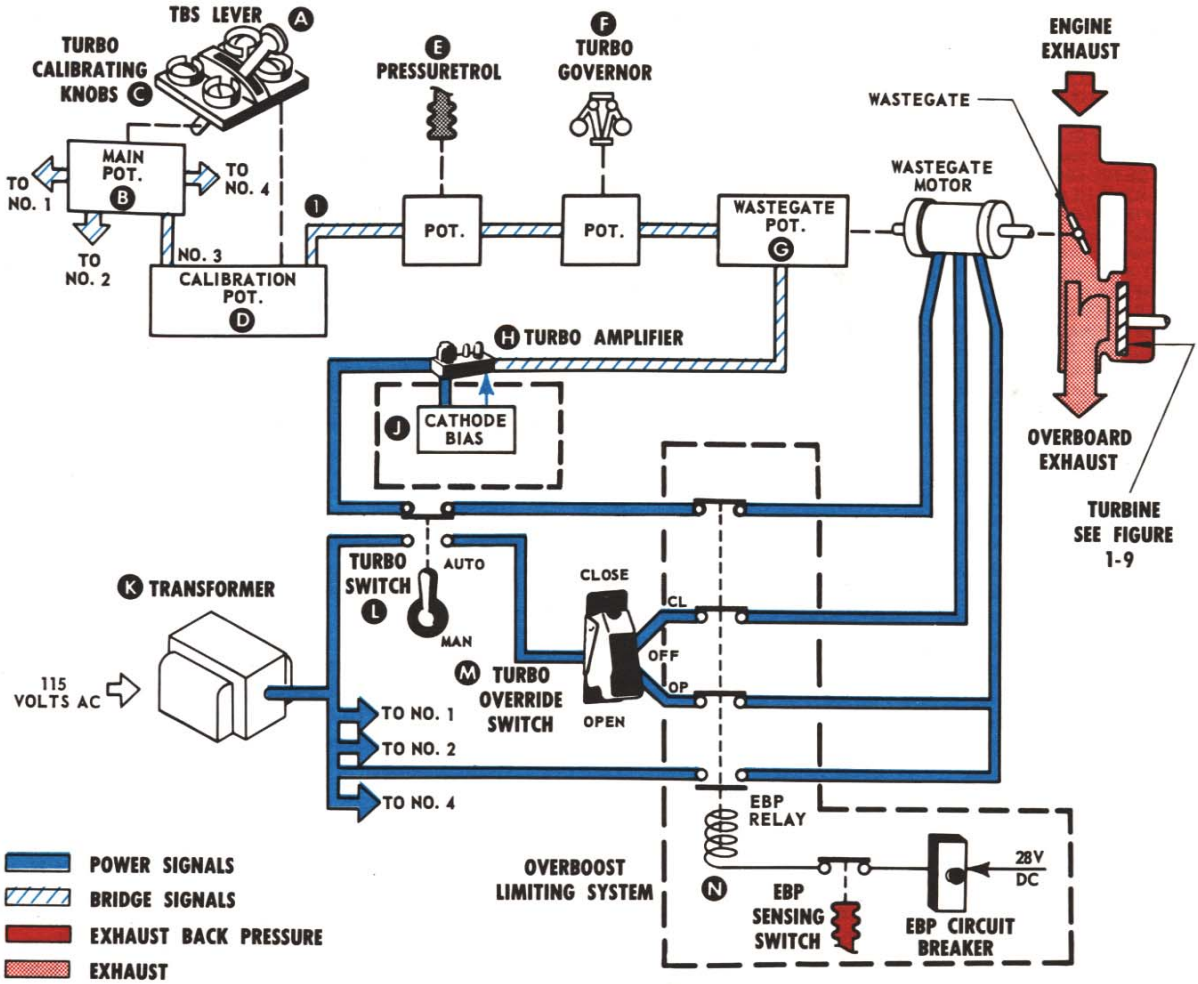
Ignition boost is selected for each engine individually by an engine starting selector switch on the overhead panel; refer to ENGINE STARTING SELECTOR SWITCH, this section. Once the engine has been selected, the starting vibrators are energized by the ignition boost switch (5, figure 1–11) on the starter control base, located on the overhead panel. Depressing the switch provides a hotter spark for starting. The circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1-37).

PRIMING SYSTEM

Engine priming is electrically controlled by a pushbutton primer switch (3, figure 1–11) adjacent to the starter switch. The engine starter selector switch controls engine selection. Each engine is primed through a solenoid valve located in the fuel line near the carburetor (figure 1–29). This valve, when actuated, allows fuel to be injected into the engine blower housing for normal or cold weather starts. Fuel is supplied to the primer solenoid by the fuel boost pumps. The primer circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Hot Fuel Prime

The hot fuel prime feature is deactivated.



1 TYPICAL FOR ALL FOUR ENGINES

A Positions main potentiometer.

B Controls initial setting of all four wastegate control bridge circuits.

C Positions calibration potentiometer.

D Permits ground adjustment of wastegate control bridge circuit to obtain uniform compressor output for each engine.

E Senses change in carburetor air inlet pressure and moves potentiometer to unbalance circuit which sends signal to turbo amplifier.

F When turbine overspeeds, governor moves potentiometer to unbalance circuit which sends an open wastegate signal to turbo amplifier.

G Positioned by wastegate motor shaft, movement balances circuit which stops signal when wastegate reaches desired position.

H Amplifies bridge circuit signals and sends power signals to wastegate motor which positions wastegate.

J Provides a cathode bias signal to the first stage of the amplifier. This bias signal will maintain an open wastegate signal in the event of a broken bridge circuit lead or similar electrical interruption.

K Separate power source.

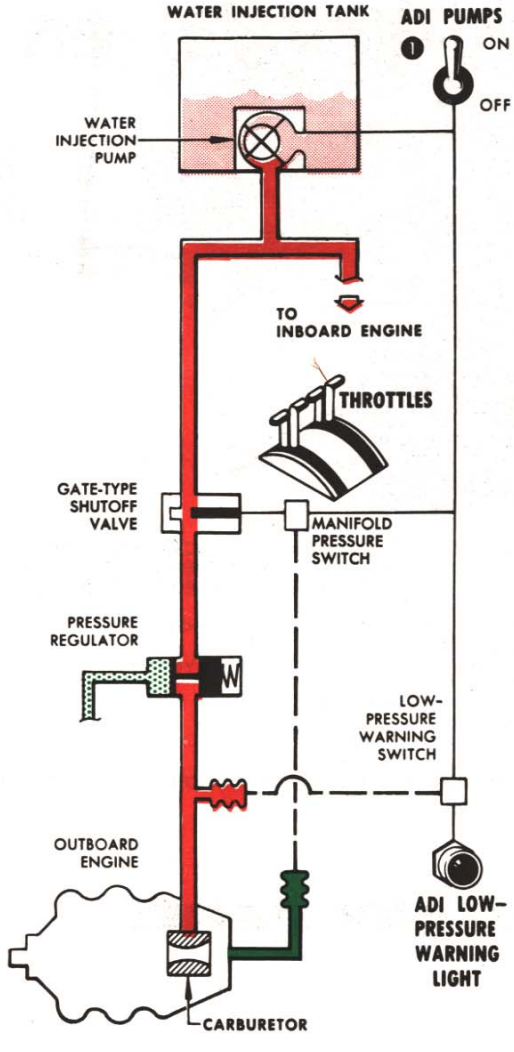
L Allows selection of either manual or automatic operation. Manual position allows operation of wastegate motor from separate power source.

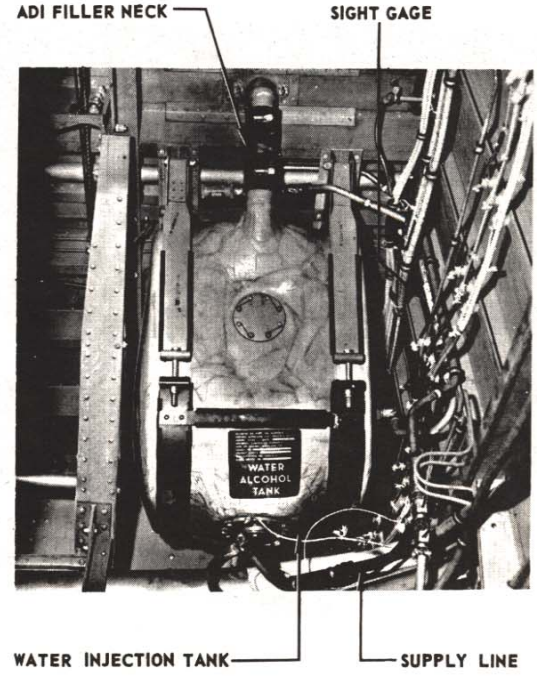
M Controls power from separate source to wastegate motor when turbo switch is on manual.

N Excessive exhaust back pressure (EBP) will deenergize EBP relay which disconnects both the automatic and manual systems and connects the separate power source to drive the wastegate open. Pulling the EXHAUST BACK PRESS circuit breaker on the overhead circuit breaker panel will also deenergize the EBP relay and have the same effect on the control systems as excessive exhaust back pressure.

TURBOSUPERCHARGER CONTROL SYSTEM

Figure 1–12





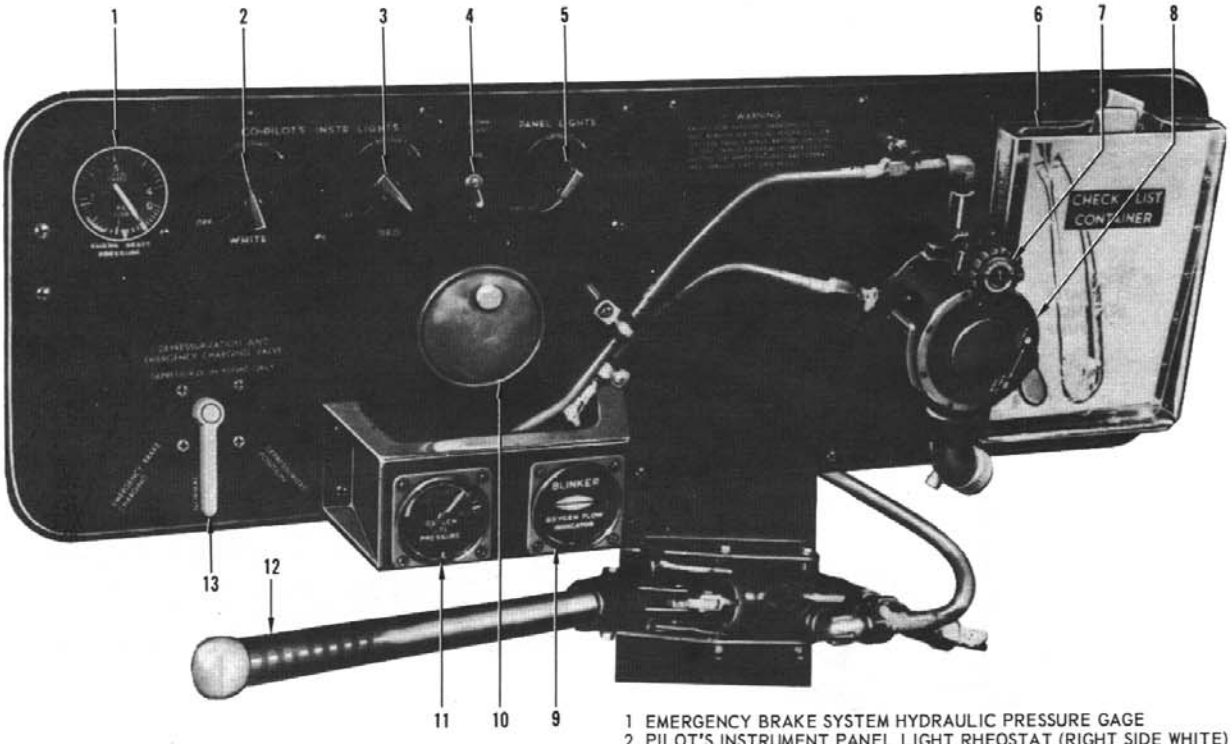
1 This switch operates ADI system for all engines (one engine shown).

PRESSURE
SUPPLY
CARBURETOR FUEL PRESSURE
MANIFOLD PRESSURE
MECHANICAL
ELECTRICAL

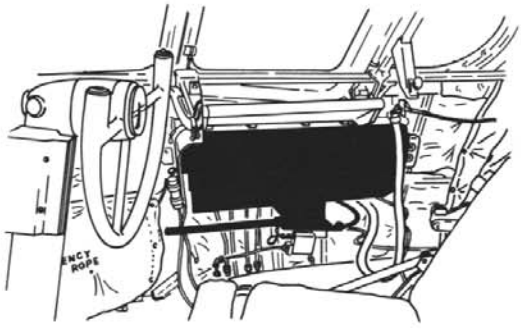
ADI PUMPS SWITCH ON, MANIFOLD PRESSURE ABOVE 45 INCHES

WATER INJECTION SYSTEM

Figure 1–13

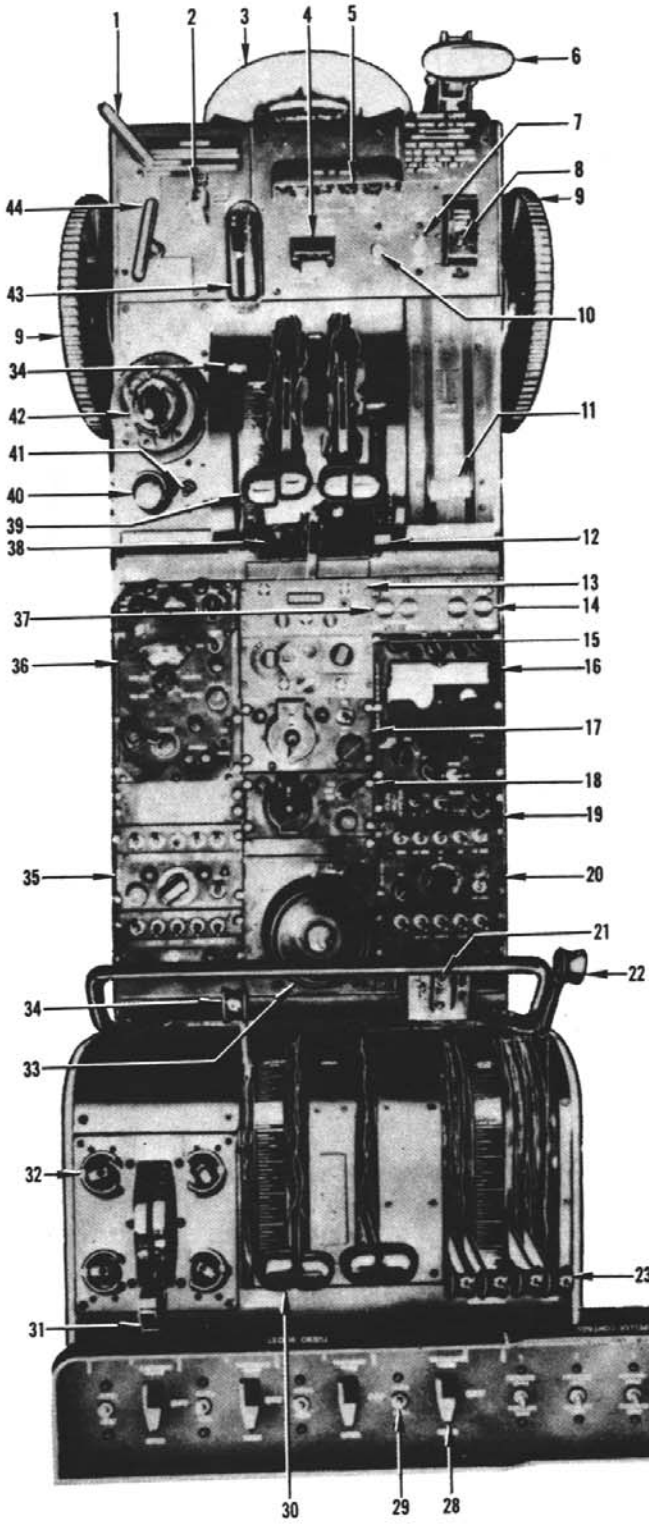


1 EMERGENCY BRAKE SYSTEM HYDRAULIC PRESSURE GAGE
2 PILOT'S INSTRUMENT PANEL LIGHT RHEOSTAT (RIGHT SIDE WHITE)
3 PILOT'S INSTRUMENT PANEL LIGHT RHEOSTAT (RIGHT SIDE RED)
4 DOME LIGHT SWITCH
5 COPILOT'S AUXILIARY PANEL LIGHT RHEOSTAT
6 COPILOT'S CHECKLIST CONTAINER
7 OXYGEN REGULATOR EMERGENCY VALVE KNOB
8 OXYGEN FLOW REGULATOR
9 OXYGEN FLOW INDICATOR
10 ASH TRAY
11 OXYGEN PRESSURE GAGE
12 HYDRAULIC HANDPUMP
13 DEPRESSURIZATION AND EMERGENCY CHARGING VALVE HANDLE

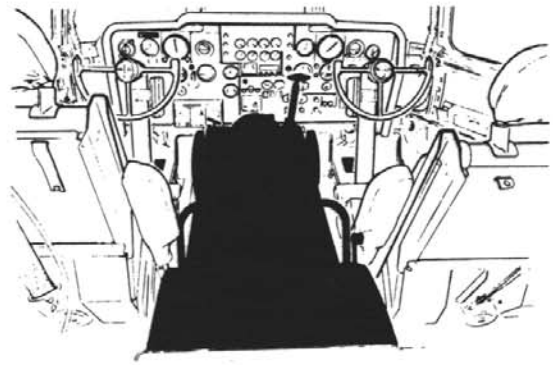


COPILOT'S AUXILIARY PANEL

Figure 1–14



1 AUTOPILOT EMERGENCY DISCONNECT HANDLE
2 RUDDER BOOST SWITCH
3 AILERON TRIM CONTROL WHEEL
4 PROPELLER REVERSE WARNING FLAG
5 WATER INJECTION (ADI) LOW-PRESSURE WARNING LIGHTS
6 SURFACE LOCK HANDLE
7 LANDING GEAR WARNING HORN RELEASE SWITCH
8 LANDING GEAR SWITCH
9 ELEVATOR TRIM CONTROL WHEEL (2 PLACES)
10 WATER INJECTION (ADI) PUMP SWITCH
11 JET ENGINE THROTTLES
12 THROTTLE LOCK LEVER
13 VHF RADIO CONTROL PANEL (1)
14 LANDING LIGHT SWITCHES
15 UHF RADIO CONTROL PANEL (1)
16 LIAISON RADIO CONTROL PANEL (AN/ARC-65)
17 VHF NAVIGATION RADIO (OMNI) CONTROL PANEL (1)
18 UHF NAVIGATION RADIO (TACAN) CONTROL PANEL (1)
19 NAVIGATION INSTRUMENT SELECTOR PANEL
20 COPILOT'S AIC-10 INTERPHONE CONTROL PANEL
21 WING FLAP SWITCH
22 MIXTURE LOCK LEVER
23 MIXTURE CONTROLS
24 SPARK ADVANCE SELECTOR SWITCHES (REMOVED OR DEACTIVATED)
25 PROPELLER AUTO CONTROL SWITCH
26 PROPELLER RESYNCHRONIZER SWITCH
27 PROPELLER GOVERNOR SELECTOR SWITCHES
28 TURBO OVERRIDE SWITCHES
29 TURBO SWITCHES
30 ENGINEER'S THROTTLES
31 TBS LEVER
32 TURBO CALIBRATING KNOBS
33 RUDDER TRIM CONTROL WHEEL
34 MASTER PROPELLER SYNCHRONIZER LEVER (2 PLACES)
35 PILOT'S AIC-10 INTERPHONE CONTROL PANEL
36 RADIO COMPASS CONTROL PANEL
37 LANDING LIGHT RETRACTION SWITCHES
38 PROPELLER REVERSE THROTTLE LOCK PLATE
39 PILOTS' THROTTLES
40 AUTOPILOT CLUTCH SWITCH
41 AUTOPILOT MASTER SWITCH
42 AUTOPILOT TURN AND PITCH CONTROLLER
43 ELEVATOR TRIM TAB INDICATOR
44 CABIN PRESSURE RELEASE VALVE HANDLE

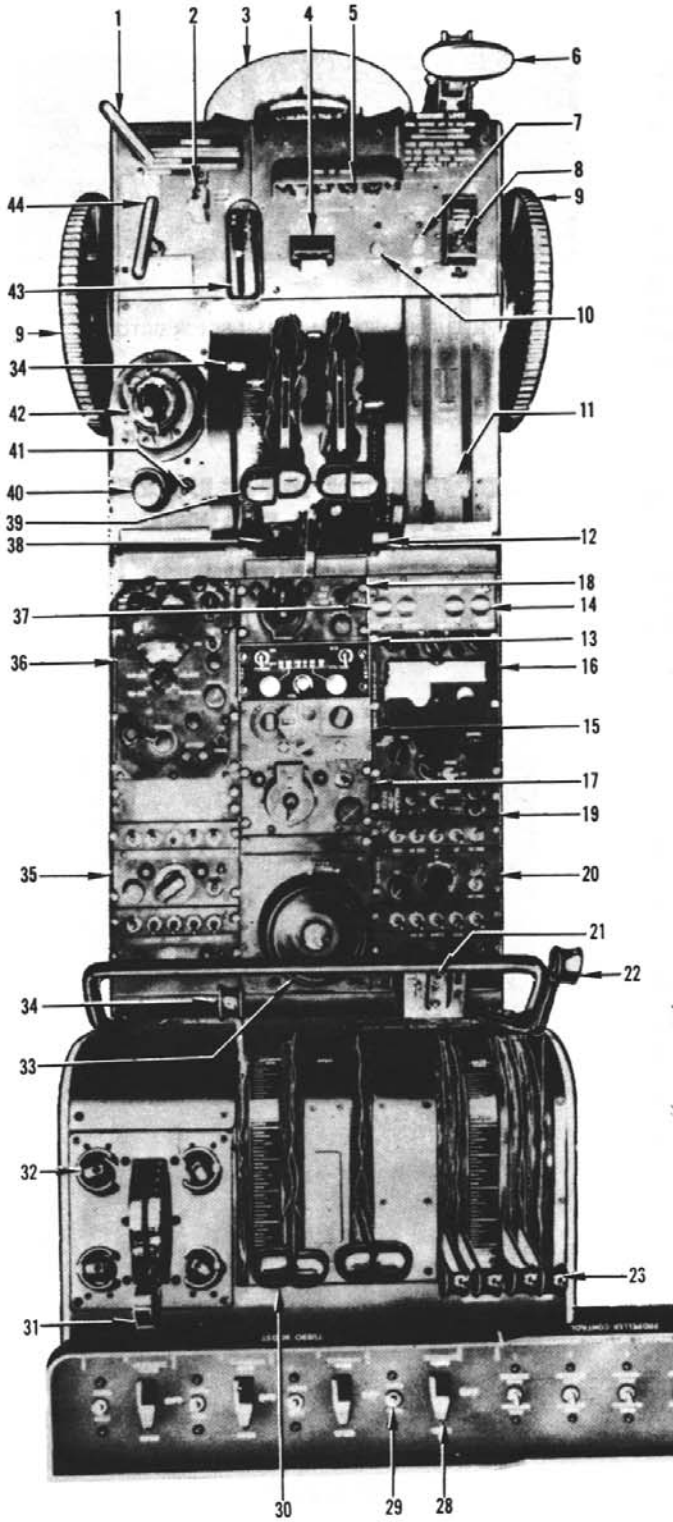


NOTES:

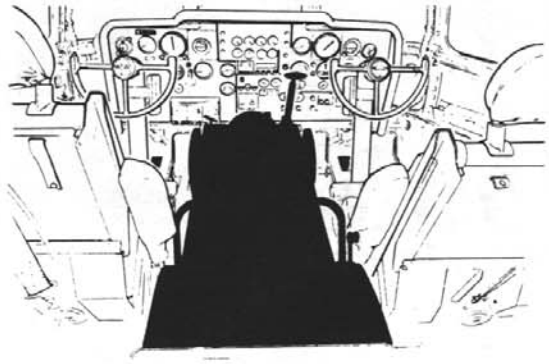
(1) 2833 ▶ 3363
AIRPLANES NOT MODIFIED BY TCTO 1C-97(K)L-505

CONTROL STAND

Figure 1-15 (Sheet 1 of 2)



1 AUTOPILOT EMERGENCY DISCONNECT HANDLE
2 RUDDER BOOST SWITCH
3 AILERON TRIM CONTROL WHEEL
4 PROPELLER REVERSE WARNING FLAG
5 WATER INJECTION (ADI) LOW-PRESSURE WARNING LIGHTS
6 SURFACE LOCK HANDLE
7 LANDING GEAR WARNING HORN RELEASE SWITCH
8 LANDING GEAR SWITCH
9 ELEVATOR TRIM CONTROL WHEEL (2 PLACES)
10 WATER INJECTION (ADI) PUMP SWITCH
11 JET ENGINE THROTTLES
12 THROTTLE LOCK LEVER
13 VHF RADIO CONTROL PANEL (1)
14 LANDING LIGHT SWITCHES
15 UHF RADIO CONTROL PANEL (1)
16 LIAISON RADIO CONTROL PANEL (AN/ARC-65)
17 VHF NAVIGATION RADIO (OMNI) CONTROL PANEL (1) (1)
18 UHF NAVIGATION RADIO (TACAN) CONTROL PANEL
19 NAVIGATION INSTRUMENT SELECTOR PANEL
20 COPILOT'S AIC-10 INTERPHONE CONTROL PANEL
21 WING FLAP SWITCH
22 MIXTURE LOCK LEVER
23 MIXTURE CONTROLS
24 SPARK ADVANCE SELECTOR SWITCHES (REMOVED OR DEACTIVATED)
25 PROPELLER AUTO CONTROL SWITCH
26 PROPELLER RESYNCHRONIZER SWITCH
27 PROPELLER GOVERNOR SELECTOR SWITCHES
28 TURBO OVERRIDE SWITCHES
29 TURBO SWITCHES
30 ENGINEER'S THROTTLES
31 TBS LEVER
32 TURBO CALIBRATING KNOBS
33 RUDDER TRIM CONTROL WHEEL
34 MASTER PROPELLER SYNCHRONIZER LEVER (2 PLACES)
35 PILOT'S AIC-10 INTERPHONE CONTROL PANEL
36 RADIO COMPASS CONTROL PANEL
37 LANDING LIGHT RETRACTION SWITCHES
38 PROPELLER REVERSE THROTTLE LOCK PLATE
39 PILOTS' THROTTLES
40 AUTOPILOT CLUTCH SWITCH
41 AUTOPILOT MASTER SWITCH
42 AUTOPILOT TURN AND PITCH CONTROLLER
43 ELEVATOR TRIM TAB INDICATOR
44 CABIN PRESSURE RELEASE VALVE HANDLE



NOTES:

(1) 22680 ▶ 33816

AIRPLANES MODIFIED BY TCTO 1C-97(K)L-505

CONTROL STAND

Figure 1-15 (Sheet 2 of 2)

STARTER SYSTEM

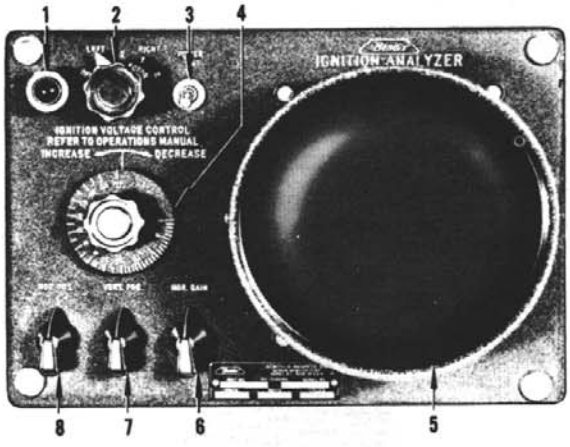
Each engine is started by a direct-cranking electrical starter mounted on the engine accessory drive case. The starter is controlled by a starter switch and an engine starting selector switch on the overhead panel.

Engine Starting Selector Switch

A rotary-type OFF–1–2–3–4 engine starting selector switch (40, figure 1–11) on the overhead panel is used to select the engine to be started. When the switch is in the 1–2–3–4 position, starter, primer, and ignition boost circuits are connected to the selected engine. When the switch is in the OFF position, the starter, primer, and ignition boost circuits are disconnected from all engines.

Starter Switch

Direct-cranking starters are controlled by a pushbutton starter switch (4, figure 1–11) on the overhead panel. The starter, primer, and ignition boost switches are grouped on a raised and guarded base. Each switch controls all four engines through a rotary-type engine starting selector switch adjacent to the raised base. The starter control circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).



1 ANALYZER POWER INDICATOR LIGHT
2 ANALYZER MAGNETO SELECTOR SWITCH
3 ANALYZER POWER SWITCH
4 VOLTAGE CONTROL SWITCH
5 ANALYZER SCREEN
6 HORIZONTAL GAIN CONTROL SWITCH
7 VERTICAL POSITION SWITCH
8 HORIZONTAL POSITION SWITCH

IGNITION ANALYZER

Figure 1–16

1 ENGINE AND MAGNETO SELECTOR SWITCH
2 RELAY-RESISTOR SWITCHES
3 SYSTEM FUSE
4 SYSTEM POWER INDICATOR LIGHT
5 SYSTEM POWER SWITCH

IGNITION ANALYZER SWITCH PANEL

Figure 1–17

IGNITION ANALYZER INTERNAL CONTROL PANEL

Figure 1–18

ENGINE INDICATORS

Ignition Analyzer System

The ignition analyzer system provides a means of detection, identification, and location of engine ignition troubles during both flight and ground operation. This analysis of ignition performance is made by interpreting and comparing the magneto voltage wave patterns of a malfunctioning system with those produced by a properly operating system, each specific trouble producing a characteristic pattern. The system consists essentially of an ignition analyzer, a switch panel, four pick-up or breaker assemblies, a relay and resistor box assembly, four filter units, and connecting leads. The ignition analyzer is located at the left of the engineer's table and directly behind the pilot's seat. The ignition analyzer switch panel (3, figure 1–22) is mounted on the engineer's auxiliary panel. The analyzer system is joined to the magneto primary circuits at the ignition switch, allowing the varying magneto primary and reflected secondary voltages to be registered as patterns on the analyzer viewing screen. These patterns will form a pattern sequence from left to right across the screen, one pattern for each cylinder fired by the selected magneto. Adjustment of horizontal and vertical position controls on the analyzer determines the position of the wave pattern on the screen; and horizontal and vertical gain controls on the analyzer enlarge the pattern horizontally and vertically for detailed study of the patterns.

Analyzer Power Supply. The regulated ac power supply circuit for the ignition analyzer is protected by a fuse or circuit breaker on the ac power panel (15, figure 1–37). The dc power supply circuit is protected by a circuit breaker on the overhead circuit breaker panel (1, figure 1–37). A system fuse (3, figure 1–17) on the ignition analyzer switch panel also protects the ac circuit to the analyzer system.

Analyzer System Power Switch. The system power switch (5, figure 1–17) on the ignition analyzer switch panel delivers power to the ignition analyzer system. The switch has two positions, ON and OFF. In the ON position, the power circuit to the ignition analyzer is closed. In the OFF position, this circuit is open.

Analyzer Power Switch. The analyzer power switch (3, filure 1–16) on the ignition analyzer controls power from the ignition analyzer switch panel to circuits within the analyzer housing. In the ON position, this circuit is closed. In the OFF position, it is open. Both the system power switch and the analyzer power switch must be in the ON position to energize the analyzer circuits.

Analyzer Magneto Selector Switch. The analyzer magneto selector switch (2, figure 1–16) on the ignition analyzer is installed to provide magneto selection when the ignition analyzer is used as a portable unit. The switch in this airborne installation operates in conjunction with the engine and magneto selector switch (1, figure 1–17) on the ignition analyzer switch panel and is always positioned to LEFT 1 when the ignition analyzer is being used.

Analyzer Horizontal Position Switch. The wave form picture on the analyzer screen is shifted to the left or right by the rotary-type horizontal position switch (8, figure 1–16) on the ignition analyzer.

Analyzer Vertical Position Switch. The wave form picture on the analyzer is shifted up or down by this rotary-type vertical position switch (7, figure 1–16) on the ignition analyzer.

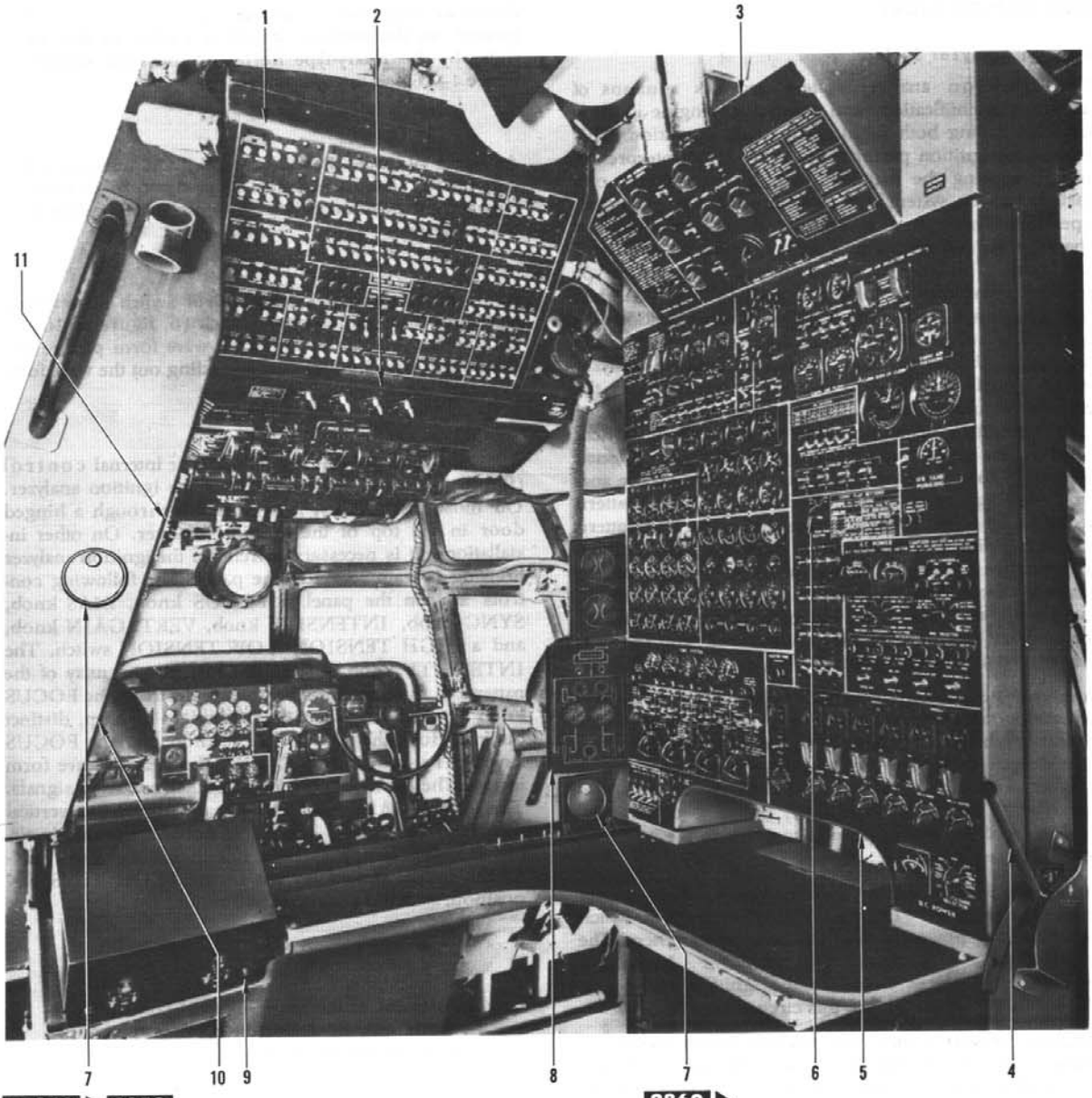
Analyzer Horizontal Gain Control Switch. The rotary-type horizontal gain control switch (6, figure 1–16) on the ignition analyzer enlarges the wave form picture in a horizontal direction, thereby spreading out the wave form to permit more detailed observation.

Analyzer Internal Control Panel. The internal control (figure 1–18) is located inside of the ignition analyzer. On most installations, it is accessible through a hinged door in the top of the ignition analyzer. On other installations, it is necessary to remove the ignition analyzer housing to gain access to the panel. The following controls are on the panel: a FOCUS knob, BIAS knob, SYNC knob, INTENSITY knob, VERT. GAIN knob, and a HIGH TENSION–LOW TENSION switch. The INTENSITY knob is used to adjust the intensity of the pattern to the degree of brightness desired. The FOCUS knob is used to adjust the pattern to a sharp, distinct outline. Both the INTENSITY knob and the FOCUS knob are coordinated to give the clearest wave form image. The BIAS knob is used to filter out stray signals. The VERT. GAIN knob enlarges the pattern in a vertical direction. The SYNC knob does not function in this airplane installation. The HIGH TENSION–LOW TENSION switch should be left in the HIGH TENSION position, as better operation will result.

Note

Adjustment of the above internal controls is to be made only by qualified electronics personnel if adjustment is required.

Engine And Magneto Selector Switch. The engine and magneto selector switch (1, figure 1–17) on the ignition analyzer switch panel provides a means of selecting the engine and each individual ignition circuit to be tested by the ignition analyzer. The selector switch is divided into four numbered quadrants, one quadrant for each engine. Each quadrant is divided into two sectors. Each sector has three switch positions, one position for the magneto firing the left side circuit of two rows or 14 cylinders, one position for the magneto firing the right side circuit of the same rows of cylinders, and one position for both of these magnetos. This makes a total of six positions for each engine and a total of 24 positions on the selector switch.



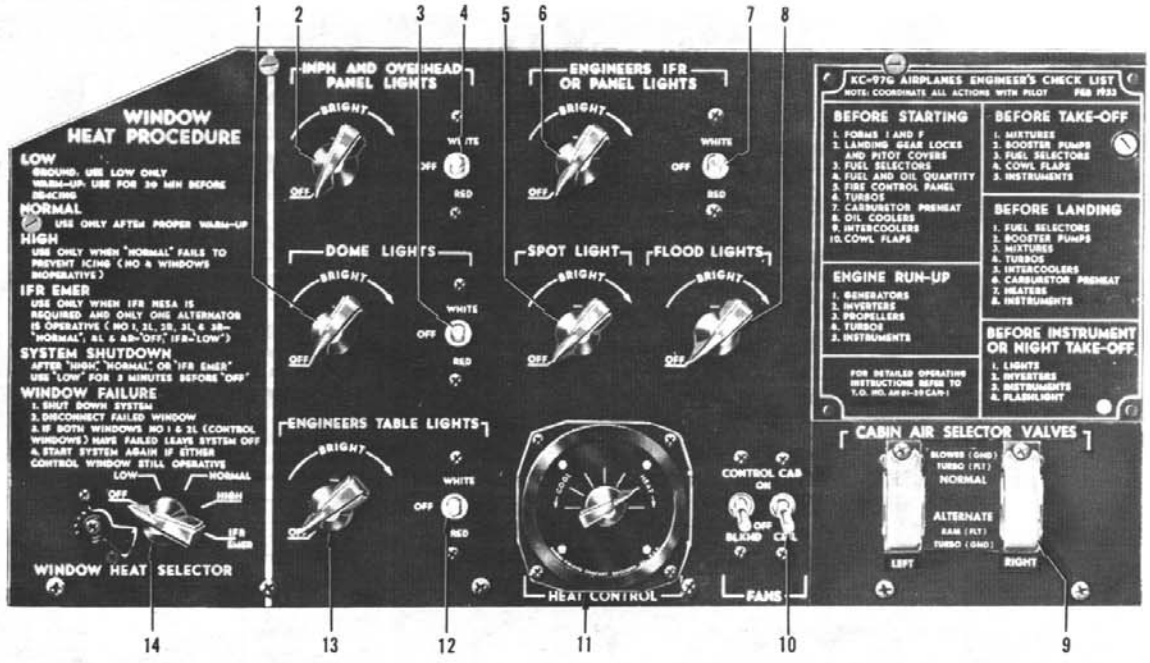
17260 ▶ 2859

2860 ▶

1 OVERHEAD CIRCUIT BREAKER PANEL
2 OVERHEAD PANEL
3 ENGINEER'S AUXILIARY OVERHEAD PANEL
4 ISODRAULIC HANDLE
5 ENGINEER'S INSTRUMENT PANEL
6 CYLINDER HEAD TEMPERATURE SELECTOR SWITCH
7 ENGINEER'S ASH TRAY (2 PLACES)
8 JET ENGINE FUEL MANAGEMENT PANEL
9 IGNITION ANALYZER
10 ENGINEER'S AUXILIARY PANEL
11 IGNITION ANALYZER SWITCH PANEL

ENGINEER'S STATION

Figure 1–19



1 DOME LIGHTS RHEOSTAT
2 ENGINEER'S INPH AND OVERHEAD PANEL LIGHTS RHEOSTAT
3 DOME LIGHTS CONTROL SWITCH
4 ENGINEER'S INPH AND OVERHEAD PANEL LIGHTS CONTROL SWITCH
5 SPOT LIGHT RHEOSTAT
6 ENGINEER'S A/R LIGHTS RHEOSTAT
7 ENGINEER'S A/R LIGHTS CONTROL SWITCH
8 FLOOD LIGHTS RHEOSTAT
9 CABIN AIR SELECTOR SWITCHES
10 CONTROL CABIN FAN SWITCHES
11 HEAT CONTROL RHEOSTAT
12 ENGINEER'S TABLE LIGHTS CONTROL SWITCH
13 ENGINEER'S TABLE LIGHTS RHEOSTAT
14 WINDOW HEAT SELECTOR SWITCH

ENGINEER'S AUXILIARY OVERHEAD PANEL

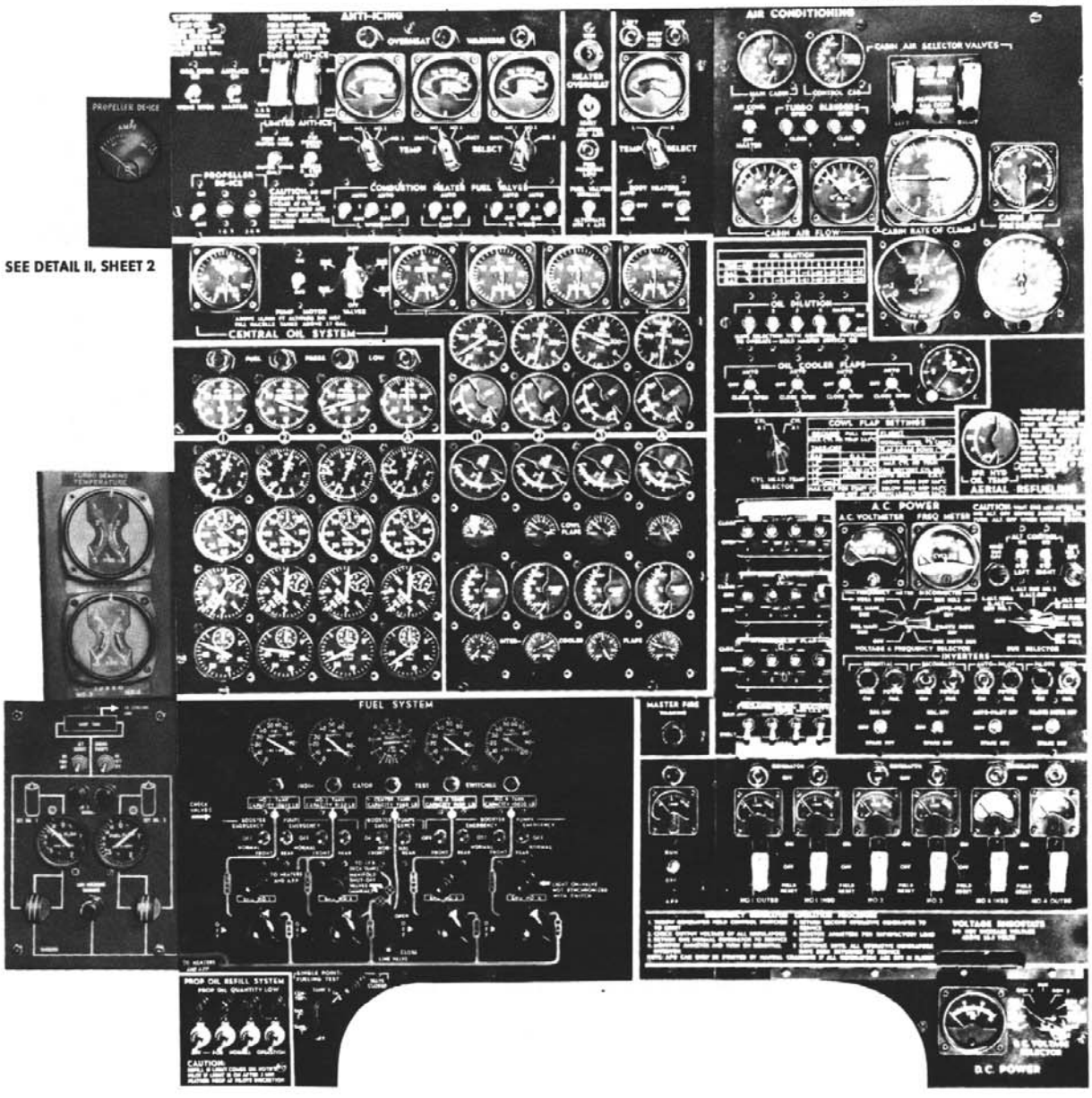
Figure 1–20

Relay-Resistor Switches. Four guarded relay-resistor switches (2, figure 1–17) are located on the ignition analyzer switch panel. In the OFF position, these numbered switches connect resistors in the circuits which protect the primary magneto circuits of the four correspondingly numbered engines. In the ON or unguarded position, these switches energize relays which bypass the resistors, thereby allowing the use of the ignition voltage control of the ignition analyzer.

Analyzer Voltage Control Switch. The voltage control switch (4, figure 1–16) on the ignition analyzer enables the engineer on a ground check to foresee ignition

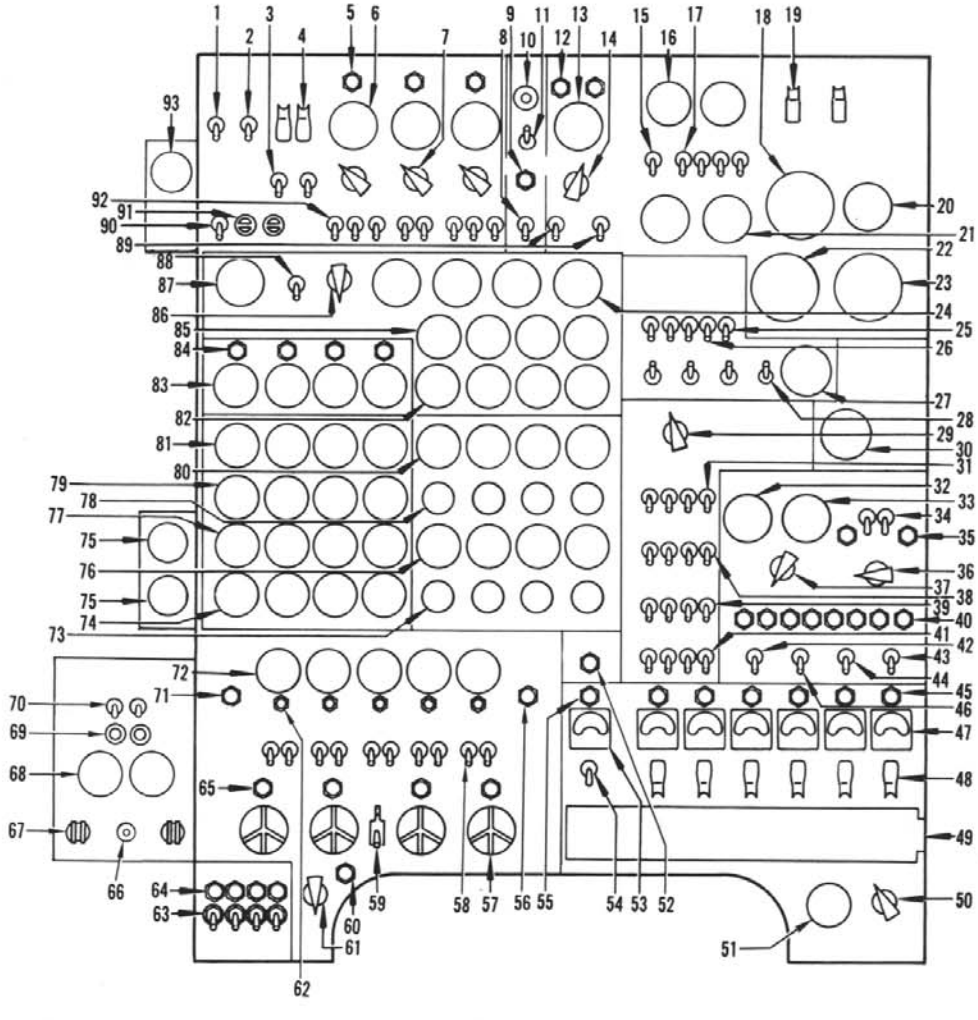
SEE DETAILS I AND III, SHEET 2

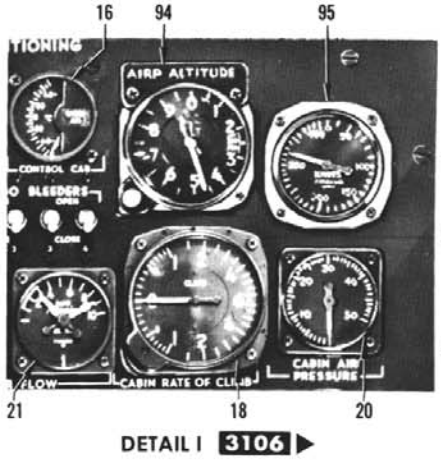
SEE DETAIL II, SHEET 2



ENGINEER'S INSTRUMENT PANEL

Figure 1–21 (Sheet 1 of 3)





DETAIL I 3106 ▶

DETAIL II 22629 ▶

DETAIL III 22737 ▶ 22806

Figure 1–21 (Sheet 2 of 3)

1 BALANCE BYPASS SWITCH (2 PLACES)
2 ANTI-ICE MASTER SWITCH (2 PLACES)
3 LIMITED ANTI-ICE SWITCHES (2 PLACES)
4 EMERGENCY ANTI-ICE SWITCHES (2 PLACES)
5 ANTI-ICING OVERHEAT WARNING LIGHTS
6 ANTI-ICING HEATER AND DUCT TEMPERATURE GAGES
7 TEMPERATURE GAGE SELECTOR SWITCHES
8 HEATER FUEL VALVE SWITCH
9 HEATER FUEL LOW-PRESSURE WARNING LIGHT
10 HEATER OVERHEAT TEST SWITCH
11 HEATER OVERHEAT RESET SWITCH
12 BODY HEATER OVERHEAT WARNING LIGHTS
13 BODY HEATER TEMPERATURE GAGE
14 BODY HEATER TEMPERATURE SELECTOR SWITCH
15 AIR CONDITIONING MASTER SWITCH
16 CABIN TEMPERATURE GAGES (3 PLACES)
17 TURBO BLEEDER SWITCHES
18 CABIN VERTICAL VELOCITY INDICATOR (3 PLACES)
19 CABIN AIR SELECTOR SWITCHES (2 PLACES)
20 CABIN AIR PRESSURE INDICATOR (CABIN ALTIMETER) (3 PLACES)
21 CABIN AIR FLOW INDICATORS (3 PLACES)
22 CABIN PRESSURE RATE-OF-CHANGE SELECTOR
23 CABIN ALTITUDE SELECTOR
24 OIL QUANTITY GAGES
25 OIL DILUTION MASTER SWITCH
26 OIL DILUTION SELECTOR SWITCHES
27 CLOCK 22701 ▶
28 OIL COOLER FLAP SWITCHES
29 CYLINDER HEAD TEMPERATURE SELECTOR SWITCH
30 AIR REFUELING HYDRAULIC OIL TEMPERATURE GAGE
31 COWL FLAP SWITCHES
32 AC VOLTMETER
33 FREQUENCY METER
34 ALTERNATOR SWITCHES
35 NESA BUS OFF WARNING LIGHTS
36 ALTERNATOR BUS SELECTOR SWITCH
37 AC VOLTAGE AND FREQUENCY SELECTOR SWITCH
38 CARBURETOR PREHEAT SWITCHES
39 INTERCOOLER FLAP SWITCHES
40 INVERTER WARNING LIGHTS
41 CARBURETOR AIR SWITCHES
42 ESSENTIAL INVERTER SWITCH
43 PILOT'S INSTRUMENT INVERTER SWITCH
44 AUTOPILOT INVERTER SWITCH
45 GENERATOR WARNING LIGHTS
46 SECONDARY INVERTER SWITCH
47 DC LOADMETERS
48 GENERATOR SWITCHES
49 GENERATOR VOLTAGE RHEOSTATS
50 DC VOLTMETER SELECTOR SWITCH
51 DC VOLTMETER
52 MASTER FIRE WARNING LIGHT
53 APU DC LOADMETER
54 APU SWITCH
55 APU GENERATOR WARNING LIGHT
56 RIGHT EXTERNAL TANK LOW FUEL FLOW WARNING LIGHT
57 FUEL SELECTOR SWITCHES
58 BOOST PUMP SWITCHES
59 CENTER WING TANK LINE VALVE SWITCH
60 SECONDARY VALVE CLOSED LIGHT
61 SINGLE POINT REFUELING TEST SWITCH
62 FUEL QUANTITY GAGE TEST SWITCHES
63 PROPELLER OIL REFILL SWITCHES
64 PROPELLER OIL QUANTITY WARNING LIGHTS
65 FUEL VALVE POSITION WARNING LIGHTS
66 MAIN FUEL SYSTEM MANIFOLD LOW-PRESSURE WARNING LIGHT
67 JET ENGINE FUEL SELECTOR SWITCHES
68 JET ENGINE FUEL FLOWMETERS
69 SUMP TANK BOOST PUMP LOW-PRESSURE WARNING LIGHTS
70 SUMP TANK BOOST PUMP SWITCHES
71 LEFT EXTERNAL TANK LOW FUEL FLOW WARNING LIGHT
72 FUEL QUANTITY GAGES
73 INTERCOOLER FLAP POSITION INDICATORS
74 FUEL FLOWMETERS
75 TURBO BEARING TEMPERATURE GAGE (2 PLACES)
76 CARBURETOR AIR TEMPERATURE GAGES
77 TORQUEMETERS
78 COWL FLAP POSITION INDICATORS
79 MANIFOLD PRESSURE GAGES
80 CYLINDER HEAD TEMPERATURE GAGES
81 TACHOMETERS
82 OIL TEMPERATURE GAGES
83 FUEL PRESSURE GAGES
84 FUEL LOW-PRESSURE WARNING LIGHTS
85 OIL PRESSURE GAGES
86 OIL TANK SELECTOR SWITCH
87 CENTRAL OIL TANK QUANTITY GAGE
88 OIL TRANSFER PUMP SWITCH
89 BODY HEATER SWITCHES
90 PROPELLER DEICING SWITCH (2 PLACES)
91 PROPELLER DEICING INDICATORS (2 PLACES)
92 ANTI-ICING HEATER FUEL VALVE SWITCHES
93 PROPELLER DEICING AMMETER
94 PRESSURE ALTIMETER 22737 ▶ (2 PLACES)
95 AIRSPEED INDICATOR 3106 ▶
96 PROPELLER DEICING LOADMETER 22629 ▶

Figure 1–21 (Sheet 3 of 3)

system difficulties and correct the condition before failure actually occurs. The most common of these failures would be fouling and incorrect gaps of spark plugs. The voltage control switch is a rotary-type switch marked with OFF and numbered positions from 0 to 50. It is engaged by pulling the knob out and rotating. When released it becomes inoperative, but will remain at the same dial number position. When this switch is engaged, a variable shunt resistance is connected across the primary of the magneto being tested. As the switch is moved in the direction of decrease, the magneto load is increased, thus reducing voltage at the spark plug. The position of the switch when misfiring or complete stoppage of firing occurs is used as an indication of the condition of the ignition system.

Analyzer Screen. The analyzer screen (5, figure 1–16) is a modified cathode-ray oscilloscope which shows the varying magneto primary and reflected secondary voltages as wave form patterns. Ignition performance is analyzed by interpreting and comparing the characteristic magneto voltage wave forms produced by a malfunctioning system with the wave forms produced by a properly operating system. The operation of the screen is regulated by controls located on the ignition analyzer switch panel, the internal control panel, and the ignition analyzer.

Analyzer System Power Indicator Light. The system power indicator light (4, figure 1–17) on the ignition analyzer switch panel will illuminate when the system power switch is positioned to ON, indicating that power is supplied to the system.

Analyzer Power Indicator Light. The analyzer power indicator light (1, figure 1–16) on the ignition analyzer illuminates when the ignition analyzer is receiving power. The light should be illuminated when the power switch on the ignition analyzer and the power switch on the ignition analyzer switch panel are in the ON position.

Tachometers

Four single-indicating engine tachometers (10, figure 1–8, and 81, figure 1–21) are on both the pilots' and the engineer's instrument panels. The tachometers are generator-motor units. Each tachometer generator is engine driven and generates its own current which controls the indicator motor at a synchronized speed. The pilots' tachometers measure engine speeds in increments of 100 rpm, and the engineer's tachometers measure engine speeds in increments of 20 rpm.

Torquemeters

Four individual torquemeters (77, figure 1–21) on the engineer's instrument panel indicate torque pressure in psi and are used as a direct means of measuring power output. When combined with engine rpm and a factor, a direct calculation of brake horsepower output at the propeller can be made. The indicating circuit is supplied with 26-volt ac power through circuit protection on the ac power panel (15, figure 1–37).

Manifold Pressure Gages And Purge Valve Buttons

Four manifold pressure gages (9, figure 1–8, and 79, figure 1–21) are on both the pilots' and engineer's instrument panels. The manifold pressure gages give a direct reading of manifold pressure in inches of Hg. Four manifold pressure purge valve buttons (8, figure 1–8) on the pilots' instrument panel provide a means of removing moisture from the manifold pressure gage lines. At idling speeds, a suction is developed and depressing the valve allows the moisture to be drawn into the engine.

Cylinder Head Temperature Gages

Four cylinder head temperature gages (80, figure 1–21) of the direct-current type are on the engineer's instrument panel. The cylinder head temperature gages are resistance bulb-type units and indicate cylinder head temperature in degrees centigrade. There are two resistance bulbs on each engine which are connected to cylinders A1 and B1. The circuits are supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Cylinder Head Temperature Selector Switch

The cylinder head temperature selector switch (29, figure 1–21) on the engineer's instrument panel allows selection of the desired set of cylinders for cylinder head temperature indication. The selector switch has A1–B1 positions. With the selector switch in either position, each of the cylinder head temperature gages will, for its respective engine, indicate the temperature of the individual cylinder selected. The selector switch is a part of the cylinder head temperature gage circuit, and is protected by the engine instrument circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Fuel Flowmeters

Each engine has a fuel flowmeter (74, figure 1–21), located on the engineer's instrument panel. The flowmeters show rate of fuel flow in hundreds of pounds per hour. On 17260▶ 22700, the indicator circuits are supplied with 26-volt ac power through the engine instrument fuses on the ac power panel (15, figure 1–37). On 22701▶, the indicator circuits are supplied with 26-volt ac power through individual fuel flow fuses on the ac power panel.

Fuel Pressure Gages

Four fuel pressure gages (83, figure 1–21) on the engineer's instrument panel indicate fuel pressure in psi for each engine. The indicator circuits are supplied with 26-volt ac power through the engine instrument fuse on the ac power panel (15, figure 1–37).

Fuel Low-Pressure Warning Lights

A fuel low-pressure warning light (84, figure 1–21), adjacent to each fuel pressure gage, illuminates when fuel pressure is low. The circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Oil Pressure Gages

Four oil pressure gages (85, figure 1–21) are on the engineer's instrument panel. The gages indicate engine oil pressure in psi. The indicator circuits are supplied with 26-volt ac power through the engine instrument fuses on the ac power panel (15, figure 1–37).

Oil Temperature Gages

A resistance bulb-type oil temperature gage (82, figure 1–21) for each engine is on the engineer's instrument panel. The gages indicate engine oil temperature in degrees centigrade. The indicating circuits are supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

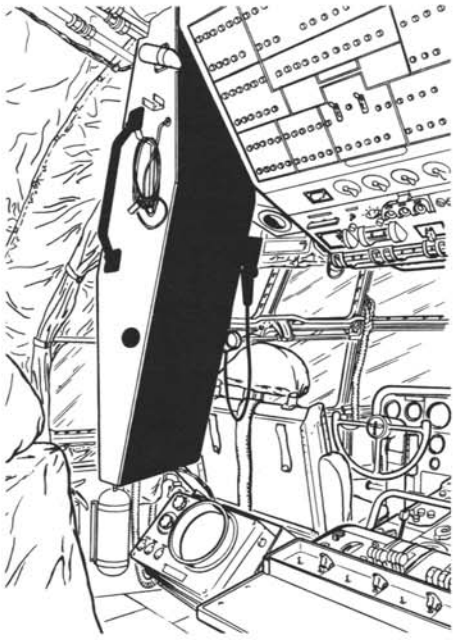
PROPELLER SYSTEM

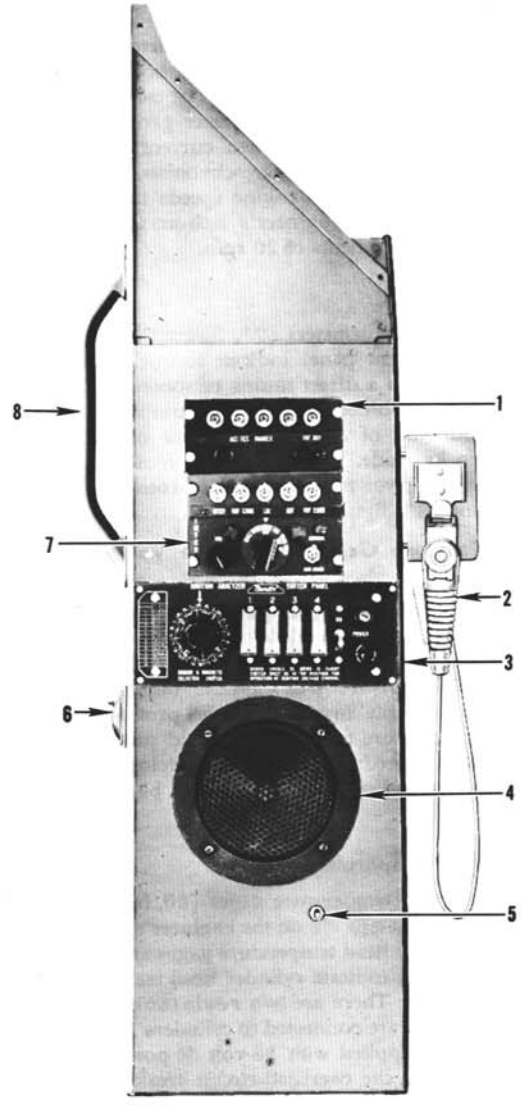
The airplane is equipped with Hamilton Standard hydromatic propellers having four solid aluminum blades. This propeller has a nonrotating control unit, incorporating an independent oil system, mounted between the engine nose section and the propeller. Controls are provided to automatically synchronize engine speeds, reverse, or feather any or all propellers. Deicing is accomplished through a boot-type electric heating element mounted along the leading edge of each blade. Current is transmitted from the airplane 28-volt dc circuit to the heating elements through the slip ring assembly attached to the propeller barrel. An emergency oil replenishing system is provided to replace oil lost from the propeller independent oil system with engine nose section oil. (See figure 1–23.)

Note

An external contactor control switch is incorporated in the number 1 blade of each propeller to terminate unfeathering and unreversing. An external contactor control switch is also incorporated in the number 3 blade. This switch closes at full reverse to stop auxiliary oil pump action.

1 INTERPHONE MIXER SWITCH PANEL
2 MICROPHONE
3 IGNITION ANALYZER SWITCH PANEL
4 LOUDSPEAKER
5 LOUDSPEAKER CONTROL SWITCH
6 ASH TRAY
7 INTERPHONE CONTROL PANEL
8 HANDHOLD





ENGINEER'S AUXILIARY PANEL

Figure 1–22

PROPELLER GOVERNOR SELECTOR SWITCHES

Four DECREASE RPM–OFF–INCREASE RPM propeller governor selector switches (27, figure 1–15) on the aft end of the control stand are used to manually control and synchronize the propeller speeds for each of the four engines. Normally, the automatic synchronizing system of propeller control is used, but in case of malfunction, operation of the selector switches will override the master lever and synchronizer operation. The selector switches are spring-loaded from the INCREASE RPM and DECREASE RPM positions to the OFF position. The circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

PROPELLER AUTO CONTROL SWITCH

The automatic propeller synchronizing system is referred to No. 1 or No. 2 engine as the master engine by a NO. 1 MASTER–OFF–NO. 2 MASTER propeller auto control switch (25, figure 1–15) on the aft end of the control stand. This switch is used in the propeller synchronizing system to select either engine No. 1 or No. 2 as a master which the other engines follow. Once the master engine has been selected, the other engines act as slaves, synchronizing with the master engine. Alternate selection of a master engine is provided in case of a master engine failure. A safety feature in the synchronizing

system limits the range of control the master engine has over the slave engines (plus or minus approximately 175 rpm from the master engine speed). In case of master engine malfunction, this feature prevents the propeller rpm of the slave engines from going either above or below the controlled range. The circuit is supplied with 28-volt dc power through an ON–OFF, switch-type circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

MASTER PROPELLER SYNCHRONIZER LEVER

Two master propeller synchronizer levers (34, figure 1–15), one to the left of the pilots' throttles and the other to the left of the engineer's throttles, are used to operate all four propeller governors simultaneously when selecting desired engine rpm. The levers are interconnected so that movement of one lever throughout the range from DECREASE RPM position to INCREASE RPM position is duplicated by the other lever. Forward movement of the synchronizer levers causes an increase in rpm, while aft movement causes a decrease in rpm. The levers are used in conjunction with automatic propeller synchronizing and are operative only when the propeller auto control switch is in the NO. 1 MASTER or NO. 2 MASTER position. When a propeller synchronizer lever is placed in the full INCREASE RPM position, the master synchronizer motor drives the four propeller governors to their maximum rpm limits. When these limits are reached by all four propellers, a holding relay cuts off all synchronizing action. Synchronizing action will remain off as long as the propeller synchronizer levers are in the full INCREASE RPM position. Thus, failure of the master engine on takeoff will have no effect on the speed of the slave engines. Circuit breaker protection is provided by the circuit breaker switch provided for propeller auto control on the overhead circuit breaker panel (1, figure 1–37).

PROPELLER RESYNCHRONIZER SWITCH

A spring-loaded propeller resynchronizer switch (26, figure 1–15) on the aft end of the control stand is used to synchronize the propellers after rpm selection has been made with the master propeller synchronizer levers. Because of normal tolerances in setting individual governor limits, the slave engines may not be in the synchronizing range (plus or minus 175 rpm from the master engine rpm). In this case the master propeller synchronizer levers will not set the speed of the propellers in proper synchronization, thus causing propeller noise beat. When using the resynchronizer switch, by pushing to RESYNC, holding, and releasing a few times, complete engine synchronization can be obtained. This switch is used immediately after any movement of the master propeller synchronizer levers, except when they are in full INCREASE RPM or full DECREASE RPM position. Circuit breaker protection for the resynchronizer switch is the same circuit breaker as used for the auto control switch on the overhead circuit breaker panel (1, figure 1–37).

PROPELLER FEATHERING BUTTONS

Four guarded propeller feathering buttons (25, figure 1–11) are on the extreme forward end of the overhead panel. The buttons have PUSH FEATHER–PULL UNFEATHER and neutral positions. The feathering operation is initiated when the feathering button is pushed. After a fixed time, 18 ± 2 seconds, a spring action returns the button to the neutral position. The propeller is unfeathered by pulling the feathering button out. The unfeathering operation is accomplished as given in RESTARTING ENGINE IN FLIGHT, Section III. The circuit is supplied with 28-volt dc power through four feathering circuit breakers and one timer circuit breaker on the overhead circuit breaker panel (1, figure 1–37). An additional propeller feathering switch for each engine is on the overhead panel. Refer to FIRE SWITCHES, this section.

PROPELLER REVERSE THRUST CONTROL

The propeller reverse thrust is controlled by the throttles. Refer to THROTTLES and PROPELLER REVERSE THROTTLE LOCK PLATE, this section.

PROPELLER OIL REFILL SWITCHES

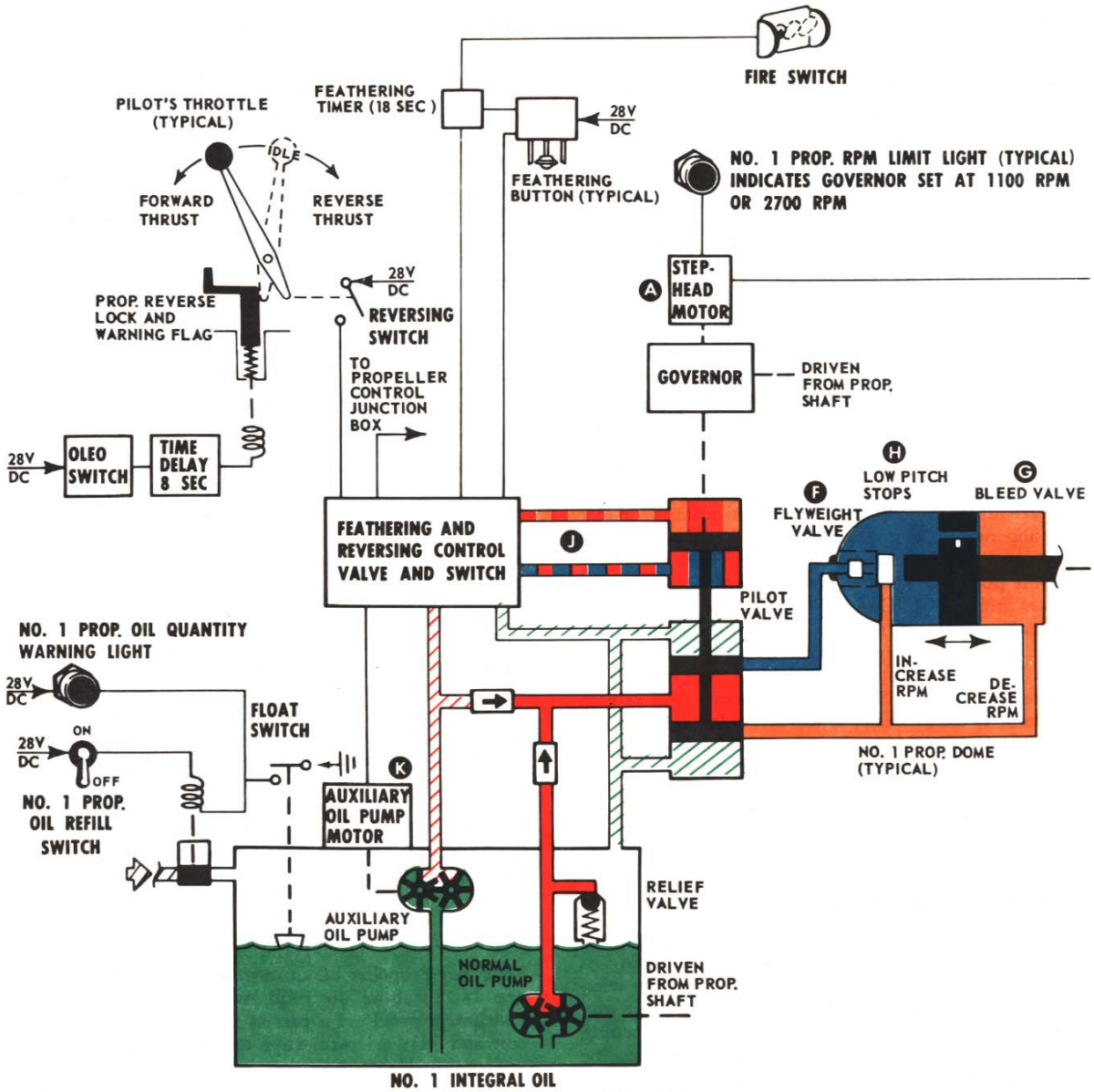
Four propeller oil refill switches (63, figure 1–21) on the engineer's instrument panel are used to energize the propeller oil refilling circuit. Placing the switches to ON allows engine oil to flow into the propeller oil tank, provided the float switch in the propeller oil tank is approximately at the 2.5-quart level (or less) as indicated by a warning light. When the propeller oil quantity level reaches approximately 4 quarts, the supply of engine oil is automatically shut off by the float switch even though the switch is left in the ON position. The circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37), which protects both oil refill and warning light circuits.

PROPELLER OIL QUANTITY WARNING LIGHTS

Four red propeller oil quantity warning lights (64, figure 1–21) above the refill switches on the engineer's instrument panel are a part of the propeller oil refill circuit and illuminate when the float switch drops to approximately the 2.5-quart level regardless of refill switch position and go out when approximately 1.5 quarts have been added. The circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37) which protects both warning light and emergency oil refill circuits.

RPM LIMIT LIGHTS

Four amber rpm limit lights (13, figure 1–8) on the pilots' instrument panel illuminate to show when the maximum or minimum rpm limit settings are reached. The circuit is supplied with 28-volt dc power through an ON–OFF, switch-type circuit breaker on the overhead circuit breaker panel (1, figure 1–37).



- NORMAL OIL (LOW PRESSURE)
- INTEGRAL OIL SUPPLY
- AUXILIARY OIL (HIGH PRESSURE)
- RETURN
- DECREASE RPM PRESSURE
- INCREASE RPM PRESSURE
- CONTROL PRESSURE, REVERSING AND UNFEATHERING
- CONTROL PRESSURE, FEATHERING AND UNREVERSING
- ENGINE OIL PRESSURE
- MECHANICAL
- ELECTRICAL

(A) Stephead motor positions spring in governor to select rpm.

(B) Propeller governor selector will always override automatic synchronizing system.

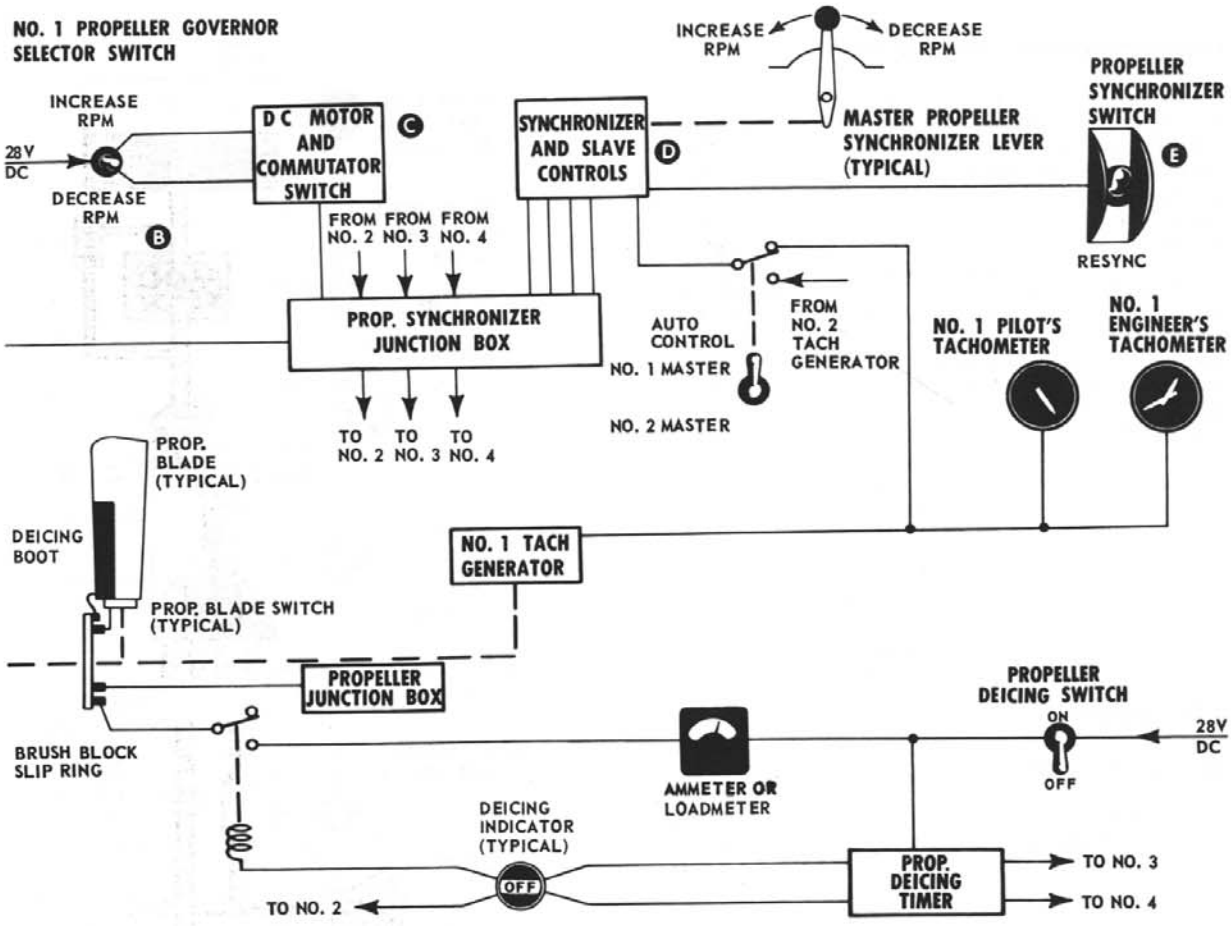
(C) DC motor and commutator switch control stephead motor, so that in the event of electrical power failure, governor remains at last setting.

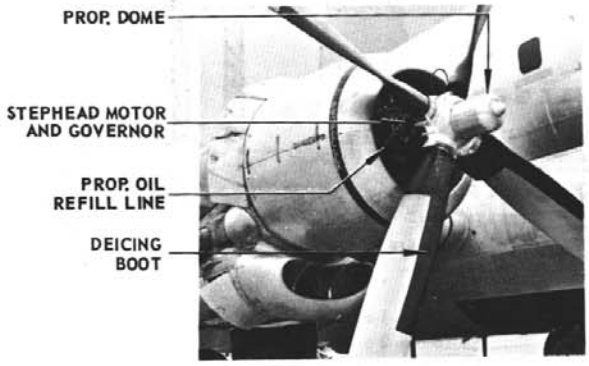
(D) Synchronizer will control slave engines rpm when slave engines are within ±3% of master engine rpm. When master synchronizer lever is at full increase (calibrate), all engines will go to 2700 rpm and the 3% does not apply.

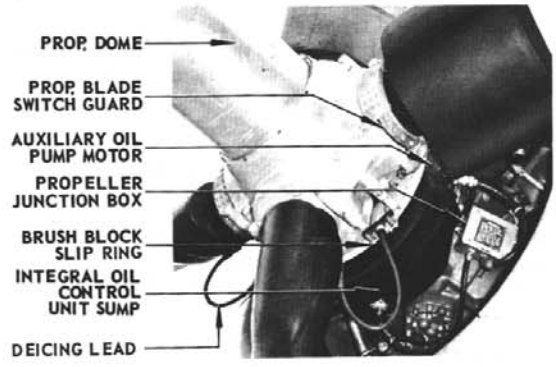
(E) Resynchronizer switch will change slave engine rpm a maximum of 3% of master engine rpm.

PROPELLER SYSTEM

Figure 1–23 (Sheet 1 of 2)







F Flyweight valve closes at 2535 to 2665 rpm and above to prevent overspeed by trapping oil on forward side of piston. Oil flow thru bleed valve allows a slow blade rotation to increase rpm. This causes the slow rpm increase which occurs when changing to power settings above METO power. Decrease rpm oil pressure or feathering oil pressure will override the flyweight valve.

G Bleed valve closes at 3000 to 3100 rpm and prevents further blade rotation toward increase rpm. Bleed valve will stay closed until power is reduced to 1500 to 1700 rpm.

H Low pitch stops prevent flat pitch and reverse pitch operation by normal propeller oil pressure. When throttles are moved to reverse idle, high pressure oil will retract the low pitch stops and propeller blades will rotate to reverse pitch.

J Control pressure overrides governor during feathering and reversing cycles.

K Auxiliary oil pump motor operates only during feathering and reversing cycles to provide high pressure oil.

Figure 1–23 (Sheet 2 of 2)

PROPELLER REVERSE WARNING FLAG

A red propeller reverse warning flag (4, figure 1-15) is provided in a housing on the control stand. When the airplane leaves the ground, and all three landing gear oleo switches are actuated, power will be supplied, after an 8-second time delay, to engage a reverse lock on the pilots' throttles, preventing throttle movement into the REVERSE OPEN range. When the lock is engaged, the red flag will pop up and expose the LOCKED marking on the flag, indicating that the propellers cannot be reversed. When any one of the landing gear oleo switches is actuated upon contact with the ground, power is supplied to release the reverse lock and permit throttle movement into the REVERSE OPEN range. When the lock is released, the red flag drops down and an UNLOCKED marking on the housing is exposed, indicating that the propellers can be reversed. The circuit is supplied with 28 volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1-37).

Note

If the reverse lock does not release automatically on the ground, it may be released manually by pushing down the red flag.

OIL SYSTEM

OIL SUPPLY SYSTEM

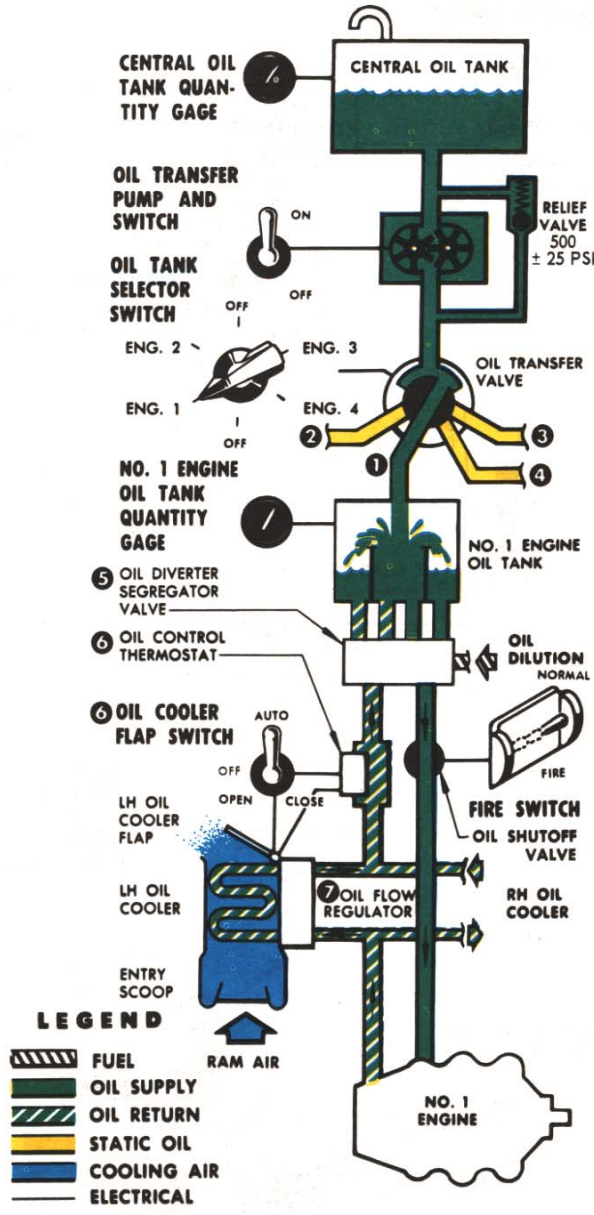
The oil supply system (figure 1-24) has a central oil tank in the lower nose compartment with a capacity of 56 US gallons and an expansion space of 2 US gallons. This supply is used to replenish each engine oil tank as needed. The oil is transferred by an electric pump which has a normal pumping capacity of 7 gallons per minute, and is directed to the desired engine tank by a transfer valve. The circuit is supplied with 28-volt dc power through a circuit breaker on the forward power panel (5, figure 1-37).

Oil Tank Selector Switch

A rotary-type oil tank selector switch (86, figure 1-21) on the engineer's instrument panel controls a tank selector valve. The switch has ENG. 1--ENG. 2--OFF--ENG. 3--ENG. 4--OFF positions. When this switch is positioned in any one of the four engine positions, oil from the central oil tank will be directed to the desired engine tank. When the switch is positioned to OFF, the valve is closed. In case of an electrical selector valve failure, the selector valve can be operated manually by removing four screws, pulling the electrical unit slightly forward, and turning it to the desired tank as indicated by an index on the selector valve. The valve is on the forward wing spar, accessible from the lower forward compartment. The circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1-37).

Oil Transfer Pump Switch

An ON--OFF oil transfer pump switch (88, figure 1-21), spring-loaded from the ON position to the



NOTE:
1. To No. 1 engine oil tank.
2. To No. 2 engine oil tank.
3. To No. 3 engine oil tank.
4. To No. 4 engine oil tank.
5. Deactivated
6. Controls RH and LH oil cooler flap.
7. Allows the oil to bypass the cooler according to oil pressure and temperature.

NO. 1 ENGINE OIL SUPPLY SYSTEM (TYPICAL) FILLING NO. 1 ENGINE OIL TANK

OIL SUPPLY SYSTEM

Figure 1-24

OFF position, and adjacent to the tank selector switch on the engineer's instrument panel, is used to turn the central oil tank transfer pump on or off. The circuit is supplied with 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Note

The oil tank selector switch must be in an engine-selected position before the transfer pump may be energized.

ENGINE OIL SYSTEM

Each engine has an individual oil system which includes an engine oil tank, two oil coolers, and an oil control thermostat. The engine oil tank has a capacity of 32.5 US gallons and an expansion space of 7 US gallons. Oil cooler flaps switches, when in the AUTO position, cause the thermostat to automatically regulate oil temperature by operating the oil cooler flaps to allow the proper amount of cooling air to flow through the oil coolers. An oil dilution system is incorporated into the oil system to aid in cold weather starting. Refer to OIL SYSTEM, Section VII, and oil dilution procedures under ENGINE SHUTDOWN under COLD WEATHER PROCEDURES, Section IX.

Oil Cooler Flap Switches

The oil cooler flaps for each engine are operated by OPEN–OFF–AUTO–CLOSE oil cooler flap switches (28, figure 1–21) on the engineer's instrument panel. The switches are spring-loaded from the OPEN and CLOSE positions to the OFF position. When a switch is in the AUTO position, the oil coolers automatically maintain oil temperature within the normal operating range. If extreme operating conditions exist and failure of the automatic circuit causes abnormal oil temperatures, the oil cooler flaps can be operated by the manual OPEN or CLOSE positions. The flaps are held in any desired position by positioning the switch to OFF. Approximately 15 seconds is required to fully open or close the oil cooler flaps when the manual switch positions are used. The circuits are supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Oil Dilution Switches

One OFF–ON (spring-loaded to OFF) oil dilution master switch and four OFF–ON oil dilution selector switches (25 and 26, figure 1–21) on the engineer's instrument panel energize the oil dilution solenoids, allowing fuel to mix with engine oil before the oil enters the engine. The four oil dilution selector switches select the engines to be diluted. Dilution is then accomplished by use of the oil dilution master switch (figures 1–24 and 1–29). The circuits are supplied with 28-volt dc through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Oil Shutoff Valve

An oil shutoff valve is provided between each engine and engine oil tank. These valves, when closed, will shut off all oil supplied to the engines. The valves are controlled by four fire switches on the overhead panel. Refer to FIRE SWITCHES, this section.

Oil Quantity Gage

Oil quantity gages (24 and 87, figure 1–21), one for each engine oil tank and one for the central oil tank, on the engineer's instrument panel, indicate oil quantity in US gallons. The circuits are supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

OIL SPECIFICATION AND GRADE

See figure 1–53 for oil specification and grade.

JET ENGINES

In addition to the four reciprocating engines, the airplane is equipped with two J-47-25, or -25A all-weather, axial-flow turbojet engines (figure 1–25). The jet engines are provided to give extra power during takeoff, climb, refueling operations, and other instances where additional power is required. The jet engines are contained in nacelles, suspended from pylons, which are mounted in place of the pylon fuel tanks. Guaranteed sea level static performance at 100 percent (7950 rpm) is 5970 pounds of thrust for the J-47-25 or -25A jet engine. Each engine is comprised of a 12-stage axial-flow compressor, eight direct-flow combustion chambers, and a single-stage impulse turbine, coupled directly to the compressor.

FUEL CONTROL SYSTEM

The jet engine fuel control system consists essentially of a fuel filter; a positive-displacement, engine-driven fuel pump; a stopcock; a fuel regulator; a fuel pressure control valve; fuel manifolds; and eight fuel nozzles. Initial movement of a throttle from the OFF position starts to open the stopcock (primarily an open and close valve). The stopcock is fully open when the throttle reaches the IDLE position and remains fully open for all throttle positions forward of IDLE. Movement of the throttle forward of IDLE mechanically actuates a fuel regulator which governs engine speed by regulating the fuel flow

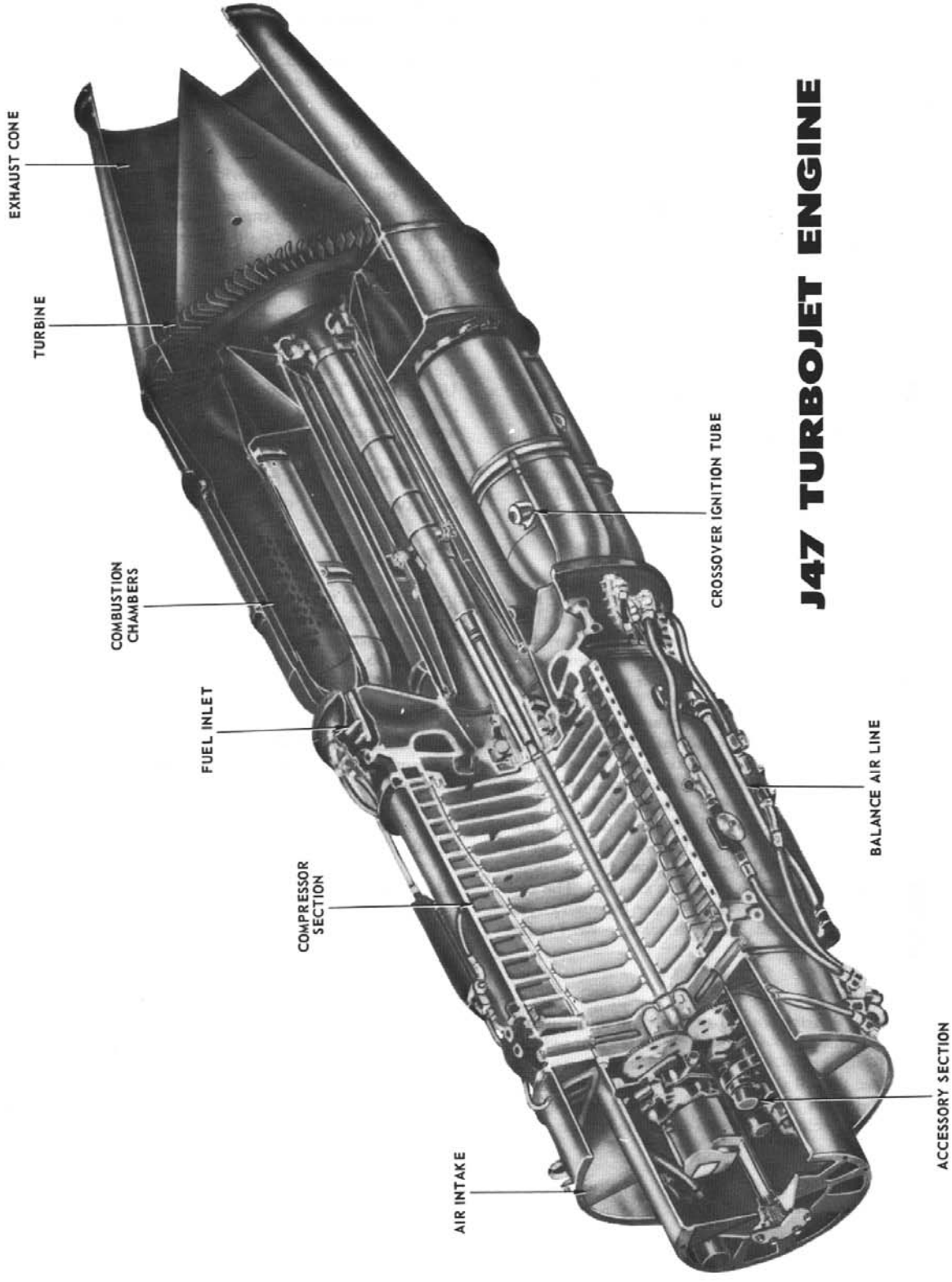

J47 TURBOJET ENGINE
EXHAUST CONE
TURBINE
COMBUSTION CHAMBERS
FUEL INLET
COMPRESSOR SECTION
AIR INTAKE
CROSSOVER IGNITION TUBE
BALANCE AIR LINE
ACCESSORY SECTION

Figure 1–25

through the fuel pressure control valve. Fuel is supplied through a fuel filter to the engine-driven fuel pump. The fuel then flows through a high-pressure filter, a fuel control valve, and a stopcock to an oil cooler, in which the fuel absorbs heat from the engine oil, thereby, acting as a coolant. From the oil cooler, the fuel flows through a flow divider to the fuel nozzles where it is atomized as it flows into the combustion chambers. The fuel regulator is the governing mechanism in the fuel control system and establishes fuel flow in accordance with three factors: throttle setting, engine speed, and compressor discharge pressure.

Throttles

Two throttles, with OFF (STOPCOCK)–START–IDLE –MILITARY POWER positions, are located on the control stand (figure 1–26). When a throttle is in the OFF position, the fuel stopcock is closed, preventing fuel flow to the engine. When a throttle is moved from the OFF position with the starter engaged, a throttle-actuated limit switch is closed, directing 28-volt dc power to the engine igniters. The START position is primarily a reference point for starting, allowing engine operation at approximately 15 percent rpm. When a throttle is placed at IDLE, the engine will operate at approximately 38 to 41 percent rpm. When a throttle is advanced to maximum power (MILITARY POWER position), the engine operates at 100 percent rpm. Detents are provided at the IDLE and START positions to prevent inadvertent movement of the throttle levers from these positions. A positive lock is provided at the OFF position.

COMPRESSOR STALL PREVENTION SYSTEM

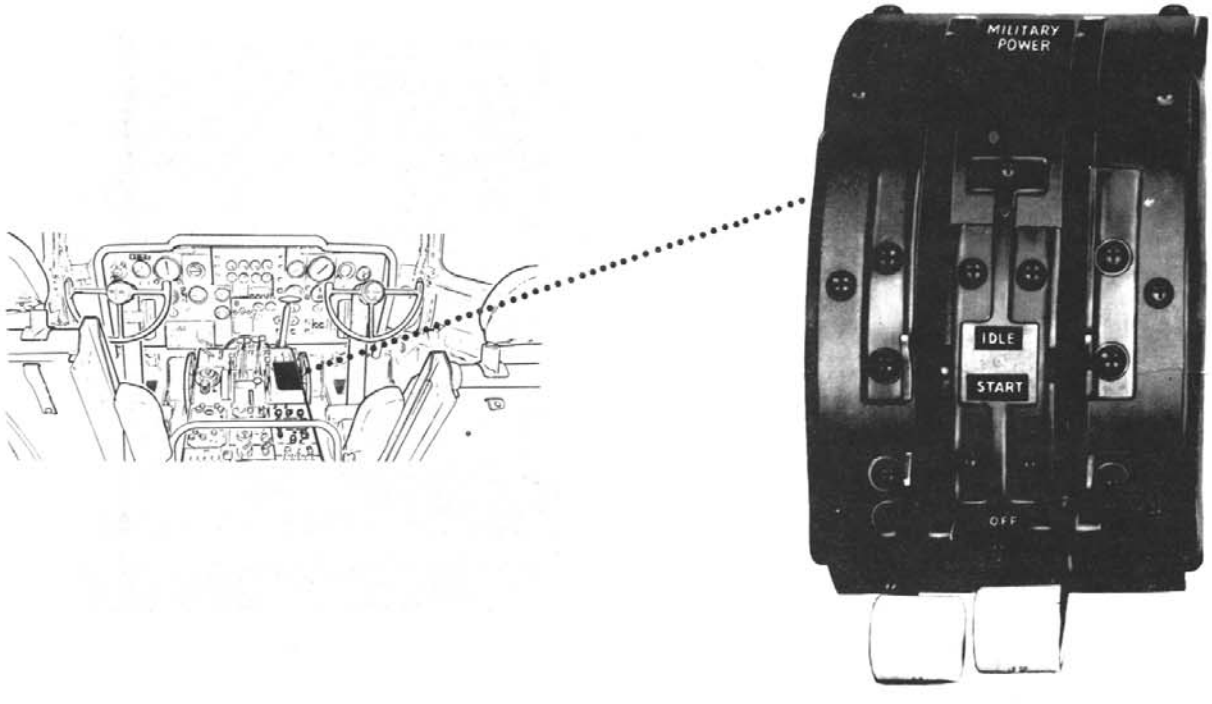
A compressor stall prevention system is provided to prevent compressor stalls which most commonly occur during sudden throttle application at low temperature. The system consists essentially of a stall prevention switch, a pressure bleed valve on each engine, and necessary connecting lines and fittings. Refer to JET ENGINE OPERATION, Section VII.

Compressor Stall Prevention Switch

A compressor stall prevention switch (4, figure 1–27), with ON–OFF positions, is located on the jet engine control panel. When the switch is placed at ON, the pressure bleed valve in each engine opens and bleeds air pressure from the fuel regulator pressure sensing line. When the switch is placed at OFF, the pressure bleed valve on each engine is closed. The switch receives 28-volt dc power through two circuit breakers on the jet engine circuit breaker panel (3, figure 1–37). Refer to COMPRESSOR STALL PREVENTION SYSTEM OPERATION, Section VII.

IGNITION SYSTEM

Two separate ignition systems, one for each jet engine, are provided for starting fuel combustion. Each system consists essentially of a pushbutton air start ignition switch, a starter switch-actuated undercurrent relay, a throttle-actuated limit switch, two ignition vibrator units, four ignition coils, and four igniter plugs. The four igniter plugs, two located in No. 3 combustion chamber,



JET ENGINE THROTTLE QUADRANT

Figure 1–26

and two located in No. 7 combustion chamber, provide the necessary spark for starting combustion. The ignition system is energized through the starting system during ground starts. When a starter switch is placed to ENGAGE, a starter undercurrent relay directs 28-volt dc power to a throttle-actuated limit switch and the starter motor. The first movement of the throttle out of the OFF position closes the limit switch which directs power through the ignition vibrators and ignition coils to the igniter plugs. The starter undercurrent relay directs power to the ignition system until the engine rpm reaches approximately 20 percent. The ignition system is energized by the air start ignition switches for air starts when the starter system is not used.

Air Start Ignition Switches

Two pushbutton air start ignition switches (3 and 8, figure 1–27), decaled AIR START IGNITION, are located on the jet engine control panel. The switches are used to control ignition for air starting. When an air start ignition switch is pressed, a time delay relay closes, directing electrical power to the throttle-actuated limit switch, bypassing the starter undercurrent relay. The first movement of the throttle out of the OFF position closes the limit switch which directs electrical power through the ignition vibrators and coils to the igniter plugs. The time delay relay remains closed, directing power to the throttle-actuated limit switch for approximately 60 seconds after the air start ignition switch is depressed. The air start ignition switches receive 28-volt dc power through two circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

STARTER SYSTEM

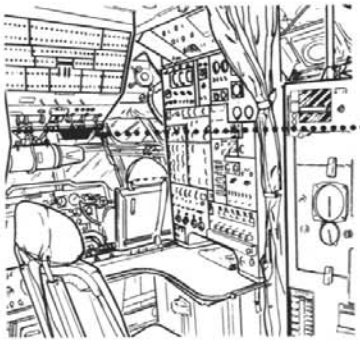
Torque for starting the jet engines is supplied by 28-volt dc starter motors through retractable starter dogs and adapters to the main rotor of each engine. Power is supplied to the starter motors by either an external power unit or the 28-volt dc system of the airplane. The starter motors engage and accelerate the rotor shafts of the engines to 15 to 25 percent rpm and are then disengaged and deenergized by the undercurrent relays. The starter undercurrent relays disengage the starter motors when a decrease in work load is sensed. A decrease in work load occurs when rotor rotation is being supported by normal combustion.

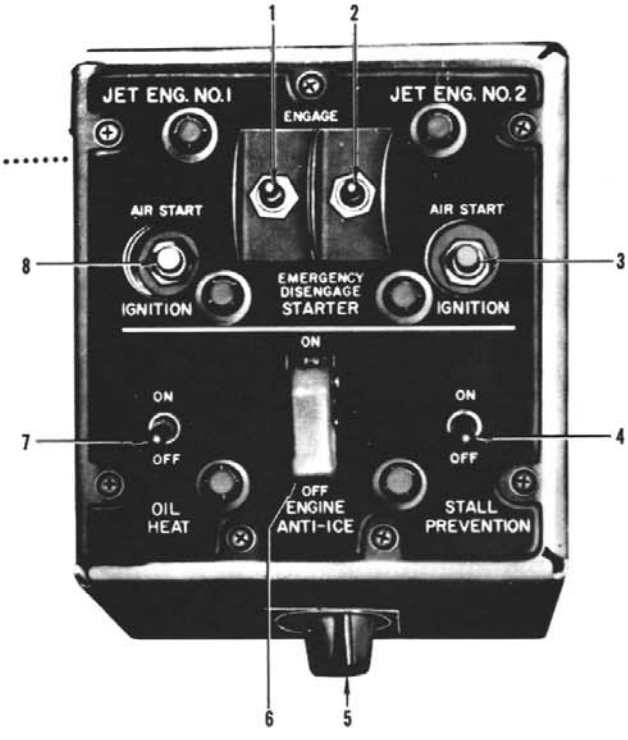
CAUTION

Damage to the airplane electrical system may result from use of the APU as a source of power for starting the jet engines.

Starter Switches

Two guarded momentary-contact starter switches (1 and 2, figure 1–27) are located on the jet engine control panel. The switches have OFF–ENGAGE–EMERGENCY DISENGAGE positions, and are spring-loaded to the OFF position. When a switch is momentarily placed to ENGAGE, 28-volt dc power is directed to the starter





1 NO. 1 JET ENGINE STARTER SWITCH
2 NO. 2 JET ENGINE STARTER SWITCH
3 NO. 2 JET ENGINE AIR START IGNITION SWITCH
4 COMPRESSOR STALL PREVENTION SWITCH
5 JET ENGINE CONTROL PANEL LIGHTS RHEOSTAT
6 JET ENGINE ANTI-ICING SWITCH
7 JET ENGINE OIL HEATER SWITCH
8 NO. 1 JET ENGINE AIR START IGNITION SWITCH

JET ENGINE CONTROL PANEL

Figure 1–27

motor and a starting cycle begins. Placing the switch at EMERGENCY DISENGAGE opens the undercurrent relay and deenergizes the starter motor. A starting cycle can be discontinued at any time by placing the starter switch to EMERGENCY DISENGAGE. When a switch is at the OFF position, the starter motor is deenergized, except during a starting cycle. The starter switches receive power from the 28-volt dc system through two circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

ENGINE INSTRUMENTS

Tachometers

Two tachometers (15, figure 1–8), one for each jet engine, are located on the pilots' instrument panel. Each tachometer indicates the rpm of the engine in percentage of maximum rated rpm (100 percent = 7950 rpm). Power is supplied to the tachometers by tachometer generators which are geared to the main rotor shafts of the engines.

Oil Pressure Gages

Two electrically operated, remote indicating oil pressure gages (36, figure 1–8), one for each jet engine, are located on the pilots' instrument panel. The gages indicate, in pounds per square inch, the oil pressure of each engine. The gages receive 26-volt, single-phase, regulated-frequency ac power through two circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

Fuel Flowmeters

Four electrically-operated fuel flowmeters (37, figure 1–8, and 68, figure 1–21), two located on the pilots' instrument panel and two located on the jet engine fuel management panel, indicate in pounds per hour the fuel flow to the jet engines. The fuel flowmeters utilize 28-volt dc and 115-volt, single-phase, regulated-frequency ac power and are protected by circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

Exhaust Gas Temperature (EGT) Gages

Two exhaust gas temperature gages (38, figure 1–8), one for each jet engine, are located on the pilots' instrument panel. The gages indicate the temperature of the engine exhaust gases in degrees centigrade. Four thermocouples, mounted in the tailpipe section of each engine, transmit indications to the gages. The thermocouples are self-generating electrical units, which require no power from the airplane's electrical system.

JET ENGINE OIL SUPPLY SYSTEM

Each jet engine is equipped with an independent oil supply system, consisting of an oil tank, two engine-driven pumps, an oil cooler, and an oil filter. The oil tanks are located in the jet engine nacelle pylons and have a capacity of 6 US gallons each, plus a 3-gallon expansion space. Oil at the correct temperature and pressure is supplied through metering jets to lubricate and cool all bearings and gears, and to supply the main fuel regulator with oil to hydraulically operate the jet engine fuel control system. A scavenge pump returns oil from the aft bearing sumps through the oil temperature control valve to the oil tank. The oil temperature control valve directs oil through the oil cooler to the oil tank, or directly to the tank, depending on the temperature of the oil. When oil passes through the oil cooler, heat is transferred from the oil to engine fuel which circulates through tubes inside the oil cooler. Oil quantity is checked by a dipstick provided in the top of each oil tank. A minimum of 4-1/2 gallons is required for flight. For oil specification and grade, see figure 1–53.

FUEL-OIL EMERGENCY SHUTOFF VALVE T-HANDLES

Two push-pull fuel-oil emergency shutoff valve T-handles (11, figure 1–8), one for each engine, are located on the pilots' instrument panel. When a handle is pulled, the fuel and oil shutoff valves for the corresponding engine close, stopping the flow of fuel and oil to the engine. The fuel and oil shutoff valves are mounted at the engine firewall, and, when closed, prevent the flow of fuel and oil past the firewall. When the handle is pushed in, the fuel and oil shutoff valves open, allowing fuel and oil to flow unrestricted to the engine. Each fuel-oil emergency shutoff valve T-handle receives 28-volt dc power through a circuit breaker on the jet engine circuit breaker panel (3, figure 1–37).

CAUTION

A fuel-oil emergency shutoff valve T-handle must never be pulled in flight unless an emergency exists. Since the jet engines windmill when shut down in flight, oil is required to prevent damage to internal parts.

OIL HEATER SWITCH

An oil heater switch (7, figure 1–27), with ON–OFF positions, is located on the jet engine control panel. The switch is used to control two electric heating elements, one in each jet engine oil tank. When the switch is placed in the ON position, electrical power is directed to a thermal switch and relay for each engine. The thermal switch and relay maintain engine oil temperature above −9°C plus or minus 6°C by automatically operating the heating element. If engine oil temperature falls below the specified limits, the thermal switches close the respective relay, allowing 115-volt, unregulated-frequency ac power to flow to the oil tank heating element. When the oil temperature is brought back to specified limits, the thermal switch opens the relay, stopping current flow to the heating element. When the oil heater switch is placed to the OFF position, the oil heating system is deenergized. The engine oil heater switch receives 28-volt dc power through a circuit breaker on the jet engine circuit breaker panel (3, figure 1–37).

FUEL SYSTEM

The fuel system (figure 1–29) provides fuel for the reciprocating and jet engines, auxiliary power unit, and combustion heaters. Fuel is supplied to the reciprocating engines either directly from the main tanks or through the fuel manifold. Gasoline may be supplied to the jet

TANK	NO. OF TANKS	USABLE FUEL			FULLY SERVICED		
		GAL	JP-4 LB	GAS LB	GAL	JP-4 LB	GAS LB
NO. 1	1	1770		10,354.5	1789.1		10,466.2
NO. 2	1	1520		8892	1539.6		9006.7
NO. 3	1	1520		8892	1539.6		9006.7
NO. 4	1	1770		10,354.5	1789.1		10,466.2
CENTER	1	1210	7744	7078.5	1218.5	7798.4	7128.2
AFT A R TANK SYSTEM	8	2908.3 (Total 8 tanks)	18,613	17,013.6	2967.5	18,992	17,360
FWD A R TANK SYSTEM	7	2910.7 (Total 7 tanks)	18,628.5	17,027.6	2953.5	18,902.4	17,278

USABLE FUEL TOTALS	GAL	JP-4 LB	GAS LB
Tanks No. 1, 2, 3, and 4	6580		38,493
Tanks No. 1, 2, 3, 4, and Center	7790		45,572
Tanks Fwd and AFT A/R	5819	37,241.6	34,041
Tanks Fwd and AFT A/R, Center	7029	44,985.5	41,119.7

NOTE:

The weights are based upon average value densities of 5.85 lb/gal for gas and 6.40 lb/gal for JP-4.

FUEL QUANTITY DATA

Figure 1–28

engines from the fuel manifold, or JP-4 may be supplied to the jet engines from the air refueling system. The fuel system consists essentially of four main tanks, eight boost pumps, six engine-driven pumps, four manifold shutoff valves, four jet engine fuel selector valves, and individual tank valves, which allow selection of fuel from any combination of tanks. Fuel in the manifold can be directed to any or all of the engines by appropriate positioning of the fuel selector valve switches and the jet engine fuel selector valve switches. The switches are not decaled, but each switch position can be determined by its relation to the schematic diagram of the fuel system. Placing a switch to create an unbroken line in the diagram indicates an open valve.

The auxiliary fuel system consists of the center wing tank. This tank contains two submerged fuel boost pumps. Flow from the center wing tank is controlled by the center tank line valve and may be isolated from the main fuel manifold by closing the No. 1 manual fuel shutoff valve. There are two submerged boost pumps in each main tank, in the center wing tank, and in the jet engine sump tank. The boost pumps are installed in such a manner that the amount of unavailable fuel in extreme flight attitudes is minimized. The boost pumps are controlled by switches on the engineer's instrument panel and jet engine fuel management panel. Check valves in the boost pump lines prevent transfer of fuel between tanks. Individual fuel tank capacities are shown in figure 1–28.

JET ENGINE FUEL SELECTOR SWITCHES

Two jet engine fuel selector switches (67, figure 1–21) on the jet engine fuel management panel control four valves in the jet engine fuel supply lines. Each switch controls a valve in the fuel manifold and a valve in the JP-4 supply line. These rotary-type switches have GASOLINE–JP-4 positions. Each position of the switch can be determined readily by its relation to the schematic diagram of the fuel system. Placing the switches to create an unbroken line in the diagram indicates that the valves are open. Placing a switch to GASOLINE electrically closes the valve in the JP-4 supply line and opens the valve in the fuel manifold, allowing gasoline to flow from the fuel manifold to the jet engine. Placing a switch to JP-4 electrically closes the valve in the fuel manifold and opens the valve in the JP-4 supply line, allowing JP-4 to flow from the air refueling system to the jet engine. The switches receive 28-volt dc power through circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

NOTE

There is a possibility of a flameout occurring while changing fuel during flight, due to a momentary interruption of fuel flow during the time required to reposition the fuel selector valves. Refer to FUEL SYSTEM MANAGEMENT, Section VII, for procedures on changing fuels during flight.

SUMP TANK BOOST PUMP SWITCHES

Two sump tank boost pump switches (70, figure 1–21) on the jet engine fuel management panel control two B-24 boost pumps in the jet engine sump tank. These switches have ON and OFF positions. Placing the switches to ON energizes the boost pumps to operate at a high speed to supply fuel under pressure at 26 to 30 psi to the jet engines. Placing the switches to OFF deenergizes the pumps. The switches receive 28-volt dc power through circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

SUMP TANK BOOST PUMP LOW-PRESSURE WARNING LIGHTS

Two press-to-test sump tank boost pump low-pressure warning lights (69, figure 1–21) are located on the jet engine fuel management panel. The lights come on to indicate that fuel pressure has dropped below 5 psi in the JP-4 supply line when the pumps are operating. The warning lights receive 28-volt dc power through a circuit breaker on the jet engine circuit breaker panel (3, figure 1–37).

MAIN FUEL SYSTEM MANIFOLD LOW-PRESSURE WARNING LIGHT

A main fuel system manifold low-pressure warning light (66, figure 1–21) on the jet engine fuel management panel indicates low fuel pressure in the main fuel system manifold. When fuel pressure in the main fuel system manifold falls below 5 psi, the light will come on. The low-pressure warning light receives 28-volt dc power through a circuit breaker on the jet engine circuit breaker panel (3, figure 1–37).

SINGLE POINT REFUELING

Two single point refueling receptacles (5 and 6, figure 4–66), located aft and below the left wing rear spar, are used to refuel all fuel tanks. The airplane main tanks and center wing tank are refueled through the forward receptacle. The air refueling tanks are refueled through the aft receptacle. Refer to SINGLE POINT REFUELING, Section IV.

AIR REFUELING

This airplane is equipped to transfer fuel in flight to receiver-type airplanes by means of the A/R system. Fuel for this purpose is carried in fuselage tanks which are connected to form a forward tank system and an aft tank system. (See 21, figure 1–4.) Fuel for air refueling may also be carried in the auxiliary fuel system. Additional fuel may be pumped from the main fuel tanks to the A/R system. Refer to AIR REFUELING SYSTEM, Section IV, and FUEL SYSTEM MANAGEMENT, Section VII.

FUEL SPECIFICATION AND GRADE

See figure 1–53 for fuel specification and grade.

FUEL SYSTEM THERMAL RELIEF

The check valves for the main and center wing fuel tanks have bleed holes to provide thermal relief. There are three thermal relief valves having a cracking pressure of 50 ± 5 psi as follows: One relieves the airplane main fuel manifold to No. 2 main fuel tank. One relieves the line between the center wing tank line valve and the manual fuel shutoff valves to the center wing tank. Another relieves the line between the manual fuel shutoff valves and the transfer valves to atmosphere. On 22655 ▶ this valve relieves the line between the manual fuel shutoff valves and the external tank manifold shutoff valve to the atmosphere.

FUEL VAPOR RETURN LINES

The fuel vapors from carburetors on engines No. 1 and No. 2 are vented back to main tank No. 2 and the vapors from carburetors on engines No. 3 and No. 4 are vented back to main tank No. 3. Normally, the rate of return flow is negligible.

FUEL SELECTOR SWITCHES

Four rotary-type fuel selector switches (57, figure 1–21) on the engineer's instrument panel control the fuel selector valves for the four main fuel tanks. The switches have six positions which permit five combinations as follows:

1. TANK TO ENGINE (TE)
2. MANIFOLD TO ENGINE (ME)
3. TANK TO MANIFOLD AND ENGINE (TME) which also permits fuel flow from TANK AND MANIFOLD TO ENGINE
4. Two TANK TO MANIFOLD (TM) positions
5. OFF

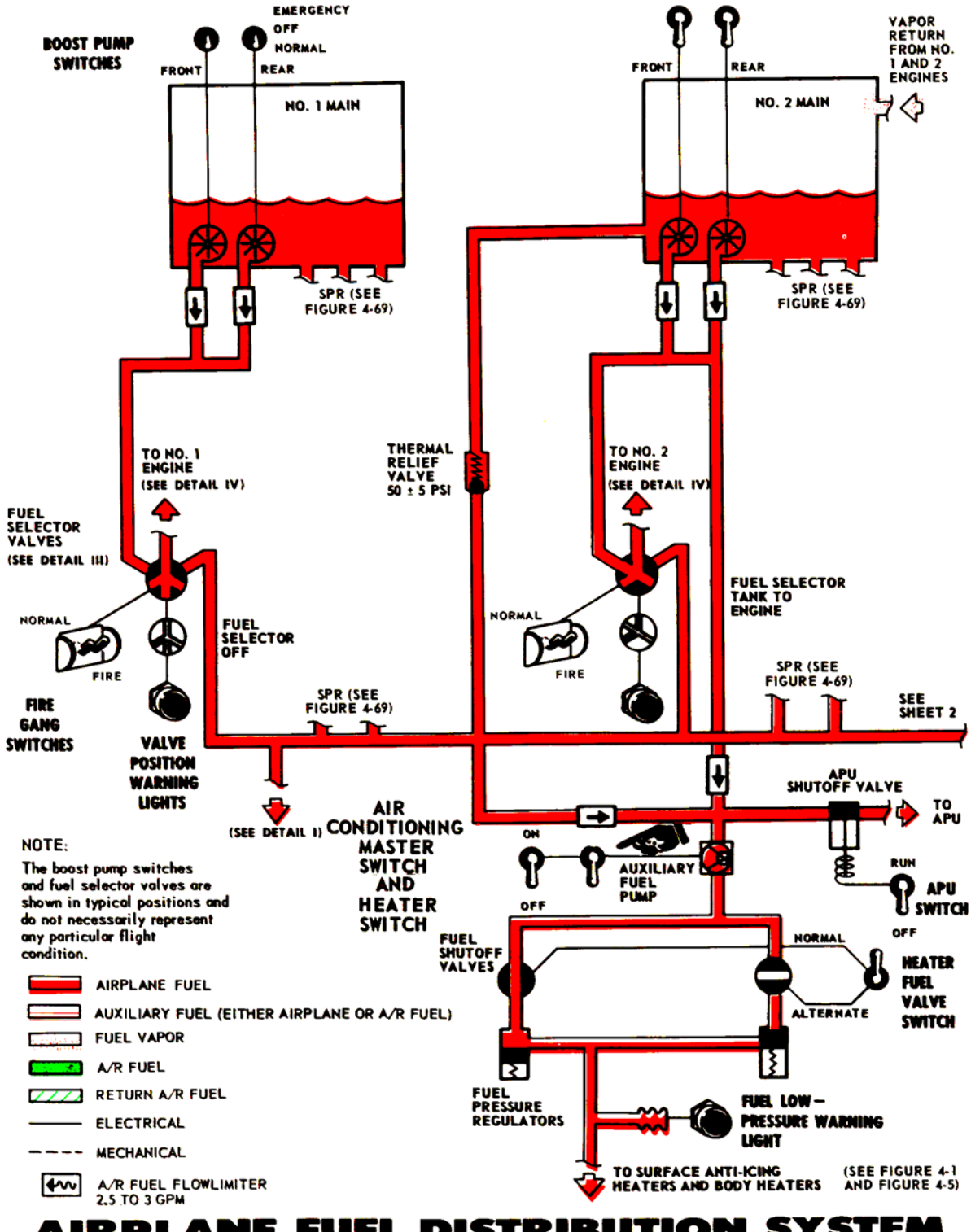
Two shutoff switches for each engine are on the overhead panel. These switches override normal control of fuel selector valves to shut off fuel to the engines. Refer to FIRE SWITCHES, this section. The selector switches are supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

FUEL VALVE POSITION WARNING LIGHTS

Four fuel valve position warning lights (65, figure 1–21), adjacent to the fuel selector switches, illuminate if the valve is not synchronized with the switches. This can be caused by system lag, selector valve failure, or fire switch actuation. The lights are of the push-to-test type. The selector switch and warning light circuits are supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

FUEL SYSTEM MANUAL FUEL SHUTOFF VALVES

Two manual fuel shutoff valves, No. 1 and No. 2 (figure 1–29), are provided in the fuel system to direct the flow of fuel from the auxiliary tank to either the airplane main fuel manifold or the A/R system. These valves are located just aft of the rear spar in the lower aft compartment. With the No. 1 valve open and the No. 2 valve closed and the center wing tank line valve open, fuel will be directed from the center wing tank to the main fuel manifold. With the No. 1 valve closed and the No. 2 valve open, fuel from the center wing tank is directed to the A/R transfer valves. With the No. 1 valve closed, the center wing tank is shut off from the airplane main fuel manifold. An additional manual fuel shutoff valve, No. 3,



AIRPLANE FUEL DISTRIBUTION SYSTEM

Figure 1-29 (Sheet 1 of 6)

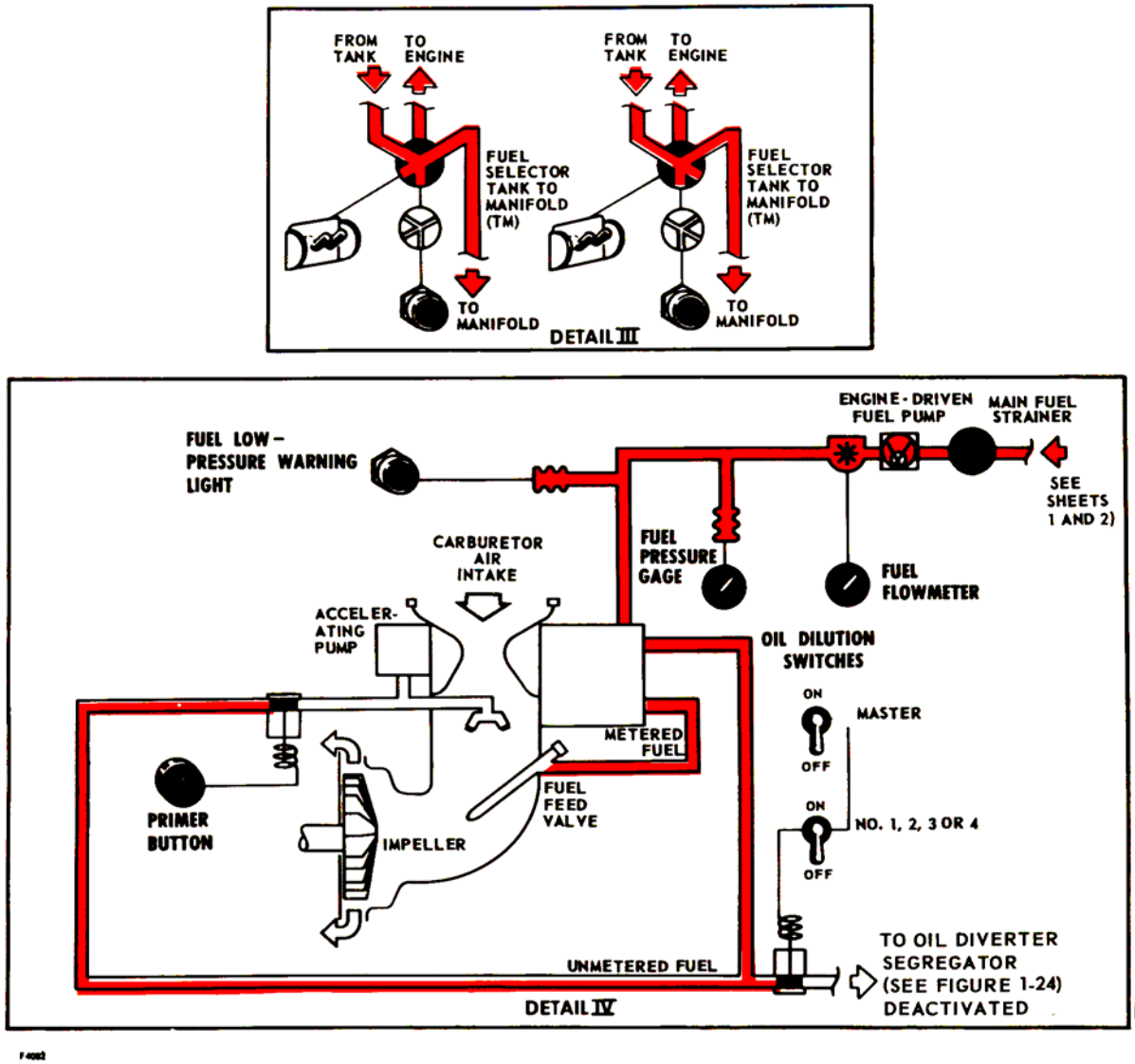


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Figure 1-29 (Sheet 6 of 6)

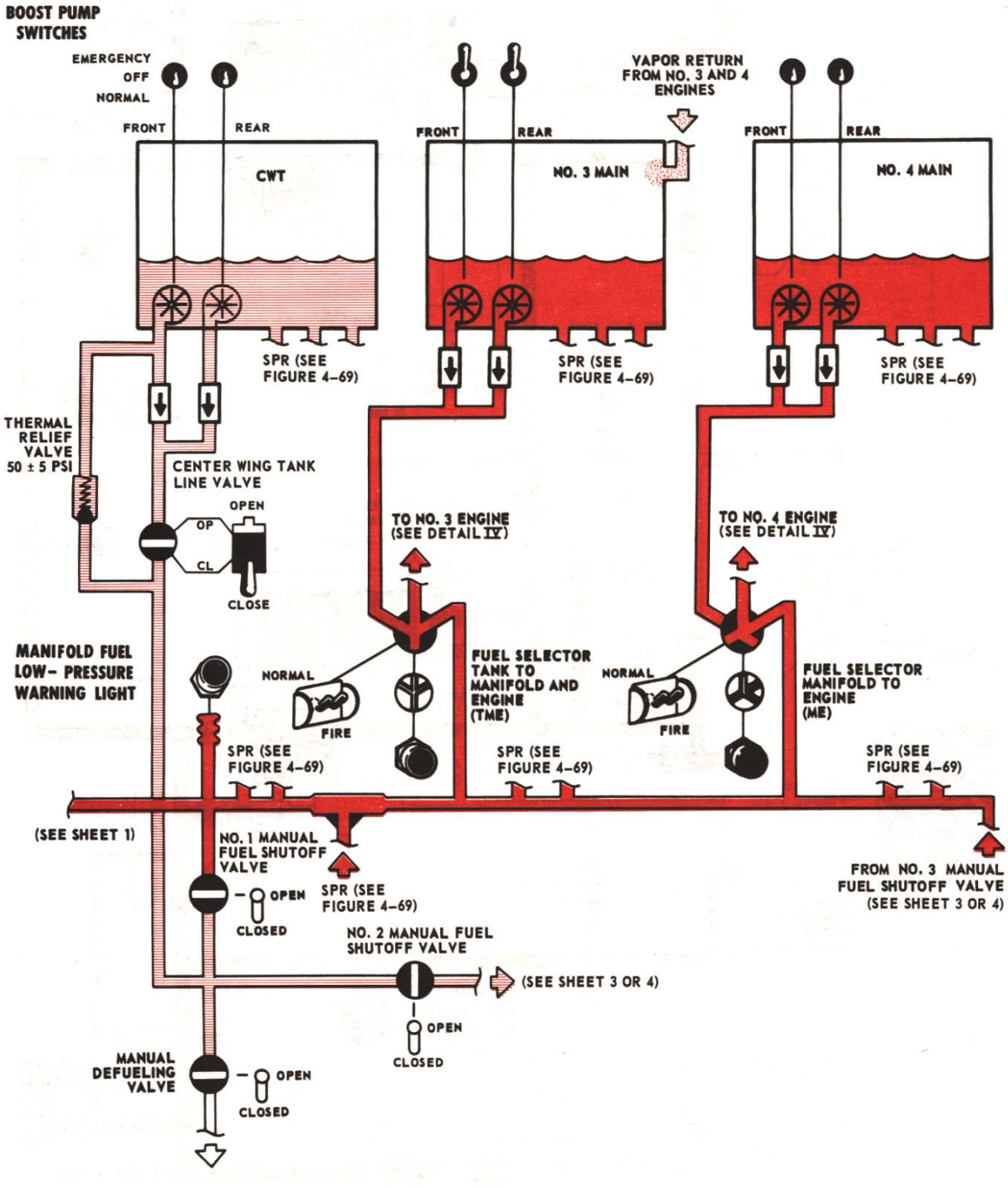


Figure 1–29 (Sheet 2 of 6)

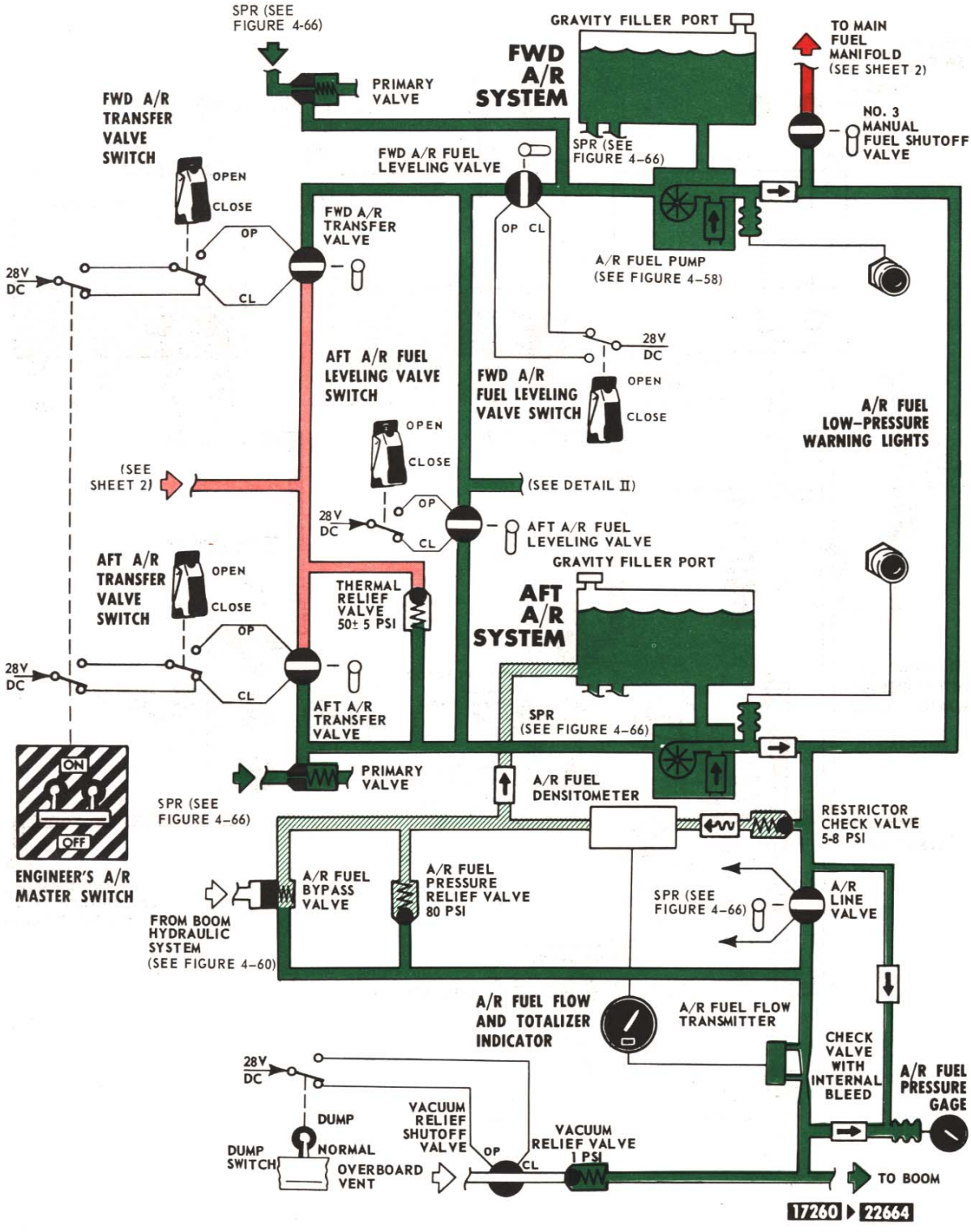


Figure 1–29 (Sheet 3 of 6)

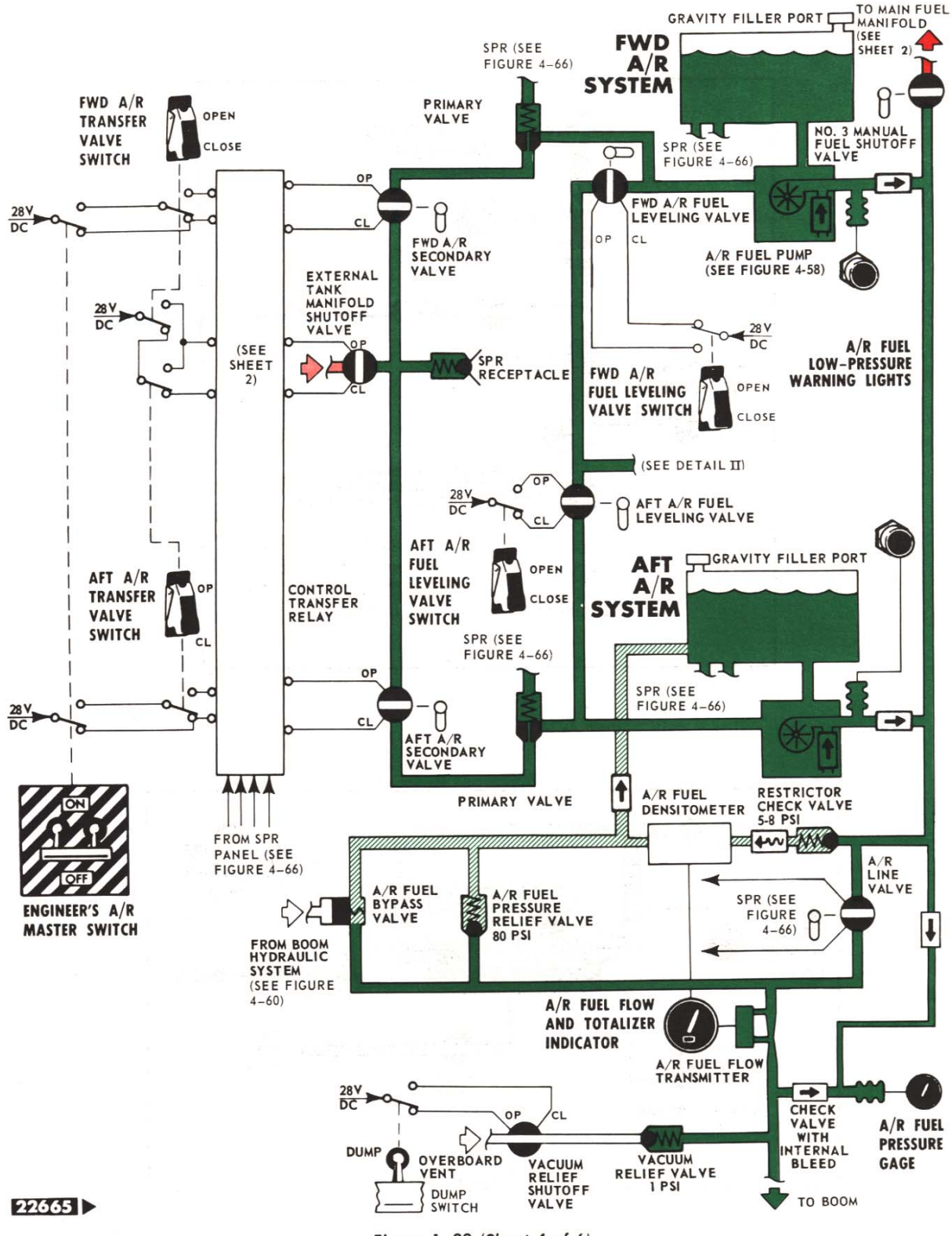
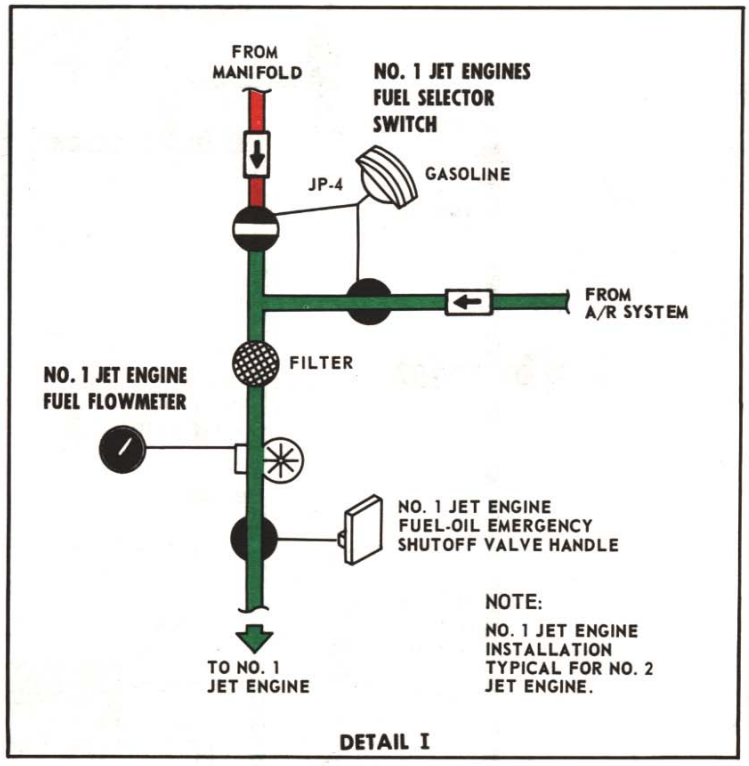


Figure 1–29 (Sheet 4 of 6)



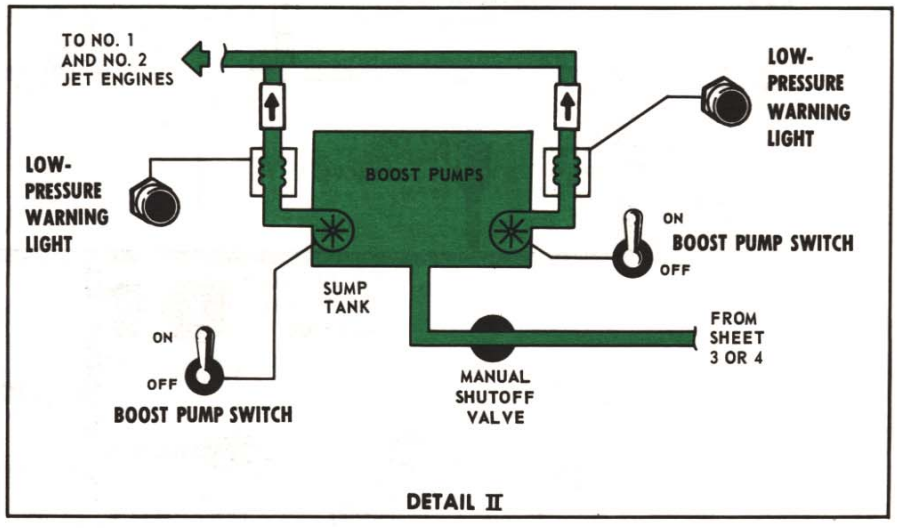


Figure 1–29 (Sheet 5 of 6)

extends the cruising range of the airplane. For location and operation of the No. 3 manual fuel shutoff valve, refer to Section IV and Section VII.

WARNING

Incorrect positioning of the manual fuel shutoff valves and the A/R transfer valves on airplanes may allow fuel to be transferred to the A/R system. Refer to FUEL SYSTEM OPERATION, Section VII.

SUMP TANK MANUAL FUEL SHUTOFF VALVE

A manual fuel shutoff valve is provided in the A/R fuel line, between the leveling line and sump tank, to control fuel from the A/R tanks and shut off fuel to the sump tank during fuel transfer and single point refueling. With the sump tank valve open and one or both leveling valves open, fuel from the A/R system will be directed to the sump tank.

CENTER WING TANK LINE VALVE SWITCH

An OPEN–CLOSE center wing tank line valve switch (59, figure 1–21) on the engineer's instrument panel controls the center wing tank valve. With the switch OPEN, the No. 1 manual fuel shutoff valve open, and the No. 2 manual fuel shutoff valve closed, fuel will flow from the tank into the fuel manifold. If the valve positions are reversed, fuel will flow into the A/R leveling manifold. With the switch in the CLOSE position, fuel cannot be drawn from the center wing tank. The circuit is supplied with 28-volt dc power through the center wing tank boost pump circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

BOOST PUMP SWITCHES

Each fuel tank has two fuel boost pumps. These pumps are controlled individually by EMERGENCY–OFF–NORMAL boost pump switches (58, figure 1–21) on the engineer's instrument panel. When the boost pump switches are at NORMAL with a no-flow condition (engine inoperative), fuel pressure will be 12 to 20 psi. When the boost pump switches are at EMERGENCY with a no-flow condition, fuel pressure will be 24 to 40 psi. When the boost pump switches are at NORMAL with a flow condition (engine operating), fuel pressure will be 23 to 27 psi. When the boost pump switches are at EMERGENCY with a flow condition, fuel pressure will be 24 to 34 psi. When the boost pump switches are OFF, the boost pumps are inoperative. The fuel pressure regulator on the engine-driven fuel pump regulates fuel pressure between 23 and 27 psi. However, fuel pressure gage calibration should be applied when checking these tolerances. With the engine operating, and with fuel pressure within limits, it is possible to have a drop in pressure when the boost pump switches are placed at NORMAL. The sudden surge in fuel pressure can cause the bypass valve to seek a new position. This new position can increase the amount of fuel being bypassed and this in turn can result in a drop in fuel pressure. The boost pump switches are supplied with 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Note

When using emergency boost during fuel management procedures, the fuel pressure should not exceed 34 psi after the desired fuel routing is established. If, with fuel flow established, 34 psi fuel pressure is exceeded, discontinue emergency boost operation and place both boost pump switches for that tank to NORMAL. Turn off all other boost pump switches, then place one boost pump switch, for another tank, to NORMAL position to use for backup pressure.

FUEL QUANTITY GAGES

Five fuel quantity gages (72, figure 1–21) on the engineer's instrument panel show the quantity of fuel in pounds for the main tanks and the center wing tank. Pushbutton fuel quantity gage test switches (62, figure 1–21) adjacent to the gage are used to show circuit continuity of the fuel quantity indicating circuits. The circuits are supplied with 115-volt ac power through circuit protection on the ac power panel (15, figure 1–37).

ELECTRICAL SYSTEMS

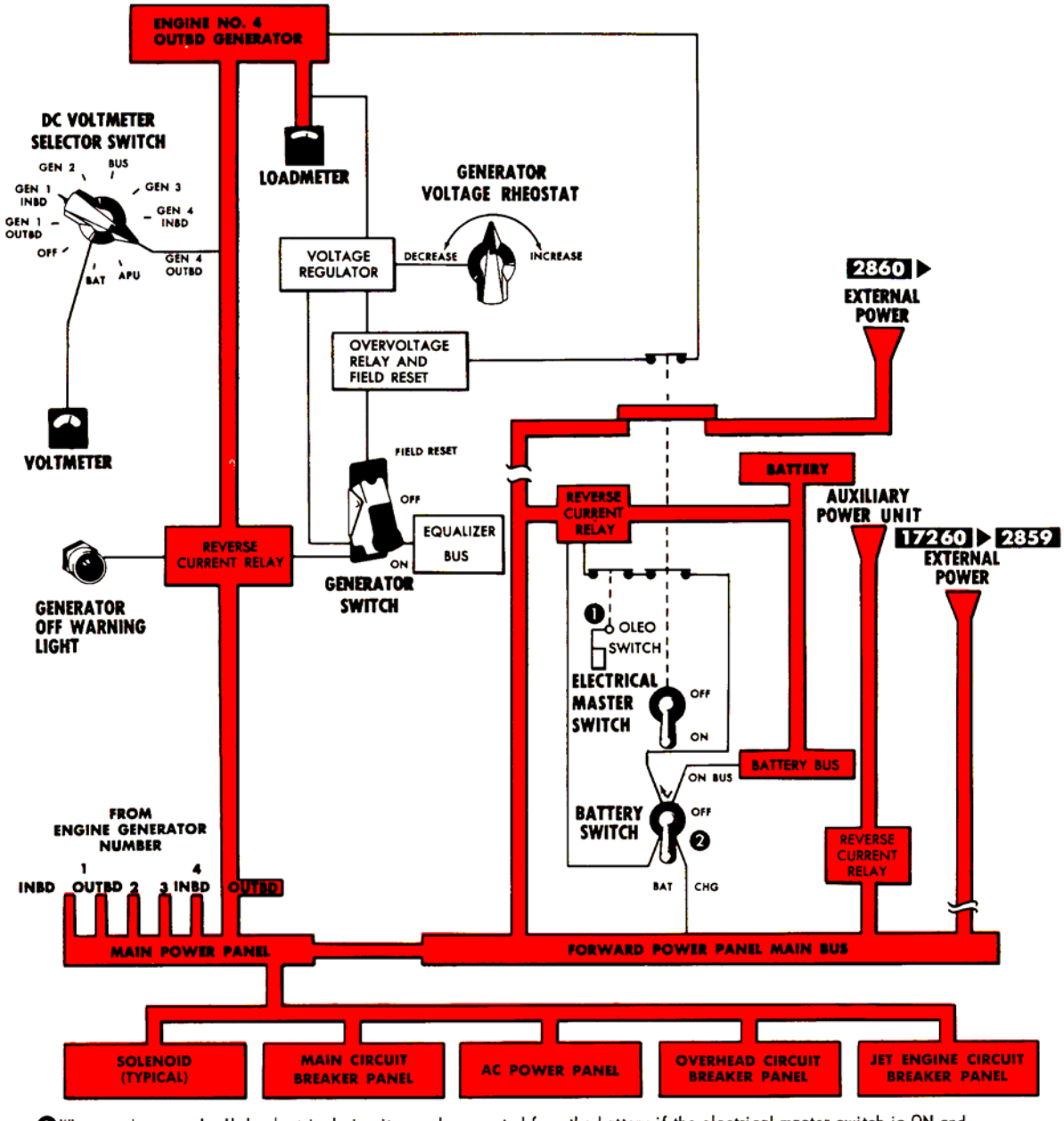
The electrical systems are the dc power system, ac power system, and variable frequency ac system. These systems are described in the following paragraphs.

DC POWER SYSTEM

Twenty-eight volt dc power is supplied to the dc power distribution system by six engine-driven generators and by an auxiliary power unit. (Refer to Section IV for description and operating instructions for the auxiliary power unit.) Parallel operation on the dc power system is accomplished by an equalizing circuit. This circuit is common to all generators operating in parallel and is designed to cause all generators to take an equivalent share of the load. If an unbalance occurs such that one generator has high voltage with respect to the other generators, a current flow will result in the equalizer circuit to cause the generator with high voltage to be lowered and the generator with low voltage to be raised. A battery in the lower forward compartment is provided as an emergency source of dc power. An external power supply may be connected to the dc power distribution system through an external power receptacle. Circuit breakers and fuses (figure 1–36) provide circuit protection for all dc power-operated equipment. See figure 7–11 for listing of major dc power-operated equipment loads. See figures 1–30 and 1–31 for schematic diagrams of dc power generation and distribution.

Battery

The airplane has a 24-volt, 36 ampere-hour, nickel-cadmium battery. The battery is in the lower forward compartment of the airplane. Use of battery current is controlled by a switch on the overhead panel. The battery is used in emergencies as a source of power for the flight instrument spare inverter and for the turn and slip indicator. See figure 1–31 for a list of other equipment which may be operated from the battery bus. The battery may be connected to the airplane bus on the ground only; however, the battery is connected to the emergency (battery) bus at all times regardless of the battery switch

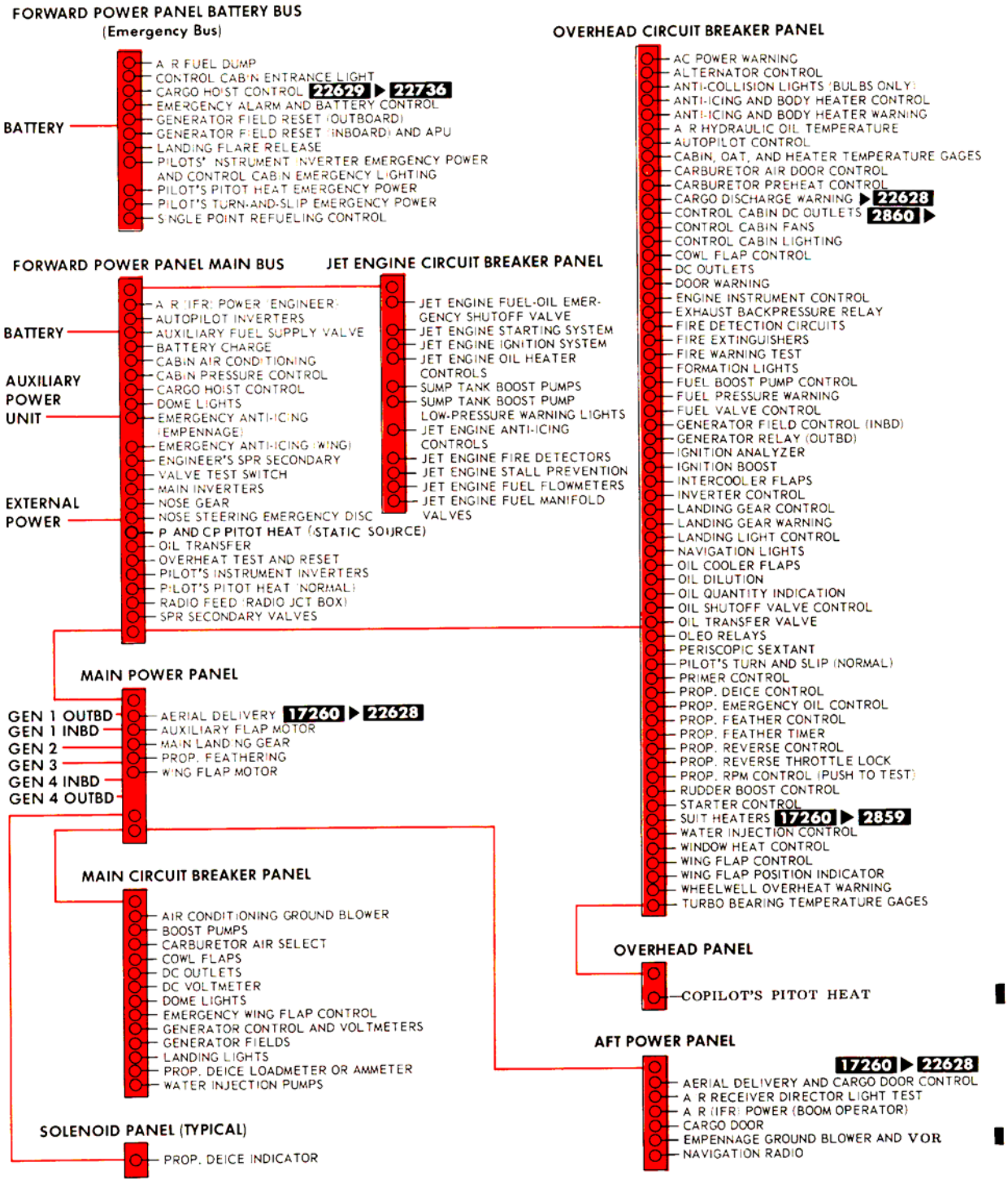


❶ When on the ground, all dc electrical circuits can be operated from the battery if the electrical master switch is ON and the battery switch is ON BUS.

❷ When in flight, battery bus voltage will be the same as generator voltage (28v dc) if the battery switch is in BAT CHG. With the battery switch OFF or ON BUS the battery bus will be at battery voltage (24v dc).

DC POWER GENERATION

Figure 1–30



DC POWER DISTRIBUTION

Figure 1–31

position. The nickel-cadmium battery differs from a lead-acid battery in both principle and operation. The electrolyte in a nickel-cadmium battery is a potassium hydroxide solution. During charging and discharging, the specific gravity of the electrolyte does not change; therefore, specific gravity measurements cannot be used to determine the state of charge of the battery.

Generators

Each of the six 28-volt, 300-ampere, engine-driven generators is connected to the main power panel through a current limiter. The current limiter protects the bus against a generator or reverse current relay failure. The voltage is regulated automatically by carbon-pile type regulators. Each generator has an overvoltage control unit which will disconnect the generator from the dc power distribution system in the event of high generator voltage. Two generators are mounted on the accessory section of each outboard engine and one generator is mounted on the accessory section of each inboard engine. The generators normally supply all of the power required for operation of dc power operated equipment in the airplane, and also supply dc power to the inverters.

DC External Power Receptacle

An external power receptacle (16, figure 1–53) for dc power is on the bottom of the fuselage near the forward entry door.

Auxiliary Power Unit

Refer to Section IV for description of the auxiliary power unit and controls.

DC Outlets

On 17260 ▶ 2859 there are 11 28-volt dc outlets. Five heated suit control panels are located in the control cabin. There is one at the pilot's, copilot's, and engineer's stations and two at the navigator's station. Four casualty blanket outlets are located in the main compartment. Two signal lamp outlets are located just forward of the boom pod, one on either side of the fuselage. The heated suit control panels and the signal lamp outlets are suitable for use with the interairplane (aldis) signal lamp.

On 2860 ▶ there are five 28-volt dc outlets. Three are located in the control cabin at the pilot's, copilot's, and navigator's stations. Two outlets are located on opposite sides of the fuselage just aft of the left rear exit hatch. These outlets are suitable for use with the interairplane (aldis) signal lamp.

Electrical Master Switch

The electrical master switch (41, figure 1–11) on the overhead panel completes the control circuit for the battery and generators. This ON–OFF switch must be ON to supply power to the dc power distribution system. If the master switch is OFF, the circuits to the field coils of the generators are broken and there is no output from the generators.

Battery Switch

The battery switch (1, figure 1–11) is adjacent to the electrical master switch on the overhead panel and has three positions; ON BUS–OFF–BAT CHG. The battery is isolated from the dc power distribution system when the switch is in the OFF position. To preclude the possibility of damage to the battery, the battery switch should be in the OFF position when the airplane is on the ground with the external power connected. When the airplane is on the ground and the battery switch is positioned to ON BUS, the battery is connected to the dc power distribution system. A landing gear actuated oleo switch opens when the airplane leaves the ground and deenergizes the reverse current relay, making it impossible to connect the battery to the dc power distribution system during flight while the battery switch is ON BUS or OFF. When the battery switch is placed in the BAT CHG. position and the electrical master switch is ON, the reverse current relay will close to permit charging of the battery when battery voltage is sufficiently less than bus voltage. If the current flow is reversed (battery to bus), the reverse current relay will open to prevent discharging the battery. The battery switch and control circuit are protected by a circuit breaker on the forward power panel (5, figure 1–37).

Generator Switches

Six individual generator switches (48, figure 1–21) control the engine-driven generators. These switches have ON–OFF–FIELD RESET positions and are guarded to the ON position. When a switch is in the ON position, the generator delivers power to the dc power distribution system if generator voltage is sufficiently high, but not so high to trip the overvoltage relay, and the electrical master switch is ON. In the OFF position, the generator is disconnected from the distribution system. The FIELD RESET position is used to reset the generator field relay and restore generator operation after the field relay has been tripped by generator overvoltage. The generator control switches are spring-loaded to the OFF position from the FIELD RESET position. The generator field relay control circuits are protected by two circuit breakers on the overhead circuit breaker panel (1, figure 1–37). Each generator control circuit and each generator field is protected by a circuit breaker on the main circuit breaker panel (8, figure 1–37).

Generator Voltage Rheostats

Generator voltage rheostats (49, figure 1–21), one for each generator, are on the engineer's instrument panel. The rheostats are to be used in conjunction with the loadmeters and voltmeters for adjusting generator output voltage to equalize generator load distribution.

DC Voltmeter Selector Switch And Voltmeter

A rotary-type dc voltmeter selector switch (50, figure 1–21) and a single dc voltmeter (51, figure 1–21) on the engineer's instrument panel provide a means of reading individual generator or direct-current bus voltage as selected by the dc voltmeter selector switch. The switch positions are marked OFF–GEN 1 OUTBD–GEN 1 INBD–GEN 2–BUS–GEN 3–GEN 4 INBD–GEN 4 OUTBD–APU–BAT. In the OFF position the switch disconnects the voltmeter from any power source. The output voltage of any of the generators or the battery

is determined by rotating the switch to the appropriate position and reading the voltmeter. When the switch is in the BUS position, the voltmeter is connected to the main power panel distribution bus. Each of the circuits from the power sources to the voltmeter selector switch, except the circuit from the auxiliary power unit generator, is protected by a circuit breaker on the main circuit breaker panel (8, figure 1–37).

Generator Warning Lights

Seven red press-to-test generator warning lights (45 and 55, figure 1–21) are on the engineer's instrument panel. Six of the lights are for the engine-driven generators and one is for the auxiliary power unit generator. The generator warning lights are operated by individual relays connected to the generator reverse current relays, and illumination of a light indicates that the indicated generator is not supplying power and is disconnected from the dc power distribution system. The light for any generator will illuminate if the reverse current relay opens for any reason, such as engine rpm too low for generator to cut in (approximately 1000 rpm or less) or a field relay tripped by high generator voltage.

DC Loadmeter

Seven loadmeters (47 and 53, figure 1–21) on the engineer's instrument panel indicate the output of each of the six engine-driven generators and the auxiliary power unit generator. The loadmeters are calibrated in percent of the normal rated load of each generator, and will indicate generator output continuously when the generator is operating.

AC POWER SYSTEM

The ac power system consists of three separate groups of inverters; the main inverters, autopilot inverters, and pilots' instrument inverters.

Main Inverters

The essential, secondary, and spare main inverters provide 115-volt, 400-cycle, single-phase, ac power to the essential and secondary ac busses. The essential and spare main inverters are 3000 volt-ampere inverters and the secondary inverter is a 2500 volt-ampere inverter. The essential inverter supplies power to the essential bus. The secondary inverter supplies power to the secondary bus. The spare main inverter automatically supplies power to either the essential or secondary bus in the event of essential or secondary main inverter failure. If the essential inverter should fail while the spare main inverter is supplying the secondary bus, the spare main inverter will automatically be changed over to the essential bus.

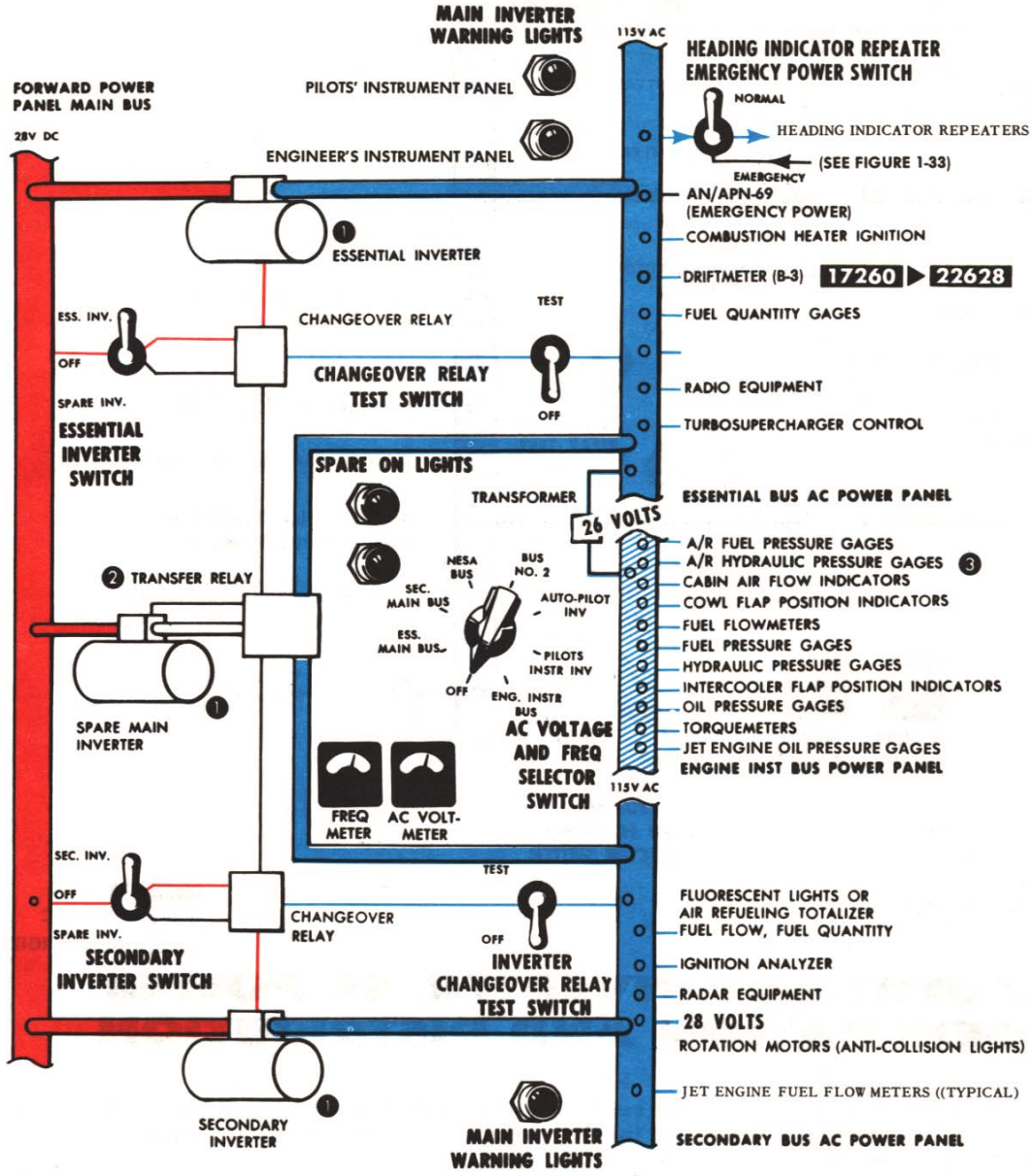
Power Supply. Each of the three main inverters receives dc power from the forward power panel (5, figure 1–37) through a current limiter. See figure 1–32 for a schematic diagram of the main inverters.

Main Inverter Switches. Two switches (42 and 46, figure 1–21) on the engineer's instrument panel control the three inverters in the main inverter system. One switch, with ESS. INV.–OFF–SPARE INV. positions, energizes and connects the essential inverter to the essential bus when in the ESS. INV. position. The second switch, marked SEC. INV.–OFF–SPARE INV., energizes and connects the secondary inverter to the secondary bus when in the SEC. INV. position. If the essential inverter becomes inoperative, the spare main inverter is automatically energized and connected to the essential bus. The SPARE INV. position on each switch provides a means of manually disconnecting either the essential or secondary inverters from their respective busses, and connecting the spare main inverter to the selected bus. When the switches are in the OFF position, no power is connected to the busses. If the spare main inverter is supplying the secondary bus, and the essential inverter switch is moved from either the ESS. INV. or OFF position to the SPARE INV. position, the spare main inverter will be connected to the essential bus; also, if the essential inverter becomes inoperative while the spare main inverter is supplying the secondary bus, the spare main inverter automatically will be transferred to the essential bus. Each of the two main inverter control circuits is protected by a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Main Inverter Warning Lights. There are five press-to-test main inverter warning lights. Two red and two amber inverter warning lights (40, figure 1–21) are on the engineer's instrument panel and one red main inverter warning light (7, figure 1–8) is on the pilots' instrument panel. In event of failure of the essential inverter, a red light on the engineer's instrument panel and a red light on the pilots' instrument panel will illuminate. When the spare main inverter automatically assumes the load of the essential inverter, or when the essential inverter switch is positioned to SPARE INV., an amber light on the engineer's instrument panel will illuminate and the red warning lights will go out. In event of failure of the secondary inverter, the second red light will illuminate and the second amber light on the engineer's instrument panel will illuminate if the spare main inverter automatically assumes the load of the secondary inverter or if the secondary inverter switch is positioned to SPARE INV. The red warning lights will go out when power is supplied to the bus by the spare main inverter.

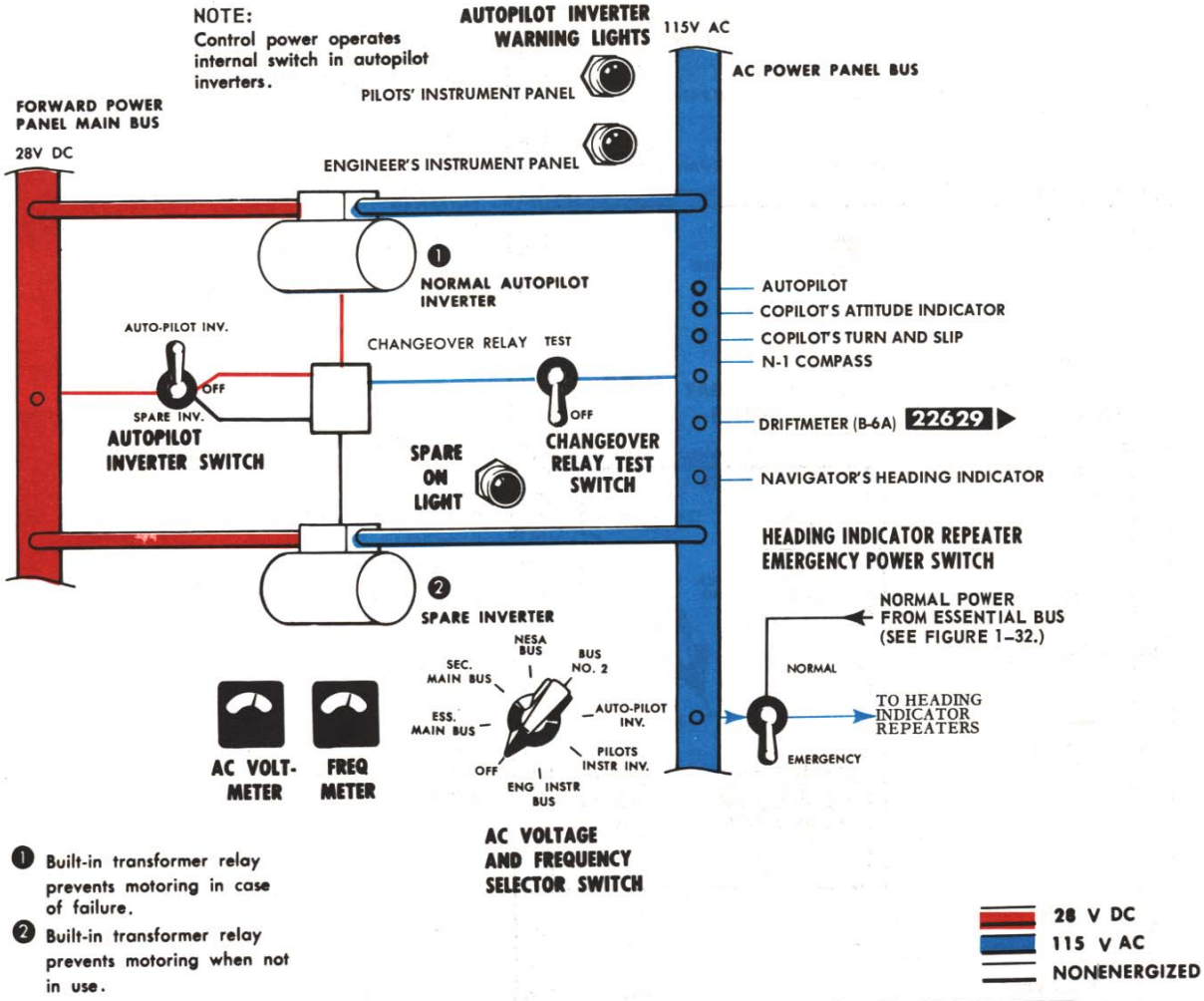
Autopilot Inverters

There are two autopilot inverters; a normal and a spare. Each autopilot inverter has a capacity of 750 volt-amperes, and produces 115-volt, 400-cycle, 3-phase ac power for operation of the autopilot, navigator's heading indicator, and the driftmeter on 22629▶. Either of the two inverters may be selected for operation. In the event of failure of the normal inverter, the spare inverter is automatically put into operation. The normal inverter will not automatically be put into operation in the event of failure of the spare inverter. DC power for the autopilot inverters is supplied through thermo-circuit breakers on the forward power panel. 17260▶22700, through thermo-circuit breakers on the AC power panel (15, figure 1-37) 22701▶, and through thermo-circuit breakers on the autopilot junction shield (14, figure 1-37) on 3142▶. See figure 1-33 for a schematic diagram of the autopilot inverters.



MAIN INVERTER POWER GENERATION AND DISTRIBUTION

Figure 1–32



1 Built-in transformer relay prevents motoring in case of failure.

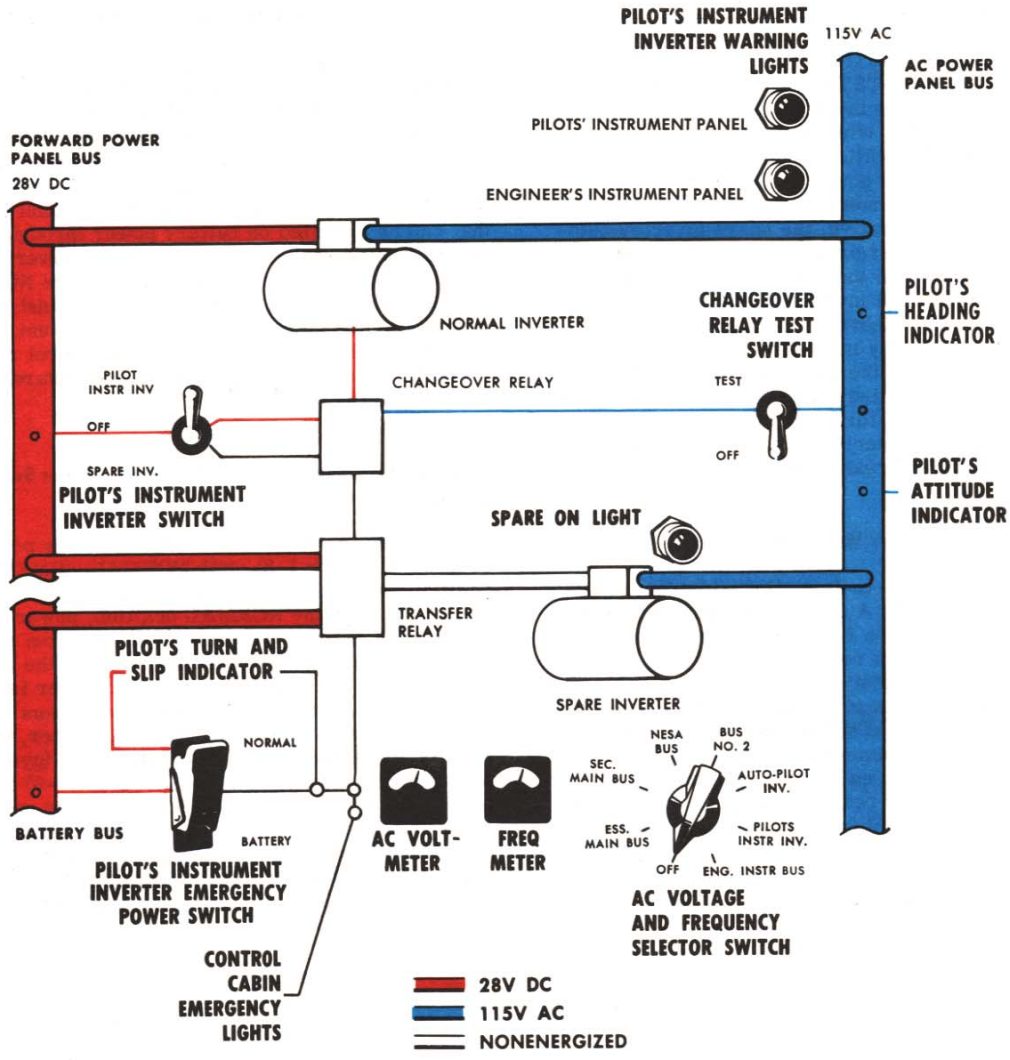
2 Built-in transformer relay prevents motoring when not in use.

AUTOPILOT INVERTER AC POWER GENERATION AND DISTRIBUTION

Figure 1-33

Autopilot Inverter Switch. An autopilot inverter switch (44, figure 1–21) on the engineer's instrument panel, with AUTO-PILOT INV.–OFF–SPARE INV. positions, controls the normal and spare autopilot inverters. When the switch is in the AUTO-PILOT INV. position, the normal autopilot inverter is energized and supplies power to the autopilot, copilot's attitude indicator, copilot's turn and slip indicator, N-1 compass, the driftmeter on 22629 ▶ , and the navigator's heading indicator. If the normal autopilot inverter becomes inoperative, the spare inverter automatically becomes energized and assumes the load. When the switch is in the SPARE INV. position, the spare autopilot inverter supplies power to the autopilot, but if the spare inverter fails, the normal inverter will not be energized automatically. When the switch is in the OFF position, no power is supplied to the instruments mentioned above. Each of the two autopilot inverter control circuits is protected by a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Autopilot Inverter Warning Lights. There are three press-to-test autopilot inverter warning lights. An amber and a red inverter warning light (40, figure 1–21) are on the engineer's instrument panel, and a red inverter warning light (14, figure 1–8) is on the pilots' instrument panel. The red lights indicate no power is supplied to the autopilot bus. In event of failure of the normal autopilot inverter, the red light on the engineer's instrument panel and the red light on the pilots' instrument panel will illuminate. The amber light on the engineer's instrument panel will illuminate and the red lights will go out when the spare autopilot inverter automatically assumes the load of the normal inverter or if the autopilot inverter switch is positioned to SPARE INV.



PILOTS' INSTRUMENT INVERTER AC POWER GENERATION AND DISTRIBUTION

Figure 1–34

Pilots' Instrument Inverters

There are two pilots' instrument inverters; a normal and a spare. Each of the inverters has a capacity of 100 volt-amperes and supplies 115-volt, 400-cycle, 3-phase ac power for the operation of the pilot's heading indicator and attitude indicator. Either of the two inverters may be selected for operation, and in the event of failure of the normal inverter, the spare inverter is automatically put into operation. However, the normal inverter will not be put into operation automatically in event of failure of the spare inverter. Each of the two inverters receive dc power from the forward power panel (5, figure 1–37) through circuit breakers. In emergencies, the spare inverter may receive power from the battery through a circuit breaker on the forward power panel. See figure 1–34 for a schematic diagram of the pilots' instrument inverters.

Pilot's Instrument Inverter Switch

A switch (43, figure 1-21) on the engineer's instrument panel, with PILOTS INSTR INV--OFF--SPARE INV positions, controls the normal and spare pilot's instrument inverters. When the switch is in the PILOTS INSTR INV position, the normal inverter is energized and supplies power to the pilot's heading indicator and attitude indicator. If the normal inverter becomes inoperative, the spare inverter automatically becomes energized and supplies power for the instruments. When the switch is in the SPARE INV position, the spare inverter supplies power to the instruments. The normal inverter will not be energized automatically in case of failure of the spare inverter. When the switch is in the OFF position, no power is supplied to the pilot's heading indicator or attitude indicator. Each of the two inverter control circuits is protected by a circuit breaker on the overhead circuit breaker panel (1, figure 1-37).

Pilot's Instrument Inverter Warning Lights

There are three press-to-test pilot's instrument inverter warning lights. A red and an amber inverter warning light (40, figure 1-21) are on the engineer's instrument panel, and a red inverter warning light (5, figure 1-8) is on the pilot's instrument panel. In event of failure of the normal pilot's instrument inverter, the red lights on the engineer's instrument panel and pilot's instrument panel will illuminate. The amber light on the engineer's instrument panel will illuminate and the red lights will go out when the pilot's spare instrument inverter automatically assumes the load of the normal inverter or when the pilot's instrument inverter switch is positioned to SPARE INV.

Pilot's Instrument Inverter Emergency Power Switch

The pilot's instrument inverter emergency power switch (45, figure 1-8), on the pilot's instrument panel, with NORMAL--BATTERY positions, connects power from the battery to the pilot's spare instrument inverter, the pilot's turn and slip indicator, and certain control cabin and panel lights when placed in the BATTERY position. For cabin and panel lights that can be operated on battery power through the pilot's instrument inverter emergency power switch, see figure 4-37. When the switch is in the NORMAL position, power is supplied to the pilot's instrument inverter by the dc power distribution system. The pilot's instrument emergency power control circuit is protected by a circuit breaker on the forward power panel (5, figure 1-37).

Heading Indicator Repeater Emergency Power Switch and Warning Light

The heading indicator repeater emergency power switch (30, figure 1-8), with NORMAL--EMERGENCY positions, is on the pilots' instrument panel. When the switch is in the NORMAL position, power is supplied to the heading indicator repeaters from the essential bus on the ac power panel. When the switch is placed in the EMERGENCY position, power is supplied to the compass repeater indicators from the normal or spare autopilot inverter, whichever is operating. The heading indicator (gyro compass) repeater warning light (17, figure 1-8) is on the pilots' instrument panel directly above the repeater emergency power switch. In the event of normal power failure the light will illuminate, indicating that emergency power is needed to operate the heading indicator repeater. The repeater power circuit is

protected by a fuse on the ac power panel (15, figure 1-37).

Note

Operation of this switch to EMERGENCY position will render all RMI's inoperative, and the ADF needles will be inoperative.

AC Voltage and Frequency Selector Switch, Voltmeter and Frequency Meter

A rotary-type ac voltage and frequency selector switch (37, figure 1-21), a single ac voltmeter (32, figure 1-21), and a single frequency meter (33, figure 1-21) on the engineer's instrument panel provide a means of reading the output voltage and frequency of each 400-cycle inverter and voltage only of variable frequency alternators, as selcted by the switch. The switch has OFF--ESS. MAIN BUS--SEC. MAIN BUS--NESA BUS--BUS NO. 2--AUTOPILOT INV.--PILOTS INSTR. INV.--ENG. INSTR. BUS positions. The voltmeter and frequency meter are connected to the power sources as indicated by the switch position, except that the frequency meter is not connected when the switch is in the NESA BUS--BUS NO. 2 positions. When the switch is in the OFF position, neither the ac voltmeter nor frequency meter are connected to a power source.

Inverter Changeover Relay Test Switches

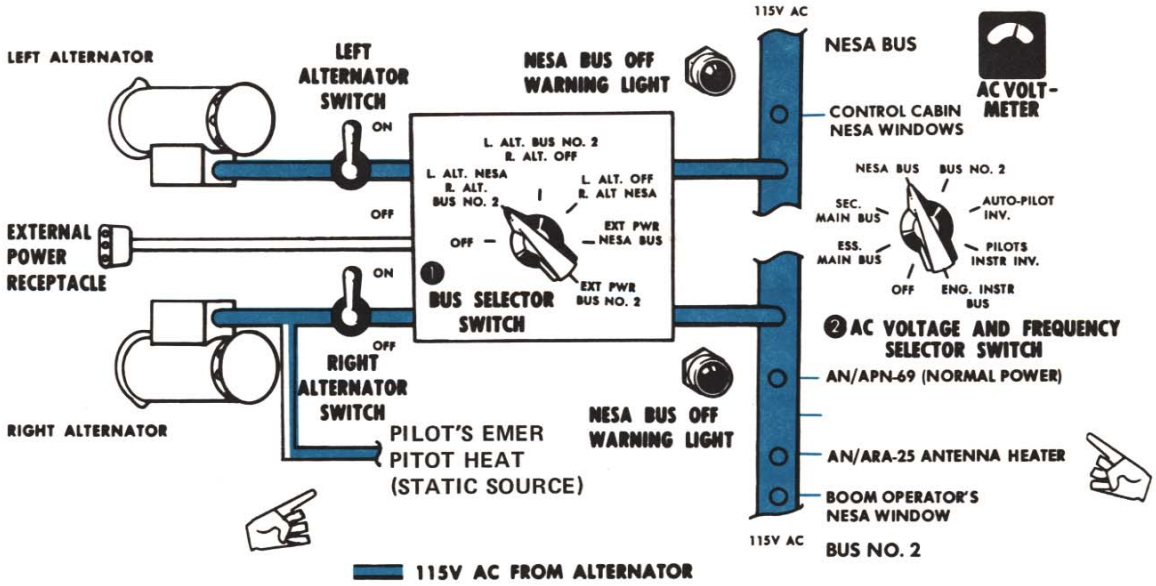
The inverter changeover relay test switches, with TEST--OFF positions, are located on the ac power panel (15, figure 1-37), except on 3142 ▶ the autopilot inverter changeover relay test switch is located on the autopilot junction shield (14, figure 1-37). This shield is across from the engineer's position on the left side of the airplane near the floor. Each switch is spring-loaded from the TEST position to the OFF position. In the circuits, the changeover relay test switches are located between the ac busses and the changeover relays. In normal operation, these switches allow a voltage to be impressed upon the relays when the inverters are in operation. To test a changeover relay, the inverter must be operating and supplying 115-volt ac power to the ac bus and the switch must be held in the TEST position for 4 seconds. This allows time for the circuit to be broken and a heating element to be connected to the main 28-volt dc bus which causes a bimetallic switch to close a circuit to a relay which in turn energizes the spare inverter.

VARIABLE FREQUENCY AC POWER SYSTEM

The variable frequency ac power system provides power for the Nesa windows in the control cabin and in the boom operator's compartment, AN/APN-69 (normal power), pilot's emergency pitot heat for static source and AN/ARA-25 antenna heater. See figure 1-35 for a schematic diagram of the variable frequency ac power system.

Alternators

Two alternating current generators, one on each inboard engine, supply power through 100-ampere fuses located in the nacelle solenoid panel to the Nesa bus and bus No. 2 in the alternator relay shield. Power from either alternator may be directed to either bus.



❶ Power flow shown with bus selector switch in L. ALT. NESA, R. ALT. BUS NO. 2 position.

❷ The frequency meter is inoperative if switch is positioned to NESA BUS or BUS NO. 2.

VARIABLE FREQUENCY AC POWER GENERATION AND DISTRIBUTION

Figure 1–35

Alternator Switches. The two alternators are controlled by two switches (34, Figure 1-21) on the engineer's instrument panel. The left- hand switch is placarded ON and OFF and the right-hand switch is placarded ON, OFF, and EMER. When the switches are in the ON position and the engines are running, alternating current of unregulated frequency is delivered to the bus selector switch. When the right-hand switch is placed in the EMER position, under total DC generator-failure conditions, alternating current of unregulated frequency is delivered directly from the right-hand alternator to the right-hand alternator bus in the alternator relay shield to provide emergency heat for the pilot's left-hand static probe. The control circuit for each alternator is protected by a circuit breaker on the overhead circuit breaker panel (1, Figure 1-37).

AC External Power Receptacle

An external power receptacle (19, figure 1–53) for variable frequency ac power is in the forward end of the nose wheel well.

Alternator Bus Selector Switch

The rotary-type alternator bus selector switch (36, figure 1–21) on the engineer's instrument panel has OFF–L. ALT. NESA–R. ALT. BUS NO. 2–L. ALT. BUS NO. 2–R. ALT. OFF–L. ALT. OFF–R. ALT. NESA–EXT PWR NESA BUS–EXT. PWR. BUS NO. 2 positions. It directs variable frequency ac power from the ac external power receptacle or from left or right alternators to the Nesa bus or No. 2 bus as indicated by the switch position. When the switch is in the OFF position, no variable frequency ac power is connected to the busses. Unmarked switch positions are also OFF positions.

Nesa Bus Off Warning Lights

There are two red, push-to-test Nesa bus off warning lights (35, figure 1–21) on the engineer's instrument panel. The warning lights for the Nesa and No. 2 bus are dc powered. The light for the respective bus will illuminate if that bus does not receive alternator power when the bus selector switch is placed in a position which would energize the bus.

NOTE:

- This chart is designed to locate circuit protection devices for both control power and operating power of electrical equipment. Where equipment is operated directly from its control and one protection device is employed, this is indicated by the word Same in the OPERATING POWER column.
- This chart may be used as a guide for emergency electrical isolation of electrical equipment by opening the desired circuits at their protective devices.

CIRCUIT TITLE	CONTROL POWER	CIRCUIT PROTECTION LOCATION	OPERATING POWER	CIRCUIT PROTECTION LOCATION
AIR REFUELING SYSTEM				
A/R fuel bypass control valve			DC	Engineer's A/R panel
A/R fuel dump (Emergency)	DC	Forward power panel	Same	
A/R fuel flow totalizer	AC	Engineer's A/R panel	Same	
A/R fuel pump control	DC	Engineer's A/R panel	Same	
A/R hydraulic oil temperature	DC	Overhead circuit breaker panel	Same	
A/R power			DC	Aft power panel
Gravity fuel dump	DC	Engineer's A/R panel	Same	
Hydraulic pressure gages 2894 ▶			AC	Engineer's A/R panel
Indicator light test			DC	Aft power panel
Poppet control	DC	Engineer's A/R panel	Same	
Pressure fuel dump	DC	Engineer's A/R panel	Same	
Receiver director light test			DC	Aft power panel
Signal amplifier	DC	Aft power panel	DC	Boom operator's panel
ANTI-ICING				
Anti-ice and air conditioning fuel supply valves	DC	Overhead circuit breaker panel	Same	
Anti-icing heaters	DC	Overhead circuit breaker panel	Same	
Anti-icing heater fuel valves	DC	Overhead circuit breaker panel	Same	
Anti-icing heater ignition		(Uses heat control circuit protection)	AC	AC power panel
Emergency anti-icing	DC	Forward power panel	Same	
Empennage ground blower		(Uses empennage heat control circuit protection)	DC	Aft power panel
Heater fuel valve	DC	Forward power panel	Same	
Jet engine anti-icing	DC	Jet engine circuit breaker panel	Same	
Overheat test	DC	Forward power panel	Same	
Pitot heat (copilot's)	DC	Overhead panel	Same	
Pitot heat (pilot's) Normal & Emergency	DC	Forward power panel	Same	
Propeller deice	DC	Overhead circuit breaker panel	DC	Main power panel
Window heat	DC	Overhead circuit breaker panel	AC	Alternator relay shield
	AC	Alternator relay shield		
	AC	AC power panel 17260 ▶ 17271		
Window heat (boom operator's)	DC	Overhead circuit breaker panel	AC	Alternator relay shield
	DC	Boom operator's panel		
AUTOPILOT				
Autopilot	DC	Overhead circuit breaker panel	AC	AC power panel 17260 ▶ 3141
			AC	Autopilot junction shield 3142 ▶
Autopilot inverters	DC	Overhead circuit breaker panel	DC	Forward power panel
N-1 compass system		(Uses autopilot circuit protection)		
CABIN HEATING, VENTILATING, AND PRESSURIZING SYSTEMS				
Body heater fuel valves	DC	Forward power panel	Same	
Body heater ignition		(Uses body heat control circuit protection)	AC	AC power panel
Body heaters	DC	Forward power panel		
Cabin air bleed	DC	Overhead circuit breaker panel	Same	
Cabin pressure control	DC	Forward power panel	Same	
Control cabin fans	DC	Overhead circuit breaker panel	Same	
Ground blowers	DC	Forward power panel	DC	Main circuit breaker panel
Overheat test	DC	Forward power panel	Same	
CARGO				
Cargo hoist	DC	Cargo hoist shield	DC	Forward power panel
	DC	Forward power panel 22629 ▶ 22736		

CIRCUIT PROTECTION AND LOCATION

Figure 1–36 (Sheet 1 of 4)

CIRCUIT TITLE	CONTROL POWER	CIRCUIT PROTECTION LOCATION	OPERATING POWER	CIRCUIT PROTECTION LOCATION
COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT				
Interrogator	DC	Radio junction box circuit breaker panel	AC	Radio junction box circuit breaker panel
Power distribution			AC	AC power panel
			DC	Forward power panel
Radio and radar equipment	AC	Radio junction box circuit breaker panel	Same	
	DC	Radio junction box circuit breaker panel		
			AC	Alternator relay shield
UHF direction finder	DC	Radio junction box circuit breaker panel		
UHF navigation (Tacan)	DC	Radio junction box circuit breaker panel	AC	Radio junction box circuit breaker panel
VHF navigation (Omni)	DC	Aft power panel		
		Aft radio rack junction box		
ELECTRICAL SYSTEM				
Alternators	DC	Overhead circuit breaker panel		
Auxiliary power unit	DC	Auxiliary power unit shield	DC	Forward power panel
Battery control	DC	Forward power panel	Same	
Generator field relays	DC	Overhead circuit breaker panel	DC	Overhead circuit breaker panel
			DC	Forward power panel
Generators	DC	Main circuit breaker panel	Same	
Inverters	DC	Overhead circuit breaker panel	DC	
Voltmeters	AC	AC power panel and alternator relay shield	Same	Forward power panel
	DC	Main circuit breaker panel	Same	
ENGINES (RECIPROCATING)				
Carburetor preheat valve	DC	Overhead circuit breaker panel	Same	
Carburetor shelter air door	DC	Overhead circuit breaker panel	DC	Main circuit breaker panel
Cowl flaps	DC	Overhead circuit breaker panel	DC	Main circuit breaker panel
Engine instruments			AC	AC power panel
			DC	Overhead circuit breaker panel
Exhaust back pressure switch	DC	Overhead circuit breaker panel	Same	
Ignition analyzer	DC	Overhead circuit breaker panel	AC	AC power panel
		Control panel and analyzer		
Ignition booster	DC	Overhead circuit breaker panel	Same	
Intercooler flaps	DC	Overhead circuit breaker panel	Same	
Oil cooler flaps	DC	Overhead circuit breaker panel	Same	
Primer	DC	Overhead circuit breaker panel	Same	
Starters	DC	Overhead circuit breaker panel	DC	Main power panel
Turbosuperchargers	AC	AC power panel	Same	
Water injection	DC	Overhead circuit breaker panel	DC	Main circuit breaker panel
ENGINES (JET)				
Fuel flowmeters	DC	Jet engine circuit breaker panel	AC	Jet engine circuit breaker panel
Fuel manifold valves	DC	Jet engine circuit breaker panel		
Ignition system	DC	Jet engine circuit breaker panel		
Oil pressure gages			AC	Jet engine circuit breaker panel
Oil tank heaters	DC	Jet engine circuit breaker panel	AC	Jet engine circuit breaker panel
Stall prevention	DC	Jet engine circuit breaker panel		
Starter system	DC	Jet engine circuit breaker panel	Same	Forward power panel
Sump tank boost pumps	DC	Jet engine circuit breaker panel	Same	Forward power panel
		Jet engine circuit breaker panel	DC	Forward power panel
FIRE EXTINGUISHING AND FIRE WARNING				
Fire detectors			DC	Overhead circuit breaker panel
Fire extinguishing	DC	Overhead circuit breaker panel		
Fire warning test	DC	Overhead circuit breaker panel	Same	
Surface anti-icing and body heater fire warning	DC	Overhead circuit breaker panel	Same	
FLIGHT CONTROLS				
Emergency wing flaps	DC	Main circuit breaker panel	DC	Main power panel
Rudder boost	DC	Overhead circuit breaker panel		
Wing flaps	DC	Overhead circuit breaker panel	DC	Main power panel
FUEL SYSTEM				
A/R line valve	DC	Engineer's A/R panel	Same	
Boost pumps	DC	Overhead circuit breaker panel	DC	Main circuit breaker panel
Fuel gages			AC	AC power panel

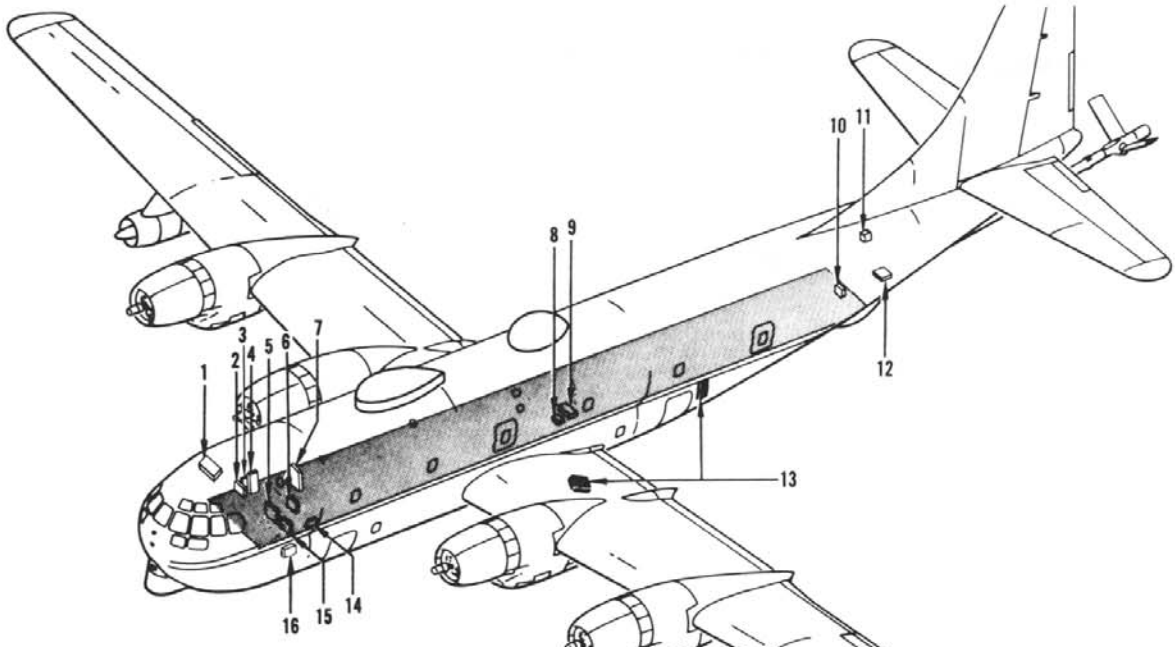
Figure 1–36 (Sheet 2 of 4)

CIRCUIT TITLE	CONTROL POWER	CIRCUIT PROTECTION LOCATION	OPERATING POWER	CIRCUIT PROTECTION LOCATION
FUEL SYSTEM (cont)				
Fuel leveling valve (A/R)	DC	Engineer's A/R panel	Same	
Fuel pressure warning			DC	Overhead panel
Fuel selector valve	DC	Overhead circuit breaker panel	Same	
Fuel shutoff valve (Emergency A/R)			DC	Engineer's A/R panel
Fuel transfer valves (A/R)	DC	Engineer's A/R panel	Same	
Jet engine fuel-oil emergency shutoff valves	DC	Jet engine circuit breaker panel	Same	
Single point refueling	DC	Forward power panel	Same	
Single point refueling secondary valves	DC	Single point refueling panel	Same	
MAIN HYDRAULIC SYSTEM				
Hydraulic pressure gages			AC	AC power panel
Hydraulic shutoff valves	DC	Overhead circuit breaker panel	Same	
INSTRUMENTS				
Boom position indicators			DC	Boom operator's panel
Engine Instruments			AC	AC power panel
			DC	Overhead circuit breaker panel
Fuel gages			AC	AC power panel
Pilot's attitude indicator			AC	AC power panel
Pilot's heading indicator			AC	AC power panel
Temperature cabin, OAT and heater			DC	Overhead circuit breaker panel
Turn and slip indicator (copilot's)			AC	(Uses autopilot circuit protection)
Turn and slip indicator (pilot's)			DC	Overhead circuit breaker panel
Voltmeters	DC	Main power panel	Same	
Wing flap position indicator			DC	Overhead circuit breaker panel
LANDING GEAR				
Main landing gear	DC	Overhead circuit breaker panel	DC	Main power panel
Nose landing gear	DC	Overhead circuit breaker panel	DC	Forward power panel
Oleo relays			DC	Overhead circuit breaker panel
Portable auxiliary motor		(Uses emergency wing flap circuit protection)		
Warning horn	DC	Overhead circuit breaker panel	Same	
LIGHTING				
Anti-collision lights and color control	DC	Overhead circuit breaker panel	Same	
Anti-collision lights rotation motors			AC	AC power panel
Boom operator's lights	DC	Boom operator's panel	Same	
Control cabin	DC	Overhead circuit breaker panel	Same	
Control cabin entrance light	DC	Forward power panel	Same	
Engineer's refueling panel lights	DC	Engineer's A/R panel	Same	
Exterior lights (A/R)	DC	Boom operator's panel	Same	
Fluorescent lights 17260 ▶ 3267	AC	AC power panel	Same	
Formation lights	DC	Overhead circuit breaker panel	Same	
Landing lights	DC	Overhead circuit breaker panel	DC	Main circuit breaker panel
Lower aft compartment	DC	Main circuit breaker panel	Same	
Lower forward compartment	DC	Forward power panel	Same	
Main compartment	DC	Main circuit breaker panel	Same	
Miscellaneous lights	DC	Overhead panel	Same	
Navigation lights	DC	Overhead circuit breaker panel	Same	
Rendezvous beacon lights	DC	Boom operator's panel	Same	
Taxi lights	DC	Overhead circuit breaker panel	Same	
MISCELLANEOUS				
DC outlets			DC	Overhead circuit breaker panel
			DC	Main circuit breaker panel
Driftmeter	AC	AC power panel	Same	
Emergency alarm	DC	Forward power panel	Same	
Landing flare release	DC	Forward power panel	Same	
Periscopic sextant	DC	Overhead circuit breaker panel	Same	
Suit heaters 17260 ▶ 2859	DC	Overhead circuit breaker panel	Same	
NOSE STEERING SYSTEM				
Nose steering emergency valve	DC	Forward power panel	Same	

Figure 1–36 (Sheet 3 of 4)

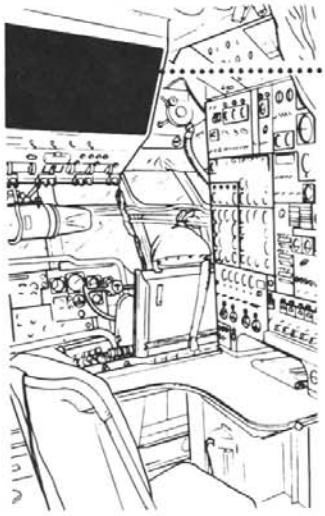
CIRCUIT TITLE	CONTROL POWER	CIRCUIT PROTECTION LOCATION	OPERATING POWER	CIRCUIT PROTECTION LOCATION
OIL SYSTEM				
Oil dilution	DC	Overhead circuit breaker panel		
Oil quantity gage			DC	Overhead circuit breaker panel
Oil shutoff valves	DC	Overhead circuit breaker panel	Same	
Oil transfer pump	DC	Overhead circuit breaker panel	DC	Forward power panel
PROPELLERS				
Auto rpm	DC	Overhead circuit breaker panel		
Emergency oil	DC	Overhead circuit breaker panel	Same	
Feathering	DC	Overhead circuit breaker panel	DC	Main power panel
Manual rpm	DC	Overhead circuit breaker panel		
Reversing	DC	Overhead circuit breaker panel		
RPM limit	DC	Overhead circuit breaker panel		
Throttle lock	DC	Overhead circuit breaker panel	Same	
WARNING INDICATORS				
AC power			DC	Overhead circuit breaker panel
Cargo discharge signal 17260 ▶ 22628	DC	Overhead circuit breaker panel	Same	
Anti-icing and body heater fire	DC	Overhead circuit breaker panel	Same	
Door closed			DC	Overhead circuit breaker panel
Fire detectors			DC	Overhead circuit breaker panel
Fire detector test	DC	Overhead circuit breaker panel	Same	
Fuel and hydraulic pressure (A/R)			DC	Engineer's A/R panel
Fuel pressure			DC	Overhead circuit breaker panel
Fuel quantity gage test (A/R)	DC	Engineer's A/R panel	Same	
Jet engine fire detection test	DC	Jet engine circuit breaker panel		
Jet engine fire detection warning lights	DC	Jet engine circuit breaker panel		
Landing gear and wing flaps			DC	Overhead circuit breaker panel
Turbo bearing temperature gages	DC	Overhead circuit breaker panel	Same	
Wheel well overheat			DC	Overhead circuit breaker panel

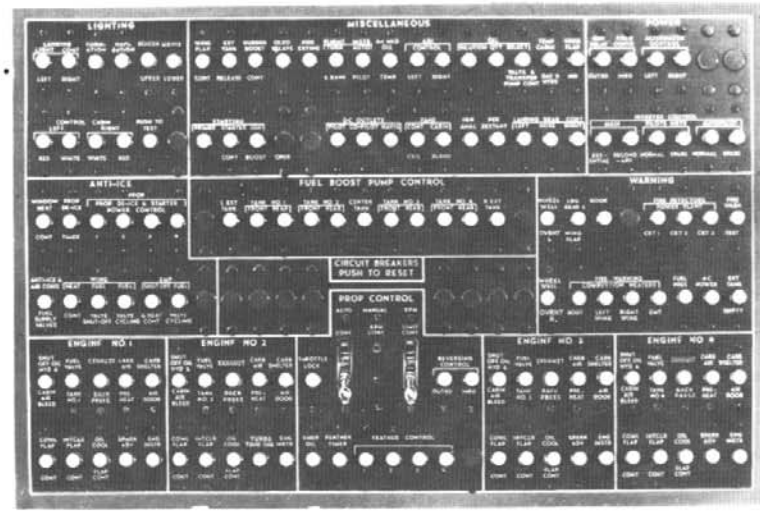
Figure 1–36 (Sheet 4 of 4)



1 OVERHEAD CIRCUIT BREAKER PANEL (DC)
2 RADIO JUNCTION BOX CIRCUIT BREAKER PANEL (AC-DC)
3 JET ENGINE CIRCUIT BREAKER PANEL (AC-DC)
4 ENGINEER'S A/R PANEL (AC-DC)
5 FORWARD POWER PANEL (DC)
6 AUXILIARY POWER UNIT CIRCUIT BREAKER PANEL (DC)
7 CARGO HOIST SHIELD (DC)
8 MAIN CIRCUIT BREAKER PANEL (DC)
9 MAIN POWER PANEL (DC)
10 AFT POWER PANEL (DC)
11 AFT RADIO RACK JUNCTION BOX (DC)
12 BOOM OPERATOR'S PANEL (AC-DC)
13 SINGLE POINT REFUELING PANEL (DC)
14 AUTOPILOT JUNCTION SHIELD (DC)
15 AC POWER PANEL
16 ALTERNATOR RELAY SHIELD (AC)

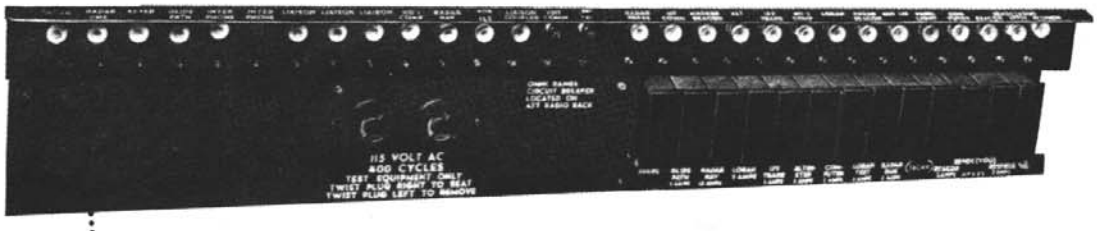
1 OVERHEAD CIRCUIT BREAKER PANEL (TYPICAL)





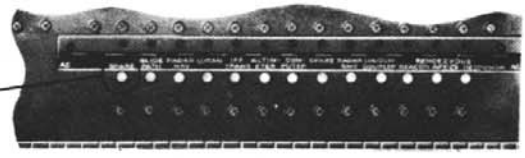
CIRCUIT BREAKER PANELS LOCATION

Figure 1–37 (Sheet 1 of 7)



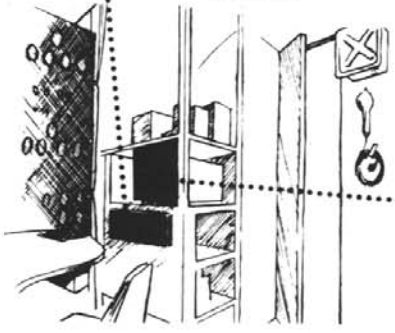
2 RADIO JUNCTION BOX CIRCUIT BREAKER PANEL (TYPICAL) 17260 ▶ 22700
SEE DETAIL I

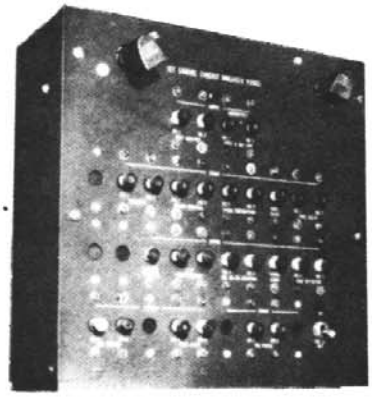
22680 ▶ 33816
AIRPLANES MODIFIED BY TCTO 1C-97(K)L-505



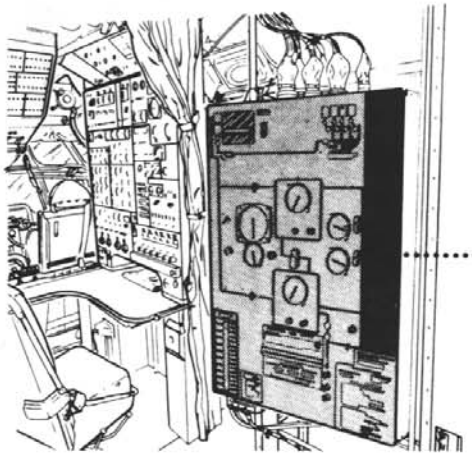
VHF COMM
RECEIVER
DETAIL II

DETAIL I 22701 ▶
SEE DETAIL II





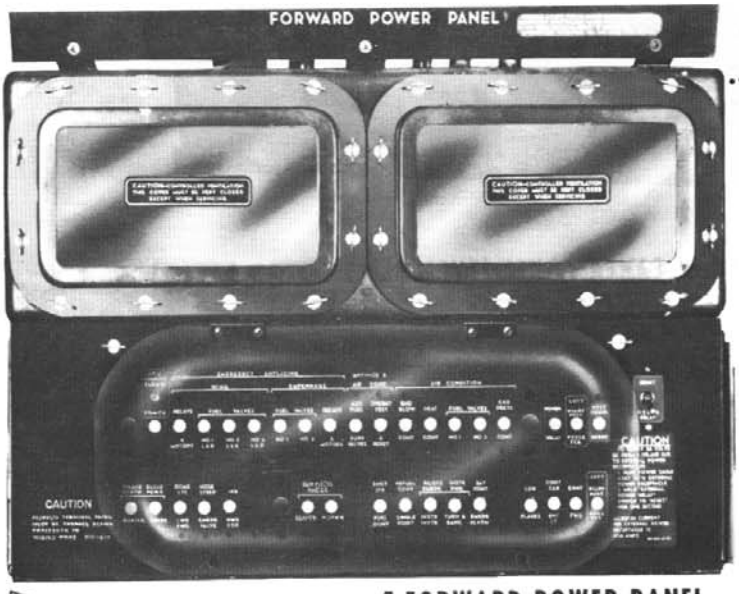
3 JET ENGINE CIRCUIT BREAKER PANEL



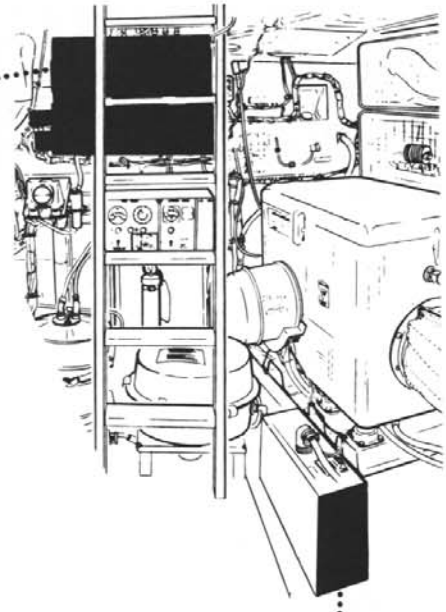
22665 ▶

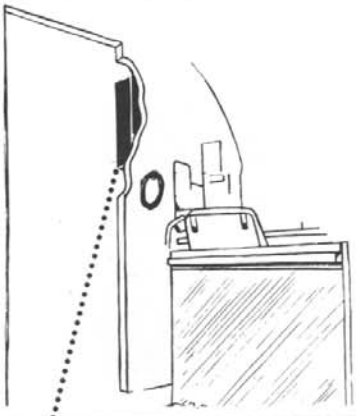
4 ENGINEER'S A/R PANEL

Figure 1–37 (Sheet 2 of 7)



5 FORWARD POWER PANEL

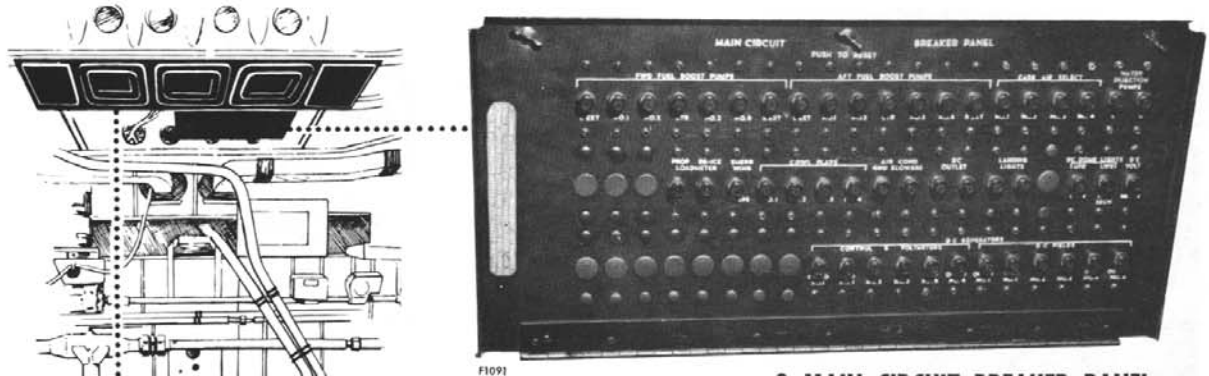




6 APU CIRCUIT BREAKER PANEL

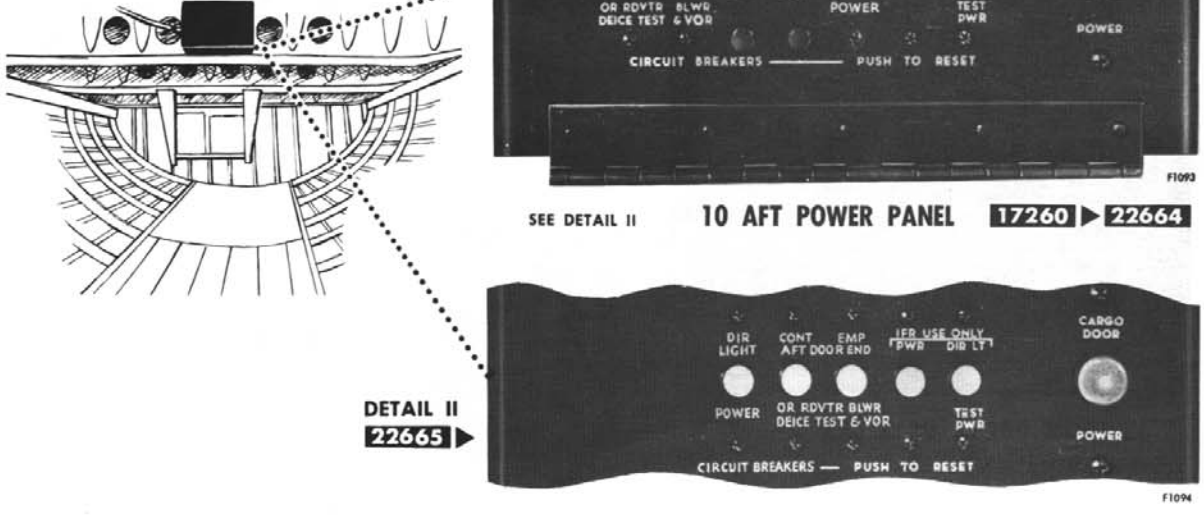
7 CARGO HOIST SHIELD

Figure 1–37 (Sheet 3 of 7)



8 MAIN CIRCUIT BREAKER PANEL

9 MAIN POWER PANEL



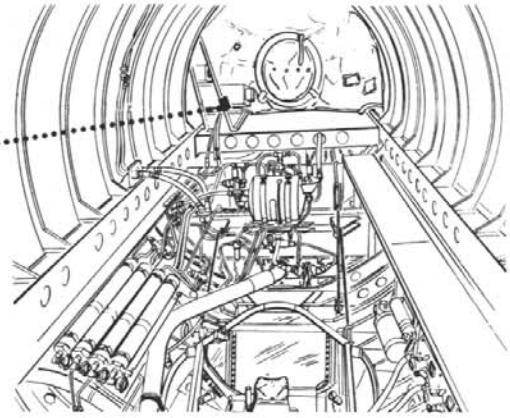
SEE DETAIL II

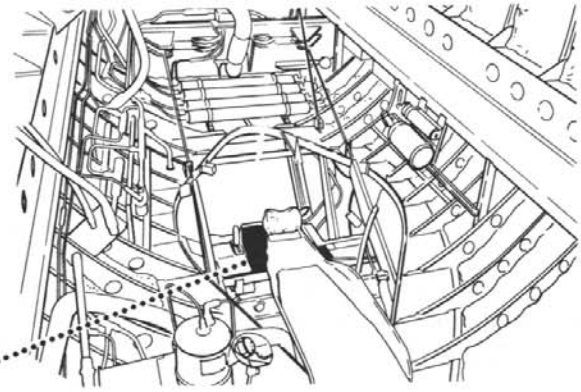
10 AFT POWER PANEL 17260 ▶ 22664

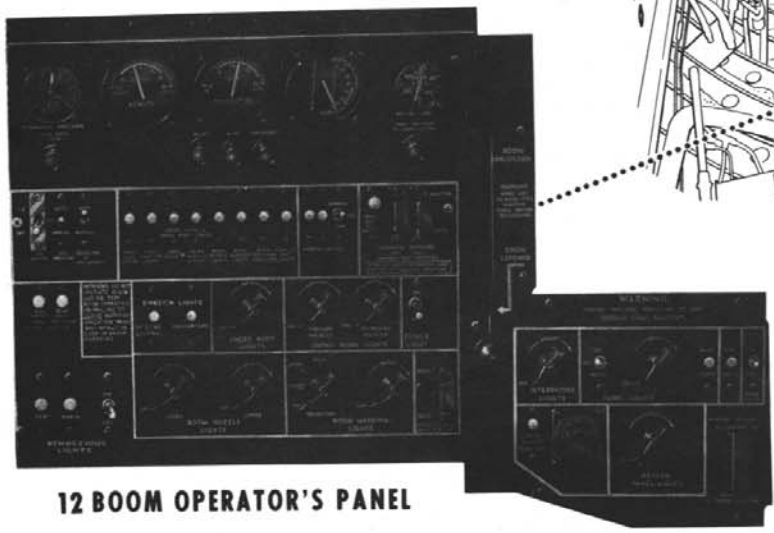
DETAIL II
22665 ▶

Figure 1-37 (Sheet 4 of 7)

11 AFT RADIO RACK JUNCTION BOX



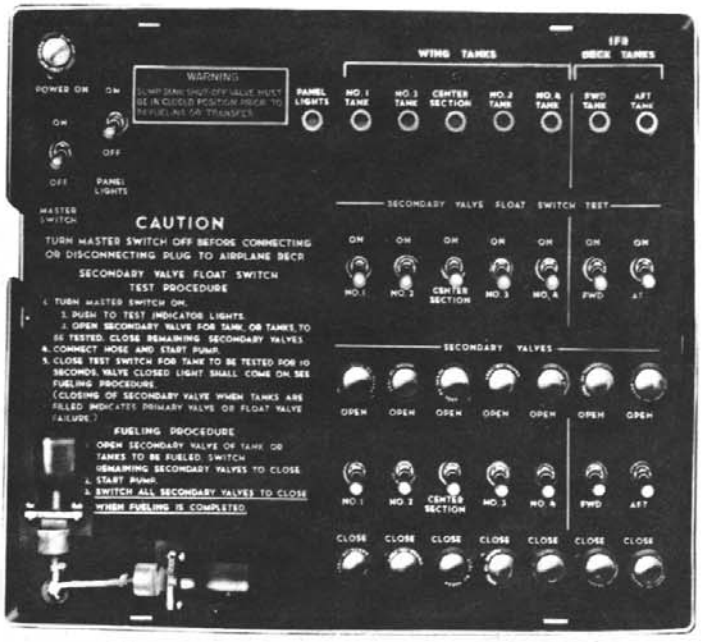




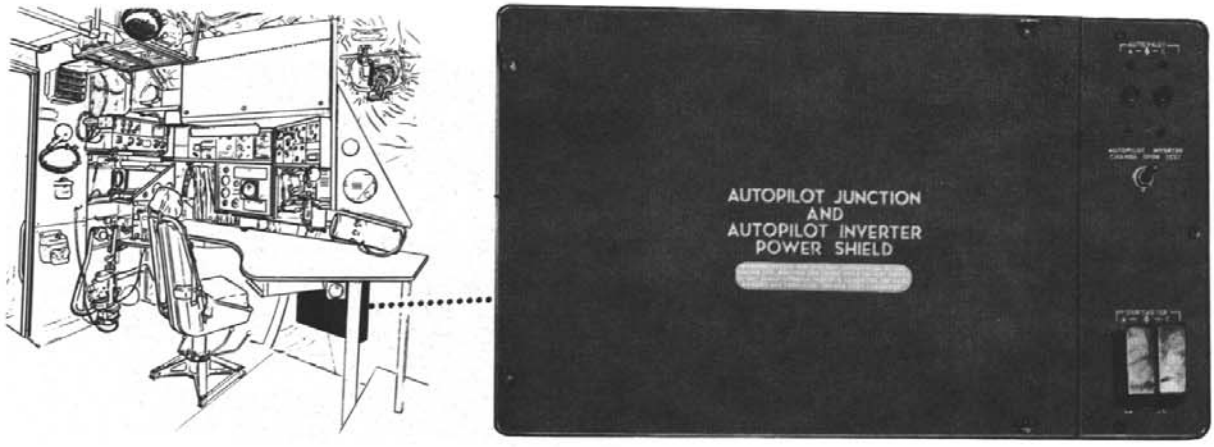
12 BOOM OPERATOR'S PANEL

17260 ▶ 22700

Figure 1–37 (Sheet 5 of 7)

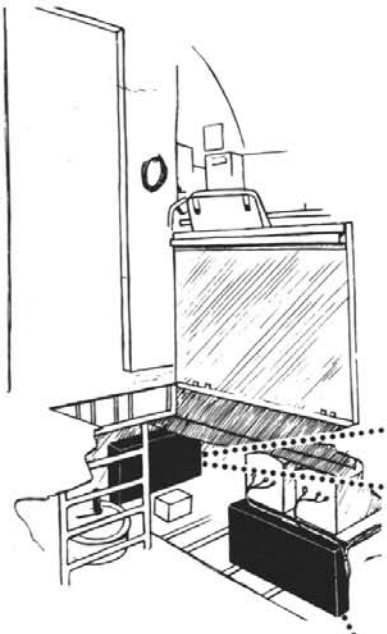


13 SINGLE POINT REFUELING PANEL

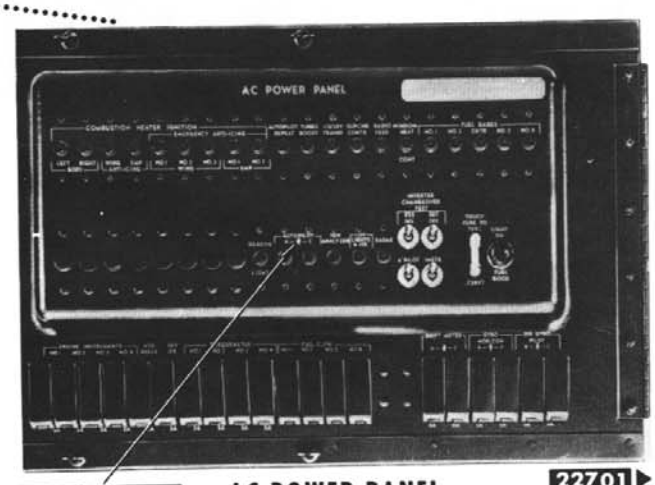


14 AUTOPILOT JUNCTION SHIELD 3142 ▶

Figure 1–37 (Sheet 6 of 7)



15 AC POWER PANEL 17260 ▶ 22700



22701 ▶ 3141 AC POWER PANEL 22701 ▶

DETAIL III
17260 ▶ 17271

DETAIL IV
22701 ▶

16 ALTERNATOR RELAY SHIELD
SEE DETAIL III AND IV 2826 ▶ 22700

Figure 1–37 (Sheet 7 of 7)

HYDRAULIC SYSTEM

The airplane is equipped with three separate hydraulic systems. The following titles will be used in all future references to these systems. Only the main system is discussed in this section.

Main Hydraulic System	Rudder Boost
	Service Brakes
	Emergency Brakes
	Nose Wheel Steering
	Windshield Wipers
Air Refueling Hydraulic	Pressure System
Systems (Refer to	Boom System
Section IV.)	Fuel Pump System
	Isodraulic System
Forward Cargo Door Hydraulic System (Refer to Section IV.)	Cargo Door

MAIN HYDRAULIC SUPPLY SYSTEM

The main hydraulic supply system (figure 1–38) supplies hydraulic power to operate the rudder boost, service brakes, nose wheel steering, and windshield wipers; main system pressure is also used to charge the emergency brake system. On ▶ the main hydraulic system also drives a pump motor combination which provides pressure to the A/R boom system. Pressure is supplied by two engine-driven hydraulic pumps, one each on No. 2 and No. 3 engines. The pumps are set to maintain 1500 to 1650 psi, and a check valve in each pump pressure line prevents loss of system pressure in the event one pump becomes inoperative. Both engine-driven hydraulic pumps are self-lubricated by the flow of hydraulic fluid. Should fluid flow to the pump be stopped for any reason, damage to the pump will result. However, it is not advisable to stop an engine in flight in an effort to save a hydraulic pump. A fluid reservoir in the control cabin holds a normal operating supply of 3.5 US gallons including a 0.5-US gallon reserve for the handpump. A handpump is provided to supply pressure to the service brake system in the event of failure of both engine-driven hydraulic pumps. The handpump can also be used to recharge the emergency brake system. During in-flight operation, the hydraulic system may be depressurized by manually actuating a depressurization valve. The emergency brake system pressure is isolated from the main system by a check valve and is not affected by depressurization.

Depressurization And Emergency Charging Valve Handle

The depressurization and emergency charging valve handle (13, figure 1–14) on the copilot's auxiliary panel is a three-position handle and is mechanically linked to a control valve. The three positions are: NORMAL–EMEGGENCY BRAKE CHARGING – DEPRESSURIZED POSITION. With the handle in the NORMAL position, the emergency brake system is isolated and both hydraulic pumps supply pressure to the entire main system. Moving the valve handle to the EMERGENCY BRAKE CHARGING position, system pressure or service brake pressure, whichever is higher, will charge the emergency brake accumulator and, in this position, pressure will still be supplied to the entire hydraulic system. When the valve handle is moved to the DEPRESSURIZED POSITION, main system pressure is discharged directly into the return system leaving only the emergency brake system pressurized. The DEPRESSURIZED POSITION is to be used in flight in the event of a line rupture to save hydraulic fluid and to reduce the danger of fire due to hydraulic fluid contacting electrical equipment.

Hydraulic Handpump

The hydraulic handpump (12, figure 1–14), below the copilot's auxiliary panel, is provided to supply pressure to the service brakes in the event of failure of both engine-driven hydraulic pumps. The handpump can be used to recharge the emergency brake system by first placing the depressurization and emergency charging valve handle in EMERGENCY BRAKE CHARGING position.

Hydraulic System Pressure Gages

Three hydraulic system pressure gages are provided. Two are on the pilots' instrument panel. One gage indicates main system pressure. (See 35, figure 1–8.) The other gage indicates service brake system pressure (See 32, figure 1–8.) A hydraulic pressure gage (1, figure 1–14) on the copilot's auxiliary panel indicates emergency brake system pressure. All hydraulic pressure gages read in psi and receive 26-volt ac power through fuses on the ac power panel (15, figure 1–37).

Hydraulic System Low-Pressure Warning Lights

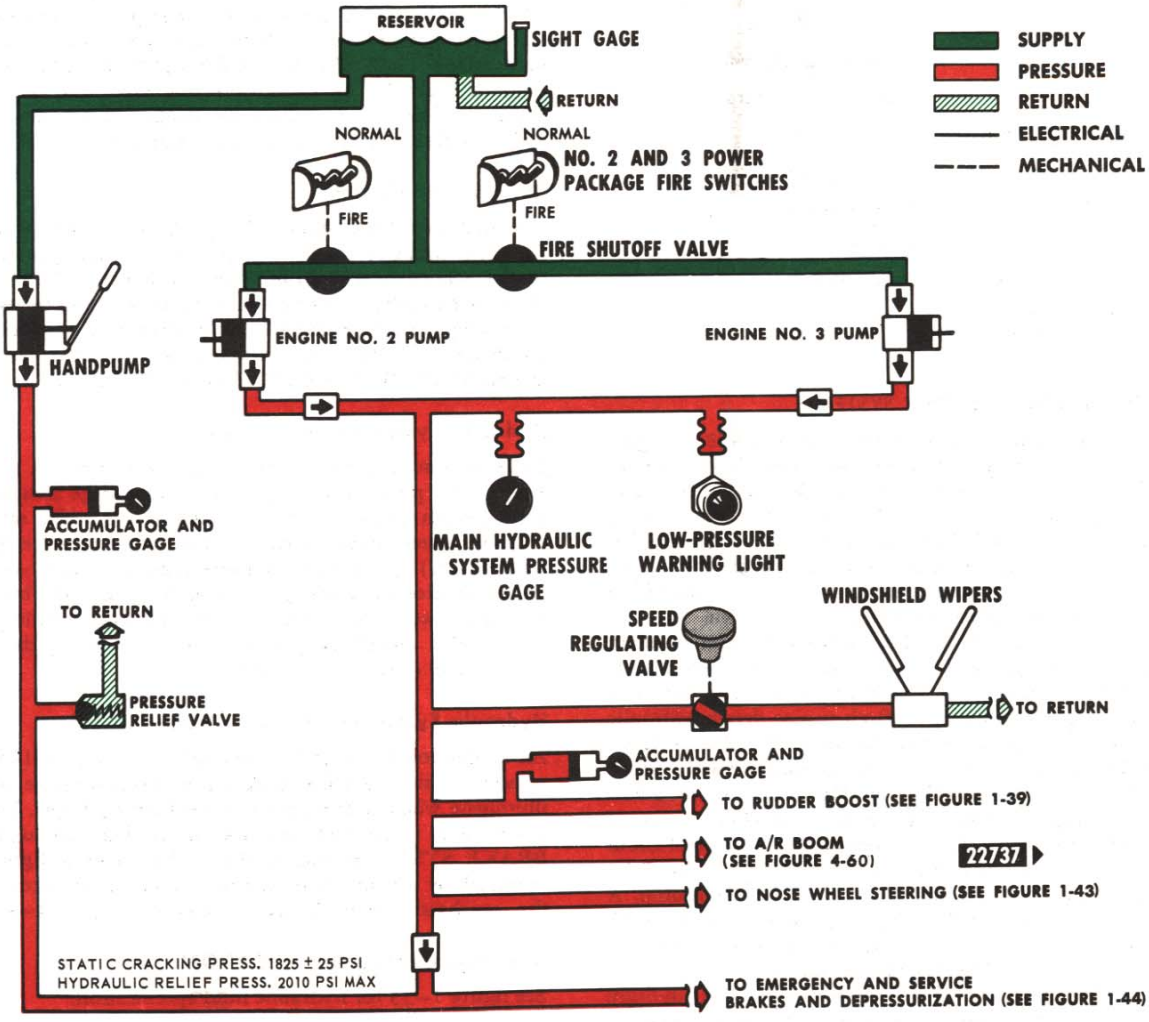
An amber low-pressure warning light (34, figure 1–8), adjacent to the main hydraulic system pressure gage, will illuminate when system pressure falls below 900 psi. Two other lights in the hydraulic system are described under BRAKE SYSTEMS, this section. The warning light is operated by 28-volt dc power from a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

HYDRAULIC FLUID SPECIFICATION

See figure 1–53 for hydraulic fluid specification.

FLIGHT CONTROL SYSTEM

The airplane is controlled in flight from either the pilot's or copilot's station by conventionally operated aileron, wing flap, elevator, and rudder surfaces. The surfaces are cable-operated, except the wing flaps, which are operated electrically, and the rudder, which has a hydraulic boost system in addition to the cable. The rudder cables move the rudder trim tab which aerodynamically positions the rudder surface. Wing flap and rudder boost circuit breakers are on the overhead circuit breaker panel (1, figure 1–37).



MAIN HYDRAULIC SUPPLY SYSTEM

Figure 1–38

SURFACE LOCK HANDLE

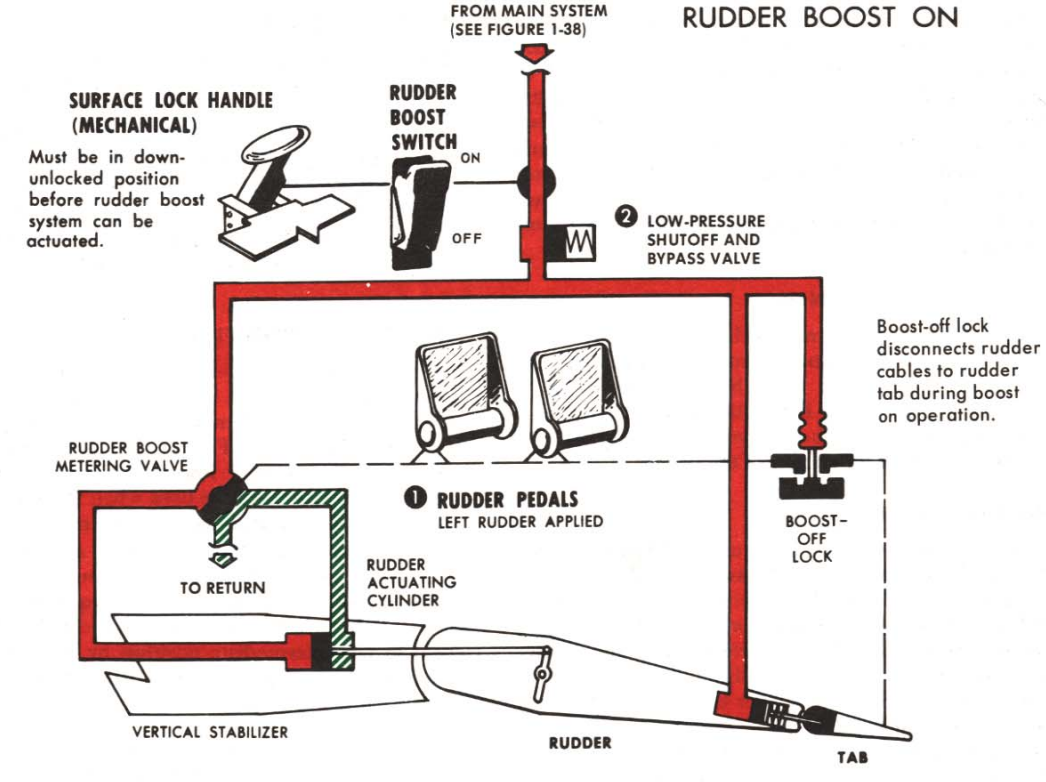
A red surface lock handle (6, figure 1–15) on the forward end of the control stand is provided to lock the control surfaces, partially lock the throttles, and turn off rudder boost pressure when the surfaces are locked. The handle has UP-LOCKED–DOWN-UNLOCKED positions. Before the lock is effective in the UP-LOCKED position, the ailerons and rudder must be in neutral, the elevators down, and at least two throttles closed for engines on opposite sides of the fuselage (engines 1 and 4 or 2 and 3, etc). When the handle is in the UP-LOCKED position, the surfaces are locked mechanically and movement of the throttles is restricted to prevent a takeoff with surfaces locked. All four throttles can be advanced to give approximately 50 percent engine power, but the interlock prevents two throttles for engines on the same side of the airplane from being advanced beyond this point. When the handle is in the DOWN-UNLOCKED position, the surfaces are unlocked, throttle movement is unrestricted, and rudder boost can be turned on.

CONTROL COLUMNS AND WHEELS

The dual control columns and wheels for elevator and aileron control are conventional. Each control column wheel contains a microphone switch and an autopilot release switch (4 and 5, figure 1–6, and 3 and 2, figure 1–7) on the outboard side of the control column wheels.

TRIM CONTROL WHEELS AND INDICATOR

Trim control wheels (3, 9, and 33, figure 1–15) and indicator (43, figure 1–15) are on the control stand.



RUDDER BOOST SYSTEM

Figure 1–39

RUDDER PEDALS

The rudder pedals are conventional in appearance and operation and are hinged for toe operation of the hydraulic brakes. A latch on the outside edge of each rudder pedal permits fore-and-aft adjustment of the pedal.

RUDDER BOOST SYSTEM

The primary purpose of the rudder boost system (figure 1–39) is to provide effective rudder control at low airspeeds with unsymmetrical power as would occur if an engine failed during takeoff or landing. The main hydraulic supply system (figure 1–38) provides pressure to operate the rudder boost system. With rudder boost turned on, movement of the rudder pedals controls a metering valve connected to the cables. Hydraulic pressure from the metering valve operates an actuating cylinder which moves the rudder surface. The trim tab is automatically disconnected and locked in a centered position. Operation of the rudder trim control wheel adjusts the metering valve for rudder trim during boost on. Since hydraulic pressure supplies the total force required to operate the rudder surface, artificial feel is induced in the rudder boost system by means of coil springs. For a given amount of pedal deflection, the rudder surface will assume different positions for the conditions of boost on and boost off; therefore, the rudder boost system should not be turned on or off during any maneuver requiring rudder operation.

Note

If pressure from the main hydraulic supply system to the rudder boost system falls below 875 ±35 psi, a shutoff and bypass valve (figure 1–39) will stop hydraulic pressure from entering the rudder boost system, and allow normal boost-off operation of the rudder.

Rudder Boost Switch

The rudder boost switch (2, figure 1–15) on the forward end of the control stand has ON–OFF positions and is guarded to ON. This switch opens or closes a shutoff valve in the main hydraulic supply system pressure line leading to rudder boost actuating units. The rudder boost switch is wired in series with a switch operated by the surface lock handle. The rudder boost system is turned on by positioning the rudder boost switch to ON and the surface lock handle to DOWN-UNLOCKED position. Placing the switch in OFF closes the shutoff valve and automatically depressurizes the rudder boost system; the rudder trim tab is then cable-operated. Power and circuit protection is through the overhead circuit breaker panel (1, figure 1–37).

WING FLAP SYSTEM

The electrically operated wing flaps are of the Fowler type. Lowering the flaps moves the left elevator trim tab proportionally to prevent a nose-high condition. Raising the flaps moves the left elevator trim tab proportionally to prevent a nose-low condition. An auxiliary wing flap motor, mechanically connected to the normal wing flap motor (figure 1–40), is used to raise or lower the flaps if the normal motor fails. This motor is portable and is also used for emergency operation of the main landing gear. A warning horn will sound at any flap setting when any combination of two throttles for engines on opposite sides of the airplane are advanced more than three-fourths open except between 22 and 44 percent with the weight of the airplane on the landing gear. Operating dc power for the main and auxiliary wing flap motors is through separate current limiters on the main power panel (9, figure 1–37). Control circuit protection is through the overhead circuit breaker panel (1, figure 1–37) for the normal wing flap motor and through a circuit breaker on the main circuit breaker panel (8, figure 1–37) for the auxiliary wing flap motor.

WING FLAP SWITCH

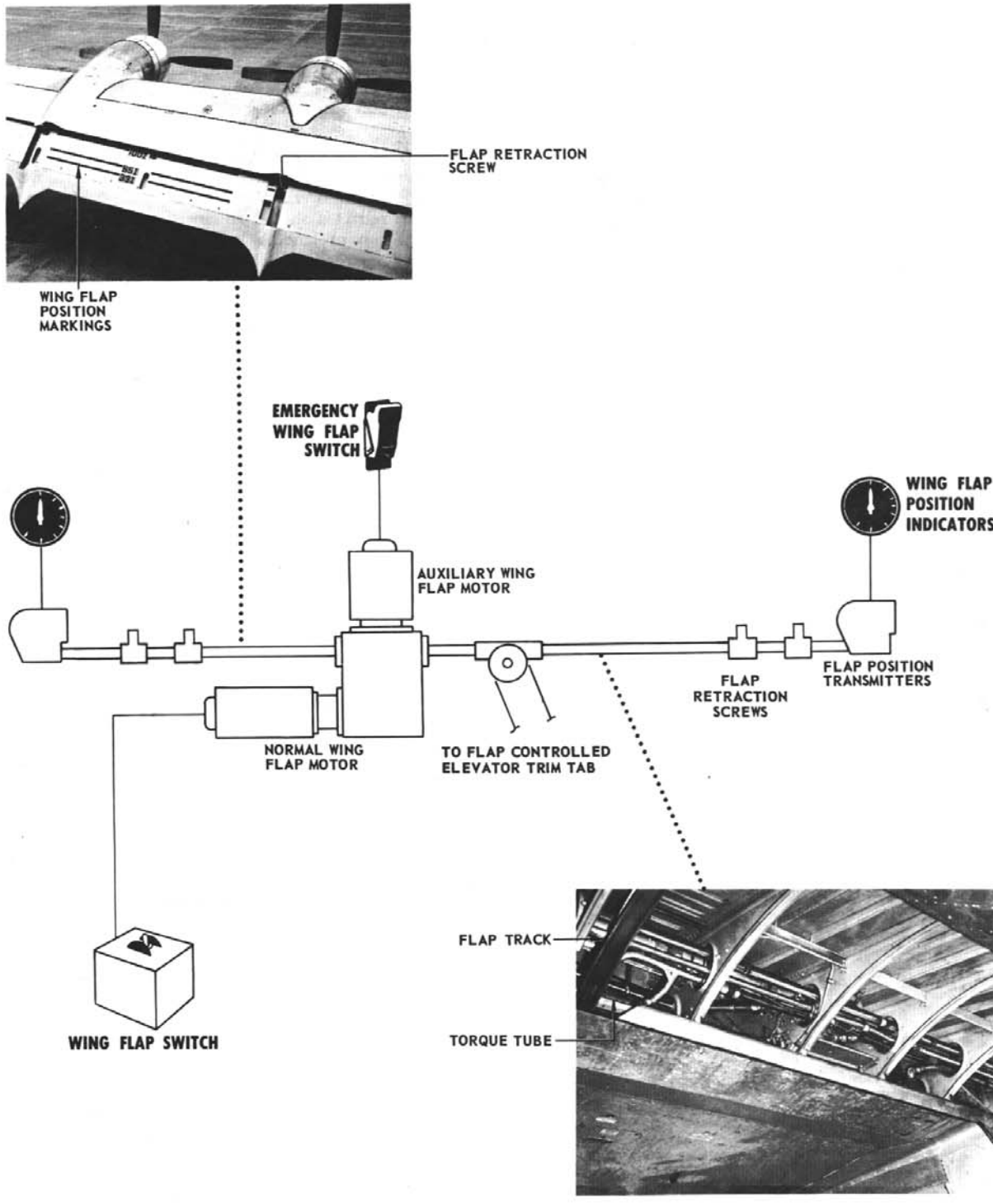
The wing flaps are normally controlled by the wing flap switch (21, figure 1–15) on the control stand. The switch has DOWN–OFF–UP positions, and is spring-loaded to OFF from both the DOWN and UP positions. Holding the switch in UP or DOWN fully raises or lowers the flaps in approximately 25 seconds. The flaps are held in any intermediate position by releasing the switch to OFF. A circuit breaker for the flap control is provided on the overhead circuit breaker panel (1, figure 1–37).

EMERGENCY WING FLAP SWITCH

A guarded DOWN–OFF–UP emergency wing flap switch (18, figure 1–11) on the overhead panel controls the auxiliary wing flap motor. The switch is spring-loaded and guarded to OFF. Holding the switch in UP or DOWN fully raises or lowers the flaps in approximately 25 seconds. Care must be used when the emergency wing flap switch is operated, as there are no limit switches on the auxiliary wing flap motor circuit, and the operation of the motor after the stops are encountered will impose high torsional loads on the flap torque tube system and may result in a burned-out motor clutch. The flaps are held in any intermediate position by releasing the switch to OFF. Circuit protection is through the main circuit breaker panel (8, figure 1–37).

CAUTION

Since the emergency wing flap system does not incorporate limit switches, impact loads imposed on the flap drive system at the extremities of wing flap travel are considerably higher than those imposed when the normal wing flap system is operated. Therefore, the use of the emergency wing flap switch should be limited except in event of emergency. Refer to Section III for procedure to be used in emergency wing flap training operations.



WING FLAP SYSTEM

Figure 1–40

WING FLAP POSITION INDICATORS

Two wing flap position indicators (33, figure 1–8) on the pilots' instrument panel register flap position in percent. Failure of the wing flap drive mechanism will be indicated by a difference in the instrument readings. A circuit breaker for the wing flap position indicators is on the overhead circuit breaker panel (1, figure 1–37).

WING FLAP POSITION MARKINGS

There are three orange color stripes painted on the top side of each wing flap, outboard of the inboard nacelles. (See figure 1–40.) These stripes provide a means for visually checking the amount of wing flap travel from the scanner's position in the main compartment during flight operation. Each stripe is marked with corresponding numerals indicating the percent of wing flap travel.

LANDING GEAR SYSTEM

The fully retractable tricycle landing gear is electrically operated and consists of two main dual-wheel landing gears and a steerable dual-wheel nose gear. The landing gear is exceptionally friction-free in operation and extends fully in approximately 4 seconds and retracts fully in approximately 10 seconds. The main and nose landing gears are mechanically locked in the up and down positions. Only motor or manual operation will unlock and retract or extend the landing gear. Three ground safety locks, one for each landing gear, are provided to prevent accidental collapse of the landing gear while on the ground. (See figure 1–42.) Red warning streamers are attached to the locks for easy recognition. Oleo-actuated safety switches are provided on both main gear oleos and the nose gear oleo to prevent accidental retraction of the landing gear when the airplane is on the ground. These oleo-actuated safety switches are wired in series, so that all three switches must be closed before any of the landing gear may be retracted. Manual operation is provided for each main and nose landing gear, and portable auxiliary motor operation is provided for the main landing gear. In an emergency these controls can be quickly and easily reached. The auxiliary wing flap motor (figure 1–40), mounted above the normal wing flap motor, can be removed and used for emergency operation of the main gear; however, the handcrank is simpler and quicker for emergency extension of the gear. To use the motor for landing gear operation, it must be removed from the mounting bracket by removing the wing bolts and mounted on the landing gear adapter. The motor is controlled by a switch at the top of the motor. The switch has three positions, and is moved in the indicated direction for the required operation. The circuit breaker for the auxiliary wing flap motor is on the main circuit breaker panel (8, figure 1–37).

LANDING GEAR SWITCH

A DOWN–OFF–UP landing gear switch (8, figure 1–15) on the control stand controls normal landing gear extension or retraction. When the switch is in the UP position, the landing gear will retract provided all wheels are off the ground; when in the DOWN position, the landing gear will extend; and when in the OFF position, the landing gear actuation circuits are deenergized. Three circuit breakers on the overhead circuit breaker panel (1, figure 1–37) provide individual circuit breaker protection for each landing gear normal control circuit. Each main landing gear motor receives power through a current limiter in the main power panel (9, figure 1–37). The nose landing gear motor receives power through a circuit breaker on the forward power panel (5, figure 1–37).

LANDING GEAR EMERGENCY RETRACTION SWITCH

The landing gear emergency retraction switch (30, figure 1–11) on the overhead panel will permit the landing gear to be retracted should an emergency occur during the takeoff run or landing roll. The switch is spring-loaded and guarded from SAFETY OVERRIDE to the NORMAL position. Holding the switch in the SAFETY OVERRIDE position will override the oleo safety switch circuit. The normal landing gear switch must be in the UP position before the landing gear emergency retraction switch will energize the system. DC power and circuit protection is through the overhead circuit breaker panel (1, figure 1–37).

LANDING GEAR WARNING HORN RELEASE SWITCH

The warning horn, on the ceiling above the copilot, will sound if any landing gear is not extended and locked, and any throttle is retarded to less than one-fifth open. It will also sound at any flap setting when any combination of two throttles for engines on opposite sides of the airplane are advanced more than three-fourths open, in either forward or reverse thrust, except between 22 and 44 percent with the weight of the airplane on the landing gear. A landing gear warning horn release switch (7, figure 1–15), spring-loaded from HORN RELEASE to the NORMAL position, is provided on the control stand. When the switch is actuated to the HORN RELEASE position, the warning horn is silenced until again energized by one of the above conditions. The warning horn will sound for each throttle independent of the others. The warning horn release switch will not silence the horn when the airplane is on the ground. Circuit protection is through the overhead circuit breaker panel (1, figure 1–37).

WARNING

The landing gear warning horn and light microswitches are set for throttle position only. At high field elevations or high power settings, the warning horn may not indicate an unsafe gear condition since throttles may not be retarded to the one-fifth open position necessary to actuate the microswitches.

EMERGENCY HANDCRANKS

In an emergency, the landing gear can be operated manually by handcranks. The nose gear handcrank (figure 1–41) is on the underside of the lower nose compartment hatch. The main gear handcranks (figure 1–41) are adjacent to the emergency operation adapters on each side of the airplane, aft of the rear spar. The number of turns to raise or lower the landing gear are: 490 turns for main gear, 220 turns for nose gear.

CLUTCH HANDLES

Clutch handles (figure 1–41) are located near the main landing gear emergency operation adapters. Operation of

the clutches releases the main landing gear motors and engages the manual systems. The pull handles must be pulled out approximately 12 inches when the manual system is used. A clutch lever (figure 1–41) is located near the nose landing gear emergency operation adapter. Operation of the clutch releases the nose landing gear motor.

LANDING GEAR POSITION INDICATORS

Three tab-window type landing gear position indicators (41, figure 1–8) on the pilots' instrument panel show, by interchangeable tabs, the positions of the main and nose landing gears. When any gear is up and locked, the corresponding UP tab will appear in the window; a landing gear in an intermediate position will be indicated by a tab with slanting alternate red and white stripes; and a down and locked gear will be indicated by a tab showing a symbol of a wheel. When power is off, a slanting red and white stripe tab will show in the window. Power and circuit protection is through the overhead circuit breaker panel (1, figure 1–37).

LANDING GEAR WARNING LIGHT

A red landing gear warning light (42, figure 1–8) on the pilots' instrument panel is illuminated unless all three landing gears are extended and locked or unless all three gears are retracted and locked with all throttles more than one-fifth open. Power and circuit protection is through the overhead circuit breaker panel (1, figure 1–37).

WHEEL WELL OVERHEAT WARNING LIGHTS

Two wheel well overheat warning lights (27, figure 1–8) on the pilots' instrument panel will illuminate if the brakes or tires are overheated when retracted. The overheat condition is sensed by two adjustable detector switches in each main wheel well. These switches are set to close at 200°F (93°C). Circuit protection is through the overhead circuit breaker panel (1, figure 1–37).

NOSE WHEEL STEERING SYSTEM

The nose wheels are steerable to 68 degrees each side of center through hydraulically operated cylinders while the airplane is on the ground. (See figure 1–43.) When the nose wheel leaves the ground, hydraulic pressure is shut off by an oleo-actuated valve, and the nose wheel centers itself. In the event of hydraulic pressure failure, the nose gear has a conventional caster action allowing directional control of the airplane by engine and brake operation.

NOSE GEAR STEERING WHEEL

Nose gear steering is controlled by a nose gear steering wheel (10, figure 1–6) mounted on a pedestal forward and to the left of the pilot's control column. An arrow on the wheel and a mark on the pedestal indicate when the nose wheel is centered. The nose wheel turns in the direction selected by the steering wheel and remains in that position until the steering wheel is returned to center. A cable followup system will return the nose wheel to its original course should the wheel be deflected momentarily by some obstacle. The nose wheel must be centered before the gear will retract.

CAUTION

When the airplane is being towed by the nose wheel and the hydraulic system is charged, do not operate the steering wheel as this action will damage the mechanism.

NOSE WHEEL STEERING EMERGENCY DISCONNECT BUTTON

When manually depressed, the push-pull nose wheel steering emergency disconnect button (3, figure 1–6) on the steering pedestal electrically actuates the emergency bypass valve (figure 1–43), bypasses hydraulic fluid pressure past the nose wheel actuating cylinders, and allows the nose wheel to caster. This button is used to release the nose wheel in event of steering system malfunction. An indicator light, within the push-pull button, illuminates when the button is depressed. The button must be raised manually to reengage the steering mechanism. Power and circuit protection is through the forward power panel (5, figure 1–37).

Note

DC power must be available for operation of the emergency nose wheel disconnect.

BRAKE SYSTEMS

SERVICE BRAKE SYSTEM Less TCTO 505

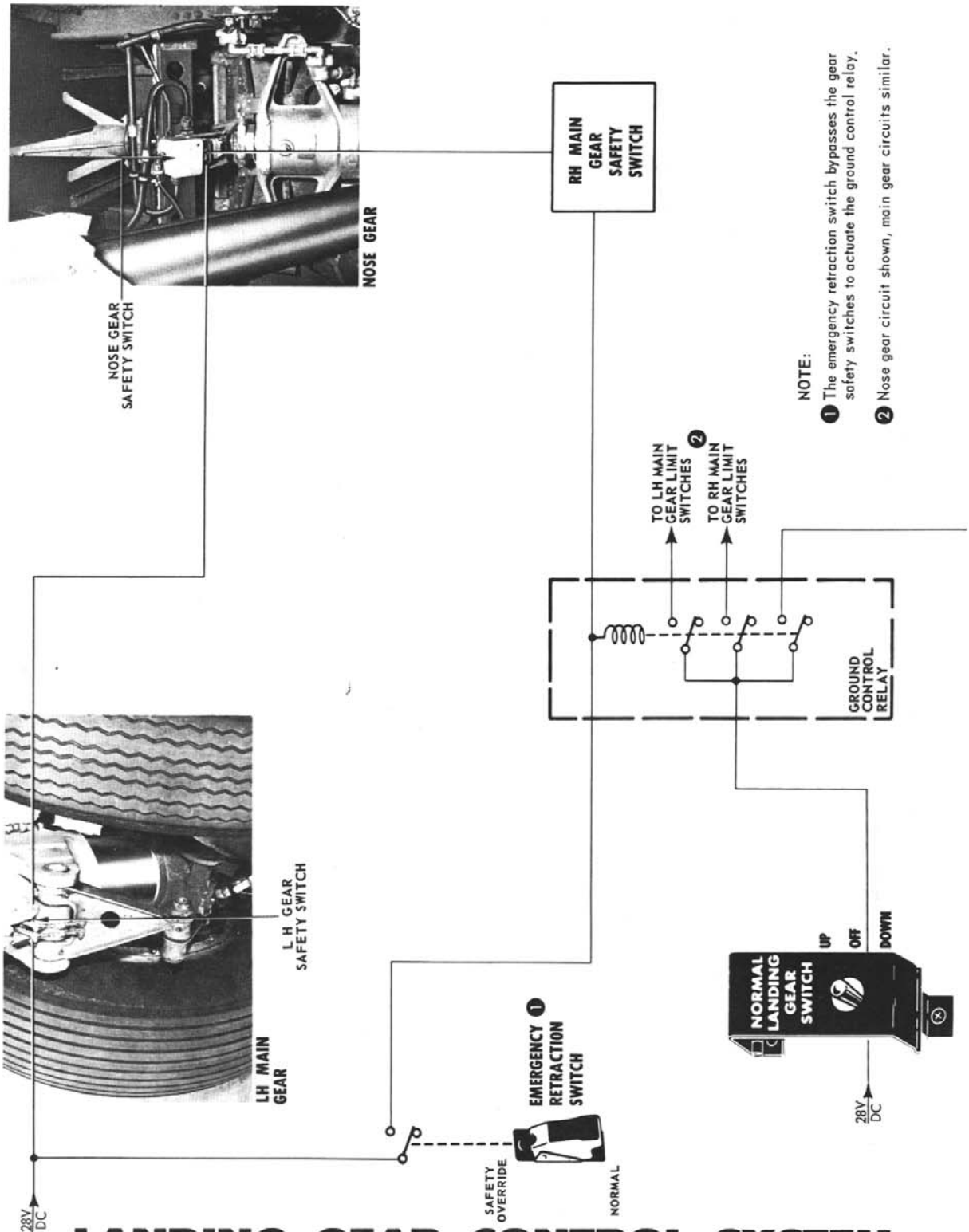
Main hydraulic supply system pressure is used to operate the service brakes. (See figure 1–44.) Toe pressure on the pilot's or copilot's rudder pedals will acutate the brakes in the conventional manner. However, the brake ports of the copilot's brake metering valves are connected to the return ports of the pilot's brake metering valves. Therefore, hydraulic pressure which enters the brake system due to operation of the copilot's brake metering valves must pass through the pilot's metering valves before reaching the brakes. When the pilot applies slight pedal pressure, additional hydraulic pressure is prevented from entering the brake system due to operation of the brakes by the copilot. In addition, the hydraulic pressure that is applied by either pilot returns through the copilot's metering valve. Therefore, when the copilot applies brake pressure, only that portion of the hydraulic pressure applied by the pilot which is in excess of that applied by the copilot will return to the reservoir when the pilot releases his brakes. Hydraulic pressures at the brakes are not additive. If equal brake pedal pressure is applied by both pilot and copilot, the hydraulic pressure which reaches the brakes is identical to that which would have reached the brakes if only the pilot has applied pressure.

CAUTION

Brake action normally should be applied by the pilot. If it becomes necessary for the copilot to apply brakes, the pilot must release his brake pedals. This is necessary to allow copilot's braking action to be effective through the pilot's metering valves.

Note

If the pilot has applied pressure to his brake pedals first, the copilot's brake pedals are rendered inoperative until the pilot has released the pressure on his brake pedals.



LANDING GEAR CONTROL SYSTEM

Figure 1–41 (Sheet 1 of 2)

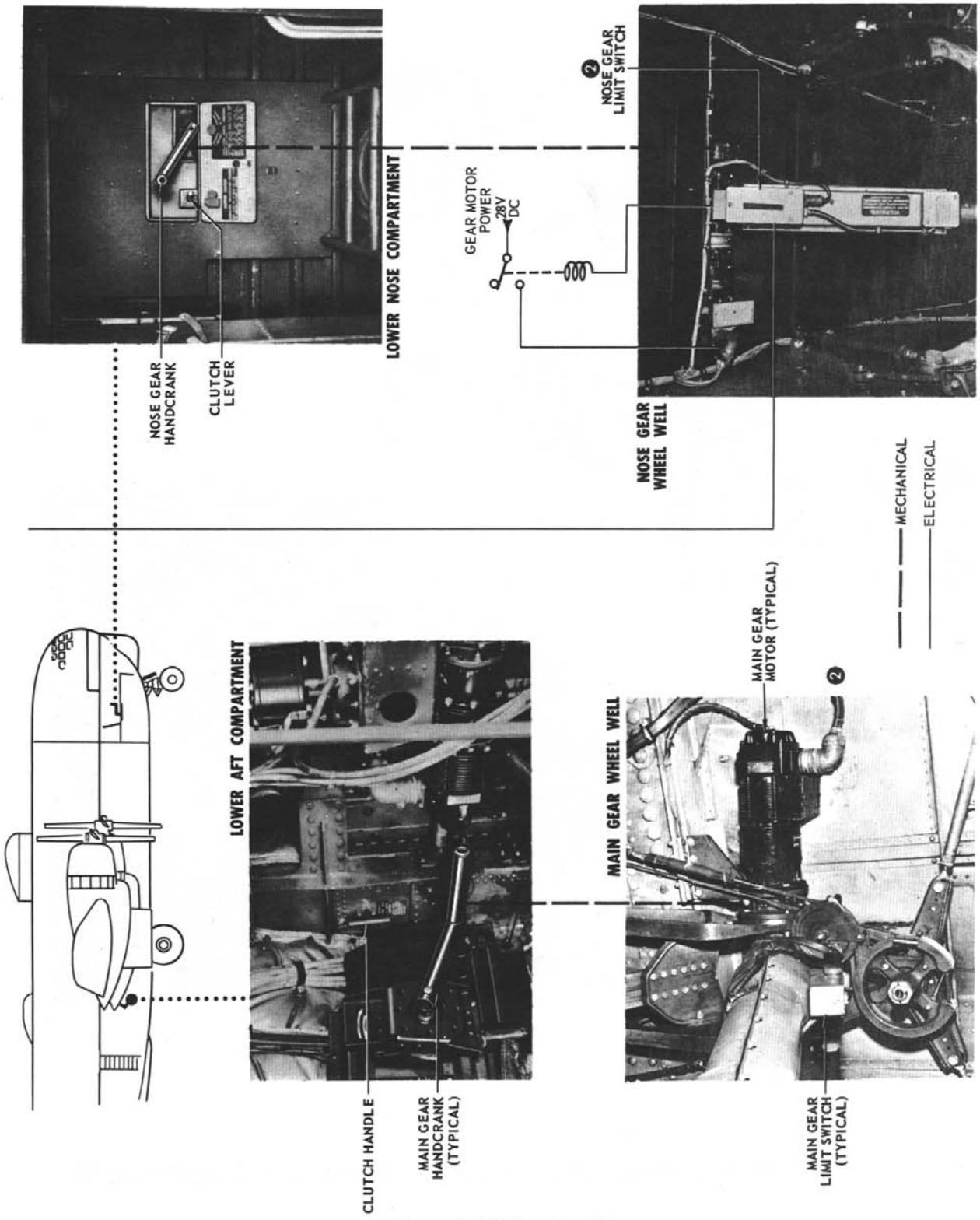
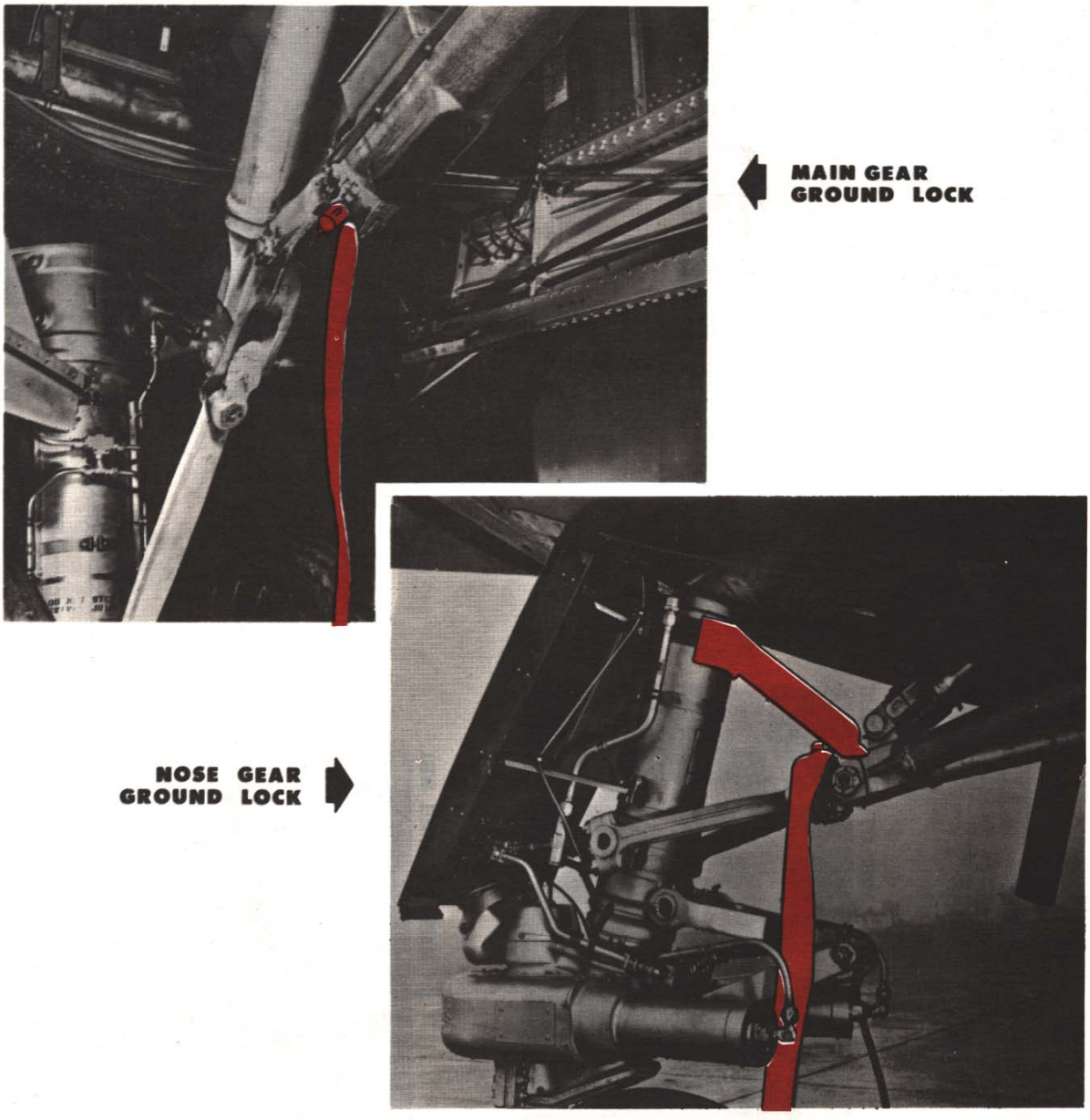
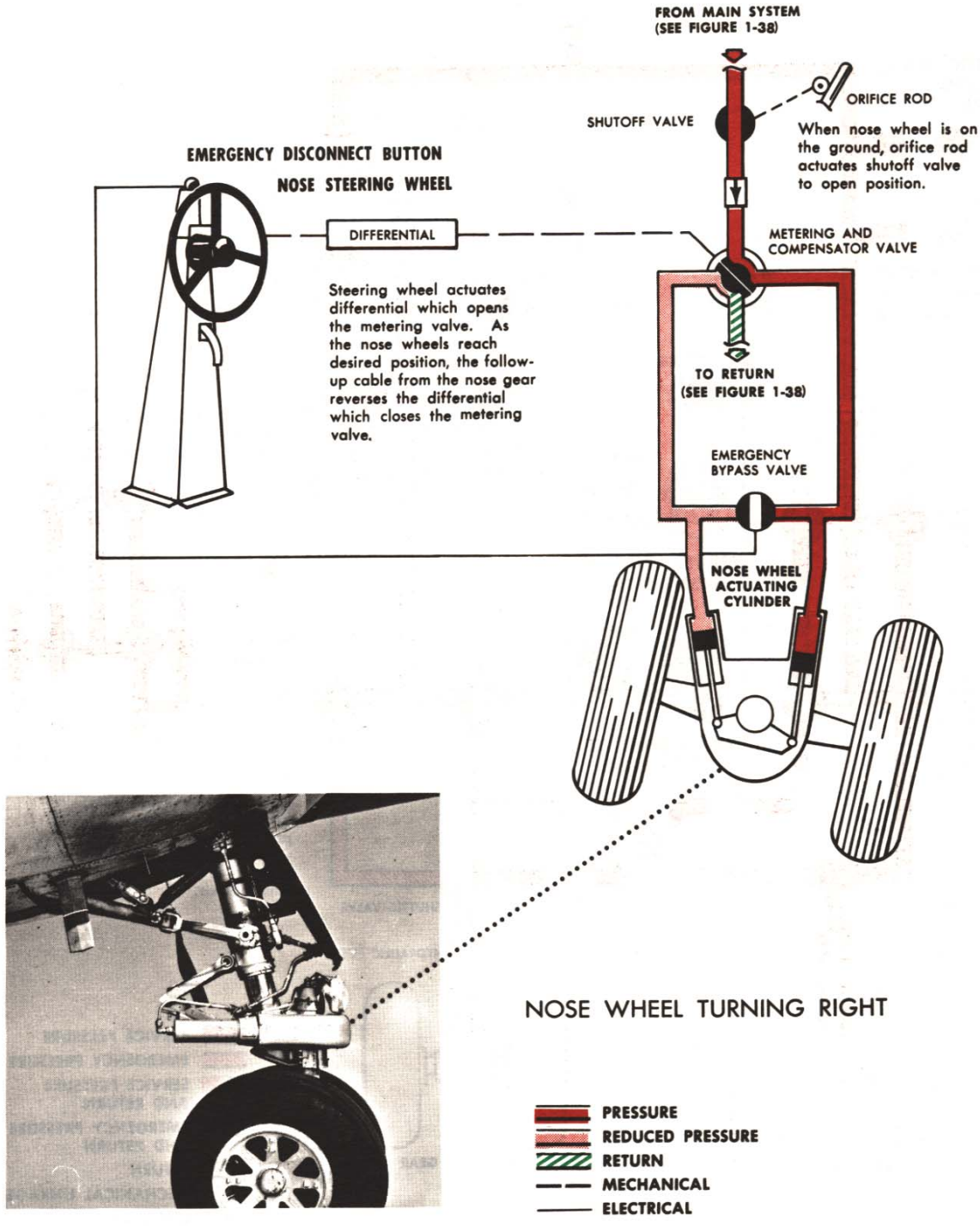


Figure 1–41 (Sheet 2 of 2)



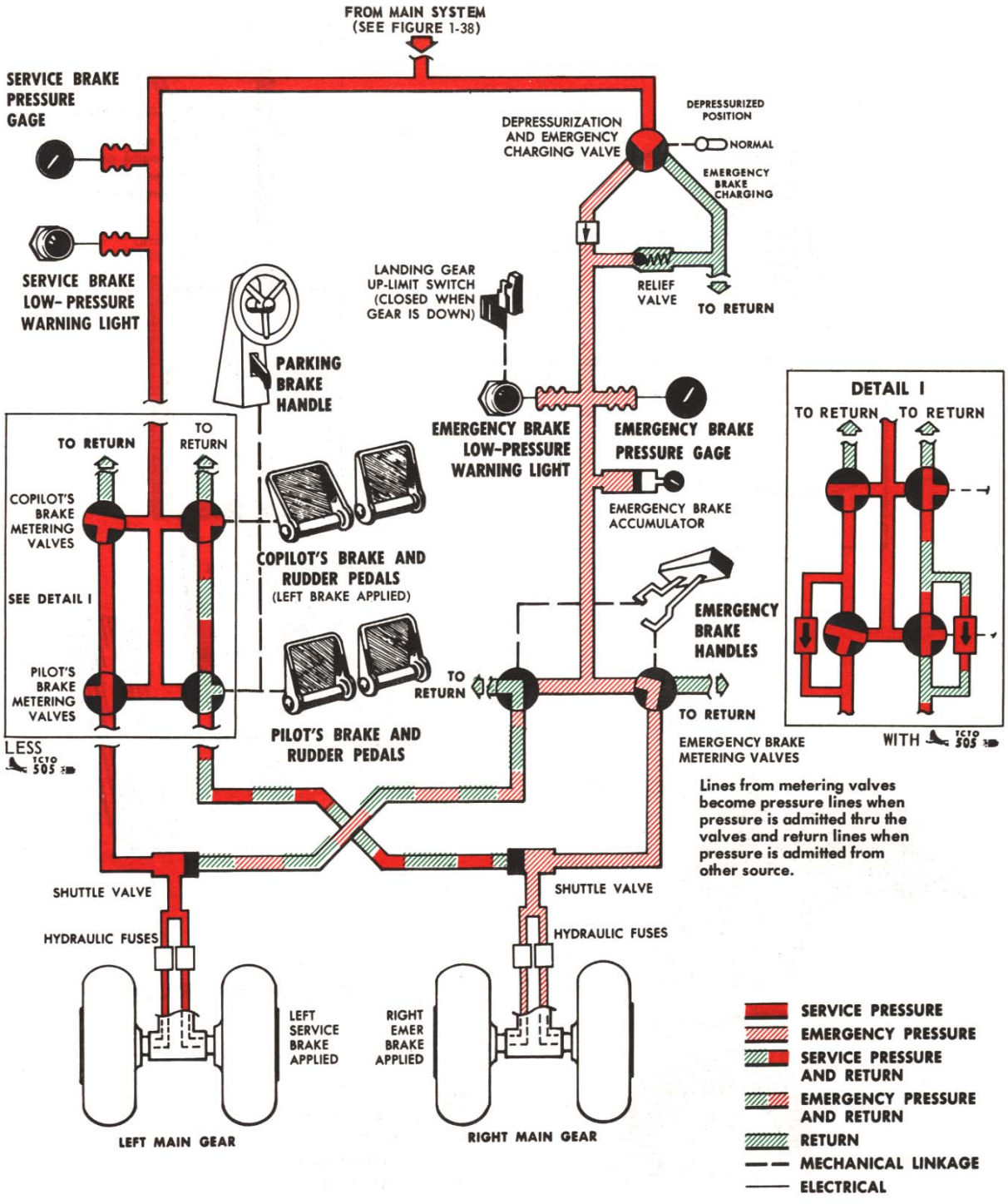
LANDING GEAR GROUND SAFETY LOCKS

Figure 1–42



NOSE WHEEL STEERING SYSTEM

Figure 1–43



SERVICE AND EMERGENCY BRAKE SYSTEMS

Figure 1–44

SERVICE BRAKE SYSTEM

The service brake system on airplanes incorporating TCTO 505 is the same as on airplanes not incorporating TCTO 505, with the exception that two lines and check valves are added which bypass the pilot's brake metering valves. (See Detail I, figure 1–44.) These bypass lines and check valves permit simultaneous braking action by both pilots. Actuation of the copilot's brake metering valves can admit pressure to the brake system, through the bypass lines and check valves. This occurs when the pilot's metering valves have been actuated first and the normal pressure route through the pilot's metering valve is blocked.

Hydraulic Fuses

A hydraulic fuse in the brake line to each wheel is designed to shut off the flow of fluid after a quantity of fluid somewhat in excess of that required to operate the brakes has passed the fuse. (See figure 1–44.) Should a brake line rupture, the fuse will close and stop the flow of fluid through the brake line until the brakes are released. When the brakes are released, the fuses will reset themselves. If the affected brake is actuated again, a like amount of fluid will be lost until the fuse again shuts off flow.

Parking Brake Handle

A parking brake handle (9, figure 1–6) is on the nose wheel steering pedestal. Parking brakes are set by applying toe pressure to the pilot's rudder pedals and pulling the spring-loaded parking brake handle upward. The parking brakes are automatically released when the pilot's rudder pedals are again depressed.

EMERGENCY BRAKE SYSTEM

The emergency brake system (figure 1–44) stores pressure in an accumulator for emergency operation of the service brakes. Only two applications of emergency brakes are available.

Emergency Brake Levers

Two emergency brake levers on the ceiling over the pilots' station are mechanically linked to the emergency metering valves. Pulling handles downward meters hydraulic pressure to the brakes. Each handle controls one main landing gear brake. Handles may be used individually or togeteher.

DEPRESSURIZATION AND EMERGENCY CHARGING VALVE HANDLE

For a description of this handle, refer to MAIN HYDRAULIC SUPPLY SYSTEM, this section.

BRAKE SYSTEM PRESSURE GAGES

A hydraulic pressure gage (32, figure 1–8) for the service brake system is on the pilots' instrument panel, and an emergency brake system hydraulic pressure gage (1, figure 1–14) is on the copilot's auxiliary panel. The gages are marked in psi. Circuit protection and 26-volt ac power is through the ac power panel (15, figure 1–37).

BRAKE SYSTEM LOW-PRESSURE WARNING LIGHTS

Two amber brake low-pressure warning lights (29 and 31, figure 1–8) on the pilots' instrument panel are provided for the service and emergency brake systems. The service brake system warning light will illuminate when hydraulic pressure is below 900 psi, and the emergency brake system warning light will illuminate when emergency brake hydraulic pressure is below 1250 psi. Both lights are wired so that they operate only when the landing gear is extended. The lights are supplied 28-volt dc power through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

WINDSHIELD WIPERS

Hydraulically operated windshield wipers clear the windows directly in front of the pilot and copilot. The wipers are operated by the main hydraulic supply system (figure 1–38). The windshield wipers are turned on and speed regulated by rotating the control knob (11, figure 1–10) counterclockwise.

CAUTION

To prevent damaging the windshields or wipers, the wipers should be operated only when the windshields are wet. Should the wipers fail to park when turned off, the control knob should be turned slightly toward the open position until the wipers move to the parked position.

INSTRUMENTS

Only those instruments which are not properly a part of a complete system, such as fuel system, are listed in figure 1–45. The instruments listed include pitot- and static-operated instruments, alternating current-operated instruments, and direct current-operated instruments. Pitot and static sources are shown in figure 1–46.

PILOT'S ATTITUDE INDICATOR

The pilot's attitude indicator (6, figure 1–8) on the left side of the pilots' instrument panel is supplied with power from the 115-volt ac pilots' instrument inverters through circuit protection on the ac power panel (15, figure 1–37). The power-off warning flag becomes visible if power is removed from any phase; however, it does not indicate incorrect reading caused by mechanical malfunction which should be detected by cross-referencing the other flight instruments. Should partial or complete power failure occur, the instrument will remain operative until the gyro loses speed, providing adequate time to switch on the pilot's instrument inverter emergency power; however, should the instrument become sluggish or the horizon bar waver due to the gyro losing speed, it should be caged until emergency power has been established and the gyro has had sufficient time to regain

speed. The instrument may be caged by means of a gyro centering device, operated by pulling out the cage knob on the front of the instrument.

A type MF-2 attitude indicator is installed. It embodies a card-type face and a double horizon bar. The degree of climb or dive is indicated by reference of the miniature airplane to the horizon bar. Maximum horizon bar deflection in climb or dive is approximately 27 degrees. A knob on the front of the instrument adjusts the miniature airplane to indicate zero pitch in a shallow climb or dive. The degree of bank is indicated by the position of the bank pointer relative to the bank index scale.

WARNING

A considerable amount of pitch error in the indication of the attitude indicator may result from accelerations or decelerations. It will appear as a climb indication after a forward acceleration and a dive indication after deceleration when the airplane is flying straight and level. This error is most noticeable at the time the airplane breaks ground during the takeoff run. At this time, a climb indication error will normally be noticed; however, the exact amount of error will depend upon the acceleration and elapsed time of each individual takeoff, but may be in excess of 1-1/2 bar widths. The erection system will automatically remove the error after the acceleration ceases.

CAUTION

Caging of the attitude indicator should be kept to a minimum. Care should be exercised when caging the instrument on the ground or in the air to avoid undue stresses to the gyro bearings. The airplane should always be in a straight and level attitude when caging the instrument in flight.

Note

After applying power to the attitude indicator, a period of 30 seconds should be allowed for the gyro to attain speed. The instrument should then be caged and immediately uncaged to prevent unnecessary torque stresses on the instrument mechanism.

COPILOT'S ATTITUDE INDICATOR

The copilot's attitude indicator (20, figure 1–8), which functions as a vertical gyro control unit, is on the right side of the pilots' instrument panel. The indicator automatically transmits signals to the aileron and elevator servos, returning the airplane to the proper attitude in pitch or roll when displacement occurs with reference to the vertical seeking gyro. A caging knob on the lower right corner of the indicator is used to erect the axis of the gyro in the vertical gyro control unit to the vertical axis of the airplane. When the autopilot is energized, but not engaged, the vertical gyro control unit serves as a conventional attitude indicator. The master heading indicator, copilot's attitude indicator, and copilot's turn and slip indicator operate continuously when the autopilot inverter is operating, even though the autopilot master switch is not in the ON position.

PILOT'S INSTRUMENT INVERTER EMERGENCY POWER SWITCH

For a description of the switch, refer to AC POWER SYSTEM, this section.

ALTIMETER

PILOT'S AND COPILOT'S ALTIMETER

An AAU-21/A Altimeter-Encoder is installed on the pilot's instrument panel and an AAU-27/A Altimeter is installed on the copilot's instrument panel. The AAU-21/A Altimeter-Encoder combines pneumatic altimeter (counter-drum-pointer display) and an altitude-reporting encoder in one self-contained unit. The 10,000 and 1,000 foot counters and the 100 foot drum provides a direct digital output and readout of the altitude in increments of 100 feet from—1000 to 38,000 feet. The digital output is referenced to 29.92 in. hg, and is not affected by changes of barometric setting. The pointer repeats the indications of the 100 foot drum and serves both as a vernier for the drum and as a quick indication of the rate and sense of altitude changes. Referring to Figure 3, there are two methods to read indicated altitude on the counter-drum-pointer altimeter: (1) read the counter-drum-window, without reference to the pointer, as a direct digital readout in thousands and hundreds of feet; or (2) read the thousands of feet on the two counter indicators, without referring to the drum and then add the 100 foot pointer indication.

The self-contained encoder provides altitude encoded in 100 foot increments for automatic transmission when AIMS/IFF transponder is enabled and interrogated on Mode C. In case of power loss to the encoder, a CODE OFF flag will appear automatically in a window in the upper-left portion of the display, indicating that altitude information is no longer being transmitted to the ground. In this condition, the instrument continues to function as a normal barometric altimeter.

The barometric pressure setting is entered by use of a normally operated Barometric Set knob in the lower-left front of the instrument case. The barometric pressure setting appears on counters in the window in the lower right of the display and has a range of settings from 28.1 to 31.0 in. hg.

An internal vibrator operates continuously whenever aircraft DC power is turned on. The vibrator minimizes internal mechanical friction, enabling the instrument to provide a smoother display during changing altitude conditions. Should vibrator failure occur, the altimeter will continue to function pneumatically, but a less-smooth movement of the instrument display will be evident with changes in altitude.

WARNING

If the altimeter's internal vibrator is inoperative due to either internal failure or DC power failure the 100 foot pointer may momentarily hang up when passing through "0" (12 o'clock position). If the vibrator has failed, the 100 foot pointer hang up can be minimized by tapping the case of the altimeter. Pilots should be especially watchful for this failure when their minimum approach altitude lies within the 800-1000 part of the scale (1800-2000 feet, 2800-3000 feet, etc.), and should use any appropriate altitude backup information available.

The AAU-27/A Altimeter (copilot's) is similar to the AAU-21/A Altimeter-Encoder (pilot's) except this instrument does not have an altitude encoder nor the CODE OFF display mechanism. The indicated altitude on the altimeter is from -1000 to 50,000 feet. The altitude diplay, altimeter settings, and vibrator considerations described for the altimeter-encoder also apply to this altimeter.

Altimeters (19, figure 1–8, and 1, figure 4–44) are provided, one each, for the pilot, copilot, and navigator. The altimeter registers pressure altitude above sea level with compensating mechanisms for variation in station barometric pressure. Three pointers on the altimeter give pressure altitude: the hundred-foot (long) pointer (4, figure 1–47) indicates hundreds of feet altitude; the one thousand-foot (broad) pointer (2, figure 1–47) indicates thousands of feet, and the ten thousand-foot (narrow) pointer (1, figure 1–47) with the triangular index marker on the outer edge of the dial indicates tens of thousands of feet. The barometric scale (3, figure 1–47) and the barometric pressure set knob (6, figure 1–47) are interconnected to allow the altimeter to be set to station barometric pressure corrected to sea level pressure. The low altitude warning symbol (5, figure 1–47) is a crosshatched area that comes into view below 16,000 feet.

WARNING

It is possible to misset an altimeter by 10,000-foot increments and still have the proper pressure setting in the barometric scale. Check all three pointers to be sure the altimeter indicates the proper field elevation before takeoff.

EMERGENCY EQUIPMENT

The location of the emergency equipment, except for the engine fire detection and extinguishing systems, is shown in figure 3–1.

FIRE DETECTOR SYSTEM

An automatic fire detector system is provided to detect a fire condition in any of the power packages or combustion heater areas. The system illuminates red master fire warning lights on the pilots' and engineer's instrument panels if a fire condition exists. The exact area which has a fire condition is indicated either by fire warning lights (9, 10, 15, and 39, figure 1–11) on the overhead panel

INSTRUMENT	OPERATING POWER	POWER SOURCE	CIRCUIT PROTECTION LOCATION
Airspeed Indicators	Pitot and Static Systems	Pitot and Static Systems	None
Pilot's Altimeter	Static System AC and DC Electric	Static System AC and DC Power Distribution System	Radio Junction Box
Copilot's Altimeters	Static System and DC Electric	Static System and DC Power Distribution	Radio Juntion Box
Navigator's Altimeter	Static System	Static System	None
Vertical Velocity Indicators	Static System	Static System	None
(1) (2) (3) Pilot's Turn and Slip Indicator	DC Electric	DC Power Distribution System	Overhead Circuit Breaker Panel
	Emergency Power	Battery Bus	Forward Power Panel
(1) (3) Pilot's Heading Indicator	AC Electric	Pilots' Instrument Inverter	AC Power Panel
(1) (3) Pilot's Attitude Indicator	AC Electric	Pilots' Instrument Inverter	AC Power Panel
Outside Air Temperature Gages	DC Electric	DC Power Distribution System	Overhead Circuit Breaker Panel

(1) These instruments can be operated by battery power in case of dc power failure if the pilot's instrument inverter emergency power switch is positioned to BATTERY. (See figure 1–34.)

(2) Pilot's turn and slip indicator is calibrated for 4-minute turns. Copilot's turn and slip indicator is calibrated for 2-minute turns.

(3) For copilot's instruments see figure 1–33 and AUTOPILOT, Section IV.

INSTRUMENTS

Figure 1–45

for the engineer, or on the pilots' instrument panel for wheel well overheat warning lights (27, figure 1–8). Fire sensing units located behind the exhaust collector ring, around the turbosupercharger, on the engine oil tank, in the accessory section of the power package, in the wing D ducts, in the combustion heater cavities, around the APU, and in the main landing gear wheel wells cause the fire warning lights to illuminate during a sudden overheat condition such as a fire would cause. The fire detector system is powered from 28 volts dc through circuit breakers on the overhead circuit breaker panel (1, figure 1–37). The electrical master switch must be ON to operate the fire detector system. The battery switch must be ON BUS, the electrical master switch must be ON, and the nose landing gear must be extended and contacting the ground so as to actuate the oleo switch in order to operate the system from battery power.

Fire Detector System Test Buttons

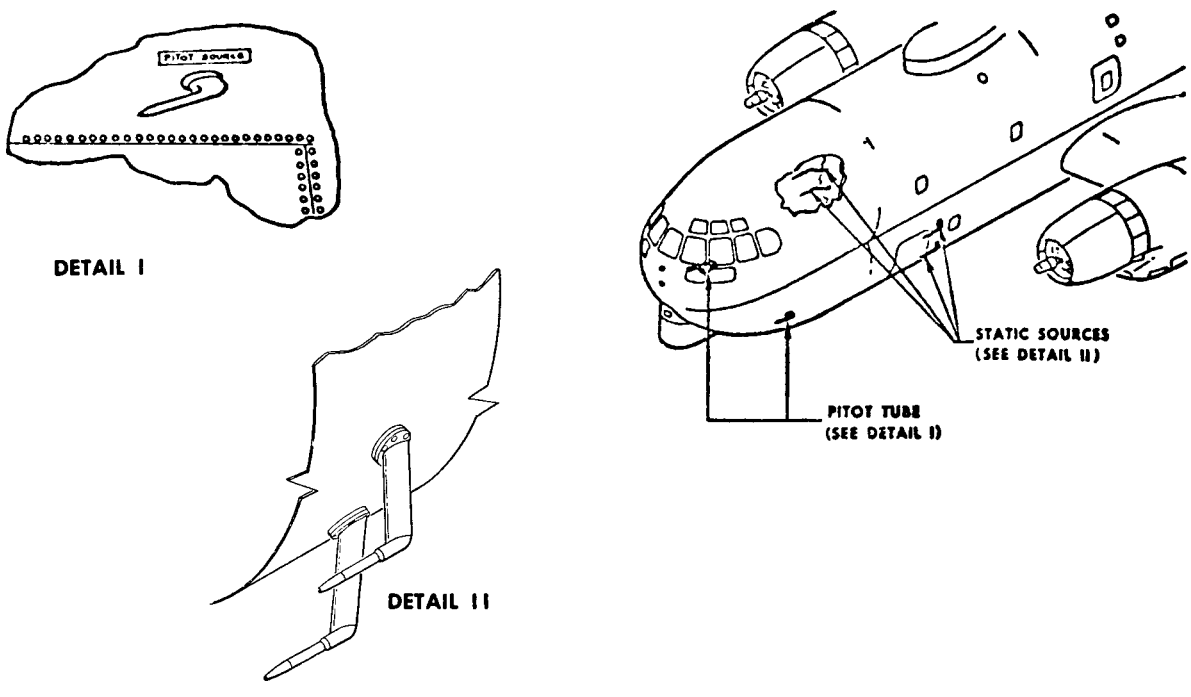
There are three push-to-test fire detector system test buttons (8, figure 1–11) on the fire section of the overhead panel to test the continuity and operation of the three circuits making up the fire detector system. Pushing either circuit 1 or circuit 2 button will illuminate the power package fire warning lights on the fire section of the overhead panel and the master fire warning lights on the pilots' and engineer's instrument panels. Pushing circuit 3 button will illuminate the power package fire warning lights, the heater warning lights, and the main landing gear wheel well warning lights. The test circuits are operated from 28-volt dc power through circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Master Fire Warning Lights

Two red, push-to-test master fire warning lights (16, figure 1–8, and 52, figure 1–21) are provided; one on the pilots' instrument panel and the other on the engineer's instrument panel. Both lights will illuminate in case of a sudden increase in temperature in engine or anti-icing and body heater areas. Power is 28-volt dc through circuit protection on the overhead circuit breaker panel (1, figure 1–37).

JET ENGINE FIRE DETECTION SYSTEM

Each jet engine is equipped with a fire detection system. Each system consists essentially of thermally actuated fire detector units, mounted in each engine nacelle, and a fire detection warning light. If a fire occurs in an engine, the



PITOT AND STATIC SOURCES

Figure 1–46

sudden rise in temperature will cause the fire detector unit to be actuated. The fire detector units, when actuated, complete an electrical circuit to the fire warning light, causing the light to come on.

Fire Detection Test Switch

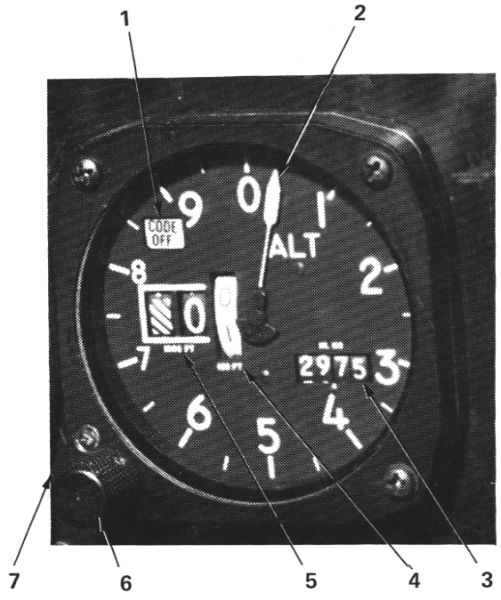
A jet engine fire detection test switch (12, figure 1–8) is between the fuel-oil emergency shutoff valve T-handles on the pilots' instrument panel. The switch has NORMAL and TEST positions and is spring-loaded to the NORMAL position. Placing the switch in the TEST position energizes the fire detection warning circuits for both engines, and the fire detection warning lights come on. In the NORMAL position, the switch opens the fire detection circuit, permitting normal operation. The switch receives 28-volt dc power through circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

Fire Detection Warning Lights

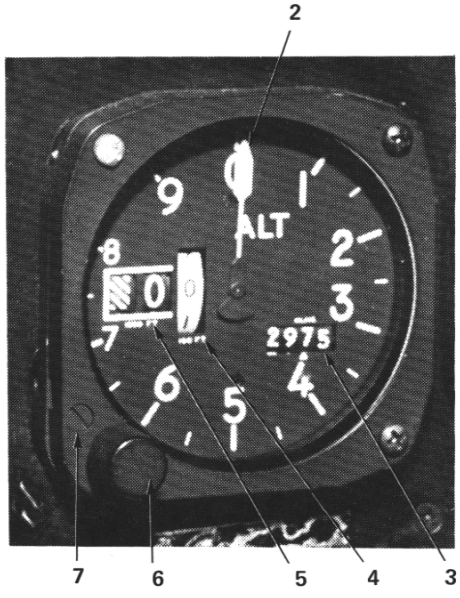
Two red fire detection warning lights, one for each engine, are incorporated in the jet engine fuel-oil emergency shutoff valve T-handles (11, figure 1–8). If an engine fire detector unit is actuated, the fire warning light for that engine comes on. The lights may be tested individually by pressing the fuel-oil emergency shutoff valve T-handles. The lights receive 28-volt dc power through circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

FIRE EXTINGUISHER SYSTEM

A CO_2 fire extinguisher system (figure 1–48) is provided to supply two separate charges of CO_2 to the power packages, wing anti-icing heaters, and empennage anti-icing heaters. The CO_2 is stored in two sets of four bottles; each set is located in a main landing gear wheel well. Each set of bottles will furnish one complete charge of CO_2. The two upper bottles in each set are fitted with solenoid-actuated valves to release the CO_2 charge. The CO_2 charge released from the upper bottles actuates the release valves on the lower bottles through tubing connecting the bottles. The upper bottles are also connected with tubing so that if one of the solenoids fail to operate, the other solenoid-actuated valve will release the entire charge of CO_2 in the set of four bottles. Actuation of the CO_2 release switch in either direction will release the charge from one set of bottles. CO_2 is then directed through tubing to a common manifold line which serves all probable fire areas. Select direction switches open directional control valves located in the lines between the manifold and fire areas. These valves direct the CO_2 charge to be dispersed in the selected fire area through perforated runs of tubing or directly into the equipment. A CO_2 bottle is also located adjacent to the APU. Actuation of the APU CO_2 release switch (11, figure 1–11) will discharge the entire bottle into the turbine cover. These control switches are located on the fire section of the overhead panel. All controls are powered by 28-volt dc through



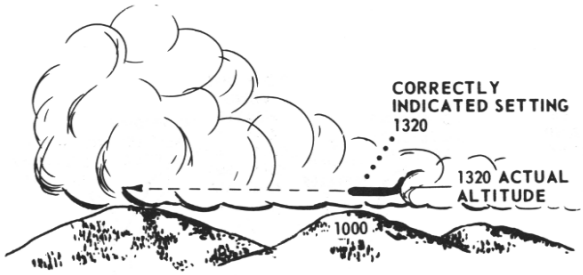
AAU-21/A ALTIMETER-ENCODER
PILOT



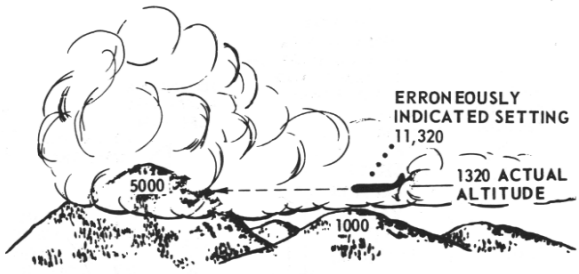
AUU-27/A ALTIMETER
CO-PILOT

1. MODE C CODE-OFF FLAG WINDOW.
2. ONE HUNDRED FOOT POINTER (INDICATES HUNDREDS OF FEET) (2 PLACES).
3. BAROMETRIC SCALE WINDOW (2 PLACES).
4. ONE HUNDRED FOOT WINDOW (2 PLACES).
5. ONE THOUSANDS FOOT WINDOW (2 PLACES).
6. BAROMETRIC SETTING KNOB (2 PLACES).
7. ZERO SET LOCKING SCREW (2 PLACES).

Figure 1-47. Pilot's and Copilot's Altimeters.

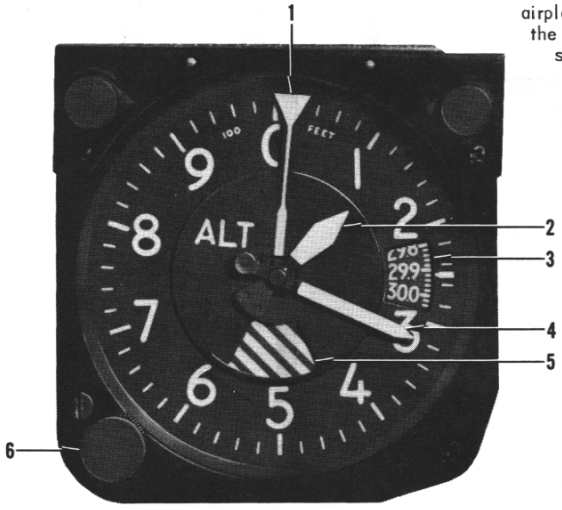


CORRECTLY INDICATING ALTIMETER

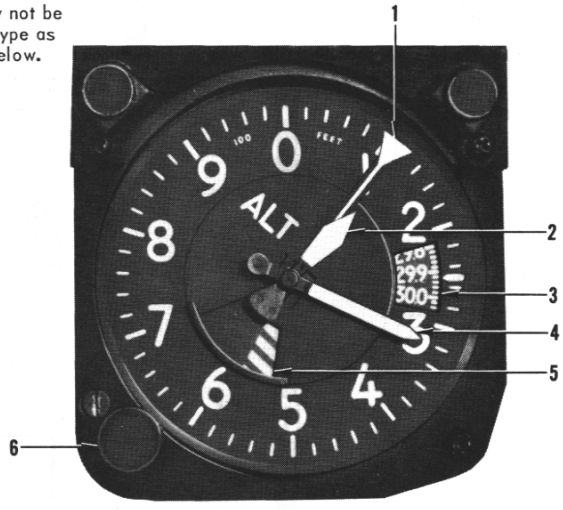


ERRONEOUSLY INDICATING ALTIMETER

NOTE:
The altimeters in the airplane may not be the newer type as shown below.



INDICATED SETTING – 29.92 IN. HG
ALTITUDE – 1320 FEET



INDICATED SETTING – 29.92 IN. HG
ALTITUDE – 11,320 FEET

NOTE:
Altimeter setting is 10,000 feet high

1 TEN THOUSAND-FOOT POINTER (INDICATES TENS OF THOUSANDS OF FEET) (2 PLACES)
2 ONE THOUSAND-FOOT POINTER (INDICATES THOUSANDS OF FEET) (2 PLACES)
3 BAROMETRIC SCALE (2 PLACES)
4 HUNDRED-FOOT POINTER (INDICATES HUNDREDS OF FEET (2 PLACES)
5 LOW ALTITUDE WARNING SYMBOL (2 PLACES)
6 BAROMETRIC PRESSURE SET KNOB (2 PLACES)

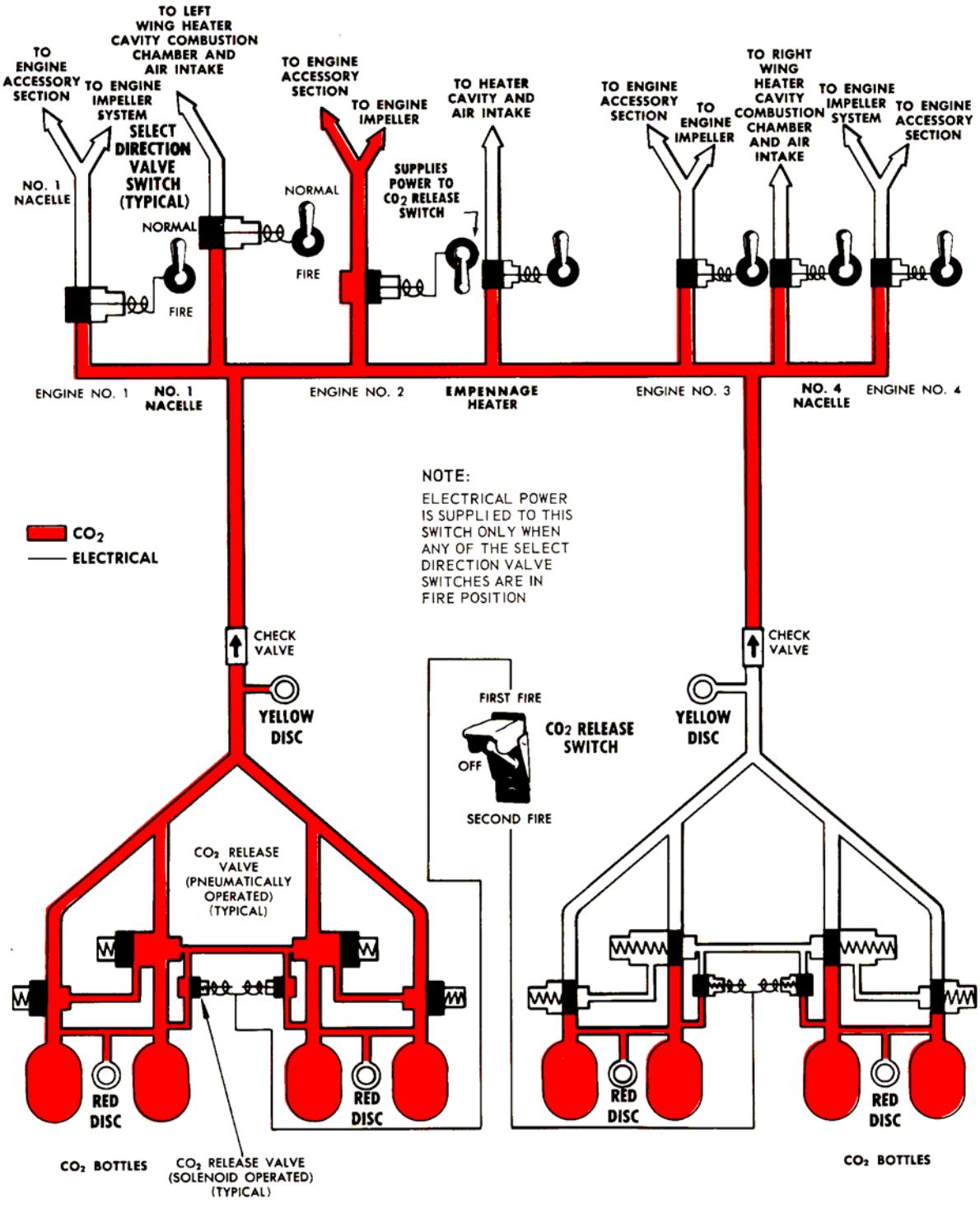
NAVIGATOR'S ALTIMETER SETTINGS

Figure 1-47A

circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Fire Switches

Fire Gang Bar Switches. A fire gang bar plate is located aft of each group of power package and surface anti-icing heater fire switches on the overhead panel. When a power package fire gang bar switch (16, figure 1–11) is positioned to FIRE, it will actuate the select direction valve switch; the sheltered air door switch; the fuel valve switch; the fuel, oil, hydraulic fluid, and cabin air bleed switch; and the propeller feathering switch. When the empennage, right wing, or left wing anti-icing heater fire gang bar switch (12, 13, or 37, figure 1–11) is positioned to FIRE, it will actuate the surface anti-icing heater select direction valve fire switch and the heater shutoff switch. Each gang bar is spring-loaded from the FIRE position to the NORMAL position.



FIRE EXTINGUISHER SYSTEM

Figure 1–48 (Sheet 1 of 2)

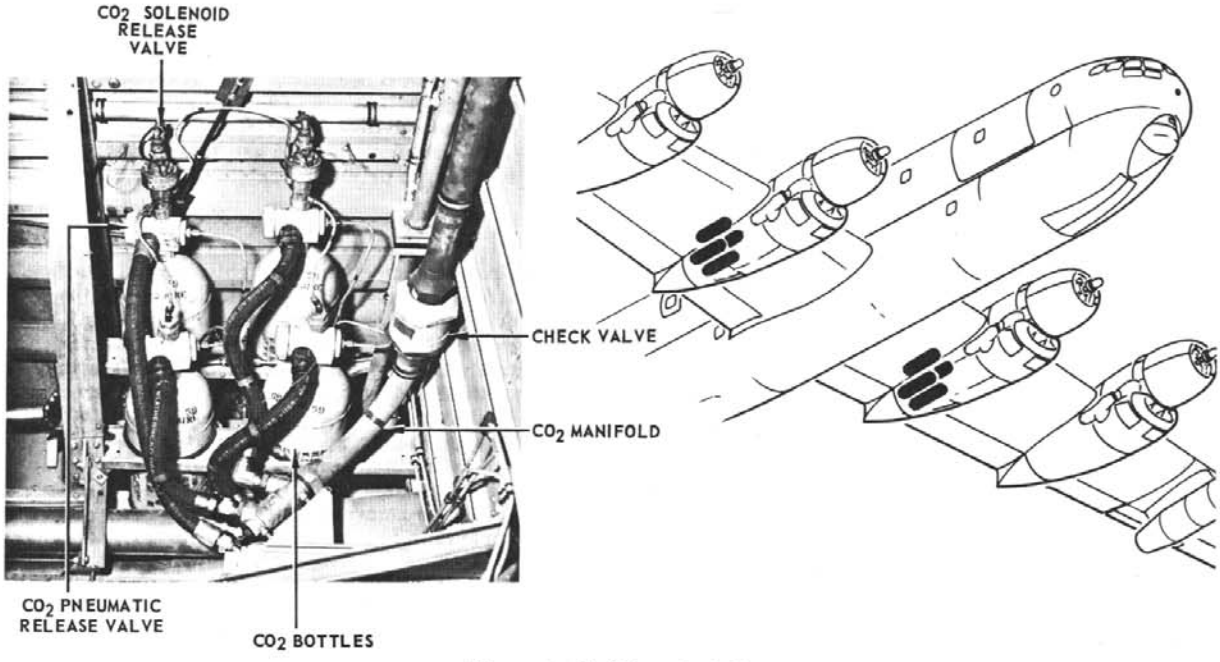


Figure 1–48 (Sheet 2 of 2)

Select Direction Valve Switches. These switches (16, figure 1–11) with NORMAL–FIRE positions are on the fire section of the overhead panel. One switch is provided for each power package. When the switch is placed to FIRE, the select direction valve is armed and will open, allowing the charge of CO2 to enter the power package selected.

Sheltered Air Door Switches. The NORMAL–FIRE positions of the switches (16, figure 1–11) control the operation of the sheltered air door. When the switch is placed to FIRE, the sheltered air door stops ram air from entering the induction system. One switch is provided for each power package.

Fuel Valve Switches. The switches (16, figure 1–11) with NORMAL–FIRE positions is provided for each power package. When the switch is placed to FIRE, the fuel selector valve is turned to the TANK TO MANIFOLD position. When the switch is returned to NORMAL, the fuel selector valve will return to its originally selected position.

Fuel, Oil, Hydraulic Fluid, And Cabin Air Bleed Switches. One switch (16, figure 1–11), with NORMAL–FIRE positions, is provided for each power package. When the switch is placed to FIRE, fuel, oil, and hydraulic fluid are shut off from the power package and the cabin pressurizing air supply from that power package is shut off.

Propeller Feathering Switches. The NORMAL–FIRE positions of these switches (16, figure 1–11) control the propellers. When the switch is placed to FIRE, the propeller feathers. This switch is spring-loaded to the NORMAL position and will return to NORMAL when released; however, the propeller will feather in the same manner as if the pilots' propeller feathering button were pressed.

Anti-Icing Heater Select Direction Valve Switches. These switches (12, 13, and 37, figure 1–11), one for each set of surface anti-icing heaters, are on the fire section of the overhead panel. When the switch is placed to FIRE, it actuates the directional control valve to allow the CO_2 charge to enter the heater area from the fire extinguisher system manifold.

Anti-Icing Heater Shutoff Switches. These switches (12, 13, and 37, figure 1–11), one for each set of surface anti-icing heaters, are on the fire section of the overhead panel. The switch, when placed to FIRE, discontinues heater operation by stopping intake air flow and fuel supply to the heaters and deenergizing the heater ignition circuit.

Body Heater Fire Switch. One body heater fire switch (38, figure 1–11) with NORMAL–FIRE positions on the fire section of the overhead panel is used to discontinue heater operation. When this switch is placed to FIRE, it will shut off the fuel supply to the body heaters besides deenergizing the heater ignition circuit. Body heater fires cannot be extinguished from the airplane's fire extinguisher system, but will have to be extinguished with portable hand extinguishers stowed in the airplane.

CO_2 Release Switch

The guarded CO release switch (14, figure 1–11) on the fire section of the overhead panel releases the two charges of CO_2 when one or more select direction valve switches are positioned to FIRE. The switch has three positions, FIRST FIRE–OFF–SECOND FIRE. By moving and holding the switch at least 5 seconds to FIRST FIRE position, the charge of CO_2 from the left set of the CO_2 bottles will be released to the predetermined fire area. By moving and holding the switch to SECOND FIRE position for at least 5 seconds, the remaining charge of CO_2 will be released.

NOTE

The select direction valve switches must be ON to release the CO_2 charges. The 5-second holding of the CO_2 release switch allows positioning of the CO_2 release valve.

In order to use battery power to release the CO_2 charges, the electrical master switch must be ON, the battery switch must be ON BUS, and the nose landing gear must be extended and contacting the ground so the oleo switch is actuated.

APU CO_2 Release Switch

The APU CO_2 release switch (11, figure 1–11), marked AUX POWER UNIT CO_2 RELEASE, when positioned to ON will release the contents of a CO_2 bottle into the turbine cover. The switch is spring-loaded and guarded to the OFF position, and when operated, must be held ON for 5 seconds.

CO_2 Discharge Indicator Discs

Discharge indicator discs are provided on the left-hand side of the inboard nacelles to visually determine if the CO_2 charge has been released from either set of bottles or any bottles within the set. A ruptured or missing yellow disc indicates the complete set of bottles have been discharged and needs replacing. Missing red discs indicate the bottles have been discharged by thermal expansion. A ruptured or missing aft red disc indicates the outboard bottles have been discharged and need replacing and a ruptured or missing forward red disc indicates the inboard bottles have been discharged and need replacing. There is also a discharge disc for the APU CO_2 bottle located in the skin adjacent to the APU exhaust. If the disc is ruptured or missing, the bottle needs replacing.

HAND FIRE EXTINGUISHERS

There are eight bromochloromethane hand fire extinguishers located throughout the airplane. For location, see figure 3-1. The effective range of the extinguishers is 25 feet, when operated vertically to within 15 degrees from horizontal.

WARNING

Do not use fire extinguishers to cool equipment. Heavy dense suffocative or toxic smoke occurs when bromochloromethane (CB) is used on hot metal or open fire. However, CB is safer to use than previous fire extinguishing agents. Avoid more than 5 minutes exposure to CB because irritation of the eyes and nose will occur. Obtain adequate respiratory and eye protection (cover nose and mouth with a damp cloth), and use 100% oxygen as soon as the primary fire emergency permits.

NOTE

- Bromochlormethane is highly corrosive to aircraft metal, paint and plexiglass. In the event the fire extinguisher starts to leak, the extinguisher should be inverted and the control valve depressed (cover the nozzle with a cloth or aim into a can, etc., to catch any liquid which may be discharged). This will release the stored charge of pressurizing gas with a minimum discharge of fluid and render the extinguisher harmless. The extinguisher should be returned to its bracket and be reported for replacement in Form 781.

- The type A-20 (CB) hand fire extinguisher should be held upright to fight fire. The extinguishing agent pickup is at the bottom of the extinguisher. In the inverted position the gas will bleed off and render the extinguisher inoperative.

EMERGENCY ALARM BELL

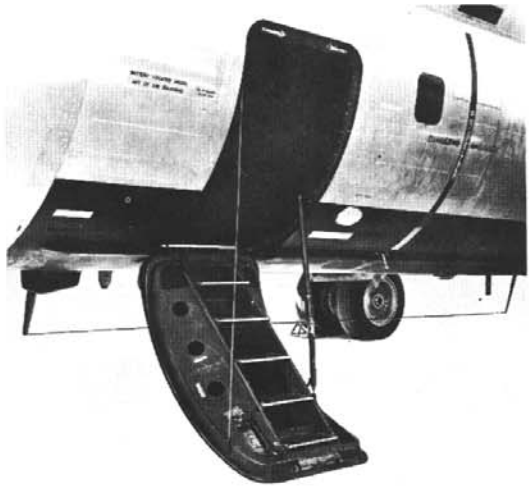
The emergency alarm bells in the airplane are controlled by a single ON–OFF emergency alarm bell switch (17, figure 1–11) on the overhead panel. One alarm bell is located aft of the forward hatch on the ceiling of the lower forward compartment; another is located on the right side of the main compartment over the wing center section; another is located forward of the lower aft compartment entrance ladder in the lower aft compartment; and another is located in the control cabin near the pilot's control column. A fifth alarm bell is located aft of the boom operator's station. When the switch is positioned to ON, power is supplied from the emergency bus on the forward power panel or from the battery shield, causing the bells to ring simultaneously. Circuit protection for the bell is on the forward power panel (5, figure 1–37).

AXES

There are two hand crash axes (18, figure 1–10, and 8, figure 3–1). One is located on the pilot's auxiliary panel and one is located on the emergency panel at the left side of the main compartment in the rear of the airplane.

EMERGENCY EXITS

Two emergency escape hatches (figure 3-6) are provided on each side of the fuselage. The escape hatches are opened inboard by pulling a lever marked PULL. Refer to Section III for escape hatch operation. The pilot and copilot are each provided with an emergency exit window. These window can be opened by pulling a handle inboard and sliding the window aft along a set of tracks. The aft entry door



FORWARD ENTRY DOOR

Figure 1–49

is provided with an emergency release handle for jettisoning the door during flight. The release mechanism overrides the latch and disconnects the winch cable and support arm. The door hinge design is such that as the door falls past the full open position, the hinge will disengage, allowing the door to fall free.

COMPARTMENT HATCHES

There are four hatches in the airplane other than emergency escape hatches. These hatches provide access between compartments. One hatch in the control cabin floor provides access to the lower nose compartment; one hatch in the forward end of the main compartment floor provides access to the lower forward compartment; one hatch in the aft end of the main compartment floor provides access to the lower aft compartment; and another hatch in the aft end of the main compartment provides access to the tail compartment.

ESCAPE ROPES

Three escape ropes (1, figure 3–1), stowed in bags, are provided for use of crewmembers to lower themselves from the airplane in an emergency. One is located at the pilot's sliding window, one at the copilot's sliding window, and one at the left escape hatch aft of the trailing edge of the wing.

SIGNAL LAMPS

An interairplane (aldis) signal lamp (19, figure 4–18) is located on the aft bulkhead on the left side of the control cabin and another is located just aft of the rear escape hatch on the right side of the main compartment. The signal lamp may be plugged into any convenient dc outlet receptacle.

LIFE RAFTS

Four 20-man life raft stowing brackets are located throughout the main compartment over the A/R tanks. The life rafts (9, figure 3–1) are held in place by two straps. There are no special provisions for automatic launching of the rafts. Therefore, in order to launch the rafts, the straps must be unfastened and the rafts must be removed from the airplane through the escape hatches over the wing. After the rafts have been removed from the airplane, they can be inflated by pulling the CO_2 release cable.

FIRST AID KITS 17260 ▶ 22628

There are positions for eight first aid kits (4, figure 3–1) in the airplane. Two first aid kits are in the control cabin: one on the pilot's auxiliary panel and one on the right side of the cabin to the left of the water tank. Six first aid kits are in the main compartment: two on each side of the fuselage over the wing center section, one on the left side of the forward bulkhead, and one on the emergency panel.

22629 ▶

There are positions for 15 first aid kits (4, figure 3–1). Two first aid kits are in the control cabin; one on the pilot's auxiliary panel and one on the right-hand side of the cabin to the left of the water tank. There are 12 first aid kits in the main compartment: one is on the left side of the forward bulkhead, two are just aft of the forward cargo door, three are on the right-hand side of the fuselage over the wing center section, two are on the left-hand side of the fuselage above the escape hatch over the wing center section, two are over the aft escape hatch on the right-hand side, one is over the aft escape hatch on the left-hand side, and one is on the emergency panel forward of the boom operator's station. One first aid kit is in the lower forward compartment opposite the forward entry door.

LANDING FLARES

Two landing flare tubes (7, figure 3–1), each containing provisions for one 3-minute night landing parachute flare, are provided in the tail compartment. The flares are released electrically by actuating two flare release switches (35, figure 1–11) on the overhead panel.

PYROTECHNIC PISTOL

A single-shot, breech-loading, double-action, pyrotechnic pistol and signal flares (11, figure 3–1) are stowed at the forward end of the navigator's table. The pistol is fired from a mount that is protected against cabin pressure loss by a manually operated external door. The pistol can be reloaded and refired repeatedly without removing it from the mount.

FIRE FIGHTERS' OXYGEN SETS

Three sets of oxygen equipment, for use in fighting inflight fires, are installed in the airplane. One is located on the aft side of the main compartment bulkhead to the right of the doorway, one on the emergency equipment panel forward of the Boom Operator station, and the other on the aft side of the radio rack in the lower forward compartment. Each set consists of portable oxygen cylinder equipment with a demand- type oxygen regulator and a cylinder pressure indicator. A full-face type oxygen mask is stowed in a canvas container attached to the cylinder harness.

FIRE FIGHTERS' GLOVES

A pair of asbestos gloves is stowed at each location of the fire fighters' oxygen sets.

ENTRY DOORS

Entrance to the airplane is gained through the two entry doors on the left side of the fuselage. The forward entry door (figure 1–49) gives access to the lower forward cargo compartment and the aft entry door gives access to the lower aft compartment. These doors may be opened from the outside by placing the hand through an opening, which is covered by a flush-type, spring-loaded plate on the door, and pressing a trigger on the inner portion on the door. This procedure releases the handle on the outside of the door and it is then slowly lowered to the ground. Steps are built in the door to allow ease of climbing into the airplane.

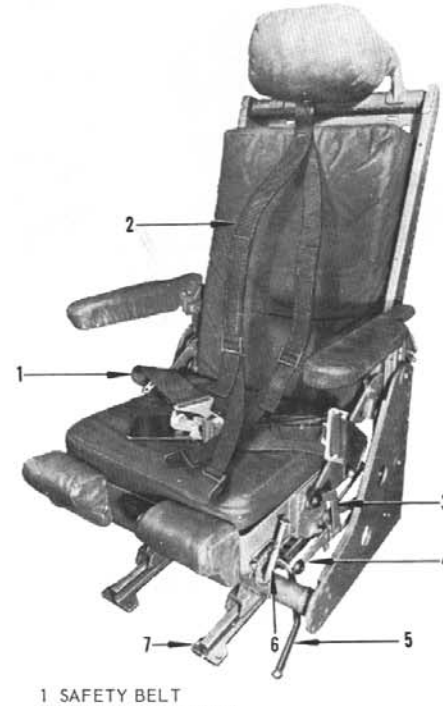
SEATS

CREW SEATS AND SAFETY BELTS

The pilot and copilot are provided with identical seats, except that the seat controls are on the left for the pilot and on the right for the copilot. These seats are fully adjustable for height and fore-and-aft-movement (figure 1–50). The engineer's and navigator's seats are adjustable for fore-and-aft or left and right, vertical, and radial movement (figure 1–51). On 3178▶, the seat is adjustable fore and aft along a set of tracks. On ▶3177, the seat is adjustable left and right along a set of tracks. These seats are provided with safety belts. The pilot's, copilot's, navigator's, and engineer's seats are provided with a safety belt, shoulder harness, and inertia reel lock. A left auxiliary troop seat, including a safety belt, near the left rear escape hatch, is for the boom operator when he is not engaged in air refueling.

SHOULDER HARNESS INERTIA REEL LOCK HANDLE

A handle (6, figure 1–50, and 3, figure 1–51), with LOCKED and RELEASED positions, is located on the left side of the pilots', navigator's, and engineer's seats. A latch is provided for positively retaining the handle at either position. By pressing down on the top of the handle, the latch is released and the handle may be moved freely from one position to the other. When the handle is in the RELEASED position, the reel harness cable will extend to allow the crewmember to lean forward. However, the reel harness 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 handle is moved to the LOCKED position and then returned to the RELEASED position. When the handle is in the LOCKED position, the reel harness cable is manually locked so that the crewmember is prevented from bending forward. This position provides an added safety precaution over and above that of the automatic safety lock.



1 SAFETY BELT
2 SHOULDER HARNESS
3 SEAT BACK ADJUSTMENT LEVER
4 SEAT ELEVATION LEVER
5 SEAT FORE-AND-AFT ADJUSTMENT LEVER
6 INERTIA REEL LOCK HANDLE
7 SEAT TRACKS

PILOT'S SEAT

Figure 1–50

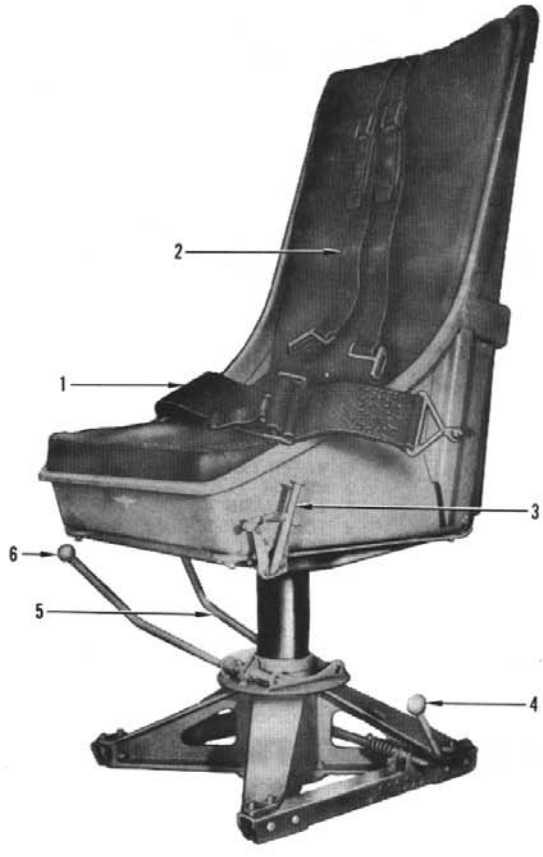
Note

It is recommended that the shoulder harness be manually locked during maneuvers and flight in rough air or as an added precaution in event of a forced landing.

MISCELLANEOUS EQUIPMENT

CELESTIAL SIGHTING PLATFORM

This platform is for the navigator to stand on when using the periscopic sextant. It is adjustable for vertical movement and has a locking pin for securing it to the control cabin floor. When not in use, the platform is stowed in the main compartment and securely tied down.



1 SAFETY BELT
2 SHOULDER HARNESS
3 INERTIA REEL LOCK HANDLE
4 SEAT FORE-AND-AFT ADJUSTMENT LEVER
5 SEAT ELEVATION LEVER
6 SEAT RADIAL ADJUSTMENT LEVER

ENGINEER'S AND NAVIGATOR'S SEATS (TYPICAL)

Figure 1–51

HEATED SUIT PROVISIONS 17260 ▶ 2859

A control box is installed at each crew station to control heated clothing. Each box includes a rheostat, a heated suit outlet, and a 24-volt dc electrical outlet. (See figure 1–36 for circuit protection of heated suit equipment.) The rheostat is marked OFF–LOW–HIGH and controls the output of the heated suit outlet only. When the rheostat is moved from the OFF to the LOW position and the suit heater cord is plugged in, power is supplied to the heated suit. Then the rheostat may be varied between the LOW and HIGH positions to control the temperature of the heated suit.

Note

Heated suit cords must be disconnected when engines are being started to lessen the electrical load.

DATA CASE

An airplane data case is mounted on the right side of the control cabin behind the engineer's instrument panel.

AIRPLANE LOAD ADJUSTER

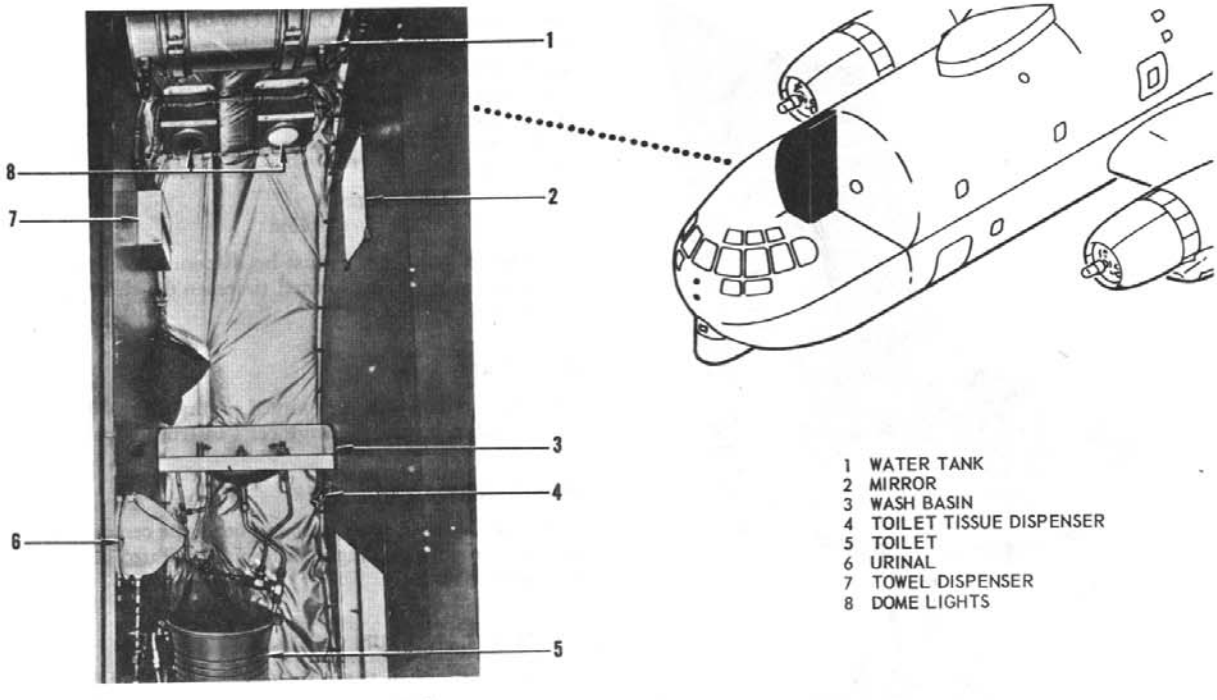
The load adjuster, used for computing the center of gravity under various loading conditions, is located in the control cabin.

BLACKOUT AND SUN CURTAINS

All the windows in the main compartment and the lower forward and aft compartments, including the hatches, are equipped with curtains. These curtains are attached by snapping them to clips on the window frame. Snap-on type curtains are also provided at the navigator's window and the window behind the engineer's station. The pilots' sliding windows are equipped with curtains that can be manually rolled up. When rolled up, they are held in place with straps; when unrolled, they are snapped in place. A special curtain is provided to shade the plexiglass area around the sextant mount. This curtain is rolled up and held in place by straps when not in use. A curtain on each side of the fuselage is provided to isolate the pilot, copilot, and engineer from the lighted navigation station during night operations. The curtains are folded against the cabin wall and held in place by straps when not in use. On 2826▶ a green plexiglass shield is provided for the boom operator's window to reduce glare from clouds and receiver airplanes.

LADDERS

There are three fixed ladders in the fuselage. One connects the lower nose compartment with the control cabin; another connects the lower forward compartment with the main compartment; and the third connects the main compartment with the lower aft compartment. There is also a curved refueling ladder. This ladder is used when servicing the A/R tanks and is stowed in the aft main compartment just forward of the boom operator's station. The ladder hooks onto the fuselage above the left wing and provides access to the A/R servicing ports.



TOILET COMPARTMENT

Figure 1–52

TOILET EQUIPMENT

There is a toilet compartment (figure 1–52) in the aft right corner of the control cabin. In the compartment there is a urinal, toilet, washwater tank, wash basin, towel disposal container, mirror, and towel and soap dispensers. At the aft end of the main compartment a curtained toilet compartment, equipped with toilet and urinal, can be installed. This toilet compartment is readily removable and can be stowed on the right side of the lower aft compartment .

WARNING

To preclude injury to personnel during ditching and crash landing, loose equipment will not be stowed in forward toilet compartment.

TABLES

Tables are installed at the navigator's and engineer's positions.

STOWAGE DRAWER

A stowage drawer is provided under the navigator's table.

ASH TRAYS

Ash trays are located at each crew station.

BOOM STOWING MIRROR

A rear view mirror is provided in the boom operator's compartment aft of the instrument panel to assist him in stowing the A/R boom.

STOWAGE CABINET

A stowage cabinet is located directly above the navigator's table. This cabinet is used for stowing the airplane G file and miscellaneous equipment.

ACCESSORY EQUIPMENT

The following accessory equipment is provided in a kit with each airplane for servicing and ground use: pitot head covers, air intake plugs, mooring eyes, wing jacking pads, turbo nozzle box clearance gages, nose gear ground lock, main gear external down locks, tow bar adapter, engine covers, engine cowl heating shields, engine accessory section heating adapter, turbo cooling cap clearance gage, fuel tank quantity gage, engine oil tank quantity gage, boom lock pin, boom nozzle cover, 1/2-inch hex socket insulated wrench, mooring and jacking point, jacking cone fitting, and a tail strut base.

AUXILIARY EQUIPMENT

The following equipment and its operation is described in AUXILIARY EQUIPMENT, Section IV.

1. Cabin Pressurizing, Heating, And Ventilating Equipment
2. Anti-Icing Systems
3. Communications And Associated Electronic Equipment
4. Lighting Equipment
5. Oxygen Equipment
6. Autopilot
7. Navigation Equipment
8. Auxiliary Power Unit
9. Single Point Refueling
10. Cargo Loading Equipment
11. Troop Carrying Equipment
12. Air Refueling

FLUID SPECIFICATIONS

FLUID	SPECIFICATION			NUMBER OF FILLER POINTS
FUEL	MILITARY SPECIFICATION AND OCTANE RATING	NATO SYMBOL	COMMERCIAL GRADE	
AVIATION GAS	RECOMMENDED MIL-G-5572, Grade 115/145	F-22	AVN GAS. 115/145	1 center wing tank 4 main fuel tanks
	FIRST ALTERNATE Grade None	None	AVN GAS. 108/135	1 single point for center wing and main tanks
	SECOND ALTERNATE MIL-G-5572, Grade 100/130	F-18	AVN GAS. 100/130	1 A/R single point 2 A/R gravity
JET ENGINE FUEL	RECOMMENDED JP-4 MIL-J-5624	F-40	Jet B	
	FIRST ALTERNATE Avn Gas MIL-G-5572	F-22 F-18	Avn Gas. 115/145 108/135 100/130	1 A/R single point 2 A/R gravity
	SECOND ALTERNATE JP-5 MIL-J-5624	F-44	Jet A-1	
ENGINE OIL	MIL-L-22851A, Type II	O-128	D-1120	4 engine oil tanks 1 central oil tank Before servicing ensure that the engines have been properly scavenged
JET ENGINE OIL	RECOMMENDED MIL-O-6081, Grade 1010	O-133	1010	2 engine oil tanks
	ALTERNATE MIL-O-6081, Grade 1005	O-132	1005	
PROPELLER OIL MIXTURE	Normal temperatures 50% MIL-O-6081, Grade 1010 50% MIL-C-6529, Type II (one part MIL-C-6529, Type I, blended with three parts MIL-L-22851A, Type II)	O-133 C-623 C-622 O-128	1010 D-1120	4
	Cold temperatures 60% hydraulic oil, MIL-H-5606 40% rust inhibitor, MIL-H-6083, Type I	H-515 C-635		
TURBO OIL	Above -9.4°C (15°F) (ground temperature) use MIL-L-22851A, Type III	O-123	D-1080	4
	Below - 9.4°C (15°F) (ground temperature) use MIL-O-6081, Grade 1010	O-133	1010	
AUXILIARY POWER UNIT OIL	MIL-L-7808 (turbine)	O-148		1 (in APU)
HYDRAULIC FLUID	MIL-H-5606 (red)	H-515		1 main hydraulic tank 1 A/R system hydraulic reservoir 1 boom system reservoir 22737 ▶ 1 forward cargo door tank
OXYGEN	MIL-O-27210, Type I, Grade A			1
WATER INJECTION	Above -50°F (-45.5°C) (ground temperature) use 40 ± 5% clean distilled water and 60 ± 5% methyl alcohol (O-M-232, Grade A) (NATO Symbol S-747) Alternate: Above - 30°F (-34.4°C) (ground temperature) use 40 ± 5% clean distilled water and 60 ± 5% ethyl alcohol (MIL-A-6091(1)) (NATO Symbol S-738) For inclusion of oil-emulsive, corrosion preventive (MIL-C-4339) use in the amount of 2/3 of 1% of the total volume NOTE Water injection system shall be drained when ambient temperatures below the recommended temperatures for the particular mixture are anticipated on the ground. If temperatures below those recommended are likely to be encountered in flight, drain the system or consume the entire amount on takeoff and initial climb.			2

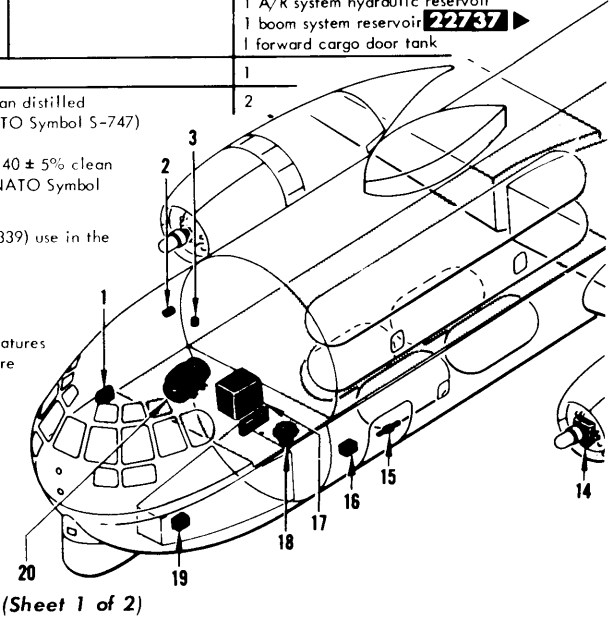


Figure 1–53 (Sheet 1 of 2)

SERVICING

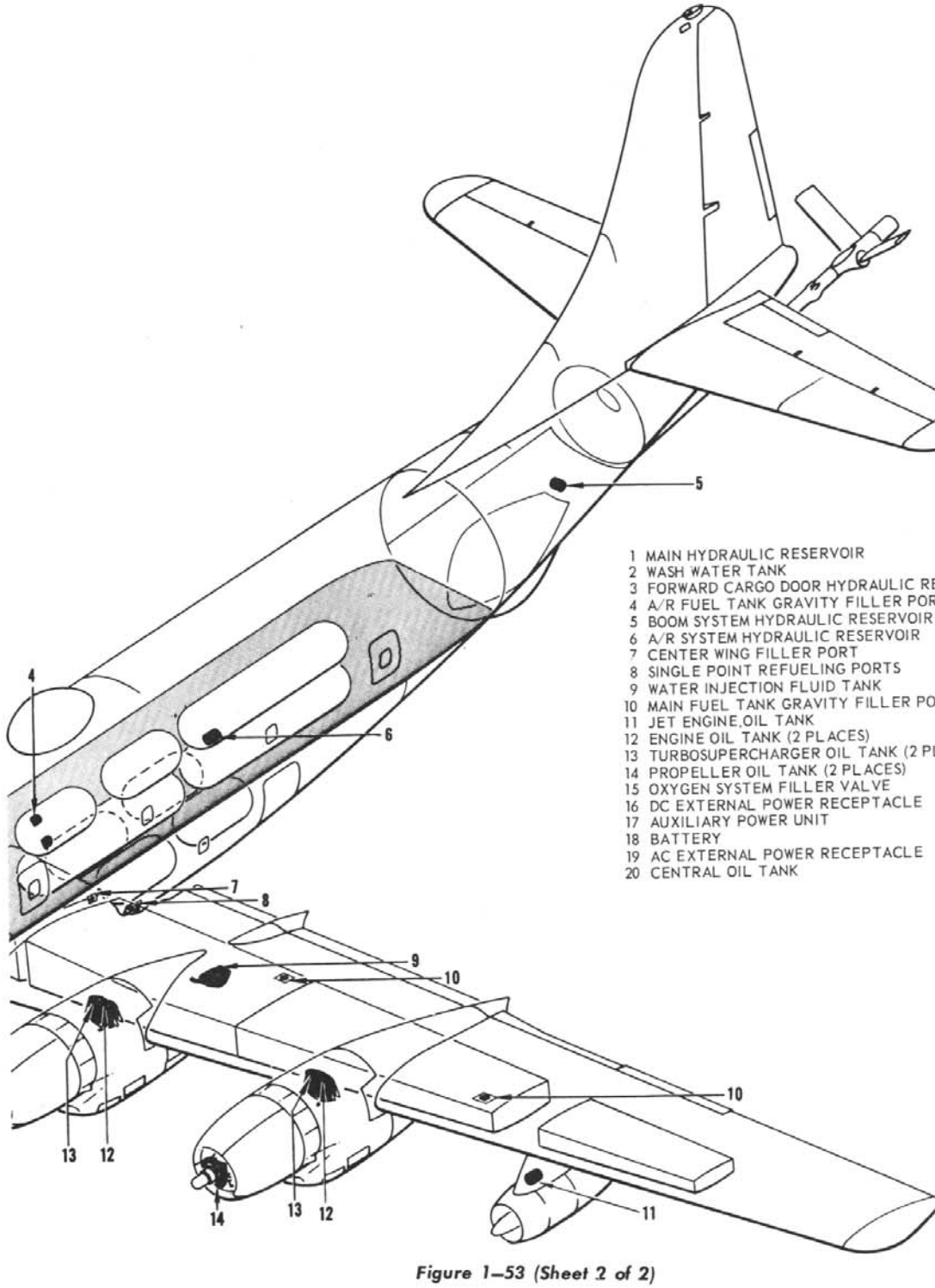


Figure 1–53 (Sheet 2 of 2)

SECTION II
NORMAL PROCEDURES

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SCOPE

Procedures outlined in this section were designed for world-wide operation. For expanded information on operation of the airplane under all weather conditions, refer to Section IX. These procedures and sequences of events will suffice for any type of climatic condition at the time of mission. When the word Climatic is used in the action column, only that action which pertains to the existing weather should be followed. In general, the purpose of this section is to establish a proper sequence of events and to set forth those procedures and techniques which must be performed in a prescribed manner during a complete flight under normal conditions. The sequence begins when the flight crew arrives at the airplane and does not end until the crew has completed its postflight duties. This provides a comprehensive picture of the requirements of a typical mission.

Note

- This section contains text and the pilots' and engineer's amplified checklists. The text is divided into primary paragraphs which form the phases of a normal flight. Each of these paragraphs is usually followed by an amplified checklist for the particular phase of flight. The amplified checklist is presented in a chronological form that will enable the flight crew to complete their inspection, checks, and operation of the airplane in an expedient, yet thorough, manner. The amplified checklist describes in detail the steps to be completed and is divided into major parts throughout this section.
- The abbreviated checklists, published as separate technical orders, are to serve only as a reminder. The checklists are numbered the same as the amplified and repeat the amplified step in condensed form. To show which of the crew is to accomplish each step, code letters appear after the response as follows: (P) Pilot, (CP) Copilot, (N) Navigator, (E) Engineer, (BO) Boom Operator, (GC) Ground Crewman, and (ALL) All Crewmembers. The amplified checklist explains the condensed checklist to be used during airplane operation. A circle around a number denotes that coordination is required between crewmembers or between crewmembers and ground crewman.
- The code G appears in this Section to provide for flight crew standardization. It identifies checklist items peculiar to C-97G airplanes assigned for support of air refueling operations.

To avoid undue complication of this section, it will include only normal procedures applicable to the pilot, copilot, and engineer. Procedures for other crewmembers will be given only when coordination is required to properly execute a particular function. For specific duties of other crewmembers, refer to Sections IV and VIII. The following action will be required in complying with the response portion of the pilots' preflight inspection checklists.

Condition – A visual check only is required.

Security – A physical check is required.

Checked – An operational check is required.

CREW ASSEMBLY

Note

- The ground crew will be at the airplane at the time of the flight crew's arrival to answer questions as to the status of the airplane and its systems. Certification of the maintenance preflight inspection completion will be made prior to review of the Form 781 by the pilot. The "exceptional release", if not accomplished, should be completed after the Form 781 is reviewed. The ground crew will have all dust covers and plugs removed and heater access cavity doors open.
- Upon arrival at the airplane, crewmembers will load and stow all personal and professional equipment. The boom operator will stow the spare parachute(s). The pilot will review the Form 781 with the ground crew and then assemble the crew. Any preflight discrepancies or irregularities should be reported to the pilot immediately in order to preclude unnecessary delays.

1. Assemble Crew – ASSEMBLED. (P)

   Pilot will verify that all crewmembers are present.

2. Form 781 – READ (AS APPLICABLE). (P)

   Read discrepancies pertinent to the various crew positions.

3. Mission And Weather Briefing – COMPLETE. (P)

   The pilot will brief the crew on any mission changes that have developed since the general briefing.

4. Instructions And Questions – CLEARED. (P)
5. Starting Engines Time – ANNOUNCED. (P)
6. Preflight – INITIATED. (P)

   Instruct the crew to initiate preflight inspection.

VISUAL INSPECTION

The visual inspection procedures outlined in this section are predicated on the assumption that maintenance personnel have completed all the requirements for preflight and postflight; therefore, duplicate inspection and operational checks of systems by crewmembers have been eliminated, except for certain items required in the interest of flying safety. To afford maintenance personnel full opportunity to perform the required maintenance, postflight and preflight inspection, and to develop sound practices, close adherence to the typical time schedule is recommended.

During thru flights, when all engines are shut down and there is no change in the basic crew, only the checklist items preceded by an asterisk (*) must be accomplished before takeoff. Other checklist items may be accomplished at the pilot's discretion.

PROCEDURES AND TECHNIQUES

The procedures and techniques described herein are mandatory and must be performed in the prescribed manner, except where deviations are required in the interest of flying safety.

PREPARATION FOR FLIGHT

FLIGHT RESTRICTIONS

Refer to OPERATING LIMITATIONS, Section V, for flight restrictions and operating limitations.

FLIGHT PLANNING

Determine the required fuel load, airspeeds, power settings, etc, for the complete mission, using the operating data contained in T. O. 1C-97(K)L-1-1. Refer to Sections IV and VIII and Major Air Command Directives for additional flight planning requirements.

TYPICAL TIME SCHEDULE

1. Crew Assembly..... 1:10 Before Takeoff Time.
2. Starting Engines Time..... Engine start will be timed to have all reciprocating engines started 35 minutes before takeoff time. Jet engines will normally be started 10 minutes prior to takeoff.
3. Taxi..... As applicable in accordance with operating limitations.
4. Takeoff..... On Time.

Note

Dependent upon local or climatic conditions, unit commanders may, in some instances, find it necessary to deviate from the above time schedule.

TAKEOFF AND LANDING DATA CARDS

The takeoff and landing data cards to be used by the pilots during takeoff and landing will be completed by the engineer. The cards will be completed prior to arrival at the airplane for preflight. The engineer will compute the data from information contained in Part 10 of T. O. 1C-97(K)L-1-1. Both takeoff and landing data will be completed before each flight for use in the event of an emergency landing shortly after takeoff. Landing data otherwise may be completed at any time that landing conditions and time are known.

WEIGHT AND BALANCE

The Weight and Balance Clearance Form 365F will be completed by the boom operator. The pilot will obtain the completed Form 365F and check the takeoff and anticipated landing gross weights before flight, as well as the location of the center of gravity. The pilot will ascertain that a check of the loading of the required fuel and payload has been accomplished. Refer to OPERATING LIMITATIONS, Section V, and T. O. 1-1B-40, Manual of Weight and Balance, as supplemented by the weight and balance computer, for weight and loading information.

WARNING

Do not attempt a takeoff or landing unless the weight and balance of the airplane are within the operating limits.

ENTRANCE INSTRUCTIONS

Entrance into the airplane is gained through a door on the left side of the lower forward compartment or through a door on the left side of the lower aft compartment. A ladder adjacent to the forward entry door provides access to the main compartment through a hatch in the floor. The control cabin is entered through the forward bulkhead door in the main compartment.

PREFLIGHT

PILOTS' PREFLIGHT INSPECTION

The pilot is responsible for the safe operation of the airplane, safety of the crew, and the efficient accomplishment of the assigned mission. Each member of the crew has received a thorough course of technical training pertinent to his particular specialty; therefore, certain duties concerning the preflight inspection should be delegated to each crewmember. These duties, when so assigned, are performed under the pilot's supervision. Normally, the pilot will accomplish the exterior and the interior preflight checks.

Note

The pilot and copilot begin the interior inspection check of the control cabin. The copilot will complete the radio preflight inspection and then assist the pilot with the remainder of the preflight inspection, if required. This sequence of events allows the engineer sufficient time to pressurize the main fuel manifold and jet engine fuel supply lines for subsequent inspection by the pilot. At the completion of the exterior preflight inspection, the pilot will advise the engineer that the inspection is completed.

INTERIOR INSPECTION

Control Cabin

1. Oxygen Equipment Check – CHECKED AND STOWED. (P, CP)

   For oxygen system check, refer to Section IV.

* 2. Landing Gear Switch – DOWN (GUARD DOWN). (CP)

   Landing gear switch will be in DOWN position during all ground operation.

3. Heading Indicator Repeater Emergency Power Switch – NORMAL. (CP)

4. Pilot's Emergency Instrument Power and Light Switch - BATTERY, THEN NORMAL. (P)

   Place the switch in the BATTERY position, ascertain the power operation by checking that the directional gyro OFF flag disappears and applicable cockpit lights illuminate, and return the switch to NORMAL.

5. Reverse Warning Flag – DOWN. (CP)
6. APS-42 Auxiliary Indicator Controls – FULL CCW. (CP)
7. Landing Gear Emergency Retraction Switch – NORMAL AND SAFETIED. (P)

* (8.) Ready For Power – REPORT RECEIVED. (P, E)

Receive report from engineer that he is ready for power on the airplane.

* (9.) Alarm Bell – CHECK. (P, CP, E, BO, GC)

When the engineer reports, "Ready for power," the copilot, when directed by the pilot, will ring the alarm bell. The alarm bell will be checked with the battery switch in the OFF position and prior to power being applied to the airplane. The alarm bell check is the signal for the boom operator to start the APU. If external power is to be used, this is the signal for the ground crewman to plug in external power.

10. Wing Flap Warning Horn – CHECK. (P)

    Insure that wing flaps are not between 22 and 44 percent, advance two opposite throttles, and check that the warning horn sounds.

CAUTION

Do not extend or retract the wing flaps without clearance from the ground crewman.

11. Trim Control Wheels – FREE MOVEMENT AND NEUTRAL. (P, CP)

* 12. Radios – ON. (P, CP)

Turn on all radio equipment to allow warmup for subsequent operational check.

Control Cabin (Cont)

* 13. Landing Gear Indicator And Warning Light – CHECK. (P)

14. FLIP Documents – COMPLETE AND CURRENT. (P, CP)

a. Enroute Charts.

b. Enroute Supplements.

c. Terminal Charts.

(15.) Fuel Manifolds – PRESSURIZED. (P, E)

Prior to departing control cabin for exterior inspection, insure that fuel manifolds are pressurized.

EXTERIOR INSPECTION

WARNING

Location of AIMS system pitot-static tubes is extremely dangerous to personnel departing the aircraft as they are located at eye level height. Care must be taken to insure personnel have enough clearance from the fuselage, before moving toward rear of the aircraft on the left side.

Note

Perform exterior inspection in sequence shown in figure 2–1.

Forward Fuselage And Nose Section

* 1. Left pitot and pitot static tubes - COVERS REMOVED, TUBES UNOBSTRUCTED (P)

* 2. Right pitot and pitot static tubes - COVERS REMOVED, TUBES UNOBSTRUCTED (P)

Right Wing Section

* 1. Lower Wing Surface – CONDITION. (P)

Starting at the wing tip, check the entire lower wing surface for fuel leaks while progressing inboard to the fuselage.

* 2. Jet Engine – CONDITION. (P)

Check that engine is clear of foreign objects and for security of accessory dome.

3. No. 4 Nacelle Heater Cavity – CONDITION. (P)

With heater cavity doors open, check heater cavity for general condition and fuel, oil, and hydraulic leaks. Check that heater outlet plug is installed securely and engine preheat switch is OFF.

4. Nacelle Heater Cavity Doors - CLOSED AND LATCHES SECURED. (P-GC)

5. Wing Flap Well – CONDITION. (P)

With wing flaps full down, check fuel valves and fuel and hydraulic lines for leaks. Check wiring and bonding for condition.

Rear Fuselage And Empennage Section

* 1. Rear Fuselage And Empennage – CONDITION. (P)

Left Wing Section

Note

For split preflight method, copilot starts at this point. (See figure 2–1.)

1. Wing Flap Well – CONDITION. (P OR CP)

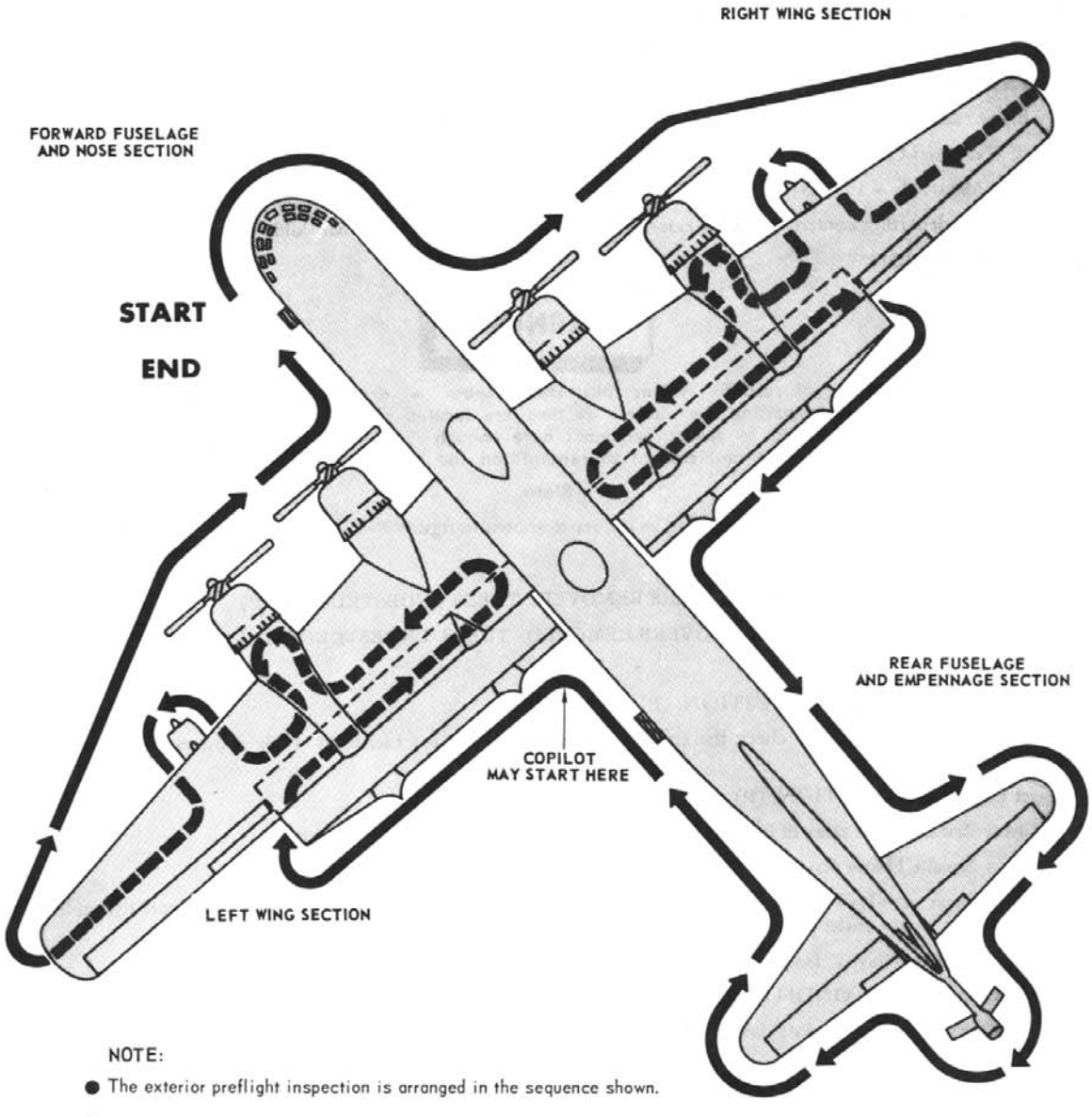
With wing flaps full down, check fuel valves and fuel and hydraulic lines for leaks. Check wiring and bonding for condition.

2. SPR Caps – SECURITY. (P OR CP)

Check that single point refueling port caps are installed securely.

* 3. Lower Wing Surface – CONDITION. (P OR CP)

Starting at the fuselage, check the entire lower wing surface for fuel leaks while progressing outboard to the wing tip.



NOTE:

- The exterior preflight inspection is arranged in the sequence shown.
- In order to expedite completion of this inspection, a split method may be used. Starting at the LEFT WING SECTION, the copilot may complete this portion ending at the lower forward entrance door.
- If snow, ice, or frost prevails, refer to ALL WEATHER OPERATION, Section IX.

THE EXTERIOR INSPECTION

Figure 2–1

EXTERIOR INSPECTION (Cont)

4. No. 1 Nacelle Heater Cavity – CONDITION. (P OR CP)

   With heater cavity doors open, check heater cavity for general condition and fuel, oil, and hydraulic leaks. Check that heater outlet plug is installed securely and engine preheat switch is OFF.

5. Nacelle Heater Cavity Doors - CLOSED AND LATCHES SECURED. (P-CP-GC)

* 6. Jet Engine – CONDITION. (P)

   Check that engine is free of foreign objects and for security of accessory dome.

* (7.) Ground Locks – REMOVED AND STOWED. (P, CP, GC)

   Direct ground crew to remove ground locks and stow.

(8.) Exterior Inspection – COMPLETED. (P OR CP, E)

   Notify engineer that Exterior Inspection is complete.

INTERIOR INSPECTION – POWER ON (To be accomplished by copilot)

1. Radio Compass – CHECK.

   Check reception, nulls, and ADF bearing pointer for proper indication. Leave tuned to desired station.

2. VOR Receiver:

   a. Instrument Select Switch – VOR-ILS.

   b. Local Station – TUNE.

   c. VOR Bearing Pointer – CHECK FOR CORRECT INDICATION.

   d. Pilot's Course Indicator – CHECK.

      Set the bearing indicated by the VOR bearing pointer in the course selector window. Check that the course deviation indicator centers and the TO/FROM indicator reads TO. Set the radial indicated by the tail of the VOR bearing pointer in the course selector window. Check that course deviation indicator centers and the TO/FROM indicator reads FROM.

3. TACAN:

   a. Instrument Select Switch – TACAN.

   b. Local Station – TUNE.

   c. TACAN Bearing Pointer – CHECK FOR CORRECT INDICATION.

   d. Range Indicator – CHECK.

   e. Pilot's Course Indicator – CHECK.

      Set the bearing indicated by the TACAN bearing pointer in the course selector window. Check that the course deviation indicator centers and the TO/FROM indicator reads TO. Set the radial indicated by the tail of the TACAN bearing pointer in the course selector window. Check that the course deviation indicator centers and the TO/FROM indicator reads FROM.

4. VHF Radio – CHECK.

   Check operation of VHF radio. Leave tuned to desired frequency.

5. UHF Radio – CHECK.

   Check operation of transmitter and receiver. Leave tuned to desired frequency.

   Note

   No transmission will be made on emergency (distress) frequency channels except for emergency purposes.

6. Liaison Radio (ARC-65):

   a. Channelization Card – CHECK (IF APPLICABLE).

      Check channelization card against required frequencies outlined in current directives. Any rechannelization required should be made as time permits.

INTERIOR INSPECTION – POWER ON (Cont)

b. Operation – CHECK.

c. Time Signal – TUNE (IF REQUIRED).

Tune time signal and leave on for navigator time hack, if required.

7. IFF Antenna Switch - BOTH. (CP)

* 8. IFF/SIF – STDBY.

ENGINEER'S PREFLIGHT INSPECTION

INTERIOR INSPECTION

Control Cabin – Power Off

1. Cabin Pressure Relief And Release Valves – CLOSED.
2. Oxygen Equipment – CHECK AND STOW.

   For oxygen system check, refer to Section IV.

* 3. Circuit Breakers:

   a. Jet Engine Starter Circuit Breakers – OUT.

   b. All Other Circuit Breakers – IN.

4. All Switches – OFF OR NORMAL.

(5.) Report To Pilot – "READY FOR POWER." (E, P)

Control Cabin – Power On

* 1. Electrical Master And Battery Switches – AS REQUIRED.

   If the APU is to be used for preflight, turn the electrical master switch ON and the battery switch to ON BUS. If external power is to be used, turn the electrical master switch ON and leave the battery switch OFF.

* 2. External Power Or APU – STARTED AND ON THE LINE.

* 3. Bus Voltage – CHECKED.

   Check bus boltage to insure 28 volts before any operational checks are started.

* 4. Inverters (Essential, Secondary, And Autopilot) – ON.

   Place essential, secondary, and autopilot inverter switches on the normal switch positions, checking voltage and frequency at each. Report on interphone, "Inverters on."

* 5. SPR Test – VALVES CLOSED.

   Check that secondary valves are closed by moving SPR test switch to each tank position; check that valve closed light illuminated at each position. Return switch to OFF.

6. Fire Detection System – CHECK.

   Advise pilot, "Checking fire detection."

   Pull fire warning test circuit breaker while actuating number 3 test circuit to check the APU fire warning light, then reset circuit breaker.

(7.) Normal Fuel System:

Perform carburetor pressure check on all engines as follows:

a. Fuel Selector Switches – TE.

Control Cabin – Power On (Cont)

b. Main Wing Tanks Boost Pump Switches - NORMAL (NOTE FUEL PRESSURE RISE).

c. Fuel Selector Switches - OFF.

d. Boost Pump Switches - OFF (PRESSURE HOLDS 10 to 14 PSI APPROXIMATELY 10 SECONDS).

e. Fuel Selector Switches - TE.

f. Main Wing Tanks Boost Pump Switches - CHECKED.

Check each boost pump individually on NORMAL. Allow fuel pressure to stabilize, then move one pump per tank to EMERGENCY. Check that fuel low-pressure warning lights go out. Turn boost pumps from EMERGENCY to OFF. Note that fuel low-pressure warning lights come on at 22 to 20 psi. Turn remaining boost pumps to EMERGENCY. Note fuel pressure. Turn all boost pumps OFF.

g. Fuel Selector Switches - TME.

h. CWT Boost Pumps - CHECKED (IF REQUIRED).

Check each boost pump on NORMAL. Then check each boost pump on EMERGENCY. Notice fuel pressure rise on all reciprocating engine fuel pressure gages.

i. Boost Pump Switches – ON (APPLICABLE ENGINES). (E, P, CP, BO)

Turn all boost pump switches to NORMAL, then one to EMERGENCY. Leave in this position for pilot's and boom operator's fuel checks of the fuel system.

j. Leveling Valve - OPEN (FORWARD OR AFT) (IF DECK FUEL IS CARRIED).

k. Jet Engine Fuel Selector Switches - AS REQUIRED.

l. Sump Tank Boost Pump Switches - ON (IF DECK FUEL IS CARRIED). Notify Pilot.

CAUTION

To prevent overheating, do not operate sump tank boost pumps with no-flow condition longer than 10 minutes.

8. Instruments – CONDITION.

Check power on indication of all instruments. Check A1 and B1 cylinder head temperature with cylinder head temperature selector switch. Record manifold pressure gage readings for reference during engine runup.

9. A/R Panel – CHECKED.

a. A/R Master Switch – ON.

b. Push-To-Test Lights – CHECKED.

c. A/R Fuel Quantity – CHECKED.

A/R fuel level as required, and record fuel quantities on engineer's log.

10. Isodraulic System - CHECK.

Check isodraulic handle for correct synchronization. Insure slave unit full CLOSE with isodraulic handle at ZERO. Check isodraulic handle for cushion at ZERO.

Isodraulic Sync Procedure (if required)

To obtain full travel and positive off, complete the following steps:

Control Cabin – Power On (Cont)

a. Open synchronization valve.

b. Advance handle to 5.

c. While retarding handle to ZERO, close the synchronization valve (finger-tight) to obtain about 1/2 inch cushion.

11. All Fuel and Oil Quantities - CHECKED.

Determine all fuel and oil quantities, and enter on the engineer's log at this time.

* 12. Takeoff and Landing Data Cards - CHECK.

* (13.) All Switches - AS REQUIRED. (ALL)

Essential, secondary and autopilot inverter switches on.

* (14.) External Power/APU — STARTED AND ON LINE, VOLTAGE CHECKED. (E, BO, OR GC)

Engineer will signal boom operator to start APU. After APU is on the line, direct ground crewman to disconnect and remove external power unit.

BEFORE STARTING ENGINES

PILOTS

Note

From this point on through the Engine Shutdown checklist, all checklists will be announced on interphone except the LANDING checklist. Items that appear on the amplified checklist in quotation marks require interphone communication, except between the pilot and copilot. Except where otherwise indicated, the pilot will take the necessary action and make the correct response.

G 1. No Smoking and Seat Belt Lights - "ON" (CP)

* 2. Lights – AS REQUIRED. (P, CP)
Turn rotating beacon ON and navigation lights on BRIGHT and STEADY. Turn on remaining exterior lights and interior lights as required.

* 3. Nose Steering Disconnect Button – ENGAGE. (P)

Depress nose wheel steering emergency disconnect button, check, and return to engage.

* 4. Reverse Lock Plate – OPENED. (CP)

Leave reverse lock plate open for all ground operation. This will permit reversal of propellers in the event of brake malfunction and will also make reversing available while taxiing on ice or slick surfaces.

* 5. Depressurization And Emergency Charging Valve Handle – NORMAL. (CP)

ENGINEER

* 1. Electrical Master And Battery Switches – AS REQUIRED.

If the APU is to be used, turn the electrical master switch ON and the battery switch to ON BUS. If external power is to be used, turn the electrical master switch ON and leave the battery switch OFF.

* 2. Essential Inverter Switch – ESS INV.

Check voltage and frequency.

3. Cowl Flap Switches – AS REQUIRED.

Open cowl flaps, except during cold weather when they will be left in the position set.

* 4. Throttles – CRACKED.

Throttles cracked (approximately 1 inch for 1000 rpm).

5. Prop. Sync Lever – FULL INCREASE RPM.

6. TBS Lever – 0.

PILOTS

* (6.) Wing Flaps – UP. (P, CP, GC)

  Pilot checks with ground crewman that wing flaps are clear of obstructions and directs copilot to move wing flap switch to UP.

* 7. Form 781 And TOLD Card – CHECKED. (P)

  Insure Form 781 is aboard and TOLD card is available for reference.

* (8.) Engineer Report – RECEIVED. (P, E)

ENGINEER

7. Turbo Switches – AUTO.
8. Turbo Override Switches – OPEN, GUARDS DOWN.
9. Prop. Governor Selector Switches – FULL INCREASE RPM (LIGHTS ON).
* 10. Prop. Auto Control Switch – NO. 1 MASTER.
* (11.) Report To Pilot – "BEFORE STARTING ENGINES CHECKLIST COMPLETE." (E, P)

STARTING ENGINES

PILOTS

* 1. Parking Brakes – SET. (P, CP)

  Copilot checks hydraulic pressure in service brake system. If pressure is below 320 psi, operate the handpump until pressure reaches 320 psi, to insure parking brakes being set. Check that the essential inverter warning light is not illuminated.

* 2. Radio Call - COMPLETED. (CP)

  Copilot contacts tower/command post and advises airplane location starting engines.

ENGINEER

* 1. Boost Pump Switches (One Per Main Tank) – NORMAL.
* 2. Engine Starting Selector Switch – NO. 3.

STARTING ENGINES (Cont)

PILOTS

* (3.) Start Engines – DIRECT ENGINEER TO START ENGINES. (P, CP, E)

If a ground crewman is not available, the copilot will check and state over interphone, "No. 3 and No. 4 clear; clear to start No. 3." The engineer will state over interphone, "Turning No. 3," and continue with the starting engines procedure. The copilot will count 1 thru 20 blades for No. 3 and No. 4 engines over interphone and report if fuel starts to run out of the blower drain. The pilot will repeat the above procedures for starting No. 2 and No. 1 engines.

* 4. Hydraulic Pressures – CHECKED. (P, CP)

With No. 3 engine running, copilot checks No. 3 hydraulic pump by observing rise in pressure. Turn the depressurization and emergency charging valve to EMERGENCY BRAKE CHARGING, check emergency pressure, return to NORMAL, and report to pilot, "Hydraulic pressures normal."

5 Jet Engines - START (If applicable)

If jet engines are started at this point, refer to JET ENGINE GROUND START checklist.

* (6.) Ground Crewman - DISMISS. (P, GC)

Pilot calls ground crewman and states, "Ground crewman, this is pilot; remove external power unit and chocks. I will taxi after a visual signal from you. You are clear to disconnect interphone."

7. Manifold Pressure Lines – PURGE (30 SECONDS). (P, CP)

* (8.) Instruments – SET AND UNCAGED. (P, CP, N, E)

Check that instrument inverter warning light is not illuminated. Pilot and copilot will reset and uncage all flight instruments, check N-1 compass synchronized, crosscheck standby compass, and cage and uncage attitude indicators.

ENGINEER

* (3.) Engines – START. (E, P, CP, GC)

NORMAL Engine Start

When pilot directs that engines be started, the engineer will contact ground crewman on interphone and state, "Ground crewman, this is engineer; ready to start No. 3." Ground crewman replies, "Chocks in place, ground locks and pitot covers removed, all propellers clear, fire guard standing by on No. 3." Press starter switch. After 20 blades, place ignition switch to BOTH and turn on ignition boost and prime. The ground crewman will count 20 blades on interphone and report if fuel starts to run out of the blower drain.

CAUTION

Do not prime engine before engaging starter. To prevent hydraulic lock, avoid every possibility of liquid fuel collecting in the intake pipes or cylinders.

NOTE

- All normal starts will be made on prime. Refer to SYSTEMS OPERATION, Section VII, for starting procedures.
- Eight blades are sufficient for engine start made within 1 hour of last shutdown, as engine is still lubricated; 20 blades will be used for engine starts made after a 1-hour engine shutdown.

* 4. Oil Pressure – CHECKED.

Check for an oil pressure indication immediately and at least 50 psi within 30 seconds or shut down engine. Announce over interphone, "Oil pressure No.__."

* 5. Mixture Lever – AUTO RICH, RELEASE PRIMER.

After engine rpm has stabilized at 1000 rpm on primer and throttle, bring mixture lever slowly to AUTO RICH position and when 100 rpm drop is noticed, release primer.

CAUTION

Be ready to return mixture lever to FUEL CUT-OFF at first sign of failure to continue running. Continue cranking. If engine does not start within 1 minute from time of engaging, stop cranking and allow starter to cool for at least 1 minute before repeating starting procedure. If engine fails to start after second attempt, check engine completely and prepare for new start.

PILOTS

7. Manifold Pressure Lines – PURGE (30 SECONDS). (P, CP)

* (8.) Instruments – SET AND UNCAGED. (P, CP, N, E)

Check that instrument inverter warning light is not illuminated. Pilot and copilot will reset and uncage all flight instruments, check N-1 compass synchronized, crosscheck standby compass, and cage and uncage attitude indicators.

* 9. Door Warning Light – OFF. (CP)

* 10. Tower Call – COMPLETED. (P,CP)

Request taxi and takeoff information.

* (11.) Altimeters – SET. (P, CP, N)

Pilot, copilot and navigator will set altimeters and compare readings. Check all three pointers to assure proper readings. Pay particular attention to the position of the 10,000-foot pointer.

* (12.) Taxi Report – RECEIVED. (ALL)

Copilot sounds the alarm bell and pilot announces, "Taxi report." Crew reports in the following order: Boom operator, navigator, and engineer. The boom operator will report, "Alarm bell checked, boom operator ready." (If duties preclude reporting, the boom operator may visually signal the navigator who will also report for the boom operator.) The navigator will report, "Navigator ready." The engineer will report, "Engineer ready."

ENGINEER

* (6.) Repeat Steps 2, 3, 4, And 5 On No. 4, 2, and 1 Engines In Turn After Each Engine Is Cleared. (E, P, CP, GC)

* 7. Starter Selector Switch – OFF.

* (8.) Inverter(s) - ALL ON and CHECKED (E, P, N)

Report on interphone, "Inverters on."

* 9. All Boost Pump Switches – OFF.

* 10. Fuel Pressures – CHECKED.

Check pressures from engine-driven fuel pumps.

* 11. Battery Switch – ON BUS

Place battery switch to ON BUS after external power is removed, if used.

* 12. APU - AS REQUIRED

* (13.) Report To Pilot – "ENGINEER READY." (E, P)

CAUTION

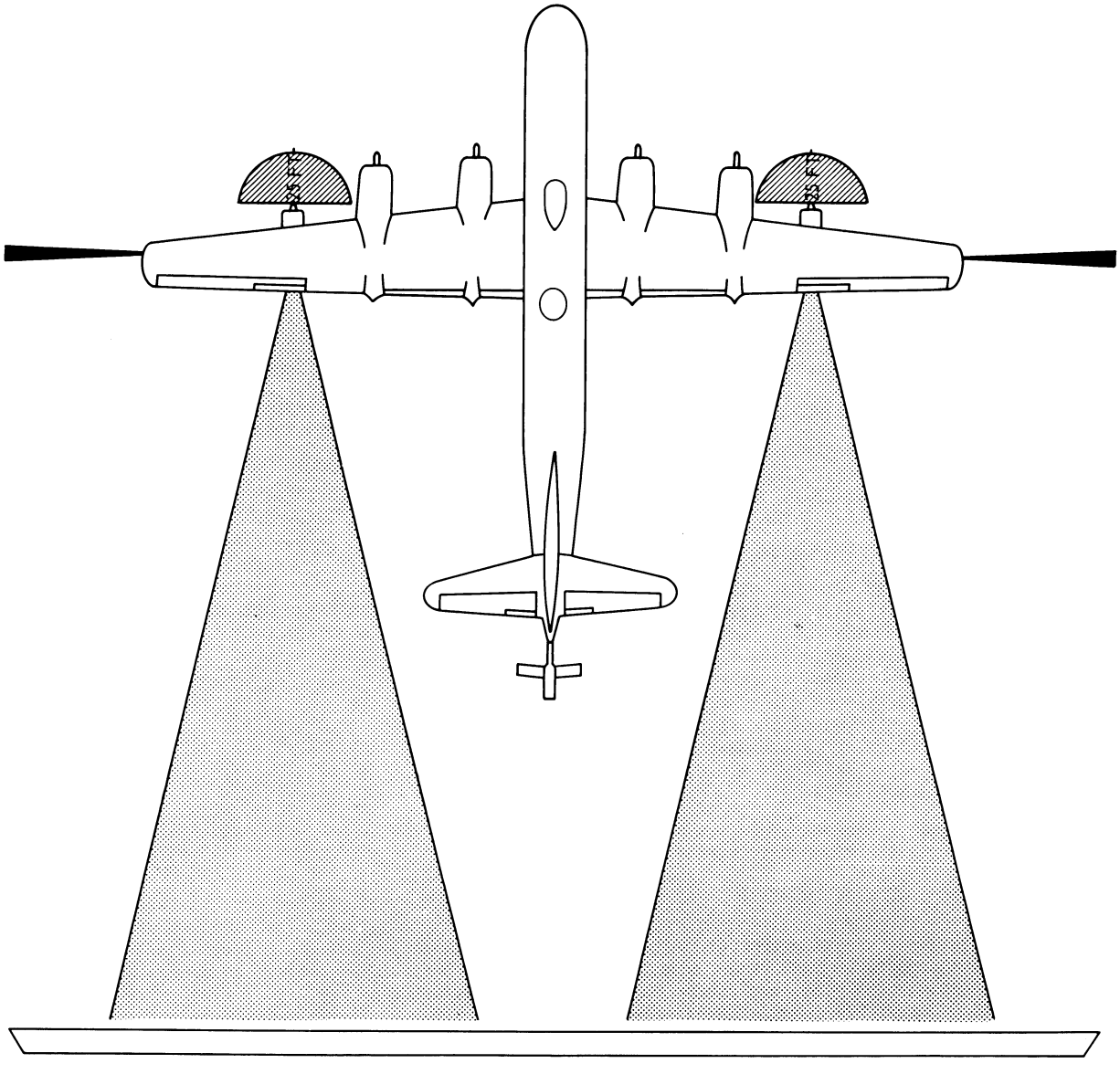
Taxi on stable engine operation; 1200 rpm will not be exceeded with oil temperature less than 40°C.

ENGINE GROUND OPERATION

The ground operation of each engine must be held to an absolute minimum. Engines shall be run only when it is necessary to perform the required checks. An engine should be shut down when possible during a prolonged check of another engine to prevent running unnecessarily. Prolonged ground running causes fouling of the spark plugs. Head the airplane into the wind during ground operation to provide better engine cooling. When it is necessary to run an engine on the ground for an extended period of time, it shall be run at field barometric pressure with the prop. sync lever in full INCREASE RPM for a period of 1 minute out of every 10 minutes. Engines must be manually leaned to produce a mixture 20 to 40 rpm leaner than best power during ground operation between minimum idle and 1200 rpm. This procedure will act to clear away the fouling deposits in the incipient stages. Manual leaning will be used when practical. When it is necessary to run an engine on the ground for extended periods, the turbosupercharger shall be operated for a period of 1 minute out of every 10 minutes. This will insure priming of the turbo oil pump and proper lubrication of the bearings during ground run windmilling. Refer to SYSTEMS OPERATION, Section VII, for the procedure to be followed for turbosupercharger operation and the procedure to be followed when spark plug fouling conditions are evident. See figure 2–2 for danger areas when operating jet engines on the ground.

CAUTION

- Running engines on ground with a 90-degree crosswind of 10 knots and over increases normal propeller blade stresses by two to three times. This will also cause engine overheat, resulting in failure of cylinder exhaust valve seats (during subsequent engine operation). Head the airplane into the wind for any ground running.
- Brakes should be used carefully and as little as possible during all ground operation. Dangerous overheating can result without any indications to the pilot.
- If any backfiring is encountered or evidenced during ground runup, the engine in question should be shut down immediately and the reason for the backfiring determined.



NOTE:
If jet blast deflector is not provided, area must be cleared for 250 feet behind airplane.

- JET INTAKE AREA
- JET BLAST AREA
- TURBINE DISINTEGRATION AREA

DISTANCE (FEET)	MPH	°F
0	1200	1000
10	800	750
20	450	400
30	340	300
40	240	225
50	180	175
60	160	150
70	130	135
80	100	125
90	70	115
100	60	100

DANGER AREAS

Figure 2–2

TAXI

CAUTION

If propeller low oil quantity warning light comes on before takeoff, cut engine and have it checked and reserviced. This should be accomplished in order to prevent possible propeller oil starvation.

NOTE

See figure 2–3 for minimum turning radius.

PILOTS

After receiving visual signal from ground crewman, release parking brake. If necessary, advance the throttles to start initial roll and check normal brake operation.

CAUTION

- Do not exceed 1200 rpm with manual lean mixture. Do not operate in restricted rpm range of 1250 to 1650 rpm, except when passing through.

- After the airplane starts rolling, retard throttles to keep engines at a low power adequate for taxiing. Use the brakes to control the speed, but do not ride the brakes. Brake action normally should be applied by the pilot. Taxi slowly. Use the steering wheel to control airplane direction, but avoid excessive movement of the nose wheel. Begin a turn with a slight change in nose wheel direction and gradually increase until desired turn is established. Use the same technique to straighten the airplane. If the airplane resists the turn and the nose wheel skips or skids, use an outboard engine to help the airplane turn. When making a sharp turn, allow the airplane to roll while turning to prevent tire damage resulting from pivoting on a locked wheel. Painted areas on runways, taxiways, and ramps are significantly more slippery than nonpainted areas. In addition, painted areas sometimes serve as condensation surfaces and it is possible to have wet, frosty, or even icy conditions on painted areas when the overall weather condition is dry.

- Thrust reversal will not be used to back the airplane, except in emergencies.

- In the event an engine stops during taxiing, the engine should not be restarted until a fire guard is posted, except in emergencies.

- When painted areas are wet, the braking condition may deteriorate to the extent that the RCR is near to that for an icy condition.

ENGINEER

* 1. Analyzer Power Switch - ON.

* 2. Air Conditioning - ON

* 3. Cabin Pressure Rate-Of-Change Selector - MAX.

* 4. Cabin Altitude Selector - SET.

* 5. Alternator Control Switches and Bus Selector ON.

* 6. Carburetor Air Switches – CLIMATIC.

Refer to ALL WEATHER OPERATION, Section IX.

* 7. Intercooler Flap Switches – CLIMATIC.

The intercooler flap switches are normally CLOSED. Refer to Sections VII and IX for operation.

* 8. Carburetor Preheat Valve Switches – CLOSED, THEN OFF.

* 9. Cowl Flap Switches – CLIMATIC.

* 10. Oil Cooler Flap Switches – CLIMATIC

Refer to ALL WEATHER OPERATION, Section IX.

* 11. Boost Pump Switches (Main Tanks) - NORMAL.

Turn boost pumps in each tank on NORMAL, CWT boost pumps as required, and CWT line valve as required.

NOTE

It is permissible to take off with one boost pump in a wing tank inoperative, provided at least 1200 pounds (200 gallons) of fuel is carried in that tank.

* 12. Fuel Selector Switches – TE.

Refer to FUEL SYSTEM OPERATION, Section VII.

* 13. Engineer's A/R Panel – OPERATING POSITION.

a. A/R Hydraulic Pressure – CHECK.

TAXI (Cont)

PILOTS

* 1. Normal Brakes – CHECKED. (P, CP)

As soon as the airplane begins to roll, the pilot will check normal braking action; the copilot will monitor hydraulic pressures during all taxi operations and notify the pilot of any abnormal indications.

* 2. Emergency Brakes – CHECKED, SYSTEM RECHARGED. (P, CP)

When the airplane is clear of congested parking areas and prior to reaching normal taxi speed, the pilot will announce, "Emergency brake check," over interphone, check the emergency brakes, and then direct the copilot to recharge the emergency brake system.

* 3. Instruments - CHECKED. (P, CP)

Check turn and slip indicators and heading indicators for correct movement. Check airspeed and vertical velocity indicators for correct reading.

* (4.) Engineer's Report - RECEIVE. (P, E)

ENGINEER

* 14. If Deck Fuel Is Carried:

a. A/R Panel Master Switch – ON.

b. Fuel Dump Switches Cover – OPEN.

c. Isodraulic Handle Strap - RELEASED

d. A/R System Fuel Level – CHECKED.

15. Oil Transfer System – AS REQUIRED.

Transfer 1 gallon of oil to each tank, using both the central and engine oil tank quantity gages as a reference.

* (16.) Report To Pilot – "TAXI CHECKLIST COMPLETE." (E, P)

AIRPLANE BACKING USING REVERSE THRUST

The use of reverse thrust for backing shall be restricted to isolated occasions dictated by an emergency or an absolute operational necessity. If required, the following procedure will be used:

CAUTION

Insure that maneuvering area is clear of obstructions and free of debris which could damage the propellers. Brief the taxi signalman on path and distance to be traversed.

a. Unlock controls, taxi slowly and anticipate stopping so that forward thrust can be used for braking action.

b. Assure that forward thrust is available by taxiing with reverse thrust on inboard engines only, on lightly loaded airplanes.

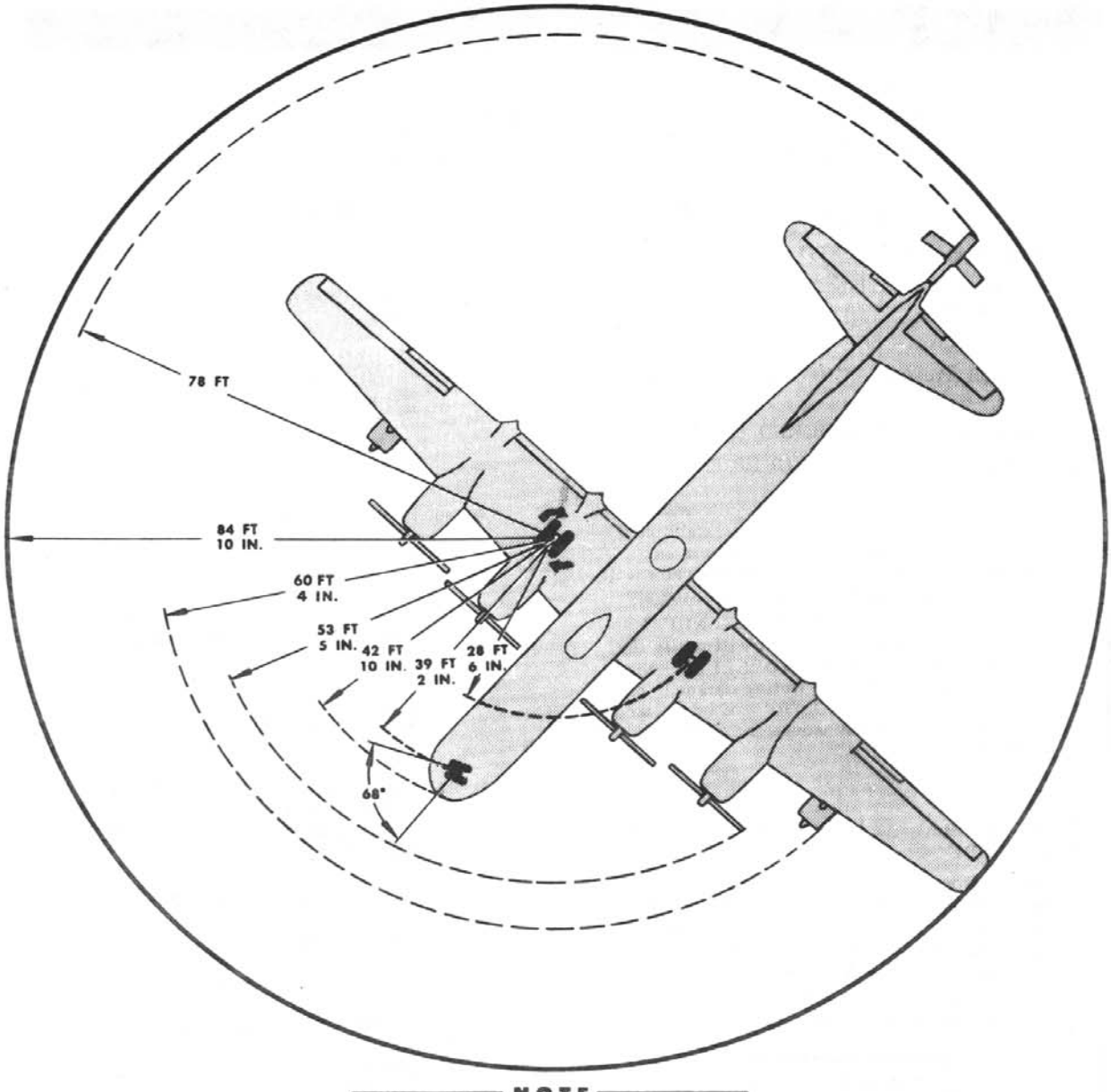
c. If necessary, use all four propellers in reverse thrust to initiate backing. Return outboards to forward thrust after airplane is in motion and maintain rearward motion with inboards.

d. Use forward thrust as primary means of stopping.

CAUTION

Use of brakes while backing is not recommended. The possibility of setting the airplane on its tail exists if excessive braking is applied.

e. Check forward thrust after backing is completed.



NOTE

AVERAGE GROUND CLEARANCE

INBOARD PROPELLERS	1 FT 5 IN.
OUTBOARD PROPELLERS	2 FT 7 IN.
JET ENGINES	4 FT
FUSELAGE	2 FT 9 IN.

MINIMUM TURNING RADIUS (TYPICAL)

Figure 2–3

ENGINE RUNUP

NOTE

An abbreviated engine runup, incorporating only those items deemed necessary by the pilot, is permissible when an airplane is being flown on multilanding flights and by the same crew who performed the initial runup.

PILOTS

1. Nose Wheel – CENTERED. (P)

   Park the airplane with nose into the wind and center nose wheel.

2. Parking Brakes – SET. (P)
3. Hydraulic Pressure – CHECKED NORMAL. (CP)
4. Flight Controls – UNLOCKED. (P, CP)
5. Runup Report – RECEIVE. (P, CP, E, BO)

   Prior to beginning runup, the copilot will select and report visual reference point established and check continually during runup for any movement of the airplane. Boom operator will visually clear the area to the rear of the airplane and report, "CLEAR FOR RUNUP." When ready for runup, the pilot will notify the engineer, "CLEAR FOR PROPELLER AND ENGINE OPERATION." During darkness or poor visibility, exterior lights will be utilized to aid in detecting any movement of the airplane.

6. Propeller Reversal and Feathering - CHECKED. (P, E, CP)

   After engineer reports, "Ready to reverse," the pilot will place all four throttles in reverse idle thrust. All four engines will be stabilized at 1000 rpm. The pilot will then call (over interphone), "Checking No. 1," and depress the feathering button. The engineer will report, "Load". The pilot will note a rise in rpm.

CAUTION

If engineer reports, "no load is indicated," during reversal and feathering check, the auxiliary oil pump is inoperative and propeller will not fully feather in flight.

NOTE

If a decrease in rpm is noted when the feathering button is depressed, it indicates that the propeller did not reverse.

ENGINEER

1. Mixture Levers - AUTO RICH.
2. Magneto Grounding (800 To 1000 RPM) - L, R, OFF, BOTH.
3. Propeller Operational Check

   Accomplish after pilot notifies "Clear for propeller and engine operation."

   a. Propeller Holding Relay - CHECK.

      (1) Governor Selector Switches (Four) - DECREASE RPM FOR APPROXIMATELY 4 SECONDS.

      Check that all rpm limit lights are out. Wait approximately 5 seconds before retarding prop sync lever.

      (2) Prop. Sync Lever - TOWARD DECREASE RPM APPROXIMATELY 2 INCHES, THEN ADVANCE TO FULL INCREASE.

      Check that all rpm limit lights are on.

   b. Reversal - CHECK. (E, P)

      (1) Throttles - 1000 RPM.

      (2) Report - READY TO REVERSE. (E, P)

      (3) Check loadmeters for load indication and report "LOAD," when feathering button is depressed.

   c. Propeller Feathering - CHECK. (E, P)

      (1) Throttles - 1200 RPM.

      (2) Report - READY FOR FEATHERING CHECK.

      (3) Check loadmeters for load indication and report "LOAD," when feathering button is depressed.

PILOTS

This check will be completed on all four engines. After all four propellers have been checked, the pilot will move the throttles to forward thrust idle position, and call (over interphone), "Engineer's throttles".

CAUTION

If a propeller sticks in reverse thrust, immediately have engineer cut the engine and investigate.

Upon completion of the reversal check, the engineer will set rpm on all engines at 1200. Adjust throttle friction brake. The pilot will check feathering action. Starting with No. 1 engine, depress the feathering button until a 200 rpm drop is noted and then return feathering button to neutral. An initial rpm decrease is a positive indication that the propeller has returned to forward thrust. During the feathering check of No. 1 engine only, the copilot will check that all propeller limit lights remain on. This is to check that the propeller holding relay is functioning properly. As each feathering button is depressed, the engineer will report load indication on the respective loadmeter, and the pilot will state that he has observed the rpm drop.

ENGINEER

d. Manual Controls - CHECK.

(1) Throttles - 1850 RPM.

(2) Prop. Sync Lever - FULL INCREASE RPM.

(3) Auto Control Switch - ON.

(4) Governor Selector Switches - FULL DECREASE RPM.

(5) Prop. RPM Limit Lights (Four) - TACHOMETER SHOULD INDICATE 1100 ± 50 RPM.

(6) Governor Selector Switches - FULL INCREASE RPM.

(7) Prop. RPM Limit Lights (Four) - ON.

Note

Operation in either direction requires 8 to 15 seconds.

e. Auto Master Synchronizer - CHECK.

(1) Throttles - 1850 RPM.

(2) Prop. Sync Lever - FULL INCREASE RPM.

(3) Auto Control Switch - OFF.

(4) Prop. Sync Lever - RETARD TO FULL DECREASE RPM.

Check that four prop. rpm limit lights are on.

(5) Auto Control Switch - NO. 1 MASTER.

Tachometer should indicate 1100 ± 50 RPM.

(6) Prop. Sync Lever - ADVANCE TO 1850 RPM AND RESET THROTTLES TO 30 INCHES HG.

(7) Resynchronizer Switch - RESYNC MOMENTARILY.

Repeat if necessary. Tachometer should indicate 1850 rpm.

(8) No. 1 Throttle - 1650 RPM.

(9) Tachometer - 175 RPM MAXIMUM DROP ON NO. 2, 3 & 4 ENGINES.

(10) No. 1 Throttle - 30 INCHES HG.

ENGINE RUNUP (Cont)

PILOTS

ENGINEER

(11) Resynchronizer Switch - RESYNC MOMENTARILY.

Repeat if necessary. Tachometer should stabilize at 1850 rpm.

(12) Prop. Sync Lever - FULL INCREASE RPM.

4. Generators and Alternators - CHECK.

Check voltages on both alternator buses. Check that generators are on the line and load equally distributed.

5. Engine Power And Ignition System – CHECK.
   a. Throttle(s) – FIELD BAROMETRIC PRESSURE.
   b. Tachometer – CHECK 2025 ± 75 RPM.

Note

The limits stated above are desirable; however, unpredictable location conditions may cause the tolerances to be exceeded even though the propeller-engine combination is performing satisfactorily. In this case, with the airplane headed into the wind, if all engines are not within the above tolerance, the spread between the highest and lowest engine rpm should not exceed 100 rpm.

   c. Torque Pressure And Normal Fuel Flow – CHECK.
   d. Ignition Switch – FROM BOTH TO L; NOTE RPM DROP; RETURN TO BOTH. FROM BOTH TO R; NOTE RPM DROP; RETURN TO BOTH.

RPM drops are as follows: normal is 45 to 50 rpm; maximum allowable is 80 rpm. Maximum allowable difference between right and left magneto is 20 rpm.

CAUTION

Do not exceed maximum allowable cylinder head temperature for ground operation.

(7.) Engineer's Report – RECEIVE. (P, E)

(6.) Report To Pilot – "ENGINE RUNUP COMPLETE." (E, P)

JET ENGINE GROUND START

Note

Tail winds could affect normal starting of Jet engines.

PILOTS

1. Jet Engine Throttles – STOPCOCK. (CP)
2. Jet Engine Anti-Icing Switch – OFF. (CP)
3. Compressor Stall Prevention Switch – OFF. (CP)

ENGINEER

1. Body Heater Switches – OFF. (1)
2. Jet Engine Starter Circuit Breakers – SET.
3. Leveling Valve Switches – AS REQUIRED.

PILOTS

4. Jet Engine T-Handles – IN. (P)

   Push the jet engine fuel-oil emergency shutoff valve T-handles in and check that the warning light (which lights up the white plastic handle) is operating for each valve.

5. Jet Engine Fire Detection Test Switch – TEST. (P)

   Check that both jet engine fire warning lights come on, then release switch to NORMAL.

6. Clear Area – CLEAR AREA FOR JET START. (P, CP, BO)

   Boom operator will make certain that the area behind the airplane is clear for jet start and report over interphone.

7. Fire Guard – POSTED. (P, CP)

8. Notify Engineer – "POWER FOR JET ENGINE START." (P, CP, E)

   The engineer will set all four reciprocating engines (to provide electrical power) and report, "Ready to start jets."

CAUTION

Do not attempt jet engine starts utilizing APU only, as sufficient electrical power is not available and damage to APU may occur.

9. Notify Engineer – "ENGAGING J-1." (P, CP, E)

   When engineer reports, "Ready to start jets," hold the selected jet engine starter switch at ENGAGE for approximately 2 seconds, then release switch to OFF.

CAUTION

Do not engage the two jet engine starters simultaneously as an overload of the electrical system will occur.

Note

During jet engine ground start, the engineer will monitor the generator loadmeter of the engines being utilized for electrical power. When the load increases, indicating starter is engaged, the engineer will report, "Engaged."

ENGINEER

4. Jet Engine Fuel Selector Switches – AS REQUIRED.

5. Sump Tank And CWT Boost Pump Switches – AS REQUIRED.

6. CWT Line Valve – AS REQUIRED.

7. Engineer's Report – "READY TO START JETS." (E, CP, P)

   On pilot's command, "Power for jet engine start," set all four reciprocating engines at 1000 rpm or above.

CAUTION

APU should be operating to provide additional electrical power for jet engine starts; however, jet engines may be started with only six (6) generators on the line (No APU), but is not recommended as a normal procedure.

8. Loadmeters – MONITOR. (E, CP, P)

   During jet engine ground start, the engineer will monitor the generator loadmeters. When the load increases, indicating starter is engaged, the engineer will report, "Engaged." The loadmeter will gradually decrease from the peak load as the jet engine starts, then the load will suddenly drop to normal as the starter disengages. The engineer will report, "Disengaged."

9. Throttles – RETARD (IF REQUIRED).

   When J-2 disengages, retard throttles if required.

10. APU – OFF.

11. Jet Engine Starter Circuit Breakers – PULLED OUT.

Note

Jet engine starter circuit breakers must be pulled out after all jet starts so that inadvertent flight operation of the starter switches will not damage the starters.

JET ENGINE GROUND START (Cont)

PILOTS

10. Jet Engine Throttle – START, THEN IDLE. (CP)

    At 6 percent rpm, place jet engine throttle in START position. Check for combustion as indicated by a rise in EGT. EGT should peak between 550° and 750°C. Allow EGT to stabilize, then advance engine to idle speed (40 percent) maintaining 675° to 715°C EGT.

CAUTION

- If combustion has not occurred by the time the engine reaches 12 percent rpm, or if the engine speed has not reached 12 percent rpm within 40 seconds after the starter switch was placed at ENGAGE, position affected jet engine starter switch to EMERGENCY DISENGAGE and close the throttle to discontinue the start. Allow the combustion chambers to drain and the starter to cool for at least 3 minutes before attempting another start. The starter should not be engaged for longer than 1 minute without the aid of combustion. The starter is limited to three starts of 1-minute duration during any 30-minute period. The starter must be allowed to cool for 30 minutes before a fourth start may be attempted.
- If an EGT of 950°C or above is encountered during start, the pilot will shut down engine and record the degree and duration of overtemperature condition on Form 781.

Note

If initial starting peak EGT ever exceeds 850°C or consistently exceeds 800°C with throttle in START detent, record this in Form 781 so that START detent can be readjusted.

11. Jet Engine Starter Switch – EMERGENCY DISENGAGE.

    As an added precaution, position starter switch to the EMERGENCY DISENGAGE position after the engineer reports, "Disengaged," or rpm exceeds 30 percent.

12. Jet Engine Instruments – CHECK. (P, CP)

    Allow jet engine to stabilize at idle rpm and check all engine instruments before accelerating to a higher rpm.

ENGINEER

PILOTS

ENGINEER

CAUTION

If no rise in oil pressure is noted by the time idle rpm is reached, increase rpm until a definite rise in oil pressure is noted. If no oil pressure is noted before 80 percent rpm is reached, or within 60 seconds after reaching idle rpm, shut down the engine and determine the cause of the malfunction.

Note

During cold weather starts, the oil pressure may exceed the maximum limits until the oil temperature reaches the normal operating range.

13. Notify Engineer – "ENGAGING J-2." (P, CP, E)
14. Repeat Steps 10, 11, And 12.

JET ENGINE GROUND SHUTDOWN

PILOTS

1. Jet Engine Throttles – 70 PERCENT, THEN STOPCOCK. (CP)

CAUTION

During shutdown of an engine, uneven cooling will cause the shroud ring to contract more rapidly than the turbine wheel. This difference in rate of contraction may cause the turbine blades to strike the inner circumference of the shroud ring, causing damage to both parts. Except in cases of emergency, it is therefore recommended that the engine be operated at 70 percent rpm for a minimum of 2 minutes to allow the shroud ring and the turbine wheel to cool as much as possible before shutting down the engine.

2. Jet Engine T-Handles – OUT. (P)

CAUTION

The jet fuel-oil emergency shutoff valve T-handle should be pulled when engine rpm reaches 0 percent. Shutting off oil supply while the engine is still coasting down can collapse the engine oil supply line. If shutoff occurs after the engine has stopped turning, oil will drain from tank to engine increasing possibility of a post-shutdown fire.

ENGINEER

1. Sump Tank And CWT Boost Pump Switches – OFF.

   Position switches to OFF when jet engines are shut down.

2. CWT Line Valve – CLOSED.
3. Leveling Valves – CLOSED.
4. Jet Engine Starter Circuit Breakers – OUT.

BEFORE TAKEOFF

PILOTS

* 1. Trim Control Wheels – SET. (P)

Set all trim control wheels for takeoff.

* 2. Autopilot Switch – OFF. (P)

* 3. Rudder Boost – ON. (P)

* 4. Throttle Lock Lever – SET. (P)

Adjust throttle lock as desired for takeoff.

* 5. Jet Engine T-Handle – IN. (P)

* (6.) Wing Flaps – SET 33 PERCENT. (P, CP, BO)

In freezing weather, operate wing flaps through one complete cycle before setting flaps for takeoff. Hold wing flap switch at DOWN until indicators read 33 percent. At this time boom operator will report, "Both flaps – percent."

Note

Where short runways are a problem, 55 percent wing flaps may be used for takeoff. Refer to T. O. 1C-97(K)L-1-1. Under these circumstances, the warning horn will sound when the throttles are advanced.

* (7.) Takeoff Data – REVIEWED. (ALL)

When the engineer reports, "Ready for briefing," the pilot will brief the copilot, navigator, and engineer on necessary items on the TOLD card. S1/S2 takeoff performance monitoring procedures will be reviewed as necessary. Emergency considerations will be reviewed with the crew. The TOLD card will be reaccomplished with each 5000-pound gross weight change and fully reviewed any time a change occurs in the pilots' or engineer's crew positions. If a crewmember change occurs at the navigator's position, acceleration check time will be reviewed with the replacement navigator.

* 8. Instrument Select Switch – SET (AS REQUIRED). (P, CP)

Place the instrument select switch to desired position (VOR-ILS or TACAN) for departure.

* 9. Anti-Icing Equipment – CLIMATIC. (P)

* 10. Safety Belt And Shoulder Harness – FASTENED. (P, CP)

* 11. Reverse Lock Plate – CHECK OPENED. (CP)

ENGINEER

* (1.) Report To Pilot – "READY FOR BRIEFING." (E, P)

2. Air Conditioning Master Switch - ON.

* 3. Oil Cooler Flap Switches – AS REQUIRED.

* 4. Prop. Sync Lever – FULL INCREASE RPM.

* 5. Engine Pressures And Temperatures – CHECKED (WITHIN TAKEOFF LIMITS).

Refer to OPERATING LIMITATIONS, Section V, and SYSTEMS OPERATION, Section VII. The minimum oil temperature is 60°C.

Note

Emergency takeoffs may be started at 50°C minimum oil temperature.

* 6. Sump Tank Or CWT Boost Pump Switches – AS REQUIRED.

WARNING

During climb and while JP-4 is being supplied to the jet engines from the A/R system, select fuel from the forward A/R tanks or main fuel system if aft A/R tanks contain less than 5000 pounds of fuel.

PILOTS

* 12. Flight Controls – UNLOCKED AND CHECKED. (P, CP)

Copilot unlocks surface lock handle and pushes full down. Pilot checks control for full, free travel and notes main hydraulic system pressure fluctuation for indication of rudder boost operation.

CAUTION

If strong and/or gusty surface winds and control whipping have been experienced, visually recheck all flight controls for proper movement and response.

* 13. Heading Indicators – SET. (P, CP)

Pilot and copilot set heading indicators with runway heading under the top index. Pilot sets heading indicator to agree with copilot's N-1 heading.

* 14. Attitude Indicators – CHECKED. (P, CP)

Pilot's and copilot's attitude indicators adjusted to align the miniature airplane with the horizon bar. Check that warning flags are out of view.

* 15. Tower Call – COMPLETED. (CP)

Obtain takeoff clearance from the tower. Remaining checklist items will be completed after receiving takeoff clearance.

* (16.) Cowl Flaps – SET. (P, E)

The pilot will direct the engineer to set cowl flaps for takeoff.

WARNING

Leaving the cowl flaps open more than 3 inches will materially reduce takeoff performance and reduce control effectiveness upon retraction of the wing flaps. Severe buffeting will also occur.

* 17. ADI Switch – AS REQUIRED. (P, CP)

The ADI switch is normally ON.

NOTE

Maximum power, with ADI, will be used for all takeoffs if available. During the initial portion of takeoff run, the engineer will notify the pilot of any apparent ADI malfunction. The pilot, prior to takeoff, will determine what course he will follow in the event of ADI failure(s). This will be dependent on gross weight, temperatures, altitude, or other pertinent conditions.

ENGINEER

7. Leveling Valves - AS REQUIRED.

* 8. Turbo Switches - MAN.

* 9. Turbo Override Switches - OPEN (GUARDS DOWN) 10 SECONDS, THEN OFF (GUARDS UP).

* 10. Safety Belt and Shoulder Harness - FASTENED.

* 11. Mixture Levers - AUTO RICH (LOCKED).

* 12. Body Heater Switches – OFF.

CAUTION

If combustion heaters have been operating, leave ground blowers on for 3 minutes after turning heater switches OFF to purge combustion chambers of unburned fuel.

* (13.) Cowl Flap Switches – SET (WHEN DIRECTED). (E, P)

BEFORE TAKEOFF (Cont)

PILOTS

* 18. Windows - CLOSED. (P, CP)

* 19. Pitot Heat Switches - ON. (CP)

* 20. AIMS/IFF Controls — AS REQUIRED (MODE AND CODE AS BRIEFED). (CP)

* 21. Jet Engine Compressor Stall Prevention Switch — ON, THEN OFF. (CP)

Switch will be turned OFF after being checked during takeoff.

* (22) Takeoff Report - RECEIVED (ALL).

Pilot will announce over interphone, "Takeoff report," Boom operator reports, "Cowl flaps set, boom operator ready." Navigator reports, "Navigator ready," and engineer reports, "Engineer ready."

ENGINEER

* (14) Report To Pilot - "ENGINEER READY." (E, P)

Notify pilot if in sheltered air.

TAKEOFF

TAKEOFF PROCEDURE

Good takeoff technique and strict attention to the recommended minimum speed schedules is required in order to obtain the results shown in the takeoff charts of T.O. 1C-97(K)L-1-1. At takeoff weights above 155,000 pounds, it is imperative to hold minimum climbout speeds until a safe altitude is attained, since early acceleration requires considerable distances and reduces available climb path slopes. When climbout performance or terrain clearance is not critical, the pilot may find it advisable to climb out to wing flap retraction altitude at higher airspeeds and accomplish wing flap retraction in an accelerated climb profile. This technique will avoid exaggerated nose-high attitudes which may be objectionable. See figure 2-4 for normal takeoff and initial climb procedures.

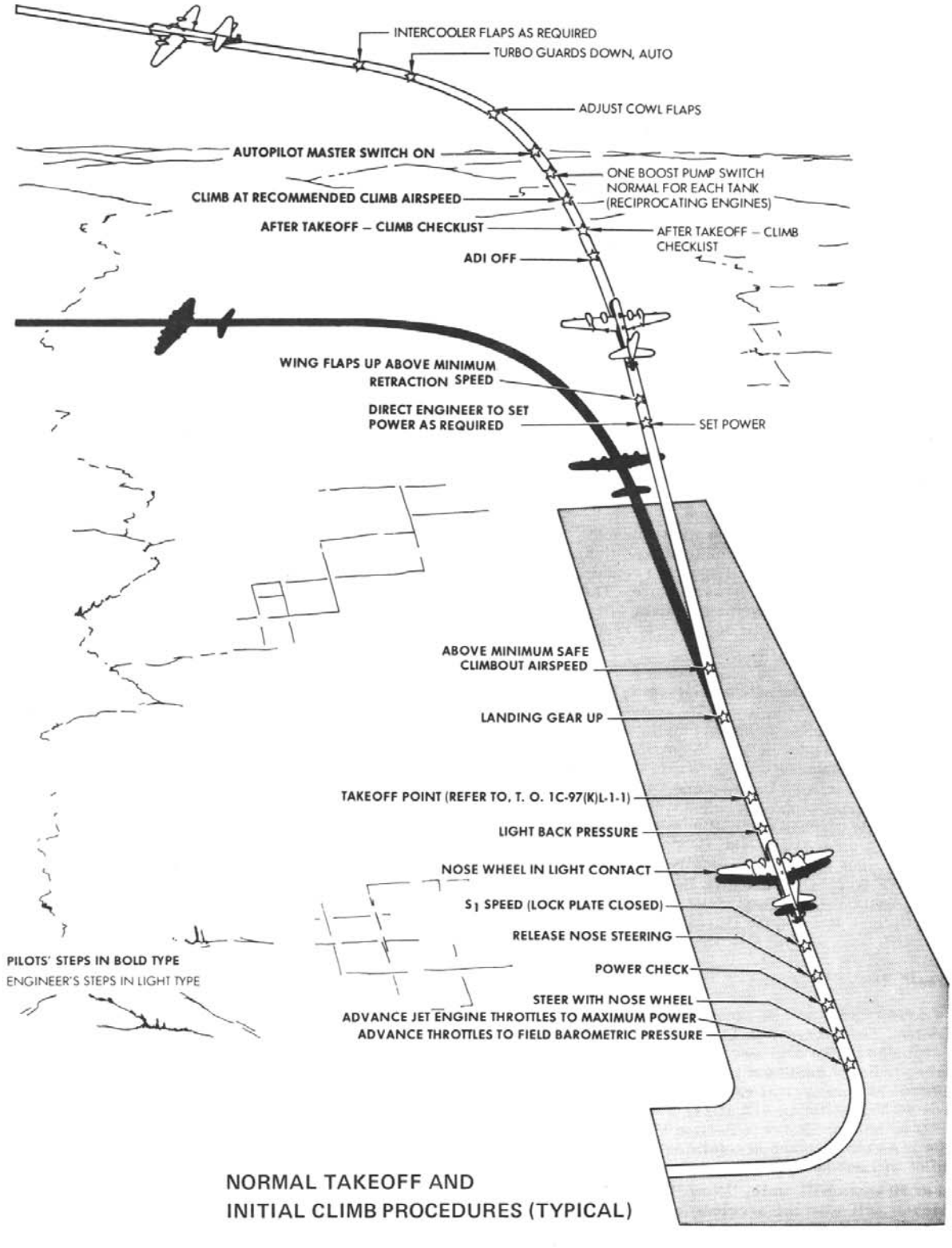
Note

ADI will not be turned off if one or more engines fail to receive ADI unless engine instrument readings indicate it is detrimental to the engine.

Normal Takeoff Technique (4-Engine)

Normal takeoff will be made from a static position on the runway. Direct the engineer to advance the reciprocating engine throttles to "Field Barometric" pressure and allow power to stabilize. When the power has stabilized, the engineer will report, "Power stabilized." The pilot will announce over the interphone, "Pilot's throttles," release the brakes and advance reciprocating engine throttles toward maximum power. The pilot will maintain directional control with nose wheel steering, and the copilot will hold the controls and monitor airspeed. Acceleration check will be accomplished as outlined under TAKEOFF ROLL.

When a rolling takeoff is necessary, allow the airplane to continue the roll when taxiing onto the runway. Gradually increase power on all engines during the turn, leading with the engines on the outside of the turn. Use the nose wheel steering to control the airplane direction. Avoid skids or skips, excessive speeds, and use of brakes during the turn onto the runway. As the airplane approaches alignment with the runway, increase power on the engines on the inside of the turn to assist in maintaining directional control. Increase power on all engines to maximum power.



NORMAL TAKEOFF AND
INITIAL CLIMB PROCEDURES (TYPICAL)

Figure 2–4

Normal Takeoff Technique (6-Engine)

Align the airplane on the runway and direct copilot to advance jet engine throttles to 80 percent rpm. When jet engine rpm stabilizes, place compressor stall prevention switch to OFF and note a slight rise in rpm. Direct engineer to advance reciprocating engine throttles to "Field Barometric," and copilot to advance jet engine throttles to 100 percent rpm. When power has stabilized, the engineer will report, "Power stabilized." The copilot will report, "Jet engines stabilized." The pilot will announce over interphone, "Pilot's throttles," release the brakes and advance reciprocating engine throttles toward maximum power. The pilot will maintain directional control with nose wheel steering, and copilot will hold the controls and monitor airspeed. Acceleration check will be accomplished as outlined under TAKEOFF ROLL.

Have engineer maintain a close watch on all reciprocating engine instruments during takeoff. Leave control column in neutral position until within 10 knots of takeoff speed, then ease control column back and allow airplane to fly itself off in a near-level attitude.

NOTE

The compressor stall prevention solenoid valve is held closed (switch in off position) by dc power. The valve will open and remain open in the event of dc power failure. The compressor stall prevention system will operate continuously until dc power is restored.

5-Engine Takeoff (Operational Necessity)

Five-engine takeoff may be accomplished when operational requirements dictate. Approval for five-engine takeoff must be obtained from the Commander of the unit possessing the airplane. Because of possible directional control problems, the takeoff should be thoroughly planned and optimum performance conditions such as gross weight, OAT, field elevation, RCR and winds should be carefully considered. TAKEOFF WITH ONE ENGINE INOPERATIVE, Section III, will be thoroughly reviewed and strictly adhered to for a five-engine takeoff.

Takeoff Roll

The power check will be accomplished as soon as possible. Only exceptions to normal operations will be reported by the engineer. Torquemeter readings below predicted minimum performance torque will be reported as a numerical value. (Takeoff may be made without utilizing ADI at 247 TPSI, if CAT is -25°C or colder. Refer to Section V for TPSI limitations.) As the airplane accelerates to 65 knots, the copilot will announce over interphone, "70 knots----," and at 70 knots will state, "Now." At this instant, the navigator will start the acceleration check timing. When the copilot calls, "Now," the pilot will check his indicated air speed. This is a check for gross error in the air-speed indicating systems. If the pilot's airspeed indicator reads other than 70 knots, this difference will be applied at the end of the acceleration check to determine if satisfactory acceleration has been attained. At 70 knots, the pilot will take over the controls and release nose wheel steering if definite rudder control has been attained. Four seconds before the end of the computed time, the navigator will state, "Time-----," and at the expiration of time will state, "Hack." When the navigator states, "Hack," the pilot and copilot will check their respective airspeed indicators and the copilot will call out (not over interphone) the airspeed indicated on the copilot's indicator. If minimum acceptable airspeed has not been attained, the pilot will abort the takeoff.

As the airplane continues to accelerate, at 5 knots below S_1 speed the copilot will call (not over interphone), "S_1-----," and at S_1 speed will state, "Now," and close the throttle reverse lock plate. (S_1 and S_2 speeds may be the same.) At this time the pilot will announce, "Engineer's throttles." The engineer will acknowledge. The copilot will notify the pilot when S_2 speed is reached. Liftoff will be accomplished at S_2 speed, which is takeoff speed with necessary corrections. If a definite loss of power occurs prior to reaching S_1, the pilot will initiate an abort. Takeoff may be aborted for any emergency prior to reaching S_1 with the assurance that safe abort capability exists. If loss of power occurs after S_1 is passed, the takeoff should be continued.

NOTE

- If a navigator is not on board the airplane, the copilot will assume the navigator's duties in accomplishing acceleration check timing.
- The engineer will notify the pilot of any apparent ADI malfunction during takeoff and climbout.
- If the acceleration check is less than 8 seconds, the takeoff performance acceleration check may be deleted from the TOLD card.

CAUTION

- At all times during the takeoff and climbout the engineer will check fuel flow and adjust rpm, manifold pressure, and torque pressure so as not to exceed safe operating limitations.
- If backfiring is encountered during takeoff run and time permits, the takeoff shall be aborted. If backfiring occurs after refusal speed, power should be reduced as soon as possible only after minimum safe altitude and minimum climb speed is reached. The airplane will be returned to base as soon as possible.

At 5 to 10 knots below takeoff speed the pilot will ease the pressure off the nose wheel, using back pressure on the controls, and allow the airplane to fly off of the ground.

WARNING

Do not attempt to manually adjust the fuel mixture during takeoff, except as outlined in ELIMINATION OF CARBURETOR ICE, Section VII, as this may cause detonation.

Minimum Roll Takeoff Technique

Use of 55 percent wing flaps instead of 33 percent decreases takeoff ground roll by 8 to 16 percent. (Refer to T. O. 1C-97(K)L-1-1.) Further reduction may be achieved in emergencies by pulling the airplane off at speeds not exceeding 5 knots below the recommended takeoff speed. Align the airplane on the extreme end of the runway. Hold brakes and advance jet engine throttles to maximum power. After checking jet engine instruments, advance reciprocating engines to 50 inches Hg manifold pressure. Release brakes and advance reciprocating engine throttles to maximum power. When within 5 knots of liftoff speed, lift the nose and fly the airplane off the runway with a smooth, but definite, attitude change.

Obstacle Clearance Takeoff Technique

Use MINIMUM ROLL TAKEOFF TECHNIQUE, this section, except do not reduce takeoff speeds below the recommended schedule. Raise the landing gear as soon as the airplane is safely airborne. Do not accelerate, but maintain minimum climbout speed and maximum power and takeoff wing flap setting until obstacles have been cleared. In general, obstacles more than a mile distant from takeoff point are best cleared with 33 percent wing flaps, while closer obstacles can be cleared with greater margins using 55 percent wing flaps. With 55 percent wing flaps the acceleration necessary to reach wing flap retraction speed impairs the climbout path. For distant or high obstacles, allow the airplane to accelerate while still maintaining some vertical velocity to the recommended wing flap retraction speed. The wing flaps should then be started up and allowed to retract to the desired climb position in one continuous operation without loss of altitude.

Transition Flying

Note

For brake cooling requirements and subsequent takeoff restrictions, see figure 5–4.

See 4- and 3-ENGINE TAKEOFF FLIGHT PATHS in the Appendix, T. O. 1C-97(K)L-1-1, for accurate information on possible takeoff flight paths.

Crosswind Takeoff Technique

Use maximum power on all engines during the takeoff run. Maintain direction during the initial run stages by means of nose wheel steering. Nose wheel steering effect can be improved by holding the nose wheel down by means of the control column. When sufficient speed has been obtained to allow control with the rudder, discontinue use of the nose wheel steering and use the rudder. Continue with normal takeoff. After takeoff, make a coordinated turn to crab into the wind to maintain the runway heading. See CROSSWIND CORRECTION CHART, T. O. 1C-97(K)L-1-1, to obtain the runway wind component for crosswind takeoffs.

Night Takeoff Technique

Refer to NIGHT FLYING, Section IX.

AFTER TAKEOFF – CLIMB

If the airplane is to remain in the traffic pattern, omit pilots' steps 7 and 8 and engineer's steps 2 and 5 thru 8.

CAUTION

If backfiring is encountered during flight, power on the malfunctioning engine shall be reduced and carburetor air temperature and cylinder head temperature decreased. If backfiring continues, engine shall be feathered immediately and a landing made as soon as possible at the nearest airfield suitable to the pilot.

PILOTS

1. Landing Gear Switch – UP, THEN OFF. (P, CP)

Note

- Landing gear may be left extended when remaining in the pattern.
- When the airplane is definitely airborne the pilot will call and visually signal, "Gear up." The copilot will raise the landing gear. After obstacles have been cleared and after reaching minimum flap retraction speed or 140 knots (whichever is greater), the pilot will instruct the copilot to raise flaps. The copilot will check that the landing gear indicators indicate INTERMEDIATE and UP during the landing gear retraction cycle and advise the pilot, "Gear up," when the indicators indicate up. Placing landing gear switch to OFF after pilot calls for the AFTER TAKEOFF - CLIMB checklist.

(2.) Power – SET. (P, CP, E)

When landing gear is up, direct engineer to set METO or CLIMB power as required; and copilot to set jet engines as required.

Note

When remaining in closed traffic, and traffic pattern airspeed and altitude have been established, direct engineer to set power as required and copilot to set jet engines as required.

ENGINEER

(1.) Power – SET. (E, P)

Set power when directed by pilot.

2. Boost Pump Switches – NORMAL (ONE PER TANK).

   Four boost pumps, one per tank, will be on NORMAL for climb, all other boost pump switches as required.

3. Cylinder Head Temperature – CHECKED (POSITION SELECTOR SWITCH TO HOTTEST CYLINDER).

PILOTS

3. Wing Flaps - FULL UP. (P, CP)

   Upon reaching wing flap retraction speed, decrease rate of climb and retract wing flaps to the full up position while accelerating to the recommended climb speed.

WARNING

Maintain a positive rate of climb at all times during wing flap retraction.

Note

- The copilot will monitor the dual flap indicators for any indication of unbalanced wing flap movement. In event unusual roll attitude of the airplane is encountered during wing flap operation, immediately correct with aileron and rudder control and simultaneously return the wing flaps to a symmetrical position.
- When remaining in the pattern, wing flaps may be left extended at 33 percent at pilot's discretion until setting wing flaps at 55 percent on the BEFORE LANDING Checklist.

4. Landing Lights – OFF, THEN UP. (P, CP)

   Normally, the copilot will retract and turn off landing lights at this point. (After approximately 1 minute, return the retraction switch to neutral.) However, landing lights may be turned off and retracted at pilot's discretion if the use of landing lights is a hindrance rather than an aid to visibility.

5. ADI Switch – OFF. (CP)

   After METO or CLIMB power is set, turn ADI OFF and pilot will call for AFTER TAKEOFF–CLIMB Checklist.

6. Wheel Well Light Switches – OFF. (CP)

7. Autopilot Master Switch – ON. (P, CP)

Note

Allow 1 minute for amplifier warmup prior to engaging autopilot.

8. AIMS/IFF "NORMAL" (AS REQUIRED). (CP)

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.

ENGINEER

4. Cowl Flap Switches – AS REQUIRED.

   Set minimum cowl flap opening to obtain desired CHT.

5. Generators, Inverters, And Alternators – CHECKED FOR PROPER VOLTAGE AND POWER OUTPUT.

6. Carburetor Air Switches – AS REQUIRED.

CAUTION

Notify pilot if in sheltered air.

7. Turbo Switches – CLIMATIC.

   The purpose of this step is to place turbos in automatic control. (Maintain carburetor air temperature at plus 20°C, if possible, to aid fuel vaporization.) Advise pilot of turbo operation.

   a. TBS Lever – 0.

   b. Turbo Override Switches – OPEN, GUARDS DOWN.

Note

This will set up the turbo controls to insure open wastegates in a minimum of time for an emergency.

   c. Turbo Switches – AUTO (ONE AT A TIME).

      Monitor manifold pressure closely to prevent inadvertent overboost.

   d. Intercooler Switches – OPEN TO 2 INCHES (OR AS DESIRED).

      Accomplish before advancing TBS lever to anticipate carburetor air temperature rise when turbo is added.

   e. TBS Lever – CAREFULLY ADVANCE AS DESIRED.

CAUTION

Do not exceed carburetor air temperature limits when using turbo. When setting up turbo, always advance the TBS lever carefully until a definite rise in manifold pressure or cabin air flow is noted. No rise means malfunction; return the turbo switch for the affected engine to MAN. Investigate when safe altitude is reached by using the TURBOSUPERCHARGER EMERGENCY OPERATION, Section III.

AFTER TAKEOFF – CLIMB (Cont)

PILOTS

G 9. No Smoking and Seat Belt Lights - AS REQUIRED (CP)

(10) Engineer's Report – RECEIVE. (P, E)

ENGINEER

NOTE

It may not always be possible to maintain 53 inches Hg manifold pressure up to high altitudes at 2550 rpm. This may be due to the exhaust back pressure switch limiting available boost indicated by a 4- to 6-inch Hg manifold pressure fluctuation. This will also be observed during hot day operations; however, if only one or two engines are deficient, a malfunction should be suspected.

f. Carburetor Air Temperature – CONTROL WITH INTERCOOLER FLAP SWITCHES.

8. Engineer's A/R Panel (If Deck Fuel Is Carried):
   a. Fuel Dump Switches Cover – CLOSED.
   b. A/R Master Switch – AS REQUIRED.
   c. Engineer's A/R Panel – AS REQUIRED.
9. Cabin Pressurization - CHECKED AS REQUIRED.

(10) Boom Operator's Report -RECEIVED. (BO,E)

Boom operator will report "Boom Operator's Walk Around Inspection is Complete."

(11) Report To Pilot - "CABIN PRESSURIZED - AFTER TAKEOFF-CLIMB CHECKLIST COMPLETE." (E,P)

CLIMB

CLIMB PROCEDURE

Climb characteristics of this airplane are good. At normal weights it has a high vertical velocity rate for its size and has good acceleration from takeoff point to climbout airspeed. Shortly after breaking ground, it will be necessary to roll in some nose-down trim, but as climb is established, part of this trim will be removed, continuing the climb with some nose-down trim reading. After obstacles have been cleared, the vertical velocity is reduced to allow the airplane to accelerate to minimum wing flap retraction airspeed or 140 knots, whichever is greater. Power is reduced to METO or CLIMB power, and wing flaps are retracted to the full up position. The recommended climb airspeeds and the corresponding wing flaps up climb performance are shown in T.O. 1C-97(K)L-1-1. After the climb checklist is complete, the engineer will notify the pilot of a desired airspeed and jet engine setting for cruise.

CRUISE

CAUTION

Do not exceed 190 knots IAS when actuating sheltered air doors. Airspeed is restricted to 210 knots IAS when operating in sheltered air.

PILOTS

1. Cruise Power - SET. (P, CP, E)

   Upon reaching cruise altitude, allow airplane to accelerate to 5 knots above cruise airspeed, then direct copilot to set cruise power on jet engines and engineer to set cruise power on reciprocating engines. Trim airplane as required.

2. Altimeter Setting - CHECKED. (P, CP)

3. Engineer's Report – RECEIVE. (P, E)

   Note

   Copilot will crosscheck the copilot's heading indicator and repeater compasses against the magnetic compass every hour during slaved operation of the N-1 compass system. Advise navigator if any variation exists.

ENGINEER

1. Power – SET AS REQUIRED (WHEN DIRECTED). (E, P)

   Adjust power for long range cruise or as mission requires; refer to Section VII and T. O. 1C-97(K)L-1-1.

   Note

   For propeller operation during flight, refer to Section VII.

2. Intercoolers And Carburetor Air Switches – AS REQUIRED.
3. Turbo Switches – AS REQUIRED.
4. Cowl Flap Switches – AS REQUIRED.

   Set cowl flaps to minimum gap required for desired cylinder head temperature.

5. Fuel Selector Switches And Boost Pump Switches – AS REQUIRED.
6. Battery Switch – BAT. CHG (IF APPLICABLE).

   Check battery switch on BAT. CHG. Switch must be in this position for reverse current relay to operate and maintain battery charge in flight. Check battery voltage periodically with voltmeter selector switch in BATTERY position and battery switch OFF.

7. Analyzer – CHECK ENGINES EVERY HOUR.

   Every hour, or more often if spark plug fouling is indicated by an erratic torque oscillation or by ignition analyzer, clean spark plugs by method described in FOULING PROTECTION DURING CRUISE OPERATION, Section VII.

8. Mixture Levers – AS REQUIRED.
9. Report To Pilot – "CRUISE CHECKLIST COMPLETE." (E, P)

SECONDARY CLIMB

PILOTS

(1.) Power – SET. (P, CP, E)

Direct engineer to set CLIMB or METO power and copilot will set jets as directed by pilot.

(2.) Engineer's Report – RECEIVE. (P, E)

ENGINEER

1. Mixture Levers – AUTO RICH.
2. Fuel Selector Switches – AS REQUIRED.

(3.) Power – SET. (E, P)

Set power as directed by pilot.

4. Intercooler Switches – AS REQUIRED.
5. Turbo Switches – AS REQUIRED.
6. Cowl Flap Switches – AS REQUIRED.

(7.) Report To Pilot – "SECONDARY CLIMB CHECKLIST COMPLETE." (E, P)

JET ENGINE IN-FLIGHT SHUTDOWN

PILOTS

1. Jet Engine Throttles – IDLE. (CP)

Allow jet engines to idle 1 minute before shutdown.

(2.) Jet Engine Throttles – STOPCOCK. (CP, E)

CAUTION

A fuel-oil emergency shutoff valve T-handle must never be pulled in flight unless an emergency exists. Since the jet engines windmill at all times while in flight, oil is required to prevent damage to internal parts.

3. Jet Engine Anti-Icing Switch – OFF. (CP)
4. Compressor Stall Prevention Switch – OFF. (CP)
5. Jet Engine Oil Heater - ON (If not removed from airplane). (CP)
6. Instruments - CHECK. (P, CP)

Check particularly that the jet engine tachometer indicates the proper windmilling rpm.

ENGINEER

(1.) Boost Pump Switches – AS REQUIRED. (E, CP)

When jet engines are shut down, position boost pump switches as required.

2. CWT Line Valve Switch – AS REQUIRED.
3. Leveling Valve Switches – AS REQUIRED.

JET ENGINE AIR START

PILOTS

CAUTION

To prevent damage to the starters do not use starter switches while jet engines are windmilling.

1. Jet Engine Fire Detection Test Switch – TEST. (P)

   Position switch to TEST, then release to NORMAL, checking that both jet engine fire warning lights come on.

2. Jet Engine Instruments – CHECK. (P, CP)

   Check that all jet engine instruments are giving normal indications. Tachometers should indicate approximately 12 to 18 percent rpm when windmilling; the oil pressure should be 1 to 4 psi; and all other instruments should indicate zero.

3. Jet Engine Anti-Icing Switches – AS REQUIRED. (CP)

4. Compressor Stall Prevention Switch – OFF. (CP)

5. Jet Engine Throttles – STOPCOCK. (CP)

6. Jet Engine Air Start Ignition Switches – DEPRESS. (CP, E)

   Receive engineer's report before depressing air start ignition switches.

7. Jet Engine Throttles – START. (CP)

   Check for combustion as indicated by a rise in EGT. Allow EGT and fuel flow to stabilize before advancing throttles to IDLE.

Note

- At altitudes of 25,000 feet and higher, it may be necessary to advance the throttles past START and sometimes to IDLE to obtain necessary fuel flow for starting. Best starts will be obtained with fuel flow between 400 and 500 pounds per hour. It may be necessary to retard the throttles after combustion to prevent overtemperature or compressor stall.
- If there is no indication of combustion within 30 seconds after advancing the throttles to START, retard the throttles to STOPCOCK. Allow at least 1 minute for fuel drainage before repeating starting procedures.

8. Jet Engine Throttles – IDLE. (CP)

   At 20,000 feet, idle is approximately 60 percent rpm. Slowly advance throttle to idle rpm, using EGT to govern rate of throttle advance. Maintain EGT between 450° and 500°C.

9. Jet Engine Instruments – CHECK. (P, CP)

   Allow the jet engines to stabilize at idle rpm and check that engine instruments are within limits before accelerating to a higher rpm. Do not attempt throttle burst from any rpm below idle.

ENGINEER

1. Jet Engine Fuel Selector Switches – AS REQUIRED.
2. Leveling Valve Switches – AS REQUIRED.
3. Boost Pump Switches – AS REQUIRED.

4. Report To Pilot – "READY FOR JET START." (E, CP)

DESCENT

DESCENT TECHNIQUE

Analysis shows that, compared to level flight, the energy derived from descent while maintaining long range cruising airspeeds provides 2.2 nautical miles additional range for every 1000 feet decrease in altitude. This is virtually independent of the rate of descent used provided cruising airspeeds are maintained. Refer to the T. O. 1C-97(K)L-1-1 for discussion.

RAPID DESCENTS

At long range cruising airspeeds a rate of descent up to 1000 feet per minute may be used without affecting the range an appreciable amount. However, fast descents result in less economical engine operation because of the lower power settings that must be used, but they are used for such a short time that no appreciable decrease in range results unless airspeeds appreciably higher than long range cruising are used. When descending at airspeeds other than long range cruising airspeeds, the factor of 2.2 nautical miles per 1000 feet is not correct. It is apparent that descending at very high airspeeds would reduce this factor considerably. To expedite descent, jet engines should be off, landing gear extended, and wing flaps lowered to 55 percent. Normal cruise airspeed may be maintained if below airspeed limitation for airplane configuration.

REQUIRED POWER SETTINGS

If nature of flying conditions in descent requires a large reduction in power, reduce rpm as well as manifold pressure. For descents or other low power maneuvers, or perhaps a simulated engine failure, it is important to cushion the high inertia loads on the master rod bearings which occur at conditions of high rpm and low manifold pressure. As a rule of thumb, it is well to remember that each hundred rpm requires at least 1 inch Hg manifold pressure. For example, 20 inches Hg at 2000 rpm.

EFFECT OF COOLING

During descent the cooling required is reduced and consequently the cowl flaps can be closed tighter than in level flight, thus tending to make 2.2 nautical miles per 1000 feet somewhat conservative.

DESCENT

This checklist need not be accomplished for changes in altitude during cruise. Accomplish the checklist in preparation for approach to the traffic pattern or landing. The pilot will insure that the copilot and navigator are informed as to the specific letdown and approach to be used with emphasis on intermediate altitude restrictions and minimum altitude.

PILOTS

1. Crew Briefing – COMPLETE. (ALL)

   Obtain and notify engineer of landing ETA, runway temperature, pressure altitude, and RCR.

G 2. Turn On No Smoking and Seat Belt Lights (CP)

3. Instrument Select Switch – SET (AS REQUIRED). (P, CP)

   Place the instrument select switch to desired position (VOR-ILS or TACAN) for approach.

4. Anti-Icing Equipment – CLIMATIC. (P)

5. Nose Steering – ENGAGED. (P)

   Check that switch is UP and light is OUT.

ENGINEER

CAUTION

- During descent, transfer oil only in accordance with OIL TRANSFER OPERATION, Section VII, to prevent overfilling nacelle oil tanks.
- Operation at high rpm and low manifold pressures should be kept to a minimum. Each 100 rpm requires 1 inch Hg manifold pressure; otherwise, master rod bearing failures may result.
- Slowly decrease cylinder head temperature to allow uniform cooling of the cylinders; otherwise, failure of the exhaust valve seats may result during subsequent engine operation.

1. Mixture Levers – AS REQUIRED.

PILOTS

6. AIMS/IFF - CHECKED (CP)

   Within 1 hour prior to estimated time of landing, a positive IFF check should be made with an air traffic control facility.

7. Safety Belt And Shoulder Harness – FASTENED. (P, CP)

8. Rudder Boost – ON. (P)

WARNING

To avoid a possible violent airplane maneuver, never turn rudder boost on during any maneuver which requires rudder action or excessive rudder trim. Rudder deflection with the same rudder forces differs with boost off.

9. Landing, Go-Around, Landing Data Card – REVIEWED. (P, CP, E)

   Review landing and go-around procedures; review all information on landing data card prior to landing and check appropriate stall speeds according to stall speed placard.

10. Compressor Stall Prevention Switch – AS REQUIRED. (P, CP)

11. Altimeters - SET (P, CP, N)

    Compare forecast altimeter setting with the setting obtained from FAA facilities. Pilot will announce altimeter setting over interphone. Pilot will announce altimeter setting over interphone after passing through transition altitude. Pilot and copilot will compare altimeter readings.

12. Crew Report – RECEIVE. (P, E, BO)

    Boom operator and engineer will report, "DESCENT Checklist complete."

ENGINEER

2. Turbo And Intercooler Switches – AS REQUIRED.

   Maintain carburetor air temperature outside of icing range.

3. Carburetor Air Switches – AS REQUIRED.

4. Cowl Flap Switches – AS REQUIRED.

5. Oil Cooler Flap Switches – AUTO.

6. Cabin Altitude And Rate-Of-Change Selector – AS REQUIRED.

7. Airplane Fuel Quantity Gages – CHECKED.

8. Battery Switch – ON BUS.

9. Overhead Panel Circuit Breakers – CHECKED SET.

10. Engineer's A/R Panel:

    a. Panel In Operating Position And A/R Master Switch – ON.

    b. A/R Fuel Quantity Gages – CHECKED.

    c. A/R Master Switch – AS REQUIRED.

    d. A/R Panel – AS REQUIRED.

WARNING

During descent and while JP-4 is being supplied to the jet engines from the A/R system, select fuel from the aft A/R tanks or main fuel system if forward A/R tanks contain less than 2000 pounds of fuel.

11. Landing Data Card – PRESENT TO PILOT. (E, P, CP)

    The data card may be accomplished at any time that landing conditions and time are known.

NOTE

During transition flying, data cards will be prepared for every 5000-pound weight change.

12. Report To Pilot – "DESCENT CHECKLIST COMPLETE." (E, P)

BEFORE LANDING

PILOTS

NOTE

- Prior to any approach or landing, the crew will accomplish the BEFORE LANDING Checklist.
- Refer to Section V for weight and cg limitations.
- On the downwind leg the pilot will call for the BEFORE LANDING Checklist. If the airplane remains in the traffic pattern following takeoff, the DESCENT Checklist need not be accomplished. However, a review of the landing data card, go-around, and landing procedures will be accomplished, but need not be repeated after the initial review provided no change occurs in the landing data card, or pilots' and engineer's crew positions. If no change occurs in the pilots' or engineer's crew position, only a review of the TOLD card is required with each 5000-pound weight change.
- Referring to figure 2–6, enter the downwind leg at the altitude prescribed in command and/or local directives. Maintain this altitude throughout the downwind leg. The turn from the downwind leg to the final approach will be a descending 90-degree turn to the base leg, with a gradual reduction in altitude throughout the maneuver. A rollout, to wings level attitude on base leg, will be of sufficient duration to allow for visual clearance of aircraft in all directions. Roll out on final approach at a minimum altitude of 700 feet.

1. Autopilot – OFF. (P)

   Pilot will depress autopilot release switch. Insure by slight movement of controls that clutches are released and turn the autopilot master switch OFF.

2. Jet Engines – AS REQUIRED.

   The jet engines will normally be shut down before landing. When one or more reciprocating engines are not operating normally, or when go-around performance is marginal, the jet engines will be running for the approach and will be shut down when a safe landing is assured.

NOTE

Jet engines will be shut down immediately after touchdown when the landing is assured, as the landing roll is excessively increased with the jet engines running.

3. Instrument Select Switch - SET (AS REQUIRED). (P)

(4.) RPM – CALL FOR 2350 RPM. (P, E)

The pilot will direct the engineer to set 2350 rpm; engineer will respond, "RPM 2350." (2550 or 2700 if required with one or more engines inoperative).

ENGINEER

1. Mixture Levers – CHECK AUTO RICH (LOCKED).

(2.) RPM – SET 2350 RPM OR AS DIRECTED AND REPORT TO PILOT. (E, P)

3. Cowl Flap Switches – SET (1 TO 3 INCHES).
4. Boost Pump Switches:
   a. Main – NORMAL.
   b. CWT And Sump – AS REQUIRED.

PILOTS

(5.) Landing Gear Switch – DOWN. (P, CP)

The pilot will state on interphone, "Landing gear down. Request visual check." The copilot will place the landing gear switch DOWN and cover in place. Crewmembers will visually check that the main landing gear and nose landing gear are down and report checks to engineer. The copilot will check that the landing gear indicators indicate INTERMEDIATE and DOWN during the landing gear extension cycle and check the warning light. The pilot checks landing gear position indicators for down and locked condition.

If performance is critical, with one or more engines inoperative, landing gear will be lowered on final approach when certain that the field can be reached.

WARNING

The landing gear warning horn and light microswitches are set for throttle position only. At high field elevations or high power settings, the warning horn may not indicate an unsafe gear condition since throttles may not be retarded to the one-fifth open position necessary to actuate the microswitches.

CAUTION

If any landing gear fails to extend by use of the normal system, the affected landing gear will be extended manually. When there is any indication that the landing gear position indicators (Selsyn) and/or warning light indicate a landing gear position different from the known position, the landing gear will be extended manually. This is to insure that the landing gear is down and in the locked position before a landing is attempted. Recycling of the landing gear should not be attempted to lower a defective landing gear unless the manual system has failed.

6. Hydraulic System - CHECK. (CP)

Copilots checks hydraulic supply for proper level and all three hydraulic pressure gages for normal pressure.

(7.) Wing Flaps – Set 55 PERCENT. (P, CP, BO)

Direct copilot to set wing flaps 55 percent. Boom operator will report wing flap setting.

CAUTION

With one or more engines inoperative, set wing flaps as required, but do not extend flaps over 55 percent until certain that the field can be reached without increasing power.

ENGINEER

5. CWT Line Valve Switch – AS REQUIRED.
6. Fuel Selector Switches – AS REQUIRED.

   Fuel selector switches will normally be in the TE position.

7. Jet Engine Fuel Selector Switches - AS REQUIRED.
8. TBS Lever – CLIMATIC.
9. Turbo Switches – CLIMATIC.

   Leave switch in AUTO if TBS is being used.

10. Turbo Override Switches – CLIMATIC.

    Open 10 seconds (after TBS lever is placed at zero), OFF, GUARDS UP.

11. Carburetor Air Switches – CLIMATIC.
12. Intercooler Flap Switches – CLIMATIC.

    With filters installed, open 2 inches if sheltered air doors are in SHELT position.

13. Body Heater Switches – OFF.
14. Safety Belt And Shoulder Harness – FASTENED.

BEFORE LANDING (Cont)

PILOTS

9. Landing Lights – EXTEND (AS REQUIRED). (P, CP)

   The pilot will direct the copilot to extend the landing lights. Copilot will extend and turn lights on to determine if they are operating. After the check they will be left in the extended position, but turned off until needed on final approach.

10. Landing Gear Switch – DOWN (ON FINAL IF PERFORMANCE IS CRITICAL AND ONE OR MORE ENGINES INOPERATIVE). (P, CP)

    Request and receive visual check of landing gear position. Extend landing gear on final approach when certain the field can be reached.

(11.) Engineer's Report – RECEIVE. (P, E)

(12.) Final Wing Flaps – SET AS REQUIRED. (P, CP, BO)

Boom operator will report wing flap setting. Use 55 to 80 percent wing flaps if snow conditions require, to prevent wing flap damage.

CAUTION

- At a gross weight less than 105,000 pounds, and at 15 to 18.5 percent MAC, wing flaps must be limited to 80 percent throughout the approach to touchdown.
- Add 10 knots or actual gust values below 10 knots to approach and touchdown speeds during gusty or strong crosswind conditions.

ENGINEER

(14.) Report To Pilot – "GEAR DOWN, CHECKLIST COMPLETE." (E, P, N, BO)

15. Surface Anti-Icing Heater Switches – OFF.

    Place switches to OFF when airplane approaches the flare point.

16. TBS Lever – 0.

    Place TBS lever to 0 when airplane approaches the flare point.

GO-AROUND

PILOTS

1. Crew Notified – GO-AROUND. (P)

(2.) RPM 2700 – SET. (P, E)

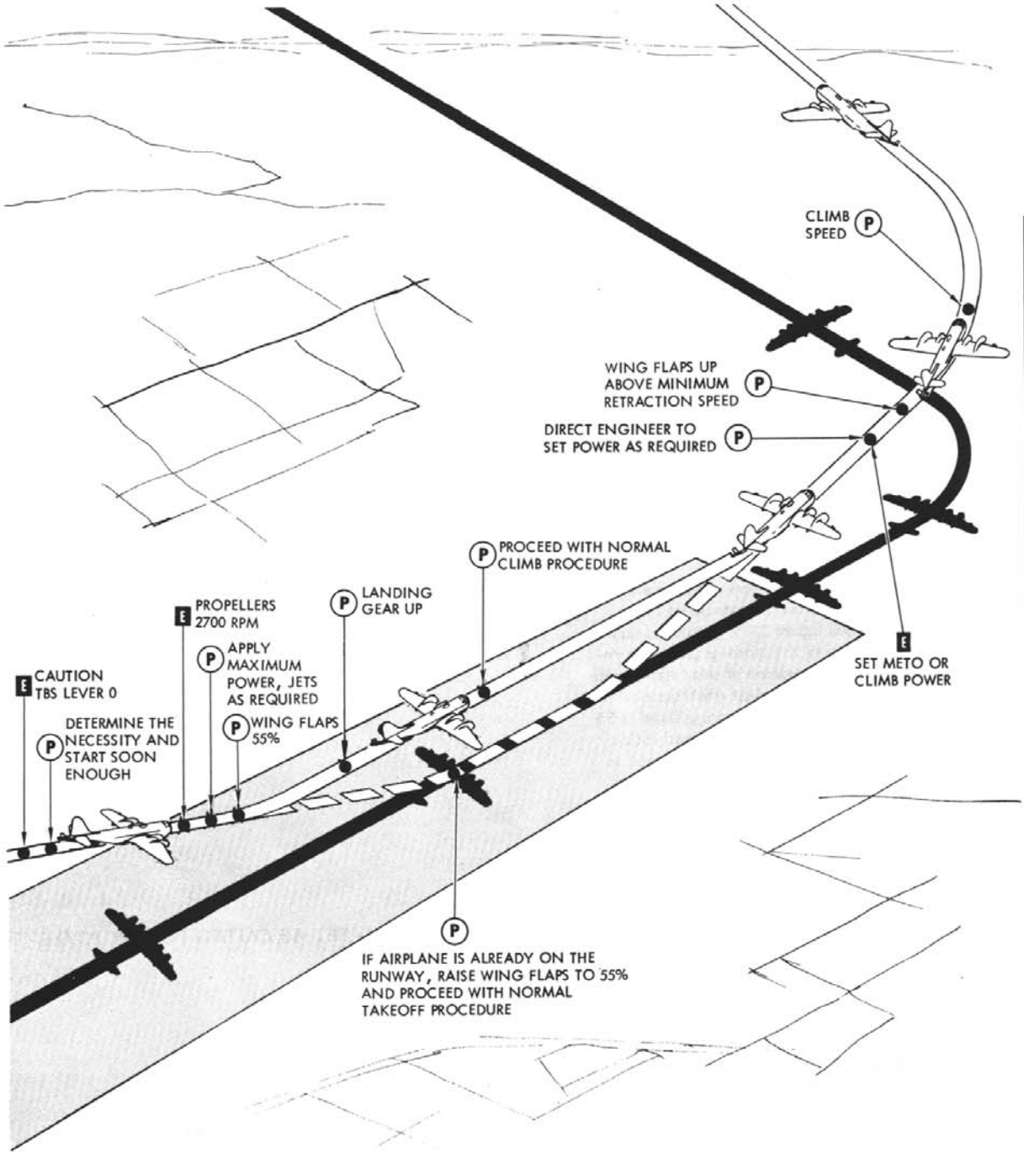
Direct engineer to increase rpm to 2700.

ENGINEER

1. TBS Lever – 0.

(2.) RPM – INCREASE TO 2700. (E, P)

When directed by pilot, advance prop. sync lever to 2700 rpm.



GO-AROUND PROCEDURE

Figure 2-5

GO-AROUND (Cont)

PILOTS

(3.) Throttles – ADVANCED. (P, CP, E)

Advance throttles evenly and smoothly to maximum power. Engineer will adjust throttles to maximum power. Notify engineer, "Engineer's throttles." Copilot will set jet engine throttles as directed.

4. Wing Flaps – SET 55 PERCENT. (P, CP)

Note

- Immediate wing flap retraction to 55 percent is required to effect a safe go-around.
- When directed to set wing flaps to 55 percent, copilot will raise wing flaps to 55 percent in one movement.

5. Landing Gear Switch – UP, THEN OFF. (P, CP)

Signal copilot for landing gear UP when it is evident that contact with the runway will not be made.

Note

- Retraction of the landing gear must be started the instant it is certain the airplane will not touch down. (See figure 2–5.) Unnecessary delay in retraction of the landing gear may result in prolonged operation at near stall conditions and the inability to clear obstructions. If touchdown is inevitable, leave wing flaps at 55 percent and maximum power on, and touch down as lightly as possible. Then proceed as nearly as possible in accordance with takeoff procedures, depending upon length of runway available, obstructions, etc.
- In an emergency, the landing gear and wing flaps can be raised simultaneously if three or more generators are operative.

(6.) Power – AS REQUIRED. (P, CP, E)

When a safe go-around altitude and airspeed are obtained, call for power, as required. Copilot will set jet engine throttles.

7. Wing Flaps – FULL UP. (P, CP)

After obstacles are cleared, direct copilot to retract wing flaps when reaching minimum wing flap retraction speed or 140 knots, whichever is greater, and a safe altitude. After wing flaps are up, call for AFTER TAKEOFF-CLIMB Checklist.

ENGINEER

(3.) Power – ADJUST TO MAXIMUM POWER. (E, P)

Acknowledge throttle control.

4. Pressures And Temperatures – CHECKED WITHIN LIMITS.
5. Cowl Flap Switches – ADJUST AS REQUIRED.

(6.) Power – SET AS CALLED FOR BY PILOT. (E, P)

TOUCH AND GO LANDING

CAUTION

- Runway conditions will be taken into consideration when making touch and go landings.
- Airplane weight will not exceed the maximum weight for transition as reflected in Major Command directives.
- Jet engines will be operating on all touch and go landings above gross weights of 130,000 pounds.

Note

- 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 within the immediate proximity of the ground. Touch and go landings will be made only when authorized by the Major Command concerned.
- The pilot will notify the crew of his intention to make a touch and go landing and verbally review this procedure and action to be taken in the event that the takeoff is aborted. The boom operator will report all wing flap movement throughout the touch and go landing. The engineer will closely monitor takeoff and landing gross weights. The TOLD card will be recomputed for every 5000-pound change in actual airplane gross weight.

PILOTS

(1.) RPM 2700 – SET. (P, E)

When ground contact is made and the pilot has made the decision to continue the touch and go, he will direct the engineer to set rpm at 2700.

2. Power – SET (APPROXIMATELY 15 INCHES HG). (P)

Pilot will advance power to approximately 15 inches Hg to preclude too rapid deceleration of the airplane.

3. Elevator Trim – SET. (P, CP)

Direct copilot to set trim as desired.

(4.) Wing Flaps – SET 33 PERCENT. (P, CP, BO)

Direct copilot to adjust wing flaps to 33 percent in one movement. Boom operator will report wing flap movement and setting.

(5.) Maximum Power – SET. (P, CP, E)

Advance throttles to maximum power. Engineer will adjust throttles to maximum power. Set jet engine throttles as required. Notify engineer that he has the throttles when commited to takeoff. Engineer will acknowledge.

6. Airspeeds – CALLED OUT. (CP)

Copilot reports S_2 airspeed to the pilot.

Note

Complete applicable items on the AFTER TAKEOFF – CLIMB Checklist.

ENGINEER

(1.) Prop. Sync Lever – FULL INCREASE RPM (FOUR LIGHTS ON). (E, P)

On initial touchdown, advance prop. sync lever to full INCREASE RPM, checking that four prop. rpm limit lights are illuminated.

2. Boost Pump Switches (Main Tanks) – NORMAL (EMERGENCY, ONE PER TANK, IF REQUIRED).

CAUTION

To reduce danger of fuel leakage, return boost pump switches to NORMAL if fuel pressure exceeds limits when operating in EMERGENCY position.

(3.) Power – ADJUST THROTTLES TO MAXIMUM POWER. (E, P)

Engineer acknowledges he has taken control of throttles.

4. Pressures And Temperatures – CHECKED WITHIN LIMITS.
5. Cowl Flap Switches – ADJUST AS REQUIRED.

LANDING

Refer to Part 6 of T.O. 1C-97(K)L-1-1. See figure 2-6 for normal approach and landing pattern.

NORMAL LANDING TECHNIQUE

Every approach and landing should be planned as though reverse thrust were not available.

WARNING

Under no circumstances will thrust be reversed during flight prior to ground contact or an uncontrollable sink rate will result.

Maintain a 130 KIAS or charted approach speed, whichever is greater on final approach until approaching runway threshold. Airspeed will then be reduced during landing flareout to pass over runway threshold at minimum approach airspeed (approximately 25 KIAS above stalling speed). On all approaches for landing, including instrument approaches, the copilot will monitor the altimeter and vertical velocity indicators. He will advise the pilot when the angle of bank exceeds 30 degrees, airspeed falls below computed traffic pattern or final approach speeds, or when the airplane appears to be dangerously low to the ground or other obstructions (visual and altimeter crosscheck). A power-on approach with a rate of descent of approximately 600 feet per minute as the airplane approaches the flareout point is recommended for all landings unless otherwise necessitated by emergencies. Power-off landings should be avoided, since this type of landing increases the altitude at which the flareout must be initiated and thus increases the precision necessary for a satisfactory landing. This is especially true of crosswind landings. The airplane should touch down on the main wheels first with the nose wheel slightly off the runway. Three-wheel or nose-wheel landings should be avoided. As soon as the airplane is safely on the ground, the nose wheel should be lowered smoothly to the runway. Rudders should be used for directional control as long as possible. When rudder is no longer effective the pilot will use nose wheel steering for directional control. When the airplane has slowed to 60 knots, use normal braking action. Slow the airplane to normal taxiing speed before turning off the runway to avoid severe side strain on the nose gear.

CAUTION

When landing with a full forward cg, the airplane has a tendency to land in a three-point attitude or with nose wheel first. This tendency is partially offset by the use of an 80 percent wing flap setting. This wing flap setting is the optimum for best landing speed and elevator control.

FORWARD CG LANDING TECHNIQUE

When landing with a full forward cg, especially the 15 to 18.5 percent MAC range allowable below 105,000 pounds gross weight, the airplane has limited elevator control and a tendency to land nose wheel first. This may be offset by using not more than 80 percent wing flaps on final approach and touchdown, and increasing minimum approach speed 130 percent of full wing flap power-off stall speeds. Minimum power must be maintained at 15 inches Hg manifold pressure on final approach and throughout the flareout where a gradual reduction of power is made to contact the ground with main landing gear first in a slightly nose-up attitude.

WARNING

Do not chop throttles during approach, as settling of the airplane will result.

CAUTION

The limited elevator control and light elevator stick forces present, coupled with a full forward cg, make strict adherence to the recommended airspeed and power and wing flap settings mandatory for adequate control during landing. Strict adherence to these recommendations is also necessary to offset the tendency of the airplane to land in a three-point attitude or nose wheel first.

HEAVY WEIGHT LANDING TECHNIQUE

Landings up to the maximum allowable takeoff gross weight can be made without exceeding the structural limits of the airplane. However, under heavy weight conditions, it is extremely important that the airplane be greased on with a low sinking speed at touchdown. Pilot should give consideration to reducing weight if conditions warrant.

MINIMUM ROLL LANDING TECHNIQUE

To make a minimum roll landing, make a normal approach at charted stalling airspeed, plus 15 knots. Extend the final approach and come in lower with power on and full wing flaps. Aim for touchdown on the first usable portion of the runway and begin flareout before reaching the end of the runway so that touchdown will be as close as possible to the end of the runway. Ease power off and lower nose wheel to ground immediately. Open throttle reverse lock plate, pull throttles back, and apply reverse thrust. Continue to apply power at REVERSE OPEN until the airplane comes almost to a stop, then return to forward thrust. Use normal brakes as the airplane speed falls below 50 knots.

CROSSWIND LANDING TECHNIQUE

In making a crosswind landing, the following variations have to be taken into consideration:

a. Velocity of the wind

b. Condition and length of runway

c. Wind component (90-degree, 25-knot wind component maximum)

d. Gustiness of wind

There are three methods of making crosswind approaches:

a. Lower the upwind wing

b. Crab into the wind

c. Combination of the first two methods

A 55 percent wing flap setting is recommended for best control. This wing flap setting and an approach airspeed of 125 percent stall (adjusted for gusts) make the approach slightly longer than usual. This will enable the pilot to establish a definite ground track along the prolongation of the runway. Just before touchdown on the runway, align the airplane with the runway and level the wings. Under extreme crosswind conditions, raise the wing flaps as soon as the main landing gear is on the runway, place the nose wheel on the runway and hold forward pressure on the yoke as this will give positive steering control. On dry runways it is better to set the airplane down on the upwind landing gear rather than hit the runway in a crabbing attitude. On runways covered with smooth ice or packed snow with no dry spots or ruts, landing in a crab attitude is permissible and will minimize the possibility of losing directional control and sliding off the edge of the runway.

NIGHT LANDING TECHNIQUE

Use normal landing technique. Do not turn on landing lights in a turn. Avoid using landing lights if landing in fog, smoke, or thick haze. Under such conditions, reflection of the light from the haze or fog impedes rather than aids vision, making the landing lights useless. Have the copilot monitor airspeed and altitude down the final approach. Leave some power on (15 inches Hg manifold pressure during flareout and touchdown). The use of the taxi light will greatly aid the pilot in seeing the runway directly in front of the airplane.

LANDING ON SLIPPERY RUNWAYS

When landing on wet or icy runway, touchdown should be made as close to the end of the runway as possible in order to make the maximum use of runway length for slowing the airplane.

Wet Runway

Generally, if runway is well drained, landing on a wet runway is accomplished normally. However, if the runway contains low spots or is covered with water of undetermined depth, use reduced wing flap position to prevent possible damage to wing flap surfaces. If the runway is slippery or if water conditions are such that directional control of the airplane might be difficult, leave the outboard engines in forward thrust for directional control and decelerate by using reverse thrust on the two inboard engines.

Icy Runway

Extreme care must be exercised when landing on icy runways. A combination of brakes and power setting is required. When landing on an icy runway, leave the outboard engines in forward thrust for directional control of the airplane and decelerate by using reverse thrust on the two inboard engines. Excessive use of either brakes or power may result in an uncontrollable skid.

THRUST REVERSING TECHNIQUE

Thrust reversing will be utilized only after all wheels are definitely on the ground. Normally, reverse thrust idle will be used unless runway available is critical. After the airplane has touched down and is rolling straight down the runway, the copilot will hold the control column slightly forward, release the throttle lock, and open the throttle reverse lock plate. The pilot then will close the throttles to forward thrust idle position, pause momentarily, then lift the throttles over the detent and into the reverse thrust idle position.

Note

To preclude accidental or inadvertent reversed action of an individual propeller, do not momentarily stop or leave the throttles on top of the throttle detent during reversal procedures.

Reverse thrust is most effective during the initial part of the landing roll. Normally, the reverse thrust idle position will be used to decelerate the airplane to 60 knots, at which time the throttles will be returned to the forward thrust idle position and normal braking used as required. If for emergency reasons power is required in the REVERSE OPEN range, a definite pause should be made in the reverse thrust idle position. This is required to allow the propeller blades to move past the flat pitch position before moving the throttles on back into the REVERSE OPEN range to obtain the amount of reverse thrust desired. Apply power gradually in the REVERSE OPEN range after ascertaining that all propellers are in reverse. If an engine starts to die during propeller reversal, the engineer will notify the pilot and try to keep the engine running by moving the mixture lever to a leaner mixture position. The engineer should not move his throttles during the reversing cycle. Refrain from using the nose wheel steering until the ground speed has decreased, to prevent skidding of the nose wheel tires. When landing on runways covered with light dry snow or heavy dust, pilot visibility may be impaired by blowing dust forward of the airplane if reverse thrust is used at

low speeds. For more positive feel and control of all throttles, the overhand, palm down, technique for reversing is recommended.

WARNING

During landing, when the airplane is in the three-point attitude on the runway and any propeller has been placed in reverse thrust, the pilot will not attempt to place the propeller in forward thrust and attempt a takeoff. This procedure, if attempted, can result in the propeller staying in flat pitch and preventing acceleration to takeoff speed.

CAUTION

- If a propeller oil quantity light is illuminated, do not attempt to use reverse thrust on that engine (or its opposite) as the oil quantity may be insufficient to accomplish reverse thrust.
- In the event an engine is lost during reverse thrust operation or taxiing, the engine will not be restarted until a fire guard is posted, except in emergencies.
- Difficulty in holding controls may be encountered when using reverse thrust below 60 knots.
- If the airplane starts a yaw to either side during any part of the reversing procedure, the following procedures will be accomplished simultaneously:

a. Rudder will be used primarily to correct the yaw.

b. Apply brakes as necessary.

c. The reversed throttles will be brought to the forward thrust position.

d. Outboard engines may be used for forward thrust to aid in returning the airplane to the desired track, if necessary.

e. On dry pavement nose wheel steering is effective and should be used.

NORMAL LANDING PROCEDURE AFTER TOUCHDOWN

When ground contact is made, the copilot will unlock the throttle lock lever and open the throttle reverse lock plate and check that warning flag is down. The engineer will move the prop. sync lever to full INCREASE RPM and check that all four rpm limit lights are illuminated in anticipation of a possible go-around. The mixture levers will be unlocked by the engineer only after there is no possibility of a go-around, but prior to any thrust reversal. The engineer will open the cowl flaps if reverse thrust will not be used or after reverse thrust is completed. As the pilot moves the throttles back into idle reverse position, the copilot will move the control wheel forward and hold it steady to prevent any thrashing around if reverse thrust is required. The pilot will have his hand on nose wheel steering during transition into reverse to counteract unsymmetrical reversing or other unusual condition. The copilot will then check the hydraulic pressure and report to the pilot, "Hydraulic pressure checks okay," or cite exceptions. Normally the pilot will begin braking the airplane at 60 KIAS, applying light brake pressure initially and increasing the pressure as required in order to obtain a steady rate of deceleration to the end of the landing roll. The airplane should not be allowed to roll free and then braked heavily near the end of the runway in order to stop.

CAUTION

Because of the airplane momentum and the fact that it is light on the ground for some distance after touchdown, it is possible to unintentionally lock a wheel even with very light brake pressure. Apply brakes carefully if needed.

Note

Brake action normally should be applied by the pilot.

LANDING

PILOTS

1. Jet Engine Throttles – STOPCOCK. (CP)

Note

Jet engines will be shut down immediately after touchdown when the landing is assured, as the landing roll is excessively increased with the jet engines running.

2. Throttles – UNLOCKED. (CP)

   Unlock throttle friction upon touchdown.

3. Reverse Lock Plate – OPENED. (CP)

   Copilot opens lock plate upon touchdown and checks that warning flag is down.

ENGINEER

1. Prop. Sync Lever – FULL INCREASE RPM.

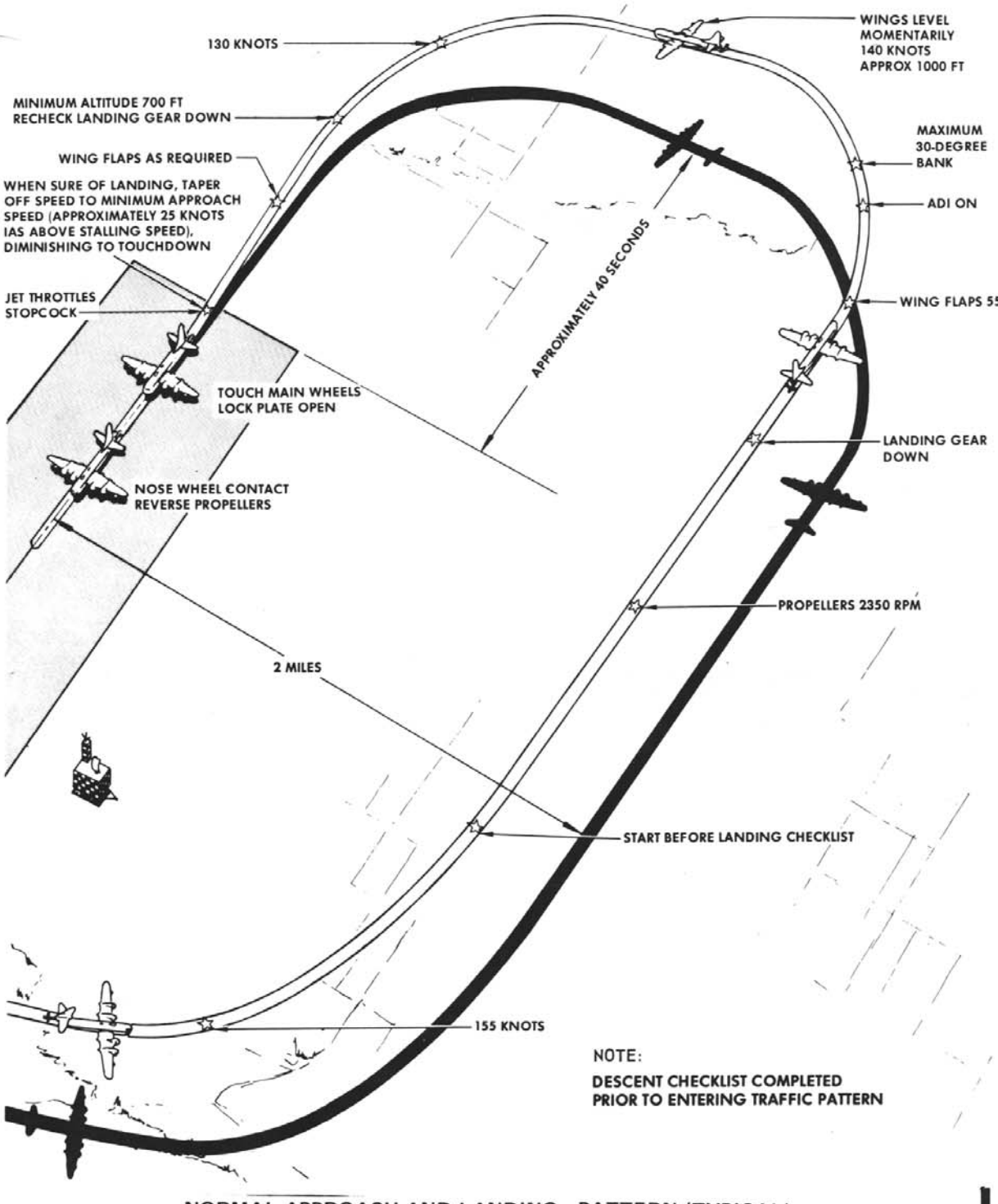
   Advance prop. sync lever to full INCREASE RPM after touchdown.

2. Mixture Levers – UNLOCKED.

   Unlock mixture levers after touchdown.

3. Cowl Flap Switches – OPEN.

   Open cowl flaps if reverse thrust will not be used or after reverse thrust is completed.



NORMAL APPROACH AND LANDING PATTERN (TYPICAL)

Figure 2–6

LANDING (Cont)

PILOTS

4. Reverse Thrust – APPLIED (AS REQUIRED). (P)

   Reverse thrust idle normally will be used only after all wheels are definitely on the ground and airplane is rolling straight down the runway. If runway available is critical, all four propellers should be reversed and reverse thrust applied as required. The pilot will reverse the propellers, as required, and will have his hand on nose wheel steering during transition into reverse to counteract unsymmetrical reversing or other unusual conditions. Under normal conditions, return throttles to forward thrust idle at 50 knots and utilize nose wheel steering.

   Note

   To preclude accidental or inadvertent reversed action of individual propeller, do not momentarily stop or leave the throttles on top of the throttle detent during reversal procedures.

5. Hydraulic Pressure – CHECKED. (P, CP)

   The copilot will check the hydraulic pressure and report to pilot, "Hydraulic pressure checks okay."

6. Brakes – APPLIED. (P)

   Normally begin braking at 50 knots.

ENGINEER

AFTER LANDING

PILOTS

1. AIMS/IFF - STANDBY/OFF (AS REQUIRED). (CP)

   Note

   Position the AIMS/IFF MASTER Switch to STBY or OFF as soon as possible after landing. If it is desired to retain the mode 4 codes between flights, it is necessary to lock the codes into the computer before positioning the MASTER control to "OFF." Positioning the MASTER control to "OFF," or removing power from the aircraft without first locking the codes into the transponder computer will zeroize the MODE 4 CODES. To lock the code, momentarily place CODE control in the "HOLD" position after landing, and then proceed with the normal stopping procedure. When power is next applied, the transponder computer will again operate normally. If it is again desired to lock the code in the transponder computer, it is necessary to repeat the "HOLD" procedure. The transponder computer will zeroize any time that power is applied and the CODE control is positioned to "ZERO," even if the "HOLD" function has been activated. Once the code is zerozed, the code is not available until reset.

ENGINEER

DURING TRANSITION FLYING, ENGINEER'S CHECKLIST NEED NOT BE ACCOMPLISHED.

1. Boost Pump Switches – OFF.
2. APU Switch – ON.
3. Oil Cooler Flap Switches – CLIMATIC.

   The oil cooler flap switches are normally at AUTO; during cold weather place to OPEN, then OFF.

4. Turbo Switches – AUTO.

PILOTS

2. Flight Controls – LOCKED. (CP)

   Flight controls may be locked after throttles have been returned to forward thrust and airplane is under control.

CAUTION

Controls must be centered and locked with rudder boost on. If the rudder is centered after the surface lock handle is raised, movement of the rudder pedals will depressurize the rudder boost hydraulic system, unlocking the rudder trim tab.

(Following may be performed after airplane is clear of runway.)

3. Pitot Heat Switches – OFF. (CP)
4. Landing Lights – AS REQUIRED. (CP)

   Landing lights may be used for taxiing as required.

5. ADI Switch – OFF. (CP)
6. Wing Flaps – UP. (CP)

   Wing flaps may be retracted to 33 percent if another takeoff is to be accomplished.

7. Trim Tabs – CENTERED. (CP)

   Reset all trim tabs to neutral. If an excessive amount of trim has been required that is not the result of fuel or cargo loading, it will be noted in the Form 781.

8. Forward Thrust – CHECKED (IF REQUIRED). (P, CP)

   If reverse thrust was used, the copilot will depress feathering buttons momentarily and watch for initial rpm drop. This is positive indication of forward thrust.

9. Cabin Pressure – RELEASE. (P, CP)

   Copilot will open cabin window to insure that all cabin pressure has been released.

(10.) Engineer's Report – RECEIVE (IF APPLICABLE). (P, E)

Note

- Outboard engines may be shut down at pilot's discretion.
- During transition flights, when the engines are not shut down after landing and the same basic air crew is to fly the aircraft, only the AFTER LANDING and BEFORE TAKEOFF Checklists need be accomplished.

ENGINEER

5. Turbo Override Switches – OPEN, GUARDS DOWN.
6. Anti-Icing Master Switch – ON.

   After ten seconds pull the empennage heater control breaker on the overhead panel and return the anti-icing master switch to off. This procedure will allow the empennage hearing ram air duct to remain closed while aircraft is parked.

7. Window Heat Selector Switch – OFF.
8. Alternator Switches – OFF.

   Use following sequence:

   a. Alternator Bus Selector Switch – OFF.

   b. Alternator Control Switches – OFF.

9. Prop. Deicing Switch – OFF.
10. Prop. Auto Control Switch – OFF.
11. Magneto Grounding – CHECKED.
12. Idle Mixture – CHECKED (AS REQUIRED).

    If any mixture malfunction is suspected, an idle mixture check will be performed. With engines set in 800 to 1000 rpm range and cylinder head temperature between 175° and 200°C, move each mixture lever slowly and evenly toward FUEL CUTOFF. "Slowly" may be defined as the rate of movement which would require 12 to 15 seconds to move the mixture lever from AUTO RICH to best power position. This slow movement of the lever is necessary so that the engine can respond to the change in fuel-air mixture and so that an accurate reading can be obtained as the best power mixture is reached. If a rise of more than 10 rpm is noted, the idle mixture is too rich a mixture.

Note

If the airplane is at its home station and the idle mixture is found to be out of adjustment, enter in Form 781. Change of altitude will affect idle mixture; therefore, when the airplane is away from home station, the idle mixture should not be reported.

13. Analyzer Switch – OFF.
14. Air Conditioning Master Switch – OFF.

(15.) Report To Pilot – "AFTER LANDING CHECKLIST COMPLETE." (E, P)

ENGINE SHUTDOWN

PILOTS

1. Parking Brakes – SET. (P)
2. Jet Engine T-Handles – OUT. (P)

CAUTION

This jet engine fuel-oil emergency shutoff valve T-handles should be pulled after engine rpm reaches 0 percent. Shutting off oil supply while the engine is still coasting down can collapse the engine oil supply line. If shutoff occurs after the engine has stopped turning, oil will drain from tank to engine increasing possibility of a post-shutdown fire.

(3.) Engines – SHUT DOWN NO. 1, NO. 3, AND NO. 4. (P, E)

Pilot directs engineer to shut down No. 1, 3, and 4 engines.

(4.) No. 2 Hydraulic Pump – CHECKED, SHUT DOWN NO. 2 ENGINE. (P, E)

With No. 2 engine running, pilot depresses nose wheel steering disconnect button and moves nose wheel steering while observing fluctuation of main hydraulic pressure gage. After No. 2 hydraulic pump is checked, pilot directs engineer to shut down No. 2 engine.

5. All switches – OFF OR NORMAL. (P AND CP)

Retract landing lights.

Note

Landing gear switch will be left in the DOWN position and cover in place.

6. AIMS/IFF Codes – As Required. (CP, N)

Note

This action is required during Engine Shutdown or before leaving the aircraft.

7. Reverse Lock Plate – CLOSED. (CP)
8. Parking Brakes – RELEASED. (P)

Release parking brakes after assuring that chocks are in place.

ENGINEER

1. Secondary, Autopilot, And Flight Instrument Inverter Switches – OFF.
2. Oil Dilution – COMPLETED IN COLD WEATHER.

Refer to Section IX to accomplish oil dilution for the purpose of aiding next engine start when expected OAT is 0°F(−18°C) or below. Enter time period of dilution in Form 781.

(3.) Engines No. 1, No. 3, and No. 4 - SHUT DOWN (WHEN DIRECTED) (E, P)

Shut down by placing mixture levers in FUEL CUTOFF.

CAUTION

After cylinder head temperature stabilizes below 180°C, set throttle to maintain 1000 to 1200 rpm for a period of 1 minute to accomplish engine scavenging.

(4.) After Hydraulic Pump Check – SHUT DOWN NO. 2 ENGINE (WHEN DIRECTED). (E, P)

Shut down No. 2 engine with mixture lever in FUEL CUTOFF.

5. Ignition Switches – OFF.
6. Essential Inverter Switch – OFF.
7. Oil Cooler Flap Switches – CLOSE AND OFF.
8. Carburetor Air Switches – SHELT (IF REQUIRED).
9. Fuel Selector Switches – TE.

This prevents fuel gravity leveling which could possibly cause overfilling inboard tank.

10. All Switches – OFF OR NORMAL.
11. Circuit Breakers – PULLED.
    a. Turn And Slip.
    b. Starter Control.
    c. Prop. Reversing Control.
    d. Jet Engine Starter.
    e. Interphone.
    f. Altimeter Vibrator.

PILOTS

(9.) Engineer's Report – RECEIVE. (P, E)

10. AIMS/IFF Mode 4 Computer - SECURE (As required). (CP)

ENGINEER

(12.) Report To Pilot – "ENGINE SHUTDOWN CHECKLIST COMPLETE." (E, P)

Note

Cowl flaps need not be shut below 2 inches after engine shutdown.

POSTFLIGHT INSPECTION

WARNING

Location of AIMS system pitot-static tubes is extremely dangerous to personnel departing the aircraft as they are located at eye level height. Care must be taken to insure personnel have enough clearance from the fuselage, before moving toward rear of the aircraft on the left side.

The pilots will make an exterior check for any obvious airplane damage. Insure Form 781 entries are completed.

Note

The pilots' and engineer's normal procedures also appear in T. O. 1C-97(K)L-1CL-1 and T. O. 1C-97(K)L-1CL-2 respectively, which are abbreviated checklists. The abbreviated checklists have each numbered step (and some substeps) of the normal and emergency procedures.

SECTION III

EMERGENCY PROCEDURES

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NOTE

- This Section contains text and amplified checklists to describe procedures to be followed in any emergency except those in connection with auxiliary equipment. This Section is presented in approximately chronological order, with emergency procedures grouped as they might be expected to occur during the course of a flight. Ground emergencies are discussed first, as they might occur during engine start or taxi. Next are takeoff emergencies, inflight emergencies, and on through the course of a flight, followed by systems emergency operation. The text is divided into primary paragraphs in accordance with the type of emergency and, where applicable, is followed by an amplified checklist for that particular emergency. The amplified checklists describe in detail the actions to be taken. In the checklists in this Section, certain actions are given in capital letters and bold face type. These actions are called critical actions and constitute the minimal steps to be taken by a crewmember to insure survival. These steps must be committed to memory. The boom operator and/or navigator will insure that passengers and extra crewmembers are notified of the emergency. A thorough evaluation of each emergency should be made prior to initiating corrective action to avoid incorrect action. All steps in each checklist must be accomplished when time permits in order to insure complete control of each emergency. To facilitate correct actions in an emergency, the items in all emergency checklists are directive in nature rather than of the challenge and response type. Regular personnel coding is used to designate the crewmember that will accomplish the actions.

- STOP-THINK-COLLECT YOUR WITS

  A thorough evaluation of each emergency should be made prior to initiating corrective action.

CREW COORDINATION

An emergency requires the full, coordinated effort of each crewmember. Emergency procedures should be practiced at every opportunity so the crew will become proficient in every procedure. All crewmembers shall be able to accomplish BOLD FACED procedures without reference to the checklist. When the pilot calls for an emergency checklist, all crewmembers will acknowledge. A well-trained crew will know the problem and, if properly indoctrinated, will react correctly and effectively under any condition. Except during engine separation, the copilot will make all power changes during any emergency until completion of the BOLD PRINT memory items and at any other time when required by the emergency checklist.

The CALL position of the interphone will be used, when required, to report emergencies. Any crewmember seeing a fire will announce, "Smoke" and/or "Flame." Crewmembers will also identify type and location of the flame/smoke.

NOTE

When any crew member cannot be contacted by normal interphone procedures, the CALL position will be used.

EMERGENCY SIGNALS

If time and circumstances permit, the pilot will advise the crew of the emergency, give instructions, and receive acknowledgement, by interphone.

ON THE GROUND

1. Prepare to abandon airplane: Three short rings the alarm bell.
2. Abandon airplane: One long sustained ring.

IN THE AIR

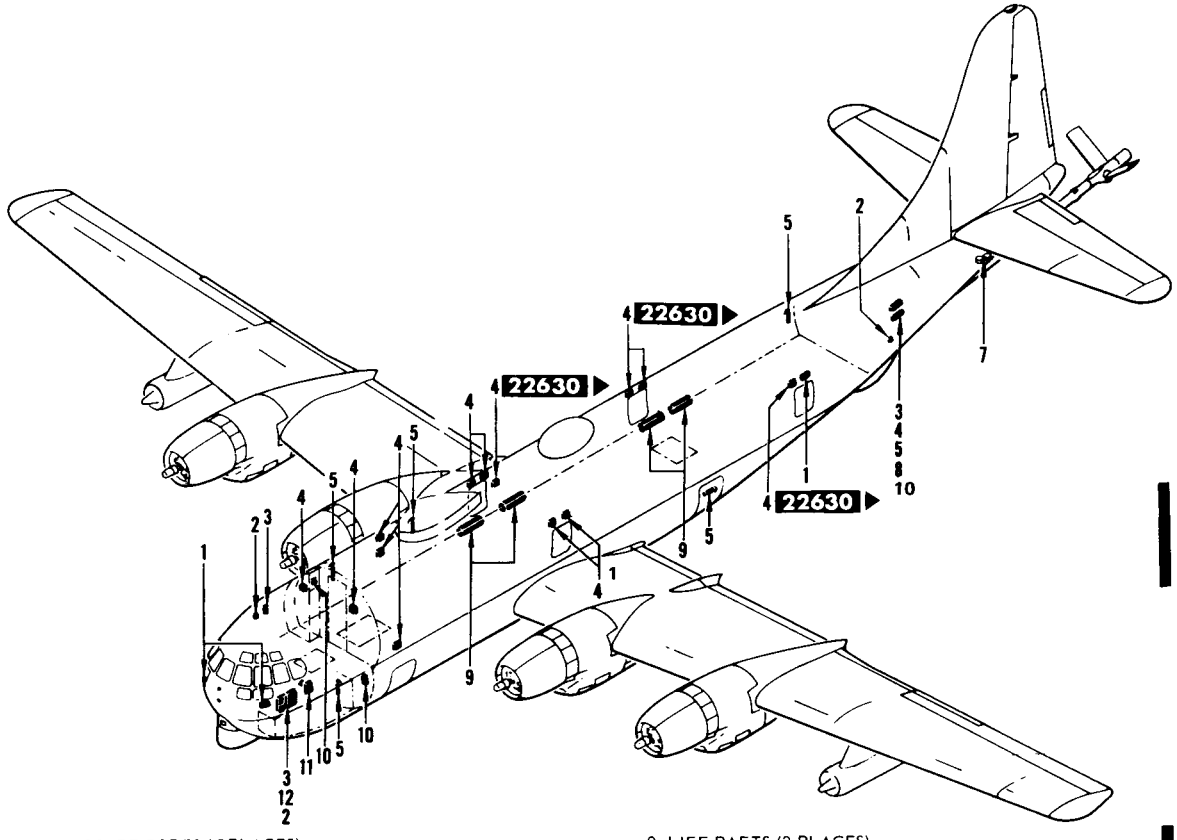
1. Prepare to bail out: Three short rings on the alarm bell.
2. Bailout: One long sustained ring.
3. In the event an immediate bailout is required and there is insufficient time for complete preparation, the pilot will sound one long ring on the alarm bell and announce on CALL position of interphone, "Bail out, bail out, bail out," and depressurize cabin.
4. Prepare for ditching or crash landing: Six short rings on the alarm bell.
5. Ditching or crash landing: One long sustained ring.
6. Ditching or crash landing immediately after takeoff: One long sustained ring.

During takeoff roll, any crewmember noting an abort condition will call, "Reject (followed by a description of the condition)," over the interphone. The pilot will make the decision to abort the takeoff or treat the condition as an inflight emergency. If the decision is made to abort, the pilot will announce, "Abort," over the interphone. If reject is called above decision speed, the pilot will state, "Continue takeoff," over the interphone and call for the appropriate emergency checklist.

CHECKLISTS

Use of the following terms in the emergency checklists will be interpreted as follows:

1. NOTIFY: Informing crew orally of an existing or impending emergency which does not require use of the alarm bell signals.
2. ALERT: Informing crew orally and by use of alarm bell to indicate necessity of initiating preparatory action for abandonment of the airplane, ditching, or crash landing.
3. WARN: Informing crew orally and by use of alarm bell to indicate necessity to execute bailout or brace for impact.
4. INFLIGHT: Anytime after S_1 speed has been reached.



1 ESCAPE ROPES (3 PLACES)
2 PORTABLE OXYGEN CYLINDER RECHARGER (3 PLACES)
3 PORTABLE OXYGEN CYLINDER (3 PLACES)
4 FIRST AID KIT (8 PLACES)
5 FIRE EXTINGUISHER (6 PLACES)
6 **DELETED**
7 LANDING FLARE TUBES
8 EMERGENCY PANEL: FIRE EXTINGUISHER, FIRST AID KIT, AND CRASH AXE
9 LIFE RAFTS (2 PLACES)
10 FIRE FIGHTERS' OXYGEN SETS (3 PLACES)
11 PYROTECHNIC PISTOL AND SIGNAL FLARE
12 PILOT'S AUXILIARY PANEL: CRASH AXE, FIRST AID KIT, FIRE EXTINGUISHER, PORTABLE OXYGEN CYLINDER, AND PORTABLE OXYGEN CYLINDER RECHARGER

EMERGENCY EQUIPMENT

Figure 3-1

GROUND EMERGENCIES

RECIPROCATING ENGINE FIRE DURING GROUND OPERATION

PILOTS

1. CALL TOWER (CP)

(2.) ALERT CREW (P, CP)

Alert crew of fire emergency and location by means of the interphone. Copilot will execute three short rings on the alarm bell.

3. STOPCOCK JET ENGINES (P, CP)

(4.) ABANDON AIRPLANE (ALL)

If fire is out of control, warn crew to abandon airplane. Copilot will execute one long ring on the alarm bell. Crewmembers will, after abandoning the airplane, render assistance as necessary to extinguish the fire.

ENGINEER

(1.) DETERMINE, REPORT OR ACKNOWLEDGE (ALL)

If torching or stack fire is encountered during engine starting, consideration should be given to discontinuing priming and continue cranking to blow out the fire.

2. GANG BAR AFFECTED ENGINE

After the airplane is safely stopped.

3. ALL MIXTURES OFF

4. RELEASE CO_2

Hold CO_2 release switch in FIRST FIRE position for 5 seconds. After engine stops and fire is still not extinguished, move CO_2 release switch to SECOND FIRE position; hold for 5 seconds.

(5.) REPORT FIRE STATUS TO PILOT (E, P)

(6.) Electrical Master and Ignition Switches OFF.

When the pilot gives the command to abandon the airplane, the engineer will turn off the master and ignition switches.

JET ENGINE FIRE DURING GROUND OPERATION

Jet engine fire extinguishing systems are not installed.

PILOTS

1. STOPCOCK JET ENGINES (P, CP)

2. PULL JET ENGINE T-HANDLE (APPLICABLE ENGINE). (P, CP)

NOTE

- If fire occurs during starting and the starter is still engaged, continue operating the starter. Motoring the engine will increase airflow through the engine and will often eliminate fire and/or smoke.

ENGINEER

(1.) DETERMINE, REPORT, OR ACKNOWLEDGE (E, P)

PILOTS	ENGINEER
● Do not attempt to engage starter if starting cycle has been completed. Attempting to engage the starter while engine is rotating will result in damage to the retractable starter dogs.	
3. **CALL TOWER (CP)**	
(4.) **ALERT CREW (P, CP)** Alert crew of fire emergency and location by means of the interphone. Copilot will execute three short rings on the alarm bell.	(2.) Shut Down Reciprocating Engines (When Directed) (E, P)
(5.) **SHUT DOWN RECIPROCATING ENGINES (P, E)** Direct engineers to shut down reciprocating engines.	(3.) Electrical Master and Ignition Switches OFF When the pilot gives the command to abandon the airplane, the engineer will turn off the master switch and all ignition switches.
(6.) **ABANDON AIRPLANE (ALL)** If fire is out of control, warn crew to abandon airplane. Copilot will execute one long ring on the alarm bell. Crewmembers will, after abandoning the airplane, render assistance as necessary to extinguish the fire.	

EMERGENCY TAXIING INSTRUCTIONS

If, while taxiing, the hydraulic system and emergency brakes fail, the hydraulic pressure cannot be raised with the handpump, and towing facilities are not available, use propeller reverse thrust action for braking the airplane. Since the steering system will usually be inoperative when the brakes fail, it will be necessary to use the engines for steering the airplane, as the nose wheel will caster freely. To maintain maximum control during emergency taxiing, open the throttle reverse lock plate, move the inboard engine throttles to REVERSE OPEN range, and then close the outboard engine throttles to a low idling speed until the airplane slows to a safe speed for taxiing. Next, reduce power on the inboard engines and idle the outboard engines at 1000 rpm. While taxiing, leave the inboard engines in reverse thrust until the airplane is clear of obstructions. Forward speed may be controlled with the outboard engines.

CAUTION

Continued or repeated use of reverse thrust may cause overheating with subsequent engine damage.

When the airplane is clear of all obstructions, again operate the inboard engines to stop the airplane. Have the engineer place the mixture levers for the outboard engines in the FUEL CUTOFF position. While this is being done, move the inboard engine throttles to the forward idle position to return the propeller to normal pitch.

FUEL PRESSURE DROP—ENGINE OPERATING NORMALLY

On The Ground

If the fuel pressure drops below the minimum operating limits during ground operation, but the engine continues to operate normally, stop the airplane and shut down engine immediately.

In The Air

If the fuel pressure drops below the minimum operating limits during flight, but the engine continues to operate normally, the cause may be one or more of the following: an instrument failure, clogged pressure lines, or a fuel leak. All applicable fuel systems and engine instruments should be checked for any signs of irregular indications. All applicable main and air refueling system switches, circuit breakers, and valves should be visually checked for correct position.

NOTE

If this does not correct the trouble, the following possible course of action, of which course A is generally the best, will depend upon the prevailing circumstances. Such factors as the known condition of the airplane, the remaining engines, stage and requirements of the mission, and power requirements should all be considered.

A. Shut down the engine if it is not needed to sustain flight or to reach a destination safely, by placing the mixture lever in the FUEL CUTOFF position and complete the ENGINE FAILURE FIRE IN-FLIGHT checklist.

B. Continue the engine in operation at or above cruising speed while maintaining a fire watch if the engine is needed to sustain flight or to maintain altitude and it cannot be determined if an actual leak exists. However, prior to power reduction for entrance to the landing pattern, shut down the engine by placing the mixture lever in the FUEL CUTOFF position and complete the ENGINE FAILURE/FIRE IN-FLIGHT checklist.

C. Continue the engine in normal operation if a fuel line failure check as outlined in TO CHECK A SUSPECTED LEAK IN THE AIRPLANE FUEL SYSTEM, this Section, indicates no fuel leak present.

EMERGENCY ENTRANCE

See figure 3-2.

TAKEOFF EMERGENCIES

ABORT

If an emergency occurs prior to S_1, the pilot will announce, "Abort," over interphone if takeoff is to be aborted.

PILOTS (Only)

1. **CLOSE THROTTLES (P)**
2. **STOPCOCK JETS (P, CP)**
3. **REVERSE PROPELLERS (SYMMETRICAL ENGINES) (P)**
4. **APPLY BRAKES (P)**

In extreme cases, retract the landing gear using normal and emergency switches.

WARNING

Do not exceed braking limits shown in figure 5-4 as this may cause tire explosions and fire that could endanger the crew and airplane.

NOTE

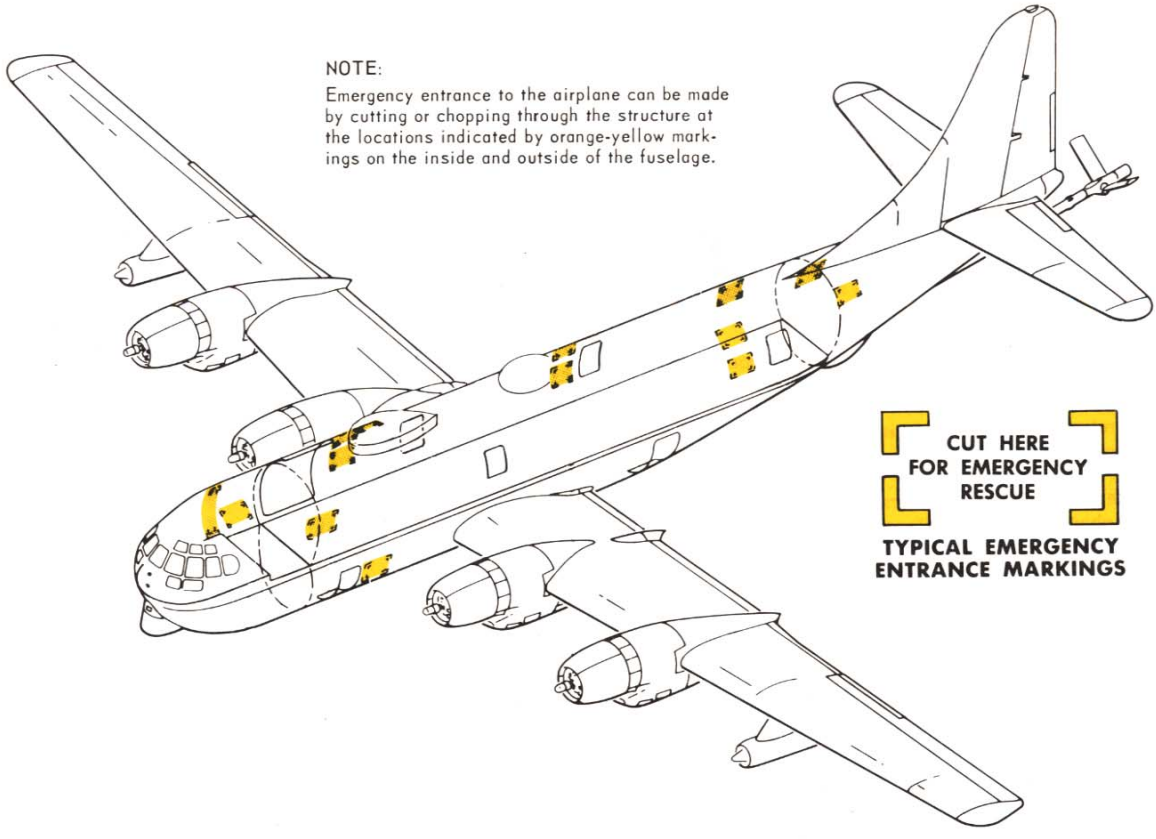
Figure 5-4 must be referred to any time after excessive braking has been used. Refer to BRAKING LIMITATIONS, Section V, and USE OF LANDING WHEEL BRAKES, Section VII.

TAKEOFF WITH ONE ENGINE INOPERATIVE

NOTE

This type takeoff is not recommended but may be accomplished when properly authorized. Takeoff with one engine inoperative will be accomplished only under optimum RCR conditions. Takeoff with adverse crosswinds (inoperative engine on the upwind side) will not be accomplished. Rudder boost must be on.

The primary consideration in accomplishing a takeoff with one engine inoperative is directional control. However, adequate directional control is available during the takeoff ground run if proper techniques for using nose wheel steering, rudder and asymmetrical engine power are observed. After the airplane is airborne, sufficient directional control can be



EMERGENCY ENTRANCES

Figure 3-2

maintained with rudder and ailerons. Refer to FIVE ENGINE TAKEOFF CONSIDERATION, Part 2 of T.O. 1C-97(K)L-1-1.

WARNING

If an engine fails, it is extremely doubtful that directional control can be maintained, especially if the failure occurs on the same side as the inoperative engine. If an engine failure on either side is experienced prior to takeoff, the takeoff will be aborted. Between takeoff and minimum inflight control speed, if an engine failure occurs on the same side as the inoperative engine, power must be reduced on the opposite jet engine to maintain directional control.

CAUTION

Proper use of symmetrical power and limited use of nose wheel steering is essential during the initial phase of the takeoff roll. Excessive asymmetrical power at brake release and over-correction with nose wheel steering will cause the nose wheel to skip, which will degrade acceleration and directional control.

Takeoff With One Jet Engine Inoperative

1. Align airplane in center of runway.
2. Set brakes.
3. Set reciprocating engines at barometric pressure.

4. Set operable jet engine at 80 percent rpm and complete stall prevention check.
5. Release brakes and advance reciprocating engines to maximum power.
6. Maintain directional control with nose wheel steering until rudder becomes effective (approximately 60 knots).
7. After reaching 90 KIAS, advance the throttle on the operable engine to 100% at a rate commensurate with rudder control.
8. When the airplane is definitely airborne, retract landing gear.
9. Climb at safe three-engine airspeed until obstacles are cleared.
10. When safe wing flap retraction airspeed is reached, raise wing flaps in about 10% increments until up.
11. Trim airplane for hands-off.

Takeoff With One Reciprocating Engine Feathered

CAUTION

Emergency static source heat will not be available if the No. 3 engine is inoperative.

1. Align airplane in center of runway.
2. Set brakes.
3. Advance jet engines to 80% rpm and make stall prevention check, then advance to 100% and stabilize.
4. Set symmetrical reciprocating engines at barometric pressure.
5. Set asymmetrical reciprocating engine at idle rpm.
6. Release brakes and advance symmetrical reciprocating engines to maximum power.
7. Maintain directional control with nose wheel steering until rudder becomes effective (approximately 60 knots).
8. When reaching 90 KIAS, advance power on asymmetrical engine to maximum power at a rate commensurate with rudder control.
9. When the airplane is definitely airborne, retract landing gear.
10. Climb at safe three-engine airspeed until obstacles are cleared.
11. When safe wing flap retraction airspeed is reached, raise wing flaps in about 10% increments until up.
12. Trim airplane for hands-off.

PROPELLER FAILURE

The 34G60, solid Dural propeller is a hydromechanical design in which oil pressure opposes the inherent tendency of the blades to rotate to flat pitch. If the pitch lock is effective, movement to flat pitch, due to loss of governing, will be retarded above 2600 rpm and essentially stopped at 3100 rpm. Overspeeds above 3100 rpm then indicate leakage in the dome assembly which will make feathering difficult, if not impossible. As rpm increases, the blade twisting forces also increase until, at 3800 rpm, maximum available oil pressure is required for control. At higher rpm, feathering cannot be accomplished, since available oil pressure is limited. A leak in transfer passages or dome assembly may further limit available oil pressure, thereby reducing the rpm at which feathering will occur. Therefore, every safe means of reducing propeller overspeed must be used to bring the rpm back to a controllable range.

Propeller Overspeed on Takeoff

If an overspeed occurs during takeoff, the first decision required is whether to continue or abort. If the blades are at mechanical low pitch stop, as indicated by less than 3300 rpm with full power, an airplane control problem is not indicated and some power may be obtained from the engine at reduced throttle setting. In this case, continuing the takeoff may be preferred to a last minute abort with unsymmetrical reversing a possibility. However, when operating from long runways, this airplane may be capable of safely stopping in the remaining distance, even after the normal decision point is passed. In any case of propeller control loss, an abort is justified and a safe stop is preferred to continuing the takeoff. A propeller with the pitch lock engaged (3100 rpm) can possibly be reversed and should be used if required to effect a safe stop. In the event of governor failure, the propeller blade angle is limited by the pitch lock or low pitch stop so that some power may be obtained from engine.

WARNING

When takeoff performance is critical, it is recommended that the propeller be permitted to overspeed allowing pitch lock to engage (approximately 3100 rpm). On climbout, rpm will increase approximately 50 rpm with each 10 knots increase in IAS. No attempt should be made to reduce rpm with throttle prior to pitch lock engaging, since a relatively ineffective flat blade angle at reduced throttle will result.

CRASH LANDING/DITCHING AFTER TAKEOFF

PILOTS

1. **GEAR—AS REQUIRED (P, CP)**
2. **LOCK SHOULDER HARNESS (P, CP)**

   Pilot and copilot manually lock inertia reel.

3. **WING FLAPS SET AS REQUIRED (P, CP)**

   Signal copilot to set flaps full down for crash landing or 55 percent for ditching. Land as slowly as possible.

4. **WARN CREW (P, CP)**

   Copilot will notify personnel by interphone on CALL position for crash landing: copilot executes one long sustained ring on alarm bell.

(5.) **CLOSE THROTTLES (P, CP, E)**

Close all throttles immediately before ground contact. Jet throttles to STOPCOCK.

ENGINEER

1. **LOCK SHOULDER HARNESS**

(2.) **MIXTURE LEVERS OFF AND IGNITION SWITCHES TO OFF (E, P)**

Move mixture levers to FUEL CUTOFF, and turn ignition switches OFF when pilot closes throttles.

3. **MOVE ELECTRICAL MASTER SWITCH TO OFF**

Turn electrical master switch OFF just as ground contact is made.

INFLIGHT EMERGENCIES

ENGINE FAILURE

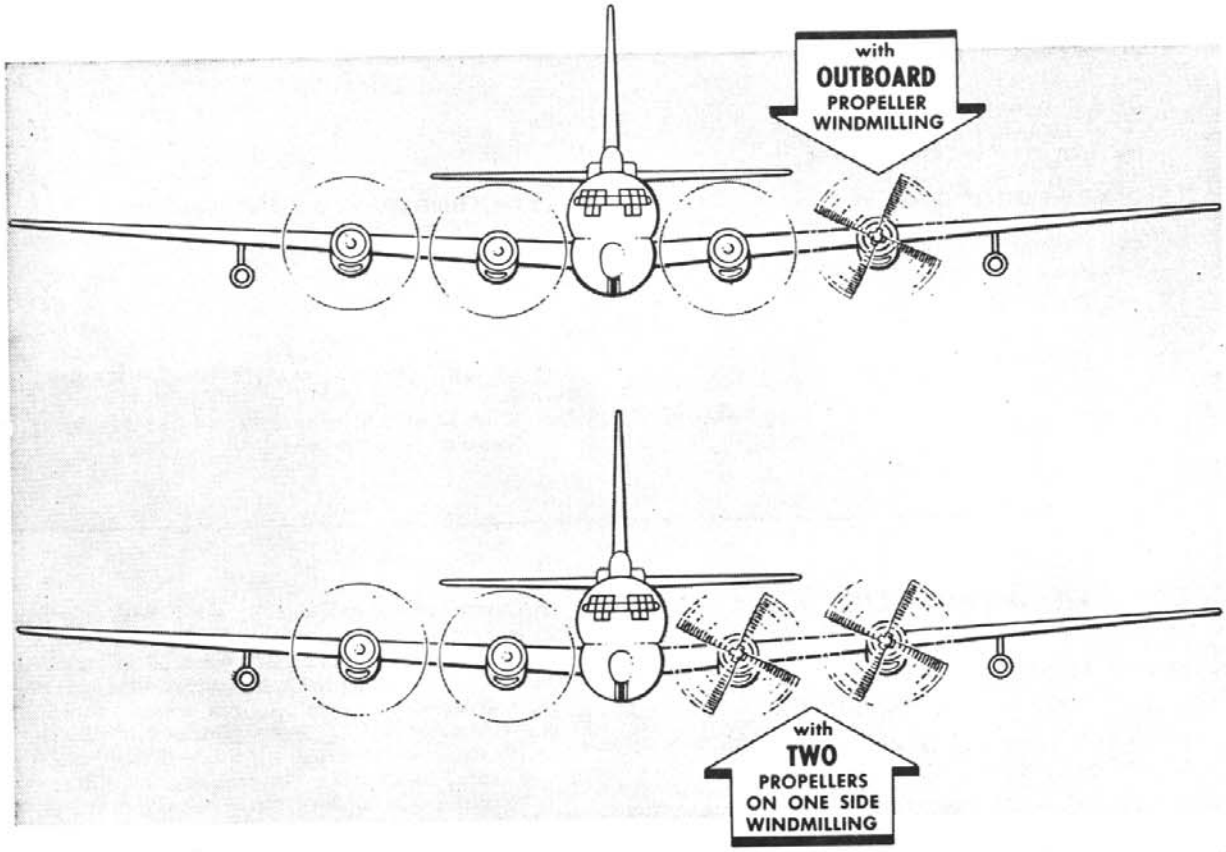
Flight Characteristics Under Partial Power Conditions

The flight characteristics of the airplane remain excellent even when engine failures occur. Only at maximum power and slower airspeeds does the airplane require a great amount of trim to compensate for the turning action caused by engine failure. Very little trimming of the airplane is needed at cruise power. The rudder boost system, when operating, enables directional control to be maintained down to minimum control speeds (figure 3-3) with only light to moderate rudder pedal forces. The airplane is fully controllable with rudder boost off at all takeoff speeds from the unstick point onward except at very light gross weights, but requires considerably higher rudder pedal forces. Aileron control and trim tabs are effective at all times during takeoff and cruise conditions. The most critical time to encounter engine loss is during takeoff after S_1 speed is reached and a safe stop cannot be accomplished. Directional control must be maintained if a safe takeoff is to be made. Minimum control speed with rudder boost on will generally be lower than takeoff speed if the failed engine can be shut down and the propeller feathered; however, nose wheel steering should be used until positive rudder control is attained.

TO MAINTAIN DIRECTION

You Need These Speeds: (Jet Engines Off)

Rudder Boost ON—110 knots
Rudder Boost OFF—130 knots



Rudder Boost ON—128 knots
Rudder Boost OFF—165 knots

NOTE:
Refer to FLIGHT CHARACTERISTICS UNDER PARTIAL POWER CONDITIONS, this section, for detailed information.

MINIMUM CONTROL SPEEDS

Figure 3-3

Symptoms Indicating Engine Failure

Symptoms indicating engine failure include low torque pressure, low fuel flow, decreasing cylinder head temperature, low oil pressure, and dropping off of manifold pressure and rpm. Airplane yaw or loss of performance, however, is the primary index of power loss.

Control of Yaw

The most adverse conditions for maintaining constant headings occur at low airspeeds with unsymmetrical power. The speeds shown in figure 3-3 are for zero yaw and slight angle of bank required to hold a heading. Lower speeds may be maintained by holding a maximum bank angle of 5 degrees and full rudder with the airplane flying in a yawed attitude. The values shown are for sea level standard conditions, 3500 bhp per engine on the operating engines, and windmilling propellers on the inoperative engines. Flap position does not affect minimum control speeds. Feathering the inoperative propellers or decreasing power will reduce the minimum control speeds. The 5-degree bank conditions reduce the values shown by 5 to 10 knots and feathering by 7 to 10 knots. Normally, flight at the speeds given for minimum control should not occur except at relatively light gross weights during takeoff, approach to landing, or go-around. If cruising speeds are never allowed to fall below best holding speeds, minimum control speeds are no problem in cruise, even in emergency conditions.

Reduction of Airspeed

To describe the control problem as airspeed is reduced, zero yaw might be maintained with rudder and aileron applied as necessary to keep the wings almost level, the dead engine side being kept a little high, until a maximum rudder deflection is reached. If further reduction in speed occurs, additional aileron deflection can be used to bring the dead engine side higher, until full aileron deflection is reached. Then, if airspeed is reduced further, the airplane can no longer maintain a constant heading and will turn toward the dead engine side. Some buffeting is to be expected before the minimum control speed is reached, particularly when propellers are windmilling on the inoperative engines. Under some conditions at the higher weights, stalling speeds may be reached before full deflection of the controls. If control is lost momentarily, while flying in the region of minimum control speeds, it can be regained by differential throttling and increasing airspeed.

Jet Engine Failure

Flight Characteristics With One Jet Engine Inoperative

Flight characteristics with one jet engine operative are similar to those with one outboard reciprocating engine inoperative. At maximum power and slow airspeeds, a large amount of trim is required to compensate for the turning action which results from failure of a jet engine. At cruise power, very little trim is required.

Jet Engine Failure Symptoms

The first and most positive indication of jet engine failure is a definite change in exhaust gas temperature (EGT). Bearing failure, broken or missing turbine blades, main rotor unbalance, or stator and rotor engagement will usually cause engine vibration; but, due to the normal vibration of the reciprocating engines, any vibration of a jet engine may go undetected. It is possible for jet engine malfunction or failure to occur without causing any engine vibration or loss of rpm, in which case the only indication will be a change in EGT.

NOTE

The following checklists incorporate engine failure, engine fire, and cleanup procedures for all phases of flight from takeoff to landing. Specifically, it applies after S1 speed has been passed and a safe stop cannot be accomplished, and after touchdown until a go-around is no longer likely. The appropriate action will be accomplished, depending upon the existing emergency. After the completion of bold face items, the complete checklist including the cleanup items will be accomplished.

ENGINE FAILURE/FIRE IN FLIGHT

WARNING

- If an engine fire occurs while the wing flaps are extended, the wing flaps should be promptly retracted provided flight performance permits such action without further endangering the airplane.
- In flight, battery power is not available to discharge CO_2.
- The sheltered air door may be damaged or lost if gangbarred above 190 KIAS.

CAUTION

Emergency static source heat will not be available if the No. 3 engine is inoperative.

PILOTS

(1.) GANG BAR/FEATHER AFFECTED ENGINE (P, CP, E)

The pilot will call for gang bar/feather as the situation dictates.

Direct engineer to gang bar affected engine.

NOTE

To preclude premature action in the event of a malfunctioning or defective engine fire warning system, the pilot should, if circumstances permit, crosscheck with the engineer for engine indications and with the boom operator for visual indications.

(2.) RELEASE CO_2 (IF FIRE EXISTS) (P, E)

If fire persists after engine is gang barred, direct engineer to discharge CO_2 as required.

3. If Performance is Critical:

a. Gear Up (P, CP)

NOTE

If airplane drag is not critical, and fire is on an inboard engine, the landing gear should be extended.

(b.) Dump Fuel (P, E)

(4.) Power as Required (P, CP, E)

Direct copilot to set jet power and engineer to set reciprocating power as required.

ENGINEER

(1.) DETERMINE, REPORT OR ACKNOWLEDGE (E, P)

Use instruments, particularly torquemeter to assist pilot.

(2.) Gang Bar Affected Engine (When Directed) (E, P)

CAUTION

If engine fails to feather, return FUEL, OIL, HYDRAULIC FLUID, and CABIN AIR BLEED SWITCH to normal to prevent engine seizure.

(3.) Release CO_2 (When Directed) (E, P)

4. Mixture Affected Engine OFF.

5. Mixtures Remaining Engines AUTO RICH.

(6.) Dump Fuel (When Directed) (E, P)

Switch jet engines to gasoline when practicable (Refer to EMERGENCY JETTISON, this Section.)

(7.) Set Power (When Directed) (E, P)

PILOTS

5. Rudder Boost ON (P)

6. Notify Crew of Intentions (P)

(7) Receive Engineer's Report (P, E)

ENGINEER

8. Complete ENGINE CLEANUP Checklist.

CAUTION

If an abrupt rise in the rate of fuel flow occurs while operating at a constant power, a fuel line rupture and leak between the fuel flow transmitter and engine are indicated. Utilize the ENGINE FAILURE/FIRE IN FLIGHT procedure as outlined. Direct the engineer to conduct a line check if desired. Refer to TO CHECK A SUSPECTED LEAK IN THE AIRPLANE FUEL SYSTEM, this Section.

JET ENGINE FAILURE/FIRE IN FLIGHT

Jet engine fire extinguishing systems are not installed.

PILOTS

(1.) **STOPCOCK AFFECTED ENGINE (P, CP)**

2. **PULL JET ENGINE T-HANDLE (IF FIRE EXISTS) (P, CP)**

CAUTION

- Since an inoperative jet engine will windmill at approximately 12 to 18 percent rpm, a supply of oil is necessary to lubricate the engine parts and to keep the fuel in the engine from overheating. Do not pull the jet engine T-handles unless a fire hazard exists.
- Do not attempt to restart a failed jet engine in flight until cause of failure has been definitely determined. Refer to JET ENGINE AIR START, Section II.

3. If Performance is Critical:

a. Gear Up (P, CP)

(b.) Dump Fuel (P, E)

(4.) Receive Engineer's Report (P, E)

ENGINEER

(1.) **DETERMINE, REPORT OR ACKNOWLEDGE (E, P)**

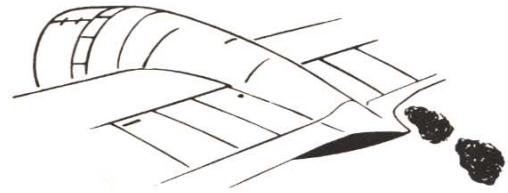
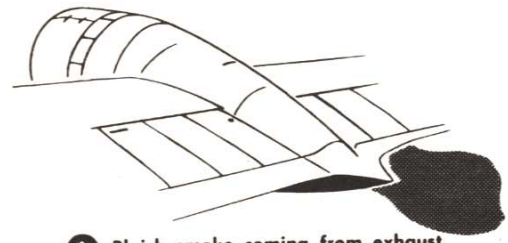
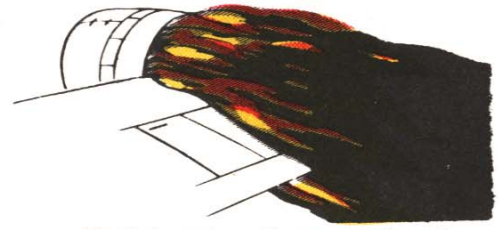
2. Shut Off Fuel Supply Affected Engine.

Switch fuel selector for the affected engine to assure fuel supply is shut off.

3. Mixtures AUTO RICH (All Reciprocating Engines).

(4.) Dump Fuel (If Directed) (E, P) Refer to EMERGENCY JETTISON, this Section.

(5.) Report Checklist Complete (E, P)

CAUSE	ACTION	
Detonation, afterfire, and/or backfire. Also fouled plugs or failing valves. If fuel pump drive shaft is broken, engine gets insufficient fuel and mixture leans excessively. Indicated generally by high CHT, high CAT., fluctuating MP, fuel flow, and in some cases fluctuating cabin air flow. Lean mixtures cause high CHT. High CAT. produces detonation. Fluctuation in MP, fuel flow, and cabin air flow will result from violent backfire. If detonation continues, engine failure and fire is imminent.	Turn on fuel boost pump if fuel pressure is below normal. Decrease CAT and CHT and enrich mixture, checking for proper rpm and MP correlation. Increase airspeed.	 1 Puffs of black smoke from exhaust.
On ground at idling speeds, indicates mixture too rich. In flight, usually at high power settings, this can occur and indicates too rich mixture. There will be no instrument indications.	On ground, increase throttle and blow fire out. In flight, move mixture control slightly to lean mixture.	2 Light orange colored fire coming from exhaust.
Damaged or worn-out piston rings permitting cylinder to pump oil. Also caused by leaking impeller seal allowing oil to seep into induction system. At night this condition appears as fire; however, it is only hot oil burning in exhaust stack and exhaust stream. No instrument indication, but slight power loss will usually occur.	No inflight action is possible. Record in Form 781 and monitor condition.	 3 Bluish smoke coming from exhaust.
Oil leaking onto exhaust stacks and vaporizing. Not a dangerous condition providing oil leak is not excessive. In some cases, leaking oil in turbo shrouds and turbosupercharger area will ignite. Oil leak in supercharger area can cause fire along full length of nacelle. No instrument indications, except for possible drop in oil quantity.	Normally, no action is necessary unless fire develops. If fire occurs, use engine failure/fire procedures, removing source of heat and fuel, and fire should go out.	4 Thin wisps of bluish-grey smoke from exhaust and cowl flap area.
Fuel fire in accessory section generally caused by broken fuel line. Low fuel pressure and abnormally high CHT are instrument indications. Fire warning lights will come on. Engine operation may be erratic, depending upon malfunction.	Use engine failure/fire procedures. Prepare to abandon airplane if fire does not go out.	 5 Black smoke with orange-yellow flame coming from accessory section.

ENGINE SMOKE AND FLAME IDENTIFICATION

Figure 3-4 (Sheet 1 of 2)

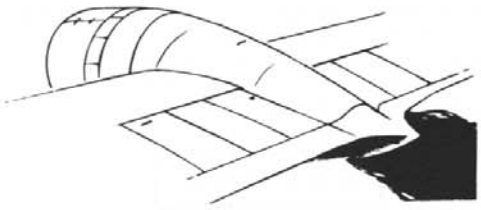
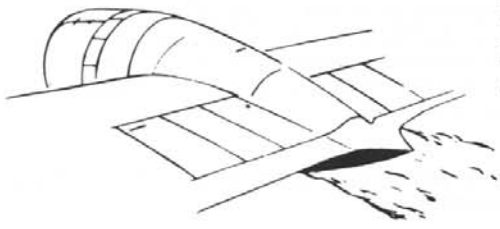
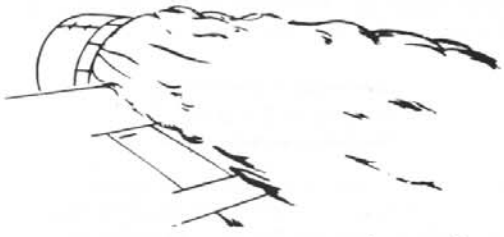
	CAUSE	ACTION
6 Grey smoke coming from cowl flap of forward engine section.	Cylinder failure or exhaust stack failure. If condition results in blown cylinder head or open exhaust stack, fire and black smoke will appear in exhaust stream.	During takeoff or when more than 3-engine power is required for safety, reduce power slightly and let engine operate until safe altitude and airspeed is attained, use engine failure/fire procedures.
 7 Black smoke coming from exhaust.	Induction fire. Instruments will indicate sudden drop of MP and rpm. This loss will be regained due to action of automatic controls on prop. and turbosupercharger, but definite power loss occurs. This could be mistaken for power or turbo surge. CAT. is not reliable indicator because instrument records temperature of air flowing through carburetor, not induction system heat.	Use engine failure/fire procedure and fire should be extinguished without damaging engine.
 8 Dense white smoke coming from exhaust.	Induction fire in advanced stages. Very dangerous condition. Magnesium accessory section has probably ignited. CAT. will rise rapidly to maximum reading.	Action in (7) above should have been taken to extinguish fire before it reaches this stage. Use engine failure/fire procedures. Alert crew for bailout. IF FIRE DOES NOT GO OUT WITHIN 30 SECONDS, IT MAY BE BEST TO ORDER CREW TO BAIL OUT, AS FIRE WILL PROBABLY CAUSE EXPLOSION IN WING.
 9 Dense white smoke coming from cowl flap areds.	Indicates induction fire has burned through intake pipe and it is possible engine may fall off its mounts.	Fire has progressed to extremely dangerous stage. THERE IS NO REMEDIAL ACTION. Prepare to abandon airplane.
10 Black smoke coming from accessory section.	Oil fire in accessory section. Fire detector lights should come on for area affected. CAT. will be abnormally high, accompanied by loss of power. If fire has burned through intercooler, smoke will come out of intercooler flaps.	Use engine failure/fire procedures.

Figure 3-4 (Sheet 2 of 2)

ENGINE CLEANUP

ENGINEER (Only)

1. If Master Propeller Feathered:

   Indicated by a slight rpm drop on remaining engines.

   a. Auto Control Switch to Other Position.

   b. Actuate Resynchronizer Switch (Momentarily).

2. Governor Selector Switch DECREASE RPM (Feathered Propeller).

   Hold until the rpm limit light indicates the low rpm limit.

3. Boost Pump Switches OFF (Or As Required).

4. Fuel Selector Switch (As Required).

5. Generator Switch(es) OFF.

6. Alternator Switch (If Applicable) OFF.

7. Turbo Bleeder Switch CLOSED.

8. Oil Cooler Flaps Switch CLOSE, then OFF.

9. Intercooler Flaps Switch CLOSED.

10. Set Cowl Flaps Switch (3/4 inch).

11. Ignition Switch OFF.

12. Move Throttle to OPEN (Full Forward).

13. Turbo Switch MAN.

14. Turbo Override Switch OPEN (10 Seconds, then OFF).

15. Select Directional Valve Switch NORMAL.

16. Shelter air door switches to NORMAL and RAM.

17. Report to Pilot, "Engine Cleanup Complete" (E, P)

PRACTICE OF EMERGENCY PROCEDURES

Emergency flight procedures will be demonstrated or practiced only under the safest operating conditions and strictest control. No emergency procedures affecting control of the airplane will be practiced during adverse weather, darkness, or when runway conditions are below maximum safety conditions. For emergency procedures affecting airplane control, an adequate airspeed and altitude will be retained throughout the practice maneuver in case an actual emergency should develop. A simulated field elevation should be set up as a base point and traffic patterns flown at the normal altitude above the base point. The minimum altitude for the demonstration or practice of all unusual maneuvers and emergency procedures except the PRACTICE TAKEOFF ENGINE FAILURE and LANDING AND GO-AROUND procedures will be 5000 feet above the terrain. Descents below 200 feet will not be made during GO-AROUND practice maneuvers. Simulated emergency landings and takeoffs will be made only when a fully qualified instructor pilot has immediate access to the controls. The pilot in command will alert all crewmembers prior to practice maneuvers to be especially watchful during the entire period.

CAUTION

Engine shutdown in flight for training purposes shall be held to an absolute minimum. Engine shutdown above 180°C cylinder head temperature shall be avoided if at all possible. These conditions will result in failure of cylinder exhaust valve seats during subsequent engine operation.

Practice Maneuvers With One or More Engines Inoperative

Retarding the desired throttle(s) to 15 inches Hg manifold pressure and decreasing corresponding RPM manually to 1500 will simulate propeller feathered condition. Retarding the desired throttle or throttles to idle, will simulate a windmilling propeller.

CAUTION

Although the above conditions will approximate the drag of an engine failure, they may cause engine bearing damage. In order to minimize engine bearing damage, the throttle or throttles should be advanced as soon as corrective action has been initiated because lubricating oil flow to the bearing is virtually cut off by reverse bearing loading. Manifold pressure of less than 1 inch Hg per 100 rpm will cause engine bearing damage. The longer the engine is operated at low power and high rpm the greater will be the extent of the bearing damage. Also, the lower the manifold pressure and the higher the rpm the more the damage.

The checklist procedure for engine failure may be accomplished by touching the controls without actually completing the operation called for.

WARNING

During takeoff or while airborne, do not, except in an emergency and then only with extreme caution, move any engine throttle back into the idle range unless the reverse pitch warning flag shows the word LOCKED and the throttle reverse lock plate is closed.

Required Power Settings

If the nature of flying conditions in descent requires a large reduction in power, reduce rpm as well as manifold pressure. For descents or other low power maneuvers, or perhaps a simulated engine failure, it is important to cushion the high inertia loads on the master rod bearings which occur at conditions of high rpm and low manifold pressure. As a rule of thumb, it is well to remember that each hundred rpm requires at least 1 inch Hg manifold pressure. For example, 23 inches Hg at 2300 rpm. Operation at high rpm and low manifold pressure should be kept to a minimum.

Practice Takeoff Engine Failure

If the engine failure is simulated, use rudder and ailerons to maintain directional control. Use trim tabs to reduce control forces during climbout. Climb out at best climb airspeed for 33 percent wing flaps. Raise the wing flaps when a safe airspeed and altitude are reached. Do not hurry wing flap retraction, as the airplane will climb easily, gaining altitude smoothly and rapidly.

Turns With Engine Failure

After the airplane is trimmed for inoperative engine practice, try some turns. Turns may be made safely in either direction if sufficient airspeed is maintained. Any variation of airspeed will change the effect of the trim and make handling of the airplane during the turn more difficult.

Effect of Propeller Pitch on Trim

To determine the drag effect of an unfeathered propeller, retard two throttles on one side to 25 inches Hg manifold pressure and set the propeller blades for those engines to a higher pitch position using manual decrease rpm. Trim the airplane for this condition. Now change the propeller pitch, on the engines throttled back, to a lower pitch position (2500 rpm). As the blade angle flattens out, the drag on that side of the airplane will increase, upsetting the trim and causing the airplane to turn into the throttled engines. Return the propeller controls to the full decrease rpm position and the airplane will level out.

Effect of Speed on Trim

Retard the throttle of an outboard engine and trim the airplane for a constant airspeed condition. Take feet off the rudder pedals and ease the control column back. As the airspeed decreases, note that the preset trim loses effect and the airplane begins to turn into the throttled engine. Push the control column forward past the neutral position. As the airspeed builds up to a higher value than that at which the trim was preset, the airplane will begin to turn in the opposite direction as the trim effect increases.

Effect of Power Reduction on Trim

Retard two throttles on one side to 30 inches Hg manifold pressure. Trim the airplane for this condition. With feet off the rudder pedals, ease the control column back. As the airspeed decreases, the airplane will turn into the throttled engines. Counteract this condition by retarding the throttles of the operating engines slowly. Direction can be maintained by this means up to the stall buffet region.

Practice Landing and Go-Around

Landings and go-arounds under inoperative engine conditions may be simulated at altitude by flying a traffic pattern over a basic landing altitude. If any altitude is lost, gain it back on downwind leg, but never at the expense of airspeed. Roll out most of the trim as touchdown point is reached. During go-around practice, note the altitude lost between the time you decide to go-around and the time you are safely in a climb condition. Try a simulated go-around from a point 50 feet above simulated touchdown with the airspeed 20 knots above stalling airspeed. Determine whether a go-around under these conditions can be made without losing the 50 feet. Note airplane acceleration characteristics during the simulated go-around.

RESTARTING ENGINE DURING FLIGHT

CAUTION

Do not restart an engine unless it can be determined that it will be safe to do so.

PILOTS

(1.) "Restart Engine Number____" (P, E)

Direct engineer to restart engine.

2. Reduce Airspeed (160 Knots IAS) (P)

The airspeed should be reduced prior to unfeathering the propeller to minimize the possibility of propeller overspeeding.

(3.) Receive Engineer's Ready to Unfeather Report (P, E)

4. Pull Out Feathering Button (CP)

Pull out feathering button until rpm rise is observed. Pilot will direct boom operator to maintain watch on engine during start.

ENGINEER

(1.) Commence Restart Engine Procedure (When Directed) (E, P)

2. Gang Bar Switches NORMAL.

(3.) Check Hydraulic Lock (Eight Blades) (E, BO)

Crank engine thru continuously for a count of eight blades to check for hydraulic lock.

4. Close Throttle (Affected Engine) to Approximately 1/2 Inch Open.

CAUTION

Adjust throttle cautiously to avoid engine backfire which can cause damage to the engine.

5. Governor Selector Switch (Feathered Propeller) DECREASE RPM.

Hold until rpm limit light indicates the low rpm limit.

6. Turbo Switch MAN.

7. Turbo Override Switch OPEN (Guard Down).

8. Turbo Calibrating Knob Full CCW.

9. Fuel Selector Switch TE.

10. Boost Pump Switch NORMAL (At Least One).

11. Oil Cooler Flap Switch AUTO.

12. Ignition Switch BOTH.

(13.) Report to Pilot, "Ready to Unfeather" (E, P)

CAUTION

Watch for oil pressure rise, and if no rise, notify pilot.

PILOTS	ENGINEER
	14. Move Mixture Lever to AUTO RICH (At 800 RPM).
	NOTE Advance throttle enough to get a positive reading on the torque meter to insure the engine is running.
	15. Warm Up Engine as Required (At 1400 RPM with Appropriate MP).
	16. Set Cowl Flaps as Required.
	17. Set Intercooler Flaps as Required.
	18. When Operating Oil Temperature is Reached: a. Turbo Switch AUTO. b. Increase RPM and Throttle Slowly to Desired Power. c. Turn Turbo Calibrating Knob Clockwise to Desired Manifold Pressure. d. Prop. Resynchronizer Switch RESYNC (Momentarily).
	19. Check Turbo Bleeder Switch OPEN.
	20. Generator Switch(es) ON.
	21. Alternator Switch (If Applicable) ON.
(5.) Receive Engineer's Report (P, E)	(22.) Report to Pilot, "Restarting Engine Checklist Complete" (E, P)

PROPELLER OVERSPEED/RUNAWAY

When flying at high altitude or airspeed, an overspeeding propeller which does not exceed 3300 rpm indicates the pitch lock is effective and feathering should be possible. If the pitch lock is effective, limited operation in fixed pitch may be used in an emergency. However, this is beyond the normal design intent of the pitch lock which will slowly leak and increase rpm. It is preferable to feather the defective propeller while it is still in the controllable speed range.

The loss of oil pressure from the dome or transfer area is indicated by failure of the pitch lock. Primary emphasis must be given to rpm reduction to effect feathering. Complete engine shutdown, airspeed reduction, and altitude reduction will materially aid in regaining propeller control. Figure 1A7-2, T.O. 1C-97(K)L-1-1, indicates the effect on rpm. Minimum airspeeds and maximum rates of descent are obtained with extended wing flaps. The amount of wing flap extension used depends on minimum control speed, terrain clearance, or weather problems. Windmilling speeds with extended wing flaps can be as much as 800 rpm less than with the wing flaps up, which may make feathering possible.

PROPELLER OVERSPEED/RUNAWAY—IN FLIGHT

PILOTS

ENGINEER

1. **REPLENISH PROP. OIL**

2. **DECREASE RPM WITH GOVERNOR SELECTOR SWITCH**

3. **RETARD THROTTLE (AFFECTED ENGINE) TO 2900 RPM**

   If rpm follows and holds, it is an indication that the propeller is in pitch lock.

(1.) **FEATHER PROP. (AFFECTED ENGINE) (P, CP, E)**

This step will be initiated if propeller is uncontrollable. If in pitch lock, refer to CONTINUOUS OPERATION IN FIXED PITCH, this Section. If rpm is below 3500 and performance is critical, rpm may be reduced by intermittent (1-second) applications of the propeller feathering button until rpm is reduced to 2700.

(4.) **NOTIFY PILOT (IF PROP. IS CONTROLLABLE, UNCONTROLLABLE, OR IN PITCH LOCK) (E, P)**

(2.) **MIXTURE OFF (AFFECTED ENGINE) (P, E)**

3. **OBTAIN MINIMUM AIRSPEED (P)**

If propeller fails to feather, reduce airspeed. On takeoff, maintain minimum climbout speed. In cruising flight, reduce airspeed to approximately 20 knots above stall airspeed. Wing flaps should be lowered to 55 percent.

(5.) Mixture (Affected Engine) OFF (When Directed) (E, P)

6. Mixture (Other Engines) AUTO RICH.

4. If Performance is Critical:

   a. Gear Up (P, CP)

   (b.) Dump Fuel (P, E)

(7.) Dump Fuel (When Directed) (E, P)

Refer to EMERGENCY JETTISONING, this Section.

All data on pages 3-20A and 3-20B deleted.

PILOTS

(5.) Direct Engineer to Set Power (P, CP, E)

Copilot will set jet throttles.

6. Notify Crew of Emergency (P)

(7.) Receive Engineer's Report (P, E)

ENGINEER

(8.) Set Power (When Directed) (E, P)

CAUTION

Reducing rpm below 2550 on affected engine with either feathering button or manual decrease switch may unseat the flyweight and cause a secondary overspeed.

9. Complete ENGINE CLEANUP Checklist.

WARNING

A flat pitch runaway propeller has never been known to occur on this airplane and such an occurence is considered extremely remote. However, if it does occur, the windmilling drag and extremely high rpm will make continued flight undesirable. If an immediate safe landing is not possible and flight conditions are such that prolonged flight is required, consideration should be given to gang barring the affected engine. This step, which combines feathering and engine freezing action, will probably result in propeller separation and should only be used in cases where survival of the aircraft and crew is doubtful with propeller windmilling.

PROPELLER REVERSAL DURING FLIGHT

If a propeller reverses in flight, the windmilling drag will be similar to a low pitch stop forward windmilling propeller. If reversal was due to inadvertent crew action, it should be returned to forward pitch by feathering. If due to control failure, there is danger of going to flat pitch on the recovery attempt. It may be best to cut the engine with the mixture lever and hold the propeller in reverse by reverse idle throttle. The engine turning backward will probably freeze due to oil pump reverse running. Windmilling rpm can be more effectively controlled at slow airspeed and low altitude. Land as soon as possible.

CONTINUOUS OPERATION IN FIXED PITCH

Manifold pressure should not be decreased to less than 1 inch Hg per 100 rpm. During fixed pitch operation with constant manifold pressure and altitude, a reduction of 10 knots IAS will reduce engine speed approximately 50 rpm. A reduction of altitude will allow an increase in manifold pressure at a given rpm during fixed pitch operation with constant airspeed. Internal seal leakage should be anticipated during constant operation in fixed pitch. This is indicated by a gradual increase in rpm with a constant airspeed, altitude, and throttle setting.

NOTE

If feathering action is available, pitch may be increased to produce the desired power condition by the following sequence:

1. Increase engine speed with throttle to 2800 rpm.
2. Decrease rpm to 2700 with intermittent (1-second) applications of the feathering button.
3. Repeat steps 1 and 2 above until a power setting of 50 inches Hg manifold pressure and 2700 rpm are obtained.
4. Retard throttle to desired rpm for cruise.

WARNING

Operation in pitch lock is considered to be an emergency condition. Feather propeller (if possible) and land at the nearest suitable airfield.

ENGINE FREEZING

Engine freezing is a hazardous undertaking at best and must be considered a last resort measure only. It should be noted that freezing does not reduce drag below that of a windmilling (against low pitch stop) propeller. Unfortunately, the 34G60, solid Dural propeller will generally separate from the airplane when rapid freezing is attempted at high rpm. As a result, a runaway propeller has become a serious emergency. However, freezing with Dural propellers has been accomplished at low rpm. Some reasons for freezing might be:

a. Unbalance from cuff or tip damage.

b. High rate of oil loss.

c. Continued high speed windmilling may cause ultimate seizure after more nose section heating has been realized.

The decision to freeze and the manner in which it is to be accomplished must be made by the pilot. If the decision is made to freeze the engine, the following procedures are recommended, which utilize successful past experience to provide the best means for controlling the 34G60, solid Dural propeller.

1. Maintain minimum airspeed.

2. Use intermittent freezing to reduce rpm.

3. Complete the process by continuous freezing, before nose heating makes separation imminent.

Previous experience has proven that consideration should be given to feathering the adjacent propeller if propeller separation is considered probable. Propellers separating from the aircraft have resulted in damage to the adjacent propeller. Propeller separations have been preceded by engine and airplane vibration and the emission of smoke and sparks from the engine nose section. Actual separation has occurred within 1 to 3 minutes after these indications. If the propeller that has separated from the airplane should strike an adjacent propeller or engine upon which power is applied, complete separation of the adjacent propeller or engine could result.

It is impossible to predict the direction in which the propeller may travel as it leaves the airplane. Dependent upon the speed of propeller rotation, airplane attitude, airspeed, or any combination thereof, the propeller may go up, down, right, or left. If the emergency involves an inboard propeller and if time and circumstances permit, personnel should be removed from the adjacent fuselage area. Depressurization of the airplane should be considered. If the emergency involves an outboard propeller, a turn away from the windmilling propeller may be applicable. This may provide additional clearance between the airplane and a propeller that has separated.

WARNING

The discharge of CO_2 has not been effective in emergencies involving engine nose section fires which have resulted from propeller separation.

ENGINE SEPARATION DURING FLIGHT

In the event an engine is separated from the airplane without warning, it is recommended that the following procedure be used:

WARNING

With the exception of the actuation of the entire gang bar to the FIRE position, the only other switch or control for the separated engine to be actuated is the CO_2 select directional valve switch, except to turn off equipment. Action to the contrary may cause the entire circuit to be shorted out, causing loss of controls to good engines.

PILOTS	ENGINEER
	(1.) DETERMINE, REPORT OR ACKNOWLEDGE (E, P)
(1.) GANG BAR AFFECTED ENGINE (P, E)	(2.) Gang Bar Affected Engine (When Directed) (E, P)
Direct engineer.	
2. Rudder Boost On (P)	
NOTE Do not hesitate to use full available travel of these control surfaces even though considerable buffeting is experienced. Vibration from tail buffeting is not of a nature or magnitude to cause failure of any primary structure essential to continued flight of the airplane.	
(3.) Set RPM 2550 (P, E)	(3.) Increase RPM (Remaining Engines) Manually to 2550 (When Directed) (E, P)
Direct engineer to set rpm to 2550 on remaining engines.	
NOTE This step is included so manifold pressure can be immediately increased or reduced as required. In addition, a power reduction on the clean side will be accentuated by increased propeller drag.	
(4.) Set Power as Required (P, E)	(4.) Set Power (When Directed) (E, P)
Direct engineer to make necessary power changes. Use unsymmetrical power as required to aid directional control.	Make rpm changes manually.
NOTE Do not hesitate to exceed METO power as needed for either control or performance.	
(5.) Open Cowl Flaps on Clean Side (P, E)	(5.) Open Cowl Flaps (Clean Side) (When Directed) (E, P)
Direct engineer if additional drag on that side is required for directional control.	6. CO_2 Select Directional Valve Switch NORMAL.
6. Set Wing Flaps (P, CP)	
Direct copilot to set wing flaps as required to reduce buffeting or to improve elevator control. Usually 10 to 20 percent is sufficient to eliminate all but extremely severe buffeting, but more may be required. Also refer to BUFFETING, Section VI.	
7. If Airplane is Uncontrollable: Use Bailout Procedure.	

BODY HEATER OVERHEAT DURING FLIGHT

Body heater overheat conditions are usually caused by insufficient cabin air flow to provide adequate cooling of the heaters. However, due to the complexity of the body heater system, certain malfunctions, such as faulty cycling switches, stuck or frozen fuel valves, or shorted electrical system components, could cause an overheat condition.

a. If an indication of a body heater overheat condition should occur, the following actions will be taken to prevent the possibility of a body heater fire:

(1) Immediately turn the affected body heater switch to OFF.

(2) Check that cabin air flow is normal. Adjust as required.

(3) Monitor body heater temperature, which should decrease as a result of steps (1) and (2) above.

b. If the body heater overheat condition continues, a system malfunction is indicated and the following actions must be taken:

(1) Actuate the body heater fire switch to FIRE.

(2) Pull the anti-ice and air conditioning fuel supply circuit breaker.

(3) Turn emergency anti-ice switch OFF if applicable.

(4) Pull body heater ignition fuses/circuit breakers on the AC power panel.

(5) Pull air conditioning fuel valve circuit breakers No. 1 left and No. 2 right on the forward power panel. Follow FUSELAGE/ELECTRICAL FIRE IN FLIGHT checklist and do not attempt further operation of the body heater which was overheated.

c. If the body heater overheat condition was corrected as a result of step a above, the body heater may be operated cautiously with body heater switches in AUTO or EMERG as follows:

(1) Place affected body heater switch to OFF: Temperature below 50°C.

(2) Place heat control rheostat to MEDIUM.

(3) Place body heater switch to AUTO or EMERG as required and closely monitor heater temperature for an overheat condition.

d. If the procedure outlined in step b above has been completed and heater operation is required:

(1) Place all heater switches OFF.

(2) Replace fuses and circuit breakers except for the affected heater.

(3) Return fire switch to NORMAL.

(4) Operate remaining heaters normally, closely monitoring the previously malfunctioning heater for possible combustion.

FUSELAGE/ELECTRICAL FIRE IN FLIGHT

If smoke or flame is reported, the following procedure will be completed and the cause will be determined prior to initiating SMOKE OR FUME ELIMINATION checklist.

NOTE

Oxygen masks will be donned when conditions warrant.

PILOTS	ENGINEER
(1.) **FIND FIRE (ALL)**	(1.) **DETERMINE, REPORT OR ACKNOWLEDGE (ALL)**
Pilot directs crewmembers to fire area.	
(2.) **FIGHT FIRE (ALL)**	(2.) **FIGHT FIRE (AS REQUIRED) (E, P)**
Determine and shut off system feeding fire.	If the source of fire is reported as a result of fuel system failure, shut off applicable system feeding the fire. If source of fire is electrical, all applicable equipment will be turned off, or circuit breakers or fuses pulled.

PILOTS	ENGINEER

WARNING

Do not use fire extinguishers to cool equipment. Heavy, dense, suffocative or toxic smoke occurs when bromochloromethane (CB) is used on hot metal or open fire. However, CB is safer to use than previous fire extinguishing agents. Avoid more than 5 minutes exposure to CB, because irritation of the eyes and nose will occur. Obtain adequate respiratory and eye protection. (Cover the nose and mouth with a damp cloth.) Use 100 percent oxygen as soon as the primary fire emergency permits.

NOTE

The type A-20 (CB) hand fire extinguisher should be held upright to fight fire. The extinguishing agent pickup is at the bottom of the extinguisher. In the inverted position the gas will bleed off and render the extinguisher inoperative.

3. Source not Found (Electrical):	3. Electrical Fire (Source not Found):
a. Instrument Emergency Power Switch EMERGENCY (P)	a. Move Mixture Levers to AUTO RICH.
b. RPM as Required (P, CP)	b. Set Cowl Flaps Switches (2 Inches).
(c.) Turbo Wastegates as Required (P, E)	(c.) Open Wastegates (As Required) (E, P) Set wastegates when directed by pilot.
(d.) Right Alternator Switch Emergency (P, E)	(d.) Right Alternator Switch Emergency (as directed) (E, P)
(e.) Electrical Master Switch OFF (P, E)	(e.) Electrical Master Switch OFF (When Directed) (E, P)
f. Pitot Heat Switches EMERGENCY (CP)	
4. Fire Extinguished:	4. Fire Extinguished:
(a.) Turn Off All Switches (ALL)	(a.) Turn Off All Electrical Equipment (Except Emergency Bus) (When Directed) (E, P)
	b. Turbo Switches MANUAL.
	c. Turbo Override Switches OFF.
(b.) Electrical Master Switch ON (P, E)	(d.) Electrical Master Switch ON (When Directed) (E, P)
	e. Generator Switches ON (One at a Time).
	f. Essential and Pilot's Instrument Inverter Switches ON.
(c.) Essential and other Equipment ON (ALL)	(g.) Switches - ON (One at a Time) (For Essential Equipment) (E, P)
(5.) Use SMOKE AND FUME ELIMINATION Checklist, as Required (ALL)	Carefully observe equipment and instruments. As soon as fault is detected, isolate this circuit or equipment by disconnecting or leaving inoperative.
If smoke is not severe, direct engineer to set cabin altitude selector above airplane altitude and rate-of-change to MAXIMUM. This will eliminate most of the smoke and fumes present in most cases.	

WING AND EMPENNAGE FIRE DURING FLIGHT

PILOTS

ENGINEER

1. DETERMINE, REPORT OR ACKNOWLEDGE (E, P)

2. GANG BAR AFFECTED HEATER

3. RELEASE CO_2 FIRST FIRE

Report to pilot CO_2 discharged and fire status.

1. RELEASE CO_2 SECOND FIRE (AS REQUIRED) (P, E)

Direct engineer to discharge second CO_2 charge if necessary.

2. FIRE NOT EXTINGUISHED, USE BAILOUT PROCEDURE (P)

3. Fire Extinguished:

a. Land as Soon as Possible (P)

WARNING

To prevent a recurrence of the fire, do not restart affected heaters.

4. Release SECOND FIRE CO_2 (When Directed) (E, P)

5. Fire Extinguished, CO_2 Directional Valve Normal.

WHEEL WELL FIRE DURING FLIGHT

If a wheel well overheat warning light illuminates or fire or explosion occurs, the pilot will initiate the following procedure:

PILOTS (Only)

1. GEAR DOWN (P, CP)

WARNING

- If engine fire exists, accomplish ENGINE FAILURE/FIRE IN FLIGHT checklist.
- The landing gear will be extended for in-flight inspection, brake and wheel cooling, and to preclude possible tire explosion and wheel well fire if a wheel well overheat warning light illuminates or if two or more of the following conditions are observed on inboard engines:

a. Erratic readings on No. 2 or No. 3 engine instruments.

b. No indication on loadmeter.

c. Fuel low-pressure warning light on.

d. Fluctuating engine rpm.

e. No. 2 or No. 3 fire warning light on.

CAUTION

The pilot should anticipate failure of both tires on landing and utilize as much of the runway as possible. Refer to BOTH TIRES FLAT ON ONE MAIN GEAR, this Section.

SMOKE OR FUME ELIMINATION

PRESSURIZED OR UNPRESSURIZED

PILOTS

1. Oxygen Masks On, if Required (P, CP)
2. Pull Cabin Pressure Release (P)
3. Open Main Compartment and Floor Hatches (P, N, BO)

   Open per EMERGENCY EXITS, figure 3-7. Direct crew to open left aft and either the right or left overwing hatches and floor hatches.

CAUTION

Although optimum smoke and fume elimination is offered by removal of the left aft and either overwing hatch, drag increases rapidly as more than one compartment hatch is removed. Therefore, altitude, airspeed, and power requirements must be considered if more than one hatch is removed.

NOTE

If smoke and fumes are also present in the control cabin, open pilot's emergency exit window along the aft edge slightly (about 2 or 3 inches) by pulling inboard on the latching mechanism. Do not slide the window open.

4. Close Emergency Release Valve.

NOTE

To reduce fume accumulation in the control cabin due to air flow effects, direct a crewmember to close the cabin pressure emergency release valve after the emergency exit hatches have been opened.

5. Increase Airspeed (As Desired) (P)

   Increase to assist ventilation.

6. Determine if Smoke and Fumes are Eliminated (ALL)

ENGINEER

1. Oxygen Mask On, if Required.
2. Turbo Bleeder Switch CLOSE (If Engine Fire).
3. Cabin Air Selector Switches ALTERNATE.

FUEL FUMES

PILOTS

If fuel fumes are detected or reported, the pilot will initiate the following procedures:

1. Set Instrument Emergency Power Switch to Battery (P)
2. Set RPM (As Required) (P, CP)

   Direct copilot to set rpm as required.

ENGINEER

1. Set Mixture Levers and Cowl Flaps (As Required).

   Set mixture levers and cowl flap switches as required for any power change that may be accomplished.

CAUTION

Continuous operation at 2350 rpm and at maximum manifold pressures might produce excessive engine oil temperatures due to the oil coolers not being allowed to adjust to the higher power setting of 2350 rpm prior to turning the electrical master switch off.

NOTE

If fuel reserve is a factor in reaching a landing area, the power should not be changed from the cruise setting. If landing is soon to be made or fuel reserve is not critical, it would be more desirable to set rpm at 2350 in preparation for the landing.

3. Autopilot OFF (P)
4. Rudder Boost ON (P)

2. Move Fuel Valves and Switches (As Required).

   Move A/R transfer and line valve switches to CLOSE. Move fuel valve selector switch to TE, if fuel loading permits.

(5.) Open Turbo Wastegates (As Required) (P, E)

(3.) Turbo Wastegates OPEN (As Required) (E, P)

Turbo switches manual for 10 seconds, then guards up.

CAUTION

With turbo wastegates in a closed position, precise landing technique must be executed to minimize the possibility of a go-around; whereby damage to the engine and/or supercharger may be incurred.

NOTE

Turbo wastegates should always be opened unless a flight condition, such as terrain clearance above 10,000 feet, icing conditions, and/or other hazards require their use. If turbo operation is required, omit step 3 of the engineer's checklist.

6. Jet Engine Throttles as Required (P, CP)

PILOTS	ENGINEER
(7.) Electrical Master Switch OFF (P, E)	(4.) Electrical Master Switch OFF (When Directed) (E, P)
8. Descend as Required (P)	
9. Pitot Heat ON EMERGENCY, as Required (P)	
(10) Oxygen Masks On, if Required (ALL)	5. Oxygen Mask On, if Required.
Direct crew to don oxygen masks if oxygen is required.	6. Turn Off All Electrical Switches.
11. Pull Cabin Pressure Release Valve Handle (P)	7. Turbo Controls OFF and MANUAL.
	a. TBS Lever 0.
	b. Turbo Switches MANUAL.
(12) Open Main Compartment and Floor Hatches (P, N, BO)	c. Turbo Manual Override Switches OFF (Guards Up).
Direct crew to open left aft and either the right or left overwing hatches and floor hatches.	
13. Close Cabin Pressure Emergency Release Valve.	
NOTE To reduce fume accumulation in the control cabin due to airflow effects, direct a crewmember to close the cabin pressure emergency release valve after the emergency exit hatches have been opened.	
14. Increase Airspeed (As Required) (P)	
Increase to assist ventilation.	
(15) Fuel Fumes Cleared (ALL)	8. Fuel Fumes Cleared:
(16) Verify All Electrical Switches OFF (ALL)	(a.) Electrical Master Switch ON (When Directed) (E, P)
(17) Electrical Master Switch ON (P, E)	b. Generator Switches ON (One at a Time).
Direct engineer to turn master switch ON when crew reports all switches OFF.	c. Inverter Switches ON (As Required).
	d. Other Equipment ON (As Required).

WARNING

Do not operate any of the following when fuel fumes are present near the equipment:

APU	HF equipment	Radio altimeter
A/R system	AIMS/IFF radio	Radio compass
Autopilot	Interaircraft signal lamp	Rendezvous equipment
Cabin heaters	Localizer and VOR receiver	Search radar
Control cabin cooling fan	Loran radio	Tacan
Glide slope receiver	Pull marker beacon circuit breaker	

EMERGENCY JETTISONING

Fuel Dumping

Fuel dumping may be accomplished by pressure and by gravity. The gravity dumping method may be used in the event of failure of the air refueling fuel pumping system or if both outboard engines are inoperative. If air refueling fuel pump hydraulic pressure is lost during dumping on airplanes 22737 ▶, dumping will be accomplished automatically by the gravity method since the boom nozzle poppet is held open by the airplane hydraulic system.

NOTE

In the event of hydraulic pressure loss in the boom system, the poppet valve may be opened by the use of the emergency handpump system.

Pressure Fuel Dumping

Pressure fuel dumping requires a completely charged boom hydraulic system for maximum effectiveness. This is necessary because hydraulic pressure is required to open and hold open the boom nozzle poppet valve. Even though there may be sufficient pressure available to open the poppet valve before fuel flow is started, the force due to the weight of fuel flowing past the valve will tend to close the valve. Thus, maximum boom pressure will give maximum flow weight before inadvertent nozzle poppet closure. The boom operator's A/R master switch and the hydraulic pressure switch must be OFF during takeoff and climb to prevent damage to the A/R pumps and gear boxes due to pressure surges at high engine rpm. Therefore, the engineer must advance the isodraulic handle slowly until the hydraulic pressure builds up.

NOTE

To insure capability of pressurization, the A/R hydraulic depressurization valve must be CLOSED. On airplanes 22737 ▶, the airplane hydraulic system depressurization and charging valve must also be in the NORMAL position. The line valve, A-1 pump control, pressure fuel dump, gravity fuel dump, and the poppet control circuit breakers must all be set to accomplish pressure fuel dumping.

Use the following procedure for pressure fuel dumping:

ENGINEER (Only)

1. **A/R MASTER SWITCH ON**
2. **MOVE FUEL DUMP SWITCHES TO DUMP**
3. **ADVANCE ISODRAULIC HANDLE**
4. **MONITOR FUEL FLOW**
5. Jet Engine Fuel Source.

   If deck fuel is being used, gasoline manifold must be pressurized before switching jet engine fuel source.

6. Fuel Dumping Complete:

   a. Retard Isodraulic Handle (To OFF).

   b. Fuel Dump Switches NORMAL.

Reactivating Fuel Dump System After Nozzle Poppet Closure

ENGINEER (Only)

Reactivate the fuel dump system after an inadvertent nozzle poppet closure as follows:

1. **RETARD ISODRAULIC HANDLE (TO OFF)**
2. **MOVE FUEL DUMP SWITCHES TO NORMAL**
3. **MOVE A/R MASTER SWITCH TO OFF**
4. **FOLLOW FUEL DUMP PROCEDURE**

   Limit fuel flow to 200 ppm below poppet closure flow rate.

WARNING

In an actual emergency, dump fuel with the boom in the stowed position.

NOTE

- In the event fuel dumping is required with low hydraulic pressure, the engineer will position his fuel dump switches to DUMP and wait momentarily for hydraulic pressure to build up before advancing the isodraulic handle.
- During fuel dump other than emergency, it is recommended that the boom be lowered to the trail position prior to fuel dumping. This will eliminate the necessity of boom inspections after flight to clear any fuel or vapors that may have collected under the boom fairing.
- A pressure fuel dump rate of approximately 6000 ppm may be expected. With one outboard engine inoperative, 60 percent of the above figure should be realized.

Gravity Fuel Dumping

With this method of dumping, the fuel dump rate may reach 2600 ppm, depending primarily upon the amount of fuel in the air refueling tanks and the airplane attitude. The poppet control, the gravity fuel dump, and line valve circuit breakers must all be set to accomplish gravity dumping. After the boom

is lowered to the trail position, raise the nose of the airplane to a slight nose high attitude, if possible, and direct the engineer to position the fuel dump switches to the dump position.

CARGO JETTISONING

In jettisoning cargo, the left aft escape hatch should be considered the primary jettisoning exit. The cabin should be depressurized before any of the hatches are opened. Reduce airspeed as much as possible and lower wing flaps to 55% to attain a tail high attitude in order to prevent possible damage to the horizontal stabilizer by jettisoned cargo.

WARNING

Personnel accomplishing the jettisoning should be properly secured to the airplane by a personnel restraining harness.

NOTE

Communications should be maintained between the pilot and personnel in the main cargo compartment.

RAPID DECOMPRESSION

When a rapid decompression occurs, the cabin pressure is reduced to the outside pressure in less than 1 second. Any rapid decompression affects all crewmembers and can be extremely dangerous if occurring at high altitudes. Following are some of the effects accompanying rapid decompression:

a. Rush of air from lungs.

b. A momentary dazed sensation that passes immediately.

c. Possible gas pains.

d. Anoxia, if oxygen equipment is not immediately available.

Following are precautions to observe in pressurized compartments:

a. Maintain a safe pressure differential.

b. Have oxygen equipment readily available.

c. Have heavy flight clothing available.

If a rapid decompression occurs, the pilot should try to ascertain the cause of the trouble and if it cannot be fixed in flight, he should decide whether to continue on his mission or to descend to a safe altitude immediately. When passengers are carried, make an emergency descent to a safe altitude.

BAILOUT

When bailout is required or decided upon, try to plan bailout before the last minute. Overwater bailout is not recommended unless visual contact is made with adequate surface help. If surface help is available, head the airplane in a direction to allow the crew to drift onto the course and just ahead of the rescue vessel. 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 life rafts offer more elaborate survival and signalling 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 life vest only. Wearing an antiexposure suit will increase this time, but still cannot compare with the time of survival possible in a life raft. Antiexposure

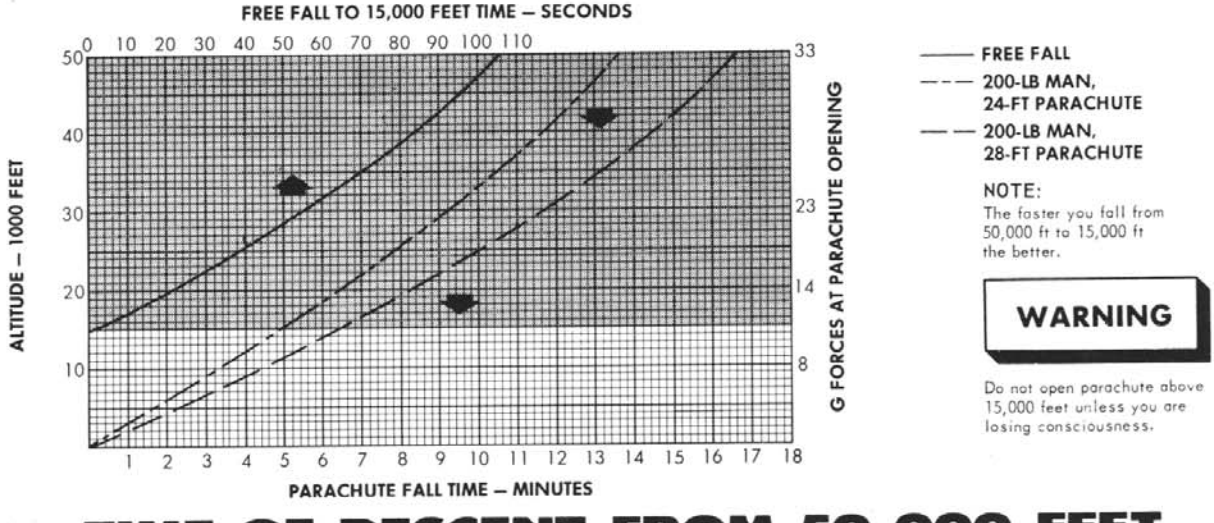


Figure 3-5

suits available in the airplane should be put on if time permits; it takes about a minute to put on a suit. Antiexposure suits should be worn over flying clothing, then put on life vests and parachute harness; mittens will be found in the leg pockets. When the bailout order is given, if time permits, crewmembers should check each other to see that all straps and packs are properly adjusted. Release survival kits, emergency radios, and multiple-place life rafts between personnel as they leave the airplane. This will insure that personnel land as near the survival equipment as possible. If time permits, with 16 or more personnel, the pilot should make two runs dropping half the personnel each time. The best altitude for bailout is about 2000 feet and at as slow an airspeed as practical. If bailout becomes necessary above 15,000 feet, delay opening parachute until reaching 15,000 feet or lower, depending on terrain, to reduce parachute opening impact See figure 3-5 for time of free fall descent from any altitude to 15,000 feet and expected G forces at parachute opening.

BAILOUT

In the event an immediate bailout is required and there is insufficient time for complete preparation, the pilot will sound one long ring on the alarm bell, announce on call position on interphone, "Bail out, bail out, bail out," and depressurize the cabin.

PILOTS

1. **ALERT CREW (ALL)**
2. SIF/IFF EMERGENCY (P, CP)
3. Transmit Distress Message, if Time Permits (CP, N)

   Copilot will transmit the distress message and position report received from the navigator.
4. Don Survival Gear (P, CP)
5. Autopilot Switch ON (P)
6. Pull Cabin Pressure Release Valve Handle (P)
7. Reduce Airspeed (P)
8. Open Hatches (P, BO)

   Direct boom operator to open bailout hatch(es).
9. Warn Crew (ALL)
10. Engage Autopilot (P)

    After jumpmaster reports that all personnel have bailed out, engage autopilot.

ENGINEER

NOTE

Due to the nature of various emergencies, the engineer is required to remain in his position to assist the pilot after the PREPARE TO BAIL OUT signal is given and will be unable to effect bailout preparation. When this situation exists, as the bailout signal is given, the engineer will don chest pack, adjust parachute harness, and proceed to the bailout exit. Attach survival kit if time permits.

EMERGENCY DESCENT

PILOTS

1. Close Throttles (P, CP)

   Rate of descent will be increased with jet throttles off.

2. Set RPM 2000 (P, CP)

   Direct copilot to set rpm to 2000.

NOTE

At 2000 rpm and below, the 1 inch Hg per 100 rpm rule may be disregarded.

3. Gear Down (P, CP)

   Direct copilot to extend gear when airspeed permits.

4. Wing Flaps 55 Percent (P, CP)

   Direct copilot to extend flaps to 55 percent when airspeed permits.

5. Maintain Airspeed (190 Knots IAS) (P)

ENGINEER

1. Mixture Levers AUTO RICH.
2. Set Cowl Flaps (3 Inches).

NOTE

The pilot will initiate the emergency descent recovery at 1000 feet above planned level-off altitude. Recovery is accomplished by retracting the landing gear and then raising the wing flaps to the full UP position. Establish power as required.

LANDING EMERGENCIES

LANDING WITH ONE OR MORE ENGINES INOPERATIVE

Landing with one or more engines inoperative will require no great variation from the normal landing procedure. Increased rpm settings, use of trim to compensate for unsymmetrical power, and final approach procedures will be salient factors contributing to a successful landing. When one engine is inoperative, the jet engines should be running during the approach to ensure that the additional power will be readily available. In the case of two or more engines inoperative, the jet engines will be started prior to entry into the traffic pattern and power utilized to compensate for the inoperative engines. With both jet engines and any two reciprocating engines operating, ample power is available to accomplish a successful landing or go-around.

CAUTION

If symmetrical power is not available, do not use propeller reversal to aid in stopping the airplane.

NOTE

If both inboard engines are inoperative, the hydraulic pumps will not be operating. However, if the brake pedals are not depressed prior to touchdown, several brake applications will be available for use after landing. Use hydraulic handpump to maintain pressure.

Landing at a High Gross Weight

The jet engines will be operating for all heavy-weight approaches, and will shut down at touchdown. Every attempt, consistent with safety, should be made to lighten the airplane when a landing is to be made at a high gross weight. (Refer to Section V.) Each crewmember will be in his crash landing position. Make the airplane touch down as smooth and light as possible.

GO-AROUND WITH ONE OR MORE ENGINES INOPERATIVE

The additional power available from the jet engines minimizes the problem of go-around with one or more engines inoperative. As in any unsatisfactory approach, the decision to go-around should be made as soon as possible. When considering the factors affecting a go-around in terms of altitude, airspeed, gross weight, airplane configuration, wind conditions, runway facilities, and visibility, the advantages of a controlled crash landing should be weighed against the possibility of an unsuccessful go-around. This is especially important if airplane performance is critical or if altitude is marginal. If the decision is made to go-around using unsymmetrical power, the following cautions should be remembered:

a. Never lose directional control of the airplane. If required, use maximum rudder and as much aileron as necessary.

b. Prior to turning on to final approach, plan exactly what must be done and by whom. Inform the copilot and engineer of the duties they must perform, so they will be ready for immediate and accurate execution of the procedure, if required.

c. All available power should be used for go-around, and a clean configuration (landing gear and wing flaps retracted) should be attained as soon as possible.

INADVERTENT PITCH LOCK

Inadvertent pitch lock can occur during go-arounds or other maneuvers in which rapid throttle advancement is made, causing engine overspeed. This will be evident if rpm follows throttles when METO power is set or further power reductions are made.

Climb to 1500 feet above terrain and use the following procedures to reset bleed valves:

ENGINEER (Only)

1. Affected Engine:

   a. Reduce RPM to 1500.

      RPM may be reduced with throttle or governor selector switch.

   b. Return Power to METO.

   c. Retard Throttle 10 Inches Hg.

   d. If RPM does not follow, bleed valves have been reset.

   e. If RPM does follow, refer to CONTINUOUS OPERATION IN FIXED PITCH, this Section.

2. Repeat Step 1 on remaining affected engines.

LANDING WITH LESS THAN 55 PERCENT OF WING FLAPS

When a landing is made with less than 55 percent of flaps, use flaps-up approach and touchdown speeds from Figure 1A6-1, T.O. 1C-97(K)L-1-1. The airplane should be flown so that the flareout is made close to the ground. The amount of flareout required will be less than that needed for a full flap or 55 percent flap landing for two reasons: First, with considerable power on and flaps up, the approach will be flatter than normal; and second, the pitch attitude of the airplane during a flaps-up approach is much nearer the landing attitude. The attitude of the airplane after flareout should be held as close to a three-point attitude as possible. It is much easier to bring the nose up in landings with reduced flap settings and there will be a tendency to land with the tail somewhat lower than with the flaps full down. With power on, contact the ground with the main wheels slightly before the nose wheel touches down. A partial flap (less than 55 percent) or flaps-up landing should be considered as an emergency landing.

LANDING WITHOUT BRAKES

Land with wing flaps full down and make contact with the main gear first. Ease the nose wheel onto the runway as rapidly as possible. After nose wheel makes contact, move symmetrical (normally inboard) throttles to REVERSE. The amount of reverse thrust required will depend on runway available. For stopping distance with no brakes, full flaps and full reverse thrust see Figure 1A6-2, T.O. 1C-97(K)L-1-1. Directional control becomes more difficult to maintain as throttles are moved from REVERSE IDLE to REVERSE OPEN. As speed decreases during the landing roll, rudder control becomes less effective. If nose wheel steering is completely inoperative, directional control must be maintained by use of differential throttling, particularly at speeds below 60 knots. Keep inboard throttles in reverse and use outboard throttles for directional control.

If some hydraulic pressure is available for braking, use brakes for steering at lower speeds or for final braking. If the airplane cannot be stopped prior to depletion of normal brake pressure, transition to emergency brakes will be necessary. To conserve hydraulic pressure, avoid multiple brake applications. Each application should be applied steadily and with increasing pedal pressure. Hold each application as long as possible.

NOTE

When using emergency brakes, only two applications are available.

Conditions permitting, careful consideration should be given to runway length, width, slope, obstructions, climatic conditions, and towing equipment available when selecting an airfield for landing without hydraulic pressure.

CAUTION

After airplane is stopped, chock the wheels and shut down engines. If towing facilities are not available and taxiing is absolutely necessary, follow EMERGENCY TAXIING INSTRUCTIONS, this Section.

LANDING WITH FLAT TIRE

All excess fuel should be dumped before landing with any tire or tires flat.

Nose Gear Tire Flat

With one or both nose wheel tires flat, relocate movable equipment and cargo to move the cg to the aft limit. Crew will assume crash landing stations. Make a normal approach and landing. After touchdown hold the nose wheel off ground as long as possible, then lower it gently. Do not use brakes or reverse thrust unless necessary. Do not taxi.

One Main Gear Tire Flat

Make a normal approach and landing. The one good tire should be able to carry the load if a smooth landing is made. The airplane may be taxied off the runway with one tire flat.

Both Tires Flat on One Main Gear

Relocate all movable equipment forward if possible to move the cg toward the forward limit, thus throwing more weight on the nose wheel for positive steering. Make a normal approach and landing, but keep the flat tires off the ground as long as possible. The airplane will try to turn into the flat tire side; therefore, land the airplane with the good tires along the edge of the runway so that the width of the runway is available for the veering tendency during the landing roll. Use aileron to help keep the weight off the flat tires after touchdown. Use reverse thrust and brakes on the good tire side and nose wheel steering to maintain a straight landing roll. Do not attempt to taxi.

CRASH LANDING

When a crash landing is to be made, the pilot should alert the crew by interphone and with six short rings on the alarm bell and give orders to prepare for a crash landing. A crewmember will notify other personnel and will assist in positioning and securing the passengers. All personnel not located in the main compartment should proceed there immediately. All personnel should be forward of station 790. The location and number of positions providing the maximum safety in a crash landing are shown in figure 3-6. The personnel normally occupying the center troop seats should take up positions on the floor. The side troop seats should be occupied first, as shown in figure 3-6, and all other personnel should take up positions on the floor, facing forward (except those seated against bulkhead 230) with floor safety belts fastened and with their arms locked around their knees.

NOTE

- Figure 3-6 should not be interpreted as restricting the number of personnel which can be carried, but only to show the location and number of positions which afford the maximum safety in the event of a crash landing.
- On a runway, land with as much of the landing gear extended as possible in preference to a gear-up belly landing. With nose gear only extended, it is advisable to retract it and make a belly landing.
- On hard or soft flat terrain, landing should be made with the landing gear fully extended. Extended landing gear will absorb some of the initial impact loads of crash landings in rough terrain. However, roughness of terrain, power requirements, gear down drag, and other pilot judgement factors should be considered prior to electing to crash land with the gear up or down.

PILOTS

(1.) Alert Crew (ALL)

Alert personnel by means of interphone on CALL position. Copilot executes six short rings on the alarm bell.

(2.) Direct Engineer to Dump Fuel (P, E)

Direct engineer to dump A/R fuel if aboard. Have engineer transfer excess airplane fuel for dumping if required.

(3.) Secure or Stow Loose Equipment (P, BO)

4. Position AIMS/IFF Master Control to EMERGENCY (CP)

Copilot will transmit distress message if navigator is not aboard.

ENGINEER

(1.) Dump Fuel (When Directed) (E, P, BO)

Begin dumping A/R fuel if on board. (Refer to FUEL DUMPING, this Section.) Transfer airplane fuel for dumping if directed by pilot. Switch jet engines to GASOLINE for jet engine operation.

2. Turn Off APU.

3. Body and Surface Anti-Icing Heater Switches OFF.

PILOTS

(5.) Open Windows, Doors, and Exits (P, CP, BO)

Open and secure pilot's and copilot's windows; have crew open and stow emergency exit hatches, and open control cabin door.

(6.) Order Personnel to Crash Landing Positions (P, BO)

Order personnel by interphone on CALL position to take crash landing positions and brace themselves.

NOTE

Give all nonessential personnel permission to bail out.

7. Fasten and Lock Safety Belt and Shoulder Harness. (P, CP)

Remove parachute harness prior to fastening safety belt and shoulder harness.

ENGINEER

4. Fasten and Lock Safety Belt and Shoulder Harness.

Remove parachute harness prior to fastening safety belt and shoulder harness.

CAUTION

The crewmember is prevented from bending forward when the inertia reel lock handle is in the LOCKED position; therefore, all switches not readily accessible should be cut off before moving the handle.

8. Autopilot OFF (P)

9. Rudder Boost ON (P)

(10.) Mixture Levers RICH (P, E)

The pilot will direct the engineer to set mixture auto rich; the engineer will repeat upon completion of this action, "Mixtures auto rich and locked."

(5.) Move Mixture Levers to AUTO RICH and Locked (When Directed) (E, P)

CRASH LANDING (Cont)

PILOTS

(11.) Call for 2350 RPM (Use 2550 or 2700 If Required) (P, E)

The pilot will direct the engineer to set 2350 rpm. Engineer will respond, "RPM 2350." The pilot will make all throttle adjustments from this point on. (Use 2550 or 2700 rpm if required with one or more engines inoperative.)

12. Jet Engines as Required (P, CP)

If airplane performance is critical, jet engines will be operating.

13. Gear as Required (P, CP)

a. With Nose Gear Only Retracted, Hold Nose Up (After Touchdown).

With nose gear only retracted, hold the nose of the airplane up as long as possible; then ease it down to the runway.

b. With One Main Gear Retracted, Make Contact On Nose Gear and Extended Main Gear.

With one main gear retracted, make contact in a near three-point attitude on the extended main gear. After nose wheel touches, hold control column forward and use aileron to hold the wing tip off the ground as long as possible - be prepared for a ground loop.

NOTE

Use reverse thrust on the extended gear side with caution. Use brakes as required to keep airplane on the runway.

c. With One Main Gear Down, Make Contact On One Main Gear.

With one main gear and nose gear retracted, make contact with the one gear; hold up nose and use aileron to keep the wing up as long as possible.

ENGINEER

(6.) Set RPM 2350 or as Directed (E, P)

Report to pilot.

7. Cowl Flap Switches OPEN (2 Inches)

8. Boost Pump Switches OFF.

PILOTS

d. With all Landing Gear Retracted, Flare Out Close to Ground, Normal Landing Attitude.

With both main gear and nose gear retracted, flare out close to ground and maintain normal landing attitude.

14. Set Wing Flaps 55 Percent (P, CP)

Direct copilot to extend wing flaps to 55 percent.

15. ADI ON (CP)

16. Wing Flaps Full Down on Final Approach (P, CP)

Direct copilot to extend flaps full down.

17. Landing Lights ON (If Required) (P, CP)

18. Warn Personnel (P, CP)

Notify personnel by interphone on CALL position to brace for crash landing. Copilot executes one long ring on the alarm bell just prior to impact.

19. Jet Engine Throttles STOPCOCK (P, CP)

On pilot's command, copilot places jet engine throttles to STOPCOCK.

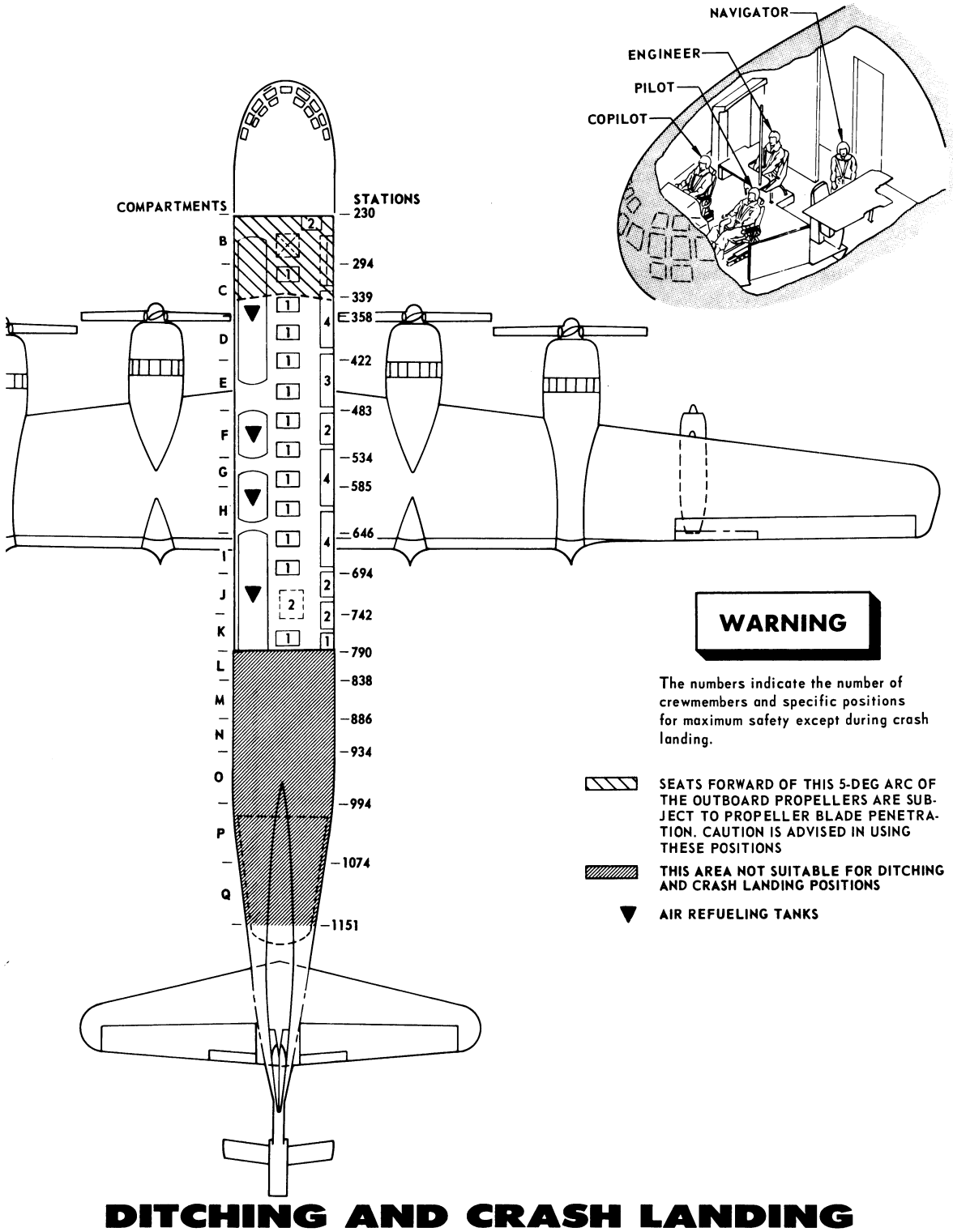
(20). Close Throttles (P, E)

ENGINEER

(9.) Move Mixture Levers to FUEL CUTOFF and Ignition Switches to OFF (E, P)

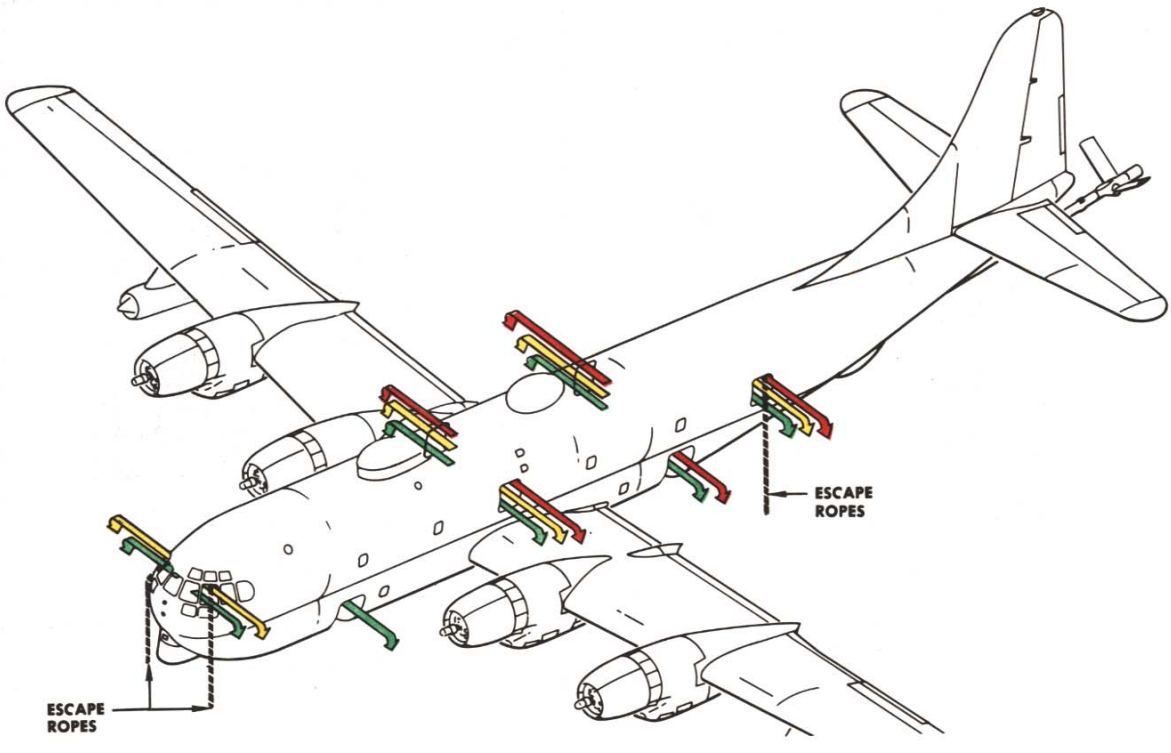
Move mixture levers to FUEL CUTOFF and turn ignition switches OFF when pilot closes throttles.

10. Electrical Master Switch OFF (At Ground Contact).



DITCHING AND CRASH LANDING POSITIONS

Figure 3-6



Bailout Exits (SEE ALSO DETAIL I)

With ten or less aircrew and passengers, the primary exit for bailout is the left aft hatch in the main compartment, with the right aft hatch alternate. When the total number of passengers and crew-members is eleven or more, the primary exits are the left and right rear escape hatches.

WARNING

When utilizing the left aft hatch as the primary bailout exit, do not open either of the overwing hatches as the increased volume and velocity of air entering this hatch will render its use extremely hazardous. Stand to one side when removing hatches to avoid possible inward force when hatch is released.

Stow boom before leaving the airplane in flight so that personnel will be less likely to hit it during bailout.

BAILOUT EXITS

DITCHING EXITS

GROUND EXITS

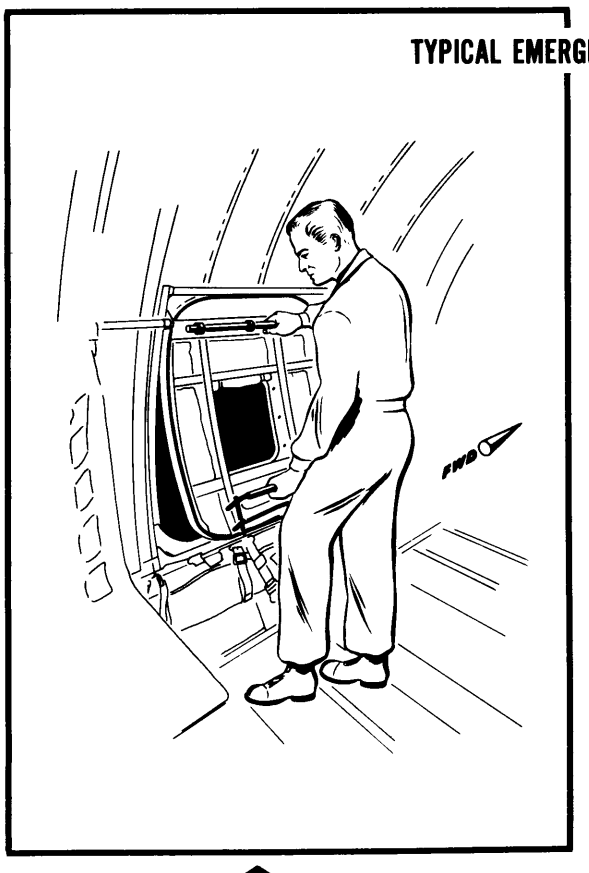
NOTE

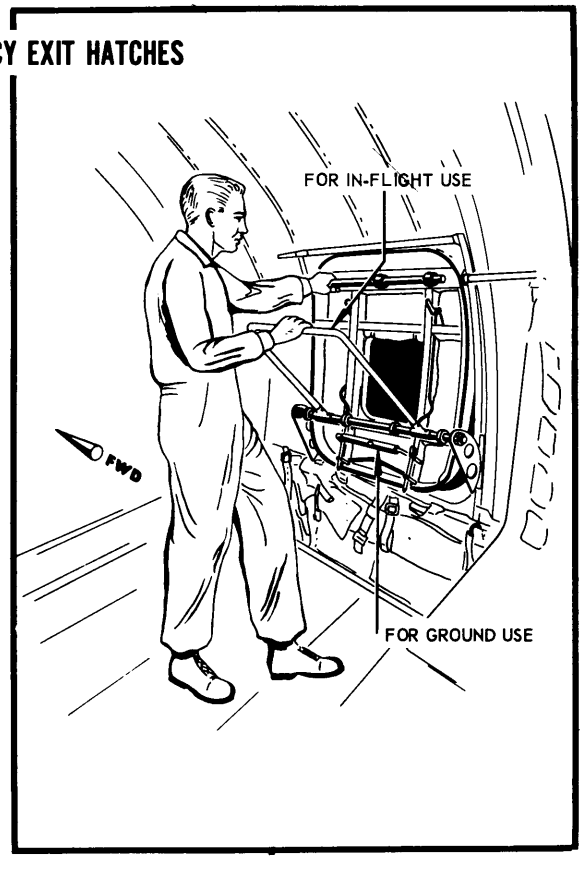
The bailout sequence is: All passengers, navigator, engineer, copilot, boom operator, and pilot. One-half of all passengers, engineer, and pilot use right hatch. Remainder of passengers and flight crew use left hatch.

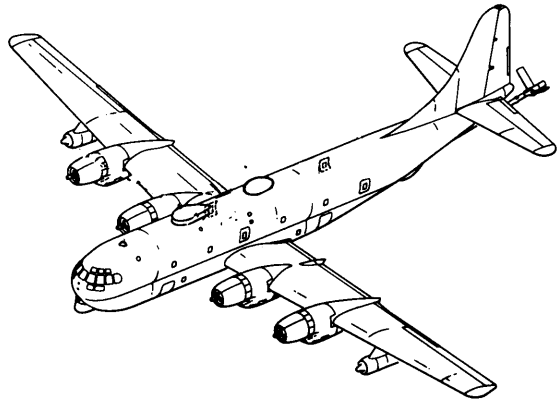
EMERGENCY EXITS

Figure 3-7 (Sheet 1 of 3)

TYPICAL EMERGENCY EXIT HATCHES







TO OPEN ORIGINAL HATCHES IN FLIGHT OR ON THE GROUND.

1. Stand at forward edge of hatch, facing the hatch.
2. Grip upper bar of left overwing hatch with right hand.
3. Grip release bar with left hand and pull up on handle to release pins and pull hatch away from frame.
4. To remove right overwing hatch, reverse hand holds.

WARNING

Be prepared for inward force when hatch is released.

DETAIL I

Figure 3-7 (Sheet 2 of 3)

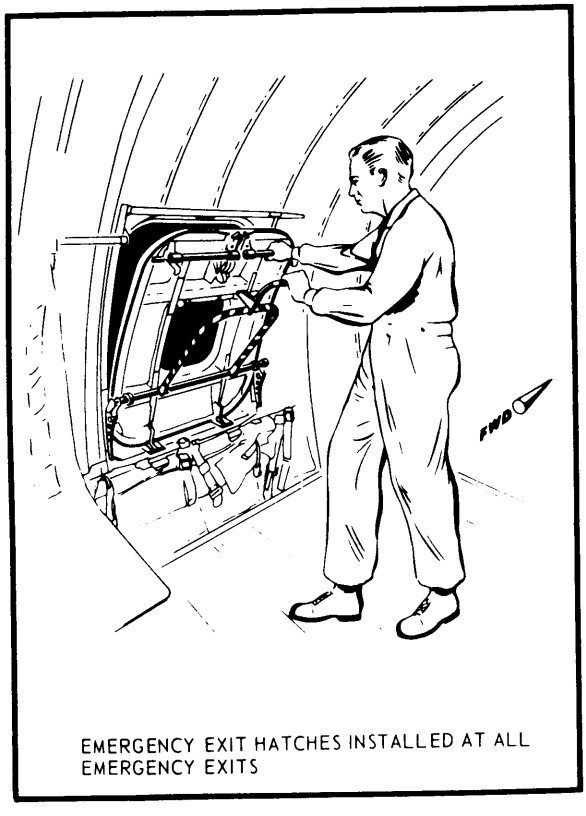
TO OPEN MODIFIED HATCHES

DURING FLIGHT

1. Stand facing escape hatch at hatch forward edge.
2. With palms down, grip emergency release bar with both hands.
3. Remove hatch by applying a hard jerk to release pins. Continue a steady pull inboard and with a downward movement of release bar until pressure is relieved from handle.
4. Grasp bar at upper edge of hatch with the forward hand, step back, pulling release bar completely down, and remove hatch from opening.

DURING GROUND OPERATION

1. Use lower release bar attached to release pins by pulling up on release bar and pulling escape hatch away from frame.



EMERGENCY EXIT HATCHES INSTALLED AT ALL EMERGENCY EXITS

WARNING

- Depressurize cabin before attempting to open emergency exits. If the airplane is not depressurized, the emergency exits cannot be opened because the available leverage will not overcome cabin pressure.
- Airspeed should be reduced to 130 knots IAS before attempting to remove the overwing hatches.
- Care should be taken when opening the lower aft entrance door, as any cabin pressure differential may cause forceful ejection of anyone or anything in front of the door.
- Parachutes will be worn when opening and closing exterior hatches and doors, or when duties require that the crewmembers work in the proximity of open doors and hatches.

NOTE:

Drag increases rapidly as additional emergency exit hatches are opened. It is estimated that two opposite hatches that are open produce twice the drag as only one open hatch. An overwing and aft hatch produce approximately four times as much drag as only one open hatch and all four hatches open produce approximately eight times as much drag as only one open hatch. Open overwing hatches allow relatively high pressure air from the fuselage to flow to the relatively low pressure area of the upper wing surface. A flow of higher pressure air into the low pressure area of the upper wing surface causes a reduction in lift produced by the wing. To compensate for this reduction in lift, the airplane wing angle of attack must be increased, thereby increasing drag. From this it can be seen that any combination of open overwing hatches and aft hatches, or a break anywhere in the fuselage, will allow air circulation to the low pressure area of the upper wing and cause a considerable increase in drag.

TO OPEN ALL HATCHES IN FLIGHT OR ON THE GROUND

1. Stand facing escape hatch at hatch forward edge.
2. Place forward hand on upper bar and aft hand on emergency release bar.
3. Pull emergency release bar inboard and with a downward movement of release bar until pressure is relieved from handle.
4. Step back, pulling release bar completely down, and remove hatch from opening.

DETAIL I (Cont)

Figure 3-7 (Sheet 3 of 3)

DITCHING

The airplane is well-suited for ditching because of the body configuration, with a high-rounded nose, upswept empennage, and boat-like lower fuselage. In ditching, it may not be necessary to abandon the airplane. Under most conditions, it will be better to remain on the airplane which provides an excellent platform for survival and rescue.

Ditching Equipment

The pilot will ascertain before each overwater flight that the necessary equipment is on board and stowed in the proper places. The following list will be used as a guide:

a. Life Rafts - The number and type of life rafts on board will be governed by the number of persons on board the airplane. Four 20-man life rafts may be stowed above the air refueling tanks in the main cabin. (See figure 3-1.)

b. Life Vests - At least one life vest will be available for each person aboard. Crewmembers and passengers will wear life vests during all overwater takeoffs and landings and at any time the pilot deems it necessary.

c. Crash Axes

d. Antiexposure Suits

e. First Aid Kits

f. Flashlights

g. Survival Kits

Ditching Preparation

When it becomes apparent that ditching is necessary, the pilot directs copilot to give alert signal on alarm bell (six short rings) and orders the crew to prepare for ditching. A crewmember notifies other personnel to prepare for ditching and assists in positioning and securing the personnel, as shown in figure 3-6. Personnel not located in the main compartment should proceed there immediately, and all personnel should don antiexposure suits if time permits. No personnel should be allowed aft of station 790. The lower compartment doors should not be opened. Open the right overwing hatch and stow it securely inside the airplane. Secure, stow, or jettison all loose equipment and cargo as necessary. Place emergency equipment and any extra life rafts near the emergency exits that open over the wing and secure them in position. Leave the 20-man life rafts in the stowing brackets until after airplane is ditched. If the APU is running, turn it off and close the exhaust valve. Turn off the cabin heaters and check that the floor hatches are closed. Turn on all exterior lights to assist in rescue.

NOTE

The preceding recommendations or figure 3-6 are not to be interpreted as restricting the number of personnel which can be carried, but only to indicate the location and number of those positions which provide the maximum safety in the event that ditching the airplane becomes necessary.

Ditching Method

The following procedure should be used to ensure the greatest safety during the ditching operation: Best results are obtained if the ditching is accomplished while power is available. Power will allow the pilot to choose the most favorable spot and condition for ditching. In daylight it is recommended that the airplane be ditched along the top of a swell, parallel to to the swells unless the wind is high. In high winds, ditch into the wind to take advantage of the lowered forward speed. Use a flap setting of 55 percent to give the lowest rate of descent (100 fpm is recommended) and lowest forward speed during the ditching. Flare out just above the water and assume a landing attitude of level to 5 degrees nose high at surface contact. This attitude gives the best distribution of landing shock over the fuselage. Avoid contact in a nose-down position. At the time of surface contact, attempt to have the lowest possible forward speed consistent with safe control of the airplane to reduce the landing impact.

WARNING

- Do not ditch at attitudes of more than 5 degrees degrees nose high. Ditching attitudes above 5 degrees nose high may result in extensive damage to the lower aft compartment and may cause the fuselage to break in the vicinity of the boom pod.
- Under no circumstances should the airplane be stalled in. The resulting leaks and structural damage from a stalling impact would greatly reduce the safety of the ditching operation.

If ditching conditions permit, feathering of the inboard propellers should be considered. Feathering the inboard propellers may lessen the possibility of propeller or engine separation, upon impact, with possible resultant fuselage fracture and personnel injury. The decision to feather or not to feather the inboard propellers will be influenced by many factors, such as airplane gross weight, sea and weather conditions, daylight or darkness, number of engines operating, etc. If feathering action is initiated during flareout or just prior to impact, close coordination between pilots will be necessary to avoid a rapid settling or stalling of the airplane.

Power Off and Partial Power Ditching

In ditching with one or more engines inoperative, the following criteria should be used:

a. With symmetrical power conditions, use reciprocating engine and jet engine power as required to give the flattest approach and the lowest possible forward speed.

b. If power is available on engines No. 2 and No. 4 or No. 2 and No. 3 and jet engines are operating, ample power is available for normal control.

c. With only two engines operative on the same side of the airplane, use power on the inboard engine and jet engines as required.

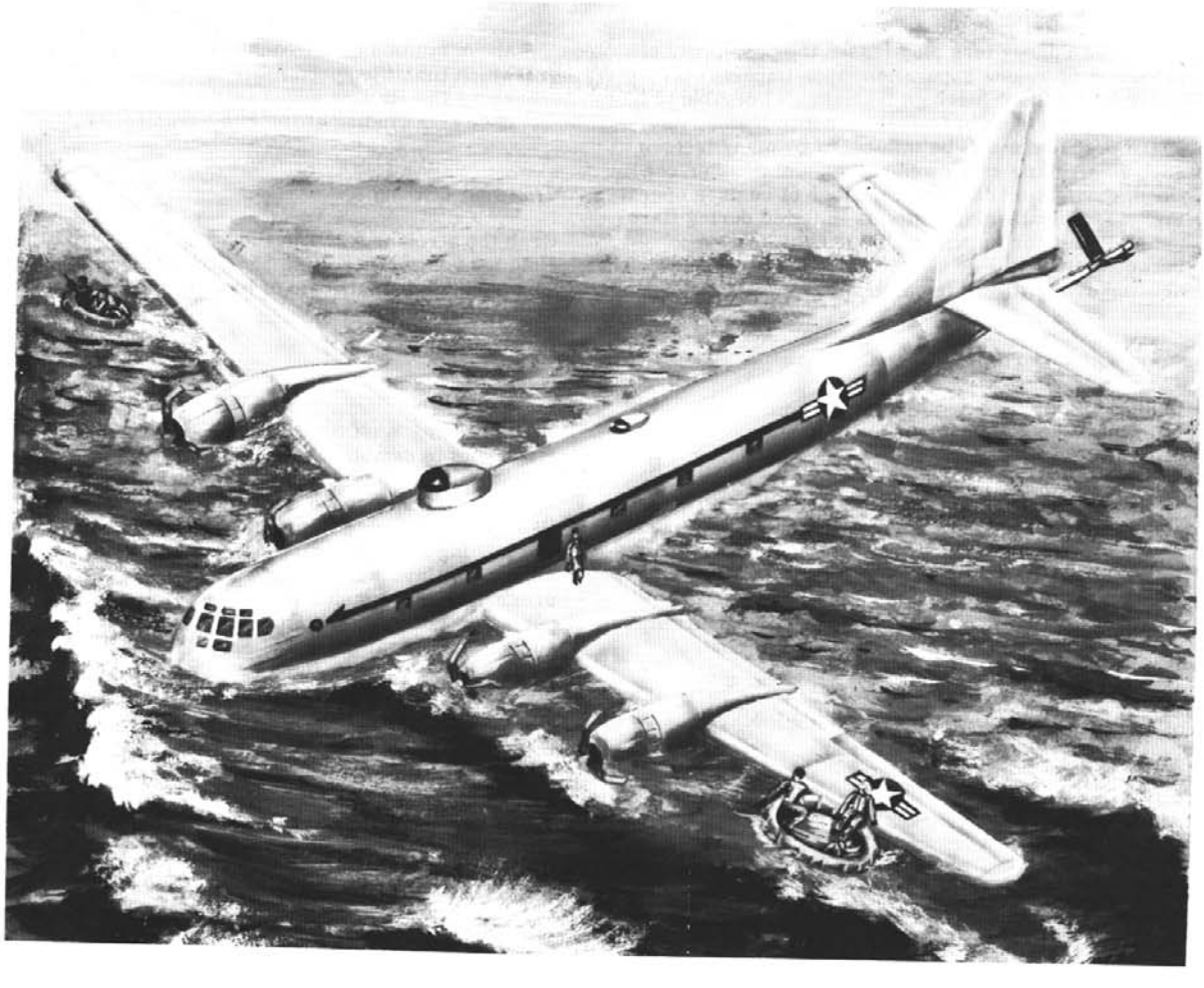
d. On letdown with power off or any engine inoperative, it is advisable to hold the speed 10 knots above minimum approach speed until flareout, at which time the speed shall be reduced to just above the stalling speed as the level to 5 degrees nose high landing attitude is assumed.

Crosswind Ditching

Crab the airplane with the rudder to kill the drift. Hold the wings level. Use 55 percent wing flaps and assume a landing attitude of level to 5 degrees nose high.

Night Ditching

Night ditching must be conducted with the aid of instruments to establish the proper attitude of the airplane. Make an instrument letdown, holding the airspeed to 10 knots above minimum approach speed. Use 55 percent wing flaps. If power is available, use landing lights to examine the sea surface. If conditions are favorable, choose a ditching heading as previously recommended. If impossible to judge the surface conditions, head into the wind using knowledge of the prevailing winds or wind fix. Continue using 55 percent wing flaps to give the lowest possible rate of descent and lowest possible forward speed. Assume a ditching attitude of level to 5 degrees nose high and hold the wings level to avoid digging a wing into the sea and cartwheeling the airplane.



CREWMEMBER	PROVIDE	POSITION	EXIT (WHEN LAUNCHING TWO RAFTS)
PILOT	Parachute, flashlight, and first aid kit	Pilot's seat	Right overwing hatch. Take command of No. 1 raft.
COPILOT	Parachute, flashlight, and first aid kit	Copilot's seat	Left overwing hatch. Take command of No. 2 raft (if applicable).

DITCHING CHART

Figure 3-8 (Sheet 1 of 2)

CREWMEMBER	PROVIDE	POSITION	EXIT
ENGINEER	Parachute, flashlight, first aid kit, and water	Engineer's seat	Right overwing hatch
NAVIGATOR	Navigation kit, flashlight, flares, and pyrotechnic pistol	Navigator's seat	Left overwing hatch
BOOM OPERATOR	Life raft, flashlight, first aid kit and water		Left overwing hatch
PASSENGERS OR ADDITIONAL CREWMEMBERS	As briefed		

WARNING

Do not inflate the life rafts inside the airplane; when they are inflated, they will not pass through the exits.

CAUTION

Extreme care should be taken when launching life rafts to prevent damage of the rafts by ragged edges of flaps or leading edges of wings.

NOTE

- If time permits, antiexposure suits will be donned in accordance with the procedure outlined in BAILOUT, this Section.
- Launch rafts from forward edge of wing. CO_2 activation and raft inflation will occur after the first 5 feet of lanyard pull, then the raft will float or extend a distance of approximately 20 feet from the point where the lanyard is secured. This will prevent raft from being blown away. When launching one raft, all crew members and passengers will use the right over wing hatch or as directed by the pilot prior to ditching. Additional rafts will be designated No. 2, No. 3, etc, if more than one raft is launched due to passenger requirements. One-half of all passengers, engineer, and pilot use the right overwing hatch. Remainder of passengers and flight crew use left overwing hatch. A minimum of one crewmember will be designated for each raft.
- Remain in the vicinity of the airplane until it sinks.

Figure 3-8 (Sheet 2 of 2)

DITCHING PROCEDURE

Ditch on top of a swell, parallel to the swells, when the wind velocity is estimated to be less than 30 knots and the height of the sea is less than 20 feet. With wind speeds in excess of 30 knots and sea conditions greater than 20 feet, ditching into the wind is recommended. Wind speeds in excess of 30 knots are generally indicated by extensive white caps and blowing spray.

NOTE

- Wind velocity will be greater than normal for a given sea condition and wave height when a storm is building and less than normal when a storm is abating.
- The smooth water side of white caps is upwind.

PILOTS

FIRST ACTION

(1.) Alert Crew (ALL)

Alert crew by means of the interphone on CALL position. Copilot executes six short rings on the alarm bell. Advise approximate time remaining.

(2.) Dump Fuel (if necessary) (P, E, BO)

3. Turn AIMS/IFF to EMERGENCY (CP)

(4.) Distress Message (CP, N)

Copilot will transmit distress message while Navigator keeps up with the position of aircraft. Transmit updated position reports when available.

(5.) Jettison Cargo (if necessary) (P, E, BO)

If jettisoning of cargo is necessary, pilot will direct depressurization when appropriate. Hatches may be re-installed and aircraft repressurized after jettisoning, depending on circumstances. Airspeed should be reduced as much as possible and flaps set at 55% to facilitate jettisoning.

(6.) Remove parachute harness, don anti-exposure suits and life vest (if time permits). (P, CP)

7. Turn ON Exterior Lights (CP)

TEN MINUTES

(8.) Announce ten minute warning — (ALL)

Pilot will announce to crew when there is approximately 00:10 left prior to impact; each crewmember acknowledges.

(9.) Depressurize. (P, E)

Pilot will not depressurize until BO reports ready to depressurize.

ENGINEER

FIRST ACTION

(1.) Acknowledge Alert Signal. (E, P)

(2.) Dump Fuel (When directed/if applicable) (E, BO, P)

Switch jet engines to GASOLINE for Jet engine operation. Refer to EMERGENCY JETTISON, this section.

(3.) Jettison Cargo (if necessary) (P, E, BO)

If pilot directs cargo jettisoning, engineer will depressurize when directed by the pilot by opening cabin pressure relief valve and closing turbo bleed valves as necessary for controlled depressurization.

4. Secure Control Cabin.

All loose equipment.

5. Remove parachute harness, don anti-exposure suit and life vest (if time permits).

TEN MINUTES

(6.) Acknowledge ten minute warning (E, P)

7. Cabin Heaters - OFF

(8.) Depressurize (when directed) (E, P)

Depressurize by opening cabin pressure relief valve and closing turbo bleeds as necessary for controlled depressurization. Then close cabin pressure relief valve and cabin pressure release valve (if applicable)

PILOTS

(10) Open Right Overwing Hatch (P, BO)

Pilot will confirm BO is prepared to open hatch, then give order. Control problems may be introduced if more than one emergency exit hatch is opened or if the fuselage is damaged and one overwing emergency exit hatch is opened. (See figure 3-7).

(11) Set Altimeters. (P, CP, N)

Obtain absolute altitude from Navigator.

(12) Rudder Boost ON. (P, CP)

(13) Close APU Doors (if applicable) (P, E, BO)

This step may be omitted if the APU is needed to furnish power all the way to impact with the water. The rate of flooding of the lower forward compartment will be increased slightly if the APU doors are left open.

FINAL APPROACH (2000')

(14) Anti-Ice Equipment OFF (as required) (P, E)

(15) Order Crew to Ditching Positions (ALL)

Pilot and Copilot will fasten safety belts, shoulder harnesses, and lock inertial reels. Order crew to ditching positions by means of interphone on CALL position.

(16) Set Wing Flaps (P, CP)

Direct Copilot to extend flaps as desired. 55 per cent flap setting is recommended. When ditching is imminent, wing flaps should be set prior to 1000 feet indicated altitude to permit sufficient time to compensate for change in attitude and re-establish desired rate of descent.

(17) Landing lights Extended and ON (if required) (P, CP)

18. Maintain Lowest Rate of Descent.

A 100 foot per minute rate of descent is recommended.

19. Maintain 10 knots Above Minimum Approach Speed.

(20) Warn Personnel (P, CP)

Warn crew and personnel by interphone on CALL position to brace for impact. Copilot executes one long sustained ring on the alarm bell just prior to impact.

ENGINEER

9. Cabin Air Selector Switches — NORMAL.

10. Turbo Bleed Valves — CLOSE.

11. Turn off APU (if applicable) (E, P)

FINAL APPROACH (2000')

(12) Surface Anti-Icing Heaters — OFF. (E, P)

(13) Acknowledge Ditching Position — (E, P)

Fasten safety belt and shoulder harness and lock inertia reel.

(14) Move mixture levers to FUEL CUTOFF and Ignition Switches to OFF (E, P)

Move mixture levers to FUEL CUTOFF and the Ignition Switches OFF when Pilot closes throttles.

15. Electrical Master Switch OFF at Impact.

16. Provide required equipment. After airplane comes to a stop, open as many emergency exit hatches as necessary to evacuate the airplane.

PILOTS

21. Maintain 5 degrees Nose-High Attitude During Flareout.

    The landing attitude should be level to 5 degrees nose high. Maintain an approximate normal landing attitude at impact. Avoid contact in a nose down position.

22. Stopcock Jet Engines. (P, CP)

23. Close Throttles. (P, E)

24. Hold Wings Level.

    Hold the wings level to avoid digging a wing into the sea and cartwheeling the airplane.

25. After Impact, Proceed to Emergency Exit.

    Provide required equipment. After airplane comes to a stop, open as many emergency exit hatches as necessary to evacuate the airplane.

ENGINEER

SYSTEMS EMERGENCY OPERATION

TURBOSUPERCHARGER EMERGENCY OPERATION

Engine Overboost

A rapid rise in manifold pressure often accompanied by the engine overspeeding usually indicates a turbosupercharger control system failure. An overboost may be indicated by an increase of several inches Hg manifold pressure especially if at a cruise power setting. Positive indication of failure will be no response to control by means of the TBS lever when the system is under automatic control.

ENGINEER (Only)

1. **RETARD THROTTLE (AFFECTED ENGINE)**
2. **GUARD DOWN (AFFECTED TURBO)**
3. **TURBO SWITCH MAN. (AFFECTED TURBO)**
4. Have Turbo Amplifier Fuse Checked:
   a. Replace if blown.
   b. Replace amplifier (if fuse not blown).
5. Warm Up Amplifier.
   Warm up for at least one minute.
6. Return Turbo to Automatic Control.
   Return to automatic per the procedure MANUAL TO AUTOMATIC CONTROL, ONE OR MORE TURBOS, Section VII.
7. Malfunction Still Indicated, Perform Steps 1 thru 3 again.
8. Use Manual Control (at Pilot's Discretion). (E, P)
   Coordinate with pilot to determine the need for operation in manual control.

Manual Control

The override system may be used to control the turbosupercharger for an extended period of time if the automatic control system is inoperative and the pilot decides that conditions are such that manual operation is necessary. For manual operation, refer to Section VII.

CAUTION

If the required manifold pressure cannot be obtained by actuating the turbo override switch to the CLOSE position, a leak is indicated somewhere in the exhaust system between the engine and the turbo. Continued operation with a closed wastegate will permit hot exhaust gases to escape through the leak, constituting a fire hazard.

Failure on All Four Engines Simultaneously

If a failure occurs in the automatic turbo control system to all four engines simultaneously, the trouble is probably electrical. Accomplish step 1 of ENGINE OVERBOOST, this Section, for all the turbosuperchargers. Check the SUPCHG CONTR circuit breaker or fuse on the ac power panel and the turbo amplifier fuses located in the lower nose compartment. Replace any blown fuses and reset the circuit breaker. Allow the amplifiers to warm up for at least one minute. Then return the system to automatic control per the procedure MANUAL TO AUTOMATIC CONTROL, ALL TURBOS, Section VII. If the automatic control system still does not operate properly, control all the turbosuperchargers per procedure AUTOMATIC TO MANUAL CONTROL, Section VII.

Complete Electrical Failure

If a complete electrical (ac power) failure occurs, a solenoid brake in the wastegate motor will hold the wastegate in the approximate position set at the time of power failure. Accomplish the following steps: Immediately and simultaneously (1) Retard throttle(s) (if required), (2) Move turbo override switches to OFF (guards up), (3) Move turbo switches to MANUAL. When the power is restored, allow the amplifiers to warm up for at least one minute. If the amplifiers do not warm up, check all system circuit breakers and fuses. Return the system to automatic control per procedure MANUAL TO AUTOMATIC CONTROL, ONE OR MORE TURBOS, Section VII. If the automatic control system still does not operate properly, control all the turbos per procedure AUTOMATIC TO MANUAL CONTROL, Section VII.

Turbo Lubrication Failure

In the event clear (honey-colored) oil is detected leaking in the vicinity of a nacelle, the following procedure is recommended:

1. Advise the Pilot of Turbo Oil Leakage.
2. At the Pilot's Discretion Either (For the Affected Engine):
   a. Open wastegate.
   b. Feather propeller.

Turbine Wheel Bearing Failure

NOTE

On airplanes not having TCTO 611 accomplished, the most positive indication of bearing failure and pending turbo failure is a drop in manifold pressure.

The most probable cause of turbine wheel bearing failure is faulty lubrication. On airplanes having TCTO 611 accomplished, the most positive indication of bearing failure and pending turbo failure is a rapid rise in turbo bearing temperature. (Refer to TURBO-SUPERCHARGER SYSTEM, Section VII.) If the manifold pressure drop occurs when operating with turbo boost on automatic, cause of manifold pressure drop may be determined as follows:

1. Turbo Manual Override Switch OFF (Guard Up)
2. Turbo Switch MAN.

   If manifold pressure remains constant, except for normal decrease in climb with wastegate in fixed position, malfunction is in the automatic circuits.

If manifold pressure continues to drop:

3. Turbo Manual Override Switch OPEN (Guard Down)
4. Shut Down Engine at Pilot's Discretion.

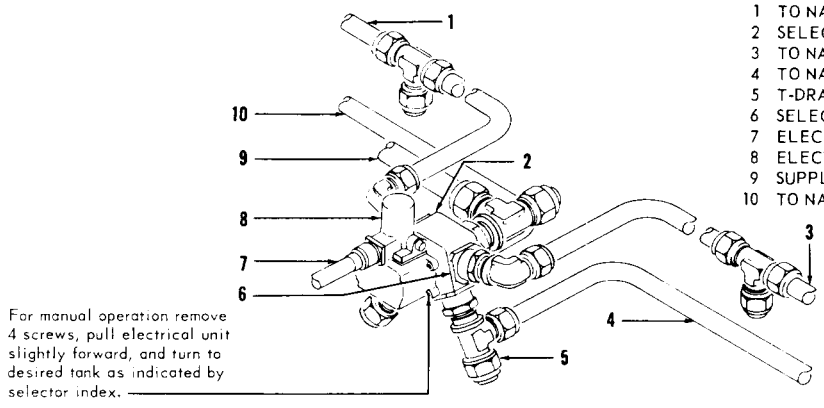
   Engine shutdown is recommended if power requirement is not critical.

OIL SYSTEM

See figure 3-9.

CAUTION

Feather propeller if oil quantity drops below 10 gallons, except when power is a critical requirement. This action is necessary to prevent engine damage due to air entrainment.



1 TO NACELLE NO. 4 OIL TANK
2 SELECTOR VALVE
3 TO NACELLE NO. 1 OIL TANK
4 TO NACELLE NO. 2 OIL TANK
5 T-DRAIN (TYPICAL) REMOVE CAP TO DRAIN
6 SELECTOR INDEX FOR MANUAL OPERATION
7 ELECTRICAL LEAD TO SELECTOR SWITCH
8 ELECTRICAL UNIT
9 SUPPLY LINE FROM TRANSFER PUMP
10 TO NACELLE NO. 3 OIL TANK

MANUAL OPERATION OF THE CENTRAL OIL SYSTEM SELECTOR VALVE

Figure 3-9

FUEL SYSTEM

Fuel Tank Leak

ENGINEER (Only)

1. Boost Pump Switches (Leaking Tank) EMERGENCY.
2. All Fuel Selector Switches TME.
3. All Other Main Wing Tank Boost Pump Switches One on NORMAL (Each Tank).
4. Open CWT Secondary Valve (Manually).

   Manually open CWT secondary valve if fuel is to be transferred into this tank.

5. Monitor Fuel Quantity Gages.
6. Leaking Tank Nearly Empty:

   a. Close CWT secondary valve.

7. Leaking Tank Empty:

   a. Fuel selector switch ME.

   b. Boost pump switches (leaking tank) OFF.

CAUTION

Do not operate boost pumps on an empty tank, as this will damage pumps.

8. Fuel Management As Required.

Fuel Line Failure, Airplane Main Fuel Manifold

ENGINEER (Only)

1. LEVELING VALVE - OPEN
2. SUMP BOOST PUMPS - ON
3. JET FUEL SELECTORS - JP-4
4. FUEL SELECTORS - T.E.
5. Move Main Wing Tank Fuel Boost Pump Switches to Normal (ONE each Tank)
6. CWT Line Valve Closed
7. CWT Boost Pumps OFF
8. Conduct Line Check (If Required)

   Coordinate with pilot if a fuel manifold line check is desired.

To Check a Suspected Leak in the Airplane Fuel System

The following are inflight procedures to check for a possible leak in the engine fuel system. Check all applicable lines, valves, switches, circuit breakers, and nacelles visually if possible.

To Check a Suspected Leak in the Fuel Manifold

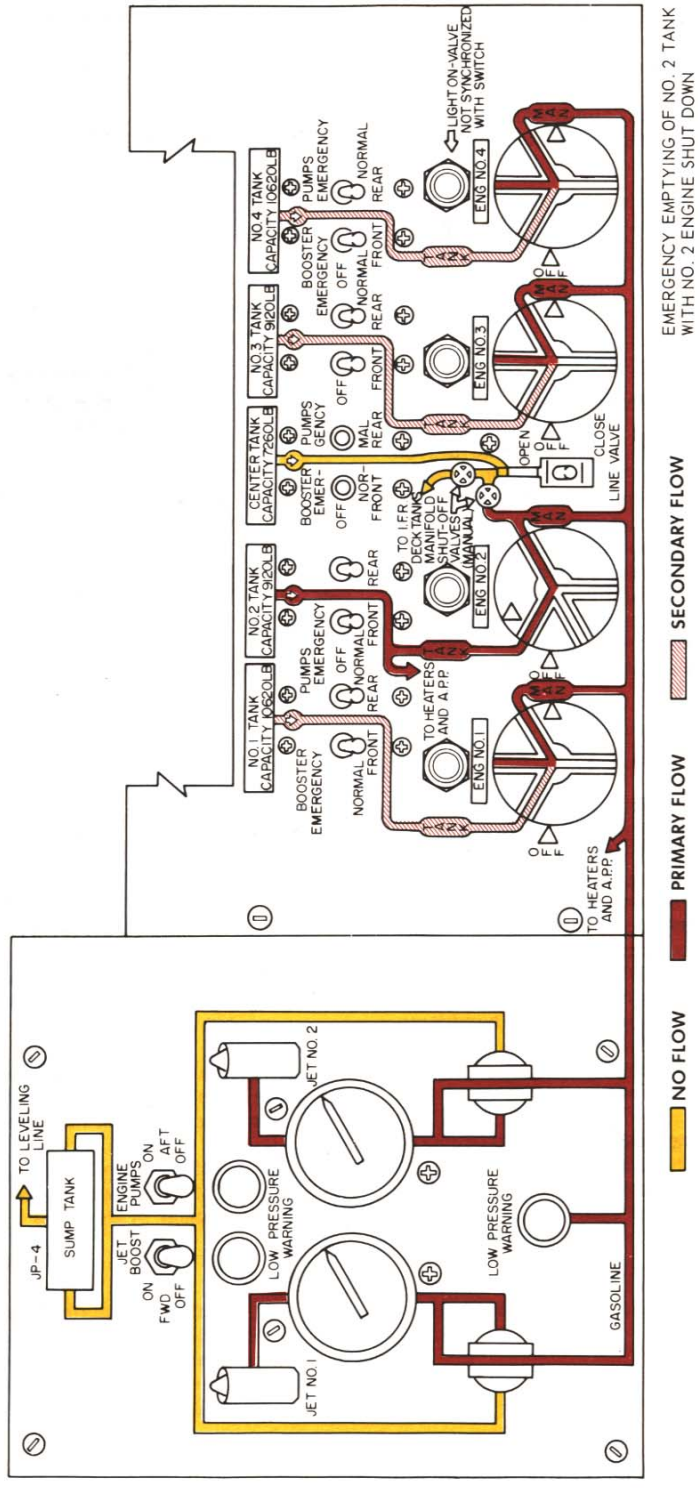
1. Sump Tank Boost Pump Switches to ON.
2. Jet Engine Fuel Selector Switches to JP-4.
3. Turn All Engine Fuel Selector Switches to TE.
4. Stop One Engine With Mixture Lever and Feather Propeller.
5. Turn Boost Pump Switches for That Engine to NORMAL.
6. When Pressure Stabilizes, Turn Boost Pump Switches to EMERGENCY.
7. When Pressure Stabilizes Again, Turn Fuel Selector Switch OFF.
8. Turn Boost Pump Switches to OFF.
9. Observe Fuel Pressure for About 10 Seconds.

   If the fuel pressure remains constant or drops slowly, continue this procedure.

10. Turn Fuel Selector Switch to TME.
11. Again Turn Boost Pump Switches for Stopped Engine to NORMAL.
12. When Pressure Stabilizes, Turn Boost Pump Switches to EMERGENCY.
13. When Pressure Stabilizes Again, Turn Fuel Selector Switch to ME.
14. Turn Boost Pump Switches to OFF.
15. Observe Fuel Pressure Indicator.

    Should the pressure drop slowly, although somewhat faster than in step 9, no leaks are indicated.

16. Restore Engine to Operation per Procedure RESTARTING ENGINE DURING FLIGHT, This Section.



FUEL SYSTEM EMERGENCY OPERATION

Figure 3-10

Engine-Driven Fuel Pump Failure

In the event an engine-driven fuel pump fails, turn both boost pump switches to EMERGENCY, or use boost pumps as necessary to maintain fuel pressure within operating limits for the tank that is supplying the engine.

ELECTRICAL SYSTEM

See figure 3-11.

HYDRAULIC SYSTEM

Failure of Engine-Driven Pump

Failure of one main hydraulic system engine-driven pump will not be noticed with No. 2 and 3 engines operating, since the remaining engine-driven pump is adequate for the maintenance of system pressure. In the event both hydraulic pumps fail, turn off the rudder boost and windshield wiper systems to conserve main system pressure. Use the hydraulic handpump to maintain service brake pressure. The emergency brake system may be recharged from main system or service brake system pressure, whichever is higher.

Line Rupture

In the event of main system line rupture with the system pressurized, move the depressurization and emergency charging handle to the DEPRESSURIZED POSITION. All hydraulic systems except the emergency brake system will become depressurized, reducing the danger of hydraulic spray, and the emergency brakes may be used during the landing roll. With the valve handle in the DEPRESSURIZED POSITION, the emergency brakes cannot be recharged from the main system or by means of the handpump.

Nose Wheel Steering Failure

If the nose wheel steering mechanism is malfunctioning and the direction of the airplane is uncontrollable, actuation of the nose wheel steering emergency disconnect button will bypass the hydraulic pressure used for steering and allow the nose wheel to caster freely. When the button is actuated, a light within the button is illuminated. The nose wheel will also caster freely if the pressure in the main hydraulic system is lost.

Emergency Brake Operation

Two hand-operated levers for emergency brake operation are above the pilot on the overhead structure. When using the emergency brakes, apply steadily. Do not pump the hand levers as this action will rapidly lower the hydraulic pressure in the emergency system. Only two full applications of the emergency brakes are available.

WING FLAP SYSTEM

To operate the wing flaps:

1. Normal Wing Flap Switch OFF.
2. Use Emergency Wing Flap Switch on Overhead Panel to Raise or Lower Flaps to Desired Position as Indicated on Wing Flap Position Indicator.

CAUTION

Limit switches are not included in the emergency wing flap system. If full flap travel is desired, return switch to the OFF position 10 percent before stops are contacted to prevent possible damage to the flap torque tube system and auxiliary motor clutch.

3. Assigned Scanner Reports Flap Position to Pilot.
4. Raise or Lower Flaps Gradually Last 10 Percent (Coordinate With Assigned Scanner), and Return Switch to OFF Position After Stops are Contacted.

LANDING GEAR SYSTEM

CAUTION

- If any gear fails to extend by use of the normal system, the affected landing gear will be extended manually.
- When any landing gear indicator and/or light is suspected to be indicating improperly, the landing gear will be extended manually.
- Recycling of the landing gear should not be attempted to lower a defective gear unless the manual system has failed.

NOTE

In event of left main gear malfunction, remove the left main gear current limiter and reset the control circuit breaker so that the right main gear and nose gear can be retracted normally if required.

ALTERNATING CURRENT FAILURES

Essential inverter power failure will affect the following:

1 A/R FUEL PRESSURE GAGES
2 APN-69 (EMERGENCY)
3 AUTOPILOT REPEATER INDICATOR
4 CABIN AIR FLOW INDICATOR
5 COMBUSTION HEATER IGNITION
6 COWL FLAP POSITION INDICATORS
7 DRIFTMETER 2833 ▶ 22619
8 FUEL FLOWMETERS
9 FUEL PRESSURE GAGES
10 FUEL QUANTITY GAGES
11 GLIDE SLOPE INDICATOR
12 HIGH RANGE RADIO ALTIMETER
13 HYDRAULIC PRESSURE GAGES 2900 ▶
14 INSTRUMENT TRANSFORMER
15 INTERCOOLER FLAP POSITION INDICATORS
16 LORAN RECEIVER
17 NESA WINDOW HEAT CONTROL
18 OIL PRESSURE GAGES
19 RADIO MAGNETIC INDICATOR (RMI)
20 TORQUEMETERS
21 TURBOSUPERCHARGER CONTROL
22 JET ENGINE OIL PRESSURE GAGES
23 APX-29A
24 TACAN (SOME AIRCRAFT)
25 PILOT'S ALTIMETER LIGHTING

Secondary inverter power failure will affect the following:

1 A/R FUEL FLOW AND TOTALIZER INDICATOR
2 A/R FUEL QUANTITY GAGE
3 FLUORESCENT LIGHTS 2833 ▶ 3264
4 ANTI-COLLISION LIGHTS ROTATION MOTORS
5 AIMS/IFF TRANSMITTER
6 IGNITION ANALYZER
7 RADAR EQUIPMENT, APS-42
8 JET ENGINE FUEL FLOWMETERS
9 TACAN (SOME AIRCRAFT)
10 ALTIMETER - ENCODER REPORTING

Inverter failure indications and emergency action..... If the essential inverter fails, an automatic changeover relay connects the spare main inverter to the essential bus, regardless of whether or not the secondary bus is energized. The essential bus red light will flash on, followed by the essential bus amber warning light as the spare inverter takes over. If the secondary inverter fails, the secondary bus red light will flash on; and automatic changeover relay starts the spare main inverter, and connects it to the secondary bus. The secondary bus amber warning light goes on and the red light goes out. If either automatic changeover relay fails, place the corresponding inverter switch in the SPARE INV position. 52-833 ▶ 52-844 Wait 3 seconds at OFF before switching to SPARE INV. If two main inverters fail, at least one bus is deenergized. The corresponding power failure red warning light remains illuminated.

Alternator failure will affect the following:

1 APN-69
2 NESA GLASS
3 ARA-25 ANTENNA HEATER
4 PILOT'S EMER PITOT HEAT (Static Source)

Emergency action..... If the alternator fails, the red warning light will illuminate. When an alternator warning light illuminates, perform the following:

1. Alternator Switch – OFF.
2. Overhead Circuit Breaker – PULL.
3. Bus Selector Switch – REPOSITION AS REQUIRED.

CAUTION

An alternator failure may be due to a faulty exciter regulator circuit which may cause excessively high voltages. If excessively high voltage exists, the exciter circuit should be disconnected by removing the A- and F- leads from the terminal strip on the voltage regulator.

NOTE:
If flight conditions permit, consideration should be given to shutting down the engine with affected alternator prior to disconnecting leads at the voltage regulator.

Instrument transformer failure will affect the following:

1 CABIN AIR FLOW INDICATOR
2 COWL FLAP POSITION INDICATORS
3 ENGINEER'S AND BOOM OPERATOR'S A/R FUEL PRESSURE GAGES
4 FUEL FLOWMETER
5 FUEL PRESSURE GAGES
6 HYDRAULIC PRESSURE GAGES
7 INTERCOOLER FLAP POSITION INDICATORS
8 OIL PRESSURE GAGES
9 TORQUEMETERS
10 A/R HYDRAULIC PRESSURE GAGES 2900 ▶
11 JET ENGINE OIL PRESSURE GAGES

Emergency action..... Control engine power by manifold pressure gages and tachometers. Use AUTO LEAN or AUTO RICH mixture setting to control fuel flow. Set cowl flaps by visual observation. Hydraulic and fuel pressure warning lights will still function in the event of a system malfunction.

ELECTRICAL SYSTEM EMERGENCY OPERATION

Figure 3-11 (Sheet 1 of 4)

ALTERNATING CURRENT FAILURES (CONT)

Flight instrument inverter power failure will affect the following:

1 PILOT'S ATTITUDE INDICATOR
2 PILOT'S HEADING INDICATOR

Failure indications and emergency action..... If the normal flight instrument inverter fails, the instrument inverter red light will flash on; an automatic changeover relay starts the spare instrument inverter. The instrument inverter amber warning light goes on as the red light goes out. If the instrument inverter changeover relay fails, place the flight instrument inverter switch in the SPARE INV position. If both instrument inverters fail, the pilot's heading indicator and attitude indicator cease to function. The flight instrument inverter power failure red warning lights go on. Place the gyro instrument emergency power switch to BATTERY if failure is due to a dc power failure.

Autopilot inverter power will affect the following:

1 AUTOPILOT
2 AUTOPILOT REPEATER INDICATORS
3 COPILOT'S ATTITUDE INDICATOR
4 COPILOT'S TURN AND SLIP INDICATOR
5 DRIFTMETER 22630 ▶
6 N-1 MASTER HEADING INDICATOR
7 N-1 COMPASS

DC ELECTRIAL SYSTEM EMERGENCY OPERATION

Direct Current Instruments

1 CARBURETOR AIR TEMPERATURE GAGE
2 CYLINDER HEAD TEMPERATURE GAGE
3 OIL QUANTITY GAGE
4 OIL TEMPERATURE GAGE
5 OUTSIDE AIR TEMPERATURE GAGE
6 PILOT'S TURN AND SLIP INDICATOR
7 WING FLAP POSITION INDICATOR
8 PILOT'S ALTIMETER VIBRATOR

When no other power is available, the battery will provide power to the emergency bus for operation of.....

1 AIR REFUELING FUEL DUMP CIRCUIT
2 APU STARTING (ON GROUND ONLY)
3 CABIN ENTRANCE LIGHT
4 EMERGENCY ALARM SYSTEM
5 EMERGENCY CONTROL CABIN LIGHTS
6 FLIGHT INSTRUMENT SPARE INVERTER
7 GENERATOR FIELD RESET
8 LANDING FLARE RELEASE
9 PILOT'S TURN AND SLIP INDICATOR
10 SINGLE POINT GROUND REFUELING
11 PILOT'S PITOT HEAT EMERGENCY POWER (PITOT SOURCE)

Generator Failure

1. In the event a generator warning light illuminates, indicating a power malfunction, check for a tripped field control relay. To accomplish this check, turn the voltmeter selector switch to the tripped generator position; if the meter indicates 2 to 3 volts, the field relay has tripped. To reclose the field relay, move the respective generator switch to RESET and then to OFF, adjust the voltage to 28 volts (if voltage cannot be adjusted down to 28 volts, an overvoltage condition exists and the generator must be made inoperative by leaving the switch in the OFF position and pulling the respective generator field circuit breaker on the main circuit breaker panel), move the generator switch to ON, and readjust the voltage to equalize the load. If the generator field control relay trips again, repeat the above procedure. If at any time it is impossible to parallel the generator or if the field relay trips again, turn generator switch OFF and pull the respective generator field circuit breaker on the main circuit breaker panel. Leave generator switch OFF until the cause of the failure has been determined and corrected.
2. In the event of generator failure (negative, zero, residual, or fluctuating voltage and zero negative, or fluctuating amperage) the following procedure will apply:
a. Generator Switch – OFF. b. Generator Field Circuit Breaker – PULLED. c. Observe Respective Engine Closely For Symptoms Of Fire. d. Troubleshoot System As Required.

Three-generator Operation..... Under normal conditions, three generators will supply sufficient power to operate all dc equipment, including the inverters. As a precautionary measure, the loadmeters should be checked frequently, especially when propeller deicers are operating. If desired, the APU may be operated to provide additional dc power.

Two-generator Operation..... Operation with two generators requires caution, and close monitoring of the dc loadmeters is essential. When the APU can be operated in conjunction with the two engine-driven generators, sufficient dc power will be available for all normal operations.

Figure 3-11 (Sheet 2 of 4)

DC ELECTRICAL SYSTEM EMERGENCY OPERATION (CONT)

Two-generator Operation (cont) ..... In the event that the APU cannot be operated, the problem is much more severe, and extreme care must be exercised. Propeller deicers should not be operated, and major systems such as wing flaps and landing gear should be operated separately. Complete the operation of one system prior to operating the next system. See figures 7-10 and 7-11 for major dc electrical equipment loads.

NOTE: The landing gear may be lowered individually by pulling individual gear control circuit breakers when considered necessary.

Failure of all generators.....

If all generators fail, it will be the result of a dc system fault or short circuit causing progressive overloading. In event of this, proceed as follows:

1. Turn electrical master switch OFF. Turn off all inverters and all dc equipment. Do not move engine controls except throttles and mixture controls. Mixtures should be set to AUTO RICH.
2. The following equipment must be turned off:
   a. Inverters, b. Alternators, c. All radios, d. Boost pumps, e. Heater switches, f. Autopilot, g. Turbo boost switch to MAN, turbo manual override switch OFF, h. Do not operate any switches or controls except to set to the OFF position, i. Turn generator switches OFF.
3. Place pilot's instrument inverter emergency power switch to BATTERY to operate spare instrument inverter, pilot's turn and slip indicator, and the emergency lights.
4. Turn electrical master switch ON. Reset each generator electrically with the generator control switch. If the generators cannot be reset electrically, reset the generators manually with the reset button on the accessible field control relays located below the voltage regulators on the right forward side of the lower forward cargo compartment. Do not move generator switches "ON" until all generator voltages have been checked with the voltmeter.
5. Turn on one generator showing normal voltage. Carefully monitor loadmeter and turn on essential inverter. Turn on a second operative generator and observe loadmeters for satisfactory load division. Continue until all operative generators are on the dc bus system. Electrically reset the generators for which the manual reset buttons were not accessible and make sure that all of these generator voltages are normal before turning them ON. Be alert for sudden changes in engine operation as the control circuits are reenergized.
6. Turn on the ADF for use as a range and navigation receiver. In orderly sequence add essential equipment, one unit at a time, constantly monitoring loadmeters to detect unusual fluctuations. Continue to nearest landing field. Consider advisability of manually extending landing gear if two or less generators are operative. Do not use propeller reverse during landing unless absolutely necessary. If propeller reversing is required, reverse the inboard propellers only to prevent sudden bus failure with the possibility of unsymmetrical reverse thrust and a consequent loss of directional control.

Number of generators required for takeoff.....

1. Takeoff may be made with four generators operating provided at least one generator is operative on each engine; however, if an inboard engine generator is inoperative then the other five generators must be operative.

VISUAL INDICATION (Generator Switch ON)

GENERATOR WARNING LIGHTS		LOADMETERS		VOLTMETERS		PROBABLE CAUSE	ACTION
Failed Generator	Other Generators	Failed Generator	Other Generators	Failed Generator	Other Generators		
ON	OFF	ZERO	ABOVE NORMAL	ZERO	NORMAL	Internal generator failure	Move generator switch to OFF; no other action possible in flight.
ON	OFF	ZERO	ABOVE NORMAL	2 to 3 VOLTS	NORMAL	Open generator field or open voltage regulator	Follow action below, if field retrips, move generator switch to OFF; leave OFF.
ON	OFF	ZERO	ABOVE NORMAL	2 to 3 VOLTS	NORMAL	Overvoltage on one generator	Move the respective generator switch to RESET and then to OFF, adjust the voltage to 28 volts (if voltage cannot be adjusted down to 28 volts, an overvoltage condition exists and the generator must be made inoperative by leaving the switch in the OFF position and pulling the respective generator field circuit breaker on the main circuit breaker panel), move the generator switch to ON, and readjust the voltage to equalize the load. If the generator field control relay trips again, repeat the above procedure. If, at that time, it is impossible to parallel the generator or if the field relay trips, turn generator switch OFF and pull the respective generator field circuit breaker on the main circuit breaker panel. Leave generator switch OFF until the cause of the failure has been determined and corrected.

Figure 3-11 (Sheet 3 of 4)

DC ELECTRICAL SYSTEM EMERGENCY OPERATION (CONT)

VISUAL INDICATION (Generator Switch ON)

GENERATOR WARNING LIGHTS		LOADMETERS		VOLTMETERS		PROBABLE CAUSE	ACTION
Failed Generator	Other Generators	Failed Generator	Other Generators	Failed Generator	Other Generators		
ON	PROGRESSIVELY ON	ZERO	ABOVE NORMAL	2 to 3 VOLTS	NORMAL, THEN 2 to 3 VOLTS WHEN LIGHTS COME ON	Overvoltage due to improper paralleling with progressive overloading	Turn off all inverters and dc equipment. In the lower forward compartment manually reset a generator field control relay that is easily accessible. Reset remaining relays by means of the generator switches. All relays can be reset electrically. Do not move generator switches to ON. Check all generator voltages with voltmeter. Turn on one generator showing normal voltage. Use rheostat to adjust to normal voltage when necessary. Carefully monitor loadmeter and turn on essential inverter. Turn on second operative generator and observe loadmeters for satisfactory load division. Continue until all operative generators are on the bus.
ON OR OFF DEPENDING ON AMOUNT OF UNDERVOLTAGE	OFF	VERY LOW	ABOVE NORMAL	LOW	NORMAL	Undervoltage on one generator due to improper paralleling	If warning light is OFF, turn rheostat up slightly to rebalance load. If warning light is ON, turn generator switch OFF; diagnose difficulty; raise voltage with rheostat.
OFF	OFF	VERY HIGH	ZERO OR REVERSED	NORMAL	NORMAL OR SLIGHTLY HIGH	Loss of paralleling circuit with resulting instability	Move failed generator switch OFF; check other loadmeters for proper load distribution. If another generator takes load, move all but one generator switch OFF. Do not make more than one attempt to place each generator on bus. Turn OFF all unnecessary electrical equipment.
ON	OFF	OFF SCALE	ABOVE NORMAL	LOW	NORMAL	Ground fault on generator leads	Move failed generator switch OFF; leave OFF. Pull field control circuit breaker.
OFF	OFF	OFF SCALE	HIGH OR OFF SCALE	VERY LOW	LOW	Ground fault on generator leads with welded reverse current relay	Turn master switch and all generator switches OFF. Pull field control circuit breakers. Turn master switch ON. Reset one circuit breaker at a time, checking each voltage and loadmeter. Low voltage and high percent load will indicate faulty generator; leave that generator switch OFF; turn other switches ON.
(These indications might be followed by blown current limiter—see next item)							
ON	OFF	ZERO	ABOVE NORMAL	NORMAL	NORMAL	Open circuit in power feed (blown current limiter)	Move generator switch OFF; leave OFF; monitor loads to make sure remaining generators are not overloading.
OFF	OFF	OFF SCALE	OFF SCALE	LOW	LOW	Ground fault on main bus	Move all generator switches to OFF; leave OFF.

Figure 3-11 (Sheet 4 of 4)

Main Landing Gear Operation With Auxiliary Flap Motor

NOTE

Boom operator will establish interphone contact with the pilot before initiating manual gear operation.

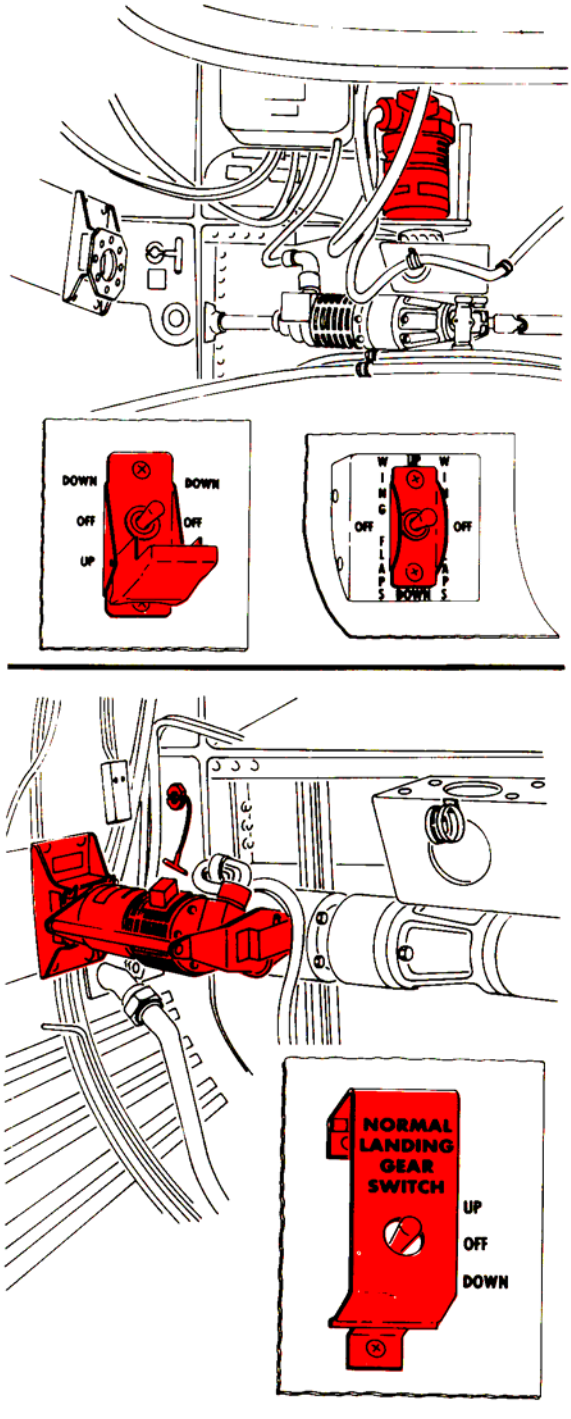
If the main landing gear motor should fail, raise or lower the gear as follows:

1. Normal Landing Gear Switch OFF; Pull Landing Gear Control Circuit Breaker.
2. Pull Emergency Wing Flap Control Circuit Breaker.

WARNING

The control circuit breaker for the portable auxiliary flap motor, located on the main dc circuit breaker panel, must be pulled when the motor is not secured. Accidental actuation of the portable flap motor switch when the motor is not secured may cause damage to the airplane or injury to the operator.

3. Pull Out Red T-Handle Near Each Emergency Landing Gear Handcrank Receptacle and Seat the Swaged Ball in the Slot to Disengage the Motor Clutch and to Engage the Manual Clutch.
4. Install Portable Auxiliary Flap Motor, Reset Emergency Wing Flap Control Circuit Breaker and Operate Switch on Motor in Direction Indicated on Switch Cover.
5. Run Motor Until Landing Gear Stops are Hit and Motor Clutch Starts Slipping (Approximately 60 Seconds Required).
6. Always Release Clutch Handle Immediately After Emergency Operation is Complete; Return Portable Auxiliary Flap Motor to Normal Stowed Position for Emergency Wing Flap Operation.



USING THE AUXILIARY FLAP MOTOR

Figure 3-12

Manual Raising of Main Landing Gear

CAUTION

If the normal gear retraction system fails, the gear will not be manually retracted unless a gear-down condition is unsafe. If a manual practice procedure is performed, gear must be operated through one complete cycle electrically before a landing to assure correct normal operation.

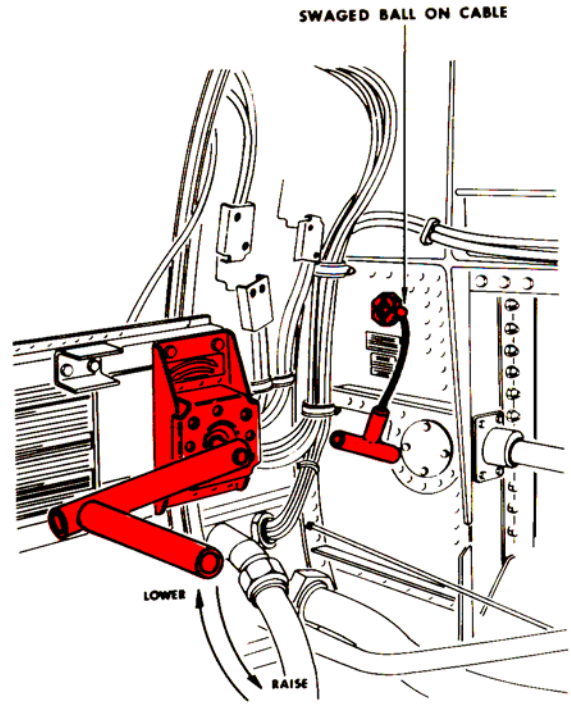
1. Landing Gear Switch OFF; Pull Landing Gear Control Circuit Breaker.
2. Pull Out Red T-Handle to Engage Manual Clutch.
3. Insert Emergency Handcrank and Rotate it in Direction Indicated Until Stops are Contacted and Lock is Engaged (490 Turns are Required).

CAUTION

- Always reset the red T-handle and oscillate emergency handcrank after emergency operation is completed to allow electrical operation of the landing gear.
- When presence of ice is suspected, turn emergency handcrank three turns in both extend and retract directions prior to pulling out red T-handle.

NOTE

Crewmember in lower aft compartment will establish interphone contact with the pilot before initiating manual gear operation.



MANUAL OPERATION OF THE MAIN LANDING GEAR

Figure 3-13

Manual Raising of Nose Landing Gear

CAUTION

If normal gear retraction system fails, the gear will not be manually retracted unless a gear-down condition is unsafe.

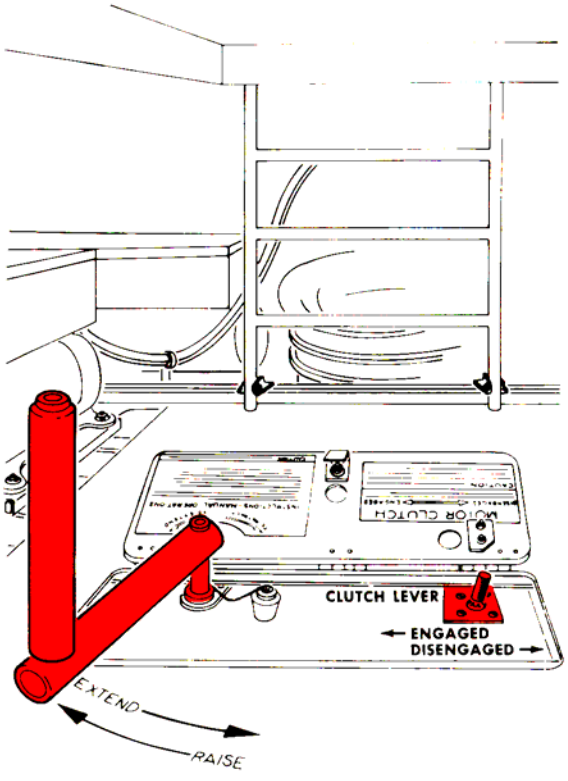
1. Check Landing Gear Switch OFF.
2. Pull Nose Gear Control Circuit Breaker.
3. Disengage Motor Clutch.
4. Remove Rubber Plug From Socket and Engage Emergency Handcrank Through Two Keyed Sections by Pressing Down on Handcrank Hub for First Full Turn.
5. Crank Gear Up.

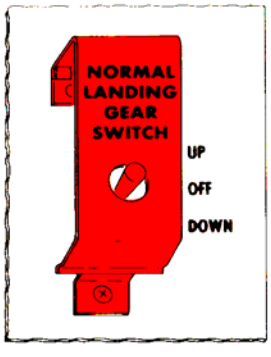
   Approximately 220 turns of emergency handcrank are required to fully retract nose gear.
6. Return Motor Clutch to Engaged Position.

CAUTION

Always return motor clutch to the engaged position. To prevent damage to motor by overspeeding, do not operate motor with clutch disengaged.

7. Remove Emergency Handcrank and Replace Rubber Plug.
8. Reset Nose Gear Circuit Breaker.





LANDING GEAR SWITCH OFF DURING MANUAL OPERATION

MANUAL OPERATION OF THE NOSE GEAR

Figure 3-14

NAVIGATOR'S EMERGENCY PROCEDURES

NOTE

The navigator and boom operator will have joint responsibility for fighting fires in the airplane. The crewmember discovering a fire will assume primary responsibility; other crewmembers will assist in fighting fires, provide all available necessary equipment, and relay information and instructions to crewmembers.

FUSELAGE/ELECTRICAL FIRE

(1.) DETERMINE, REPORT OR ACKNOWLEDGE (ALL)

Determine source of fire and report to pilot.

(2.) FIGHT FIRE (N, BO)

Shut off system feeding fire. Extinguish flames as quickly as possible.

WARNING

Do not use fire extinguishers to cool equipment. Heavy, dense, suffocative or toxic smoke occurs when bromochloromethane (CB) is used on hot metal or open fire. However, CB is safer to use than previous fire extinguishing agents. Avoid more than 5 minutes exposure to CB, because irritation of the eyes and nose will occur. Obtain adequate respiratory and eye protection. (Cover nose and mouth with a damp cloth.) Use 100 percent oxygen as soon as the primary fire emergency permits.

NOTE

The fire fighter's mask will be used when it is necessary to be on oxygen to investigate or combat fires.

(3.) REPORT STATUS (N, P)

Notify the pilot when fire has been extinguished and if any smoke or fumes are present. Should fire become uncontrollable, immediately notify pilot so bailout procedures may be initiated.

(4.) Turn Off All Electrical Equipment and Switches (As Required) (N, E)

If master switch has been turned OFF, turn all electrical switches OFF prior to turning the master switch ON.

(5.) Turn On Switches (One at a Time) (As Directed) (N, P)

If fire was from an undetermined electrical source, turn equipment on as needed when directed by pilot, carefully observing the equipment and wiring. When fault is detected, isolate circuit or equipment by disconnecting or leaving inoperative.

SMOKE OR FUME ELIMINATION

1. Oxygen Mask On (As Required)

   Use fire fighter's mask or portable oxygen bottle if necessary.

2. Attach Parachute Pack (As Required)

3. Relay Instructions (Only When Master Switch is OFF).

   If fuel fumes are reported, the interphone becomes inoperative when the engineer turns master switch OFF. At this time, navigator assumes duty of relaying pilot's instructions to other crewmembers.

(4.) Open Hatches (As Directed) (N, P, BO)

If smoke or fumes are present in lower compartment, open floor hatches to assist in ventilation, after opening the emergency hatches as directed by the pilot.

WARNING

Parachutes will be worn when opening and closing exterior hatches and doors or when duties require that the crewmembers work in the proximity of open doors and hatches.

(5.) Report Status of Smoke or Fumes (N, P, BO)

One crewmember will notify pilot when smoke or fumes no longer exist or if ventilation has not been successful.

(6.) Turn Off All Electrical Equipment and Switches (As Required) (N, E)

If master switch has been turned off, turn all electrical equipment switches OFF prior to turning master switch ON.

(7.) Turn On Switches (One at a Time) (As Directed) (N, P)

If smoke or fumes resulted from an electrical fire of undetermined source, turn equipment on as needed when directed by the pilot, carefully observing the equipment and wiring. When fault is detected, isolate circuit or equipment by disconnecting or leaving inoperative.

BAILOUT

(1.) Acknowledge Alert Signal (ALL)

If time permits, the alert signal of three short rings on the alarm bell will be acknowledged on interphone.

(2.) (If time permits) Prepare Position Report and give to CP (N, CP)

a. Determine and record position and time.

b. Determine and record course and ground speed.

c. Determine and record number of personnel on board.

d. Determine and record nature of emergency.

e. Record altitude.

3. Don and Check Anti-Exposure Suit, Life Vest, Harness and Parachute (as required).

Don anti-exposure suit and life vest as applicable prior to adjusting parachute and harness.

4. Attach Individual Survival Kit/One-Man Life Raft (if time permits).

Recheck for proper fit.

5. Bail Out on Command.

Release survival kits, emergency radios, and multiple-place life rafts as applicable between personnel as they leave the airplane.

DITCHING PROCEDURE

FIRST ACTION

(1.) Acknowledge Alert Signal (N, P)

(2.) Prepare Position Report: give to CP (N, CP)

a. Determine and record position and time.

b. Determine and record course and ground speed.

c. Determine and record number of personnel on board.

d. Determine and record nature of emergency.

e. Record altitude.

NOTE

Copilot will transmit distress message while Navigator keeps up with the position of aircraft. Navigator continuously updates aircraft position, passing information to copilot for transmission.

TEN MINUTES

(3.) Acknowledge ten minute warning (N, P)

4. Remove parachute harness, don anti-exposure suit and life vest.

5. Complete Ditching Preparation.

Assemble navigation kit, flares, pyrotechnic pistol and flashlight.

(6.) Give Absolute Altitude to Pilot (N, P, CP)

Navigator will obtain accurate absolute altitude and give to Pilot. Pilot will set absolute altitude on his pressure altimeter.

7. Continue positioning aircraft — relay to copilot.

FINAL APPROACH (2000')

(8.) Acknowledge Ditching Position (N, P)

Fasten safety belt and shoulder harness, and lock inertial reel.

9. Proceed to Emergency Exit After Impact.

After airplane has come to a complete stop, open additional emergency exit hatches if necessary and abandon airplane by appropriate exit. Assist other crewmembers in removing emergency equipment and launching life rafts.

CRASH LANDING PROCEDURE

1. Acknowledge Alert Signal (N, P)
2. Prepare Position Report.
   a. Determine and record position and time.
   b. Determine and record course and ground speed.
   c. Determine and record number of personnel on board.
   d. Determine and record nature of emergency.
   e. Record altitude.
3. Transmit Distress Message.

   Navigator will establish contact with last surface facility utilized. If contact cannot be made, navigator will establish contact on an emergency frequency. Transmit "Mayday" three times, identification three times, and emergency position report. Request fix or bearing service if desired.
4. Remove parachute harness.
5. Complete crashing landing preparation.

   Assist other crewmembers in securing loose equipment and cargo.
6. Assume crash landing position; fasten safety belt and shoulder harness.
7. Proceed to emergency exit after impact.

   After airplane has come to a complete stop, abandon airplane by appropriate exit. Assist other crewmembers in removing emergency equipment, if applicable.

BOOM OPERATOR'S EMERGENCY PROCEDURES

NOTE

The navigator and boom operator will have joint responsibility for fighting fires in the airplane. The crewmember discovering a fire will assume primary responsibility; other crewmembers will assist in fighting fires, provide all available necessary equipment, and relay information and instruction to crewmembers.

FUSELAGE/ELECTRICAL FIRE

1. DETERMINE, REPORT OR ACKNOWLEDGE (ALL)

   When cause of fire is determined, report source to pilot. If fire is of electrical origin, applicable equipment will be turned off. If fire is a result of fuel system failure, coordinate with engineer on positioning applicable fuel valves.

2. FIGHT FIRE (BO, N)

   Extinguish flames as quickly as possible.

WARNING

Do not use fire extinguishers to cool equipment. Heavy, dense, suffocative or toxic smoke occurs when bromochloromethane (CB) is used on hot metal or open fire. However, CB is safer to use than previous fire extinguishing agents. Avoid more than 5 minutes exposure to CB, because irritation of the eyes and nose will occur. Obtain adequate respiratory and eye protection. (Cover nose and mouth with a damp cloth.) Use 100 percent oxygen as soon as the primary fire emergency permits.

NOTE

The fire fighter's mask will be used when it is necessary to be on oxygen to investigate or combat fires.

3. REPORT STATUS (BO, P)

   Notify the pilot when fire has been extinguished and if any smoke or fumes are present. Should fire become uncontrollable, immediately notify pilot so bailout procedures may be initiated.

4. Fire extinguished, turn off switches (BO, P)

   Turn off switches if electrical fire resulted from an undetermined source.

(5.) Turn On Switches, One at a Time, As Directed by Pilot (ALL)

If electrical fire resulted from an undetermined source, turn equipment on as needed, carefully observing the equipment and wiring. When fault is detected, isolate circuit or equipment by disconnecting or leaving inoperative.

SMOKE OR FUME ELIMINATION

1. Oxygen Mask On (As required).

Use fire fighter's mask or portable oxygen bottle if necessary.

2. Attach Parachute Pack.

WARNING

Parachutes will be worn when opening and closing exterior hatches and doors, or when duties require that the crewmembers work in the proximity of open doors or hatches.

(3.) Open Hatches as Directed by Pilot (BO, P, N)

If smoke or fumes are present in lower compartments, open floor hatches to assist in ventilation, after opening the emergency exit hatches as directed by pilot.

(4.) Report Status of Smoke or Fumes to Pilot (BO, P N)

One crewmember will report to pilot when smoke and/or fumes no longer exist or that ventilation has not been successful.

(5.) All Electrical Equipment Switches OFF (ALL)

If master switch has been turned OFF due to presence of fuel fumes, turn all electrical equipment switches OFF prior to turning master switch ON.

BAILOUT

(1.) Acknowledge Alert Signal (BO, P, CP)

If time permits, the alert signal of three short rings on the alarm bell will be acknowledged on interphone.

2. Stow and Latch Boom (As Required).

3. Check Passenger's Survival Equipment.

Check passengers for required equipment and proper fit.

4. Don and Check Antiexposure Suit, Life Vest, and Parachute Pack.

Don antiexposure suit and life vest (if required) prior to adjusting parachute harness.

(5.) Open Emergency Exit Hatches (BO, P)

Open emergency exit hatches when directed by pilot.

(6.) Release Survival Equipment on Command (One Long Ring) (BO, P, N)

Release survival kits and multiple-place life rafts as applicable between personnel as they leave the airplane.

7. Attach Individual Survival Kit or One-Man Life Raft.

Recheck for proper fit.

(8.) Inform Pilot, "All Personnel Have Bailed Out." (BO, P)

9. Jumpmaster Bail Out.

CRASH LANDING

(1.) Acknowledge Alert Signal (BO, CP)

If time permits, the alert signal of six short rings on the alarm bell will be acknowledged on interphone.

2. Stow and Latch Boom (As Required).

(3.) Secure or Stow Loose Equipment and Cargo (BO, P)

Secure or stow loose equipment and cargo when directed by pilot.

4. Attach Parachute Pack.

(5.) Open and Stow Emergency Exit Hatches and Close Floor Hatches (BO, P)

6. Depressurize Boom Hydraulic System (BO, E)

   Depressurize boom hydraulic system after fuel dump is complete.

7. Remove Parachute Harness.

8. Check Crash Landing Positions (BO, P)

   Check that all personnel are braced for crash landing. Assume crash landing position.

9. Proceed to Emergency Exit After Impact.

   After airplane comes to complete stop, abandon airplane by any available exit. Assist other personnel to abandon the airplane.

DITCHING PROCEDURE

FIRST ACTION

1. Acknowledge Alert Signal (BO, P)

2. Stow and Latch Boom (as required).

3. Turn ON all Light Switches.

4. Jettison Cargo if necessary (BO, E, P)

   If jettisoning of cargo is necessary, pilot will direct depressurization when appropriate. Hatches may be re-installed and aircraft repressurized after jettisoning, depending on circumstances.

5. Secure or Stow Loose Equipment and Cargo/Secure Survival Equipment Near Overwing Emergency Exit Hatches.

6. Insure that passengers have proper survival equipment. Order passengers to don survival equipment. Check ditching positions. Advise pilot when complete.

TEN MINUTES

7. Acknowledge Ten Minute Warning. (BO, P, E, N)

8. Attach Parachute Pack, Report ready to open hatches. (BO, P)

9. Open and Stow Emergency Exit Hatches and Close Floor Hatches. (BO, P)

10. Close APU doors (if directed by pilot). (BO, P)

11. Remove Parachute Harness Prepare for Ditching. Boom Operator will then don anti-exposure suit (if required) and life vest.

12. Check that all personnel are in ditching position.

FINAL APPROACH (2000')

13. Acknowledge Ditching Position (P, BO)

    Fasten lap belt and assume ditching position.

14. After Impact, Proceed to Emergency Exit.

    Provide required equipment. After airplane comes to a stop, open as many emergency exit hatches as necessary to evacuate the airplane.

MANUAL LOWERING OF MAIN LANDING GEAR

1. Have Copilot Check Landing Gear Switch OFF.

2. Have Engineer Pull Applicable Control Circuit Breaker.

CAUTION

When presence of ice is suspected, turn emergency handcrank three turns in both extend and retract directions prior to pulling out red T-handle.

3. Pull Out Red T-Handle and Seat Swaged Ball.

   Seat swaged ball in slot to disengage motor clutch and to engage manual clutch.

4. Insert Emergency Handcrank.

5. Rotate 10 Turns in Down Direction.

6. Snap Red T-Handle Forward.

7. Oscillate Emergency Handcrank Rapidly; Allow Free Fall (5 Seconds).

   Rapidly oscillate emergency handcrank to free manual clutch; gear will lower by gravity after clutch is disengaged.

WARNING

After manual clutch is released, do not attempt to re-engage manual clutch or operate gear for 5 seconds. This allows time for gear to free fall and prevent damage to clutch mechanism or injury to operator which would result if manual clutch were re-engaged while gear was free falling.

8. Pull Out Red T-Handle and Seat Swaged Ball.

   This will re-engage the manual clutch.

9. Rotate Emergency Handcrank in Down Direction until stops are hit and the lock is engaged.

CAUTION

- Make certain down lock is engaged. Lock can be felt snapping into position after stops are contacted.
- If landing gear is suspected of not being down and locked, the handcrank may be lashed down with the A-1 web tiedown strap to minimize gear collapse during landing roll. This may be accomplished as follows:

  a. Leave red T-handle pulled and swaged ball seated in slot.

  b. Anchor A-1 tiedown strap to airframe and emergency handcrank so that tension will be applied in gear lowered direction; do not anchor to fluid lines.

  c. Leave handcrank anchored and swaged ball seated in slot until after landing and until ground locks are installed or jacks placed under wing.

  d. After gear has been locked down, inspect handcrank torque tubes to landing gear actuator for twists or buckles.

10. Check With Copilot for Safe Indication.

11. Reset Red T-Handle and Oscillate Emergency Handcrank.

    Always reset the red T-handle and oscillate emergency handcrank after emergency operation is completed to allow electrical operation of the landing gear.

12. Stow Emergency Handcrank.

13. Have Engineer Reset Applicable Control Circuit Breaker.

14. Have Copilot Position Landing Gear Switch DOWN.

MANUAL LOWERING OF NOSE LANDING GEAR

1. Have Copilot Check Landing Gear Switch OFF.

2. Have Engineer Pull Nose Gear Control Circuit Breaker.

3. Disengage Motor Clutch.

4. Remove Rubber Plug.

5. Engage Emergency Handcrank.

   Engage the crank through the two keyed sections by pressing down on the crank hub for the first full turn.

6. Rotate Five Turns in Down Direction.

7. Remove Emergency Handcrank; Allow Free Fall (5 Seconds).

8. Re-Engage and Rotate Emergency Handcrank in down direction until the gear hits the stops. The lock will then set with a perceptible snap.

9. Re-Engage Motor Clutch.

   If clutch does not engage, return clutch lever to DISENGAGED, insert crank, and back off approximately 180 degrees or 360 degrees to change alignment of clutch dogs, then move clutch lever to ENGAGED. After clutch lever is moved to engaged position, be certain that full travel to the down and locked position is accomplished by turning crank to down position until stops are contacted and the lock is engaged.

10. Check With Copilot for Safe Indication.

11. Stow Emergency Handcrank.

12. Replace Rubber Plug.

13. Have Engineer Reset Nose Gear Control Circuit Breaker.

14. Have Copilot Position Landing Gear Switch DOWN.

NOTE

The boom operator's emergency procedures also appear in T.O. 1C-97(K)L-1CL-4, which is an abbreviated checklist. The abbreviated checklist has each numbered step (and some substeps) of the normal and emergency procedures.

SECTION IV
AUXILIARY EQUIPMENT

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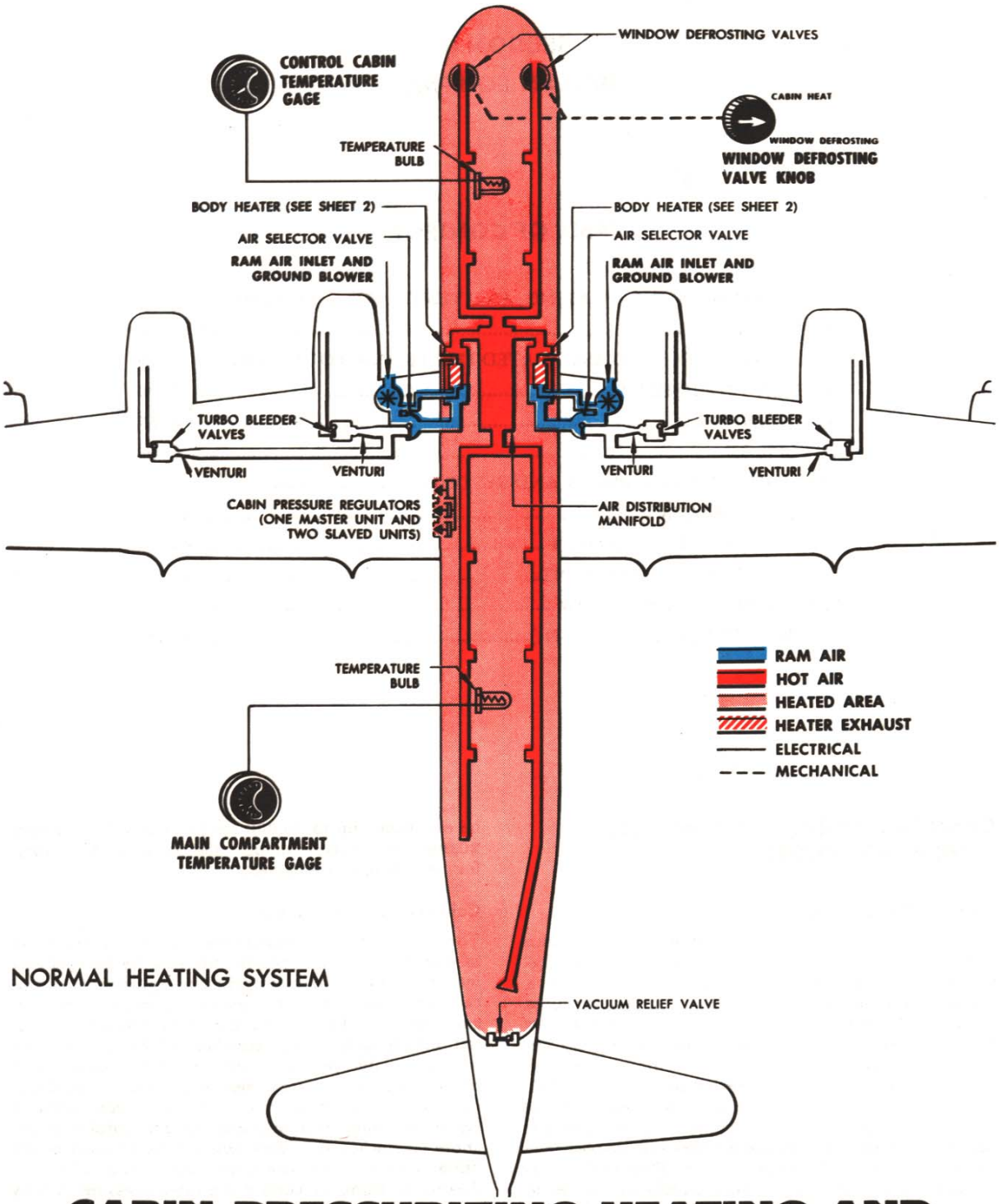
CABIN PRESSURIZING, HEATING, AND VENTILATING SYSTEMS

CABIN PRESSURIZING

Cabin pressurizing allows the crew to perform their duties at altitude with maximum efficiency. Pressurizing air (figure 4–1) is bled from the turbosupercharger of each engine and is supplied to the cabin through venturi tubes which limit the air flow and thereby prevent excessive flow which would result in starvation of the engines. Control of the cabin pressure altitude and pressure rate-of-change is accomplished by metering the discharge of air from cabin to atmosphere through three cabin pressure regulators. These regulators automatically maintain the selected cabin pressure altitude and pressure rate-of-change when the selections are within the capabilities of the pressurizing system. A cabin altitude should be selected to maintain comfort and convenience. To minimize drain on the turbo and to keep engine back pressure at a minimum, it is recommended that a cabin altitude of 5000 feet be maintained up to 20,000 feet pressure altitude. Above 20,000 feet pressure altitude, the recommended setting for cabin altitude is 8000 feet.

Cabin Pressure Regulation

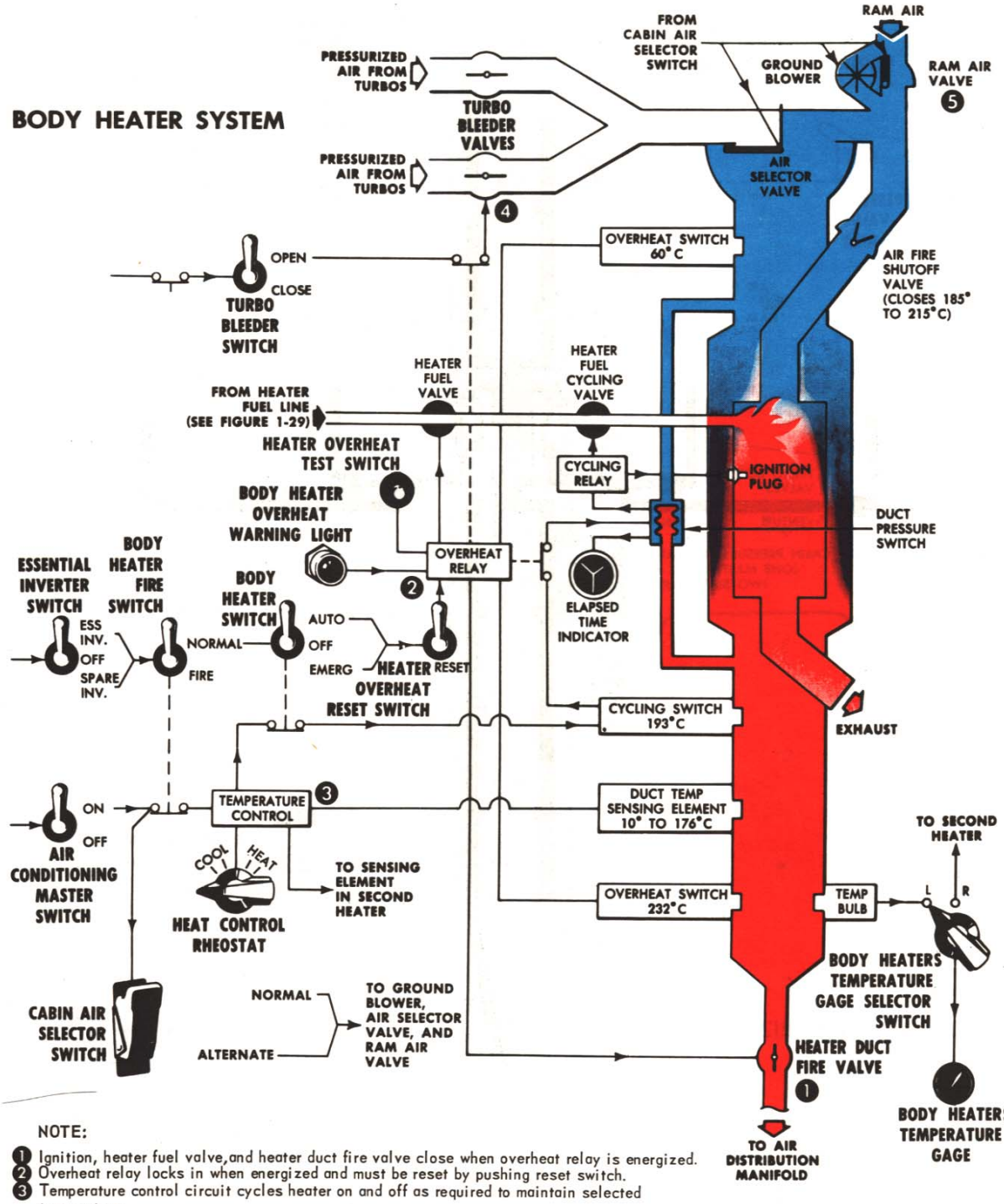
Three methods of preventing structural damage as a result of excessive positive or negative pressure are incorporated into the system. The cabin pressure regulators automatically limit the differential pressure between cabin and atmosphere to 13.4 inches Hg (approximately 15,000 feet altitude differential) regardless of the cabin altitude setting. A cabin pressure relief valve in the forward end of the lower nose compartment will automatically dump cabin air into the nose wheel well when a cabin pressure regulator malfunction increases the differential pressure above 14 inches Hg. This valve can be adjusted by the cabin pressure relief valve crank (figure 4–2) when it is desired to manually control the cabin pressure. A fully automatic vacuum relief valve, located in the tail compartment bulkhead, opens when cabin pressure is less than ambient pressure.



NORMAL HEATING SYSTEM

CABIN PRESSURIZING, HEATING AND VENTILATION

Figure 4–1 (Sheet 1 of 4)



NOTE:

1. Ignition, heater fuel valve, and heater duct fire valve close when overheat relay is energized.
2. Overheat relay locks in when energized and must be reset by pushing reset switch.
3. Temperature control circuit cycles heater on and off as required to maintain selected temperature.
4. Turbo bleeder valves close: when the engine gang bar is placed to FIRE; when the turbo bleeder switch is placed to CLOSE; or when the overheat relay closes.
5. Ram air valve is open when ground blower is off and closed when ground blower is operating.

Figure 4—1 (Sheet 2 of 4)

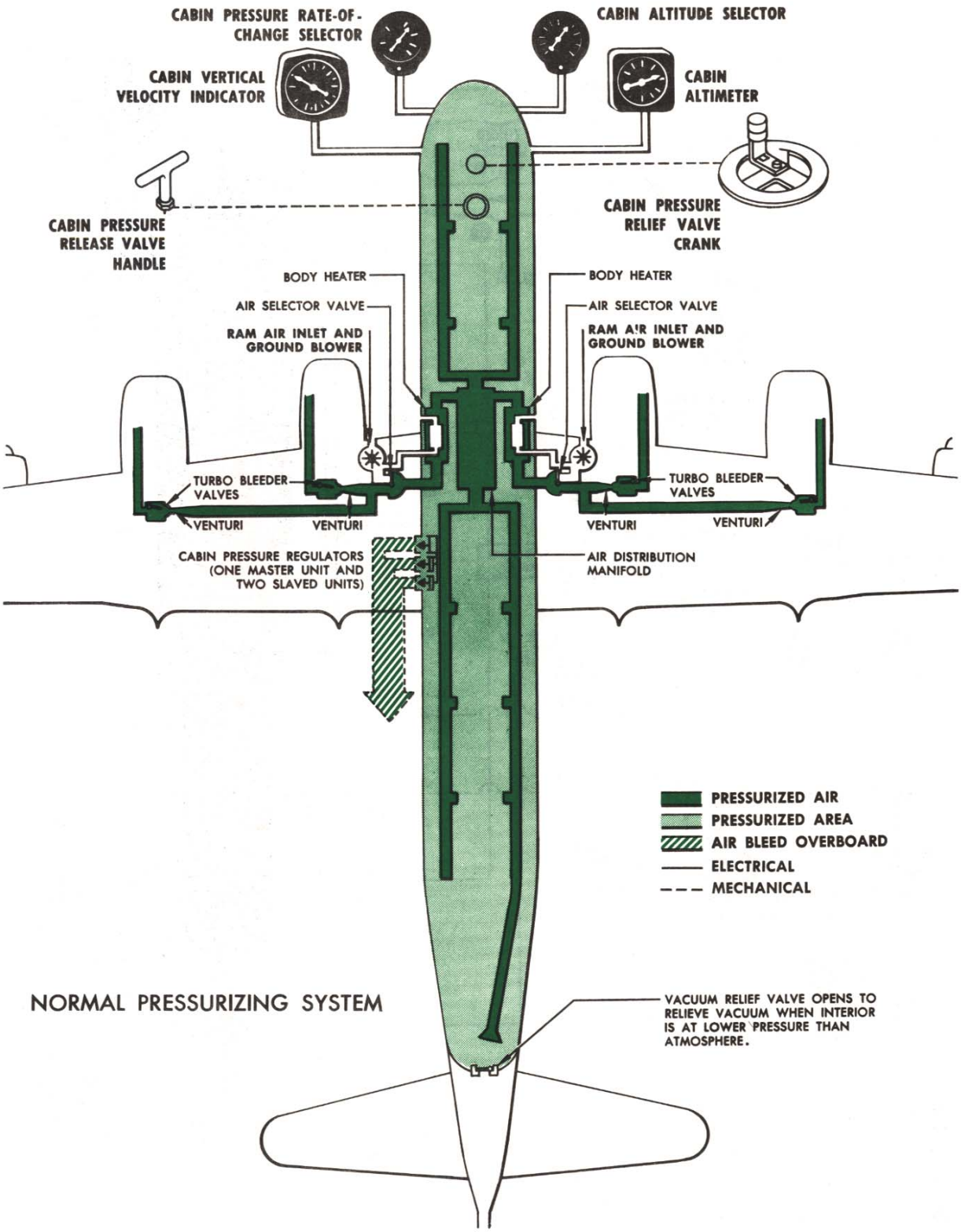
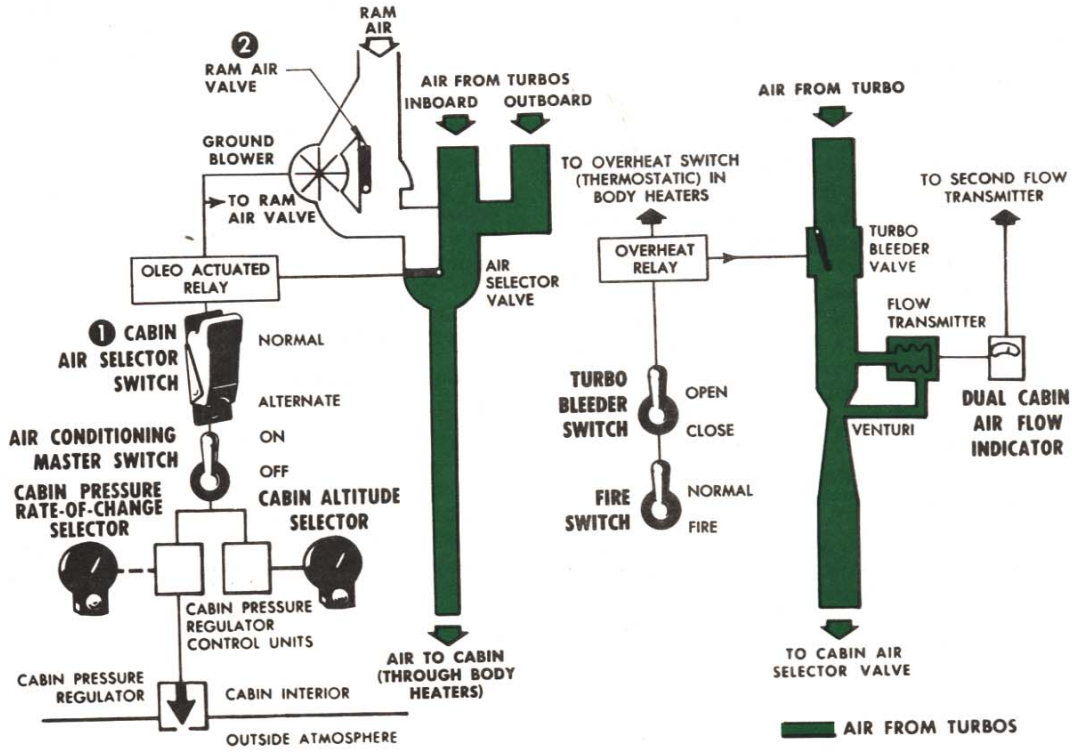


Figure 4–1 (Sheet 3 of 4)



CONTROL OF AIR SELECTOR VALVES (TYPICAL)

CONTROL OF TURBO BLEEDER VALVES (TYPICAL)

1 CABIN AIR SELECTOR SWITCH POSITION	DURING FLIGHT	ON THE GROUND
NORMAL	Turbo air directed to cabin	Ground blower air directed to cabin
ALTERNATE	Ram air directed to cabin	Turbo air directed to cabin

2 Ram air valve is closed while ground blower is operating

Figure 4-1 (Sheet 4 of 4)

CABIN HEATING AND VENTILATING

Pressurized Flight

During pressurized flight, air for cabin heating, including control cabin window defrosting, is obtained from the turbosuperchargers. (Ram air can be selected during flight; however, the ram air will not maintain pressurization.) This air is passed through two combustion-type body heaters located on the ceiling of the lower forward compartment. A cabin air distribution manifold, between the body heaters, directs the heated air into ducts which distribute it throughout the airplane. The heaters are turned on and off by the body heater switches and maintain the temperature selected on the heat control rheostat. Fuel for the body heaters comes from the No. 2 tank or the fuel manifold. This fuel supply is controlled by an auxiliary fuel panel in the left wing. The panel contains a normal and an alternate set of fuel shutoff valves and fuel regulators for the heaters. Further control of the fuel to the body heaters is provided by fuel cycling valves which are electrically actuated by an automatic temperature control or through temperature sensing elements in the heaters and ducts.

Unpressurized Flight

During unpressurized flight, air for heating and ventilating is obtained by picking up ram air in the ground blower inlets when the cabin air selector switches are in the ALTERNATE position. This air passes through the ground blower ducts and the cabin air selector valves into the normal pressurizing lines.

Ground Operations

During ground operations, air for heating and ventilating is supplied from either the turbosuperchargers or two ground blowers. The ground blowers draw fresh air through an inlet in the leading edge of each inboard wing, by the blowers, and through the cabin air selector valves into the normal pressurizing lines. This air is also ducted to the combustion chambers of the body heaters. Fusible fire valves in the combustion air lines will close if reverse combustion air flow creates an overheat condition. Oleo-actuated switches prevent use of the ground blowers when the airplane is airborne.

Cabin Air Circulation

Two electrically operated ventilating fans (1, figure 4–18) circulate the air in the control cabin. The bulkhead-mounted fan located above and aft of the navigator's station draws air from the main compartment through the fan housing to vanes which can be adjusted to deflect the air. A door at the end of the housing can be closed against spring pressure to completely close the vent opening. The second fan is above and aft of the engineer's station and directs air flow forward between the pilots' seats at head level. Refer to CONTROL CABIN FAN SWITCHES, this section.

Air Fire Shutoff Valve

An air fire shutoff valve is located in the air intake of each body heater. The valve is a split butterfly valve, hinged in the center and spring-loaded closed. When the valve is installed, it is wired open with soldering wire that will melt if a fire occurs in the air line upstream of the heaters. (See figure 4–1.) The melting point of the solder varies from 185° to 215°C (365° to 419°F).

System Power Requirements

All electrical controls in the cabin pressurizing, heating, and ventilating systems use direct current. All equipment operates on direct current except the ignition system and cabin air flow indicators which use alternating current from the main inverter essential bus.

PRESSURIZING, HEATING, AND VENTILATING SYSTEMS CONTROLS

Air Conditioning Master Switch

The air conditioning master switch (9, figure 4–3), marked ON–OFF, is located on the engineer's instrument panel. Power to the heat control rheostat and the cabin air selector switches is provided when the air conditioning master switch is in the ON position. When the master switch is in the OFF position, these circuits are deenergized. The master switch receives power through circuit breakers on the forward power panel (5, figure 1–37).

Fire Switches

Refer to FIRE EXTINGUISHER SYSTEM, Section I, for descriptions of these switches.

Cabin Altitude Selector

A cabin altitude selector (17, figure 4–3) is located on the engineer's instrument panel. This selector has a dial and needle showing the cabin pressure altitude selection in either inches Hg or 1000 feet of altitude. A knurled knob at the bottom of the dial is used to adjust the needle to the desired cabin pressure altitude. This setting is electrically transmitted to the cabin pressure regulators which automatically maintain the selected setting until a maximum differential pressure of 13.4 inches Hg is reached. Power for the cabin altitude selector control circuit is obtained through a circuit breaker on the forward power panel (5, figure 1–37).

Cabin Pressure Rate-Of-Change Selector

A cabin pressure rate-of-change selector (18, figure 4–3) is located on the engineer's instrument panel. This selector is similar in appearance to the cabin altitude selector, except that it shows the cabin pressure rate-of-change in either inches Hg per minute or 100 feet of altitude per minute. The knurled knob is used to set the cabin pressure rate-of-change which the cabin pressure regulators are to maintain during any change in cabin altitude. Power for the selector is obtained through a circuit breaker on the forward power panel (5, figure 1–37).

Turbo Bleeder Switches

Four turbo bleeder switches (11, figure 4–3), one for each turbo bleeder valve, are located on the engineer's instrument panel. The switches have two positions: OPEN –CLOSE. When the switches are positioned to CLOSE, the turbo bleeder valves are locked in the closed position. When the switches are positioned to OPEN, the turbo bleeder valves are unlocked and operate as swing check valves. Air from the turbos can pass through the body heater units to the cabin, but reverse flow of air will cause the check valves to close. Placing the engine gang bar in the FIRE position closes the respective turbo bleeder valve and makes the turbo bleeder switch ineffective. Power to the turbo bleeder switches is obtained through a circuit breaker on the overhead circuit breaker panel (1, figure 1–37) and an oil, fuel, hydraulic oil, and cabin air bleed switch on the overhead panel.

Cabin Air Selector Switches

Airplanes 17260 ▶ 22806 have two guarded cabin air selector switches (19, figure 1–21) on the engineer's instrument panel. On airplanes 31061 ▶, these two switches (9, figure 1–20) are located on the engineer's auxiliary overhead panel. The switches have two positions: NORMAL–ALTERNATE. The switches control the left and right cabin air selector valves and the ground blowers. When the switches are in the NORMAL position and the airplane is on the ground, cabin air is supplied by the ground blowers. During flight, with the switches on NORMAL, the cabin air is supplied by the turbosuperchargers. When the switches are in the ALTERNATE position, cabin air is supplied during flight by ram air passing through the ground air blower duct. When the airplane is on the ground and the switches are on ALTERNATE, cabin air is supplied by the turbosuperchargers. The air conditioning master switch (9, figure 4–3) must be ON for the cabin air selector switches to be operative. The ground blower power circuits are protected by circuit breakers on the main circuit breaker panel (8, figure 1–37).

Body Heater Switches

Two body heater switches (21, figure 4–3), marked AUTO–OFF–EMERG, are located on the engineer's instrument panel. These switches control the fuel and ignition circuits for the combustion-type body heaters. Each of the following switches must be in their normal or on position to energize the body heaters: the body heater fire switch, the air conditioning master switch, and the essential inverter switch. With the body heater switches on AUTO, the fuel and ignition circuits are energized through an automatic temperature control circuit. The temperature control starts and stops the heaters to maintain a duct outlet temperature between 10° to 176°C (50° to 349°F) depending upon the setting of the heat control rheostat. If the automatic temperature control does not operate satisfactorily, the body heater switches may be moved to the EMERG position. In this position, the automatic temperature control is cut out and the cycling switch is operative. The cycling switch prevents the outlet duct temperature from exceeding 193°C (379°F). When using the EMERG position, the cabin temperature can be controlled by periodically switching from EMERG to OFF. On 17260 ▶ 22701 ignition for the body heater switches receive power through fuses on the ac power panel. On 22701 ▶ the ignition for the body heaters receives power through circuit breakers on the ac power panel (15, figure 1–37).

Heat Control Rheostat

A heat control rheostat (11, figure 1–20), marked with COOL and HEAT ranges, is located on the engineer's auxiliary overhead panel. This rheostat is used to set the operating cycle of the body heaters, thereby controlling the overall heat output. Power to the heat control rheostat is supplied through the air conditioning master switch, body heater fire switch, and a circuit breaker on the forward power panel (5, figure 1–37). The heat control rheostat is inoperative when the body heater switches are on EMERG. Refer to BODY HEATER SWITCHES, this section. If a dangerous overheat condition arises, overheat switches either upstream or downstream of the heaters will close and energize overheat relays. When these relays are energized, they close the air fire valves downstream of the heaters, close the heater fuel valve, deenergize the ignition, and illuminate the body heater overheat warning lights. The relays lock out the heaters until the overheat condition is eliminated and a reset switch is actuated.

Heater Overheat Test Switch

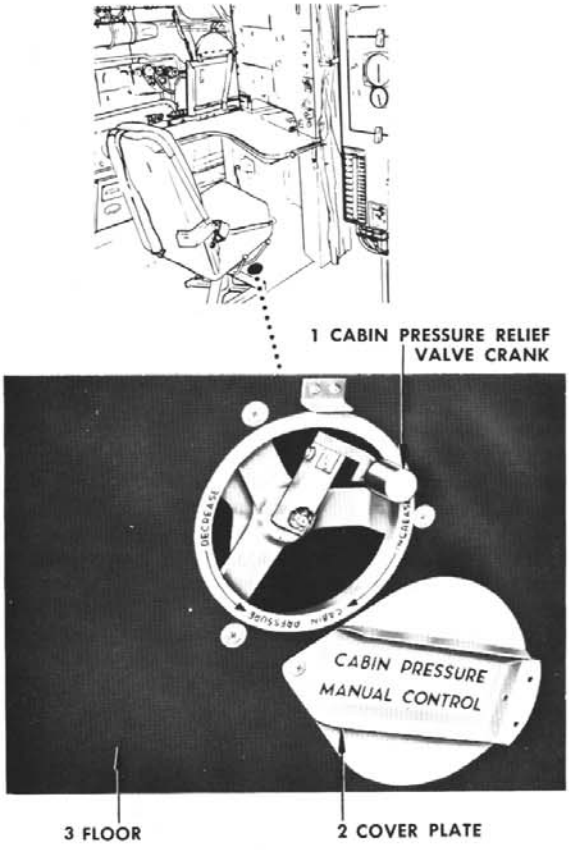
The heater overheat test switch (6, figure 4–3) on the engineer's instrument panel is used to test the overheat protection and warning circuits for the body and surface anti-icing heaters. Depressing the test switch simulates an overheat condition by actuating the overheat relay for each heater. The overheat relays turn on the body heater overheat warning lights, deenergize the ignition for each heater, and close all fuel and air fire valves to completely isolate each heater. After actuating the test switch, the heaters remain inoperative until the heater overheat reset switch is momentarily held to RESET. Refer to HEATER OVERHEAT RESET SWITCH, this section.

Note

- Actuating the heater overheat test switch when the heaters are in operation will shut down all heaters.
- Actuation of the heater overheat test switch will close the turbo bleeder valves and heater duct fire valves when the body heater switches are ON. Pressurizing air flow must be restored by positioning the heater overheat reset switch to RESET momentarily.

Heater Overheat Reset Switch

When any body or surface anti-ice heater is deactivated due to an overheat condition or by actuation of the heater overheat test switch, the unit (or units) remains shut off. Momentarily placing the heater overheat reset switch (5, figure 4–3) to the RESET position restores heater opera-



CABIN PRESSURE RELIEF VALVE CRANK

Figure 4–2

tion, providing the overheat condition no longer exists. This switch is operative when the air conditioning master switch, essential inverter switch, body heater fire switch, and the body heater switch are ON. Circuit protection is through circuit breakers on the forward power panel (5, figure 1–37).

Heater Fuel Supply Switch

The heater fuel supply switch (23, figure 4–3) on the engineer's instrument panel selects one of two fuel valves and regulators through which fuel from the No. 2 wing tank or manifold is taken for the operation of the surface anti-icing heaters and body heaters. (See figure 1–29.) With this switch in the NORMAL position, fuel for the heaters is taken through one regulator. With the switch in the ALTERNATE position, heater fuel is drawn through the alternate regulator. The essential inverter switch (42, figure 1–21) must be in the ESS. INV. position to supply power for operation of the valves. The circuit breaker for this switch is on the overhead circuit breaker panel (1, figure 1–37).

Cabin Pressure Relief Valve Crank

A cabin pressure relief valve crank (1, figure 4–2), recessed in the floor under the engineer's seat, is mechanically linked to the cabin pressure relief valve. This crank is used to manually control the escape of air from the cabin in case the automatic cabin pressure regulators malfunction. The recess is marked with INCREASE and DECREASE arrows to indicate the cabin pressure change that will result when the crank is rotated. Cabin pressure is increased when the crank is rotated clockwise and decreased when rotated counterclockwise. The cabin pressure relief valve crank must be rotated to the full increase position following any use of the crank during flight.

Cabin Pressure Release Valve Handle

A cabin pressure release valve handle (44, figure 1–15) on the control stand is connected by cable to the cabin pressure release valve (2, figure 4–4). Pulling this handle approximately 8 inches opens the valve and rapidly dumps the cabin pressure into the nose wheel well. The valve and handle are reset by relatching a hinged plate on the valve. (This latch is readily accessible behind the ladder in the lower nose compartment.)

Cabin Air Distribution Manifold

A manifold selector valve lever (31, figure 4–3) and a manifold distribution valve lever (32, figure 4–3) are located between the body heaters in the lower forward compartment. The selector valve lever positions are marked D and E and the lever is held in place by a spring which is attached to pins marked F and G. In case of a heater failure, the selector valve is used to mix the flow of heated air with unheated air. The normal position is with the selector valve lever on D and the spring on pin F; the mixing (emergency) position is with the selector valve lever on E and the spring on pin G. The distribution valve lever controls the ratio of flow of mixed air between the control cabin and main compartment. The distribution valve lever positions are marked A (normal) and B (emergency) with additional positions between and beyond these two. The air flow to the control cabin is increased in relation to the air flow to the aft compartments as the distribution valve lever is rotated counterclockwise. When the lever is in position A, the entire output of the left body heater and a part of the output of the right body heater is supplied to the control cabin and forward areas. However, if either heater has failed and it is desired to have heat in the aft compartments, the distribution valve lever should be moved to position B. The accompanying diagrams in figure 4–3 show the air flow with one heater inoperative and the selector and distribution valves set as indicated.

Note

During extreme cold weather operation with one heater inoperative, better heating results can be obtained by increasing air flow and shutting off the turbo bleeder valves on the side of the airplane of the inoperative heater. If this procedure is used it could cause a decrease in oil transfer rate to the affected engine.

Control Cabin Fan Switches

Two control cabin fan switches (10, figure 1–20) on the engineer's auxiliary overhead panel control the ventilating fans (1, figure 4–18) in the control cabin. These switches are OFF in the down position and ON in the up position. Power is supplied to the switches through two circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Cabin Air Pressure Indicator (Cabin Altimeter)

A cabin altimeter (16, figure 4–3) on the engineer's instrument panel indicates the cabin pressure altitude in thousands of feet. This indicator does not show cabin differential pressure.

Cabin Vertical Velocity Indicator

A cabin vertical velocity indicator (15, figure 4–3) on the engineer's instrument panel indicates the rate of pressure change in the cabin in thousands of feet per minute.

Cabin Air Flow Indicators

Two dual-reading cabin air flow indicators (19, figure 4–3, and 21, figure 1–21) are located on the engineer's instrument panel. These indicators measure a differential pressure at venturi tubes in each line (figure 4–1) downstream of each turbo bleeder valve and are calibrated in inches Hg. The green band (1 to 3 inches Hg) shown on the face of each indicator is the normal operating range. Part throttle and high turbo boost may cause pressures in excess of the green range. High power operations may cause this condition also, if excessive cabin leaks prevail.

Cabin Temperature Gages

The control cabin and main compartment temperatures are indicated in degrees centigrade by temperature gages (10 and 12, figure 4–3) on the engineer's instrument panel. The indicating circuits are protected by a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Body Heater Elapsed Time Indicators

The airplane has an elapsed time indicator for each body heater in the lower nose compartment mounted on the bulkhead near the ladder. The indicators automatically log the operating time of the heaters.

Body Heaters Temperature Gage And Selector Switch

The outlet duct temperature of each of the body heaters is indicated in degrees centigrade by a body heaters temperature gage (8, figure 4–3) on the engineer's instrument panel. A body heaters temperature gage selector switch (20, figure 4–3) under the gage is used to select the heater on which the indication is to be taken. The indicating circuits are protected by a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Body Heater Overheat Warning Lights

Two body heater overheat warning lights (7, figure 4–3) on the engineer's instrument panel show when the left or right body heater overheat relays have been energized. The lights remain illuminated, even when the overheat condition has been eliminated, until the heater overheat reset switch has been actuated. The circuit for the lights is protected by circuit breakers on the forward power panel (5, figure 1–37).

Heater Fuel Low-Pressure Warning Light

A heater fuel low-pressure warning light (22, figure 4–3) on the engineer's instrument panel illuminates when the fuel pressure to the heaters is less than 12 psi. Protection for the warning circuit is provided by a circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

CABIN PRESSURIZING, HEATING, AND VENTILATING SYSTEMS NORMAL OPERATION

Ground Operation

The following steps are necessary to obtain ground ventilation:

a. Check that cabin air distribution manifold valve levers are in their normal positons.

b. Have external power connected to airplane, the APU operating, or the reciprocating engines running.

c. Turn on electrical master switch.

d. Turn on air conditioning master switch.

e. Place cabin air selector switches to NORMAL.

f. Turn on control cabin fan switches, if desired.

With ground ventilation obtained, the following steps are necessary to obtain heating:

a. Energize the main inverter system.

Note

Fuel will not flow to the heaters unless the heater ignition circuit is energized by the main inverter system.

b. Have fuel pressure from No. 2 tank or manifold available.

c. Move heat control rheostat into the HEAT range.

d. Check that the body heater overheat warning lights are not illuminated.

e. Check that the heater fuel supply switch is in NORMAL position.

f. Place the body heater switches to AUTO; the body heaters should now be operating. Check that heater fuel low-pressure warning light is not illuminated.

g. Monitor the body heaters temperature gage; the body heaters should cycle at approximately 175°C (347°F).

h. When the desired cabin temperature is being approached, rotate the heat control rheostat toward the COOL range. Adjust the rheostat as necessary to maintain the desired temperature.

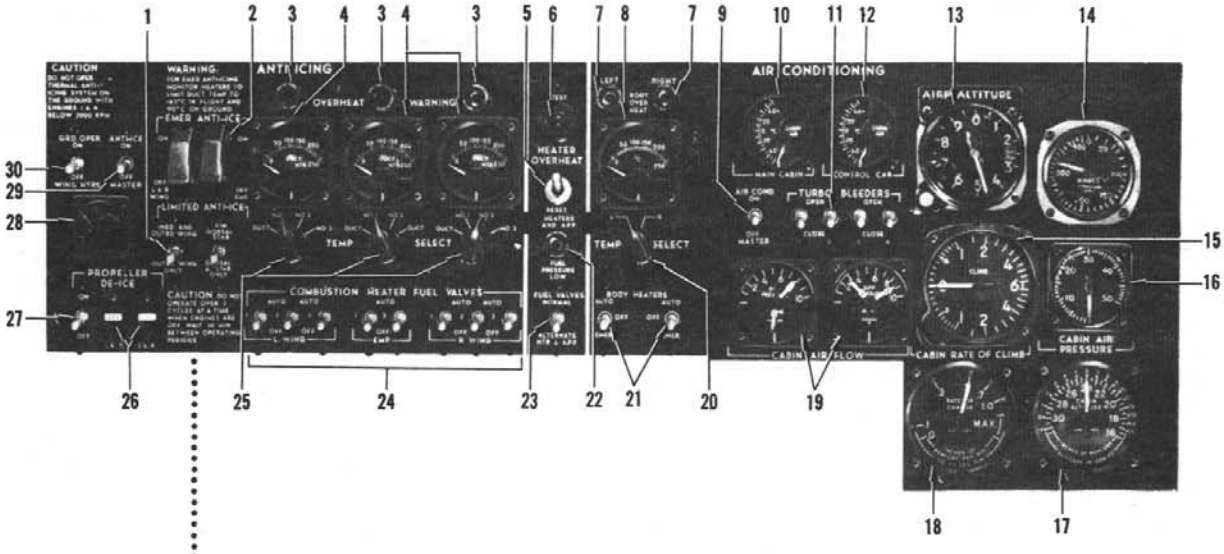
WARNING

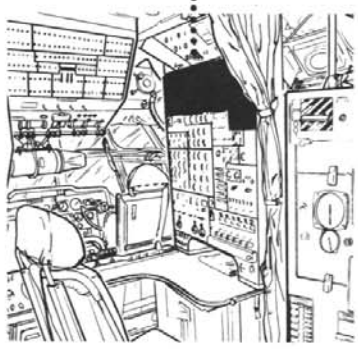
- Turn off body heaters before starting engines. The electrical power required to start the engines will reduce the voltage to the ground blowers. This will increase the fuel-air ratio. An overrich mixture may not burn. Accumulation of the fuel in the heaters may cause a fire or explosion when normal power is restored to the circuits.

- During takeoff and for several minutes prior to landing, the body heaters should be turned off. This will prevent overheat conditions from arising because of low ventilating air flow through the heaters on takeoff or reversed combustion air flow during reversed propeller operation on landing.

Flight Operation

There are several combinations of pressurizing, heating, and ventilating available during flight. These are: Ram air ventilating with or without heating, and pressurizing with or without heating. The steps necessary to obtain ram air ventilation and the steps necessary to set up heating during either ram air ventilating or pressurizing

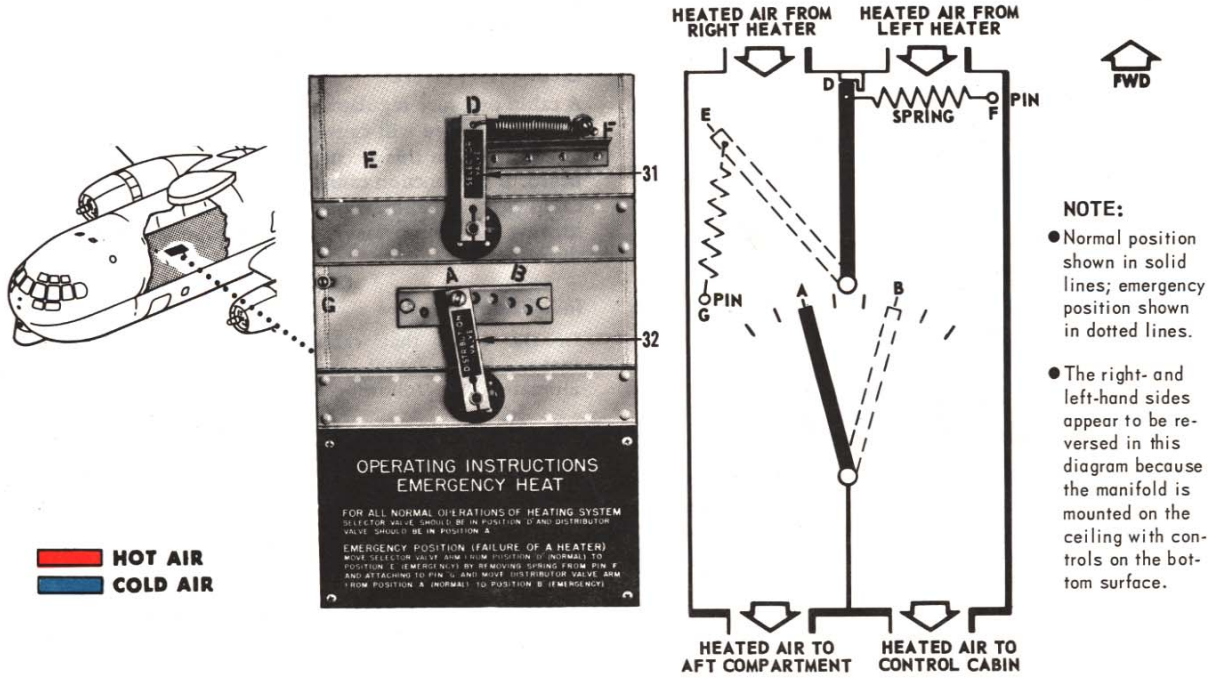




1 LIMITED ANTI-ICE SWITCHES
2 EMERGENCY ANTI-ICE SWITCHES
3 ANTI-ICE HEATERS OVERHEAT WARNING LIGHT (3 PLACES)
4 ANTI-ICE HEATER AND DUCT TEMPERATURE GAGES (2 PLACES)
5 HEATER OVERHEAT RESET SWITCH
6 HEATER OVERHEAT TEST SWITCH
7 BODY HEATER OVERHEAT WARNING LIGHT (2 PLACES)
8 BODY HEATERS TEMPERATURE GAGE
9 AIR CONDITIONING MASTER SWITCH
10 MAIN COMPARTMENT TEMPERATURE GAGE
11 TURBO BLEEDER SWITCHES
12 CONTROL CABIN TEMPERATURE GAGE
13 PRESSURE ALTIMETER 22737 ▶
14 AIRSPEED INDICATOR 3106 ▶
15 CABIN VERTICAL VELOCITY INDICATOR
16 CABIN AIR PRESSURE INDICATOR (CABIN ALTIMETER)
17 CABIN ALTITUDE SELECTOR
18 CABIN PRESSURE RATE-OF-CHANGE SELECTOR
19 CABIN AIR FLOW INDICATORS
20 BODY HEATERS TEMPERATURE GAGE SELECTOR SWITCH
21 BODY HEATER SWITCHES
22 HEATER FUEL LOW-PRESSURE WARNING LIGHT
23 HEATER FUEL SUPPLY SWITCH
24 HEATER FUEL VALVE SWITCHES
25 TEMPERATURE GAGE SELECTOR SWITCHES
26 PROPELLER DEICING INDICATORS
27 PROPELLER DEICING SWITCH
28 PROPELLER DEICING LOADMETER
29 ANTI-ICE MASTER SWITCH
30 BALANCE BYPASS SWITCH
31 MANIFOLD SELECTOR VALVE LEVER
32 MANIFOLD DISTRIBUTION VALVE LEVER

AIR CONDITIONING AND ANTI-ICING CONTROLS (TYPICAL)

Figure 4–3 (Sheet 1 of 2)



NOTE:

- Normal position shown in solid lines; emergency position shown in dotted lines.
- The right- and left-hand sides appear to be reversed in this diagram because the manifold is mounted on the ceiling with controls on the bottom surface.

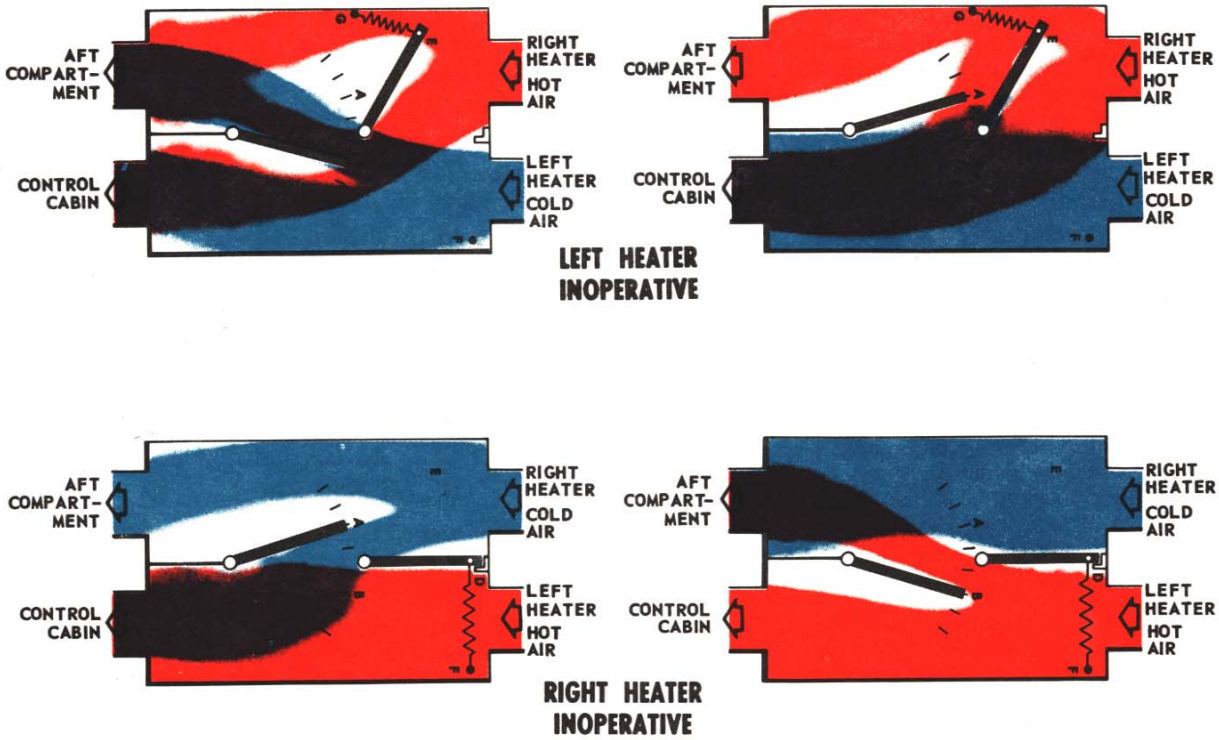


Figure 4–3 (Sheet 2 of 2)

during flight, or on the ground before the start of a flight, are as follows:

a. If possible, determine the cruise altitude and destination altitude before flight; decide on a cabin altitude for the flight.

b. Check that all cabin openings are closed, including the cabin pressure relief valve and cabin pressure release valve.

c. Check that the shutoff cocks on the cabin pressure regulators are open.

d. Set the desired altitude at which airplane is to be pressurized during flight.

WARNING

Do not pressurize with a cracked inner pane of a Nesa window. If cracking appears on the inner pane during pressurized flight, reduce altitude and depressurize to reduce the possibility of a blowout.

e. Check that the heater overheat warning lights are not illuminated.

f. During warmup, set the cabin pressure rate-of-change selector to the MAX position; this will allow the cabin pressure regulators to adjust themselves to the cabin altitude selection.

g. During flight, monitor the cabin altimeter, cabin vertical velocity indicator, and cabin air flow indicators; when changing the cabin altitude selector, first reset the cabin pressure rate-of-change selector to desired rate of change, then reset the cabin altitude selector as desired.

Shutdown

Shut down body heaters by positioning the body heater switches to OFF.

CAUTION

Heaters must be purged with air after being shut down. During flight, heaters are purged automatically by ram air to the combustion chambers and by the normal flow of cabin ventilating air over the heaters. However, on the ground, special care must be taken to purge the heaters with the ground blowers to prevent residual heat from causing an overheat condition. After body heater switches are shut off, allow ground blowers to operate for 3 minutes before turning air conditioning master switch OFF.

CABIN PRESSURIZING, HEATING, AND VENTILATING SYSTEMS EMERGENCY OPERATION

Excessive Pressure

A cabin pressure regulator malfunction resulting in an excessive pressure will cause the cabin pressure relief valve to open. When this occurs, a loud hissing noise can be heard. If malfunction cannot be corrected immediately, the cabin pressure should be manually controlled at once by turning the cabin pressure relief valve crank in the desired direction.

Insufficient Pressure

In the event that cabin pressure falls below 20.5 inches Hg (10,000 feet indicated on the cabin altimeter), the following steps should be taken:

a. All crewmembers must use oxygen.

b. Check that air conditioning circuit breakers on overhead circuit breaker panel and forward power panel are set.

c. Check cabin openings for closure as shown in figure 4–4.

d. Check that body heater overheat warning lights are not illuminated.

e. Check that the cabin air flow is within the green range on the cabin air flow indicators; if flow is low, readjust power settings (if possible) to bring it into the green range.

f. If malfunction can be corrected, repressurize in the normal manner.

Insufficient Heating

The possible malfunctions that could result in insufficient heating are covered in the following paragraphs.

If the heater fuel low-pressure warning light illuminates, proceed as follows:

a. Check that circuit breakers are set.

b. Position heater fuel supply switch to ALTERNATE.

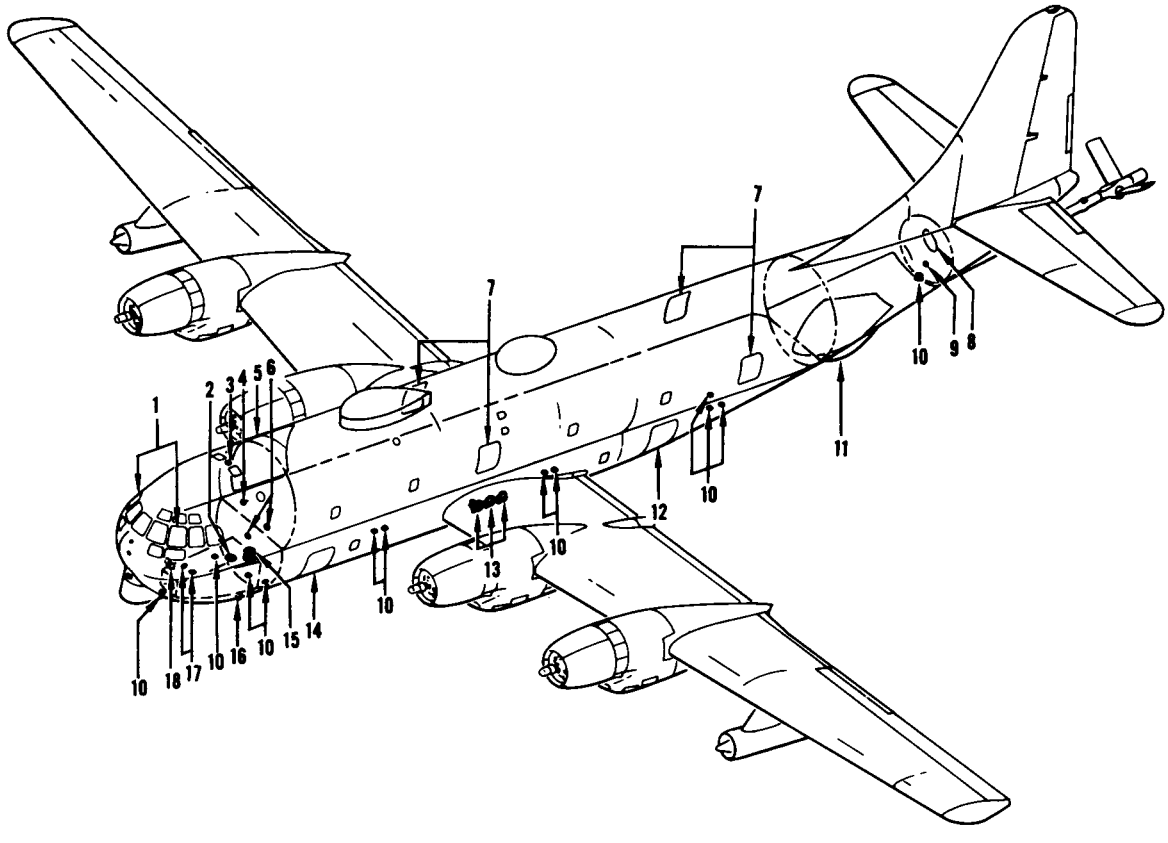
c. If fuel pressure is still low, check for fuel leaks in heater area.

d. If operation of the heaters is necessary, turn the fuel boost pump switch to EMERGENCY for the No. 2 tank or any tank supplying the fuel system manifold.

CAUTION

Operation of the boost pumps in EMERGENCY should be limited to prevent extreme shortening of boost pump life.

e. If the heater fuel low-pressure warning light remains illuminated with boost pump switch in EMERGENCY, turn body heater switches OFF and return boost pump switch to original position.



1 PILOT'S AND COPILOT'S SLIDING WINDOWS
2 CABIN PRESSURE RELEASE VALVE
3 SEXTANT DRAIN
4 PYROTECHNIC PISTOL MOUNT
5 FORWARD CARGO DOOR
6 AUXILIARY POWER UNIT INTAKE AND EXHAUST VALVES
7 EMERGENCY EXIT HATCHES (2 PLACES)
8 TAIL COMPARTMENT ACCESS DOOR
9 VACUUM RELIEF VALVE
10 DRAIN PLUGS (7 PLACES)
11 BOOM POD
12 AFT ENTRY DOOR
13 CABIN PRESSURE REGULATORS
14 FORWARD ENTRY DOOR
15 BATTERY SHIELD
16 DRIFTMETER DOME
17 PRESSURE TEST INLETS
18 CABIN PRESSURE RELIEF VALVE

CABIN PRESSURE LEAKAGE CHECK POINTS

Figure 4-4

If a heater temperature is too low, proceed as follows:

a. Move the heat control rheostat to the maximum HEAT position.

b. Check that circuit breakers are set.

c. Actuate heater overheat reset switch to RESET.

d. If heater does not come up to temperature, position the body heater switch for malfunctioning heater to EMERGENCY. Monitor heater and manually operate body heater switch as necessary.

If a low cabin temperature occurs with normal heater duct discharge temperatures, proceed as follows:

a. If in pressurized flight, check cabin air flow.

b. If in unpressurized flight, position the cabin air selector switches to ALTERNATE.

If one of the body heaters cannot be retained in operation, proceed as follows for best equal heat distribution:

a. Move the manifold selector valve lever from position D to position E by moving the spring from pin F to pin G.

b. Move the manifold distribution valve lever from position A to position B. See figure 4–3 for other combinations of heat distribution.

c. Position turbo bleeder switch on inoperative heaters to CLOSE.

Minor Smoke Or Fume Elimination

The pilot will initiate the following procedures:

a. Set the cabin altitude selector to an altitude above the airplane altitude.

b. Set cabin pressure rate-of-change selector on MAX.

c. Adjust TBS lever to obtain ventilation air flow of 5 inches differential pressure on the cabin air flow indicator.

ANTI-ICING SYSTEMS

SURFACE ANTI-ICING SYSTEM

The surface anti-icing system acts as a deicer as well as an anti-icer, since it can be used to remove snow and ice when the airplane is on the ground as well as to prevent (or remove) ice in flight. The surface anti-icing system is divided into three components consisting of a pair of heaters in the empennage and a group of three heaters in each wing. The heaters produce heated air for anti-icing. Air is taken into the heaters through ram air scoops in the leading edges of the wings and the dorsal fin. This air is heated by fuel combustion in the heaters. The heated air is then directed to corrugated inner surfaces of the wing and empennage. Heat transfer to the outer surface of the leading edges accomplishes the anti-icing. The heaters are turned on manually, but once started, the systems operate automatically with automatic cycling of the heaters, individually or in groups, to maintain proper outlet air temperature. Fuel for the heaters is taken from the No. 2 tank or from the manifold. Refer to CABIN HEATING AND VENTILATING, this section, for a description of the fuel system. Automatic warning lights indicate overheat and fuel low-pressure conditions. Differential pressure switches in each system turn off the heaters in the event that there is not sufficient air through the heaters to maintain proper ventilation. In addition to heating air for surface anti-icing, the wing heaters are also used for preheating the engines. Refer to COLD WEATHER PROCEDURES, Section IX. In the empennage system, automatically controlled blowers provide sufficient air flow for ground operation. To provide sufficient air flow for ground operation of the wing systems, it is necessary to operate the outboard engines at 2000 rpm or more, or to use external blowers. A blower in the skate area supplies the required air flow to the wing heaters when these heaters are used to preheat the engines. Refer to ENGINE PREHEAT SWITCHES, this section.

Anti-Ice Master Switch

The anti-ice master switch (29, figure 4–3) on the engineer's instrument panel controls the automatic regulating system. In the ON position, the cycling switches, differential pressure switches, empennage ground blowers, overheat control, and warning systems all operate. When this switch is in the OFF position, there is no automatic regulation of the surface anti-icing system. A circuit breaker for the circuit is located on the overhead circuit breaker panel (1, figure 1–37).

Heater Fuel Valve Switches

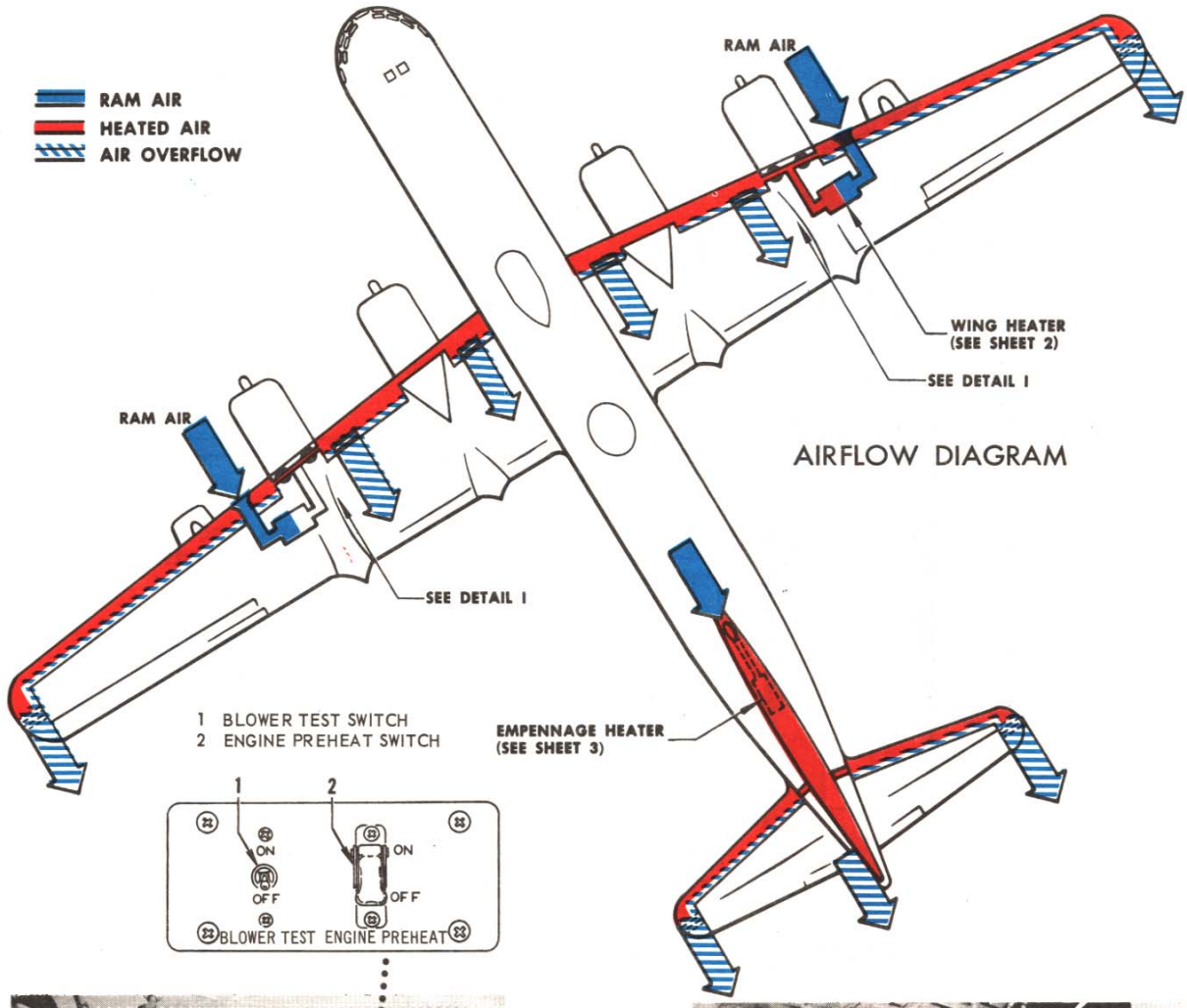
Eight heater fuel valve switches (24, figure 4–3) control the individual heater fuel valves. The action of the valves is controlled by the automatic regulating system when the switches are in the AUTO position. The valves are closed when the switches are in the OFF position. These switches are on the engineer's instrument panel; their circuit breakers on the overhead circuit breaker panel (1, figure 1–37). The essential inverter switch must be in the ESS. INV. position to have power for the operation of the valves.

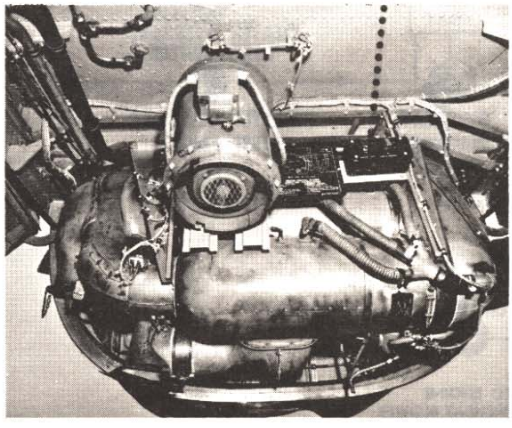
Heater Fuel Supply Switch

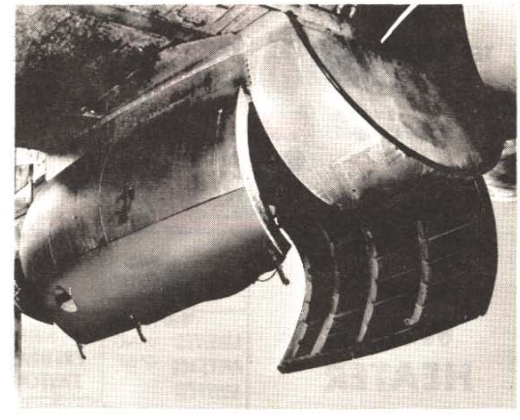
For a description of this switch, refer to CABIN HEATING AND VENTILATING, this section.

Limited Anti-Ice Switches

Two limited anti-ice switches (1, figure 4–3) on the engineer's instrument panel control selective deicing. The switch for the wing systems, when in the OUTBD WING ONLY position, shuts off the heated air to the inboard wing sections. When this switch is at the INBD & OUTBD WING position, both inboard and outboard wing sections are deiced. The empennage switch, when set at DORSAL & STAB ONLY, shuts off the flow of heated air to the vertical stabilizer; when at the FIN DORSAL STAB position, all the empennage leading edges are deiced. Circuit breakers for the limited anti-icing circuits are on the overhead circuit breaker panel (1, figure 1–37).



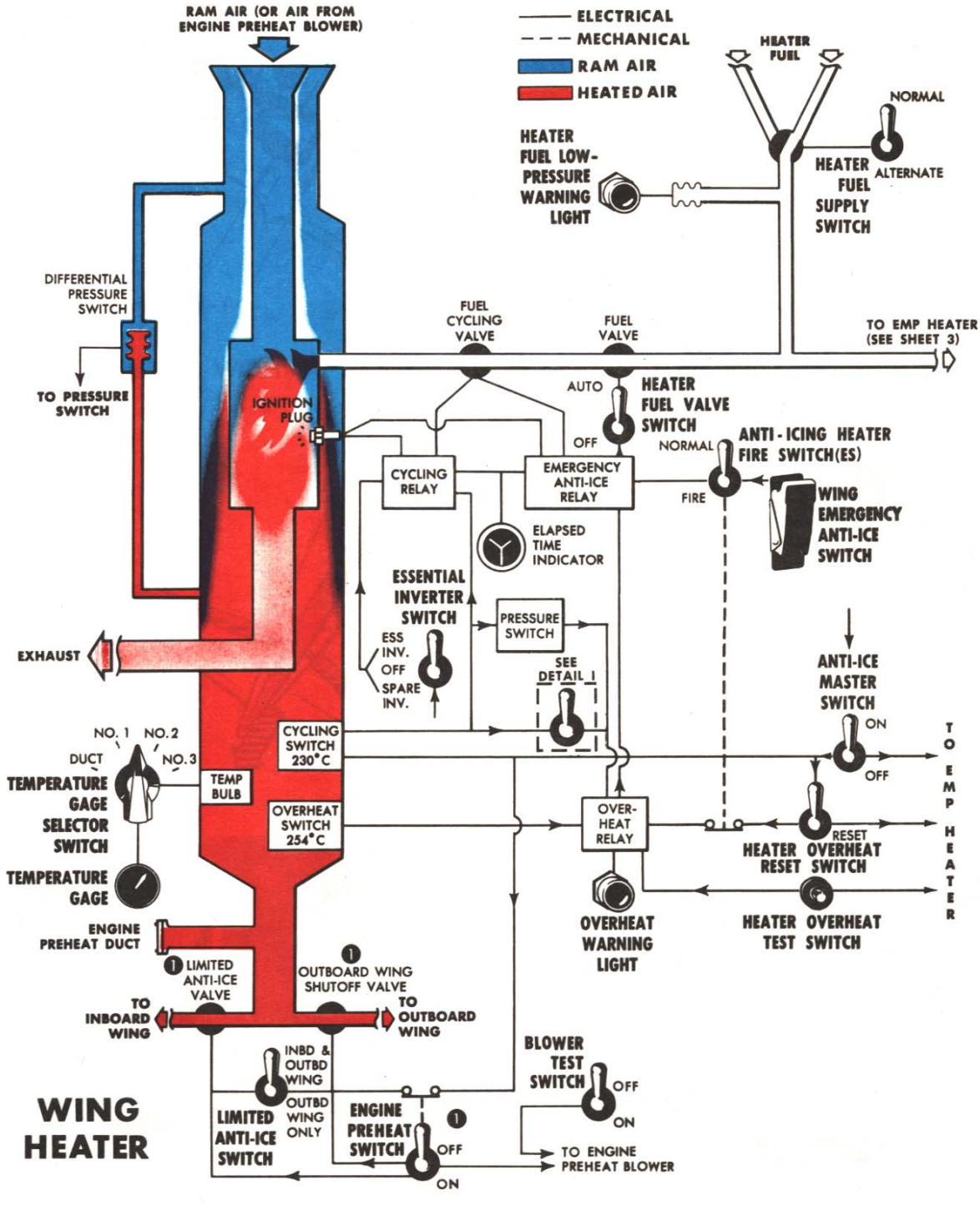




DETAIL I

WING AND EMPENNAGE ANTI-ICING DISTRIBUTION

Figure 4–5 (Sheet 1 of 3)



NOTE:

1 Limited anti-ice valve and outboard wing shutoff valve are closed when engine preheat switch is in ON position.

Figure 4–5 (Sheet 2 of 3)

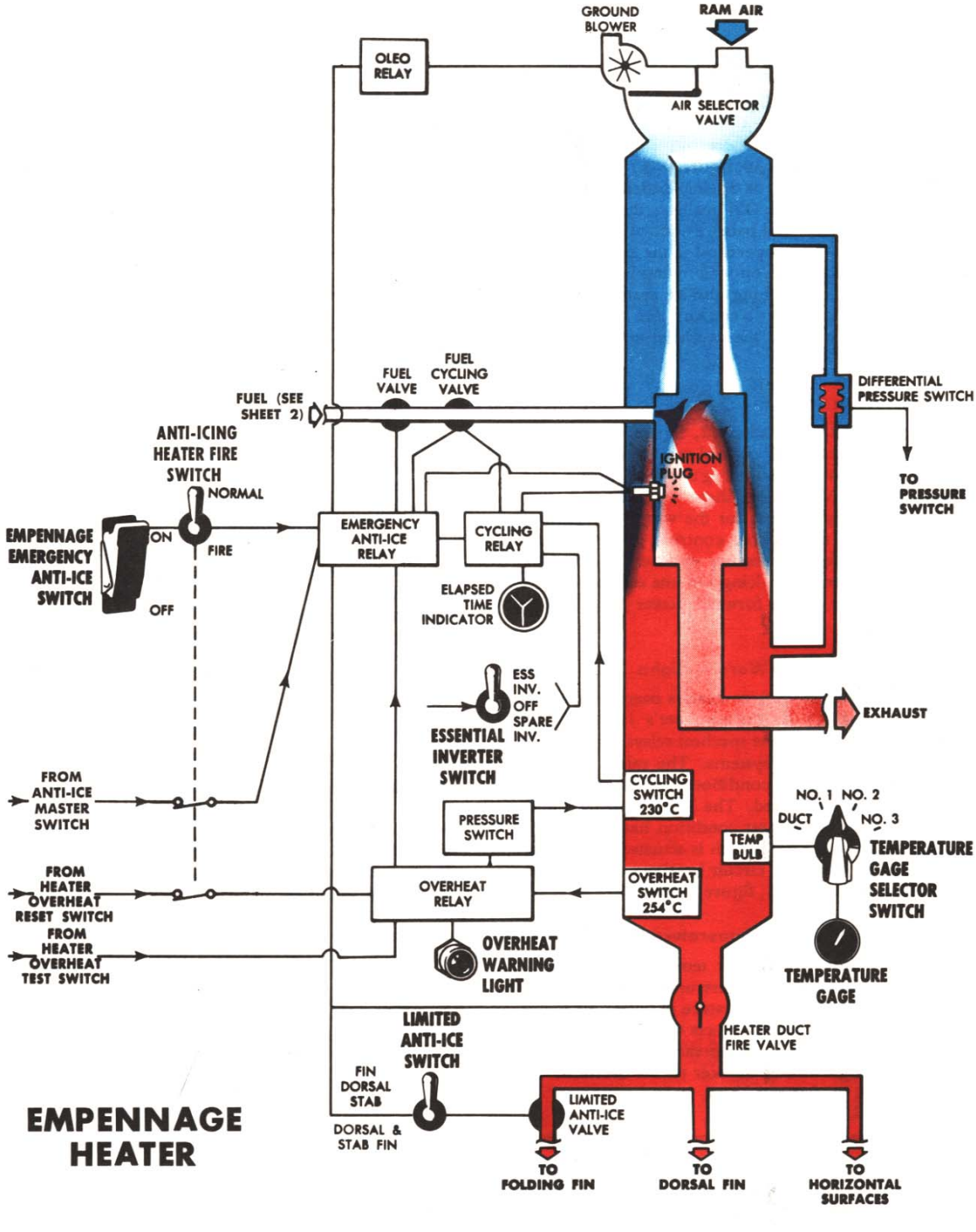


Figure 4–5 (Sheet 3 of 3)

Heater Overheat Test Switch

Refer to CABIN HEATING AND VENTILATING, this section, for a description of this switch.

Heater Overheat Reset Switch

Refer to CABIN HEATING AND VENTILATING, this section, for a description of this switch.

Balance Bypass Switch

The balance bypass switch (30, figure 4–3) on the engineer's instrument panel is spring-loaded to the OFF position. When held in the ON position, the balance bypass switch bypasses the heat balance control. The balance bypass switch also permits operation of the heaters in one wing without operating the opposite wing heaters, thereby permitting tests of the wing anti-ice system with one ground test cart. A circuit breaker for wing anti-ice ground operation is on the overhead circuit breaker panel (1, figure 1–37).

Emergency Anti-Ice Switches

Two emergency anti-ice switches (2, figure 4–3) on the engineer's instrument panel control emergency operation of the anti-icing system and are guarded to the OFF position. In the ON position, these switches directly operate the anti-icing systems for the wings and empennage by bypassing the lockout controls of the overheat relays and the differential pressure switches. In the OFF position the emergency anti-icing circuits are inoperative. Circuit breakers are on the forward power panel (5, figure 1–37).

Anti-Ice Heaters Overheat Warning Lights

Three red, press-to-test, anti-ice heaters overheat warning lights (3, figure 4–3) on the engineer's instrument panel indicate actuation of the overheat relays for the wing and empennage anti-icing systems. The relays actuate when there is an overheat condition or when the heater overheat switch is depressed. The lights remain illuminated, even when the overheat condition has been eliminated, until the heater reset switch is actuated. The warning lights are protected by circuit breakers on the overhead circuit breaker panel (1, figure 1–37).

Anti-Icing Heater And Duct Temperature Gages

Three anti-icing heater and duct temperature gages (4, figure 4–3) on the engineer's instrument panel indicate in degrees centigrade the temperature of heated air in the combustion heaters and in the ducts delivering air to the wings and empennage. The temperature gages are all protected by a single circuit breaker on the overhead circuit breaker panel (1, figure 1–37).

Wing And Empennage Heaters Elapsed Time Indicators

The airplane has an elapsed time indicator in the lower nose compartment for each heater (mounted on the forward side of the bulkhead). The indicators automatically log the operating time of the combustion-type heaters.

Temperature Gage Selector Switches

Three rotary-type temperature gage selector switches (25, figure 4–3) on the engineer's instrument panel connect duct and heater temperature sensing circuits with their temperature gages. The wing switches have DUCT–NO. 1–NO. 2–NO. 3 positions. The empennage switch has DUCT–NO. 1–NO. 2–DUCT positions. In the DUCT position, the heater outlet air duct sensing circuits are connected to their corresponding gages. In the numbered positions, the temperature sensing circuits of the corresponding numbered heaters in the wings and empennage are connected to their respective gages. A circuit breaker for the gages is on the overhead circuit breaker panel (1, figure 1–37).

Heater Fuel Low-Pressure Warning Light

For a description of this light, refer to CABIN HEATING AND VENTILATING, this section.

Engine Preheat Switches

The engine preheat switches (2, figure 4–5), one in each outboard nacelle, have two positions: ON – OFF. Placing the switch at ON turns on the engine preheat blower and closes the wing limited anti-ice valve and the outboard wing shutoff valve. The blower supplies the high volume of air required by the wing heater for combustion, and the wing limited anti-ice valve and outboard wing shutoff valve are closed so that the air from the heater will flow to the engines instead of through the wing. Placing the switch to the guarded OFF position deenergizes the blower and opens the wing limited anti-ice valve and outboard wing shutoff valve. Each switch receives power through a circuit breaker on the respective nacelle solenoid panel.

Blower Test Switches

The engine preheat blowers in the outboard nacelles can be tested with the blower test switches (1, figure 4–5). The switches are spring-loaded to OFF. Holding the switches in the ON position energizes the blowers. The switches are protected by circuit breakers on the respective nacelle solenoid panels.

SURFACE ANTI-ICING SYSTEM NORMAL OPERATION

Flight Operation

WARNING

Wing anti-icing heaters should not be operated after loss of hydraulic fluid from the A/R hydraulic system (supplied by the outboard engines) if hydraulic fluid loss cannot be isolated by normal procedures or unless it can be definitely determined that the hydraulic fluid is not entering the heater cavity.

NOTE

- AC power must be available from the essential bus for the heater ignition system. Fuel will not flow to the heaters unless the essential inverter switch is ON.
- When the anti-icing master switch is ON, power is supplied to heater ignition transformers continuously.
- The system should be turned on as soon as possible when icing is encountered. If icing is anticipated, the system should be turned on in advance so that no delay will result in bringing the surface leading edges up to proper temperature. The system should be kept on during the entire duration of the icing condition.

a. Position heater fuel supply switch to NORMAL.

b. Position all heater fuel valve switches to AUTO.

c. Position wing limited anti-ice switch to INBD & OUTBD WING, and empennage limited anti-ice switch to FIN DORSAL STAB.

d. Position anti-ice master switch to ON.

NOTE

Check each heater and duct temperature frequently during operation. Turn OFF the heater fuel valve switch for any heater that approaches the maximum temperature limit, or any heater indicating an unusually low temperature.

e. If a heater overheat warning light illuminates during operation, check all heater temperatures, and turn OFF the heater fuel valve switch for any heater near the maximum temperature limit. Use the heater overheat reset switch to start the remaining heaters of that system.

f. If the heater fuel low-pressure warning light illuminates, position the heater fuel supply switch to ALTERNATE.

g. If the light remains illuminated, turn one of the No. 2 tank boost pump switches, or a boost pump switch for any other tank supplying the manifold, to EMERGENCY.

CAUTION

Operation of boost pumps in EMERGENCY should be limited to prevent extreme shortening of boost pump life.

h. If the heater fuel low-pressure warning light remains illuminated, turn all heater fuel valve switches to OFF.

Ground Operation

The empennage anti-icing system is operated on the ground in the same manner as in flight. In order to operate the wing anti-icing systems on the ground, proceed as follows:

a. Operate the outboard engines at 2000 rpm or above.

b. Hold the balance bypass switch ON while operating the heaters.

c. Operate the heaters as in-flight operation.

To operate the wing heaters for preheating the engines, refer to COLD WEATHER PROCEDURES, Section IX.

CAUTION

When operating heaters on the ground, be sure that heaters are purged after heater shutdown by maintaining 2000 rpm for 2 minutes to prevent residual heat from causing an overheat condition.

NOTE

If the wing anti-icing systems are to be operated while the engines are not running, external power and external blowers must be used. When external blowers are used, it is not necessary to use the balance bypass switch.

SURFACE ANTI-ICING SYSTEM EMERGENCY OPERATION

Flight Operation

a. Place emergency anti-ice switches to ON.

b. Turn all heater fuel valve switches to AUTO.

c. Check heater temperature frequently, since there are no overheat lockout controls in the emergency circuits.

d. Manually cycle any heater approaching the maximum temperature limit.

If the heater fuel low-pressure warning light illuminates, proceed as follows:

a. Check that circuit breakers are set.

b. Position heater fuel supply switch to ALTERNATE.

c. If operation of the anti-icing systems is necessary, turn one of the No. 2 tank boost pump switches, or a boost pump switch for any tank supplying the manifold, to EMERGENCY.

CAUTION

Operation of the boost pumps in EMERGENCY should be limited to prevent extreme shortening of boost pump life.

d. If the heater fuel low-pressure warning light remains illuminated with boost pump in EMERGENCY, turn heaters off and return boost pump switch to original position.

Ground Operation

For checking emergency operation of the wing heaters, have outboard engines running at or above 2000 rpm, and operate as in emergency flight condition. For checking emergency operation without running the outboard engines, use external power and external ground blowers for the wings. Then proceed as in emergency flight operation.

PROPELLER DEICING SYSTEM

The propellers on this airplane are electrically deiced by means of propeller blade heating elements using dc power. Controlled by a single switch, this system deices the propellers one at a time by means of a timer. All blades of one propeller are deiced simultaneously. During operation of the system, the propeller being deiced is indicated by two tab-window type indicators on the engineer's instrument panel.

Propeller Deicing Switch

The propeller deicing switch (27, figure 4–3) on the engineer's instrument panel operates the propeller deicing system. In the ON position, current from the timer energizes relays which furnish power from the nacelle solenoid panels to the blade heating elements. In the OFF position, the propeller deicing system is inoperative. The circuit breaker is on the overhead circuit breaker panel (1, figure 1–37).

Propeller Deicing Indicators

Two propeller deicing indicators (26, figure 4–3) indicate that the deicing timer is functioning. Each indicator has an OFF flag as well as two numbered flags. One indicator has flags for No. 1 and No. 2 propellers and the other indicator has flags for No. 3 and No. 4 propellers. As the timer cam closes a propeller deicing system circuit, its numbered flag appears in the indicator window. Because of the propeller deicer timer, these two indicators alternate in operation. The indicators are protected by circuit breakers on the nacelle solenoid panels.

Propeller Deicing Ammeter Or Propeller Deicing Loadmeter

A meter for the propeller deicing system on the engineer's instrument panel indicates the amount of current going through the circuit. On 17260 ▶ 22628 the ammeter is graduated in amperes, and on 22629 ▶ the loadmeter (28, figure 4–3) is graduated in percent. Red markings show maximum and minimum allowable amperes per cycle. (See figure 5–1.) The meter is protected by circuit breakers on the main circuit breaker panel (8, figure 1–37).

PROPELLER DEICING SYSTEM OPERATION

Flight Operation

Place the propeller deicing switch (27, figure 4-3) in the ON position and check propeller deicing indicators occasionally for proper cycling. (The normal cycle is 2 minutes, each propeller being heated for 30 seconds.) Frequently monitor the propeller deicing meter through ON cycle for proper current flow to ascertain that propellers are being deiced properly. If the meter needle does not stay in the green range or flickers abnormally, it is an indication of possible failure of the circuit in one or more blades and failure to deice, with subsequent propeller unbalance.

WARNING

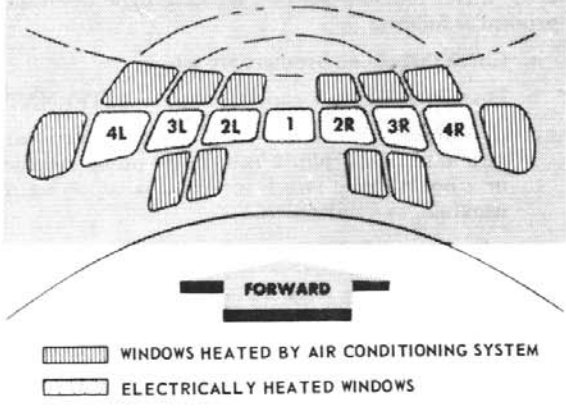
Pull the appropriate propeller deicing circuit breaker if any one propeller deicing meter reading deviates from the average by more than 20 amperes on an ammeter, or by one or more increments on a loadmeter. Retain the circuit breaker in this position for the remainder of the flight. Malfunction of the propeller deicing circuit may lead to blade failure.

Ground Operation

For ground operation with engines running, operate the system as in normal flight.

CAUTION

To avoid overheating the deicing heating elements when engines are not running, do not operate the propeller deicing system for more than two cycles in succession for each propeller. Allow 30 minutes to elapse after each period of operation.



HEATED WINDOWS (CONTROL CABIN)

Figure 4–6

WINDOW ANTI-ICING SYSTEM

Seven of the windows in the center row in the control cabin and the boom operator's center window are deiced by means of electrical (Nesa) window heat. The control cabin windows are assigned numbers as shown in figure 4–6. Windows No. 1 and 2L are control windows which automatically regulate the temperature of all the heated control cabin windows. AC power for heating the windows is supplied by two engine-driven alternators. DC control power is supplied from the generators. The use of the alternator power is determined by a bus selector switch and the voltage delivered to the windows is determined by a window heat selector switch. When either the pilot's or copilot's sliding window is open, power is cut off to all Nesa heaters. The other windows in the control cabin can be defrosted by heated air from the cabin heating system. Refer to WINDOW DEFROSTING CONTROL KNOB, this section.

Window Heat Selector Switch

The window heat selector switch (14, figure 1–20) on the engineer's auxiliary overhead panel has OFF–IFR (Air Refueling) EMER–HIGH–NORMAL–LOW positions. When in the HIGH, NORMAL, or LOW position, variable frequency ac power from the Nesa bus in the alternator relay shield (16, figure 1–37) is directed to the control cabin electrically heated windows (figure 4–6) and power from bus No. 2 in the alternator relay shield is directed to the boom operator's window heat selector switch. (See figure 1–35.) When in the IFR (Air Refueling) EMER position, power from the Nesa bus is directed to the boom operator's window heat selector switch as well as to the control cabin windows. As the switch is turned from LOW to HIGH, increasing voltages are applied to the control cabin windows. When the switch is in the IFR (Air Refueling) EMER position, a normal voltage is applied to the control cabin windows. Windows 4L and 4R do not receive power when the switch is in either the HIGH or IFR (Air Refueling) EMER positions. The temperature of the Nesa windows will cycle between 38°C and 43°C in all positions. The LOW, NORMAL, and HIGH positions of the selector switch control the voltage to the window heaters and regulate the rate of heating.

Window Defrosting Control Knob

A single window defrosting control knob (9, figure 1–10) on the pilot's auxiliary panel controls the window defrosting valves. The knob has CABIN HEAT and WINDOW DEFROSTING positions. When the knob is turned to the WINDOW DEFROSTING position, heated air from the cabin heating and pressurizing air ducts is directed through defrosting ducts to the six upper, four lower, and two rear-center windows in the control cabin. When the knob is in the CABIN HEAT position, heated air is directed to the cabin heat outlet ducts.

Boom Operator's Window Anti-Ice Switch

The boom operator's window anti-ice switch (14, figure 4–64) on the boom operator's panel has LOW–OFF–NORMAL positions. The LOW position is used to warm the boom operator's center window slowly and the NORMAL position is used for all other conditions requiring window heating. The circuit protection for this circuit is on the boom operator's panel (next to the switch).

WINDOW ANTI-ICING SYSTEM NORMAL OPERATION

For normal operation in flight, turn window heat selector switch to NORMAL only after a 20-minute warmup of the windows with the window heat selector switch in the LOW position. Before turning the window heat selector switch to OFF, operate window heating with the switch in the LOW position for 5 minutes. Windows 3L and 3R must be closed before any control cabin window can be heated. For ground operation, use LOW heat only. These steps are necessary to prevent damage to the window glass.

CAUTION

Nesa windows should be operated at as low a temperature as possible without impairing deicing or affecting safety. Excessive temperature reduces service life and contributes to cracking and layer separation.

WINDOW ANTI-ICING SYSTEM EMERGENCY OPERATION

When the control cabin windows are not being deiced sufficiently with the engineer's window heat selector switch in the NORMAL position, turn the selector switch to HIGH. Windows No. 4L and 4R do not receive current for anti-icing when the window heat selector switch is in the HIGH position. To operate the control cabin system with a window failure, shut the system off and disconnect inoperative windows at the upper and lower power leads of each window. Then, if either control window No. 1 or No. 2L is still operating, start the system again. However, if both control windows are inoperative, leave the system off.

If power to the boom operator's Nesa window fails, turn the engineer's window heat selector switch to IFR (Air Refueling) EMER.

Note

When the engineer's selector switch is in IFR (Air Refueling) EMER position, windows 4L and 4R do not receive power, and the remaining control cabin windows receive normal voltage only. The boom operator's window will receive low voltage only.

PITOT HEAD ANTI-ICING SYSTEM

Ice formation on the pitot heads is prevented or removed electrically by 28-volt dc heating elements in each of the two pitot heads and four static probes (Figure 4-6A).

PILOT'S PITOT HEAT SWITCH

A toggle switch on the overhead panel operates the pilot's and navigator's pitot and static-source heaters. The switch positions are marked NORMAL, EMER, and OFF. In the NORM position, power is supplied to the left-hand pitot head heater and the lower left-hand and upper right-hand static probe heaters through circuit breakers on the 28-volt DC bus in the forward power panel. The EMER operation, power is supplied directly to the left-hand pitot head

heater through a circuit breaker on the battery bus in the forward power panel. Emergency power is supplied to the lower left-hand static probe heater through a circuit breaker on the right-hand alternator relay shield if the right-hand alternator switch is in the EMER position.

COPILOT'S PITOT HEAT SWITCH

A circuit breaker-type toggle switch on the overhead panel operates the copilot's and engineer's airspeed and altitude indicating system. The switch positions are marked ON and OFF. In the ON position, power is supplied to the right-hand pitot head heater from the 28-bolt DC bus through the circuit breaker switch and power is supplied to the upper left-hand and lower right-hand static probe heater through circuit breakers on the 28-volt DC bus in the forward power panel.

PITOT HEAD ANTI-ICING SYSTEM OPERATION

In flight, turn the pitot heaters on by turning pitot heat switches to ON (or NORM, as applicable). Normal pitot and static source heating will be lost if all DC generators fail. By positioning the pilot's heat switch to EMER, power will be restored to the pilot's and navigator's pitot and static source heaters.

Note

The right-hand alternator supplies power for emergency operation of th pilot's and navigator's static source heat. If all DC generators have failed, the right-hand alternator switch on the flight engineer's instrument panel must also be placed in the EMER position to provide power for emergency operation of the static probe heater.

To prevent burning out the heater elements, ground operation of the pitot heaters should be limited to brief maintenance checks and extreme cold weather operations.

JET ENGINE ANTI-ICING SYSTEM

The jet engine anti-icing system provides a means of preventing ice formation on the engine by directing hot air from the compressor to the nacelle cowling, air intake guide vanes, and accessory section. The jet engine must be operating at a power setting of approximately 85 percent to provide adequate anti-icing. The jet engine anti-icing system receives 28-volt dc power through circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

CAUTION

During ground operation, the jet engine anti-icing system should not be operated at engine rpm in excess of 85 percent, as damage to the ring cowl may result.

Jet Engine Anti-Icing Switch

A jet engine anti-icing switch (6, figure 1–27), with ON – OFF (guarded) positions, is on the jet engine control panel. The switch is used to operate both jet engine anti-icing systems simultaneously. When the switch is placed at ON, two solenoid valves open, allowing hot air to be directed to the nacelle cowling, engine islands, and the accessory dome of each engine. Placing the switch at OFF closes the solenoid valves, stopping the flow of hot air. The compressor front frame struts and the inlet air guide vanes are anti-iced continuously while the engine is running. The switch receives 28-volt dc power through circuit breakers on the jet engine circuit breaker panel (3, figure 1–37).

Jet Engine Anti-Icing System Operation

a. To start, place jet engine anti-icing switch in ON position.

b. To stop, place jet engine anti-icing switch in OFF position.

Note

The anti-icing solenoid valve is held closed (switch in OFF position) by dc power. The valve will open and remain open in event of dc power failure. The island and accessory dome anti-icing will operate continuously until dc power is restored.

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

WARNING

- Due to high voltages within electronic equipment, do not attempt in-flight maintenance of electronic equipment beyond checking circuit breakers and fuses. Locations of all electronic equipment circuit breakers and fuses can be determined from figure 1–37 and figure 4–35.

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.

All electronic equipment used for communications, navigation, and identification is listed in figure 4–7. The communication radios are connected through a radio junction box to the interphone so that individual selection of the receivers and transmitters can be made at each crewmember's interphone control panel. A master dc radio and radar power circuit breaker is on the forward power panel (5, figure 1–37). Circuit protection for radio ac circuits is on the ac power panel (15, figure 1–37).

Note

Radio equipment used for two-way communications have separate transmitters and receivers. When a radio is used, the receiver operates continuously except for the periods when the transmitter is used. Since the receiver is cut out during transmission, it is not possible to transmit and receive simultaneously on the selected radio. Similarly, if other receivers use the same antenna, these receivers are cut out during transmission also.

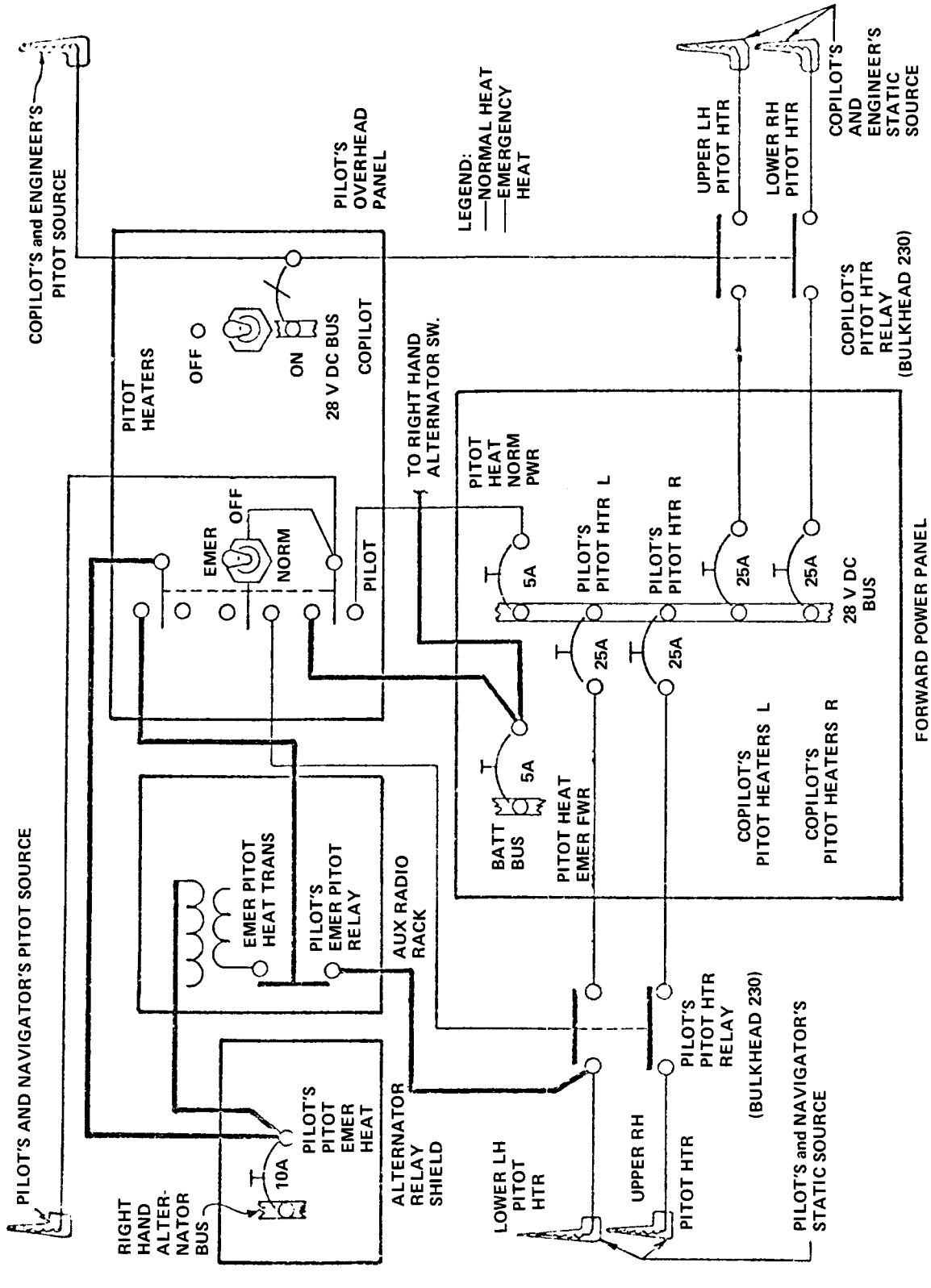


Figure 4-6A. Pitot - Static Heating

INTERPHONE (AN/AIC-10)

The airplanes have AN/AIC-10 interphone equipment. The interphone ties all communication facilities together on a common channel. The particular control panel or panels at each station determine the facilities available for talking and listening. Regular crew stations have control panels with switching arrangements that permit speech communication between crewmembers; transmission and reception on the liaison, UHF, and VHF radios; and reception of the signals from the navigation equipment. There are six stations which have auxiliary interphone installations. The auxiliary interphone panels are only connected to the interphone and call circuits so that the user is limited to talking or listening to other crewmemebers. The auxiliary interphone panels are located in the nose wheel well, at the lower aft compartment, APU, overwing emergency exit hatches, left scanner's station, the A/R hydraulic panel on 22665 ▶, and the right scanner's station on 17260 ▶ 22664. Control power is 28-volt dc with circuit protection on the radio junction box circuit breaker panel (2, figure 1-37).

Interphone Controls

Normal–Auxiliary Listen Switch. Each AN/AIC-10 interphone control panel has a normal–auxiliary listen switch (6, figure 4–8) that is safetied to NORMAL. In the NORMAL position, all the facilities on the control panel operate in the normal manner. There is a small amplifier for each control panel. If the amplifier at the user's station fails, the AUX LISTEN operation is an emergency measure for listening. Switching to AUX LISTEN bypasses the amplifier, makes the volume control ineffective, and makes it possible to listen, but not talk. Operation in this function is with reduced signal strength (no amplification) with a subsequent reduction in volume. There is a definite switching priority of the mixing switches and the interphone selector switch during individual control panel operation in AUX LISTEN. The left mixer switch has first priority. While this switch is in the ON (up) position, no other circuit is connected, regardless of the position of the other switches. Placing the left switch OFF (down) passes priority to the switch immediately to the right. Priority continues to pass to the right in this manner as each switch is shut off. All switches to the left of the switch controlling the function the user wants to listen to must be down. Placing all mixing switches down enables the selector switch to control the selection of equipment.

Interphone Selector Switch. A rotary interphone selector switch (7, figure 4-8) on the AN/AIC-10 interphone control panel is for the selection of one facility for talking and listening. Switch markings are CALL-INTER-COMM UHF 1-LIA-COMM VHF-COMM UHF 2. Rotating the selector switch to the spring-loaded CALL position enables the user to interrupt all other interphone activity to talk to the crew (regardless of the arrangement of switches on the control panels at the various stations). When using the CALL function, the selector switch must be held in the CALL position to talk and released to INTER to listen. The user can talk without pressing the mike switch when utilizing the headset with boom-type mike attached. However, when the hand mike is used, the mike switch must be used when the switch is on the CALL position to contact all stations. INTER position allows communication between all crew stations. COMM UHF position allows the operator to receive on the UHF radio and transmit when his respective mike switch is pressed. LIA position allows crewmembers to receive liaison radio signals and to transmit when his respective mike switch is depressed. COMM VHF allows the operator to receive on the VHF radio and transmit when his respective mike switch is pressed.

Interphone Mixer Switches. Five mixer switches (1, 2, 3, 4, and 5, figure 4-8) are on the AN/AIC-10 interphone control panel. These switches have INTER-UHF COMM-LIA-ADF-VHF COMM positions. When the NORMAL-AUX LISTEN switch is in the NORMAL position, the ON position of each toggle switch mixes the signal from the respective equipment separately or simultaneously with the facility selected by the interphone selector switch. This allows the crewmember to monitor incoming signals from the various equipment without changing the selector switch position. The ON position of the INTER mixer switch allows monitoring on the interphone. The ON position of the UHF COMM mixer switch allows monitoring of signals from the UHF radio receiver. The ON position of the LIA mixer switch allows signals from the liaison receiver to be monitored. The ON position of the ADF mixer switch allows monitoring of signals from the radio compass receiver. The ON position of th VHF COMM mixer switch allows audio signals from the VHF radio reciever to be monitored. In addition, five other mixer switches are on the interphone mixer switch panel. (See figure 4-8.) The additional mixer switches are marked: APN-69 MONITOR-UHF 2-MARKER-VHF NAV-TACAN. These switches allow monitoring of signals from their respective receiver. The APN-69 MONITOR mixer switch is used only at the navigator's station. The TACAN mixer switch is used only at the pilots' stations.

Interphone Volume Knob. An interphone volume knob (8, figure 4-8) on the AN/AIC-10 interphone control panel and on the auxiliary interphone control panel allows regulation of volume level received at that station. The volume knob is ineffective when the NORMAL-AUX LISTEN switch is in the AUX LISTEN position. The counterclockwise limit of the knob gives minimum volume operation. The maximum volume, before peak clipping, is obtained with the knob at approximately the midposition. Advancing the knob beyond this point results in clipping the speech peaks and increasing the average power of a speech signal when needed to overcome noise at a listener's station. (Peak clipping excludes sharp sound pressures from the ear of a listener during high average output; however, the greater power makes more noticeable the electrical background noise in the system.) Normally, the volume control should be set to midposition. The volume levels of the various equipment connected to the interphone should then be set for comfortable listening using the individual equipment volume controls.

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
INTERPHONE (AN/AIC-10)	Intercrew communication and use with other radio equipment	All crewmembers	Intraplane only except when used in conjunction with other equipment	All crew stations. Call boxes located at various positions in airplane	
VHF RADIO (WILCOX 807) 2833 ▶ 3363 AIRPLANES NOT MODIFIED BY TCTO 1C-97(K)L-505	Short range, two-way voice communication	Pilot	Up to 135 NMI at 10,000 feet, characterized by line-of-sight conditions	Control stand	1360 frequencies in the frequency range of 116.000 to 149.975 MH_z can be selected manually.
VHF RADIO (COLLINS VHF-101) 22680 ▶ 33816 AIRPLANES MODIFIED TCTO 1C-97(K)L-505	Short range, two-way voice communication	Pilot	Up to 135 NMI at 10.000 feet, characterized by line of-sight conditions	Control stand	Transmit-680 channels from 116.00 to 149.95 MH_z. Receive-720 channels from 116.00 to 151.95 MH_z. Manually selectable channels in 50 MH_z steps.
UHF RADIO (AN/ARC-27)	Short range, two-way voice and code communication	Pilot	Line-of-sight. Range varies with altitude in respect to receiving station	Pilots' panel on control stand	1750 frequencies can be selected manually
UHF DIRECTION FINDER (AN/ARA-25)	Receives signals for directional bearing and homing, both air-to-air and air-to-ground	Pilot	Line-of-sight. Range depends upon power of transmitting stations and conditions	ADF position on UHF radio control panel on control stand	Used with UHF radio set AN/ARC-27
INTERROGATOR (AN/APX-29A)	Interrogates other airplanes to identify them for air-to-air rendezvous	Navigator	180 NMI	Navigator's station	Visual portrayal of other airplanes IFF transmissions
LIAISON RADIO (AN/ARC-65 or AN/ARC-65A)	Long range, two-way voice and code communications	Copilot	Range depends on mode selected, operating frequency, and conditions. Up to several thousand miles	Control stand	Either amplitude modulation (AM) or single sideband (SSB) operation
RADIO COMPASS (AN/ARN-6)	Receives signals for directional bearings, homing, and radio range flying	Pilot and Navigator	Depends upon power of transmitting station and conditions	Control stand and navigator's station	Control may be transferred between pilot and navigator
MARKER BEACON (AN/ARN-12)	Receives location marker signals on radio navigation beams	Automatic		Beacon light is on pilot's course indicator on pilots' instrument panel	
GLIDE PATH RECEIVER (AN/ARN-18)	Indicates glide angle for instrument approach	Pilot	Short range, line-of-sight	Control stand (VOR control panel)	Indication on course indicator on pilots' instrument panel
VHF NAVIGATION RADIO (VOR) (AN/ARN-14)	VHF radio-navigation aids	Pilot	Line-of-sight	Control stand (VOR control panel and instrument select switch)	Navigation information displayed on pilot's course indicator and RMI's

COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

Figure 4–7 (Sheet 1 of 2)

TYPE AND DESIGNATION	USE	PRIMARY OPERATOR	RANGE	CONTROL LOCATION	REMARKS
UHF NAVIGATION RADIO (TACAN) (AN/ARN-21)	Provides continuous bearing and distance data to ground beacon	Pilot	195 NMI within line-of-sight	Control stand (Tacan control panel and instrument select switch)	Bearing displayed on RMI's and on pilot's course indicator. Range data displayed on range indicator on pilots' instrument panel. Requires N-1 compass data
RADIO ALTIMETER (SCR-718C)	Indicates distance from airplane to surface	Navigator	0-40,000 feet	Navigator's station	
LORAN (AN/APN-70)	Provide accurate fixes for navigation	Navigator	Up to 1400 NMI depending upon conditions and time of day	Navigator's station	
AIMS/IFF TRANSPONDER SYSTEM (AN/APX-72)	Provides for airplane recognition (Identification Friend or Foe)	Copilot	Line-of-sight	Pilot's station	
SEARCH RADAR (AN/APS-42)	Search and navigation radar	Navigator	205 NMI maximum	Navigator's station	For obstacle detection and navigation
RADAR BEACON (AN/APN-69)	Sends signals to other airplane for rendezvous	Navigator	Up to 205 NMI (AN/APS-42)	Navigator's station	Sends signals when triggered by search radar of approaching airplane. Signals are displayed on search radar of approaching airplane
RADAR PRESSURIZING EQUIPMENT	Pressurizes radar sets to provide satisfactory operation at high altitudes	Navigator		Navigator's station	
STATIC DISCHARGERS (AN/ASA-3)	Discharges static electricity to air			Wing tips and tail surfaces, boom rudde-vators, and boom nozzle hood	

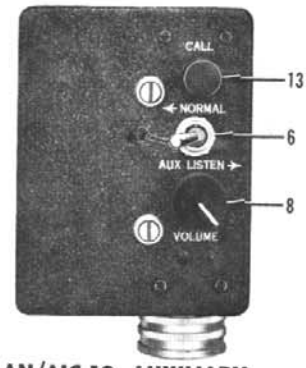
Figure 4–7 (Sheet 2 of 2)

Loudspeaker Switch. Loudspeakers at each of the major crew stations are turned on and off by an ON–OFF loudspeaker switch (14, figure 4–8) on the base of the speaker. With the switch ON, the speakers maintain the volume level set by the volume knob on the interphone control panel. With the switch OFF, no sound will be heard through the loudspeakers, unless a signal is originated using the CALL function.

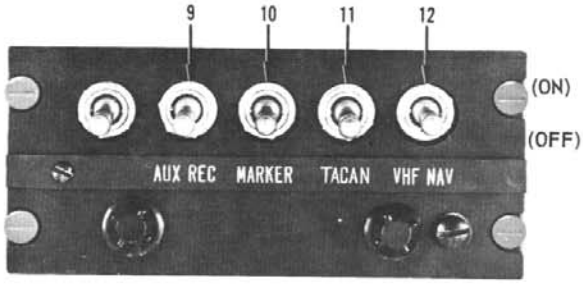
Auxiliary Interphone Call Button. The function of the auxiliary interphone call button (13, figure 4–8) on the auxiliary interphone control panels is the same as the CALL function of the selector switch on the interphone control panels at each crew station. This is an emergency provision that enables a crewmember to talk to the rest of the crew on the interphone regardless of the switch arrangements on the control panels at the various stations. Pressing the CALL button interrupts all other interphone activity and permits the user to talk without using the the press-to-talk switch.

Control Wheel Mike Switch. The control wheel mike switch (15, figure 4–8) is on the pilots' control wheels. When the switch is depressed, the respective crewmember's mike is connected to the facility selected by the interphone selector switch. The switch allows the crewmember to talk over the interphone or the selected radio

AN/AIC-10 INTERPHONE CONTROL PANEL

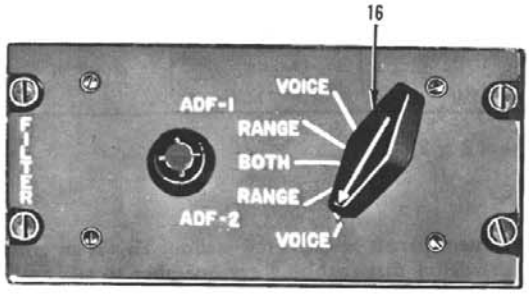


AN/AIC-10 AUXILIARY INTERPHONE CONTROL PANEL

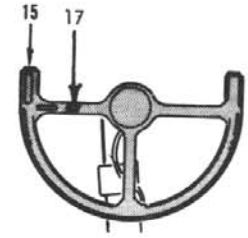


AN/AIC-10 INTERPHONE MIXER SWITCH PANEL (TYPICAL)

LOUDSPEAKER



RADIO RANGE FILTER CONTROL PANEL



CONTROL WHEEL (PILOT'S SHOWN)

1 INTERPHONE MIXER SWITCH
2 UHF RADIO MIXER SWITCH
3 LIAISON RADIO MIXER SWITCH
4 RADIO COMPASS (ADF) MIXER SWITCH
5 VHF RADIO MIXER SWITCH
6 NORMAL-AUXILIARY LISTEN SWITCH (2 PLACES)
7 INTERPHONE SELECTOR SWITCH
8 INTERPHONE VOLUME KNOB (2 PLACES)
9 AUXILIARY LIAISON RADIO RECEIVER MIXER SWITCH
10 MARKER BEACON MIXER SWITCH
11 UHF NAVIGATION RADIO (TACAN) MIXER SWITCH
12 VHF NAVIGATION RADIO (VOR) MIXER SWITCH
13 AUXILIARY INTERPHONE CALL BUTTON
14 LOUDSPEAKER SWITCH
15 CONTROL WHEEL MIKE SWITCH
16 RADIO RANGE FILTER SWITCH
17 INTERPHONE MIKE BUTTON

INTERPHONE CONTROL PANELS

Figure 4–8

without removing his hands from the control wheel to operate switches on the control panel.

Ruddevator Control Stick Microphone Button. The ruddevator control stick microphone button (2, figure 4–62) is on the ruddevator control stick. When the microphone button is depressed, the boom operator's mike is connected to the facility selected by the interphone selector switch. The microphone button allows the boom operator to talk over interphone or the selected radio without removing his hands from the boom controls during air refueling.

Foot Mike Switches. There are three foot mike switches (7, figure 4–9), one at the engineer's station and two at the navigator's station. When the foot mike switch is depressed, transmission is possible only through the equipment indicated by the interphone selector switch on the individual's interphone control panel.

Radio Range Filter Switch. The five-position, rotary radio range filter switch (16, figure 4–8) is on the radio range filter control panel. The switch has VOICE–RANGE–BOTH positions for ADF-1 use. RANGE position allows radio compass range signals to be heard at their full volume level and the voice signals reduced to a lower level. The VOICE position allows the voice signals to be heard at their full intensity while the range signals are reduced. The BOTH position disconnects the filter and allows both radio range and voice signals to be heard at equal intensity. The switch also has these positions for ADF-2; however, the switch is inoperative for ADF-2 RANGE or ADF-2 VOICE positions.

Normal Operation Of The Interphone

Intercommunications. Communication between crewmembers may be accomplished as follows:

a. Place the NORMAL–AUX LISTEN switch on the interphone control panel in NORMAL and move the interphone selector switch to INTER position. On the pilots' panels, move all mixer switches to OFF (down). The interphone is now set up for normal communication between crewmembers.

b. The pilot or copilot may communicate with other stations by depressing his control wheel mike switch. The navigator and engineer may use the foot mike switch to permit use of their mike. Volume of signals received may be regulated by the volume knob.

c. Contact all crewmembers from the pilot's or copilot's station by depressing the control wheel mike switch on the pilots' control wheel or by placing the pilot's interphone selector switch to CALL. Crewmembers may contact other crew positions by using their mike switches or by positioning their interphone selector switch to CALL. Call from stations with auxiliary interphone panels may be made by pressing the auxiliary interphone call button on that panel. While any switch is on CALL, the signals from all auxiliary equipment are disconnected from the interphone.

Note

The microphones used with this equipment are gradient microphones. Satisfactory results will therefore be obtained only when the talker's lips are very close to or touching the moisture barrier of the microphone.

Interphone/Radio Communication. Operation of the radio facilities in conjunction with the interphone may be accomplished as follows:

a. The command radios as well as intercommunication between crewmembers may be heard by placing the proper mixer switch marked UHF COMM or VHF COMM to ON. The pilot and copilot may transmit over a command radio by positioning the interphone selector switch to the desired command radio and using their mike switch on the control wheel. When transmitting, the crewmember will hear a sidetone in his headphones. The sidetone enables the user to regulate his speech by hearing his own voice in the headset. Each crewmember may receive command conversation by placing his interphone selector switch to the desired command position. The crewmembers may also listen to other facilities while receiving command radio (selected by the interphone selector switch in the desired command position) by positioning the desired mixer switch in the ON position.

b. Radio compass signals may be heard along with other communication facilities by placing the mixer switch marked ADF in the ON position. The pilot may select reception of both range and voice signals by positioning the radio range filter switch to BOTH. When positioned to ADF-1 VOICE or ADF-1 RANGE, reception of the selected signal will be more predominant. The crewmember may also listen to other facilities while listening to radio compass (selected by the ADF mixer switch) by placing the desired mixer switches in the ON position.

c. Liaison radio reception may be heard separately by positioning the interphone selector switch to LIA. All crewmembers may transmit over a liaison radio by placing their respective interphone selector switches to LIA and using their mike switch. The command mike switch must be positioned to LIAISON also.

Emergency Operation Of The Interphone

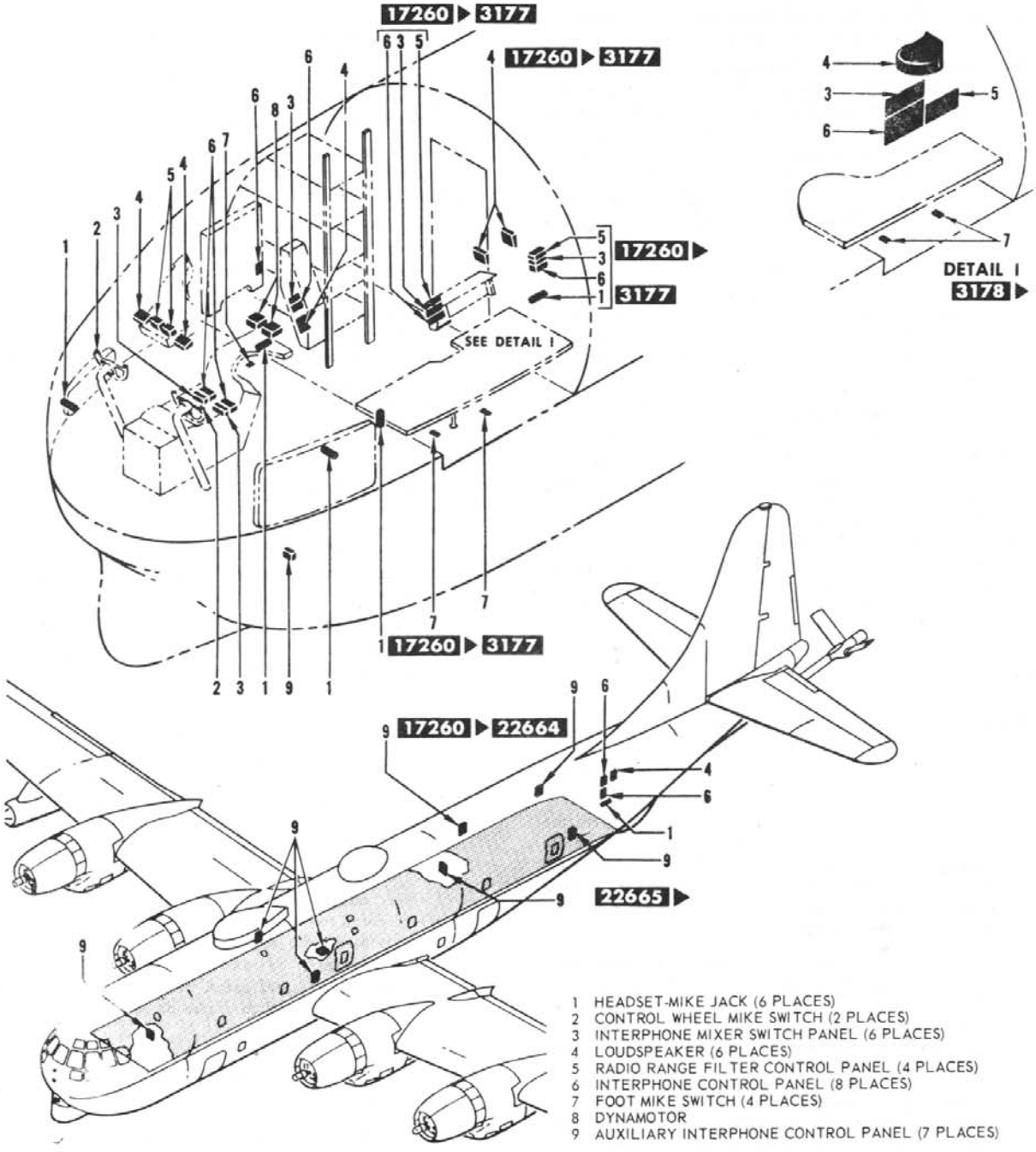
To contact all stations in an emergency:

a. The pilot or copilot positions his interphone selector switch to CALL.

b. Other crewmembers position their interphone selector switch to CALL.

c. A crewmember at a station with an auxiliary interphone panel presses his call button.

In the event of amplifier failure at any crew station, as evidenced by intercommunication silence or unintelligible signals from all facilities, proceed as follows:



1 HEADSET-MIKE JACK (6 PLACES)
2 CONTROL WHEEL MIKE SWITCH (2 PLACES)
3 INTERPHONE MIXER SWITCH PANEL (6 PLACES)
4 LOUDSPEAKER (6 PLACES)
5 RADIO RANGE FILTER CONTROL PANEL (4 PLACES)
6 INTERPHONE CONTROL PANEL (8 PLACES)
7 FOOT MIKE SWITCH (4 PLACES)
8 DYNAMOTOR
9 AUXILIARY INTERPHONE CONTROL PANEL (7 PLACES)

INTERPHONE EQUIPMENT LOCATIONS

Figure 4–9

a. Place the NORMAL–AUX LISTEN switch in AUX LISTEN.

b. Place all mixer switches in OFF position and turn interphone selector switch to the desired listening facility.

c. If the desired listening facility cannot be selected by the interphone selector switch: turn ON appropriate mixer switch. If more than one mixer switch is ON, the facility heard will be the switch which is in the ON position that has the highest priority. Refer to NORMAL – AUXILIARY LISTEN SWITCH, this section, for priority of switches.

VHF RADIO SYSTEM

The Wilcox 807 VHF command radio system is installed on KC-97L airplane serial numbers 52-833, 52-841, 52-842, 52-844, 52-869, 52-870, 52-879, 52-883, 52-884, 52-892, 52-895, 52-900 through 52-905, 52-918, 52-2603 through 52-2605, 52-2615, 52-2630, 52-2642, 52-2656, 52-2675, 52-2694, 52-2695, 52-2697, 52-2698, 52-2718, 52-2761, 53-150, 53-230, 53-232, 53-237, 53-243, 53-244, 53-264, 53-291, 53-292, 53-295, 53-296, 53-315, 53-317, 53-319, 53-327, 53-350, 53-352, 53-354, 53-355, 53-357, and 53-360 through 53-363.

The Collins VHF-101 command radio system is installed on KC-97L airplane serial numbers 52-2680, 53-200, 53-202, 53-205, 53-208, 53-218, 53-223 through 53-225, 53-240, 53-265, 53-276, 53-278, 53-280, 53-282, 53-283, 53-298, 53-304, 53-307, 53-310, 53-325, 53-348, and 53-3816.

VHF RADIO (WILCOX 807) 2833 ▶ 3363

AIRPLANES NOT MODIFIED BY TCTO 1C-97(K)L-505

The Wilcox 807 VHF radio provides short-range, two-way voice communications on a total of 1360 channels in the frequency range of 116.000 to 149.975 megacycles. Range of transmission and reception is limited to line-of-sight distances. The VHF radio control panel (figure 4—11) is located on the control stand at the pilots' station. The VHF radio control panel has facilities for selection of any one of the 1360 available channels. The radio is connected to the interphone for both talking and listening when the interphone selector switch (7, figure 4—8) is on COMM VHF, or listening when either the VHF COMM mixer switch is in the ON position or the interphone selector switch is in the COMM VHF position. Control power is 28-volt dc through a circuit breaker on the radio junction box circuit breaker panel (2, figure 1—37).

VHF Radio Controls (Wilcox 807).

VHF OFF-PWR Switch. The Wilcox 807 VHF radio is turned on by placing the OFF-PWR switch (1, figure 4—11), on the VHF radio control panel, to the PWR position, and turned off by placing the OFF-PWR switch to the OFF position.

Frequency Selector Knobs. Two frequency selector knobs (5, figure 4—11) on the VHF radio control panel are used for selecting any one of the 1360 available frequencies. The left-hand knob selects whole megacycles (116 to 149), and the right hand knob selects fractional megacycles (.000 to .975).

COMM Test Switch. This switch (4, figure 4—11) on the VHF radio control panel provides a simple means of checking receiver operation. In the absence of a readable signal, depress the COMM test switch. This disables receiver squelch action, resulting in receiver background noise, and frequently permits signals below the squelch threshold of the receiver to be heard.

VHF Radio (Collins VHF-101) 22680 ▶ 33816

AIRPLANES MODIFIED BY TCTO 1C-97(K)L-505

The Collins VHF-101 radio system provides 680 crystal-controlled channels for transmission within the frequency range of 116.00 to 149.95 MHz and 720 channels for reception within the frequency range of 116.00 to 151.95 MHz. All channels may be selected at intervals of 50 KHz from the control panel. The VHF-101 radio system is connected to the interphone system for two-way voice communications when the interphone selector switch (7, figure 4-8) is in the COMM VHF position. The system receives 28-volt dc power through the VHF COMM circuit breaker and 115-volt, A phase, variable-frequency ac power through the VHF COMM RECEIVER ac circuit breaker on the radio junction box circuit breaker panel.

VHF Radio Controls (Collins VHF-101).

The VHF radio control panel (figure 4-11) is located on the control stand at the pilot's station.

VHF ON/OFF power switch. The VHF radio system is turned on or off by placing the ON/OFF power switch (1, figure 4-11) to positions indicated on the panel.

Frequency Selector Knobs. Two frequency control knobs (2, figure 4-11) on the control panel are used to select any

one of the channels (680 for the transmitter and 720 for the receiver) within the frequency range of 116.00 to 151.95 MHz. The knob on the left selects in MHz steps and the knob on the right selects in 50 KHz steps.

Volume Control. The volume control (3, figure 4-11) adjusts the sound level in the interphone system.

Squelch Control. The SQ squelch control (4, figure 4-11), the small knob centered on the VOL control, is provided to adjust the squelch threshold of the receiver output.

Mode Selector Switch. The SCS-DCS/DCD mode selector switch (5, figure 4-11) is provided to select either of two modes of operation. When the mode selector is in the SCS position, the receiver and transmitter are both automatically tuned to the frequency indicated on the frequency indicator dial. When the mode selector is in the DCS/DCD position, the transmitter frequency is automatically tuned 6 MHz above the receiver frequency (indicated on the frequency indicator dial). In both modes of operation the receiver is disabled while transmitting.

Frequency Indicator Dial. The frequency indicator dial (6, figure 4-11) displays the frequency channel selected. The channel selected is displayed in MHz to the left of decimal point and in KHz to the right of decimal point. The frequency indicator dial indicates receiver frequency for both positions of the mode selector switch, however, when the mode selector is in the DCS/DCD position the transmitter is tuned 6 MHz above the frequency indicated.

Normal Operation of the VHF Command Radio (Collins VHF-101).

To put the VHF command radio into operation:

a. Place power switch in ON position.

b. Allow 1 minute for warmup.

c. Select mode of operation desired (SCS or DCS/DCD).

Note

When operating in SCS, all transmissions and voice communications will be on the frequency indicated on the control panel. When operating in DCS/DCD, the receiver frequency is indicated on the control panel and the transmitting frequency will be automatically tuned 6 MHz higher than the receiving frequency.

d. Select the desired operating frequency.

e. Adjust the SQ and VOL control as necessary to obtain a comfortable reception level.

f. To receive, place VHF COMM MIXER switch (5, figure 4-8) on intercommunications control panel in ON position.

g. To transmit, place transmission selector switch (7, figure 4-8) on intercom panel in VHF COMM position.

h. To turn VHF command radio off, place power switch in OFF position.

VHF Volume Control Knob. The VHF volume control knob (3, figure 4–11) on the VHF radio control panel is used to adjust the sound level through the interphone.

Frequency Indicator Dial. This dial (2, figure 4–11) on the VHF radio control panel displays the selected frequency on digital-type counter dials.

Normal Operation Of The VHF Radio (Wilcox 807).

The VHF radio can be operated from any crew station that has an interphone control panel; however, frequency selection and power are controlled at the pilots' station only. Operation of the set is as follows:

a. Place the OFF-PWR switch to PWR.

b. Ascertain that selector switch on interphone control panel is on COMM VHF.

c. Allow 30 to 45 seconds for set to reach normal operating temperature.

d. Test set for sidetone by pressing the microphone switch.

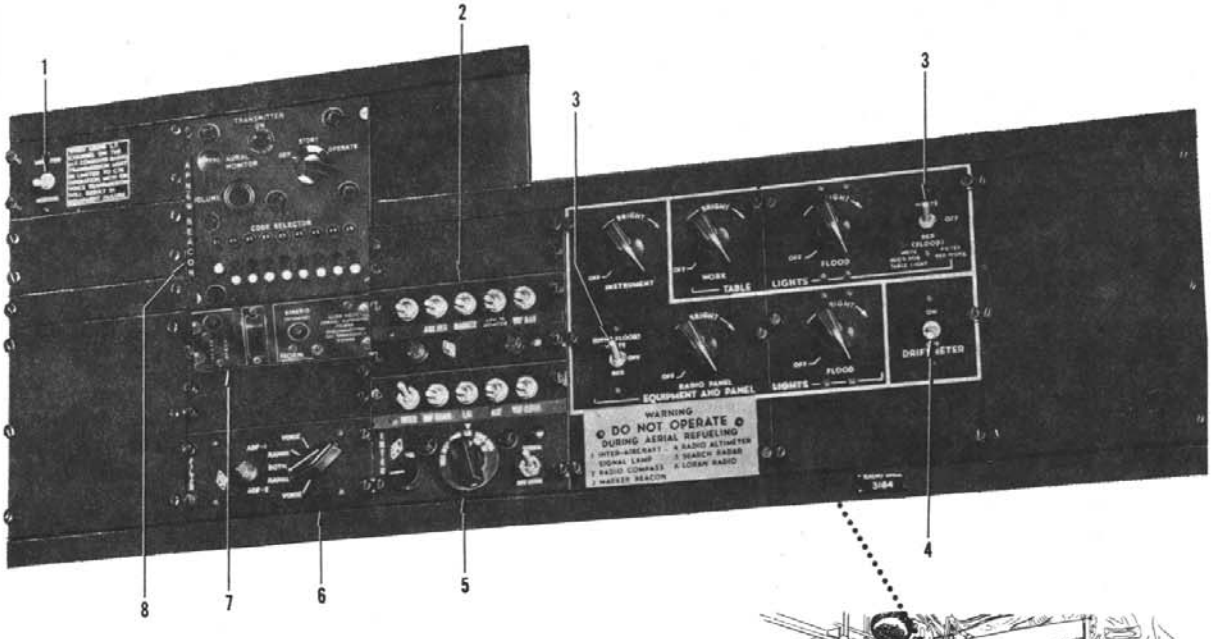
e. Release the microphone switch. With the frequency selector knobs, tune to any desired frequency. The receiver portion of the transceiver will continuously monitor the selected frequency.

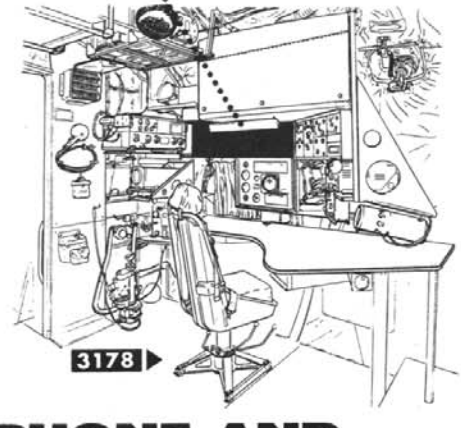
f. Adjust sound level with the VHF volume control knob. Clockwise rotation increases volume. Counterclockwise rotation decreases volume.

g. To turn the set off, position the OFF-PWR switch to OFF.

Note

The transceiver, as supplied, is capable of being tuned to transmit and receive on 1360 channels which are spaced 25 kilocycles apart. However, since the VHF communications systems now in service employ 50-kilocycle spacing, two replaceable filters are used in the transceiver which provide a receiver bandpass of 40 kilocycles for 50-kilocycle channel spacing. Alternate filters are available to provide a receiver bandpass of 20 kilocycles for 25-kilocycle channel spacing. Therefore, since the transceiver will transmit and receive on 25-kilocycle spaced channel frequencies ending in 25 and 75 kilocycles, make sure that only the 50-kilocycle spaced channel frequencies ending in 00 and 50 kilocycles are selected at the control unit to prevent adjacent channel interference in the 50-kilocycle spaced communications system.

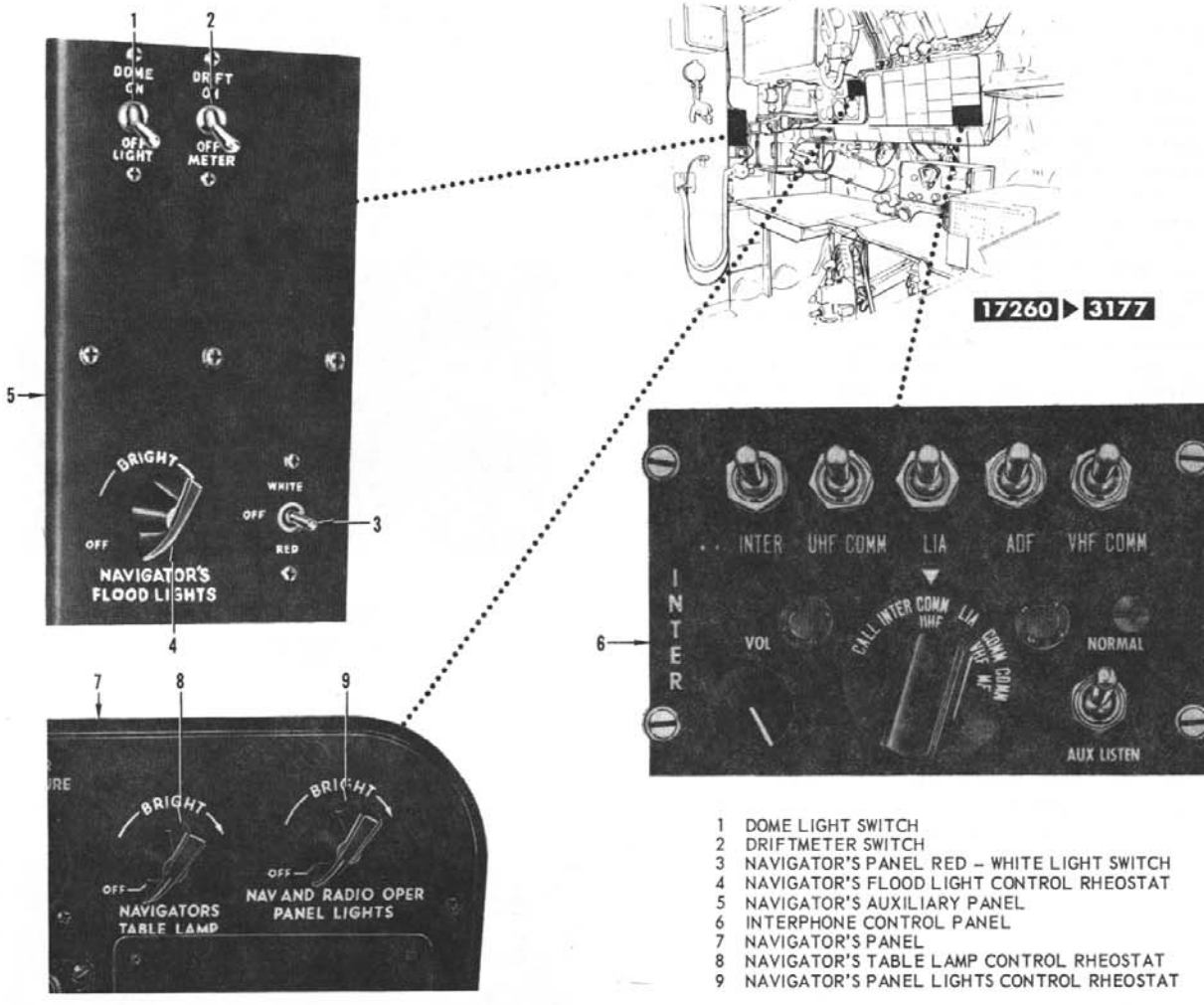




1 AUXILIARY LIAISON NORMAL/MONITOR SWITCH 3178 ▶ 3278
2 INTERPHONE MIXER SWITCH PANEL (SEE FIGURE 4–8)
3 LIGHT SWITCHES (2 PLACES)
4 DRIFTMETER SWITCH
5 INTERPHONE CONTROL PANEL (SEE FIGURE 4–8)
6 RADIO RANGE FILTER CONTROL PANEL (SEE FIGURE 4–8)
7 RADAR BEACON EMERGENCY POWER CONTROL PANEL AN/APN-69 (SEE FIGURE 4–32)
8 RADAR BEACON CONTROL PANEL AN/APN-69 (SEE FIGURE 4–32)

NAVIGATOR'S INTERPHONE AND LIGHT PANELS

Figure 4–10 (Sheet 1 of 2)



1 DOME LIGHT SWITCH
2 DRIFTMETER SWITCH
3 NAVIGATOR'S PANEL RED – WHITE LIGHT SWITCH
4 NAVIGATOR'S FLOOD LIGHT CONTROL RHEOSTAT
5 NAVIGATOR'S AUXILIARY PANEL
6 INTERPHONE CONTROL PANEL
7 NAVIGATOR'S PANEL
8 NAVIGATOR'S TABLE LAMP CONTROL RHEOSTAT
9 NAVIGATOR'S PANEL LIGHTS CONTROL RHEOSTAT

Figure 4–10 (Sheet 2 of 2)

UHF RADIO (AN/ARC-27)

The UHF radio is for short-range, two-way voice communication on frequencies between 225.0 to 399.9 megacycles. Since the radio operates in the ultra-high frequency (UHF) spectrum, the range for transmission and reception is limited to line-of-sight distances. The control panel is on the control stand at the pilots' station. (See figure 4–12.) The control panel has facilities for manual selection of any one of the 1750 available frequencies. Each panel has a channel selector switch which permits rapid selection of a common frequency. One of the preset channels is for the guard frequency and each of the remaining 20 preset channels can have any frequency within the operating capability of the set. Refer to CHANGING PRESET FREQUENCIES, this section. The radio is connected to the interphone for both talking and listening when the interphone selector switch (7, figure 4–8) is on COMM UHF (or UHF COMM, as applicable). The UHF radio is a component of the direction finder (UHF/DF) AN/ARA-25. Refer to DIRECTION FINDER (AN/ARA-25) this section.

Control power for the radio is 28-volt dc with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37).

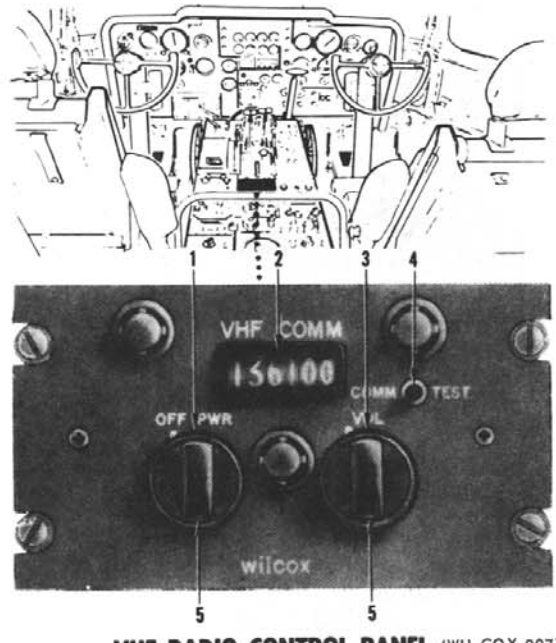
UHF Radio Controls

UHF Operation Switch. The UHF radio control panel has a UHF operation switch (5, figure 4–12) for selecting different transmitting and receiving operations. This switch has four positions. See figure 4–13 for an explanation of the switch positions.

Frequency Selector Knobs. The UHF radio control panel has three frequency selector knobs (1, figure 4–12) for manually selecting one of the 1750 different operating frequencies. The knobs are effective when the channel selector switch (4, figure 4–12) on the control panel is on M. The knobs are positioned so that the numbers of the desired frequency appear in the frequency window (2, figure 4–12). Refer to CHANGING PRESET FREQUENCIES, this section.

Channel Selector Switch. The channel selector switch (4, figure 4–12) has numbered positions from 1 to 20 for 20 preset channels plus G and M positions. The G position is used to select the guard frequency for both transmission and reception. The M position is used to permit manual selection of a frequency without affecting a preset frequency.

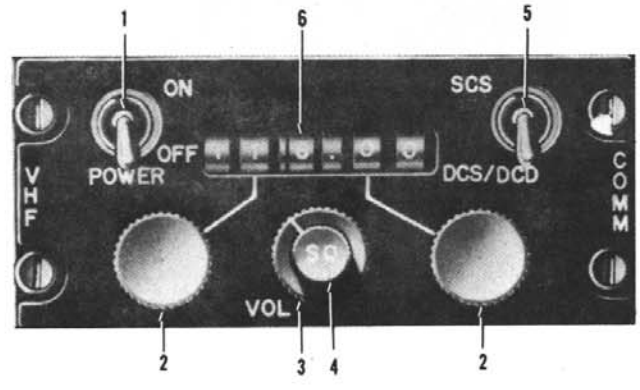
UHF Volume Knob. A volume knob (3, figure 4–12) on the control panel adjusts the audio signal level from the receiver to the interphone.



VHF RADIO CONTROL PANEL (WILCOX 807)

2833 ▶ 3363 AIRPLANES MODIFIED BY TCTO 1C-97(K)L-505

1 OFF-PWR SWITCH
2 FREQUENCY INDICATOR DIAL
3 VOLUME CONTROL KNOB
4 COMM TEST SWITCH
5 FREQUENCY SELECTOR KNOBS



VHF RADIO CONTROL PANEL (COLLINS VHF-101)

22860 ▶ 33816 AIRPLANES MODIFIED BY TCTO 1C-97(K)L-505

1 POWER SWITCH
2 FREQUENCY SELECTOR KNOBS
3 VOLUME CONTROL
4 SQUELCH CONTROL
5 MODE SELECTOR SWITCH
6 FREQUENCY INDICATOR DIAL

VHF RADIO CONTROLS

Figure 4–11

Normal Operation Of The UHF Radio

Transmission and reception on the UHF radio is possible from any crew station that has an interphone control panel; however, the channelization and power are controlled at the pilots' position.

Operation of the UHF radio is as follows:

a. Select mode of operation desired with the UHF operation switch (5, figure 4–12).

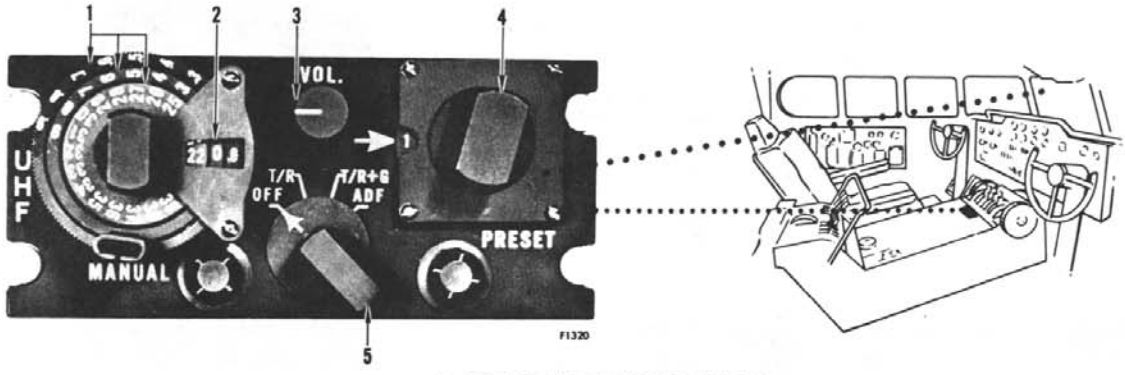
b. Select preset channel with the channel selector switch (4, figure 4–12) on the UHF control panel. The channel selector switch has an M position to make the frequency selector knobs operative.

c. Adjust volume to desired level.

Note

Tone modulation is not available from the UHF control panel.

d. If the radio is to be turned off, turn the UHF operation switch to OFF.



1 FREQUENCY SELECTOR KNOBS
2 FREQUENCY WINDOW
3 VOLUME KNOB
4 CHANNEL SELECTOR SWITCH
5 UHF OPERATION SWITCH

UHF RADIO CONTROL PANEL

Figure 4-12

OPERATOR	OPERATION SWITCH POSITION	EQUIPMENT OPERATION
PILOT	OFF	Primary power off
	T/R	Transmitter on standby, main receiver on, ADF on standby
	T/R + G	Transmitter on standby, main receiver on, guard receiver on. ADF on standby
	ADF	ADF (AN/ARA-25) antenna connected, ADF operation ready

UHF OPERATION SWITCH POSITIONS

Figure 4-13

Changing Preset Frequencies

The frequency of a preset channel can only be changed by removing the control panel. Normally, this will not be done in flight due to the ease by which any frequency can be manually selected with the frequency selector knobs (1, figure 4-12).

Emergency Operation Of The UHF Radio

If an obstruction has caused the defective operation of a desired channel, place the channel selector switch to a different channel and return immediately to the desired channel. This will often correct the difficulty. A crystal failure on one frequency will not affect all frequencies. Try operation at a different frequency. In case the channel selector switch becomes inoperative, turn the channel selector switch to M and adjust the frequency selector knobs to the desired frequency.

DIRECTION FINDER (AN / ARA-25)

The direction finder indicates the relative bearing of radio signals in the frequency range of 225 to 400 megacycles. The signals are received by the UHF radio (AN/ARC-27), using the direction finder antenna. The direction finder is controlled from the UHF radio control panel when the UHF operation switch (3, figure 4-14) is positioned to ADF. The bearing indication is displayed on the No. 2 bearing indicator of RMI's marked → .ADF ⇒ UHF/DF and the navigator's RMI. Control power is 28-volt dc with circuit protection on the radio junction box circuit breaker panel (3, figure 1-37).

Normal Operation Of The Direction Finder

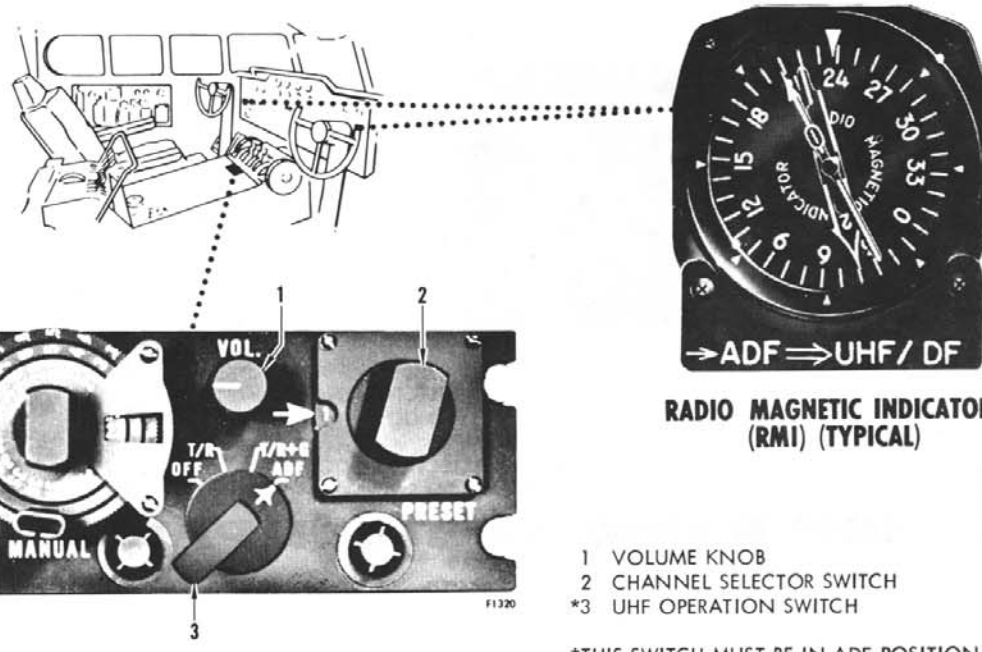
The direction finder (AN/ARA-25) is made operative by the following procedure:

a. Rotate UHF operation switch to ADF as shown in figure 4-14.

b. Select the desired frequency with the channel selector switch.

c. Allow 3-minute warmup period if the UHF operation switch was in OFF.

d. If the direction finder is being used for homing, fly the airplane to keep the UHF/DF bearing indicator of the radio magnetic indicator under the reference index at the top of the instrument.



UHF RADIO CONTROL PANEL

RADIO MAGNETIC INDICATOR (RMI) (TYPICAL)

1 VOLUME KNOB
2 CHANNEL SELECTOR SWITCH
*3 UHF OPERATION SWITCH

*THIS SWITCH MUST BE IN ADF POSITION IN ORDER TO ALLOW DIRECTION FINDER TO FUNCTION

UHF DIRECTION FINDER CONTROLS

Figure 4-14

e. If the direction finder is being used for direction finding, observe the direction of signal source (relative bearing of source) as indicated on the azimuth scale under the arrow of the UHF/DF bearing indicator of the radio magnetic indicator.

f. Turn off the equipment by placing the UHF operation switch in OFF. This turns off the AN/ARA-25 direction finder and the UHF radio. Standby operation of the direction finder is achieved by placing the UHF operation switch in T/R or T/R+G.

INTERROGATOR AN / APX-29A

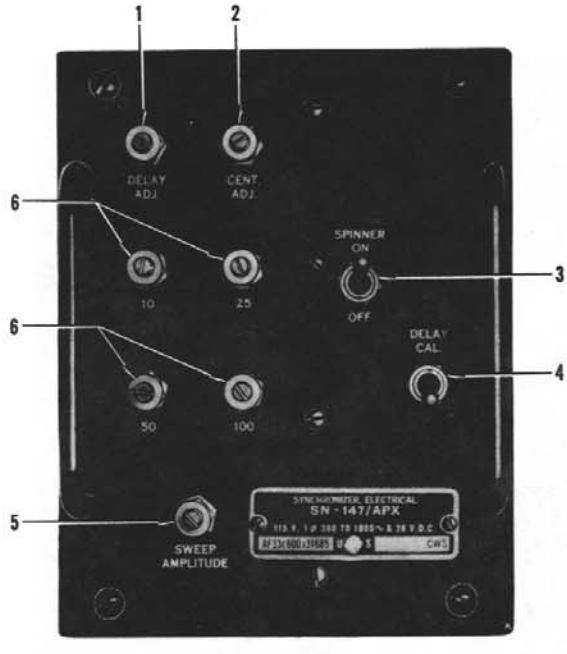
The interrogator is an airborne, 1000-megacycle interrogator-responsor used in conjunction with a transponder for air-to-air rendezvous. The purpose of the interrogator is to interrogate other airplanes and supply a visual indication of azimuth and range of the interrogated airplane to the navigator. Principle components of the interrogator are: Receiver-transmitter, interrogator synchronizer (figure 4-15), interrogator control panel (figure 4-16), rectifier power unit, interrogator antenna (14, figure 4-34), and an interrogator azimuth-range indicator (figure 4-17).

Principles Of Operation

A trigger pulse from the interrogator synchronizer is applied to the transmitting portion of the receiver-transmitter. This trigger pulse passes through three stages which produce paired pulses of 3-, 5-, or 8-microsecond spacings. The paired pulse signals are then radiated by the antenna and received by a transponder set for the same mode of operation in another airplane. The transponder decodes the signals and transmits the reply signals automatically, which are picked up by the antenna and fed to the receiver portion of the receiver-transmitter. The receiver circuit then supplies the interrogator azimuth-range indicator with the video signal for indicator screen presentation.

Receiver-Transmitter RT-319B / APX

The receiver-transmitter on the receiver-transmitter mount on the main radio rack contains the transmitting and receiving channels of the interrogator and auxiliary circuits. The purpose of the receiver-transmitter is self-explanatory, being essentially a pulse-type transmitter to transmit interrogation pulses and a superheterodyne receiver to receive and demodulate the replies from an interrogated airplane. The auxiliary circuits provide high voltage, testing facilities, and minor electronic control.



1 DELAY ADJUSTMENT SCREW
2 CENTER ADJUSTMENT SCREW
3 SPINNER SWITCH
4 DELAY CALIBRATION SWITCH
5 SWEEP AMPLITUDE ADJUSTMENT SCREW
6 MILEAGE ADJUSTMENT SCREW (2 PLACES)

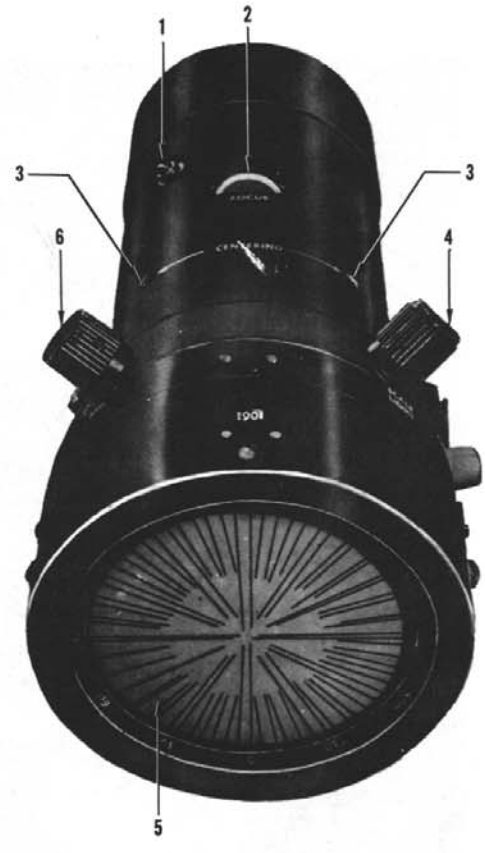
INTERROGATOR SYNCHRONIZER

Figure 4–15

1 RECEIVER GAIN CONTROL KNOB
2 RANGE-MARKERS CONTROL KNOB
3 POWER SWITCH
4 MODE CONTROL SWITCH
5 TRANSMITTER SWITCH

INTERROGATOR CONTROL PANEL

Figure 4–16



1 BRILLIANCE CONTROL SCREW
2 FOCUS CONTROL KNOB
3 CENTERING ADJUSTMENT SCREW (2 PLACES)
4 SCALE LIGHT CONTROL KNOB
5 INDICATOR SCREEN
6 MARKER BRILLIANCE CONTROL KNOB

INTERROGATOR AZIMUTH – RANGE INDICATOR

Figure 4–17

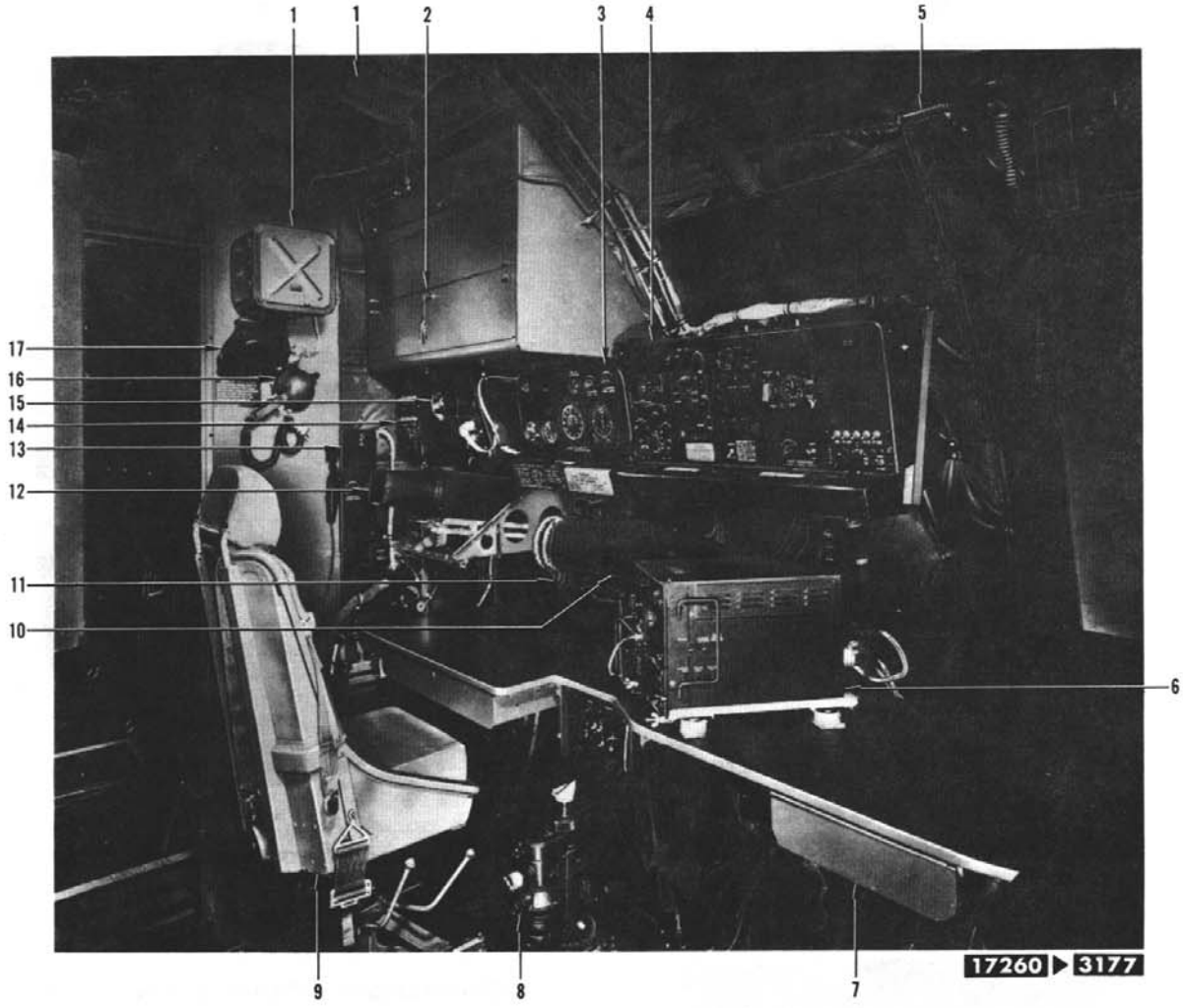
Interrogator Synchronizer SN-147/APX

The interrogator synchronizer (figure 4–15) on the main radio rack has four primary functions. They are as follows: Supply trigger pulse to the receiver-transmitter, range marker pulse to the interrogator azimuth-range indicator, sweep voltage to the antenna selsyn, and unblanking pulses to the indicator cathode ray tube. Operating switches and adjustment screws on the front panel are decaled for identification.

Delay Adjustment Screw. The delay adjustment screw (1, figure 4–15) adjusts the time between the trigger-out pulses and the start of visible sweep in the 100-nautical mile range position.

Center Adjustment Screw. The center adjustment screw (2, figure 4–15) adjusts the point at which the sweep is unblanked.

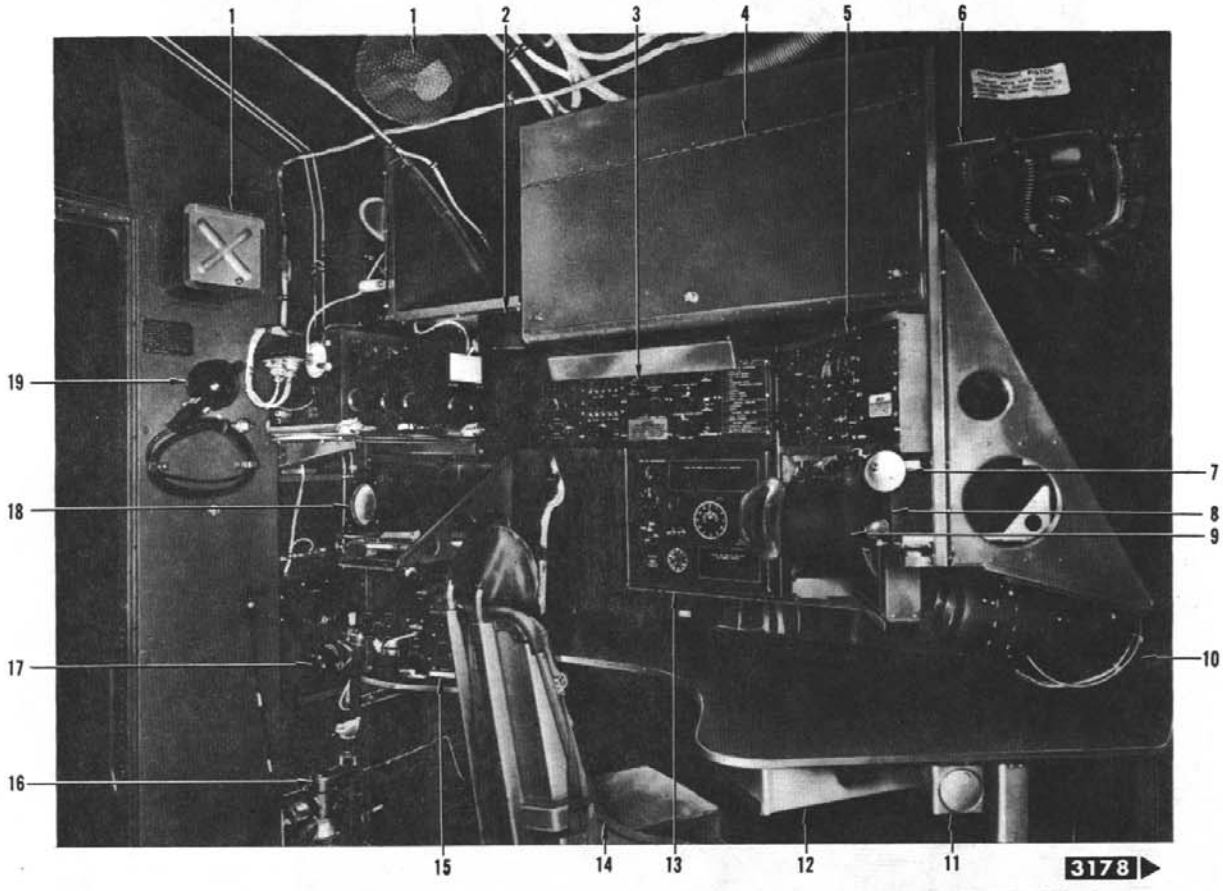
Spinner Switch. The spinner switch (3, figure 4–15) controls the power to the antenna drive motor.



1 VENTILATING FAN (2 PLACES)
2 NAVIGATOR'S STOWAGE CABINET
3 NAVIGATOR'S INSTRUMENT PANEL (SEE FIGURE 4-44)
4 RADIO AND RADAR CONTROL PANELS (SEE FIGURE 4-19)
5 PYROTECHNIC PISTOL DOOR HANDLE
6 LORAN CONTROL UNIT (SEE FIGURE 4-26)
7 NAVIGATOR'S TABLE DRAWER
8 DRIFTMETER (SEE FIGURE 4-47 OR 4-48)
9 NAVIGATOR'S SEAT
10 INTERROGATOR INDICATOR
11 SEARCH RADAR INDICATOR (SEE FIGURE 4-30)
12 LORAN INDICATOR (SEE FIGURE 4-26)
13 NAVIGATOR'S AUXILIARY PANEL
14 NAVIGATOR'S INTERPHONE CONTROL PANEL (SEE FIGURE 4-8)
15 RADIO ALTIMETER (SEE FIGURE 4-25)
16 SIGNAL LAMP
17 LOUDSPEAKER

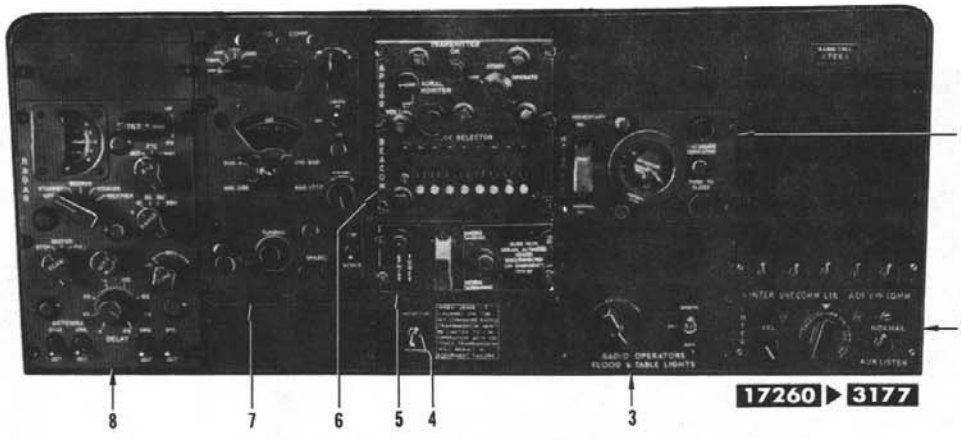
NAVIGATOR'S STATION

Figure 4-18 (Sheet 1 of 2)



1 VENTILATING FAN (2 PLACES)
2 LOUDSPEAKER
3 NAVIGATOR'S INTERPHONE AND LIGHT PANELS (SEE FIGURE 4–10)
4 NAVIGATOR'S STOWAGE CABINET
5 RADIO AND RADAR CONTROL PANELS (SEE FIGURE 4–19)
6 PYROTECHNIC PISTOL DOOR HANDLE
7 NAVIGATOR'S TABLE LAMP
8 RADIO ALTIMETER (SEE FIGURE 4–25)
9 INTERROGATOR INDICATOR
10 SEARCH RADAR INDICATOR (SEE FIGURE 4–30)
11 ASH TRAY
12 NAVIGATOR'S TABLE DRAWER
13 NAVIGATOR'S INSTRUMENT PANEL (SEE FIGURE 4–44)
14 NAVIGATOR'S SEAT
15 LORAN CONTROL UNIT (SEE FIGURE 4–26)
16 DRIFTMETER (SEE FIGURE 4–48)
17 OXYGEN REGULATOR
18 LORAN INDICATOR (SEE FIGURE 4–26)
19 SIGNAL LAMP

Figure 4–18 (Sheet 2 of 2)



1 RADAR PRESSURIZING CONTROL PANEL (2 PLACES) (SEE FIGURE 4–33)
2 RADIO OPERATOR'S INTERPHONE CONTROL PANEL (SEE FIGURE 4–8) 1243 ▶ 3177
3 RADIO OPERATOR'S FLOOD AND TABLE LIGHTS CONTROL PANEL
4 LIAISON NORMAL/MONITOR SWITCH 1243 ▶ 3278
5 RADAR BEACON EMERGENCY POWER CONTROL PANEL (SEE FIGURE 4–32)
6 RADAR BEACON CONTROL PANEL (SEE FIGURE 4–32)
7 RADIO COMPASS CONTROL PANEL (2 PLACES) (SEE FIGURE 4–21)
8 SEARCH RADAR CONTROL PANEL (2 PLACES) (SEE FIGURE 4–30)
9 INTERROGATOR CONTROL PANEL (SEE FIGURE 4–16)

RADIO AND RADAR CONTROL PANELS (TYPICAL)

Figure 4–19

Delay Calibration Switch. The delay calibration switch (4, figure 4–15) permits viewing of the amount of delay in the 100-nautical mile range on the indicator screen.

Sweep Amplitude Adjustment Screw. The sweep amplitude adjustment screw (5, figure 4–15) adjusts the length of the sweep trace.

Mileage Adjustment Screw. There are four mileage adjustment screws (6, figure 4–15) for adjusting the sweep length at 10-, 25-, 50-, and 100-nautical mile positions.

Interrogator Control Panel C-1528/APX

The interrogator control panel (figure 4–16) at the navigator's station provides a means of remotely selecting the various functions of the interrogator. The operating controls and switches on the front panel are decaled for identification.

Receiver Gain Control Knob. The receiver gain control knob (1, figure 4–16) varies the cathode bias in two stages of the receiver-transmitter to control the strength of the received signal output and overall sensitivity.

Range-Markers Control Knob. The range-markers control knob (2, figure 4–16) determines the range of the interrogator.

Power Switch. The power switch (3, figure 4–16) provides control of the power to the interrogator.

Mode Control Switch. The mode control switch (4, figure 4–16) selects the different modes of interrogation of the interrogator.

Transmitter Switch. The transmitter switch (5, figure 4–16) permits momentary or continuous interrogation.

Rectifier Power Unit PP-111/APS-10

The rectifier power unit at the navigator's station supplies the necessary operating voltages to the interrogator synchronizer and interrogator azimuth-range indicator.

Interrogator Antenna

The interrogator antenna (14, figure 4–34) on the top of the fuselage transmits signals from the interrogator and receives the replies from transponders of interrogated aircraft. The two primary functions of the antenna are as follows: Provides a means of presenting a rotating radiation pattern, and converts the sweep currents from the interrogator synchronizer to a rotating sweep by the use of a selsyn for presentation to the yoke of the interrogator azimuth-range indicator.

Interrogator Azimuth-Range Indicator IP-304/APX

The interrogator azimuth-range indicator (figure 4–17) at the navigator's station presents video target signals on the screen of the cathode ray tube. The indicator utilizes magnetic-type deflection and a permanent magnet focus mechanism. The controls and adjustment screws are decaled for identification.

Brilliance Control Screw. The brilliance control screw (1, figure 4–17) varies the bias at the grid of the cathode ray tube.

Focus Control Knob. The focus control knob (2, figure 4–17) controls the focus of the electron beam by a parallel movement of the focus magnet shunt along the neck of the cathode ray tube.

Centering Adjustment Screws. The centering adjustment screws (3, figure 4–17) adjust the perpendicular position of the focus magnet with respect to the axis of the cathode ray tube, causing the electron beam to strike the indicator screen at the desired spot.

Scale Light Control Knob. The scale light control knob (4, figure 4–17) controls the edge lighting of the reticle, illuminating the azimuth marks.

Indicator Screen. The indicator screen (5, figure 4–17) displays the presentation of the video target signals for visual inspection.

Marker Brilliance Control Knob. The marker brilliance control knob (6, figure 4–17) controls the brilliance of the range marker pulses.

Power Sources

The interrogator receives power from the 28-volt dc system and the 115-volt ac system (essential bus) through circuit breakers on the radio junction box circuit breaker panel (2, figure 1–37).

Normal Operation Of The Interrogator

The operational procedures for the interrogator are:

a. Turn on:

(1) Supply 115-volt ac power from the essential bus.

(2) Position spinner switch on synchronizer to ON.

CAUTION

The spinner will not rotate until power switch on control panel is turned ON. Turning spinner on before power switch is on eliminates the possibility of "Beaming" RF energy and prevents damage to the interrogator.

(3) Position power switch on control panel to ON. After a 1- to 2-minute warmup period, the azimuth-range indicator screen should present range markers and a sweep line.

(4) Adjust marker brilliance control knob on azimuth-range indicator for desired range marker brilliance.

(5) Adjust scale light control knob on azimuth-range indicator to desired setting.

(6) Adjust focus control knob and centering adjustment screws on azimuth-range indicator if required.

(7) Place transmitter switch on control panel to LOCK ON position.

(8) Place mode control switch on control panel to MODE 3 position.

(9) Place range-markers control knob on control panel to 10 miles.

(10) Rotate receiver gain control knob from the CCW position slowly clockwise. Two concentric circles should appear on the azimuth-range indicator screen (inner circle broad, outer circle thin). Presence of the outer circle indicates that the transmitter is operating.

Note

The indications stated in step (10) are visible on MODE 3 because of the time delay built into that circuit.

(11) Place range-markers control knob on control panel to 100D and check calibration; then set knob to desired range.

Note

Energize the delay calibration switch on the synchronizer to check calibration on 100D setting. All range markers should disappear from the indicator screen except the first range marker from the center of the screen. This marker should also not change position. If more than one range marker appears, the set is improperly calibrated but usable. Care should be exercised in giving range information. For proper operation, center of screen (when range-marker control knob is in 100D position) should be 80 NMI.

(12) When transmitting airplanes are within range, the mode switches may be checked for all positions as follows:

(a) MODE 1. Airplanes squawking MODE 1 (operating APX-6 with selector switch in NORMAL ON position) will be painted. Airplanes squawking EMERGENCY will also be painted using SIF or operating as MARK X equipment.

(b) MODE 2. Airplanes squawking MODE 2 or EMERGENCY will be painted operating as MARK X equipment. Only MODE 2 will be painted when airplanes are operating using SIF (KY-95/APX-25 or KY-95A/APX-25).

(c) MODE 3. Airplanes squawking MODE 3 or EMERGENCY will be painted when that interrogated airplane is operating MARK X equipment. In SIF using KY-95A/APX-25, emergency squawks will also be painted on MODE 3; however, using KY-95/APX-25 equipment, emergency squawks will not be painted on MODE 3.

Note

Airplanes using APX-6 transponder equipment will be interrogated on MODE 1 by APX-29A interrogator when their selector switch is on NORMAL, regardless of the position of their mode 2 or mode 3 toggle switches.

b. Turn off:

(1) Position mode control switch to MODE 1.

(2) Position receiver gain control knob to full CCW.

(3) Position transmitter switch to OUT.

(4) Position power switch to OFF.

Troubleshooting Of The Interrogator

Troubleshooting of the interrogator may be accomplished as follows:

TROUBLE	PROBABLE CAUSE	REMEDY
Sweep on indicator rotating but no apparent reception or transmission	Loose cable or defective fuse	Check connections and cables for security; replace defective fuses on receiver-transmitter unit with spares.
Improper number of range markers and selected scale (10, 25, 50, or 100 mile)	Variable resistor has changed value	Adjust appropriate mileage adjustment screw on synchronizer.
Center of scope not set at 80 miles, or operator doubts it is set properly	Variable resistor has changed value	Check set with target located between 80 and 100 miles out. If an error exists, adjust delay adjustment screw on synchronizer.
Presentation on azimuth-range indicator too faint	CTR BIAS too low	Adjust brilliance control screw on azimuth-range indicator.

Note

Adjustment of variable resistors which control range markers of the APX-29A affect only the physical length of the sweep. Except for the troubleshooting above and circuit breaker checks, no airborne maintenance will be attempted. Explain malfunctions clearly in Form 781, Part II.

LIAISON RADIO (AN/ARC-65 or AN/ARC-65A)

The liaison radio operates over a range of frequencies from 2 to 24 megacycles giving a total of 44,000 usable frequencies. The control panel for the liaison radio (figure 4–20) is on the control stand. The set permits long-range, two-way voice communication from air-to-air or from air-to-ground. The radio is turned on and off by a control switch on the liaison radio control panel. On 17260 ▶ 3177, 20 channels may be preset on the control panel and individually selected with the channel selector switch. On 3178 ▶, channel selection is accomplished by setting the frequency selection knobs to the desired frequency setting and pushing the push-to-tune button. Numerous frequency selections can be accomplished using this control panel. A time delay of up to 15 seconds is incorporated in the set to delay operation while the set is tuning after a channel change. Therefore, the crewmember operating the set should not expect immediate communication after changing channels. The receiver immediately tunes to the selected channel; however, initial tuning of the transmitter is delayed until a mike switch is used. In addition to voice communications, the liaison radio has facilities for communication by continuous wave (CW) telegraphy. The set also has provisions for operating a teletypewriter, although this equipment is not provided. The radio is connected to the interphone; therefore, to transmit and receive on the liaison radio the interphone selector switch and mixer switch must be placed in the appropriate LIA position. Control power is 28-volt dc and operating power is 115-volt ac with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37).

The AN/ARC-65 or AN/ARC-65A liaison radio has the additional capability of single sideband (SSB) transmission and reception.

WARNING

Ground operation of the liaison radio is prohibited unless the airplane is at least 200 feet from the following:

(1) Unloaded weapons or warheads.

(2) Loaded weapons in an airplane with the bomb bay doors open.

(3) GAM-77 missiles with warhead compartment doors open, or thruster and squib access door open.

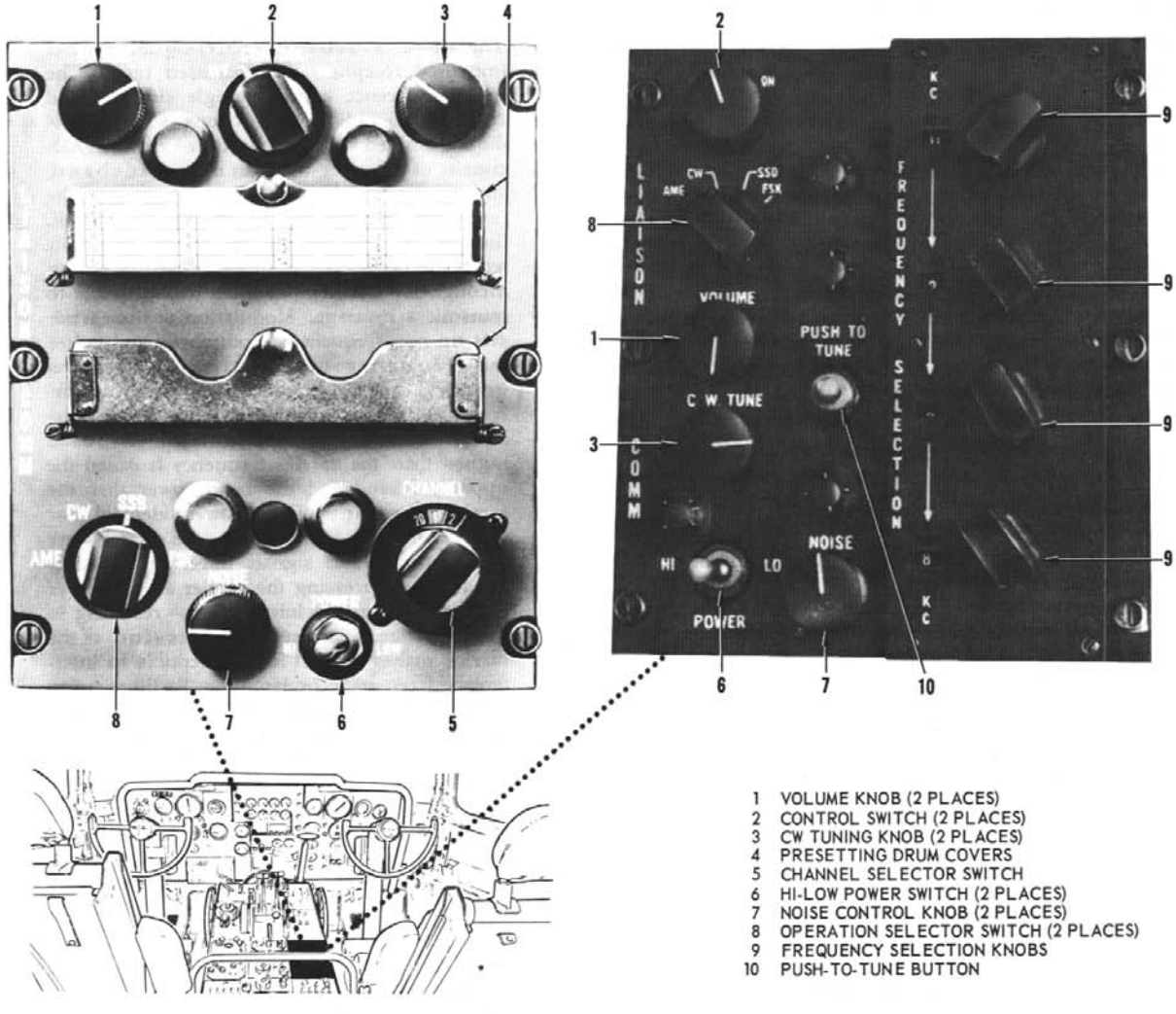
Note

The single sideband (SSB) capability gives improved reception and increased range. The major difference between single sideband and conventional radio transmissions is the form of the transmitted wave. Conventional radio signals consist of a carrier wave, an upper sideband, and a lower sideband. A carrier wave is the unmodulated output of the transmitter. In itself, the carrier conveys no information. It is only when the carrier is modulated (varied by speech through the microphone) that it is possible to transmit a message. Modulation of the carrier sets up new frequencies both above and below the frequency of the carrier. The new frequencies, called side frequencies, make up narrow bands known as sidebands. These sidebands carry all the information. The band higher than the carrier frequency is called the upper sideband and the band lower than the carrier frequency is the lower sideband. For single sideband transmission, the carrier wave is suppressed and signals travel on one sideband. By suppressing the carrier all the power is used to transmit information – resulting in greater range. Likewise, suppression of the carrier makes the set less susceptible to interference from static or jamming. Facilities using amplitude modulated (AM) radios cannot receive single sideband transmissions satisfactorily and single sideband reception of AM broadcasts has distorted pitch. To maintain compatibility with existing facilities, there is a separate unit in the receiver for AM reception and a carrier wave may be transmitted with the upper sideband to transmit "equivalent AM" (AME).

Liaison Radio Controls

Control Switch (Liaison Radio). A two-position ON–OFF rotary control switch (2, figure 4–20) on the liaison radio control panel is used to turn the equipment on and off. The control switch is also a protective device that returns the switch to OFF when there are faults in the equipment.

Volume Knob. A volume knob (1, figure 4–20) on the liaison radio control panel provides a means for adjusting the volume from the liaison radio to the interphone system during voice operation and signal sensitivity during CW operation.



1 VOLUME KNOB (2 PLACES)
2 CONTROL SWITCH (2 PLACES)
3 CW TUNING KNOB (2 PLACES)
4 PRESETTING DRUM COVERS
5 CHANNEL SELECTOR SWITCH
6 HI-LOW POWER SWITCH (2 PLACES)
7 NOISE CONTROL KNOB (2 PLACES)
8 OPERATION SELECTOR SWITCH (2 PLACES)
9 FREQUENCY SELECTION KNOBS
10 PUSH-TO-TUNE BUTTON

LIAISON RADIO CONTROLS

Figure 4–20

Channel Selector Switch. A channel selector switch (5, figure 4–20) on the liaison radio control panel has channel positions numbered from 1 to 20, providing selection of any of the preset frequencies.

Frequency Selection Knobs. On 3178▶, four frequency selection knobs (9, figure 4–20) are provided for selection of any combination of frequencies.

Push-To-Tune Button. On 3178▶, a push-to-tune button (10, figure 4–20) is provided to tune to the frequency selected by the frequency selection knobs.

HI–LOW Power Switch. A two-Position, HI–LOW power switch (6, figure 4–20) is on the liaison radio control panel. The switch provides a means of selecting the power output in a 10 to 1 proportion. The HI position is normally used when maximum range transmissions are desired. The LOW position is used when shorter range transmissions are desired.

Noise Control Knob. A noise control knob (7, figure 4–20) is on the liaison radio control panel. The knob allows adjustment of the background noise level of the receiver during voice operation. The knob should be adjusted for best reception of voice signals.

Presetting Drums. Two presetting drums in the liaison radio control panel provide means for manually presetting the frequency of each channel as selected by the channel selector switch. Each drum is protected by hinged presetting drum covers (4, figure 4–20). A special tool for the presetting operation is stowed inside the top drum

cover. A card mounted on the face of the top drum cover is used to record frequency values of each channel as the presetting operation is accomplished.

CW Tuning Knob. A CW tuning knob (3, figure 4–20) on the liaison radio control panel is used to adjust the CW beat frequency when receiving CW signals.

Operation Selector Switch (Liaison Radio). A rotary-type operation selector switch (8, figure 4–20) on the liaison radio control panel is used to select the type of liaison radio operation desired. The switch has AME–CW–SSB–FSK positions for use in a single sideband operation. CW provides CW operation with 7-kilocycle band width for general operation. FSK position is provided for teletypewriter operation, although this equipment is not provided. With the switch on SSB, the set transmits and receives single sideband-type radio waves. Placing the switch on AME (equivalent AM) permits communication with standard AM radios.

Normal Operation Of The Liaison Radio

Frequency Presetting. On 3178▶, frequency presetting is not required. When a frequency is desired, set the frequency selection knobs to the desired frequency and push the push-to-tune button. On 17260▶3177, frequencies can be preset on the control panel (with the equipment turned off). Normally, all presetting operations will be performed before flight; however, if presetting during flight is necessary, the operation can be accomplished as follows:

a. Loosen two screws holding drum covers in position and open covers.

b. Remove presetting tool from clip inside top drum cover.

c. Place channel selector switch so that the number of the channel to be preset appears on the left side of the frequency drum. Disregard the channel number that appears in the selector window.

d. Using the presetting tool, move the four buttons, one at a time, to a position under the respective numbers. This is done by sliding the socket end of the tool over the buttons and moving them along the drum to coincide with the desired numbers.

e. Move the top drum left button to coincide with the figure representing thousands of kilocycles.

f. Move the top drum right button to coincide with the figure representing hundreds of kilocycles.

g. Move the bottom drum left button to coincide with the figure representing tens of kilocycles.

h. Move the bottom drum right button to coincide with the figure representing units and halves of kilocycles.

i. Record the frequency (just set) adjacent to the applicable channel number on the card mounted on the top drum cover.

j. Turn the channel selector switch to the next channel number to be preset and repeat Steps d through i. Preset remaining channels in the same manner.

k. Close drum covers and tighten holding screws.

Note

If the drum cover doors on the control panel are not securely closed, a door interlock switch will remain open and prevent operation of the liaison radio.

Voice Communication. The liaison radio control panel has controls necessary for all types of liaison radio operation. Liaison radio voice communication can be accomplished by the following procedure:

a. Place interphone selector switch in LIA to receive and transmit liaison radio signals.

b. Place liaison radio control switch to ON.

Note

- A 40-second period is required after turning on equipment before the radio is ready for operation. The first 30 seconds allows for tube warm-up and the remaining 10 seconds allows for automatic tuning.
- If automatic tuning is not accomplished in the normal 40-second period, the control switch will go to OFF and must be returned to ON position.
- At extremely low operating temperatures (approximately −55°C) the liaison radio control switch may return to OFF in 40 seconds. If this happens, select another channel and return control switch to ON. Repeat this procedure until the control switch stays on, then allow the equipment to warm up for 15 minutes. During the warmup period, do not change channel or transmit. After the warmup period, proceed with normal operation.
- The AN/ARC-65 or AN/ARC-65A liaison radio requires a warmup time of approximately 10 to 15 minutes to give optimum performance.

c. On 3178▶, set frequency selection knobs to the desired frequency and push the push-to-tune button. On 17260▶3177, turn the channel selector switch to the channel of the desired frequency and rock the knob slightly to feel the switch click into its seat. The channel in use will be shown by the middle figure in the selector window.

d. Rotate the operation selector switch to AME, CW, or SSB, or FSK (as applicable).

e. Place power switch in HI or LOW depending on desired range of transmissions.

Note

Should the air pressure within the equipment be reduced by leakage or other means, an aneroid switch will automatically shift the equipment to low power to reduce the possibility of electrical arcing within the equipment. There is no indication when this occurs.

f. Depress the microphone switch until the sidetone signal is heard in the headphones, then release the microphone switch. The presence of the sidetone signals, while talking, will indicate the transmitter tune-up is completed and signals are being transmitted. This step will not have to be repeated unless the operating channel is changed. Adjust the volume for proper audio level and the noise control for a slight background noise in absence of signals. A sidetone will be heard in the headset when talking if the transmitter is on the air.

g. Turn the equipment off by rotating the liaison radio control switch on the panel to OFF.

Emergency Operation Of The Liaison Radio

When a frequency selection cycle is not completed in the normal time interval, causing the liaison radio control switch to return to OFF position, a second try, preferably on another channel, is recommended. If tuning is normal, return to the initially selected channel. Malfunction within the equipment is indicated by the liaison radio control switch moving to OFF position. If damage to the equipment is less important than getting the message through, transmission or reception can be resumed by holding the knob in ON position. If no sidetone is heard when attempting to transmit, the transmitter is not operating.

RADIO COMPASS (AN/ARN-6)

The low-frequency radio compass is a navigational aid for the pilot and navigator. The radio compass may be used for automatic direction finding or as a homing device on any signal transmitted at a frequency from 100 to 1750 kilocycles. This set is also used as a receiver for low-frequency range reception. Indicators for the set are on the pilots' instrument panel and the navigator's instrument panel. Control panels for the set are on the control stand for the pilot, and on the radio and radar control panels at the navigator's station, for use by the navigator. Operating power is 28-volt dc with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37).

Note

The radio compass should not be used as a navigational aid until the loop has been compensated.

Radio Compass Controls

Function Switch. A function switch (1, figure 4–21), on the radio compass control panel, is used to turn the radio compass equipment on and off, select the mode of operation, and transfer control of the radio compass to the pilots' or navigator's panel as desired. The switch positions are labelled OFF–COMP–ANT.–LOOP–CONT. and function as follows (the first four effective only from the radio compass panel having control): OFF turns off the radio compass equipment. COMP provides homing and automatic direction finding (ADF) operation. ANT. connects the sense antenna to provide for receiver operation only. LOOP is used for aural-null direction finding and receiver operation. CONT. is spring-loaded for momentary operation to transfer control from one radio compass control panel to the other each time either switch is actuated.

Note

Control is indicated to be at the pilots' radio compass control panel when one of the three operation positions of the pilots' function switch is in use, and his frequency dial and tuning meter are illuminated when the indicator light switch is on HI or LO. Another indication of control will be a deflection of the tuning meter pointer away from its clockwise stop when the equipment has warmed up approximately 15 seconds. The indication of control at the navigator's panel is the same as the pilots'.

Loop Switch. A rotary loop switch (3, figure 4–21) on the radio compass control panel provides manual control of rotation of the radio compass loop antenna. Turning the switch toward L or R rotates the loop counterclockwise or clockwise, respectively, provided the radio compass function switch is in LOOP position. The radio compass loop switch is spring-loaded to the center (off) position. The rate of loop rotation is proportional to the knob displacement from the center position and varies from approximately 5 degrees per second minimum to approximately 40 degrees per second maximum.

Tuning Crank. A tuning crank (7, figure 4–21) on the radio compass control panel selects the desired station, the frequency of which is indicated on the calibrated frequency dial.

Light Switch. An indicator light switch (4, figure 4–21) on the radio compass control panel has HI–OFF–LO positions. HI and LO positions vary the indicator light intensity. OFF position turns off the light.

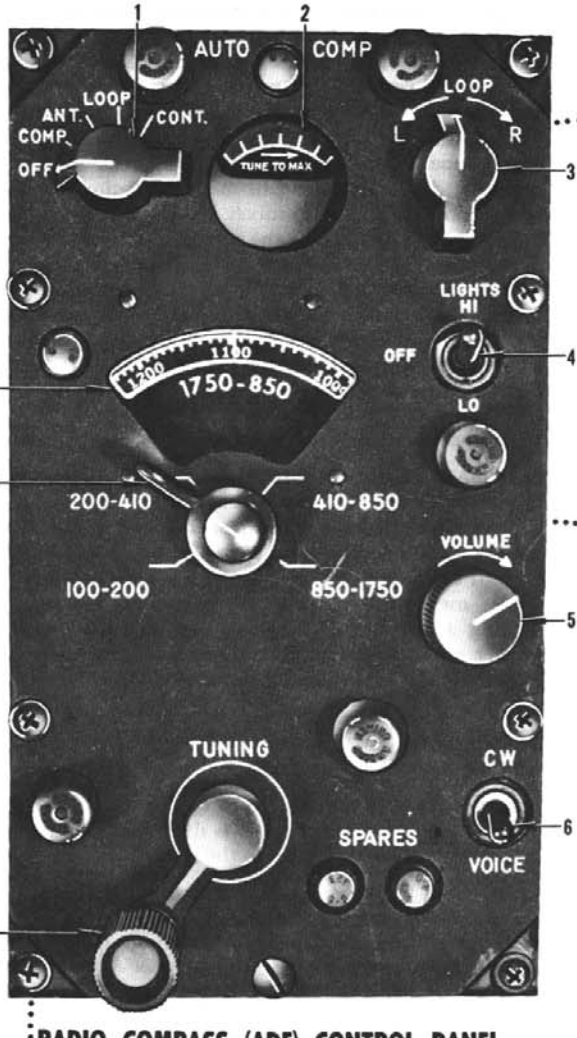
Band Switch. A band switch (8, figure 4–21) on the radio compass control panel selects any one of four receiver operating bands of frequencies. The switch positions are 100 – 200, 200 – 410, 410 – 850, and 850 – 1750 kilocycles. When a band is selected, the dial calibration is selected accordingly.

Volume Knob. A volume knob (5, figure 4–21) on the radio compass control panel is provided as a means for adjustment of the audio level to the interphone.

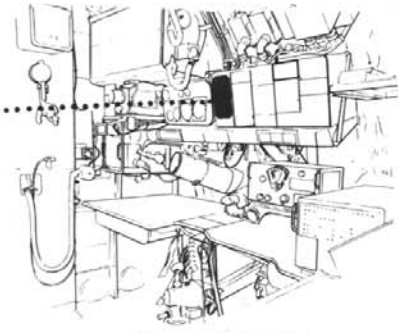
Modulation Switch. A modulation switch (6, figure 4–21), with CW–VOICE positions, on the radio compass control panel is used for selection of either code or voice reception.

Radio Compass Indicators

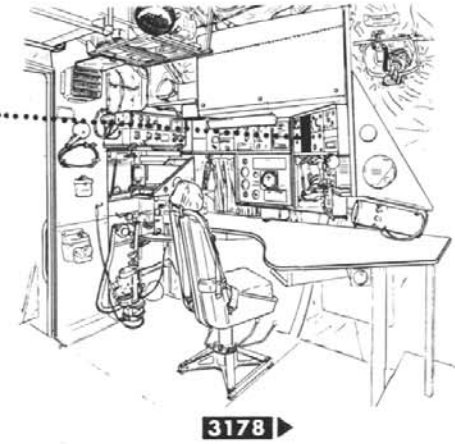
Tuning Meter. A tuning meter (2, figure 4–21) is provided on the radio compass control panel to indicate maximum signal strength during the process of tuning in a station.



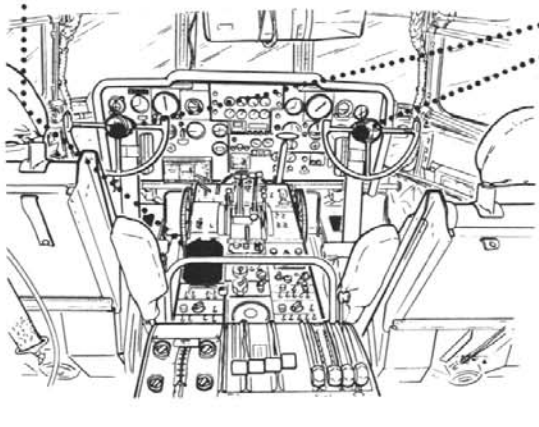
RADIO COMPASS (ADF) CONTROL PANEL



17260 ▶ 3177



3178 ▶



RADIO MAGNETIC INDICATOR (RMI) (TYPICAL)

1 FUNCTION SWITCH
2 TUNING METER
3 LOOP SWITCH
4 LIGHT SWITCH
5 VOLUME KNOB
6 MODULATION SWITCH
7 TUNING CRANK
8 BAND SWITCH
9 FREQUENCY DIAL

RADIO COMPASS (ADF) CONTROLS AND INDICATORS (TYPICAL)

Figure 4–21

Frequency Dial. A frequency dial (9, figure 4–21) on the radio compass control panel shows the frequency to which the radio compass is tuned.

Radio Magnetic Indicator (RMI). The ADF bearing pointer on the pilots' and navigator's RMI's indicates the direction of a tuned station relative to the airplane's heading. Refer to RADIO MAGNETIC INDICATOR (RMI) under VHF NAVIGATION RADIO (VOR) INDICATORS, this section.

Normal Operation Of The Radio Compass

Note

Operation on the COMP function of the radio compass while the airplane ground wire is connected may result in erroneous bearing indications.

The radio compass is made operative by the following procedure:

a. Place the function switch to ANT.

Note

If ANT. position of the function switch does not turn on the radio compass equipment, move function switch momentarily to CONT. and return to ANT.

b. Place appropriate interphone controls to the desired positions for reception of the radio compass receiver. Refer to INTERPHONE (AN/AIC-10), this section.

c. Select desired frequency band and use tuning crank to tune station and obtain maximum swing of tuning meter.

d. Place function switch in desired (type of operation) position.

e. Turn off equipment by placing function switch to OFF.

MARKER BEACON (AN/ARN-12)

A marker beacon receiver is used as a navigational and landing aid. When flying over a beacon, an identifying signal may be heard through the interphone system and is shown visually by an amber marker beacon light (7, figure 4–22). The beacon light is on the pilot's course indicator on the pilots' instrument panel. Control power is 28-volt dc with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37).

Marker Beacon Controls And Operation

No controls are available for the marker beacon receiver. The receiver is automatically operated by dc power and will operate continuously as long as power is available from the dc power distribution system.

VHF NAVIGATION RADIO (VOR) (AN/ARN-14)

The VHF navigation radio (VOR) equipment provides navigation information and comprises a portion of the instrument landing system (ILS). A course indicator on the pilots' instrument panel provides visual course and heading indication with respect to the localizer beam or a selected VOR radial. If a localizer or VOR-range signal is being received, a small warning flag in the bottom of the indicator will disappear from view to provide positive indication of station reception. Two radio magnetic indicators, one for the pilot and copilot, and one for the navigator, indicate bearing to the VOR station. The VHF navigation radio (VOR) mixer switch (12, figure 4–8) must be ON (up) to hear the station identity code on the interphone. The instrument select switch (18, figure 4–22) must be positioned to VOR-ILS to provide signals to the pilot's course indicator, the radio magnetic indicators, and the interphone. Control power is 28-volt dc with circuit protection on the aft radio rack junction box (11, figure 1–37).

VOR And Localizer Controls

Frequency Selector Knobs. Two rotary frequency selector knobs (1 and 2, figure 4–22) on the VHF navigation control panel provide control of localizer and VOR frequency selection. The knobs may be turned either clockwise or counterclockwise. Frequencies between 108.0 and 135.9 megacycles provide 280 channels for selection. Tuning a localizer frequency automatically causes the proper glide slope channel to be selected simultaneously to provide ILS glide slope information.

Power Switch. The VOR receiver is turned on and off by a two-position power switch (3, figure 4–22) on the VHF navigation control panel.

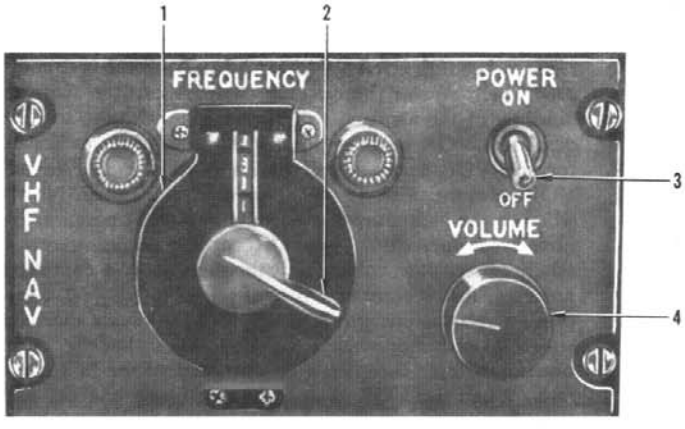
Volume Knob. A volume knob (4, figure 4–22) on the VHF navigation control panel is used to adjust the audio level from the omni receiver to the interphone.

Course Set Knob. A course set knob (12, figure 4–22) on the pilot's course indicator is used to set the magnetic bearing of a desired course in the three upper tab windows (course selector window).

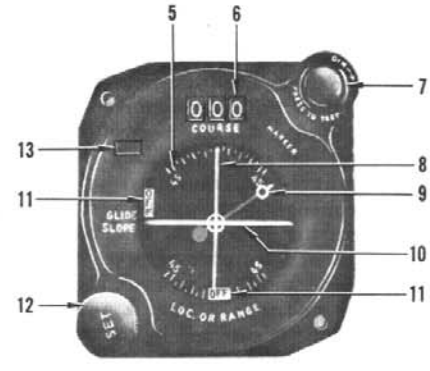
Instrument Select Switch. Input signals to the pilot's course indicator are selected by the instrument select switch (18, figure 4–22). When the switch is in the VOR-ILS position, signals from the VHF navigation radio are applied to the pilot's course indicator and the radio magnetic indicators. In the TACAN position, the pilot's course indicator input is from the UHF navigation radio. The indicator light is illuminated to show which system is operating the course indicator. The other switch position marking is left dark to aid in determining which radio system is operating the instrument.

VHF Navigation Radio (VOR) Indicators

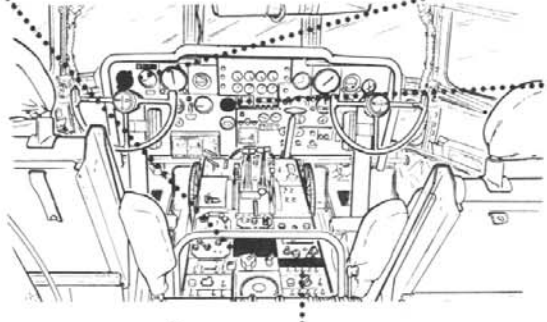
Pilot's Course Indicator. The course indicator displays either VHF (VOR or ILS) or UHF (TACAN) navigation information dependent upon the position of the instrument select switch. The pilot's course indicator (figure 4–22) is on the pilots' instrument panel. The course set knob (12, figure 4–22), marked SET, permits the pilot to set a magnetic course to reach a VOR or TACAN station. In addition, radials from stations to the right or left of course can be selected for navigational references.

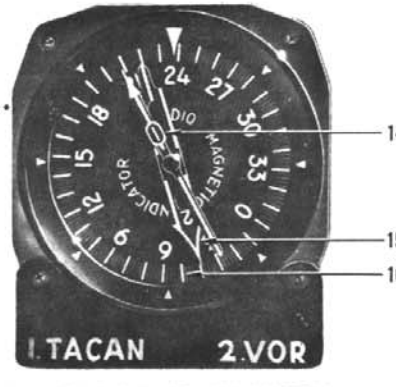


VHF NAVIGATION CONTROL PANEL



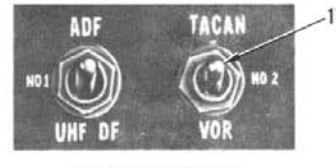
PILOT'S COURSE INDICATOR





PILOT'S RADIO MAGNETIC INDICATOR (RMI) (TYPICAL)

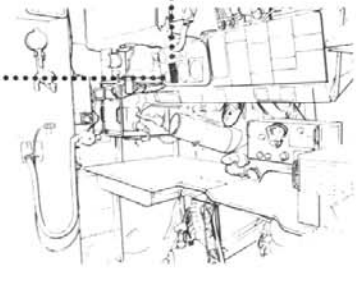
INSTRUMENT SELECT CONTROL PANEL



RMI SELECTOR SWITCHES PANEL

1 FREQUENCY SELECTOR KNOB (WHOLE MEGACYCLE)
2 FREQUENCY SELECTOR KNOB (TENTH MEGACYCLE)
3 POWER SWITCH
4 VOLUME KNOB
5 HEADING POINTER SCALE
6 COURSE SELECTOR WINDOW
7 MARKER BEACON LIGHT
8 COURSE DEVIATION INDICATOR
9 HEADING POINTER
10 GLIDE SLOPE INDICATOR
11 FLAG ALARM (2 PLACES)
12 COURSE SET KNOB
13 TO/FROM INDICATOR
14 TACAN BEARING POINTER
15 VOR BEARING POINTER
16 ROTATING COMPASS CARD
17 RMI SELECTOR SWITCHES
18 INSTRUMENT SELECT SWITCH

NAVIGATOR'S RADIO MAGNETIC INDICATOR (RMI)



VHF NAVIGATION RADIO (OMNI) CONTROLS AND INDICATORS

Figure 4–22

The selected course appears in the course selector window (6, figure 4–22). The course deviation indicator (8, figure 4–22) indicates the lateral position of the airplane relative to the selected station radial or ILS localizer beam. The displacement of the course deviation indicator from center indicates the direction of turn to position the airplane on the selected course. The glide slope indicator (10, figure 4–22) is operative only when the set is on an ILS frequency; it shows the vertical position of the airplane on the glide path. Both indicators operate in the same manner, maintaining a center position when on course and deviating from center when off course. The heading pointer (9, figure 4–22) is an N-1 compass repeater that is oriented by the course set knob to show the heading of the airplane relative to the selected radial. When the heading pointer is centered, the heading of the airplane is the same as the course shown in the course selector window. If the pointer is deflected to the left or right, the airplane heading is to the left or right number of degrees indicated on the pointer scale. Deviation of the heading pointer from the vertical index indicates the crab angle of the airplane when the course deviation indicator is centered. The TO/FROM indicator (13, figure 4–22) shows whether the course selected, if intercepted and flown, will take the airplane to or from the station. The TO/FROM indicator is blank during ILS operation or upon loss of signal. There are flag alarms (11, figure 4–22) for the course deviation indicator and glide slope indicator. The OFF flag is visible when the respective indicator is unreliable because of a weak signal or the equipment is deenergized. The flag moves out of sight when the indicator is reliable. Each course indicator has a marker beacon light (7, figure 4–22). The light is operated by the marker beacon receiver. During ILS operation, the course deviation indicator operates independently of the heading set in the course selector window.

Note

The heading pointer of the course indicator receives heading reference information from the N-1 compass system and will perform only the above functions when the N-1 compass system is operating in slaved operation. When the N-1 system is in nonslaved operation, the heading pointer will give only heading referenced to a preselected gyro datum and will be of no use for localizer and VOR operations unless synchronized with magnetic compass data.

COPILOT'S REPEATER INDICATOR (ID-525)

A repeater indicator (ID-525) is installed on the copilot's instrument panel (figure 4-22) in parallel with the pilot's course indicator (8, figure 4-22), glide slope indicator (10, figure 4-22), and marker beacon light (7, figure 4-22). Either VHF approach information (VOR or ILS) or UHF (TACAN) navigation information, dependent upon the selected position of the instrument select switch (18, figure 4-22), is thereby afforded the copilot as well as the pilot.

Radio Magnetic Indicator (RMI). The radio magnetic indicators give a composite display of airplane heading, radio compass or direction finder (ADF) station bearing, VOR station bearing, TACAN station bearing, and bearing to UHF radio stations (UHF/DF). The indicator receives heading reference information from the N-1 compass which rotates the circular compass card so that the heading of the airplane will always be under the top index. The VOR bearing pointer is the azimuth indicator for the VOR receiver and indicates the bearing to the VOR from the airplane as measured from magnetic North whether the N-1 compass system is in slaved operation or nonslaved operation. The VOR bearing pointer receives synchro excitation voltage only through the N-1 compass; however, in the event of failure of power to the N-1 compass, a relay is energized which provides an alternate source of excitation voltage. In effect, this makes the VOR bearing pointer completely independent of the N-1 compass. When the VOR is operating properly and the C-1 amplifier is receiving power, the VOR bearing pointer always indicates magnetic bearing to the station, regardless of the mode of operation of the N-1 compass or if the N-1 compass is inoperative. The directional information to the VOR is obtained from a phase difference between two rotating antennas in the ground installation. It is oriented to magnetic North for convenience only. The only function of the N-1 compass, as it affects the VOR bearing pointer, is to keep the airplane heading at the top of the rotating compass card; that is, the bearing pointer points physically in the direction of the station as well as to the number on the card which is the magnetic bearing to the station.

Normal Operation Of The VHF Navigation Radio (VOR)

The VHF navigation radio (VOR) is made operative by placing the power switch in the ON position and inoperative by placing the power switch in the OFF position.

Emergency Operation Of The VHF Navigation Radio (VOR)

In event of failure of the C-1 signal power amplifier, the pilots' and navigator's radio magnetic indicators will become inoperative. When such a failure occurs, heading indication from the rotating compass card and the TACAN and VOR bearing pointers for the radio magnetic indicator will not be available. Under these conditions, bearing information from the VOR receiver may be obtained from the pilot's course indicator by rotating the course set knob until the course deviation indicator is centered. Magnetic bearing to or from the VOR station can then be determined by observing the TO/FROM indicator and the counter reading.

GLIDE PATH RECEIVER (AN/ARN-18)

The glide path receiver is a portion of the instrument landing system (ILS). The pilot's course indicator on the pilots' instrument panel provides visual glide slope indication along with the localizer indication. Control of glide path equipment is automatic through normal operation of VHF navigation radio (VOR) equipment. See figure 4–34 for antenna location. Control power is 28-volt dc; operating power is 115-volt ac with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37).

Glide Path Receiver Indicator

A glide slope indicator (10, figure 4–22) in the pilot's course indicator provides indication of airplane position relative to the glide slope beam. The glide slope indicator will be centered if the airplane is flying on the beam during an approach. A warning flag on the left side of the indicator moves out of sight when a glide slope signal is being received.

Normal Operation Of The Glide Path Receiver

The glide path receiver is turned on and off and tuned remotely through normal use of the VHF navigation radio (VOR) equipment. The power switch (3, figure 4–22) for the VHF navigation radio starts and stops operation of the glide path equipment. When the VOR and localizer frequency selector knobs (1 and 2, figure 4–22) are set to a designated ILS localizer frequency, the glide path equipment is automatically tuned to the proper channel. Glide path equipment is in a standby condition when VOR frequencies are used.

Note

Power to the glide path receiver is turned off when the radar beacon power selector switch (8, figure 4–32) is on EMERG.

Emergency Operation of The Glide Path Receiver

Emergency operation does not differ from normal operating procedure.

UHF NAVIGATION RADIO (TACAN) (AN/ARN-21)

The airplanes have a UHF navigation radio that operates in conjunction with surface navigation beacons. The radio and a surface beacon together comprise a radio navigation system, called TACAN, that enables the airplane to obtain continuous indications of distance and bearing to a selected station. The radio has five components: receiver-transmitter, antenna, control panel, range indicator, and azimuth indicators (pilot's course indicator and radio magnetic indicators) (figure 4–23). Operating controls for the radio are on the control panel on the control stand. The panel has two channel selector knobs, a tone level control for the station identity code (marked VOL), and the OFF–REC–T/R switch for energizing the equipment. There are 126 channels available. The ground stations continuously transmit radio pulses. These pulses are detected by the receiver and translated into bearing information. TACAN supplies bearing data to the pilot's course indicator and radio magnetic indicators. For distance information, the TACAN transmitter radiates pulses known as distance interrogation pulses. These signals are detected by the ground station and cause the ground station transmitter to respond with distance reply pulses. The receiver detects the distance reply pulses, measures the time difference between the interrogation pulse and the reception of the reply pulse, and converts this time difference into a nautical miles meter reading. Distance information is shown on the range indicator (figure 4–23). TACAN information is connected to the pilot's course indicator when the instrument select switch (16, figure 4–23) is in TACAN position. The UHF navigation radio (TACAN) mixer switch (11, figure 4–8) on the interphone mixer switch panel must be ON (up) to hear the station identity code on the interphone. This navigation system requires heading data from the N-1 compass. Both 28-volt dc and 115-volt ac power are used in the operation and control of the set with circuit protection through circuit breakers on the radio junction box circuit breaker panel (3, figure 1–37).

UHF Navigation Radio (TACAN) Controls

OFF–REC–T/R Switch. Placing the OFF–REC–T/R switch (2, figure 4–23) in the OFF position, turns off all power to the set. When the switch is in REC (receive) position, the set supplies only bearing information. Bearings are displayed on the pilot's radio magnetic indicator and on some airplanes on the navigator's RMI. Bearing data is also supplied to the pilot's course indicator to give position indications with respect to the selected radial. When the switch is placed in the T/R (transmit-receive) position, the equipment is in full operation with both bearing and distance information displayed. The distance to the station is displayed by the range indicator on the pilot's instrument panel.

Channel Selector Knobs. The two channel selector knobs (1, figure 4–23) select one of 126 operating channels. The small knob determines the unit digit of the channel number and the large knob determines the tens and/or hundreds digit. The selected channel number is displayed in the window above the small knob.

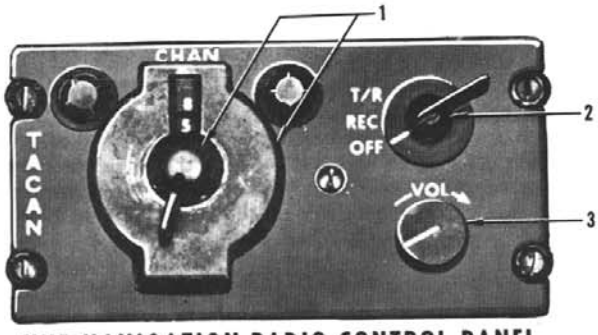
Volume Knob. The volume knob (3, figure 4–23) controls the volume of the three-letter Morse code beacon identification signal.

Instrument Select Switch. Input signals to the radio magnetic indicators and pilot's course indicator are selected by the instrument select switch (16, figure 4–23). When the switch is in the VOR–ILS position, signals from the VHF navigation radio are applied to the indicators. In the TACAN position, the indicator input is from the UHF navigation radio. The indicator light is illuminated to show which system is operating the course indicator. The other switch position marking is left dark to aid in determining which radio system is operating the instruments.

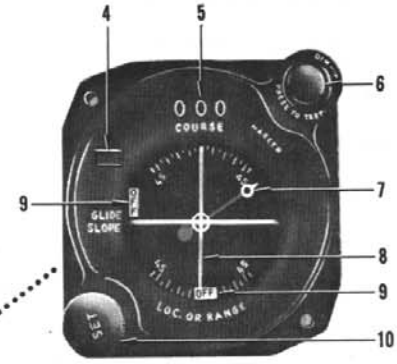
Course Set Knob. A course set knob (10, figure 4–23) on the pilot's course indicator is used to set the magnetic bearing of a desired course in the three-digit course selector window.

UHF Navigation Radio (TACAN) Indicators

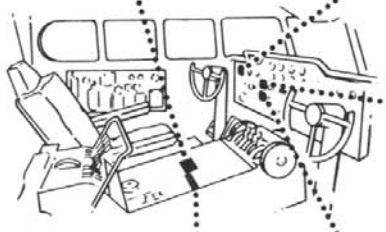
Range Indicator. The range indicator (figure 4–23) on the pilots' instrument panel displays the slant range in nautical air miles to the selected ground beacon station. When the equipment is searching for a satisfactory range signal, the indicator drum counters in the range indicator window (14, figure 4–23) are partially covered by a range warning flag and the counters move too rapidly for



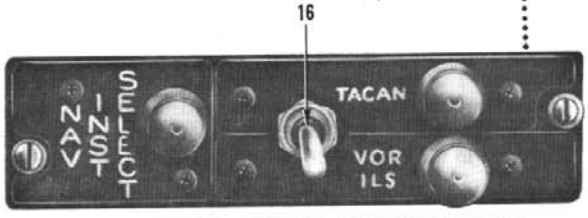
UHF NAVIGATION RADIO CONTROL PANEL



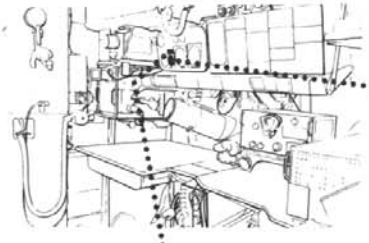
PILOT'S COURSE INDICATOR



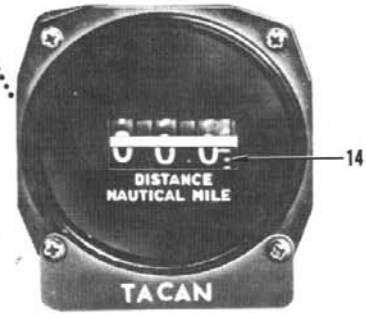
PILOT'S RADIO MAGNETIC INDICATOR (RMI) (TYPICAL)



INSTRUMENT SELECT CONTROL PANEL



NAVIGATOR'S RADIO MAGNETIC INDICATOR (RMI)



RANGE INDICATOR

RMI SELECTOR SWITCHES PANEL

1 CHANNEL SELECTOR KNOBS
2 OFF – REC – T/R SWITCH
3 VOLUME KNOB
4 TO/FROM INDICATOR WINDOW
5 COURSE SELECTOR WINDOW
6 MARKER BEACON LIGHT
7 HEADING POINTER
8 COURSE DEVIATION INDICATOR
9 FLAG ALARM (2 PLACES)
10 COURSE SET KNOB
11 TACAN BEARING POINTER
12 VOR BEARING POINTER
13 ROTATING COMPASS CARD
14 RANGE INDICATOR WINDOW
15 RMI SELECTOR SWITCHES
16 INSTRUMENT SELECT SWITCH

UHF NAVIGATION RADIO (TACAN) CONTROLS AND INDICATORS

Figure 4–23

a reading to be obtained. When the equipment has locked on to a reliable range signal, the range warning flag disappears and the counters move slowly as determined by airplane flight. Maximum reading of the range indicator is 195 nautical air miles.

Pilot's and Copilot's Course Indicator. The pilot's course indicator (figure 4-23) provides a composite display of the UHF navigation radio bearing information when the instrument select switch is in TACAN position. Deviation from the selected course to the ground station is shown by the course deviation indicator. The selected course to the station is shown in the three-digit course selector window. The course is selected by turning the SET knob. When the course deviation indicator signals are not reliable, a course deviation indicator flag alarm labelled OFF appears. A heading pointer shows relationship of the airplane heading to the selected bearing. With the course deviation indicator centered, the heading pointer indication is the crab angle of the airplane. An amber indicator light illuminates when the marker beacon receiver operates. The to/from indicator shows whether the course selected, if interceped and flown, will take the airplane to or from the TACAN station.

Note

The pilot's course indicator and the radio magnetic indicators operate in conjunction with either the VHF navigation radio (omni) or the UHF navigation radio (TACAN), depending on the position of the instrument select switch. The switch must be in TACAN position for the UHF navigation radio to operate the indicators.

COPILOT'S COURSE INDICATOR (ID-525).

The copilot's course indicator provides UHF radio navigation course information when the instrument select switch is in the TACAN position. The vertical pointer shows deviation from the selected UHF navigation path. A flag alarm on the vertical pointer appears whenever electrical signals from the selected navigation radio are weak or unreliable, or when the instrument is de-energized. A horizontal pointer, to indicate runway glide path deviations, is not operative when the UHF navigation radio is selected. An amber indicator light illuminates when marker beacon signals are received by the marker beacon radio system.

Note

The copilot's course indicator operates in conjunction with either the VHF navigation radio (VOR) or the UHF navigation radio (TACAN), depending on the position of the instrument select switch. The switch must be in the TACAN position for UHF radio navigation information to be displayed by the indicator.

Radio Magnetic Indicator (RMI). Bearing information of the UHF navigation radio is displayed on the radio magnetic indicators (RMI's) (figure 4–23). One RMI is on the pilots' instrument panel, and one RMI is on the navigator's instrument panel. On the pilots' instrument panel, the radio magnetic indicator which has the marking 1. TACAN shows UHF navigation radio bearing with the No. 1 pointer. The navigator's RMI shows UHF navigation radio bearing when the No. 2 RMI selector switch is in the TACAN position and the instrument select switch is in the TACAN position. The bearing pointers rotate continuously when the equipment is not locked on a reliable station bearing signal.

Azimuth Indicator. This indicator is next to the forward power panel in the lower compartment. It displays the relative bearing to the TACAN station. Since this information is presented on the radio magnetic indicators, the azimuth indicator is not normally used in flight.

Normal Operation Of The UHF Navigation Radio (TACAN)

To obtain bearing information from the UHF navigation radio, move the OFF–REC–T/R switch to the REC position and select the channel of the appropriate ground TACAN station. To identify the station, move the TACAN interphone mixer switch to the ON position and listen for the code signal. Adjust the volume of the signal. Place the instrument select switch in the TACAN position. When the radio magnetic indicator TACAN bearing pointers stop rotating, the search cycle of the equipment is completed and the pointers indicate the bearing of the station. The pilot's course indicator may be used to indicate deviation of the airplane from the selected course by turning the course set knob. To obtain range information in addition to bearing information, move the OFF–REC–T/R switch to T/R and read the slant range to the station in nautical miles on the range indicator after the range warning flag disappears. To turn the equipment off, move the OFF–REC–T/R switch to the OFF position.

Emergency Operation Of The UHF Navigation Radio (TACAN)

In event of failure of the C-1 amplifier, the pilots' and navigator's radio magnetic indicators will be inoperative. When such a failure occurs, heading indication from the rotating compass card and the TACAN and VOR pointers for the radio magnetic indicators will not be available. Under these conditions, bearing information may be obtained from the pilot's course indicator by turning the course set knob until the course deviation indicator is centered. Magnetic bearing to or from the station can then be read in the course selector window. The to/from indicator will show whether the selected course, if intercepted and flown, will take the airplane to or from the TACAN station. Partial failure of the equipment may not impair other functions. If the warning flag is not visible, the indication can be considered reliable.

TACAN Limitations

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 usually result in a correct lock on. This deficiency does not affect the range information provided by the TACAN equipment.

Note

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

Figure 4-24. Deleted

RADIO ALTIMETER (SCR-718C)

The radio altimeter is used in airplanes for determining height above terrain. The scale is calibrated from 0 to 50,000 feet, although the altimeter is not designed to be used above an absolute altitude of 40,000 feet. The set operates on a frequency from 400 to 2400 cps. The indicator and all controls are on the face of the set. The radio altimeter (figure 4–25) is at the navigator's station. Operating power is 115-volt ac with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37).

WARNING

Radio and radar waves can penetrate the surface of snow and ice fields; therefore, when radio and radar equipment are used for measuring terrain clearance they may indicate greater terrain clearance than actually exists. An apparent terrain clearance several hundred feet greater than actual clearance has been recorded.

Note

When two or more airplanes using radio altimeters are flying in close proximity (formation, A/R rendezvous, etc), the signals from the radio altimeter on one airplane can cause interference with the radio altimeter in the other airplane(s). The interference makes the altitude indications unusable.

Radio Altimeter Controls

Scale Switch. The scale switch (1, figure 4–25) on the face of the radio altimeter has TIMES TEN–TIMES ONE positions. In the TIMES TEN position, the lobe on the indicator travels one revolution for 50,000 feet. In the TIMES ONE position, the lobe travels one revolution for each 5000 feet.

Times Ten Zero Adjustment Knob. The times ten zero adjustment knob (2, figure 4–25) on the radio altimeter adjusts the zero lobe to zero when the scale switch is positioned to TIMES TEN.

Times One Zero Adjustment Knob. The times one zero adjustment knob (4, figure 4–25) on the radio altimeter adjusts the zero lobe to zero when the scale switch is positioned to TIMES ONE.

Circle Size Knob. The circle size knob (5, figure 4–25) on the radio altimeter adjusts the physical size of the circular trace on both the TIMES ONE and TIMES TEN positions. Normally, the adjustment is made only on the TIMES ONE position to place the trace under the etched circle on the face of the scope. On the TIMES TEN position, the trace will then fall approximately 1/4 inch inside the etched circle, but the reference lobe can still be easily read.

Receiver Gain Knob. The receiver gain knob (6, figure 4–25) on the radio altimeter has ON–OFF positions. The knob serves a double purpose. When the knob is turned clockwise from the extreme counterclockwise position to the ON position, power to all components of the radio altimeter will be applied. Further rotation of the knob adjusts the lobe height. In the extreme counterclockwise position, the set is OFF and no power is applied.

Radio Altimeter Indicators

Indicator Face. The indicator face (3, figure 4–25) on the radio altimeter has a scale which ranges from 0 to 5, allowing altitude to be read up to 50,000 feet.

Pilot Light. The pilot light (7, figure 4–25) on the radio altimeter will light when the components of the set are energized.

Normal Operation Of The Radio Altimeter

Note

Except in emergency, the SCR-718 radio altimeter equipment will be used only over broad ocean areas starting not less than 50 miles offshore unless the restriction is specifically waived by Headquarters, USAF.

To start the set, proceed as follows:

a. Turn the REC. GAIN knob clockwise about one-half turn from the OFF position to the ON position.

b. Check that the pilot light is on, indicating equipment is energized.

Note

Power to the radio altimeter is turned off when the radar beacon power selector switch (8, figure 4–32) is on EMERG.

To operate the radio altimeter, proceed as follows:

a. After turning the equipment on, allow 3 minutes or more, if possible, for the tubes to reach their operating conditions; then turn REC. GAIN knob until trace in the form of a green circle with one or more pulses on it appears on the indicator face. Set scale switch in TIMES ONE position.

b. Adjust the circle size knob so that the circle trace is barely visible as a luminous ring at the outer edge of the black calibrated scale.

c. Adjust the REC. GAIN knob so that a pulse approximately 1/4 inch high appears on the circle trace near 0 on the calibrated scale.

d. With the scale switch in the TIMES TEN position, check that the circle trace is about 1/4 inch inside the black calibrated scale.

e. Adjust the times ten zero adjustment knob until the reference pulse is at zero.

(1) After warmup, wait until the voltage to the equipment is normal (between 110 and 120 volts). If this cannot be read on a voltmeter, it may be estimated by judging the speed of the airplane engines, which should be greater than idling, but less than takeoff speed.

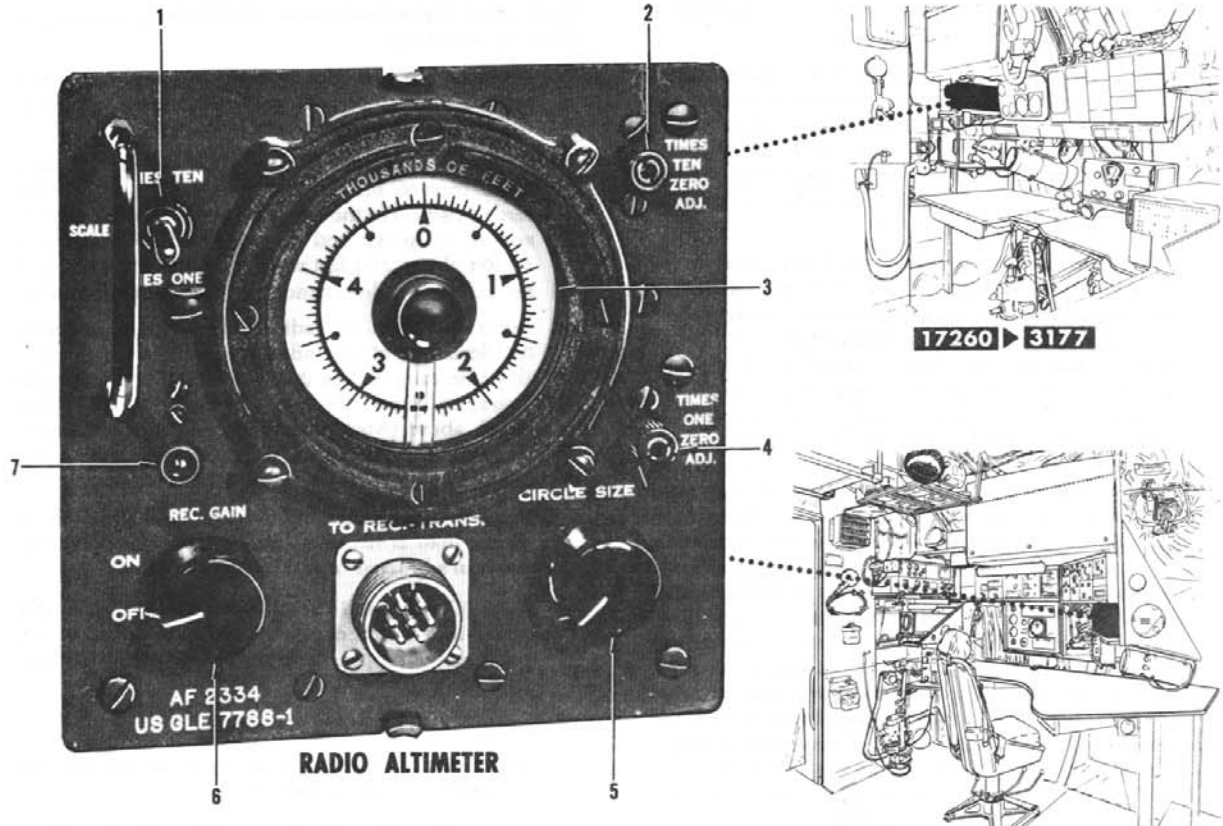
(2) Set the scale switch to the TIMES ONE position.

(3) Adjust the times one zero adjustment knob so that the reading point of the reference pulse is set to zero on the indicator scale. This should be done just as the wheels of the airplane are about to leave the ground.

(4) As the airplane climbs, the reflected pulse will move away from zero and decrease in amplitude.

(5) At an altitude of several hundred feet, turn up the REC. GAIN knob so that the reflected pulse (a new pulse appearing near zero) is 1/4 inch high.

(6) The reference pulse is due to leakage in the transmitter-receiver unit and between the transmitter and receiver antenna systems (cables and antennas); it may not be exactly at zero on the indicator scale. Record its exact position for later use. When reading altitude, adjust the REC. GAIN knob so that the reflected pulse is 1/4 inch high, disregarding any slight shift of the reference pulse to the left.



1 SCALE SWITCH
2 TIMES TEN ZERO ADJUSTMENT KNOB
3 INDICATOR FACE
4 TIMES ONE ZERO ADJUSTMENT KNOB
5 CIRCLE SIZE KNOB
6 RECEIVER GAIN KNOB
7 PILOT LIGHT

RADIO ALTIMETER CONTROLS

Figure 4–25

(7) For zero adjustment during flight, adjust the REC. GAIN knob so that the reference pulse is 1/4 inch high. Then use the times one zero adjustment knob, if necessary, to set the pulse to the reading recorded in step (6). This may be necessary to compensate for the effects of temperature and humidity changes; changes in barometric pressure have negligible effect on the zero setting. After making this adjustment, set the REC. GAIN knob so that the reflected pulse is 1/4 inch high before reading altitude. Do not add or subtract the reading of the reference pulse.

To read altitude, proceed as follows:

a. The black circular scale on the indicator is provided with a 0- to 5000-foot altitude calibration. Calibration marks are provided for every 50 feet of altitude and are sufficiently widely spaced so that readings can be estimated to the nearest 25 feet. To read the position of any pulse, determine the point along the scale where the counterclockwise edge of the pulse intersects the luminous green circle, making sure that the REC. GAIN knob is set so that the pulse to be read is 1/4 inch high. Following takeoff, the reflection pulse travels clockwise around the scale as airplane height above terrain increases.

Until the airplane reaches 5000 feet, read height merely by noting the position of the pulse.

b. When the airplane reaches 5000 feet, the reflected pulse will have progressed completely around the scale and returned to 0. As height above terrain increases further, up to 10,000 feet, the reflected pulse will travel clockwise on a second encirclement of the scale and 5000 feet must be added to the indication of the pulses.

c. When the airplane reaches 10,000 feet, the reflected pulse will have completed a second encirclement of the scale, and one further clockwise encirclement will take place for each additional 5000 feet of altitude attained. Similarly, a counterclockwise encirclement will take place for each drop to 5000 feet sustained. To obtain actual height above terrain at any time, add 5000 feet to the indication of the pulses for every previous clockwise encirclement and subtract 5000 feet from the indication of the pulses for every previous counterclockwise encirclement of the scale by the reflected pulse. However, it generally is more practicable to estimate the approximate height above terrain (by use of an aneroid altimeter such as a Kollsman and knowledge of approximate terrain height above sea level) and then to determine the exact height above terrain by adding to the reading of the indicator pulses an appropriate multiple of 5000 feet, such as that the total closely checks the estimated height. For instance, if the estimated height above terrain is 25,000 feet and the indication of the pulses is 1275 feet, then the exact height is 25,000 plus 1275 feet; that is, 26,275 feet.

d. When using this set, remember that the large times one circle (5000-foot scale) is merely an expanded vernier on the small times ten circle (50,000-foot scale). On the small circle it is possible to read to within approximately 500 feet and the scale switch should generally be left in the TIMES TEN position, especially at high altitudes. When greater accuracy is required, the large circle reading must be taken into consideration as follows: With the scale switch in the TIMES TEN position, read the reflected pulse position on the small circle to the next lower 5000-foot mark (indicated by dots and arrowheads on the indicator scale). Note this reading and switch to the TIMES ONE position; add the new reading to the one obtained previously. The large circle can, with practice, be read within 25 feet.

e. This set is not designed for use as an extremely low altitude altimeter. As the height of the airplane above the ground decreases to less than 1000 feet, reduce the gain as required to prevent the reflected pulse from becoming too broad and more than 1/4 inch high. While doing this, at about 500 feet the reference pulse will begin to be affected by the reduced gain and will begin to decrease in amplitude. By careful adjustment of the REC. GAIN control, it will be possible to see the reflected pulse move in to zero, the reference or zero pulse having completely disappeared by the time the airplane lands.

When using the radio altimeter, the following precautions should be observed:

a. Effect of Terrain. Flying over rough terrain will produce fluctuating indications, and flying over water will produce relatively steady indications.

b. Blind Spots. At altitudes of 5000 feet and all multiples thereof, the reflected pulse will occupy the same position as the reference pulse. The pulses will appear to merge and cause a blind spot; that is, a region about 250 feet wide in which the position of the reflected pulse cannot be determined accurately.

c. Accuracy. When the radio set is operating properly, the deviation of its indication from exact height above terrain is less than 50 feet. When improper operation causes the error to become greater than stated above, such improper operation is almost always shown by the indicator circle becoming oval in shape.

d. Receiver Gain. Turning the REC. GAIN knob up higher than is necessary for a satisfactory image will result in a blurred or fuzzy trace.

e. Dives, Climbs, and Banks. Sharp dives, climbs, and banks may flatten out the reflected pulse, or the pulse may disappear completely during the bank or dive.

f. Observable Defects:

(1) A circle trace which is not truly circular will cause inaccurate readings.

(2) A circle trace that is off center will cause inaccurate readings.

(3) Shifting of the reference pulse will cause inaccurate readings unless compensated for as stated in step d of NORMAL OPERATION OF THE RADIO ALTIMETER, this section.

g. Excessive Altitude. Use of the radio set at heights above sea level greater than 40,000 feet may result in impaired operation, although the accuracy of its indication will not be diminished. Use at heights above sea level greater than 45,000 feet may result in permanent damage. This damage would be caused if the reduction in air pressure were sufficient to allow voltage breakdown between closely spaced circuits carrying high potential difference.

CAUTION

Before disconnecting any unit or cable of the equipment, and before removing the fuse, be sure the altimeter is turned off.

To turn the radio altimeter off, turn the REC. GAIN knob fully counterclockwise to the OFF position.

LORAN (AN/APN-70)

The loran radio receiving set is used by the operator to receive and interpret loran signals. The set serves as a navigational aid and operates over the standard high-

frequency band from 1700 to 2000 kc, and on the low-frequency bands of 170 to 190 kc and 90 to 110 kc. Controls for the set are on the front of the receiver. The loran control unit and loran indicator (figure 4–26) are at the navigator's station. Operating power is 115-volt ac and control power is 28-volt dc. Circuit breakers for the set are on the radio junction box circuit breaker panel (2, figure 1–37).

AN/APN-70 Loran Controls

W-Delay And Y-Delay Cranks. W-delay and Y-delay cranks (17 and 7, figure 4–26) are on the loran control unit. Each crank, when turned, operates the delay revolution counter. The cranks have two speeds, the one in use being determined by position of the crank shaft. The shaft is movable in a plane perpendicular to the front panel of the receiver, and when pushed in will turn its counter at the rate of 1000 units per revolution of the crank. One revolution will cause a change of 100 units in the reading when the crank shaft is pulled out.

R-Rate Switch. The R-rate switch (2, figure 4–26) on the loran control unit serves as a pulse repetition rate selector.

Drift Controls. The loran set has a manual drift adjustment and an automatic drift adjustment. The drift control (5, figure 4–26) on the loran control unit may be used as a manual drift adjustment for synchronizing the receiving equipment with the transmitter. For most operating conditions, an ADC (Automatic Drift Control) SYSTEM is preferable to manual operation. The ADC switch (6, figure 4–26), with ON–OFF positions, is on the lower portion of the drift control, and operates independently.

L–R Switch. The L–R switch (8, figure 4–26) on the loran control unit moves the received signals to the left or to the right in order that they may be properly positioned to obtain readings.

Master–XZ Gain And Power Switch. The master–XZ gain and power switch (12, figure 4–26) on the loran control unit serves a double purpose. The switch applies power to the set when switch action is felt as the gain control is turned in a clockwise direction from its extreme counterclockwise position. The master–XZ gain control sets the level of the master pulse, or pulses, as viewed on the indicator screen. Power is disconnected when the control is returned to the extreme counterclockwise position.

Slave-Y And Slave-W Gain Controls. The slave-Y and slave-W controls (9 and 14, figure 4–26) are on the loran control unit. They operate in a manner determined by the channel switch and the HF–delay switch to set the level of the slave pulses.

Function Switch. The function switch (13, figure 4–26) on the loran control unit determines the presentation on the loran scope. (See figure 4–27.)

Local–Distant Switch. The local–distant switch (10, figure 4–26), with LOCAL–DISTANT positions, is on the loran control unit. The purpose of the switch is to adjust the signal of the antenna coupler. When a signal is being received from a distance, the switch is used in the DISTANT position to permit maximum signal input to the antenna coupler. When the switch is placed in the LOCAL position, it reduces the input to prevent overloading.

HF–Delay Switch. The HF–delay switch (11, figure 4–26) on the loran control unit sets the level of the slave pulses. The switch also determines the variable delay circuits in use in the HF positions of the channel switch.

Channel Switch. The channel switch (15, figure 4–26) is on the loran control unit. The switch, along with the R–rate switch, selects the desired station.

Focus Adjustment. The focus adjustment (19, figure 4–26) on the loran indicator is used to focus signals on the loran scope.

Brilliance Adjustment. The brilliance adjustment (20, figure 4–26) on the loran indicator is used to adjust brilliance of the signal displayed on the loran scope.

AN/APN-70 Loran Indicators

W-Delay And Y-Delay Revolution Counters. W-delay and Y-delay revolution counters (1 and 4, figure 4–26) are on the loran control unit. The counters indicate a direct reading of delay time in microseconds.

R-Rate Indicator. The R-rate indicator (3, figure 4–26) on the loran control unit indicates channel selected by use of channel and R-rate switches.

Loran Scope. The loran scope (18, figure 4–26) on the loran indicator displays the signals to be interpreted by crewmembers.

Normal Operation Of The AN/APN-70 Loran

To start the loran set, proceed as follows:

a. Apply power to the set by turning the master-XZ gain and power switch in a clockwise direction from the extreme counterclockwise position. When the power switch operates, the panel will be illuminated. Determine that the blower starts when the loran is turned on. The set requires cooling air to prevent overheating some equipment components.

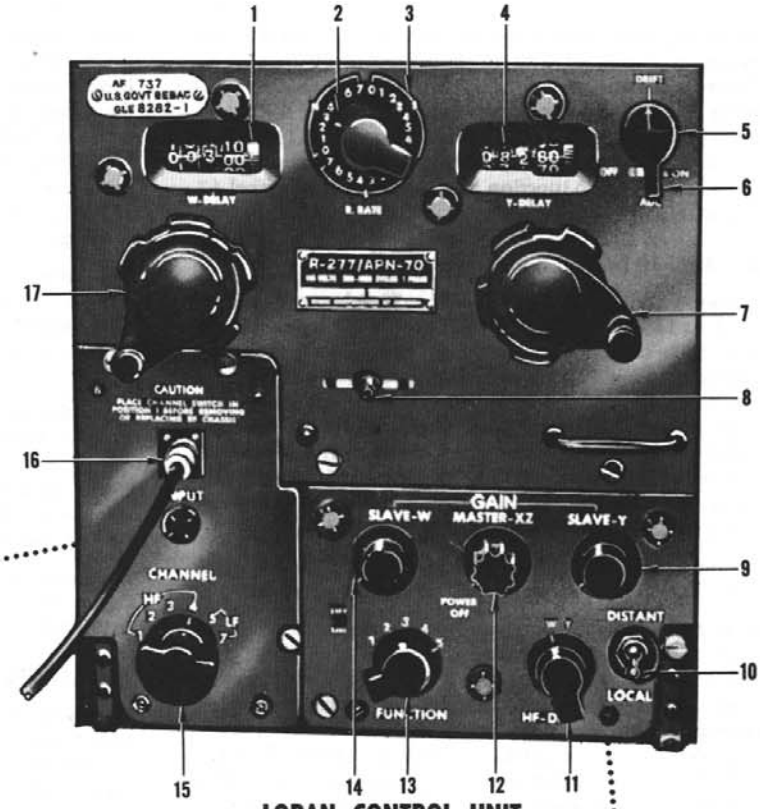
Note

Power to the loran equipment is turned off when the radar beacon power selector switch (8, figure 4–32) is on EMERG.

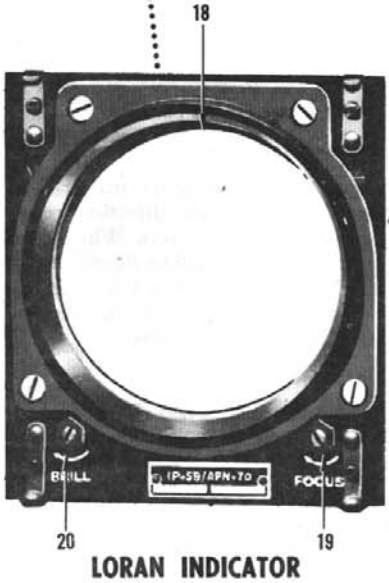
b. Allow the equipment to warm up for about 1 minute. As soon as the presentation on the loran scope becomes stable, the equipment is ready for use.

1 W–DELAY REVOLUTION COUNTER
2 R– RATE SWITCH
3 R– RATE INDICATOR
4 Y–DELAY REVOLUTION COUNTER
5 DRIFT CONTROL
6 AUTOMATIC DRIFT CONTROL (ADC) SWITCH
7 Y – DELAY CRANK
8 L – R SWITCH
9 SLAVE – Y GAIN CONTROL
10 LOCAL-DISTANT SWITCH
11 HF – DELAY SWITCH
12 MASTER – XZ GAIN AND POWER SWITCH
13 FUNCTION SWITCH
14 SLAVE – W GAIN CONTROL
15 CHANNEL SWITCH
16 ANTENNA CONNECTION
17 W – DELAY CRANK
18 LORAN SCOPE
19 FOCUS ADJUSTMENT
20 BRILLIANCE ADJUSTMENT

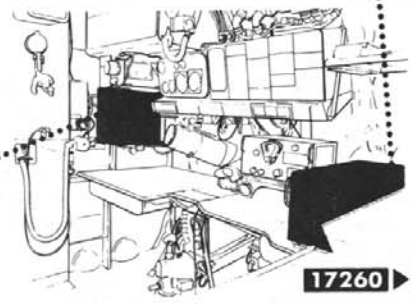
3178 ▶



LORAN CONTROL UNIT



LORAN INDICATOR



17260 ▶ 3177

NOTE:

There are additional adjustments (not shown) on the side of the control unit and the indicator for tuning the Loran. These adjustments are positioned with a screwdriver. The adjustments are:

Control Unit

PED. DUR. (Pedestal Duration)
SLOW SW. HOR. CENT. (Slow Sweep Horizontal Center)
MED. TO FAST SW. HOR. CENT. (Medium to Fast Sweep Horizontal Center)
SLOW SW. AMPL. (Slow Sweep Amplitude)
FAST SW. AMPL. (Fast Sweep Amplitude)
MED. SW. AMPL. (Medium Sweep Amplitude)

Indicator

ASTIGMATISM
VERT CENTER (Vertical Center)

AN/APN-70 LORAN CONTROLS

Figure 4–26

For HF (High Frequency) reception, proceed as follows:

a. After the set has been turned on and allowed a short warmup period, set the three gain controls at the center of their rotation, the local–distant switch to DISTANT, and the drift control to its center position.

Note

The local–distant switch is normally used in the DISTANT position, which affords greater sensitivity than the LOCAL position. The latter is used in the presence of high interfering signals, when flying in the vicinity of a loran transmitter, or when a better signal-to-noise or interference ratio is obtained in that position.

b. Turn the ADC switch to the OFF position.

c. Refer to the loran charts for the approximate geographical location of the airplane and determine at which position the channel and R-rate switches are to be set.

d. Set the channel and R-rate switches as determined from the chart.

e. Set the function switch to position 1. Two traces should appear on the screen of the loran scope, with a pedestal on each trace. See figure 4–27.

f. Set the HF-delay switch to W, and adjust the master-XZ and slave-W gain controls for signals twice the amplitude of the pedestals.

Note

- When signals are very weak, it may be advisable to preset the delay controls to the expected reading. If only one station's signal appears, place it on one of the pedestals, using the L–R switch, and locate the other station's signal by placing the function switch in position 2 and investigating either the upper or the lower trace, as the case may be. This practice may aid in the identification of ground or sky waves, since corresponding pulses should appear nearly in alignment if the estimate is close. If either the master or the slave station is double-pulsed, the appearance of the signals should make it possible to distinguish one from the other. Also, a weak signal is sometimes easier to detect if it is drifting across the trace. Therefore, if trouble is encountered in locating a weak signal, try holding the L–R switch to one side or the other while looking for the pulse.
- If the delay setting is past either end of its range for a given position of the R-rate switch, no pedestal will appear on the lower trace in function switch position 1, and there will be no lower trace in positions 2, 3, and 4 of the function switch. If the pedestal is not visible, turn the W-delay crank until the entire pedestal appears on the lower trace.

g. Adjust the drift control to hold the pulses stationary on the scope, and use the L–R switch to position one of the pulses on the leading edge of the upper pedestal. Turn the ADC switch to the ON position.

Note

The ADC (Automatic Drift Control) circuits hold the repetition rate of the loran receiving set synchronized to that of the transmitting group when a signal is properly positioned on the leading edge of either pedestal. This prevents the received pulses from drifting across the screen of the loran scope and obviates continual adjustment of the drift control. The ADC switch should be left in the ON position once the drift control has been set, except when excessive noise causes bothersome pulse jitter.

h. Rotate the drift control in both directions to check the ADC action, and return the control to its original position. If the ADC circuits are functioning normally, rotation of the drift control will not cause the signal to drift from the edge of the pedestal.

i. If the ADC action is satisfactory, proceed with step j; if not, place the local–distant switch to the LOCAL position and observe the signals and ADC action there. Leave the switch in the position which gives the better operating characteristics.

j. Use the W-delay crank in the high-speed position (shaft pushed in) to position the leading edge of the slave pedestal (on the lower trace) under the slave pulse.

Note

To determine the Indicated Time Difference, the master received pulse must be situated on the leading (left) edge of the master (top) pedestal. When it is in that position, there will be one pulse on each trace; the master pulse on the top trace and the slave pulse on the bottom trace. If the slave pulse should be situated on the master pedestal, there will be two pulses on the upper trace and none on the lower. If this should occur, use the L–R switch to situate the master pulse at the leading edge of the master (top) pedestal.

k. Turn function switch to position 2.

l. Use the W-delay crank in the slow-speed position (shaft pulled out) to vertically align the expanded pulses.

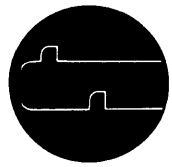
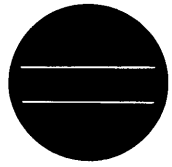
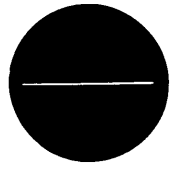
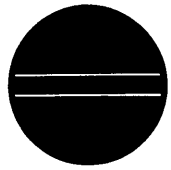
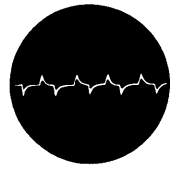
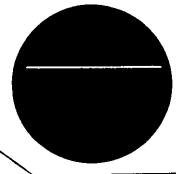
m. Turn function switch to position 3.

n. Adjust the master-XZ and slave-W gain controls so that the two pulses are of the same height as nearly as possible.

o. Superimpose the two pulses by use of the W-delay crank. Align the pulses, the leading edges especially, as closely as possible.

Note

Matching by superimposition is often difficult when either signal is weak compared to the noise level. The operator must mentally average the fluctuating signals and align the averages. This is often most easily and accurately done in position 4 of the function switch.

STEP	SWITCH	SWITCH POSITION	SCOPE	REMARKS	ADJUSTMENTS
1	Master – XZ Gain & Power W – Delay Crank Y – Delay Crank Channel Function R – Rate HF – Delay	CW to ON 11000 11000 1 1 HO W		Adjust until two traces appear. Adjust for clear and distinct traces. Master trace has a pedestal about 5/16 inch tall. Center traces vertically and horizontally. Adjust traces until ends are 1/4 inch from edge of scope.	BRILL FOCUS ASTIGMATISM VERT CENTER SLOW SW HOR CENTER SLOW SW AMPL
2	Function	2		Two traces appear about 1-1/4 inches apart. Center them and adjust ends for 1/4 inch from edge of screen.	MED TO FAST SW HOR CENTER MED SW AMPL
3	Function	3		Adjust until right edge of trace is 1 4 inch from edge of scope.	FAST SW AMPL
4	Function	4		Traces are separated 1 4 inch vertically.	No adjustment. Note in Form 781 if faulty
5	Function	5		Use W – delay crank to superimpose pips. Count 2 zeros on last two digits of W – counter. Crank above or below 11000 to separate traces.	W–DELAY CRANK
6	Function R–Rate	2 H–7, H–6, etc. See table		Adjust W–delay at fine speed until lower trace disappears.	W–DELAY CRANK
7	HF–Delay R–Rate	Y Same as step 6		Adjust Y–delay at fine speed until lower trace disappears.	Y–DELAY CRANK

TRACE MUST DISAPPEAR AT FOLLOWING SETTINGS (±10 microseconds)

BASIC RATE	STATION RATE 7	6	5	4	3	2	1	0
H	13025	13075	13125	13175	13225	13275	13325	13375
L	18025	18075	18125	18175	18225	18275	18325	18375
S	23025	23075	23125	23175	23225	23275	23325	23375

AN/APN-70 LORAN CALIBRATION CHART

Figure 4–27 (Sheet 1 of 2)

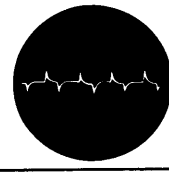
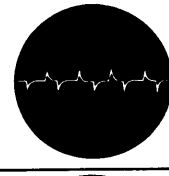
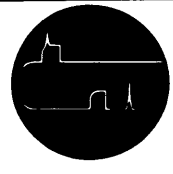
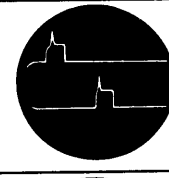
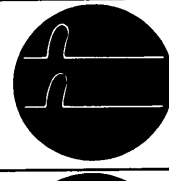
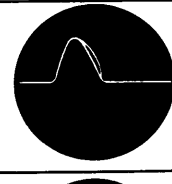
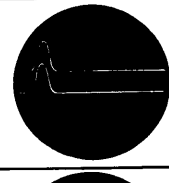
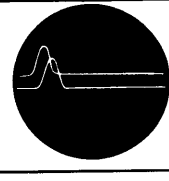
STEP	SWITCH	SWITCH POSITION	SCOPE	REMARKS	ADJUSTMENTS
8	Function R–Rate HF–Delay	5 H–7 W		Markers must be superimposed and appear as one trace for W–delay values of: 00500 02000 05000 08500 11500	W–DELAY CRANK
9	HF–Delay	Y		Markers must be superimposed and appear as one trace for Y–delay values of: 00600 02100 05100 09000 11000	Y–DELAY CRANK
10	Local–Distant R–Rate Function HF–Delay	DISTANT As desired 1 W		Use Loran chart station information to determine usable readings to obtain pips. Adjust W–delay near expected reading. Adjust for signals twice the height of pedestals. Use L–R switch to position upper pip to the left of lower pip. If no signal appears on lower trace, hold L–R switch until signal also appears on lower trace, then place upper pip on leading edge of upper pedestal.	W – DEALY CRANK MASTER – XZ GAIN & POWER SWITCH SLAVE – W GAIN CONTROL L – R SWITCH
11	ADC Drift Control	As required As required		Use drift controls to hold signals steady. Position pip on lower pedestal leading edge with W–delay crank.	L–R SWITCH DRIFT CONTROL ADC SWITCH W–DELAY CRANK
12	Function	2		Align lower expanded signal with upper signal.	W–DELAY CRANK
13	Function	3		Adjust both signals for same height. Superimpose leading edges of signals. Switch to function 4 if signals fluctuate too much.	MASTER – XZ GAIN & POWER SWITCH SLAVE – W GAIN CONTROL W – DELAY CRANK
14	Function	4		Navigation along a Loran LOP, on-course indication. W–Delay reading gives Loran LOP.	W–DELAY CRANK
15	Function	4		Navigation along a Loran LOP, off-course indication.	
16	HF–Delay	Y		Check other stations in same manner using Y–Delay.	Y – DELAY CRANK

Figure 4–27 (Sheet 2 of 2)

p. The Indicated Time Difference may now be read on the W-delay counter.

q. Using the Indicated Time Difference established on the W-delay counter, locate the position of the airplane on one loran line-of-position.

r. Select another pair of loran transmitting stations which have a service area including the approximate location of the airplane.

s. Set the channel and R-rate switches to the values obtained from the chart.

t. Turn the ADC switch to the OFF position.

u. Set the HF-delay switch to the Y position.

v. Repeat steps g through t to obtain the second Indicated Time Difference. Use the Y-delay crank and slave-Y gain control when the W-delay crank and slave-W gain control are mentioned.

w. The intersection of the two loran lines-of-position determines the location of the airplane. Allowance should be made for the distance the airplane has traveled between the two readings.

For LF (Low Frequency) reception, proceed as follows:

a. Place channel switch in position 5 or 7.

Note

Due to the recovery time of the pedestal generator circuits, the width of a slave pedestal on position 1 of function switch at positions 5 and 7 of the channel switch (the channels with which dual presentation is used) becomes progressively narrower as the corresponding delay crank is rotated in the counterclockwise direction from the point where the counter reading is approximately 02600. At a counter reading of about 02000 the pedestal width is approximately three-fourths the normal value and, as rotation of the delay crank is continued, becomes narrower still until, at a reading of about 01800, the pedestal disappears. The length of the corresponding slave trace in function switch positions 3 and 5 is dependent upon the width of the pedestal, and those traces will become increasingly shorter in the same ratio as the pedestal becomes progressively narrower. The other function switch positions (3 and 5) are not affected. Since loran readings below 02000 are not used with triad reception, the accuracy of the counter reading is not affected. Also, since the pulse match is always made near the left edge of the screen, the decrease in slave-trace length on function switch positions 2 and 4 has no effect on operation.

b. After the loran has been turned on and allowed to warm up for approximately 1 minute, set the gain controls to the center of their rotation, the local–distant switch to DISTANT, and the drift control to its center position.

c. Turn the ADC switch to the OFF position..

Note

The local–distant switch is normally used in the DISTANT position, which affords greater sensitivity than the LOCAL position. The latter is used in the presence of high interfering signals, when flying in the vicinity of a loran transmitter, or when a better signal-to-noise or interference ratio is obtained in that position.

d. Refer to loran charts and determine the settings of the channel and R-rate switches from the approximate geographical location of the airplane.

e. Set the channel and R-rate switches to the positions determined from the charts.

f. Set the function switch to position 1. Two traces and four pedestals (two on each trace) should be present on the loran scope.

Note

If a delay setting is past either end of the range for a given setting of the R-rate switch, no slave delay pedestal for that delay control will be seen in function switch position 1, and the trace corresponding to that pedestal will not appear in positions 2, 3, or 4 of the function switch. If only one pedestal should appear on the upper trace, turn the Y-delay crank until the entire second pedestal is visible. If only one pedestal should appear on the lower trace, use the W-delay crank to bring the second pedestal within range. (The HF-delay switch is inoperative in the LF settings of the channel switch and may be left in either position.)

g. Use the gain controls to adjust the amplitude of the received pulse to approximately twice that of the pedestals, and adjust the drift control to hold the signals stationary on the indicator screen.

Note

● The master-XZ gain control determines the amplitude of the signals occurring in the interval between the beginning of either trace and the end of the first pedestal. The slave-W gain control sets the signal level on the remainder of the upper trace, while the slave-Y gain control sets the signal level on the remainder of the lower trace.

● When signals are very weak, it may be advisable to preset the delay controls to the expected reading. If only one station's signal appears, place it on one of the pedestals, using the L–R switch, and locate the other station's signal by placing the function switch in position 2 and investigating either the upper or the lower trace, as the case may be. This practice may aid in the identification of ground or sky waves, since corresponding pulses should appear nearly in alignment if the estimate is close. If either the master or the slave station is double-pulsed, the appearance of the signals should make it possible to distinguish one from the other. Also, a weak signal is sometimes easier to detect if it is drifting across the trace. Therefore, if trouble is encountered in locating a weak signal, try holding the L–R switch to one side or the other while looking for the pulse.

h. Position a pulse on the leading edge of any of the pedestals by use of the L–R switch, and turn the ADC switch to the ON position.

Note

The ADC (Automatic Drift Control) circuits hold the repetition rate of the loran set synchronized to that of the transmitting group when a signal is properly situated on the leading edge of a pedestal. This prevents the received pulses from drifting across the screen of the loran scope and obviates continual adjustment of the drift control. The ADC switch should be left in the ON position once the drift control has been set, except when excessive noise causes bothersome pulse jitter.

i. Rotate the drift control in both directions to check the ADC action, and return the control to its original position. If the ADC circuits are functioning normally, rotation of the switch will not cause the signal to drift from the pedestal.

j. If the ADC action is satisfactory, proceed with step k; if not, operate the local–distant switch to the DISTANT position and observe the signals and ADC action there. Leave the switch in the position which gives the better operating characteristics.

k. Use the L–R switch to position the master station pulse X, followed by the ghost pulse X, on the leading (left) edge of the master (first) pedestal on the upper trace. This will automatically position the Z master pulse on the leading edge of the master (first) pedestal on the lower trace. If the X pulse and its ghost should appear on the lower trace, hold the L–R switch to either side until the pulse-ghost combination drifts off the lower trace and reappears on the upper. Then properly position them.

Note

If the received pulses should drift at any time during the remainder of the procedure, use the drift control to stop the signal motion and the L–R switch to reposition the pulses.

l. Use the W-delay crank in its high-speed position to move the leading edge of the slave (second) pedestal on the lower trace beneath the slave pulse.

Note

When the shaft of a delay crank is pushed in, the crank is in its high-speed position. When pulled out as far as it will go, it is in the slow-speed position.

m. Use the Y-delay crank in its high-speed position to situate the leading edge of the slave pedestal on the upper trace beneath the slave pulse.

n. Turn the function switch to position 2.

o. Use the W-delay crank in the slow-speed position to vertically align the expanded pulses on the two upper traces.

p. Use the Y-delay crank in the slow-speed position to vertically align the expanded pulses on the two lower traces.

q. Turn the function switch to position 3.

r. Use the W-delay crank to superimpose the two pulses on the upper trace. Use the slave-W gain control to make the amplitude of the two pulses exactly the same. Align the pulses, especially the leading edges, as closely as possible.

s. Use the Y-delay crank to superimpose the two pulses on the lower trace. Use the slave-Y gain control to make the amplitude of the two pulses exactly equal. Align the pulses, especially the leading edges, as closely as possible.

Note

Matching by superimposition is very difficult when either signal is weak compared to the noise level. The operator must mentally average the fluctuating signals and match the averages. This is often most easily and accurately done with the function switch turned to position 4.

t. Use the Indicated Time Difference readings to find the two loran lines-of-position on the chart. The intersection of the two lines-of-position determines the location of the airplane at the time the readings were taken.

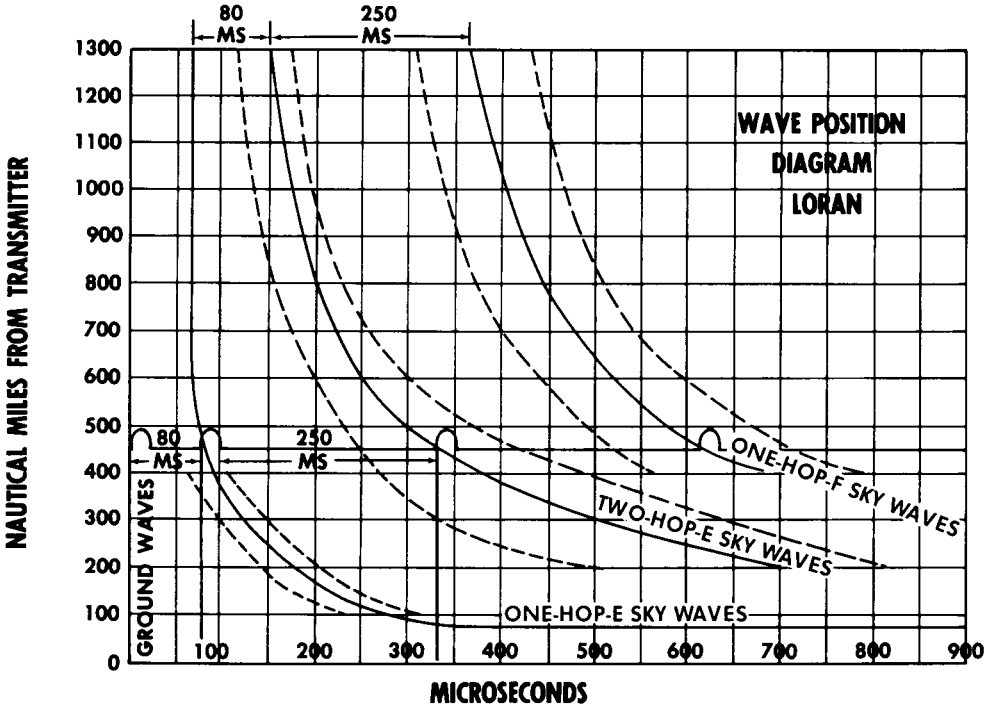
To turn the loran set off turn the master-xz gain and power switch in a counterclockwise direction until the switch operates and the panel lights go out.

Emergency Operation Of The AN/APN-70 Loran

If One Delay Channel Defective. In normal operation, the two readings required to determine the location of the airplane are made by separate delay channels. If one of the delay channels should become defective, both readings may be obtained from the channel which is functioning properly.

NOTE:

To obtain special correction used to correct a ground wave and one-hop-E sky wave match, enter the diagram with the distance from the transmitter that the sky wave is coming. The correction will be found by going across the diagram horizontally to the right from the ground wave line to the one-hop-E sky wave. If the one-hop-E sky wave is coming from the slave station, the correction is subtracted from the reading. If it is coming from the master station, the correction is added to the reading.



LORAN WAVE POSITION DIAGRAM

Figure 4–28

For reception of HF signals:

a. Place the HF-delay switch to the position which still functions properly and take the first reading using the normal procedure.

b. Set the channel switch and R-rate switch to receive the second transmitting system.

c. Use the same HF-delay setting and the same delay crank to obtain the second reading. Since the two readings are not made simultaneously, allowance must be made for the time elapsed between the two.

For reception of LF signals:

a. Take the first reading using the L–R switch to position the master pulse on leading (left) edge of the upper trace master pedestal if the W-delay channel is the one functioning normally, or on the leading edge of the lower trace master pedestal if the Y-delay channel is the good one. (If sky wave, or combined ground and sky wave reception is used, trains of pulses will be present and the normal precautions must be observed.) (See figure 4–28.)

b. Return the function switch to position 1.

c. Hold the L–R switch to the right. The received signals will move to the right of the screen and will disappear at the right edge of the trace. The signals will reappear at the left edge of the other trace and drift toward the master pedestal. The first pulse to reappear in this manner will be the other slave pulse, and the second pulse is the other master pulse. Position the second master pulse at the leading edge of the master pedestal used to obtain the first reading.

d. Using the good delay channel, take the second reading.

e. Determine the location of the airplane, making allowance for the time elapsed between the two readings.

If The Scope Presentation Is Unusable: Determine whether or not the condition is external to the set by:

a. Disconnecting the antenna connector from the jack, marked INPUT, on the loran control unit. If the interference persists, the loran receiver is defective; if not, the disturbance is coming in on the input. (If the antenna coupler is accessible, try the same test with its antenna connection.)

b. Try other positions of the channel switch. (This should be done even if the defect is found to be in the loran receiver. One channel may be defective and the others all right.)

c. Reception may be possible in spite of interference by proper use of the gain and drift controls. (Manual drift control will probably be preferable to automatic control under such conditions.)

Emergency Adjustments Of The AN/APN-70 Loran

If Sweep Length Is Defective In Function 1: Adjust the traces to a length of approximately 4 inches with the SLOW SW. AMPL. control.

If Sweep Length Is Defective In Function 2, 3, 4, or 5:

a. Turn the function switch to the position 2 or 4 and adjust the MED. SW. AMPL. control for a trace length of approximately 4 inches.

b. Turn the function switch to the position 3 or 5 and adjust the FAST SW. AMPL. control for a trace of approximately 4 inches.

If The Horizontal Centering Is Defective In Function 1: Use the SLOW SW. HOR. CENT. control to position the traces.

If The Horizontal Centering Is Defective In Functions 2, 3, 4, or 5: Use the MED. TO FAST SW. HOR. CENT. control to position the traces. The one adjustment covers the four positions.

If The Pedestal Duration (Width Of The Pedestal) Requires Emergency Adjustment:

a. Turn the function switch to position 5.

b. Superimpose the fixed and movable marker pips by use of the proper delay crank. (The adjustment may be made with either single or dual presentation. If dual presentation is used, it is only necessary to superimpose one set of marker pips.)

c. Set the PED. DUR. adjustment at the point where exactly four superimposed marker pips are visible on the indicator scope. (The positive pips are the ones extending above the trace.)

If The Vertical Centering Is Defective: Use the VERT. CENTER control to position the traces. Make the adjustment with the function switch on position 1. The single adjustment covers all positions of the function switch.

If The Trace Definition Is Poor And The Focus Adjustment Does Not Correct This Condition:

a. Turn the channel switch to position 7. (Use channel switch position 1 for loran control units having R-277A or R-277B on the nameplate at the center of the panel.)

b. Turn the function switch to position 1.

c. Turn the slave-W and the slave-Y gain controls full CCW.

d. Turn the master-XZ gain and power switch to its minimum gain position (CCW), but do not turn off the set.

e. Use the FOCUS and ASTIGMATISM adjustments to obtain the best overall definition of the traces.

f. Rotate the function switch through the rest of its positions, noting the trace definition in each position.

g. Repeat step e.

AIMS/IFF TRANSPONDER SYSTEM (AN/APX-72)

The AIMS/IFF (identification friend or foe) transponder system provides automatic radar identification and altitude information of the aircraft to all suitable equipped challenging ground facilities, aircraft, and surface ships within line-of-sight. Mode 1, 2, 3/A, C, or 4 interrogational signals on a frequency of 1,030 ± 1.5 megahertz are received by the system and decoded. The received signals are checked for a valid code and proper mode, and if the proper interrogating signal has been received, a code reply is transmitted on 1,090 ±3.0 megahertz. In addition to these normal identification and altitude reply signals, specially coded identification of position (I/P) and emergency signals may be transmitted in response to interrogating signals. The I/P reply signal is used to distinguish between aircraft displaying identical coding and the emergency reply signals indicates an emergency or distress condition of the aircraft in flight.

Normal identification operation, as well as the transmission of the I/P emergency reply signals, is accomplished in operating modes 1, 2, 3/A. Mode 1 provides 32 code combinations, any one of which may be selected in flight. Mode 2 provides 4,096 possible code combinations, only one of which is normally used in flight, since the code selection dials on the receiver-transmitter are preset before flight. Mode 3/A provides 4,096 possible code combinations, any one of which may be selected in flight. Altitude interrogations and replies are accomplished in mode C operation. The code for mode C is determined by the altitude of the aircraft and is encoded in 100 foot increments. Mode 4 operation provides secure (encrypted) IFF capability through the use of a transponder computer with the AN/APX-72 Transponder. The code for mode 4 must be preset into the computer prior to flight.

The AIMS/IFF transponder system includes a test set that provides for go/no-go self-testing of the system in modes 1, 2, 3/A and C. System self-testing for mode 4 operation is performed automatically by the transponder computer.

The major components of the AIMS/IFF system are Transponder Control C-6280 (P)/APX, Radio Receiver-Transmitter RT-859/APX-72, Antenna AT-741/A, Antenna Switching Unit SA-1474/A, Altimeter-Encoder AAU-21/A, Transponder Test Set TS-1843A/APX, IFF antenna switch, and Transponder Computer KIT-1A/TSEC.

Power to operate the AIMS/IFF equipment is supplied from the aircraft 115V AC, 1 phase Secondary Bus and the 28V DC Main Bus. DC power is supplied through three circuit breakers located on the radio junction box. AC power (115V AC, 400 Hz, 1 phase) is supplied through two circuit breakers located on the radio junction box. AC power for the altimeter lighting transformer is supplied through a 1/2 ampere circuit breaker on the AC power panel. The receiver transmitter supplies 115V AC power to the antenna switching unit and the KIT-1A/TSEC Computer. A 5 ampere circuit breaker controls 28V DC power to the altimeter-encoder and altimeter vibrators. The receiver-transmitter and transponder control receive DC power from the IFF TRANS 5 ampere circuit breaker and AC power from the IFF TRANS 5 ampere circuit breaker. The altimeter-encoder receives power through the ALT ENCODER circuit breaker. The IFF CAUTION light receives 28V DC from the transponder computer. The IFF test 5 ampere circuit breaker supplies 28V DC to the transponder test set and IFF grounding relay.

Transponder Control C-6280(P)/APX

The transponder control, Figure 4-29, contains all of the controls normally required for operating the AIMS/IFF Transponder System except for mode 2 code selections. The MASTER control turns the AIMS/IFF System on and off, places it in warmup (STBY), controls the sensitivity of the receiver (low or normal), and initiates the emergency reply operation. The IDEN-OUT-MIC switch selects I/P operation. I/P operation is selected when the switch is held in the momentary IDENT position. With the switch set to the MIC position, I/P operation is initiated by keying the UHF command transceiver. The operating modes are selected by the M-1, M-2, M-3/A, and M-C mode enabling switches. These are three-position toggle switches providing ON and OUT (off) positions plus a momentary position for test signal selection. The TEST light illuminates when the receiver-transmitter responds properly to a mode 1, 2, 3/A, or C self-test. MODE 1 and MODE 3/A thumbwheel switches select and digitally display the reply code numbers. The RAD TEST-OUT-MON switch in the RAD TEST position, enables mode 3/A to be used for external test purposes. In the MON position, the TEST light illuminates when the AIMS/IFF Transponder System replies to mode 1, 2, 3/A, or C interrogating signals. In the OUT position, the RAD TEST and MON functions are disabled, however mode 1, 2, 3/A, and C self tests are accomplished in this position. Mode 4 controls and indicators are grouped together along the left side of the control panel. The MODE 4 switch enables or disables mode 4 operation. The CODE switch provides for the selection of either the A or B mode 4 code. When momentarily placed in the HOLD position, it prevents the transponder computer from zeroizing (cancelling) the mode 4 codes when power is removed from the system. In the ZERO position, the mode 4 codes are zeroized. The AUDIO-OUT-LIGHT switch in the AUDIO position selects both audio and reply-light monitoring of mode 4 operation. An audio tone in the pilot's headset indicates valid interrogations are being received, and illumination of the REPLY light indicates that replies are being transmitted. The LIGHT position selects REPLY light monitoring only. The OUT position turns the monitoring circuit off. The transponder control is located on the pilot's overhead panel.

Radio Receiver-Transmitter RT-859/APX-72

The radio receiver-transmitter, Figure 4-29, contains the primary receiving and transmitting circuits of the AIMS/IFF Transponder System. It receives, decodes, and replies to the characteristic interrogations of operational modes 1, 2, 3/A, and 4. Absence of the transponder computer and the altimeter-encoder does not affect the operation of the receiver-transmitter except in modes 4 and C, respectively. The mode 2 four-digit reply-code select switches on the front panel select and indicate the mode 2 reply codes. Other than these switches, the receiver-transmitter is controlled by the positions of the switches and controls on the transponder control. The receiver-transmitter responds only to interrogating signals that correspond to the preset modes and codes. The receiver-transmitter is mounted on the Auxiliary Radio Rack, Station 230.

Antenna AT-741/A

Two antennas are provided with the AIMS/IFF Transponder System. The antennas receive interrogation signals from other stations and radiate the reply signals generated in the receiver-transmitter. The antennas are mounted on the top and bottom of the fuselage. Either or both antennas may be connected to the receiver-transmitter through the antenna switching unit, which is controlled by the IFF antenna switch.

Antenna Switching Unit SA-1474/A

The antenna switching unit is connected in the radio frequency path between the antennas and the test set, or between the antennas and the receiver-transmitter when the test set is replaced by the bypass cable. The antenna switching unit is controlled by the IFF antenna switch and is located on the AUX Radio Rack, Station 230.

IFF Antenna Switch

The IFF antenna switch panel contains a three-position toggle switch with positions TOP, BOTH, and BOT (bottom). In the TOP position, the antenna switching unit connects the receiver-transmitter to the top antenna on the aircraft and to the bottom antenna on the aircraft in the BOT position. When set to BOTH, the antenna switching unit alternately connects the receiver-transmitter to the top and bottom antennas at a rate of approximately 38 times per second. The IFF antenna switch is located on the pilot's overhead panel.

Note

Set the IFF antenna switch to the BOTH position for normal operation. (When operation of the IFF system is limited to only the top antenna, sensitivity of the system to interrogators located below and to the rear of the aircraft will be reduced.)

IFF CAUTION Light

The IFF CAUTION light illuminates when the IFF caution light circuit detects an inoperative mode 4 capability, provided the transponder computer is installed, aircraft power is on, and the IFF MASTER control is not off. Specific discrepancies monitored by the IFF caution light circuit are: (1) mode 4 codes zeroized, (2) transponder failure to reply to proper mode 4 interrogation, or (3) the automatic self-test function of the computer reveals a faulty computer. The IFF CAUTION light is located on the copilot's instrument panel.

Transponder Test Set TS-1843A/APX

The test set provides the capability of testing the AIMS/IFF Transponder System on a go/no-go basis in all modes, except mode 4. The test set is in the radio frequency path between the receiver-transmitter and the antenna switching unit. When one of the mode 1, 2, 3/A, or C switches are placed in the TEST position, interrogate pulse pairs for the selected mode are generated; These interrogations are applied to the receiver-transmitter to check for proper receiver frequency, sensitivity, and decoding. The test set analyses the resulting transmitter replies for proper frequency, power, bracket spacing, and antenna-circuit vswr. If all tests are within specified limts, the test set causes the TEST light on the transponder set control to illuminate, providing a go indication. The test set is mounted on the AUX Radio Rack, Station 230. A bypass cable may be used in lieu of the test set with subsequent loss of go/no-go testing capability for modes 1, 2, 3/A and C. The bypass cable is mounted in clips adjacent to the test set.

Operation

1. The starting procedure is as follows:

   a. Turn on electric power.

   b. Set transponder control MODE 1 and 3/A code select switches to the required operational code.

   c. Set receiver-transmitter MODE 2 code select switches to the required operational code.

   d. Set transponder control mode enable switches M-1, M-2, M-3/A, and M-C to ON (unless operational requirements specify that only certain modes are to be used, then set all other mode switches to OUT).

   e. Set the transponder control MODE 4 ON-OUT switch to ON and CODE switch to A or B (as required) when equipped with the transponder computer and flying into a known mode 4 interrogating environment.

   f. Set transponder control RAD TEST-OUT-MON switch to OUT, AUDIO-OUT-LIGHT switch to LIGHT, and IDENT-OUT-MIC switch to OUT.

   g. Set the prevailing atmospheric pressure on the barometric displays of the altimeter-encoder and altimeter. The altimeters should indicate local altitude.

   h. Set transponder control MASTER switch to STBY for one minute (normal ambient temperature) or five minutes (extremely low ambient temperature), then set to NORM.

2. The self-test procedure is as follows:

   a. Press to test the REPLY and TEST light. The lights should illuminate.

   b. Press to test the IFF CAUTION light. The lamp should illuminate.

Note

If the mode 4 codes are zeroized the light will be on before and after this test.

   c. Set transponder control mode enable switches M-1, M-2, M-3/A, and M-C in sequence to TEST. The TEST indicator should illuminate when each switch is in the TEST position indicating a system go condition for the particular mode being tested. Reset the mode enable switches to ON or OUT as required.

   d. The transponder computer automatically performs a self-test of the mode 4 circuits. Observe that the IFF CAUTION light is off. The IFF CAUTION light will illuminate when a mode 4 no-go condition is detected.

3. Normal operating procedures are as follows:

   a. Mode 4 monitoring. Set the transponder control AUDIO-OUT-LIGHT switch to AUDIO to provide aural and visual (REPLY light) monitoring of valid mode 4 interrogations and replies. Set the AUDIO-OUT-LIGHT switch to enable REPLY light monitoring only, if desired.

   b. Monitoring modes 1, 2, 3/A and C. Set the transponder control RAD TEST-OUT-MON switch to MON for monitoring replies to the selected 1, 2, 3/A and/or C operating modes.

   c. Antenna selection. Set the IFF antenna switch to TOP, BOT (bottom), or BOTH as required.

   d. Identification of Position (I/P) Operation. The receiver-transmitter will transmit specially coded I/P reply signals to mode 1, 2, or 3/A interrogations when the IDENT-OUT-MIC switch on the transponder control is energized. Transmission of the I/P reply signals requires the appropriate mode enable switches to be in the ON position. Use one of the following two methods to control the transmission of the I/P reply signals.

      (1) Momentarily hold the IDENT-OUT-MIC switch in the IDENT position (spring-loaded return to OUT) and then release it. This action will cause the receiver-transmitter to transmit the I/P reply signals for a period of 15 to 30 seconds in response to mode 1, 2, or 3/A interrogation. Repeat as required.

      (2) Place the IDENT-OUT-MIC switch in the MIC position. I/P reply signals can now be transmitted by momentarily keying the UHF command transceiver. When the need for the transmitting further I/P reply signals cease, return the IDENT-OUT-MIC switch to the OUT position.

4. Emergency operating procedures are as follows: During an aircraft emergency or distress condition, the system may be used to transmit specially coded emergency reply signals to mode 1, 2, or 3/A interrogations. These emergency reply signals will be transmitted as long as the MASTER control on the transponder control remains in the EMER position, regardless of the positions of the mode enable switches. For emergency operation, set the MASTER control as follows:

   a. Lift the MASTER control knob and rotate to the EMER position.

   b. When the emergency is over, return the MASTER control to NORM or LOW position.

5. Inoperative Mode 4 Operation. When illuminated, the IFF CAUTION light signifies that the AIMS/IFF equipment will not respond to mode 4 interrogations, and that operation in a known mode 4 interrogating environment should be avoided. If the IFF CAUTION light remains illuminated, the applicable flight procedures should then be employed that are operationally directed for an inoperative mode 4 condition.

6. The stopping procedure is as follows:

   a. Set the transponder control CODE switch to HOLD if required.

   b. Set the transponder control MASTER switch to OFF. Set the IDENT-OUT-MIC, M-1, M-2, M-3/A, M-C, MODE 4, AUDIO-OUT-LIGHT, and RAD TEST- OUT-MON switches to OUT.

   c. Turn off electrical power.

SEARCH RADAR (AN/APS-42)

The AN/APS-42 is an airborne navigation and search radar. The set has four main uses: to detect obstacles which could cause a collision, for spotting weather disturbances, for navigation, and for mapping terrain. The set provides a visual indication of the position of cities, landmarks, shorelines, islands, ships, other airplanes, and cloud formations. The position of such targets is indicated visually in range and azimuth in relation to the heading of the airplane. Coded radar beacon indications can also be received and are presented in the conventional spaced code groups. A control panel (figure 4–30) on the radio and radar control consoles is used to operate the set. Indications from the set are fed to a search radar scope (14, figure 4–30) at the navigator's station and to a second scope at the pilots' station. Control power is 28-volt dc, and operating power is 115-volt ac with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37).

Note

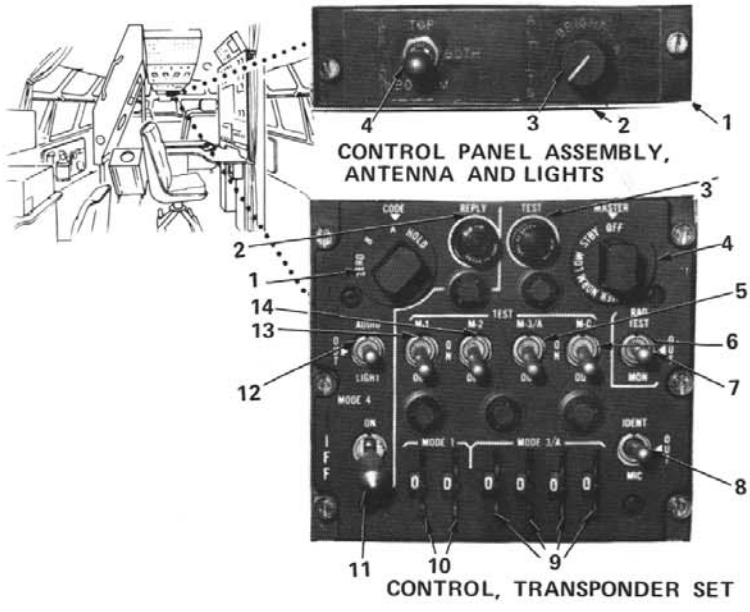
When two or more airplanes with search radar sets in operation are flying in close proximity (formation, A/R rendezvous, etc), the signals from one search radar set can cause a ghost image to appear on the search radar set in the other airplane(s).

Search Radar Controls

Antenna Heater Switch. The antenna heater switch (9, figure 4–30), with HTR and OUT positions, is on the search radar control panel. The switch energizes a resistance heater on 17260 ▶ 2859 when the switch is in the HTR position. When ambient temperature is of the order of −10°C (+14°F) or less, the antenna heaters should be energized. On 2860 ▶, no heaters are installed in the antennas, and radar functions are deenergized in these airplanes when the switch is positioned to HTR.

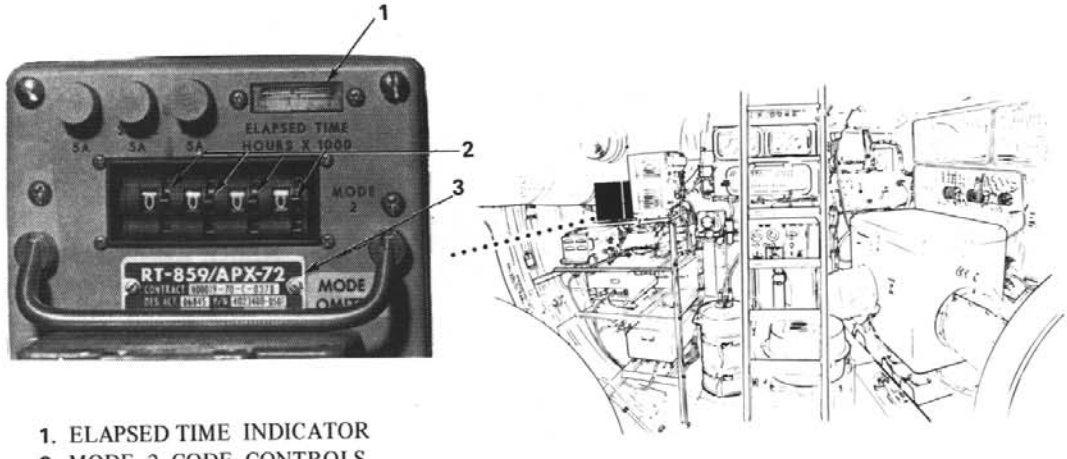
Function Switch. The function switch (13, figure 4–30) is on the search radar control panel. The switch has OFF–STANDBY–SEARCH–BEACON–WEATHER positions. In the STANDBY position, there is no transmission or reception of the radar set. In the SEARCH position, objects such as airplanes, surface vessels, rivers, land, landmarks, and the like, are indicated up to a

AIMS/IFF CONTROL PANEL



1. CONTROL PANEL ASSEMBLY
2. PLACARD
3. RHEOSTAT
4. SWITCH ANTENNA SELECTION

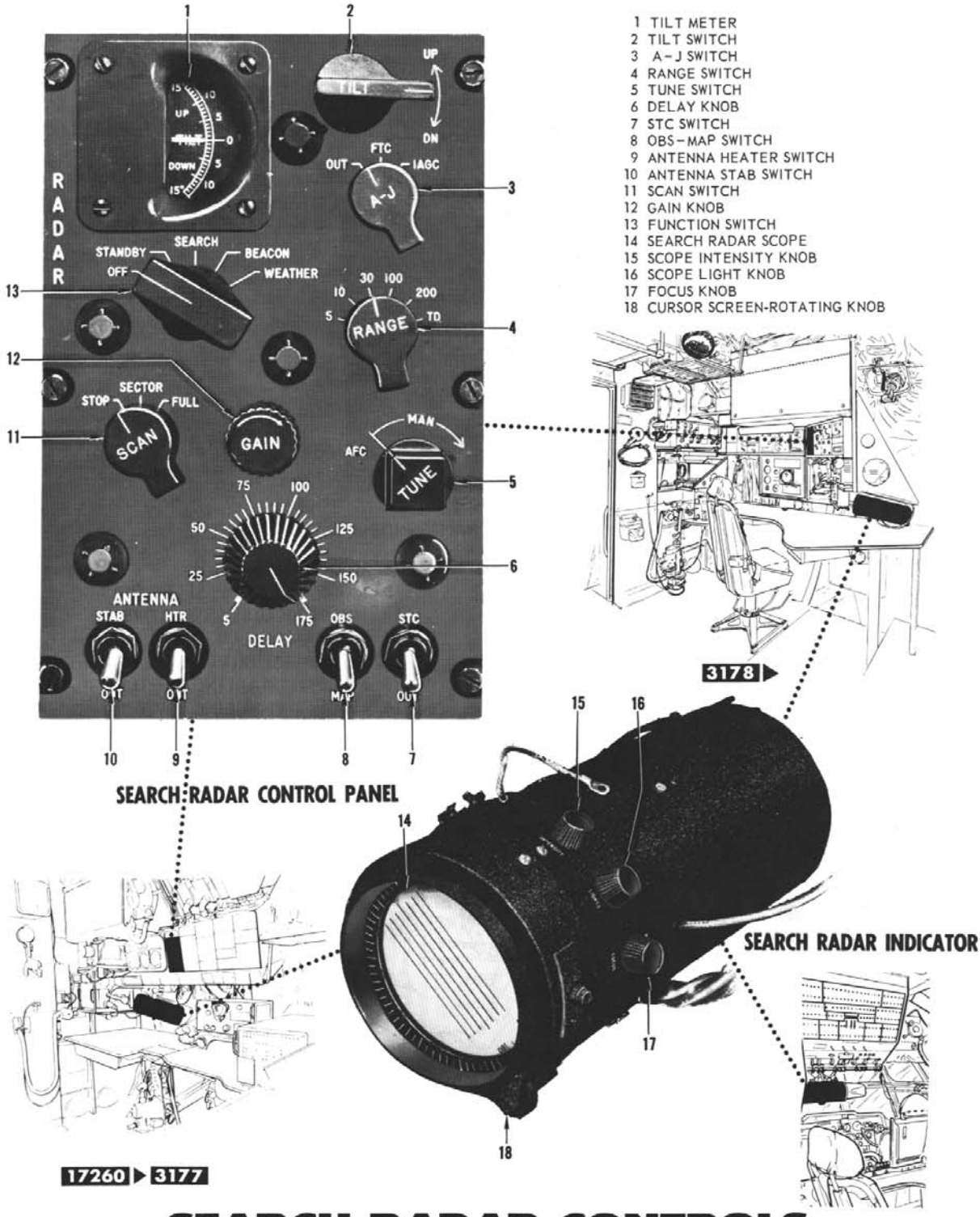
1. MODE 4 CODE SWITCH
2. MODE 4 REPLY LIGHT
3. TEST LIGHT
4. MASTER SWITCH
5. MODE 3/A ENABLING SWITCH
6. MODE C ENABLING SWITCH
7. RAD TEST/MON SWITCH
8. IDENT/MIC SWITCH
9. MODE 3/A CODE SELECTORS
10. MODE 1 CODE SELECTORS
11. MODE 4 ON/OUT SWITCH
12. MODE 4 AUDIO/LIGHT SWITCH
13. MODE 1 ENABLING SWITCH
14. MODE 2 ENABLING SWITCH



1. ELAPSED TIME INDICATOR
2. MODE 2 CODE CONTROLS
3. POWER AND CONTROL

AIMS/IFF CONTROLS

Figure 4-29.



SEARCH RADAR CONTROLS AND INDICATORS

Figure 4–30

distance of approximately 200 nautical miles. In the BEACON position, signals from beacon stations only are displayed on the search radar indicators. The beacon presentations in range and azimuth provide navigational information to determine the course and location of the airplane. In the WEATHER position, the search radar indicators show cloud formations and storm fronts indicative of the surrounding weather conditions. Signal strength from cloud formations, indicated in relative brightness on the scope, is dependent upon the moisture content or density of the cloud formation. Indications as interpreted by the observer from light or thin formations are therefore less apparent than those from more dense or heavy formations. With the range switch in the TD (target discrimination) position, any 30-mile sector of range may be expanded to full size on the scopes of the search radar indicators. This feature permits the observer to obtain greater detail of terrain or objects. OFF position aids in securing the set.

Scan Switch. The scan switch (11, figure 4–30) on the search radar control panel has STOP–SECTOR–FULL positions. In the STOP position, the search radar antenna mechanism is deenergized and no antenna scan takes place. In the SECTOR position, the antenna scans a 120-degree sector, 60 degrees each side of the heading of the airplane. Display is automatically offset on all ranges except the 200-mile position. In the FULL position, the antenna will scan 360 degrees although only 240 degrees of display on the scope will be available.

Gain Knob. The gain knob (12, figure 4–30) is on the search radar control panel. The knob adjusts the gain of the receiver portion of the set to control the level of the video signals supplied to the search radar scopes.

A–J Switch. The A–J switch (3, figure 4–30) on the search radar control panel has OUT–FTC–IAGC positions. In the OUT position, the FTC and IAGC circuits are inoperative. In the FTC (fast time constant) position, the FTC circuit is operative, reducing clutter and sharpening up targets displayed on the scope. In the IAGC (instantaneous automatic gain control) position, both the FTC and IAGC circuits are operative. Clutter is practically eliminated and all targets are sharpened.

Antenna Stab Switch. The antenna stab switch (10, figure 4–30) on the search radar control panel has STAB–OUT positions. In the STAB position, the antenna stabilization mechanism performs compensating motion in both the pitch and roll axes. In the OUT position, the antenna stabilizing mechanism does not function, and the search radar antenna remains in its fixed upright position relative to the airplane.

OBS–MAP Switch. The OBS–MAP switch (8, figure 4–30) on the search radar control panel has OBS–MAP positions. In the OBS (obstacle) position, the search radar antenna radiates a normal pencil beam. In the MAP (mapping) position, the antenna radiates an equal-energy-return beam (cosecant-squared beam). The BEACON position of the function switch provides automatic change to MAP.

Tilt Switch. The tilt switch (2, figure 4–30) with UP–DOWN positions is on the search radar control panel. The UP and DOWN positions are momentary, whereas the switch is spring-loaded to the center position. In the center or rest position, the tilt mechanism of the search radar is inoperative. In the UP position, the antenna is tilted upward continuously, elevating the beam. In the DOWN position the antenna is tilted downward continuously, depressing the beam.

Note

The limits of elevation and depression are reached by holding the tilt switch in the UP and DOWN positions respectively. Releasing the tilt switch causes the antenna to remain in the elevated or depressed position arrived at when the tilt switch was released. The degree or elevation or depression is indicated by the tilt meter. The limits of elevation or depression are set by physical stops and a friction clutch that functions automatically and independently of the tilt switch.

Range Switch. The range switch (4, figure 4–30) on the search radar control panel has five range positions and a TD position. The switch may select any of the first five range positions which vary from 5 to 200 nautical miles. By selecting TD (target discrimination), a 30-mile range sector is presented on the search radar scopes. This 30-mile range sector is manually and continuously variable to start at any desired point between 5 to 175 miles in range.

Delay Knob. The delay knob (6, figure 4–30) is on the search radar control panel. This control, which is calibrated in nautical miles, provides adjustment in range of a marker spot which appears in presentation with the first five settings of the range switch. The control also provides manual adjustment of start of the 30-mile range sector when the range switch is in the TD position.

Tune Switch. The tune switch (5, figure 4–30) on the search radar control panel has AFC–MAN positions. With the control in the AFC position (fully counterclockwise), AFC circuits are operative. In the MAN position, the manual tuning equipment is put into operation to control the tuning of the local oscillators.

STC Switch. The STC switch (7, figure 4–30) on the search radar control panel is a two-position OUT–STC control. In the OUT position, STC (sensitivity time control) circuits are inoperative with receiver gain functioning normally. In the STC position, STC circuits are operative to reduce the intensity of nearby targets and clutter. Effect is noted in the first 3 or 4 miles of range with a 10-mile maximum adjustment.

Scope Intensity Knob. The scope intensity knob (15, figure 4–30) on the search radar indicator is used to adjust the intensity of the display on the search radar scope.

Scope Light Knob. The scope light knob (16, figure 4–30) on the search radar indicator varies the

brightness of the illuminating lights for observing cursor marks and the azimuth scale. The knob also varies the brightness of the range marker and TD lights on the upper rim of the search radar scope.

Focus Knob. The focus knob (17, figure 4–30) on the search radar indicator is used for focusing or sharpening the display on the search radar scope.

Cursor Screen-Rotating Knob. The cursor screen-rotating knob (18, figure 4–30) on the search radar indicator is used to rotate the cursor lines to the desired azimuth positions.

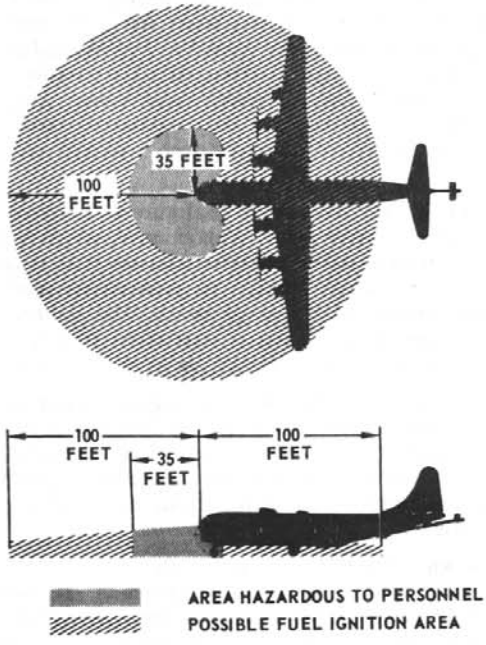
Search Radar Indicators

Search Radar Scope. The search radar scope (14, figure 4–30) on the search radar indicator displays the signals to be interpreted by the operator.

Normal Operation of Search Radar

The search radar set is put into normal operation when the airplane is airborne as follows:

a. Place the antenna heater switch to OUT.



NOTE:
Accidental entry into the hazard area does not result in injury. It is only through prolonged exposure that the possibility of danger exists.

ANTENNA RADIATION PATTERN

Figure 4–31

b. Turn the function switch from OFF to STANDBY. Wait until the normal operating delay of approximately 3 minutes is over. When the needle on the tilt meter can be moved from the zero-degree calibration by operating the tilt switch, this time delay is complete.

WARNING

Before starting the transmitter, ascertain that all personnel are clear of the antenna radiation pattern. Avoid directing the energy beam toward inhabited structures or other personnel groupings, or areas where airplanes are being serviced with fuel. See figure 4–31.

CAUTION

- When starting the search radar set at low ambient temperature, either in flight or on the ground, the procedure should be varied to prevent possible damage to the equipment. Before turning the function switch from OFF to STANDBY, first place the range switch to 100 and the scan switch to FULL. Then place the function switch to STANDBY and wait 5 minutes (10 minutes at ambient temperature below −20°C (−4°F)) before operating any other controls of the radar set. This permits initial rotation of the antenna at its slowest speed and prevents overloading the antenna drive motor and gear train. When the antenna system is operating normally after the specified time period, turn the range switch to 10 and the function switch to either SEARCH, BEACON, or WEATHER position, depending on the type of operation desired.
- Turning the function switch to any other position beyond STANDBY, with the range switch on 100 or beyond, before the radar set has reached full operating temperature can cause severe damage to electronic circuits and may render the set completely inoperative.

Note

There is no sweep on the search radar scopes during the time delay period.

c. Adjust the scope intensity knob on the search radar indicators so that the sweep line appears plainly on the scope.

d. Adjust the focus knob on the indicators so that the sweep line appears sharp and clear. Alternately readjust the focus knob and the scope intensity knob until a clear, sharp, sweep line is obtained.

e. Rotate the scope intensity knob slowly counterclockwise until the sweep line is just visible on the screen. The set should now operate in any desired function.

Search operation is accomplished by the following procedure:

a. Set the function switch to the SEARCH position.

b. Place the scan switch in the FULL position. The type of scanning performed will be shown on the search radar scopes with the sweep trace rotating a full 360 degrees around their centers. With the antenna scanning, the range marks appear as circles centered about the beginning of the sweep. From these circles, target ranges are determined.

c. Observation of specific objects in the direction of the airplane heading is slightly improved by utilizing sector scan. General coverage of the area is obtained with the full scan condition.

d. Rotate the gain control clockwise thus causing moving object and fixed echoes to appear on the indicator screen. Adjust the gain control for the best display; that is, for clearest viewing and highest degree of definition. For optimum adjustment after the proper setting of the gain control, reduce the intensity so that the sweep trace is just barely visible.

e. Utilize the A–J switch to obtain better definition of targets. Heavy masses of objects or sea return that may obscure lesser objects will be materially reduced by setting the A–J switch to FTC position. Further sharpening of the display may be obtained by utilizing the IAGC position. Utilize the position that gives the clearest indication and readjust the gain control if necessary. The A–J switch should not be used, however, unless necessary to obtain proper definition, since its use reduces the overall sensitivity of the video circuits and makes small objects, such as approaching airplanes, more difficult to detect on the longer ranges.

f. Place the STC switch on the STC position. This will reduce the intensity of nearby objects, ground clutter, and sea return. The STC circuits are effective up to 10 miles of range. Utilize the STC switch position (STC or OUT) that gives the clearest indications.

g. Place the antenna stab switch in the STAB position. This activates the roll-and-pitch-stabilization mechanism and circuits, maintaining the antenna in its normal position relative to the horizon regardless of the roll or pitch of the airplane.

h. Observe the two antenna beam pattern conditions from the displays by placing the OBS–MAP switch alternately in the OBS and MAP positions. When the airplane is airborne, terrain objects will be more apparent on lesser ranges when the OBS–MAP switch is in the MAP position. The mapping beam, which has an equal-energy-return pattern, is utilized to its best advantage when the antenna is set at zero tilt and the stabilizer is in operation. The OBS position utilizes the pencil beam which is generally used to observe objects at the longer ranges or at the same approximate altitude as the airplane. When observation of a particular object is desired, the antenna tilt switch may be used for the desired elevation or depression angle necessary for the best indicator presentations.

i. Operate the tilt switch in the UP and DOWN positions and note the tilt action and degree of tilt of the search radar antenna as indicated by the tilt meter. Optimum detection and indication with the mapping beam is generally obtained when the antenna tilt is set at zero. The normal tilt setting of the antenna when the OBS (pencil) beam is used is zero degrees. This condition is normal for observing obstacles or objects in the same approximate altitude as the airplane, and the longer range ground targets. Such objects may include mountain ranges and peaks, clouds, or other airplanes. It should be noted that under these conditions, nearby terrain objects are less clear on the indicator than when using the map beam. Other degrees of antenna tilt may be used at the discretion of the operator. These conditions generally involve the observation of particular objects which require elevation or depression of the antenna for best indication. Other conditions may be those which require simultaneous observation of airborne objects requiring a compromise setting of the antenna tilt angle.

j. Adjust the light control on the indicator for satisfactory illumination of range-marker lights and cursor.

k. Set the range switch to the desired range. Different range settings may require slight readjustment of the antenna tilt for the desired beam coverage. When the range switch is in the TD position, the 30-mile range sector, manually variable by means of the delay control, is displayed on the search radar scope. This range sector affords the operator a magnified presentation of objects on the longer ranges.

l. Turn the tune switch to MAN and check whether sharper tuning may be obtained manually than with AFC.

m. Rotate the cursor screen by means of the knurled knob to find the exact azimuth bearing of targets.

The beacon function is employed to find navigational and homing information from radar beacons at ranges up to 200 nautical miles. During beacon operation, the equipment is responsive only to X-band radar signals, and does not display normal radar targets. Since the beacon indications are in terms of range and azimuth, the navigator may employ this information for plotting a course. If homing is desired, the pilot will head the airplane so that the beacon signal appears in the zero-degree heading on the indicator. Other courses may also be conveniently plotted from two or more beacon signals. During beacon operation, the mapping beam is automatically selected.

Beacon operation is accomplished as follows:

a. Set the function switch to BEACON.

b. Set the range switch to the desired range where beacons are expected. A picture of all the beacon stations within the range of the equipment may be secured by utilizing the 200-mile maximum range. The lesser range positions may be used when looking for beacon stations of known locations. When homing on a beacon, the range settings should be correspondingly reduced to provide optimum indications as the airplane approaches the beacon location. For reading distant beacons, the range switch may be placed in the TD position, thus providing an amplified view within a 30-mile range sector. Intermittent rather than continuous operation on beacon is recommended to avoid overloading the beacon transmitter.

c. Utilize antenna stabilization by placing the antenna STAB switch in the STAB position.

d. Adjust the brightness of the indicator edge lights and range-marker lamps by means of the scope light knob for best viewing conditions of indicator presentation and the azimuth scale.

e. Adjust the scan switch to the position giving the type of scanning desired, SECTOR or FULL. If the beacon station is being used for homing, or is within a sector of 120 degrees ahead of the airplane, sector scan may be preferred.

f. Adjust the gain control for the best presentation of beacon signals.

g. Adjust the tilt switch for best signal response.

h. The range may be determined from the range marker rings. All ranges of beacon stations are referenced from the indicator origin to the first line of arc of the beacon signal.

Weather function provides indication of surrounding weather conditions from cloud and storm-front formations. Locations of formations are presented on the indicator screen in terms of range and azimuth in the same manner as that for the search function. Indication presentations also show the relative character and size of cloud and storm-front formations, thus providing the pilot with useful information for determining this course. Weather operation is accomplished as follows:

a. Place the function switch in the WEATHER position.

b. Place the range switch in the proper position to cover the range within which information is desired. When making the initial survey of the area, it may be preferable to make observations in the maximum 200-mile range, and then to select the lesser range or the 30-mile TD sector to observe particular formations.

c. Adjust the scan switch to the position giving the type of scanning desired, SECTOR or FULL. If storm avoidance is of primary concern, place the scan switch in the SECTOR position.

d. Place the OBS–MAP switch in OBS position. The obstacle or pencil beam provides best presentation of cloud and storm-front formations, since it eliminates ground targets and clutter.

e. Adjust antenna tilt to the zero tilt position with the tilt switch. Vary the antenna slightly with the tilt switch for the most clearly defined presentation. On OBS operation, ground indications may be practically eliminated by means of the tilt adjustment, providing the best analysis of weather conditions.

f. Heavy clouds and storm fronts having higher moisture content produce stronger and more intense indications than lighter clouds and lighter formations. An experienced operator has no great difficulty in interpreting presentations.

g. Amplified presentations, as provided by the 30-mile TD range sector, provide a more complete analysis of the formations. TD operation of the equipment for weather is the same as in the search function.

To place the equipment in standby, turn the function switch to the STANDBY position.

Search Radar – Turnoff

The search radar set is turned off by the following procedure:

a. Turn gain knob fully CCW.

b. Place scan switch to STOP with trace at 180 degrees.

c. Turn intensity knobs fully CCW.

d. Hold tilt Switch at UP position until 10-degree tilt is registered.

e. Place A–J switch to OUT.

f. Place range switch to 10.

g. Turn tune switch to AFC.

h. Turn delay knob fully CW.

i. Place antenna STAB switch to OUT.

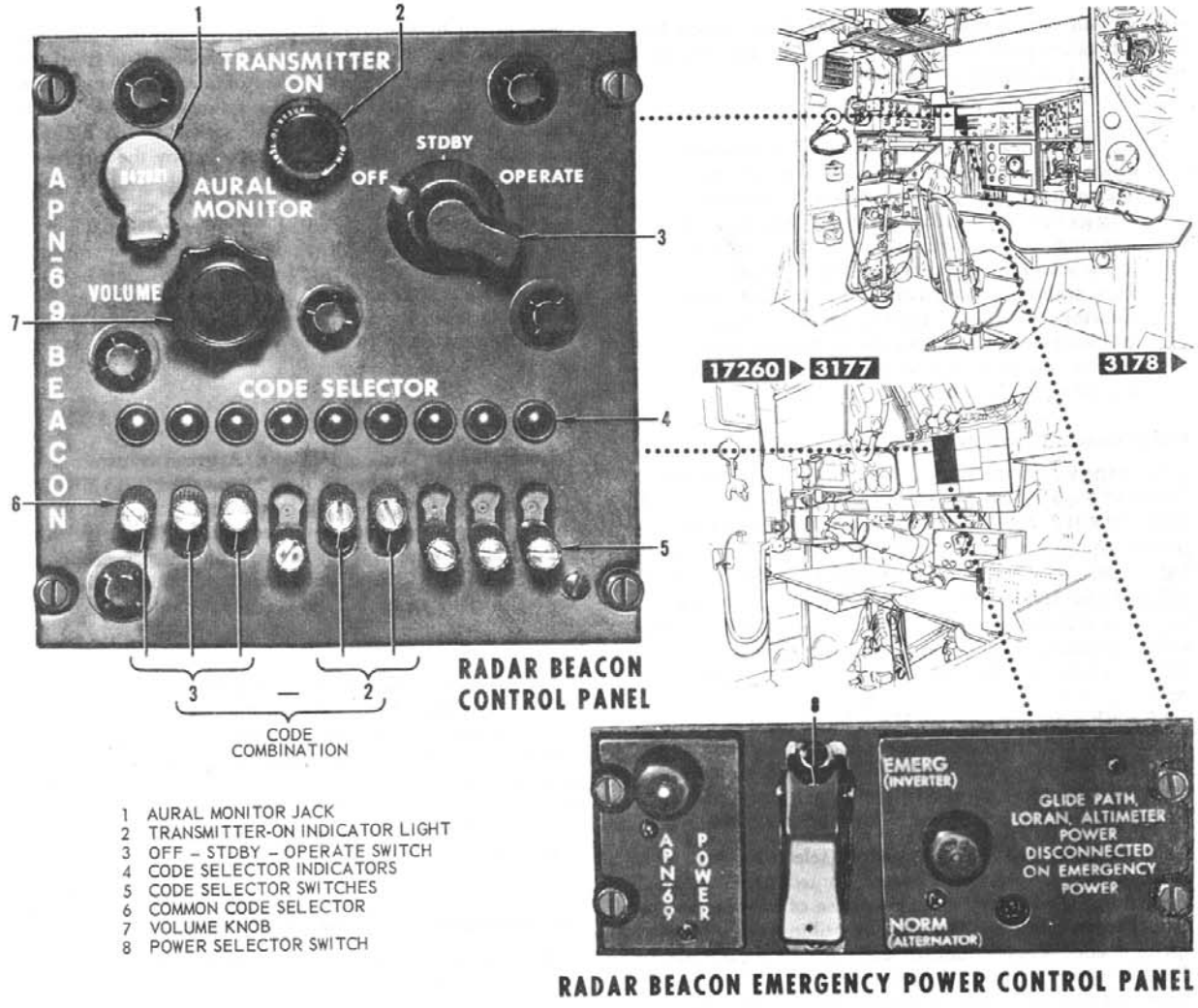
j. Place function switch in the OFF position to completely deenergize the equipment.

Note

The scope intensity knob and the scope light knob on the pilots' indicator should be full CCW when the indicator is stowed or not in use.

RADAR BEACON (AN/APN-69)

The radar beacon is used primarily as a navigational aid for air-to-air rendezvous and for formation station keeping. Two control panels (5 and 6, figure 4–19) are used to operate the set. After the equipment is energized and the desired code has been selected, the beacon operates automatically. During flight, coded reply signals are transmitted when the beacon responds to interrogation pulses from any suitably equipped radar. The beacon's response is indicated by a distinctive display on the scope of the interrogating radar. From this display, the operator of the



1 AURAL MONITOR JACK
2 TRANSMITTER-ON INDICATOR LIGHT
3 OFF – STDBY – OPERATE SWITCH
4 CODE SELECTOR INDICATORS
5 CODE SELECTOR SWITCHES
6 COMMON CODE SELECTOR
7 VOLUME KNOB
8 POWER SELECTOR SWITCH

RADAR BEACON EMERGENCY POWER CONTROL PANEL

RADAR BEACON CONTROLS

Figure 4–32

interrogating radar may identify the beacon-equipped airplane and determine its range and bearing. The response of the beacon is also indicated by a tone on the interphone. The tone can be heard by the navigator if the APN-69 MONITOR interphone mixer switch is ON (up). The reply code is established by positioning the code selector switches at the bottom of the control panel. There are 52 usable codes available. A typical code is selected as follows: For this example, the code designated 3–2 will be used. Three dash two indicates that the beacon will transmit three code elements (pulses), pause, and then transmit two code elements. Each knob on the bottom of the control panel represents one code element. The code elements are numbered from one to nine starting from the left. The first knob is stationary so the first code element is always transmitted. Therefore, the second and third knobs (first two movable code selector switches) must be ON (up) to give three successive pulses, the fourth knob must be OFF (down) to give the correct pause, the fifth and sixth knobs must be up to give the final two pulses of the code, and the remaining knobs must be down. See figure 4–32. (The correct pause is obtained if one code element is removed from a series – one switch down.) The selected code is indicated by the indicator lights above the knobs. For the code used in the above example, the first, second, third, fifth, and sixth lights would be lit. The set is turned on and off with the OFF–STDBY–OPERATE switch and is operative when the transmitter-on light is illuminated. Operating power is 115-volt ac and control power is 28-

volt dc with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37) and the alternator relay shield (16, figure 1–37).

Note

The radar beacon may trigger itself occasionally which will be indicated on the interphone by an intermittent click or buzz. When the beacon is triggered by a radar set whose antenna is scanning, a buzz will be heard in the headset at the scanning frequency of the radar antenna. This scanning frequency will be quite low, sometimes as low as four scans per minute. If the radar is not scanning but is directed on the beacon, a tone of approximately 300 cycles per second will be heard.

Radar Beacon Controls

OFF–STDBY–OPERATE Switch. The OFF–STDBY–OPERATE switch (3, figure 4–32) has three positions: OFF–STDBY–OPERATE. When the switch is OFF, the beacon equipment is deenergized, except for the panel lights and the code selector indicators. Refer to CODE SELECTOR INDICATORS, this section. Placing the switch to STDBY energizes all circuits, except the high-voltage circuits, after a 30-second delay. Switching to OPERATE makes the beacon completely energized and ready for automatic operation after a 3-minute delay. If the switch has been on STDBY for at least 3 minutes, the beacon will be completely operative as soon as the switch is placed on OPERATE. When it is desired to discontinue operation temporarily, turning the switch to STDBY keeps the beacon ready for immediate use.

Code Selector Switches. Eight code selector switches (5, figure 4–32) on the radar beacon control panel are used to establish the desired code response of the beacon system. The switches are operated by pulling the associated spring-loaded knobs outward and then lifting upward to the ON position or downward to the OFF position. Transmission of a code element occurs only when the corresponding switch knob is in the up position. When the switch knob is down, the corresponding code element is absent from the transmitted code.

Common Code Selector. The common code selector (6, figure 4–32) on the radar beacon control panel, which corresponds to the first code element, is stationary. This first code element is common to all code combinations.

Volume Knob. The volume knob (7, figure 4–32) on the radar beacon control panel adjusts the volume of the beacon tone into the interphone. The volume of the tone is also controlled by the interphone volume knob.

Aural Monitor Jack. The aural monitor jack (1, figure 4–32) on the radar beacon control panel is used for test purposes. When a headset is connected to the jack, random noise (or periodic triggering of the system) may be heard and is indicative of beacon operation.

Power Selector Switch. The power selector switch (8, figure 4–32) on the radar beacon power control panel has NORM–EMERG positions. The switch is protected by a guard in the NORM position. In this position, power to the AN/APN-69 radar beacon set is from the alternator bus No. 2. In the event of failure of the alternator bus No. 2, the radar beacon set may be made operative by placing the power selector switch to the EMERG position. Power will then be supplied by the airplane's essential inverter. However, when the switch is in EMERG, the glide slope receiver, loran, APX-29, and the radio altimeter will be disconnected. When the switch is in the NORM position, circuit protection is from the alternator relay shield (16, figure 1-37). When the EMERG position is selected, circuit protection is from the ac power panel (15, figure 1-37). When the switch is in either position, operating power is 115-volt ac.

Radar Beacon Indicators

Transmitter-On Indicator Light. A green transmitter-on indicator light (2, figure 4–32), marked TRANSMITTER ON, is on the radar beacon control panel. When the master power switch is turned to OPERATE, and a 3-minute warmup period has elapsed, the green press-to-test TRANSMITTER ON indicator light illuminates indicating that the radar beacon is ready for automatic operation.

Code Selector Indicators. Nine code selector indicators (4, figure 4–32) are on the bottom of the radar beacon control panel. The navigator's radio panel lights control controls the brilliance of the indicators. Each code selector switch (5, figure 4–32) controls its respective indicator. The indicators, when illuminated, indicate the presence of a code element inserted in the beacon response.

Normal Operation Of The Radar Beacon

The radar beacon equipment is made operative and inoperative by the following procedure:

a. Place the OFF–STDBY–OPERATE switch to OPERATE. After approximately 3 minutes of warmup period, the green transmitter-on light will illuminate, indicating the system is ready for automatic operation and will reply to interrogating pulses.

b. Set the code selector switches to the desired reply code. As an example of a 3-2 code, the first (which is the stationary one and is common to all code combinations), second, third, fifth, and sixth switch knobs would be placed in the up position. All other switch knobs would be in the down position. This would be a five-element code. The beacon system operation may be monitored by using the interphone mixer switch.

CAUTION

To prevent overloading and damaging the transmitter, do not insert more than six code elements, including the first stationary element, at one time.

c. To discontinue operation temporarily, turn the OFF–STDBY–OPERATE switch to STDBY. The equipment is then kept ready for immediate use.

d. To make inoperative, reset code selector switches to down position and turn the OFF–STDBY–OPERATE switch to OFF.

Note

A suppressor cable connecting the AN/APN-69 radar beacon and AN/APS-42 search radar synchronizer unit prevents blanking of the search radar indicators by temporarily inactivating the AN/APN-69 radar beacon.

RADAR PRESSURIZING SYSTEM

Pressurizing equipment supplies pressurized air to the search radar set (AN/APS-42) for satisfactory operation at high altitudes. The equipment is controlled by a switch on the radar pressurizing control panel (1, figure 4–19) on the navigator's radio and radar control panels. Pressure is maintained at the proper level by a pressure-operated switch within the system. Control power is 28-volt dc with circuit protection on the radio junction box circuit breaker panel (2, figure 1–37).

Radar Pressurizing System Controls

Control Switch. The control switch (4, figure 4–33) on the radar pressurizing control panel has MOMENTARY ON–OFF–NORMAL ON positions. The switch, guarded to the NORMAL ON position, controls operation of the connected air system. With the switch in the NORMAL ON position, intermittent operation of connected equipment is automatic with results indicated on the control panel. Switch positions MOMENTARY ON and OFF are used for testing and emergency.

Bleed Valve Knob. The bleed valve knob (3, figure 4–33) on the radar pressurizing control panel is marked PUSH TO BLEED. When the knob is pushed in, it mechanically actuates a valve to discharge system compressed air into the cabin. The bleed valve knob is spring-loaded to the extended (bleed valve closed) position.

Radar Pressurizing System Indicators

Pressure Indicator Light. The green pressure indicator light (2, figure 4–33) on the radar pressurizing control panel, when illuminated, indicates that the compressor is operating.

Radar Pressure Gage. The radar pressure gage (1, figure 4–33) on the radar pressurizing control panel indicates system air pressure in inches of mercury. A mask assembly with red and green range markings, leakage test, and calibration marks is fitted over the face of the indicator. The leakage test and calibration marks are used only for ground and flight test of the system after maintenance work has been accomplished.

Radar Pressurizing System Normal Operation

The radar pressurizing system must be turned on when the search radar set is to be operated and left on throughout the operation of the set. At all other times, radar pressurizing should be off. Operation of the system is as follows:

a. Place the radar pressurizing control switch to NORMAL ON; pressure indicator light should come on and remain on until pressure builds up within the green operating range on the radar pressure gage. When pressure stabilizes within the green operating range, the search radar set may be turned on.

b. After the search radar set has been turned OFF, place the radar pressurizing control switch to OFF.

Radar Pressurizing System Emergency Operation

Failure Of Automatic Pressure Regulation. In the event the pressure regulator switch malfunctions or fails and continued operation of the search radar set is essential, radar pressurizing may be maintained by manual control.

a. Place the radar pressurizing control switch in OFF.

b. Bring pressure within green operating range on the radar pressure gage either by holding the pressurizing control switch in MOMENTARY ON, or by pushing and holding in the pressure bleed valve knob.

c. When the pressure drops to the low limit of the green operating range, hold the radar pressurizing control switch in MOMENTARY ON until the pressure builds up to the high limit. Repeat this procedure as necessary to maintain the pressure within the limits of the green operating range.

Note

In an extreme emergency only, when pressure cannot be maintained in the green operating range, but can be kept within the upper and lower limits of the red (marginal) range on the radar pressure gage, the search radar set may be kept in operation by manual tuning of the units.

Inability To Maintain Pressure. If failure of the compressor, broken lines, or similar difficulty, makes it impossible to maintain proper pressure either by automatic or manual means, proceed as follows:

a. Place the radar pressurizing control switch in OFF.

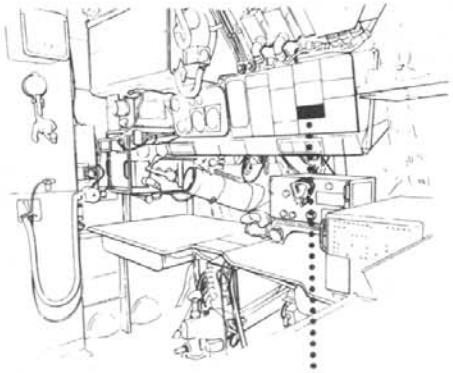
b. Turn off the search radar set.

CAUTION

Continued operation of the search radar set after failure of the radar pressurizing system is likely to result in damage to the search radar components.

STATIC DISCHARGERS

Static dischargers are provided to discharge static electricity from the airplane to the air. The dischargers are tufts of braid located on the wing tips, empennage, and ruddevators.



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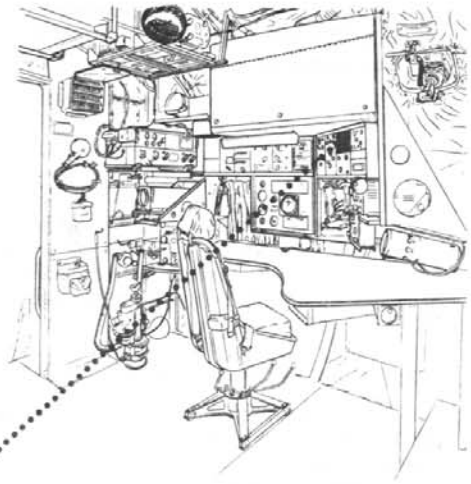

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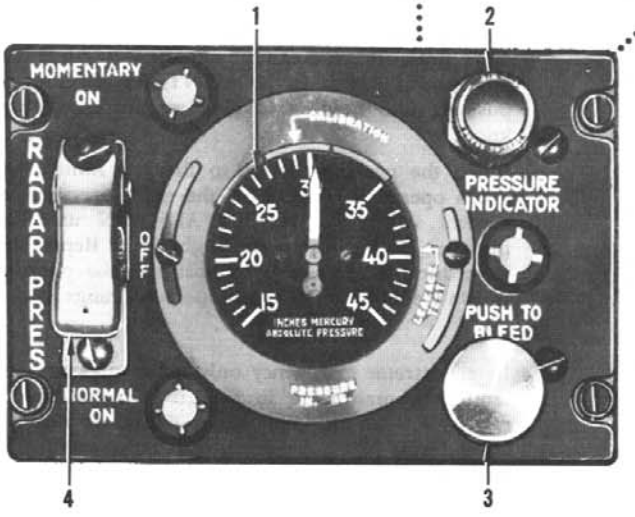
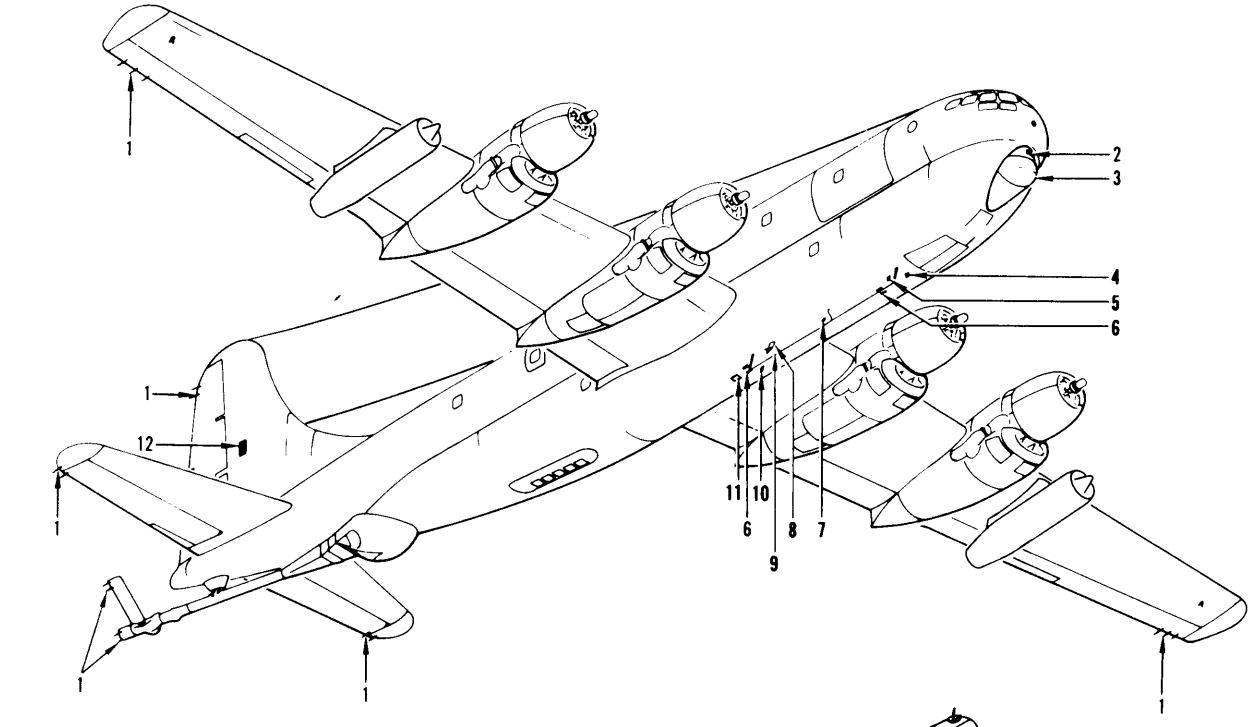


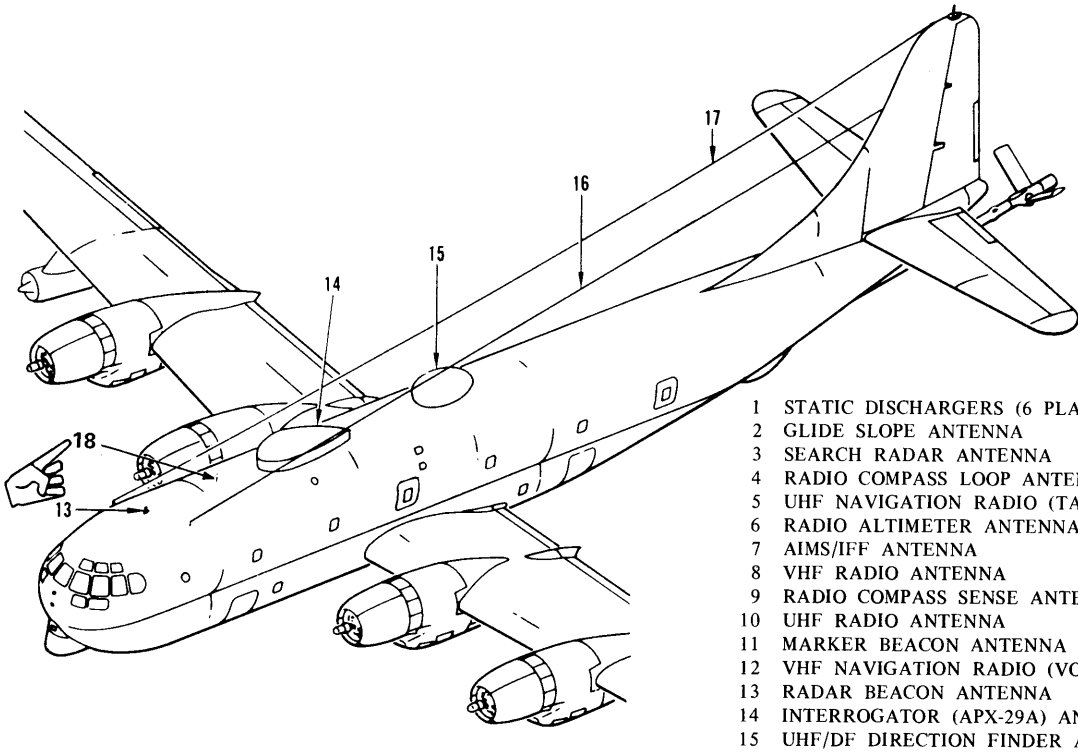
1 RADAR PRESSURE GAGE
2 PRESSURE INDICATOR LIGHT
3 BLEED VALVE KNOB
4 CONTROL SWITCH

RADAR PRESSURIZING CONTROL PANEL

RADAR PRESSURIZING CONTROLS

Figure 4–33





1 STATIC DISCHARGERS (6 PLACES)
2 GLIDE SLOPE ANTENNA
3 SEARCH RADAR ANTENNA
4 RADIO COMPASS LOOP ANTENNA
5 UHF NAVIGATION RADIO (TACAN) ANTENNA
6 RADIO ALTIMETER ANTENNA (2 PLACES)
7 AIMS/IFF ANTENNA
8 VHF RADIO ANTENNA
9 RADIO COMPASS SENSE ANTENNA
10 UHF RADIO ANTENNA
11 MARKER BEACON ANTENNA
12 VHF NAVIGATION RADIO (VOR) ANTENNA
13 RADAR BEACON ANTENNA
14 INTERROGATOR (APX-29A) ANTENNA
15 UHF/DF DIRECTION FINDER ANTENNA
16 AN/ARC-65 LIAISON RADIO ANTENNA
17 LORAN ANTENNA
18 AIMS/IFF ANTENNA (AT-741/A)

ANTENNA LOCATIONS

Figure 4–34

EQUIPMENT	POWER SOURCE	SYSTEM	AMP	TYPE	LOCATION
AN/APS-42 SEARCH RADAR					
Radar navigation	28V DC	DC	5	Circuit breaker	Radio junction box circuit breaker panel
Radar navigation	Sec Inv	AC	15	Fuse 17260 ▶ 22700	Radio junction box circuit breaker panel
			15	Circuit breaker 22701 ▶	Radio junction box circuit breaker panel
Radar pressurization	28V DC	DC	5	Circuit breaker	Radio junction box circuit breaker panel
Radar feed	Sec Inv	AC	25	Fuse 17260 ▶ 22700	AC power panel
			25	Circuit breaker 22701 ▶	AC power panel
801	Sec Inv	AC	5	Fuse	Synchronizer unit, left front
802	Sec Inv	AC	3	Fuse	Synchronizer unit, right front
401	Sec Inv	AC	10	Fuse	Receiver-transmitter unit, top
NOTE: Fuse 401 is inactive on later sets					
402	Sec Inv	AC	8	Fuse	Receiver-transmitter unit, middle
403	Sec Inv	AC	3	Fuse	Receiver-transmitter unit, bottom
AN/APX-29A INTERROGATOR-RESPONSOR					
Rendezvous APX-29	28V DC	DC	5	Circuit breaker	Radio junction box circuit breaker panel
Rendezvous APX-29	Ess Inv	AC	5	Fuse 17260 ▶ 22700	Radio junction box circuit breaker panel
				Circuit breaker 22701 ▶	
Radio feed	Ess Inv	AC	15	Fuse	AC power panel
F101	Ess Inv	AC	5	Fuse	Receiver-transmitter unit
F102	28V DC	DC	3	Fuse	Receiver-transmitter unit
AN/APN-69 RADAR BEACON					
Rendezvous beacon	28V DC	DC	5	Circuit breaker	Radio junction box circuit breaker panel
Rendezvous beacon	Altern	AC	10	Fuse 17260 ▶ 22700	Radio junction box circuit breaker panel
			10	Circuit breaker 22701 ▶	Radio junction box circuit breaker panel
Radar beacon APN-69	Altern	AC	15	Fuse 17260 ▶ 22700	Alternator relay shield
			15	Circuit breaker 22701 ▶	Alternator relay shield
Radio feed (Emergency Only)	Ess Inv	AC	15	Fuse 17260 ▶ 22700	AC power panel
			15	Circuit breaker 22701 ▶	AC power panel
501	28V DC	DC	1	Fuse	Receiver-transmitter unit, front
502	Altern	AC	6	Fuse	Receiver-transmitter unit, front
503	Altern	AC	3	Fuse	Receiver-transmitter unit, front
504	Altern	AC	3	Fuse	Receiver-transmitter unit, front
RADIO ALTIMETER					
Altimeter	Ess Inv	AC	3	Fuse 17260 ▶ 22700	Radio junction box circuit breaker panel
			5	Circuit breaker 22701 ▶	Radio junction box circuit breaker panel
Radio feed	Ess Inv	AC	15	Fuse 17260 ▶ 22700	AC power panel
			15	Circuit breaker 22701 ▶	AC power panel
101 Active Fuse	Ess Inv	AC	1-1/2	Fuse	Receiver-transmitter unit
B-3 DRIFTMETER 17260 ▶ 22628					
Driftmeter	Ess Inv	AC	1	Fuse 17260 ▶ 22628	AC power panel
B-6A DRIFTMETER 22629 ▶					
Driftmeter A	Aut Inv	AC	2	Fuse 22629 ▶ 3141	AC power panel
			2	Fuse 3142 ▶	Autopilot power panel
Driftmeter C	Aut Inv	AC	2	Fuse 22629 ▶ 3141	AC power panel
			2	Fuse 3142 ▶	Autopilot power panel
AN/ARA-25 DIRECTION FINDER					
UHF/DF	28V DC		5	Circuit breaker	Radio junction box circuit breaker panel
ARA-25 Antenna Heat	Altern		5	Circuit breaker	Alternator Relay Shield, left side
AN/APN-70 LORAN					
Loran	28V DC	DC	5	Circuit breaker 17260 ▶ 22700	Radio junction box circuit breaker panel
Receiving antenna	28V DC	DC	5	Circuit breaker 22701 ▶	Radio junction box circuit breaker panel
Loran	Ess Inv	AC	5	Fuse 17260 ▶ 22700	Radio junction box circuit breaker panel
			5	Circuit breaker 22701 ▶	Radio junction box circuit breaker panel
Radio feed	Ess Inv	AC	15	Fuse 17260 ▶ 22700	AC power panel
			15	Circuit breaker 22701 ▶	AC power panel
PERISCOPIC SEXTANT	28V DC	DC	5	Circuit breaker	Overhead circuit breaker panel
AN/ARN-14 VHF NAVIGATION RADIO (VOR)					
VOR Receiver	28V DC	DC	10	Circuit breaker	Aft radio rack
VOR Test	28V DC	DC	5	Circuit breaker	Aft radio rack
Emp-gnd blower & VOR	28V DC	DC	35	Circuit breaker	Aft power panel
VOR-ILS navigation	28V DC	DC	5	Circuit breaker	Radio rack
AN/ARN-18 Glide Path				Circuit breaker	Radio junction box circuit breaker panel
Glide Path	28 V DC	DC	5	Fuse 17260 ▶ 22700	
Glide Path	Ess Inv	AC	3	Circuit breaker 22701 ▶	Radio junction box circuit breaker panel

NAVIGATION EQUIPMENT CIRCUIT BREAKERS AND FUSES

Figure 4-35 (Sheet 1 of 2)

EQUIPMENT	POWER SOURCE	SYSTEM	AMP	TYPE	LOCATION
AN ARN-21 UHF NAVIGATION RADIO					
Tacan	Sec or Ess Inv	AC	5 5	Circuit breaker 22701▶ Fuse 17260 ▶ 22700	Radio junction box circuit breaker panel Radio junction box circuit breaker panel
Tacan	28V DC	DC	5	Circuit breaker	Radio junction box circuit breaker panel
VOR-ILS navigation	28V DC	DC	5	Circuit breaker	Radio junction box circuit breaker panel
AN/ARN-6 RADIO COMPASS					
No. 1 compass	28V DC	DC	5	Circuit breaker	Radio junction box circuit breaker panel
OUTSIDE AIR TEMPERATURE GAGE					
Temperature cabin, OAT and heaters	28V DC	DC	5	Circuit breaker	Overhead circuit breaker panel
N-1 COMPASS					
Autopilot repeat	Aut Inv	AC	3 5	Fuse 17260 ▶ 22700 Circuit breaker 22701▶	AC power panel AC power panel
Autopilot A	Aut Inv	AC	5 5 5	Fuse 17260 ▶ 22700 Circuit breaker 22701▶ 3177 Circuit breaker 3178 ▶	AC power panel AC power panel Autopilot power panel
Autopilot C	Aut Inv	AC	5 5 5	Fuse 17260 ▶ 22700 Circuit breaker 22701▶ 3177 Circuit breaker 3178 ▶	AC power panel AC power panel Autopilot power panel
Autopilot	28V DC	DC	10	Circuit breaker	Overhead circuit breaker panel
Autopilot inverter	28V DC	DC	5	Circuit breaker	Overhead circuit breaker panel
PANEL LIGHTS					
Panel lights	28V DC	DC	5	Circuit breaker	Radio junction box circuit breaker panel
NAVIGATOR'S TABLE AND INSTRUMENT LIGHTS					
Control Cabin Left red-white	28V DC	DC	15	Circuit breaker	Overhead circuit breaker panel

NOTE

Labeling of circuit - breakers and fuses may differ on some aircraft.

Altern - Alternator
Aut Inv - Autopilot Inverter
Ess Inv - Essential Inverter
Sec Inv - Secondary Inverter

Figure 4-35 (Sheet 2 of 2)

LIGHTING EQUIPMENT

EXTERIOR LIGHTS

The exterior lights all operate on dc power. See figure 4-36 for a listing of the lights, their locations, and their switch and circuit breaker locations. A special group of exterior lights is provided for underbody illumination during night A/R missions. Figure 4-38 shows tanker A/R floodlighting as seen from a receiver airplane. Two sets of anti-collision lights, one set on top and one set on bottom, are mounted on the fuselage. These lights are used as anti-collision and rendezvous lights.

Note

- The anti-collision lights should be turned OFF during flights through conditions of reduced visibility where the pilot could experience vertigo as a result of the rotating reflections of the lights against the clouds. In addition, the lights would be ineffective as anti-collision lights during these conditions since they could not be observed by pilots of other airplanes.

- The anti-collision lights operate on dc power. The motors driving the rotating light assembly operate on step-down ac power from the secondary inverter.

INTERIOR LIGHTS

See figure 4-37 for a listing of interior lights, their locations, and their switch and circuit breaker locations. A box of spare lamps is mounted on the aft left side of the control cabin bulkhead. The fluorescent lights operate on ac power. (See figure 4-39.)

Note

Airplanes 32631▶ do not have fluorescent lights in the main compartment.

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Taxi	2	On fuselage nose and nose landing gear	Overhead panel	Overhead panel (Same as switch)
Passing Light (Red)	1	On fuselage nose	Overhead panel	Overhead panel (Same as switch)
Landing	2	Under each outboard wing aft of rear spar	Control stand	Overhead panel and main circuit breaker panel
Navigation	6	Wing tips, tail cone, top and bottom of fuselage	*Two switches on overhead panel	Overhead panel
Formation	9	Three on the upper surface of each wing, three on top of fuselage	Overhead panel	Overhead panel
Wing Illumination	2	One on each side of fuselage	Overhead panel	Overhead panel (Same as switch)
Anti-Collision	8	Top and bottom of fuselage	Overhead panel	Overhead panel (lights) and ac power panel (motors)
Boom Marking	4	In boom nozzle hood	Two switches on boom operator's panel	Boom operator's panel
Boom Nozzle	2	In boom nozzle hood	Two switch-type rheostats on boom operator's panel	Boom operator's panel
Boom Chock	1	Beside boom stowing chock	Boom operator's panel	Boom operator's panel (Same as switch)
Receiver Director	10	Fuselage underside	Boom operator's panel	Boom operator's panel
Inboard Nacelle Underwing	4	Fuselage underside	Boom operator's panel	Boom operator's panel
Outboard Nacelle Underwing	2	Fuselage underside	Boom operator's panel	Boom operator's panel
Underbody	1	Fuselage underside	Boom operator's panel	Boom operator's panel
Wheel Well	3	One in each wheel well	Overhead panel	Overhead panel (Same as switch)
Rendezvous Beacon	2	Tail cone	Boom operator's panel	Boom operator's panel

NOTE:
*Lights on wing and tail can be set for STEADY or FLASH; lights on fuselage remain on STEADY at all times lights are on.

EXTERIOR LIGHTING

Figure 4–36

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Pilots'...				
Pilots' Instrument Panel (Right Side White)	3	Top of panel under crash pad hood	**Switch-type rheostat on copilot's auxiliary panel	Overhead panel
Pilots' Instrument Panel (Right Side Red)	4	Top of panel under crash pad hood	Switch-type rheostat on copilot's auxiliary panel	Overhead panel
Pilots' Instrument Panel (Left Side White)	3	Top of panel under crash pad hood	**Switch-type rheostat on pilot's auxiliary panel	Overhead panel
Pilots' Instrument Panel (Left Side Red)	4	Top of panel under crash pad hood	Switch-type rheostat on pilot's auxiliary panel	Overhead panel
Pilots' Instrument Panel (Center White)	4	Top of panel under crash pad hood	**Switch-type rheostat on overhead panel	Overhead panel
Pilots' Instrument Panel (Center Red)	5	Top of panel under crash pad hood	Switch-type rheostat on overhead panel	Overhead panel
Pilots' Instrument Panel (White)	2	One on each side of jet engine tachometers	Same rheostat used for pilots' instrument panel center red lights	Overhead panel
Pilots' Control Column (Red)	2	Top forward side of control column	Same rheostat used for pilots' instrument panel left side red lights	Overhead panel
Copilot's Control Column (Red)	2	Top forward side of control column	Same rheostat used for pilots' instrument panel right side red lights	Overhead panel
Copilot's Auxiliary Panel (Red)	3	In tube at top of auxiliary panel	Switch-type rheostat on copilot's auxiliary panel	Overhead panel
Pilot's Auxiliary Panel (Red)	3	In tube at top of auxiliary panel	Switch-type rheostat on pilot's auxiliary panel	Overhead panel
Pilot's Dome (White)	1	Overhead	**Switch on pilot's auxiliary panel	Overhead panel
Copilot's Dome (White)	1	Overhead	**Switch on copilot's auxiliary panel	Overhead panel
Pilot's Map (Red or White)	1	Left side of overhead panel	Switch-type rheostat on side of overhead panel	Overhead panel
Copilot's Map (Red or White)	1	Right side of overhead panel	Switch-type rheostat on side of overhead panel	Overhead panel
B-16 Compass Panel (Red)	1	Right side of pilots' instrument panel	Switch-type rheostat on overhead panel	Overhead panel
Overhead Panel (White)	5	Vertical step portion of the panel sections	**Switch-type rheostat on overhead panel	Overhead panel
Pilot's Altimeter	2	Within instrument	**Switch-type rheostat on overhead panel	AC Power panel

INTERIOR LIGHTING

Figure 4–37 (Sheet 1 of 5)

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Pilots' (cont)...				
Overhead Panel (Red)	7	Vertical step portion of the panel sections	Switch-type rheostat on overhead panel	Radio junction box
Pilot's and Copilot's Interphone Filter	2	On filters	Same rheostat on overhead panel as for red overhead panel lights	Overhead panel
Pilot's and Copilot's Electronic Control Panel	22	VHF radio, liaison, UHF radio, and VHF navigation radio	Control stand lights	
	6 **2901** ▶	On control panels for IFF and auxiliary liaison receiver	Same rheostat used for red overhead panel lights	Overhead panel
Navigator's...				
Navigator's Table Flood 3178 ▶	6 red 3 white	Over navigator's table; under instrument mount	RED–OFF–WHITE switch and switch-type rheostat on navigator's interphone and light panel	Overhead panel
Navigator's Table Work	1 white	Over navigator's table	Switch-type rheostat on navigator's instrument panel and interphone and light panel	Overhead panel
Navigator's Instrument 17260 ▶ **3177**	4 red 3 white	In shield above and below instrument panel	***RED–OFF–WHITE switch and switch-type rheostat on navigator's instrument panel and auxiliary panel	Overhead panel
Navigator's Instrument Panel Flood 3178 ▶	2 red 1 white	In shield above instrument panel	RED–OFF–WHITE switch and switch-type rheostat on navigator's interphone and light panel	Overhead panel
Navigator's Instrument 3178 ▶	14	In individual instruments	Switch-type rheostat on navigator's interphone and light panel	Overhead panel
Navigator's Radio Panel 17260 ▶ **3177**	3 red 2 white	In light shield below panel	***RED–WHITE switch and switch-type rheostat on navigator's radio panel	Overhead panel
Navigator's Electronic Panel 17260 ▶ **3177**	21 to 27	On control panels for interphone, radio compass, and IFF	Switch-type rheostat on navigator's instrument panel	Radio junction box
Navigator's Radio Panel 3178 ▶		In individual electronic equipment	Switch-type rheostat on navigator's interphone and light panel	Radio junction box
Navigator's Auxiliary 3178 ▶	2 white	On aft end of instrument panel flood shield over oxygen regulator	Instrument panel flood switch-type rheostat on navigator's interphone and light panel	Overhead panel

Figure 4–37 (Sheet 2 of 5)

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Engineer's...				
Engineer's Table (White)	2	Over the engineer's table; under engineer's instrument panel	Switch and switch-type rheostat on engineer's auxiliary overhead panel	Overhead panel
Engineer's Table (Red)	3	Over the engineer's table; under engineer's instrument panel	Switch and switch-type rheostat on engineer's auxiliary overhead panel	Overhead panel
Engineer's Instrument Panel Spot (Red or White)	1	On support post at engineer's station and ceiling	Switch and switch-type rheostat on engineer's auxiliary overhead panel	Overhead panel
Engineer's Instrument Panel Flood (Red)	1	At ceiling near center of fuselage	Switch and switch-type rheostat on engineer's auxiliary overhead panel	Overhead panel
Engineer's Dome (Red and White)	1 each	Overhead at engineer's station	Switch and switch-type rheostat on engineer's auxiliary overhead panel	Overhead panel
Overhead Panel Spot (Red or White)	2	On right and left side of control stand	Switch and switch-type rheostat on engineer's auxiliary overhead panel	Overhead panel
Engineer's A/R Panel Lights (Red and White)	1 each	Above engineer's auxiliary overhead panel	Rheostat and color switch on engineer's auxiliary overhead panel	Overhead panel
Engineer's Interphone Control Panel	4	On interphone control panel	Same switch and switch-type rheostat on engineer's auxiliary overhead panel as for engineer's instrument panel spotlights	Overhead panel
Boom Operator's...				
Boom Operator's Dome Lights (Same as Main Compartment Dome Lights)				
Boom Operator's Spotlights (Red or White)	2	Right and left of boom operator's station	Color switch on boom operator's panel	Boom operator's panel
Boom Operator's Panel Lights (White)	4	Forward edges of boom operator's panel	Switch-type rheostat and color switch on boom operator's panel	Boom operator's panel
Boom Operator's Panel Lights (Red)	7	Forward and aft edges of boom operator's panel	Switch-type rheostat and color switch on boom operator's panel	Boom operator's panel
Boom Operator's Oxygen Panel Floodlights (Red) 17260 ▶ 22806	2	Right and left side of boom operator's compartment	Switch-type rheostat on boom operator's panel	Boom operator's panel
Boom Operator's Oxygen Panel Floodlights (Red) 3106 ▶	1	Left side of boom operator's compartment	Switch-type rheostat on boom operator's panel	Boom operator's panel

Figure 4–37 (Sheet 3 of 5)

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Compartment...				
Main Compartment Fluorescent ▲ 17260 ▶ 3267	14	Overhead	*Adjacent to each right side light for five forward lights; adjacent to each left side light for two aft lights	AC power panel
Lower Compartments Fluorescent ▲ 17260 ▶ 3267	6	Overhead; 2 in lower forward and 4 in lower aft compartments	Adjacent to lights	AC power panel
Main Compartment Dome Lights	9	Overhead	One switch-type rheostat on right side of fuselage for each three lights; also, one switch near control cabin door, one switch on right side of fuselage aft section, and one switch on boom operator's panel, each controlling all nine lights	Main circuit breaker panel
Lower Forward Compartment Dome	2	Overhead	Overhead in lower forward compartment adjacent to hatch	Forward power panel
Lower Aft Compartment Dome	3	Overhead	Overhead in aft compartment	Main circuit breaker panel
Stowage Compartment Dome	1	Overhead	Overhead in stowage compartment	Main circuit breaker panel
Tail Compartment Dome	2	Overhead	Forward side of pressure bulkhead on LH side above tail compartment access door	Main circuit breaker panel
Lower Nose Compartment	2	Overhead	Switch adjacent to light aft of hatch	Forward power panel
Spot Extension	2	One at auxiliary power unit and one in lower nose compartment	Switch on light	Forward power panel
Control Cabin Miscellaneous...				
Entrance	1 white	Overhead in control cabin	One at top of ladder in lower forward compartment and one in control cabin adjacent to the entrance light	Forward power panel
Aft Cabin Dome	2 red 1 white	Overhead in control cabin	***ON–OFF switch on navigator's auxiliary panel or support bracket for auxiliary liaison transmitter at control cabin bulkhead	Overhead panel
Dais Step	2 red	One under navigator's table and one near bottom of back side of engineer's instrument panel	On overhead panel	Overhead panel

Figure 4–37 (Sheet 4 of 5)

LIGHTS	QUANTITY	LOCATION	SWITCH LOCATION	CIRCUIT BREAKER
Control Cabin Miscellaneous (cont)...				
Toilet Compartment Dome	1 red 1 white	Overhead in toilet compartment	***In toilet compartment	Overhead panel
Jet Engine Circuit Breaker Panel Lights	2	Jet engine circuit breaker panel	Jet engine circuit breaker panel	Jet engine circuit breaker panel

NOTE:

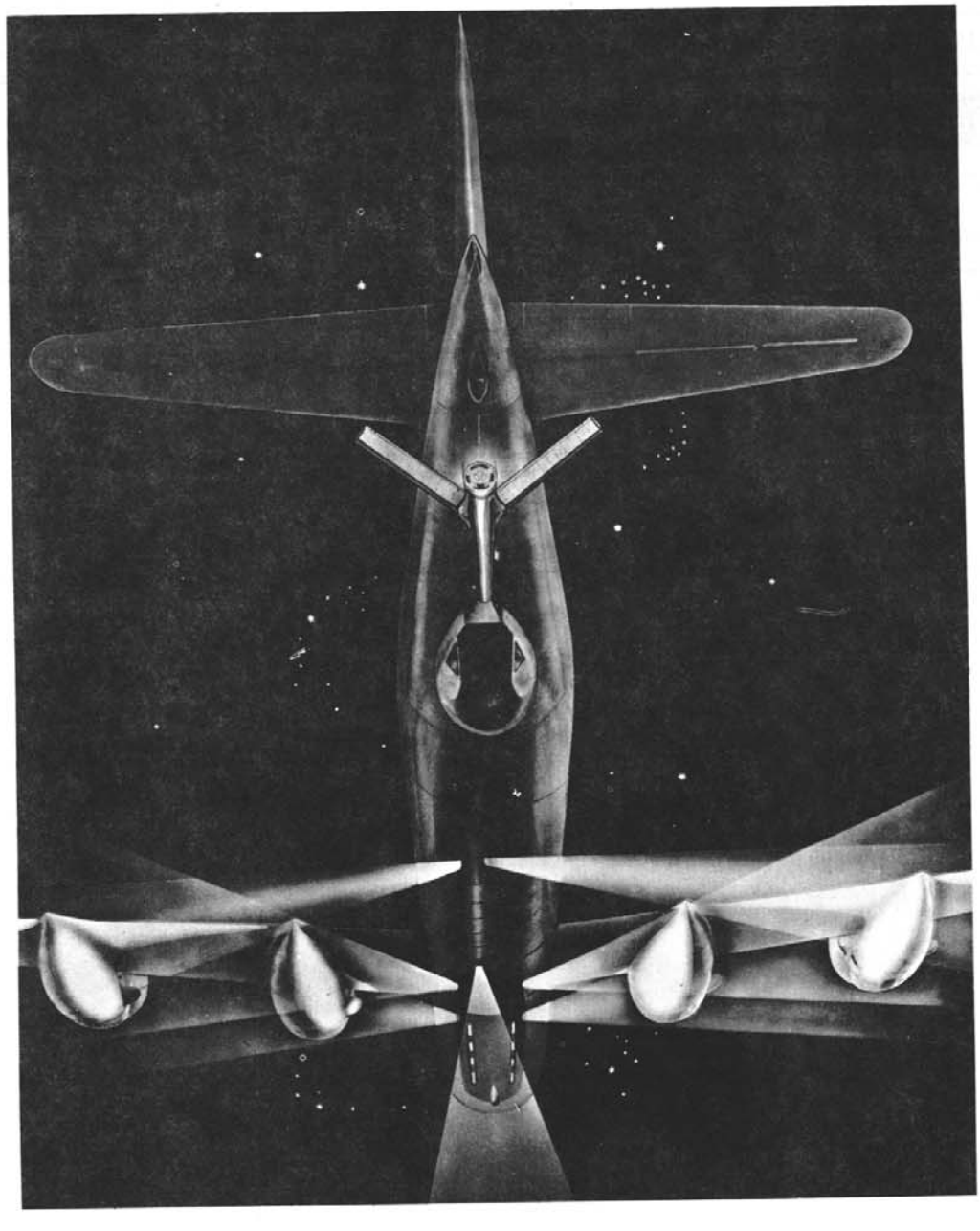
*The master light switch at the aft side of control cabin door must be ON to operate these lights.

**Lights will illuminate to full intensity regardless of rheostat position when a master control cab lights switch on the overhead panel is positioned to WHITE BRIGHT.

***White lights will illuminate only when the master control cab aft light switch on the overhead panel is positioned to AFT WHITE.

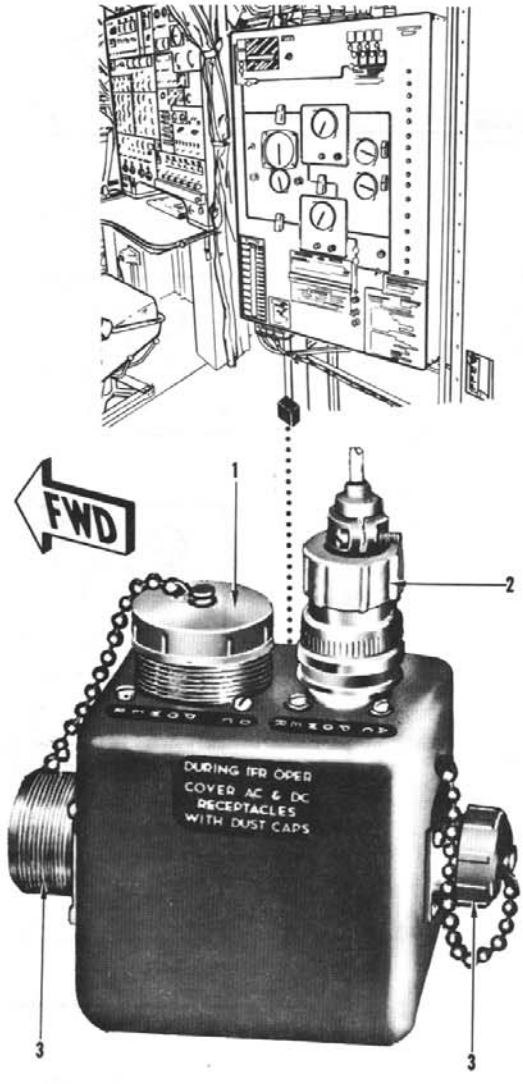
▲ Fluorescent lights are inoperative when the airplane is in the tanker configuration.

Figure 4–37 (Sheet 5 of 5)



FLOODLIGHTS ILLUMINATION

Figure 4–38



NOTE:
To transfer power from the engineer's A/R panel to the fluorescent light box, unscrew the two plugs on the bottom of the engineer's A/R panel and attach them to the two receptacles on top of the fluorescent light box. This transfer should be made with power off.

1 DC POWER RECEPTACLE
2 AC POWER RECEPTACLE
3 DUMMY RECEPTACLE (2 PLACES)

FLUORESCENT LIGHT BOX

Figure 4–39

OXYGEN SYSTEM

The 400 psi gaseous oxygen system (figure 4–40) consists of the following components: an oxygen filler valve (figure 4–41) located in the lower forward compartment just aft of the forward entry door, oxygen supply cylinders, oxygen regulators, oxygen pressure gages, and oxygen flow indicators. A pressure of 450 psi should not be exceeded when filling the oxygen system to 425 psi. Before takeoff, a minimum of 400 psi system pressure is required.

The oxygen system consists of two completely independent systems. One system supplies the navigator, engineer, and copilot. The other system supplies the pilot, the boom operator, boom instructor, and boom trainee. The pilot can be isolated in his system by a line shutoff valve. Two G-1 cylinders, one for each system, are located in the lower nose compartment. Provision is also made for the installation of two additional G-1 cylinders near the top of the lower nose compartment if the additional oxygen is needed for the crew systems. These cylinders, when installed, are also filled from the oxygen filler valve. A blinker-type flow indicator and a diluter demand regulator exist at all crew stations, including the boom operator and two assistants. The pilot, copilot, and boom operator have an oxygen pressure gage at their stations in addition to the normal equipment on these airplanes. Portable oxygen bottles are provided as shown in figure 3–1 and figure 4–40. In the control cabin, one portable bottle and recharger assembly are on the pilot's auxiliary panel, and one portable bottle and recharger assembly are forward of the engineer's instrument panel. A third portable bottle and recharger assembly are located forward of the boom operator's panel. Approximate oxygen duration in man-hours is shown in figure 4–42.

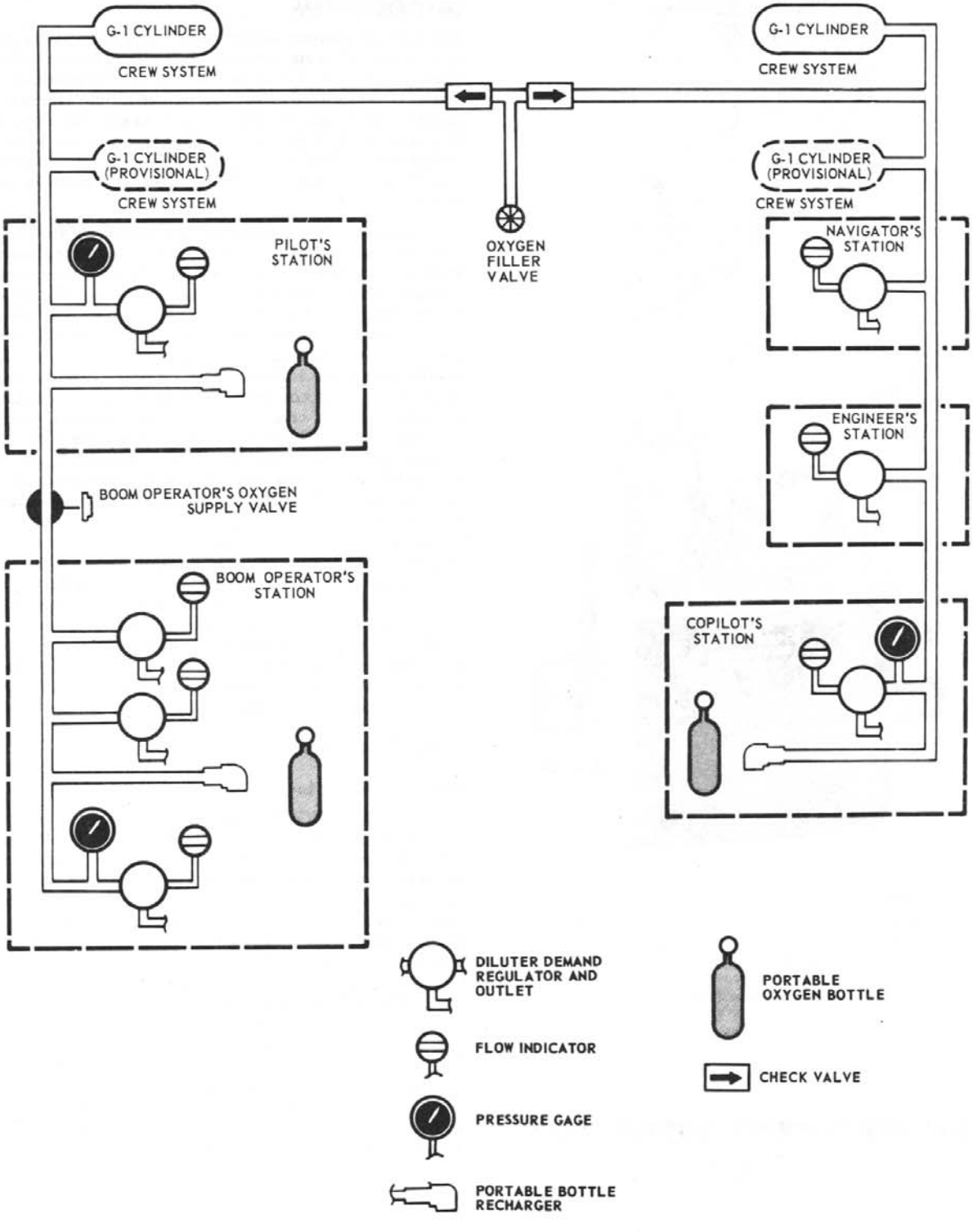
OXYGEN EQUIPMENT

Regulator Diluter Lever

A NORMAL OXYGEN–100% OXYGEN lever is located on each oxygen regulator. With the lever in the NORMAL OXYGEN position, the regulator automatically supplies the proper mixture of oxygen and air to the user up to a cabin altitude of 34,000 feet. Above 34,000 feet cabin altitude, 100% pure oxygen is supplied to the user. With the lever in the 100% OXYGEN position, the air intake port is closed and pure oxygen is supplied to the user for emergency use. The diluter lever is used in the 100% OXYGEN position when treating for hypoxia, shock, noxious fumes, or for denitrogenation.

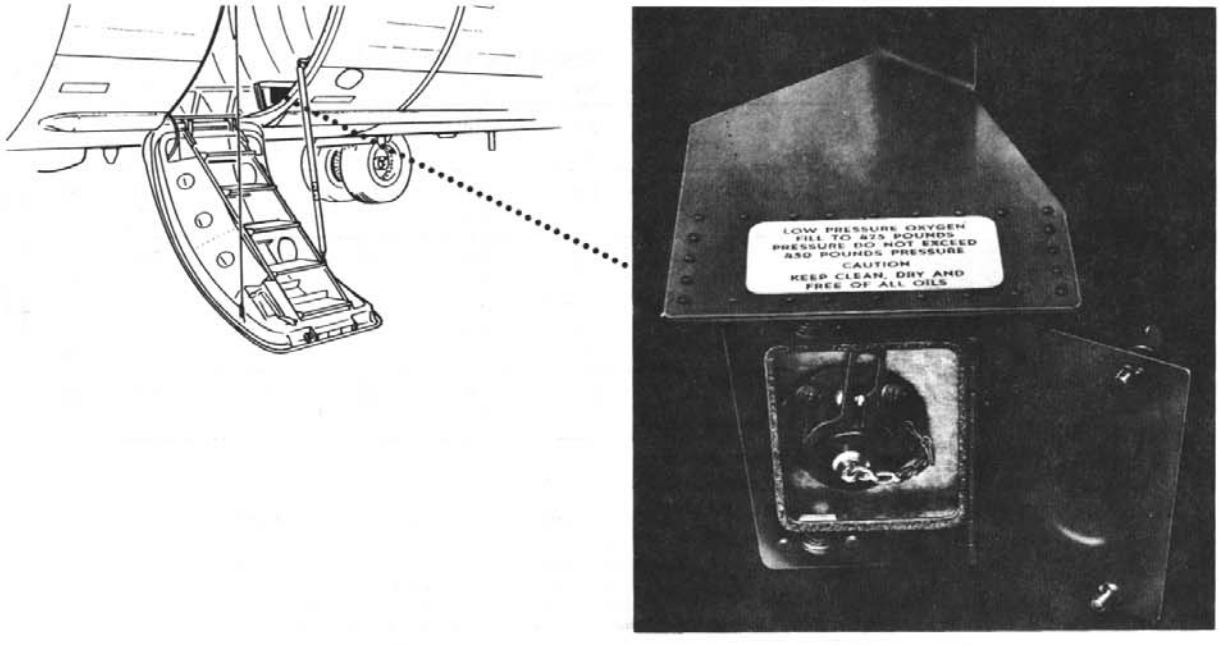
Regulator Emergency Valve Knob

An oxygen regulator emergency valve knob (16, figure 1–10) is provided on the regulator and is always safety-wired closed. This valve, when opened, supplies a continuous flow of 100% oxygen to the mask for emergency use.



OXYGEN SYSTEM

Figure 4–40



OXYGEN FILLER VALVE

Figure 4–41

Boom Operator's Oxygen Supply Valve

This handle-operated boom operator's oxygen valve is above the control cabin door and is in the oxygen line of the system which supplies the pilot. When opened, this valve allows the boom operator, boom instructor, and boom trainee to use oxygen from the pilot's oxygen system. When the valve is closed, no oxygen will flow to these boom stations.

Oxygen Pressure Gages

Oxygen pressure gages (13, figure 1–10) are provided at the pilot's, copilot's, and boom operator's stations. The gages indicate system pressure in psi.

Oxygen Flow Indicators

A blinker-type oxygen flow indicator (12, figure 1–10) is provided near each crewmember's oxygen regulator unit. Opening and closing of luminescent segments as the crewmember breathes indicates normal flow of oxygen.

Oxygen Equipment Check

a. Check oxygen pressure for minimum of 400 psi.

b. Regulator blow-back check:

(1) Diluter lever in 100% OXYGEN position.

(2) Blow with constant gentle pressure into the regulator hose.

(3) There should be continued resistance to gentle blowing.

WARNING

When performing the oxygen equipment check at low ambient temperatures, caution must be observed when blowing into the end of the oxygen hose for all temperatures near or below freezing; the cold metal connector at the end of the oxygen hose may stick to the operator's lips causing injury.

c. Check mask for general condition of all straps, connector, valves, mask hose, and other mask components.

d. Ascertain that there is a firm connection between the mask hose and the regulator hose. Check the regulator hose for damage and security. In those instances where this connection is exposed, the fitting should be handtight only.

e. Check the operation of the diluter lever; the air inlet screen should be clear; the emergency valve knob should be safety-wired in the CLOSED position.

f. With the diluter lever in the 100% OXYGEN position, the flow indicator should blink when oxygen flows through the system (upon inhalation). The diluter lever will be left in the 100% OXYGEN position.

Heavy Figures Indicate Diluter Lever 100 PERCENT
Light Figures Indicate Diluter Lever NORMAL

Oxygen Duration —MAN-HOURS

Crew

Cylinders: 1 Type G-1

CABIN ALTITUDE — FEET	GAGE PRESSURE — PSI 400	350	300	250	200	150	100	BELOW 100
30,000	**4.2** 4.5	**3.6** 3.9	**3.0** 3.3	**2.4** 2.7	**1.8** 1.8	**1.2** 1.2	**0.6** 0.6	
25,000	**3.3** 4.2	**3.0** 3.6	**2.4** 3.0	**1.8** 2.4	**1.5** 1.8	**0.9** 1.2	**0.6** 0.6	
20,000	**2.4** 4.8	**2.1** 3.9	**1.8** 3.3	**1.5** 2.7	**1.2** 2.1	**0.6** 1.2	**0.3** 0.6	
15,000	**2.1** 5.7	**1.8** 4.8	**1.5** 4.2	**1.2** 3.3	**0.9** 2.4	**0.6** 1.5	**0.3** 0.9	
10,000	**1.5** 7.5	**1.5** 6.6	**1.2** 5.4	**0.9** 4.2	**0.6** 3.3	**0.3** 2.1	**0.3** 1.2	

EMERGENCY — *Descend to Altitude Not Requiring Oxygen*

NOTE:

- To find the oxygen duration for a crew of three using oxygen from one type G-1 cylinder, divide oxygen man-hours in chart by three.
- As the airplane ascends to high altitudes where the temperature is normally quite low, the oxygen cylinders become chilled. As the cylinders grow colder, the oxygen gage pressure is reduced, sometimes rather rapidly. With a 100°F decrease in temperature in the cylinders the gage pressure can be expected to drop 20 percent. This rapid fall in pressure is occasionally a cause of unnecessary alarm. All the oxygen is still there, and as the airplane descends to warmer altitudes, the pressure will tend to rise again, so that the rate of oxygen usage may appear to be slower than normal. A rapid fall in oxygen pressure while the airplane is in level flight, or while it is descending, is not ordinarily due to falling temperature, of course. When this happens, leakage or loss of oxygen must be suspected.

OXYGEN DURATION

Figure 4–42

OXYGEN SYSTEM NORMAL OPERATION

In Flight

The regulator diluter lever on each crewmember's pressure regulator should be left in the 100% OXYGEN position.

OXYGEN SYSTEM EMERGENCY OPERATION

With symptoms of hypoxia, open the emergency valve by turning the red emergency knob counterclockwise.

WARNING

When the emergency valve control knob is opened, inform the pilot immediately because these actions will substantially reduce the duration of oxygen.

If the oxygen regulator becomes completely inoperative, disconnect the mask from the oxygen system and connect to a portable bottle.

WARNING

- Portable oxygen bottles equipped with diluter demand regulators will not provide 100% oxygen at operational altitudes unless the airflow through the regulator diluter screen is stopped.
- If the regulator becomes completely inoperative, the pilot should be informed immediately so that he can descend to an altitude not requiring oxygen.

AUTOPILOT

The airplane is equipped with a type F-1 electrically operated autopilot. The autopilot, when engaged, provides a system of automatic control which holds the airplane on any selected magnetic heading and returns it to this heading when momentary displacements occur, and simultaneously keeps the airplane stabilized in pitch and bank. While under autopilot control, the airplane can be made to climb, dive, and execute coordinated turns. Power for operation of the autopilot is provided by the autopilot inverter system. The autopilot inverter must be

operating before the autopilot can be used. The dc control circuit is protected by a circuit breaker on the overhead circuit breaker panel (1, figure 1–37). Circuit protection is provided for the operating power circuits on the ac power panel (15, figure 1–37).

AUTOPILOT EQUIPMENT

N-1 Compass System

The N-1 compass system provides directional signals for autopilot control. The autopilot may be used during either slaved operation or nonslaved operation. Refer to N-1 COMPASS SYSTEM OPERATION, this section. TION, this section.

Copilot's Turn And Slip Indicator

The copilot's turn and slip indicator (25, figure 1–8), which is calibrated for 2-minute turns and functions as a rate control gyro unit, is located on the right side of the pilots' instrument panel, and automatically transmits a rate of turn signal to the rudder servo to stabilize the airplane in yaw. The unit serves as a conventional turn and slip indicator when the autopilot inverter is operating, even though the autopilot is not energized.

Copilot's Attitude Indicator

The copilot's J-8 attitude indicator (20, figure 1–8), which functions as a vertical gyro control unit, is located on the right side of the pilots' instrument panel, and automatically transmits signals to the aileron and elevator servos, returning the airplane to the proper attitude in pitch or roll when displacement occurs with reference to the vertical-seeking gyro. A caging knob, located on the lower right corner of the indicator, is used to erect the axis of the gyros in the vertical gyro control unit to the vertical axis of the airplane. When the autopilot is energized, but not engaged, the vertical gyro control unit serves as a conventional altitude indicator. The master heading indicator, copilot's attitude indicator, and copilot's turn and slip indicator operate continuously when the autopilot inverter is operating, even though the autopilot master switch is not in the ON position.

Autopilot Master Switch

An ON–OFF autopilot master switch (41, figure 1–15) is located on the control stand. When the switch is in the ON position, power is supplied to the autopilot servo motors. When the switch is in the OFF position, the autopilot servos are deenergized.

Autopilot Clutch Switch

A pushbutton autopilot clutch switch (40, figure 1–15) on the control stand is used to engage the autopilot. When the switch is pushed in, four electrically operated clutches, one in each of the servos and one in the master heading indicator, are engaged. This connects the autopilot to the airplane control surfaces and permits signals from the master heading indicator to control the heading of the airplane.

Autopilot Release Switches

A pushbutton autopilot release switch (5, figure 1–6, and 2, figure 1–7) on each pilot's control wheel is used to disengage the autopilot. When this switch is depressed, the autopilot clutch switch pops out, releasing the clutches and fully disengaging all automatic control.

Autopilot Emergency Disconnect Handle

An autopilot emergency disconnect handle (1, figure 1–15) on the control stand is used to manually disengage the servos from the control system of the airplane in event of electrical failure or other emergencies. When the handle is pulled, the servo pulleys are released and will turn freely when control surfaces are operated manually.

Autopilot Turn And Pitch Controller

An autopilot turn and pitch controller (figure 4–43) is provided on the control stand for maneuvering the airplane when the autopilot is engaged.

Pitch Wheel. A knurled pitch wheel (2, figure 4–43) is on the right side of the controller, and UP–DOWN markings are provided above the wheel. When this wheel is rotated toward UP, the airplane will climb. When the wheel is rotated toward DOWN, the airplane will dive. A climb or dive attitude up to 40 degrees is possible.

Bank Trim Wheel. A knurled bank trim wheel (1, figure 4–43), marked LEFT–RIGHT, is on the left forward quarter of the controller. When this wheel is rotated in the RIGHT direction, the airplane will bank to the right. When the wheel is rotated in the LEFT direction, the airplane will bank to the left. Banks up to 10 degrees are possible. Do not use the bank trim wheel for making minor corrections to level wings, or a change in heading will result.

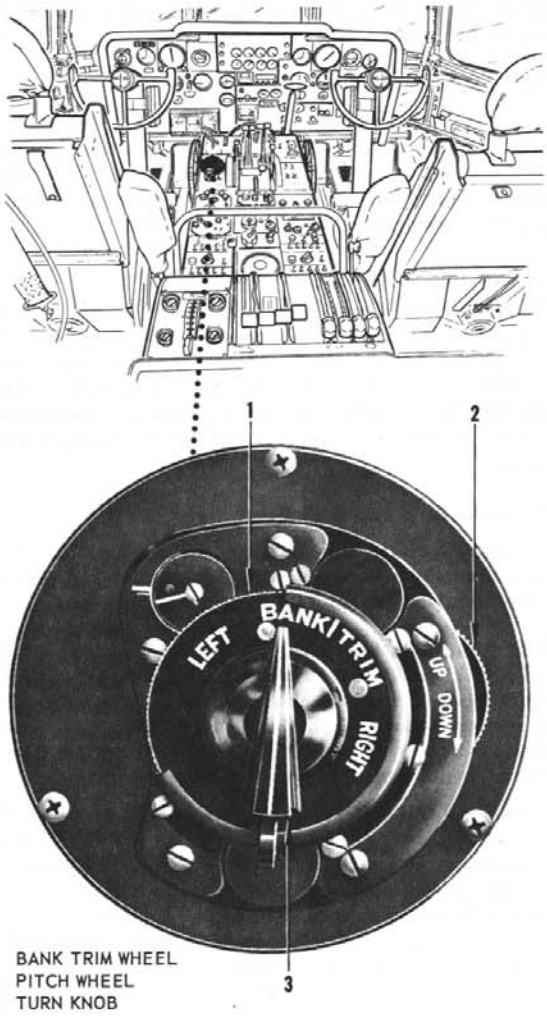
Turn Knob. A turn knob (3, figure 4–43) on the top of the controller is provided with a central detent position. When the knob is rotated to the right from this central detent position, the airplane will make a right turn. When the knob is rotated to the left from the detent position, the airplane will make a left turn. As long as the knob is out of the detent position, the airplane will continue to make a coordinated turn. When the knob is returned to the detent position, the airplane will resume level flight.

AUTOPILOT NORMAL OPERATION

In order to prevent the autopilot from inadvertently engaging during critical flight conditions, the following precautions must be observed.

a. Do not place the autopilot master switch in the ON position until a safe altitude has been reached.

b. The autopilot master switch must be in the OFF position during all refueling contacts.



1 BANK TRIM WHEEL
2 PITCH WHEEL
3 TURN KNOB

AUTOPILOT TURN AND PITCH CONTROLLER

Figure 4–43

c. The autopilot master switch must be in the OFF position prior to landing.

WARNING

Do not use autopilot during A/R operations. Inadequate or erratic autopilot functioning while in contact with a receiver airplane can result in structural damage to one or both airplanes.

Autopilot Operation – N-1 Slaved

During slaved operation of the N-1 compass system, the airplane, when on autopilot control, will fly a magnetic heading. Operation of the autopilot during slaved operation of the N-1 compass is as follows:

a. Check that the N-1 compass system is on slaved operation. Refer to N-1 COMPASS SYSTEM OPERATION, this section.

b. Engage the autopilot as described below:

CAUTION

Do not operate the synchronizer knob when on autopilot control. If synchronization of the heading pointer has been accomplished in a direction opposite that indicated by the arrow on the synchronizer knob, the heading pointer will be 180 degrees off from the correct magnetic heading. This can be checked by comparing the master heading indicator heading with the magnetic compass. Synchronizing 180 degrees off from the correct heading is an unstable condition which, if left alone, will correct itself at a rate of approximately 3 degrees per minute. During this time, the airplane will alter course at the same rate and assume the new heading as described above. The heading pointer should not be repositioned during or immediately after turns, as the system will remain in synchronization during and at the completion of the turn.

Autopilot Operation – N-1 Nonslaved

During nonslaved operation of the N-1 compass system, the airplane, when on autopilot control, will fly a gyro heading and approximate a great circle route (under a no-wind condition). Nonslaved autopilot operation is especially useful in regions where the horizontal component of the earth's magnetic field is so weak or distorted as to be unreliable. Nonslaved autopilot operation is as follows:

a. Check that the N-1 compass system is on nonslaved operation. Refer to N-1 COMPASS SYSTEM OPERATION, this section.

b. Set the desired reference heading on the indicator.

c. Engage the autopilot as described below.

Note

During nonslaved operation, the heading on the master heading indicator is not referenced to the geographical coordinate system. If a constant gyro heading is maintained, the airplane will fly a great circle route. Once the gyro heading is set, the synchronizer knob should not be adjusted at any time the autopilot is engaged.

Engaging The Autopilot

a. Check that copilot's attitude indicator is erected and uncaged.

b. Check that clutch switch is out. Check that autopilot inverter switch is at AUTOPILOT INV.

c. Turn autopilot master switch to ON. Allow 1 minute for amplifier warmup.

d. Center the turn control and pitch controller.

e. Trim airplane to fly hands off.

f. Engage autopilot by pushing clutch switch in.

CAUTION

The pilot must keep safety belt fastened when engaging autopilot to prevent being thrown from the seat in the event of autopilot malfunction. Maintain straight and level flight when engaging the autopilot and turn the autopilot off in the event of any uncontrolled action of the airplane.

Turns And Banks

Rotate the turn knob until the desired rate of turn is obtained. The bank attitude of the airplane may be changed by rotating the bank trim wheel. Do not adjust bank trim during turns.

Climbs Or Dives

Rotate the pitch wheel to obtain the desired climb or dive rate.

Disengaging The Autopilot

The autopilot is disengaged by pressing either of the autopilot release switches, or by pulling out the autopilot clutch switch. The autopilot may also be disengaged by caging the copilot's attitude indicator. To prevent a disengage transient oscillation, check and adjust pitch control to center before disengagement.

AUTOPILOT EMERGENCY OPERATION

If the autopilot cannot be disengaged by pressing the autopilot release switches, by pulling out the clutch switch, or by caging the copilot's attitude indicator, pull the autopilot emergency disconnect handle. The handle will pull out approximately 8 inches. If the above steps fail, turn autopilot master switch and autopilot inverter switch OFF.

Note

If the autopilot emergency disconnect handle has been pulled, the autopilot will not be reengaged while in flight.

Autopilot Inverter Failure

If the normal autopilot inverter fails, the spare inverter is automatically energized by the inverter changeover relay. If the changeover relay fails, as indicated by continued illumination of the red warning light, place the autopilot inverter switch in the SPARE INV position. If both autopilot inverters fail, the autopilot, copilot's turn and slip indicator and attitude indicator, the master heading indicator, and on 22359 ▶ the driftmeter will cease to function. The red warning light, indicating autopilot inverter failure, will remain illuminated regardless of the position of the autopilot inverter switch. If the autopilot is engaged, pull the autopilot emergency disconnect handle. On 3250 ▶ , when operating on autopilot, the clutch switch will automatically disengage in the event of autopilot inverter failure.

NAVIGATIONAL EQUIPMENT AND SYSTEMS

NAVIGATOR'S INSTRUMENT PANEL

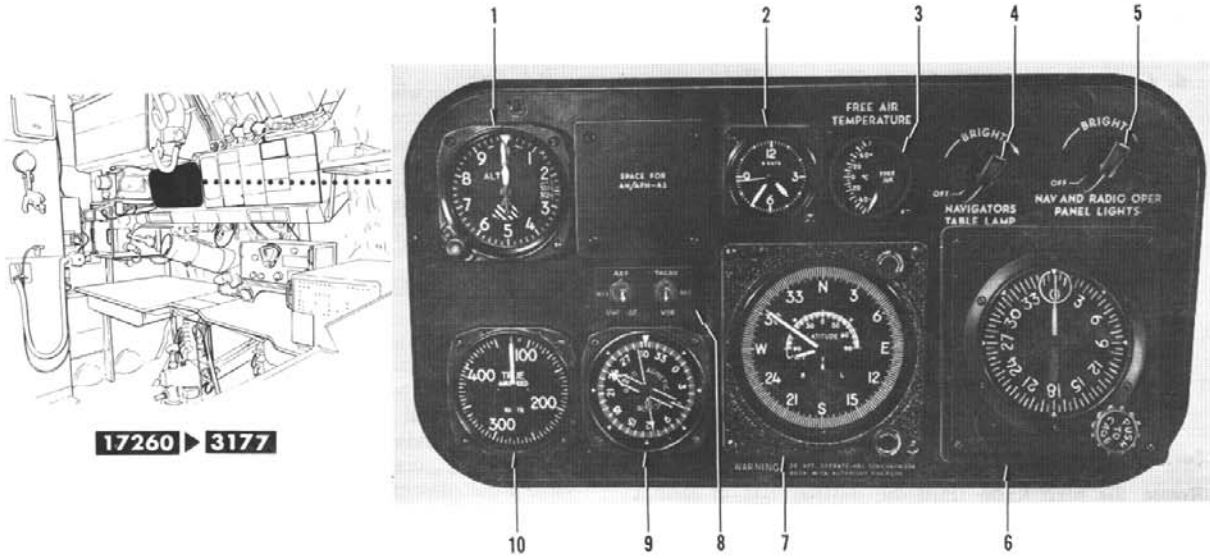
On 17260 ▶ 3177 , the navigator's instrument panel (figure 4–44) has a master heading indicator (N-1 Compass System), a radio magnetic indicator, a true airspeed indicator, an outside air temperature gage, an altimeter, a clock, two rheostats for operation of the navigator's flood and panel lights, and a heading indicator. The heading indicator only appears on 17260 ▶ 2859 . On 3178 ▶ , the same instruments appear on the navigator's instrument panel; however, the light rheostats as well as the heading indicator have been deleted. The light rheostats are on the navigator's light panel. The navigator's oxygen flow indicator, which appears on the navigator's auxiliary panel (13, figure 4–18) on 17260 ▶ 3177 , now appears on this navigator's instrument panel.

RMI Selector Switches

There are two RMI selector switches (8, figure 4–44) located on the navigator's instrument panel. The No. 1 RMI selector switch has ADF and UHF DF positions and allows the navigator to select ADF or UHF DF radio bearing information on the No. 1 pointer of his RMI. The No. 2 RMI selector switch has TACAN and VOR positions, and allows the navigator to select TACAN or VOR bearing information on the No. 2 pointer of his RMI.

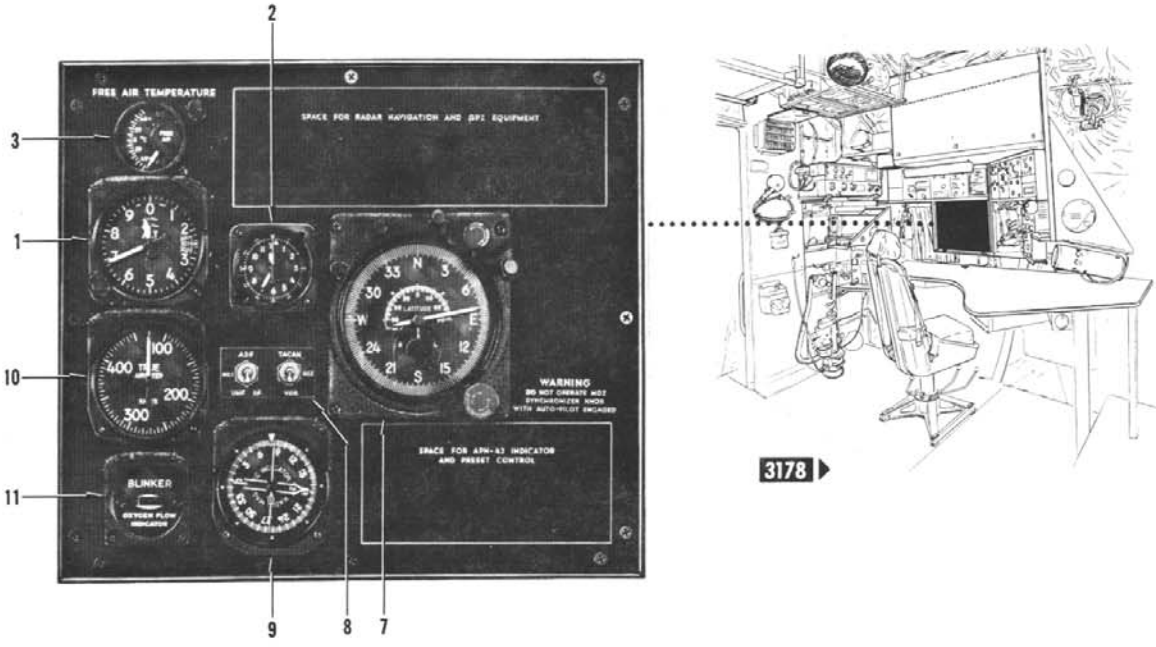
N-1 COMPASS SYSTEM

The basic component of the N-1 compass system is a gyro that can be controlled by two methods. The two methods are: slaved operation, whereby the gyro is used to stabilize magnetic heading indications, and nonslaved operation using a manually selected correction to compensate for apparent gyro drift. (An uncorrected gyro appears to drift due to the rotation of the earth.) When operated as a nonslaved gyro, corrected for latitude, the compass indicates the heading of the airplane relative to any arbitrary reference selected by the operator. Using this method of operation removes the influence of the earth's magnetism so that the compass functions in any locality. This is especially useful where the earth's magnetic field is too weak or distorted for slaved operation. When operated as a slaved compass and the heading pointer is properly synchronized, the heading indication is the airplane's magnetic heading. This method of operation may be used in any locality except in high latitudes or in areas where severe magnetic distortion occurs. The controls for the system are on the master heading indicator (figure 4–45). The system is energized when there is 28-volt dc and 115-volt ac power on the airplane and



17260 ▶ 3177

1 ALTIMETER (2 PLACES)
2 CLOCK (2 PLACES)
3 OUTSIDE AIR TEMPERATURE GAGE (2 PLACES)
4 NAVIGATOR'S TABLE LAMP RHEOSTAT
5 NAVIGATOR'S PANEL LIGHT RHEOSTAT
6 HEADING INDICATOR 17260 ▶ 2859
7 MASTER HEADING INDICATOR (N-1 COMPASS SYSTEM) (2 PLACES)
8 RMI SELECTOR SWITCHES (2 PLACES)
9 RADIO MAGNETIC INDICATOR (RMI) (2 PLACES)
10 TRUE AIRSPEED INDICATOR (2 PLACES)
11 OXYGEN FLOW INDICATOR



NAVIGATOR'S INSTRUMENT PANEL

Figure 4–44

the autopilot inverter is ON. The N-1 compass system furnishes heading data to the autopilot, navigator's master heading indicator, pilot's and copilot's heading indicator repeaters(18, figure 1-8), and the radio magnetic indicator (RMI) (21, figure 1-8 and 9, figure 4-44) at the pilot's, copilot's, and navigator's stations. Circuit protection is on the overhead circuit breaker panel (1, figure 1–37), marked FLIGHT INSTRUMENT and AUTO PILOT, and the AC power panel (15, figure 1–37), marked AUTOPILOT on 17260 ▶ 31432 or the autopilot junction shield (14, figure 1–37), marked AUTOPILOT on 31433 ▶

WARNING

The synchronizer knob should not be adjusted at any time the autopilot is engaged, since the autopilot reacts very rapidly to the signals received from the N-1 compass and an uncontrolled action of the airplane may result.

NOTE

The copilot's heading indicator repeater displays the same heading as the master heading indicator within 2 degrees, and the radio magnetic indicator headings are within 2-1/2 degrees of the master heading indicator.

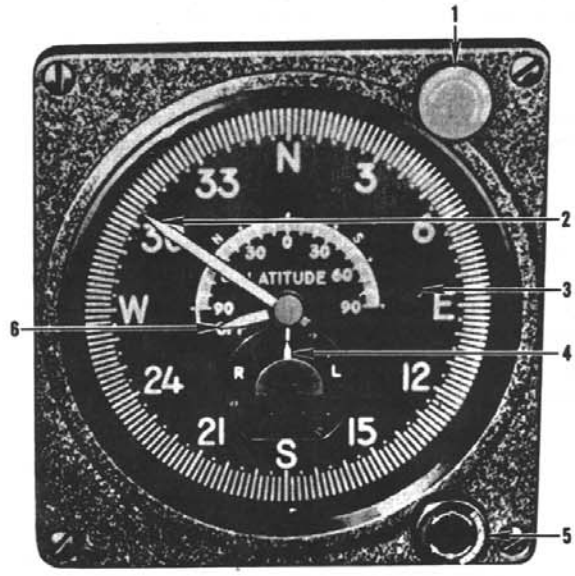
Master Heading Indicator Controls

Heading Pointer. The heading pointer (2, figure 4–45) indicates the correct magnetic heading while the compass is in slaved operation (providing the pointer is properly synchronized), or deviations from a preselected heading during nonslaved operation. Heading indications are accurate within ± 1/2 degree.

Latitude Correction Control Knob. The function of the latitude correction control knob (1, figure 4–45) is to switch from slaved operation to nonslaved operation or vice versa, and to adjust the latitude correction setting. Refer to LATITUDE CORRECTION POINTER, this section.

Latitude Correction Pointer. The latitude correction control knob (1, figure 4–45) positions the latitude correction pointer (6, figure 4–45) with respect to the latitude scale at the center of the master indicator dial face. The scale has an OFF position and is marked in 2-degree increments clockwise from 90 degrees N through 0 degrees to 90 degrees S. When the pointer is in the OFF position, the compass operates as a slaved compass. Moving the pointer to the latitude scale switches the compass to the nonslaved mode of operation and corrections are applied to the gyro to maintain accurate headings for the latitude selected. The indicated latitude should be ± 1 degree from the airplane's position and should be changed to mid-latitude for each 2 degrees change in latitude.

Synchronizer Knob. During nonslaved operation, the synchronizer knob (5, figure 4–45) is used to set the heading pointer to any desired position (usually repositioned for grid navigation reference). During slaved operation, the compass maintains synchronization automatically; however, when the compass is first energized or changed from nonslaved to slaved operation, the annunicator may indicate that the heading pointer is not synchronized with the earth's magnetic field. The knob may be turned in the direction indicated by the annunciator to bring the compass into synchronization more rapidly.



1 LATITUDE CORRECTION CONTROL KNOB
2 HEADING POINTER
3 CORRECTION INDICATOR PORT
4 ANNUNCIATOR POINTER
5 SYNCHRONIZER KNOB
6 LATITUDE CORRECTION POINTER

N-1 MASTER HEADING INDICATOR

Figure 4–45

NOTE

Rotation of this knob in flight affects all systems using N-1 compass heading information and will cause the airplane to turn when the autopilot is engaged.

Annunciator (N-1 Compass). The annunciator, operative only during slaved operation, consists of a dial and pointer (4, figure 4–45). The pointer indicates the direction in which to rotate the synchronizer knob to align the heading pointer with the earth's magnetic field. When the pointer is centered, the compass is synchronized. A 30-degree deflection of the pointer from center indicates that the heading pointer has an error of approximately 3 to 5 degrees.

Correction Indicator Port. The intermittent appearance of the small white dot behind the correction indicator port (3, figure 4–45) indicates that the compass system is

being corrected. During nonslaved operation, the white dot rotates CW in north latitudes and CCW in south latitudes; and the setting of the latitude correction pointer governs the rate of correction. The corrections applied during slaved operation keep the gyro slaved. In this mode of operation, the white dot rotates CW when the annunciator is in the R area and CCW when in the L area.

N-1 Compass System Operation

The N-1 compass system is energized when the autopilot inverter is operating. The system should be allowed to warm up for 10 minutes after being energized so that the gyros may stabilize.

Slaved Operation. The N-1 compass is put into slaved operation as follows:

a. Check that the autopilot inverter is operating.

b. Allow 10 minutes for the system to warm up and the gyros to stabilize.

c. Rotate the latitude correction control knob on the master heading indicator so that the latitude correction pointer is at the OFF position. This slaves the indicator to the remote compass transmitter.

d. Synchronize the heading pointer by rotating the synchronizer knob in the direction indicated by the annunciator pointer.

Note

It is merely necessary to rotate the synchronizer knob until the annunciator pointer is approximately centered, then allow 1 or 2 minutes for the system to drive into synchronization.

e. Check the indication of the heading pointer against the copilot's magnetic compass to avoid an ambiguous heading.

CAUTION

If synchronization is accomplished in a direction opposite that indicated by the arrow on the synchronizer knob, the heading pointer will be 180 degrees off the correct magnetic heading. This is an unstable condition which will correct itself, if left alone, at an approximate rate of 3 degrees per minute. If the airplane is on autopilot control, it will change its heading at approximately 3 degrees per minute and assume the new heading. Refer to AUTOPILOT NORMAL OPERATION, this section. Do not synchronize the heading pointer during or immediately after turns, or when the autopilot is engaged.

f. Check the correction indicator (white dot) occasionally. Rotation of the dot indicates the system is operating properly.

Nonslaved Operation. Nonslaved operation is to be used when the earth's magnetic field is too weak or distorted to be reliable, such as in regions near the earth's magnetic poles. Nonslaved operation is initiated as follows:

a. Rotate the latitude correction control knob clockwise until the latitude correction pointer indicates the latitude of the airplane position. This isolates the remote compass transmitter from the system and switches to nonslaved operation.

b. As the airplane changes position, the latitude correction pointer should be reset progressively to the new latitude.

Note

Setting the mid-latitude every 2 degrees will generally be sufficient for proper operation.

c. The reference heading may be set as desired by engaging and rotating the synchronizing knob.

CAUTION

Do not reposition the heading pointer at any time the autopilot is engaged, as erroneous headings may result. Set the desired reference heading on the indicator before engaging the autopilot.

d. Observe the correction indicator (white dot) occasionally for proper operation. The dot rotates CW in north latitudes and CCW in south latitudes.

PERISCOPIC SEXTANT AND MOUNT

A periscopic sextant is stowed on the lower forward side of the engineer's instrument panel support, just aft of the copilot's seat. Access to the periscopic sextant is from the crew passageway outboard of the engineer's panel. When being used, the sextant is mounted on a support on the ceiling of the control cabin. The periscopic sextant mount is between the overhead windows in the control cabin. A receptacle on the mount is provided to furnish power to the sextant. Control power is 28 volts dc with circuit protection on the overhead circuit breaker panel (1, figure 1–37).

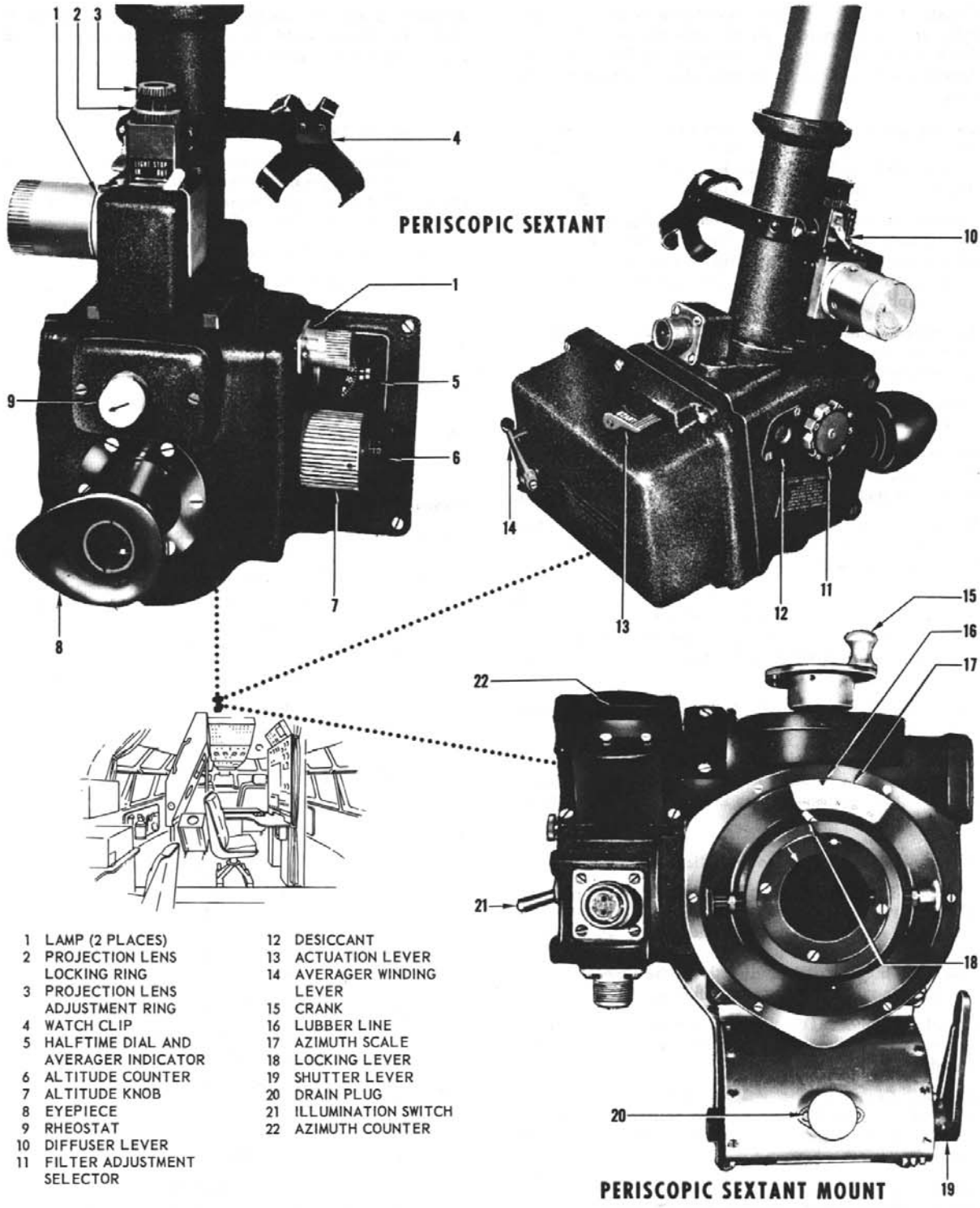
Periscopic Sextant And Mount Controls

Illumination Switch. The illumination switch (21, figure 4–46) on the mount controls illumination. The illumination of the bubble and the azimuth scale of the mount is adjustable by a rheostat. No adjustment is provided to control the illumination of the mount counter, sextant counter, averager indices, or the navigator's watch.

Eyepiece. The eyepiece (8, figure 4–46) on the sextant is adjustable from -2 to + 2 diopters for focusing.

Filter Adjustment Selector. The filter adjustment selector (11, figure 4–46) on the sextant allows the operator to select filters of various densities, so that the intensity of the sun's light may be adequately reduced.

Drain Plug. The drain plug (20, figure 4–46) on the mount is provided at the low point in the shutter retraction well for draining any water which might have collected in the mount.



1 LAMP (2 PLACES)
2 PROJECTION LENS LOCKING RING
3 PROJECTION LENS ADJUSTMENT RING
4 WATCH CLIP
5 HALFTIME DIAL AND AVERAGER INDICATOR
6 ALTITUDE COUNTER
7 ALTITUDE KNOB
8 EYEPIECE
9 RHEOSTAT
10 DIFFUSER LEVER
11 FILTER ADJUSTMENT SELECTOR
12 DESICCANT
13 ACTUATION LEVER
14 AVERAGER WINDING LEVER
15 CRANK
16 LUBBER LINE
17 AZIMUTH SCALE
18 LOCKING LEVER
19 SHUTTER LEVER
20 DRAIN PLUG
21 ILLUMINATION SWITCH
22 AZIMUTH COUNTER

PERISCOPIC SEXTANT AND PERISCOPIC SEXTANT MOUNT CONTROLS

Figure 4–46

Crank. The crank (15, figure 4–46) on the mount is provided to set indications on the azimuth counter. As the crank is turned, a slight hesitation can be felt at each 10-degree mark – a useful feature when a setting is to be made.

Locking Lever. The locking lever (18, figure 4–46) on the mount, when unlocked, allows the sextant and mount to be rotated freely. When the lever is locked, the sextant should not rotate in any direction.

Diffuser Lever. The diffuser lever (10, figure 4–46) on the sextant, when operated, obstructs the image of the scale when true heading readings are not required. This, however, does not detract from the effective illumination of the bubble.

Averager Winding Lever. The averager winding lever (14, figure 4–46) is on the sextant and allows the operator to wind the averager.

Actuation Lever. The actuation lever (13, figure 4–46) on the sextant is provided to start and stop the averager.

Shutter Lever. The shutter lever (19, figure 4–46) on the mount, when operated, opens the mount shutter and allows the sextant to be further inserted into the mount.

Rheostat. The rheostat (9, figure 4–46) on the sextant allows the operator to control the illumination of the bubble and azimuth scale.

Watch Clip. The watch clip (4, figure 4–46) on the sextant is provided to securely hold a special navigator's watch. It is mounted in such a position as to allow the watch face to be read with the eye in line with the eyepiece position.

Desiccant. The desiccant (12, figure 4–46) is located on the sextant and aids in preventing moisture.

Altitude Knob. The altitude knob (7, figure 4–46) on the sextant aids in finding the average altitude angle when the operator recenters the averager indices using the knob.

Periscopic Sextant And Mount Indicators

Halftime Dial And Averager Indicator. The halftime dial and averager indicator (5, figure 4–46) is on the periscopic sextant. This is a time dial graduated in seconds, indicating the halftime of an observation, which indication may be added directly to the time of start to give the mean time of the average altitude.

Altitude Counter. The altitude counter (6, figure 4–46) on the sextant allows the operator to read the average altitude.

Azimuth Counter. The azimuth counter (22, figure 4–46) is on the mount. This counter indicates the position of the azimuth scale with respect to the lubber line.

Lubber Line. The lubber line (16, figure 4–46) on the mount, which may be aligned with the airplane's longitudinal axis to establish a lubber line, provides indications of azimuth on the scale.

Azimuth Scale. An independently rotatable azimuth scale (17, figure 4–46) is on the periscopic sextant mount. This scale indicates azimuth heading.

Operation Of The Periscopic Sextant

The procedures described below are detailed instructions on the various operational techniques for the periscopic sextant. Personnel not completely familiar with the equipment should study them carefully.

Six procedures are discussed:

1. Inserting the sextant in the mount
2. Forming and adjusting the size of the bubble
3. Time dial check
4. Altitude average check
5. Alignment of the sextant and mount in the airplane
6. Removal of the sextant from the mount

Inserting The Sextant In The Mount.

a. With the line-of-sight locking lever on mount unlocked, insert the sextant as far as possible, with arrows on tube and mount aligned.

b. Hold the sextant firmly to prevent dropping, and rotate the lower ring of mount counterclockwise (looking up, toward mount) until it hits a stop.

c. Pull out knob marked To Insert, Remove–Pull.

d. Rotate lower ring on mount further, allowing knob to seat itself. Be sure the sextant cannot rotate in either direction with the line-of-sight locking lever locked.

Note

The provision of stops in the retracted position of the sextant is intended only to prevent its being dropped during insertion or removal. It is not advisable to leave the sextant in the retracted position for any extended period, particularly during rough weather. When the sextant is removed from the mount, it should be returned to the carrying case and secured.

e. Open the mount shutter with lever.

f. Insert sextant further until knob, marked To Retract Sextant–Pull, snaps into place.

g. Make connections between the mount and the sextant with the electrical cable.

WARNING

In the case of pressurized airplane, do not open the shutter of mount until after the sextant has been inserted to its retracted position.

Forming And Adjusting The Size Of The Bubble.

Focusing Sextant:

With the switch on the mount in the ON position, adjust the intensity of illumination with the rheostat by looking through the eyepiece and rotating the rheostat knob. Focus on the reticle image by turning eyepiece, and the bubble will be in focus.

To Form A Bubble In The Field Of View:

a. Set increase bubble knob to minimum position.

b. Tilt sextant to the right.

c. Slowly rotate the knob.

d. A bubble will be formed at the notch visible on the right-hand side of the field of view.

e. Rotate knob slowly back and forth until proper size bubble is obtained.

f. Move sextant to vertical position; i. e., when the bubble is in the center of the field of view.

g. Slowly rotate knob to maximum increase position.

Bubble Already Formed And Of The Desired Size:

a. Under this condition, there is nothing to do except to put the bubble in focus by turning the eyepiece.

b. Check to be sure the increase bubble knob is in maximum increase position.

Bubble In Field Of View Is Too Large:

a. With sextant in the vertical position, rotate increase bubble knob to maximum position.

b. Tilt sextant to the right and center the bubble in the notch.

c. Slowly rotate the knob to reduce the size of the bubble.

d. If the travel of the knob is reached without reducing bubble to the desired size, repeat cycle.

e. When desired bubble size is obtained, move sextant to vertical (bubble located near intersection of reticle).

f. Slowly rotate knob to maximum increase position.

Bubble In The Field Of View Is Too Small:

a. Knob is rotated to minimum increase position with sextant vertical.

b. Tilt sextant to right and center the bubble in the notch.

c. Slowly rotate the knob to increase size of bubble.

d. If the travel of the knob is reached without increasing bubble to the desired size, repeat cycle.

e. When desired bubble size is obtained, return sextant to vertical and slowly rotate knob to maximum increase position. Suggested size of bubble is about 1-1/2 to 2 degrees (the sun appears to subtend about 1 degree).

Note

Little or nothing will happen to bubble size unless it is resting in the notch when the knob is turned. Tilting the sextant will permit the fluid level in the air chamber to uncover the transfer port, allowing air to be drawn into the bubble chamber for bubble formation. In the vertical position, the fluid level in the air chamber will be above the transfer port, and fluid instead of air will be drawn into the bubble chamber. Except when adjusting the bubble, the increase bubble knob is to be kept at full increase at all times. The knob encloses a compensation system for changes and variations in temperature and pressure. When the knob is set at maximum position, the compensation system has its full range. When the sextant is not in use, location or size of the bubble is not important.

Time Dial Check. Fully depress the averager winding lever and release slowly. Averager will operate for 3 seconds, then stop automatically. Time dial should indicate zero. Depress and release the averager actuating lever, noting time to nearest second when sextant starts. Note time when shutter clicks closed. The time dial should read 59 when shutter clicks, since shutter closes 2 seconds before averager stops. Double dial reading since it indicates half time and compare to watch reading. The readings should agree within plus or minus 2 seconds.

Altitude Averager Check. To check the accuracy of the altitude averager, proceed with the following steps:

a. Depress and release the averager winding lever.

CAUTION

This should wind the averager, zero the time dial, and raise the shutter. Do not change altitude setting during 3-second interval immediately after releasing the averager rewind lever.

b. Turn the altitude knob until exactly 13 degrees 00 minutes is set in the altitude counter.

c. Start the sextant by depressing and releasing the averager actuating lever.

d. Stop sextant when time reads exactly 15.

e. Reset altitude counter to exactly 12 degrees 00 minutes and restart sextant.

f. Stop sextant when time dial reads 30.

g. Reset altitude counter to exactly 8 degrees 00 minutes and restart sextant.

h. Stop sextant when time dial reads 45.

i. Reset altitude counter to exactly 7 degrees 00 minutes and restart sextant. When time cycle for averager is complete, the averager stops automatically.

j. Rotate altitude knob until red blocks on altitude counter are aligned. Altitude counter should read 10 degrees 00 minutes plus or minus 2 minutes.

Alignment Of Sextant And Mount With Airplane

Adjustment Of Azimuth Counter And Scale On Mount

a. Set 000.0 degrees in the azimuth counter.

b. With the sextant in the operating position, the diffuser lever in out position, and the line-of-sight locking lever open, sight forward. Focus on the reticle image by turning eyepiece. Sighting through the sextant eyepiece and ignoring all other objects, the azimuth scale, as read against the lubber line, should agree to within 0.1 degree with the setting on the azimuth counter to assure proper alignment of the mount. Recheck to see that the azimuth counter reading has not been changed inadvertently.

Optical Adjustment Of Projection Lens Assembly

a. With sextant in the operating position in the mount, the diffuser lever must be in the out position and the true heading scale will be visible in the lower part of the field of view.

b. Rotate sextant until lubber line and vertical reticle line are coincident or nearly coincident. Ignore all other objects in the field of view.

c. Lock line-of-sight locking lever.

d. Check for parallax between lubber line and vertical reticle line, keeping bubble near center of reticle pattern.

Note

Parallax, as it applies here, is the apparent movement of the image of the lubber line (or azimuth scale) relative to the vertical line of the reticle, or vice versa, as the operator's head is moved from side to side. Parallax is to be avoided.

e. If satisfied that no parallax exists, the sextant and mount are to be considered as optically adjusted but not aligned. If not satisfied, proceed as follows:

(1) Loosen the projection lens locking ring and rotate the projection lens so that it moves either up or down. The lubber line will appear to move in an elliptical path, making a complete cycle for each revolution of the lens.

(2) Rotate the lens as many times as necessary to position the lubber line at one of the uppermost positions in its elliptical path and, at the same time, produce a sharp image of the lubber line plus a distinct lack of parallax, as described in the above note.

(3) With the locking ring loosened, be sure the lubber line is at the uppermost position of its travel in an elliptical path as the projection lens is rotated back and forth. Disregard the relative position of the vertical line of the reticle and lubber line. Lock the projection lens locking ring without further movement of the projection lens.

Alignment Of Sextant And Mount

a. The relative bearing of the vertical stabilizer is 180 degrees 00 minutes and affords the easiest point on which to check sextant alignment with the longitudinal axis of the airplane.

Note

Relative bearing is defined as the angle between the airplane's longitudinal axis and the line of sight to the object (vertical stabilizer).

b. Small errors may be introduced by parallax when sighting on a nearby object, such as the vertical stabilizer. (The average of several settings may be used, if desired, to improve accuracy when using a nearby object.)

c. Crank the azimuth counter to read exactly 000.0 degrees.

d. With the sextant inserted in the mount, the line-of-sight locking lever unlocked, and the bubble centered in the field, sight on the vertical stabilizer and lock the line-of-sight locking lever. Sighting on the stabilizer may involve both adjusting the altitude control knob and rotating the sextant in azimuth. Select a suitable filter so that both stabilizer and azimuth scale can be seen simultaneously.

Note

If lighting conditions do not permit simultaneous viewing of both stabilizer and scale, it may be necessary to change the filter adjustments to use a darker filter to see the scale.

If more light is required against the azimuth scale than is provided by the sextant, use of a flashlight or type C-4 cockpit light is recommended. If scale is blurred, the eyepiece of the sextant should be focused. During darkness it may be necessary to use an aldis lamp to illuminate the vertical stabilizer.

e. When sighting as described above, the vertical line of the reticle, stabilizer, and 180 degrees on the azimuth scale should coincide.

f. If an error greater than 1/4 degree exists between the stabilizer and 180 degrees on the azimuth scale, as viewed through the eyepiece, it may be corrected by rotating the projection lens which is mounted on top of the bubble cell. This may be done in the following manner:

(1) Loosen the projection lens locking ring.

(2) Sight through the eyepiece and rotate the projection lens in either direction until the 180-degree

mark of the azimuth scale is brought to coincide with the vertical line of the reticle and the stabilizer.

Note

Rotation of the projection lens will cause the image of the azimuth scale and the lubber line to appear to move in an elliptical path, giving two settings (high and low) where coincidence will occur. The higher of the settings should be selected.

(3) Secure the projection lens with the locking ring.

(4) The projection lens has a range of approximately 2 to 3 degrees, which should be sufficient to allow proper alignment. If unable to properly align, record the difference. This difference will have to be applied in the same direction to any heading read during flight. If this condition occurs on only one sextant, the sextant may require overhaul. If this condition occurs with several sextants in the same mount, it is indicative of the lubber line of the mount not being in alignment with the longitudinal axis of the airplane.

Removal Of The Sextant From The Mount

a. Turn illumination switch to the OFF position, and disconnect the electrical cable.

b. Holding the sextant securely with one hand, pull out knob marked To Retract Sextant—Pull, and lower the sextant to the retracted position.

c. Close the mount shutter.

d. Holding the sextant securely with one hand, pull out knob marked To Insert, Remove—Pull, and rotate the lower ring on the mount counterclockwise until arrows on tube and mount are aligned.

e. Sextant will then be free to be lowered until completely removed.

f. Return to the carrying case and secure.

CAUTION

Before replacing sextants in the carrying case, always press actuating lever or button, allowing the averager to run down; always rotate bubble knob to maximum increase position.

DRIFTMETERS

An electrically driven gyro-stabilized driftmeter (figure 4-47 or 4-48) is installed at the navigator's station. The driftmeter provides an accurate means of determining angle and degree of deviation from a predetermined course of flight. It also furnishes data from which ground speed and wind velocity can be determined. On 17260▶ 22628, the B-3 driftmeter is used. On 22629▶, the B-6A driftmeter replaces the type B-3. On 17260▶ 31177, the driftmeter gyromotor is turned on and off by an ON–OFF switch on the navigator's auxiliary panel (13, figure 4–18) at the navigator's station. On 31178▶, the gyromotor driftmeter switch (4, figure 4–10) is located on the navigator's interphone and light panels. The motor is protected by a fuse on the ac power panel (15, figure 1–37).

B-3 Driftmeter

Rheostat Knob. The rheostat knob (2, figure 4–47) on the top of the upper gyro housing, is used to turn the 3-volt lamp on and off and to control its brightness.

Gyro Switch. The gyro switch (3, figure 4–47) for starting and stopping the gyro is mounted on the side of the lower gyro housing.

Gyro Caging Knob. The gyro caging knob (4, figure 4–47) at the bottom of the lower gyro housing operates a mechanism which holds the gyro in a vertical position when it is not in use, or when it is tipped too far from the vertical during maneuvers.

Slow-Motion Knob. The slow-motion knob (6, figure 4–47) on the stationary housing just beneath the azimuth scale provides a means of fine adjustment of rotation of the instrument. It operates by means of a worm-gear mechanism which may be disengaged for free rotation of the driftmeter.

Eyepiece Adjustment Ring. Mounted on top of the gyro optics case, and holding whichever of the alternate eyepiece assemblies is in use, is the eyepiece adjustment ring (12, figure 4–47). Turn as required for clarity of focus.

Shade Glass Lever. The shade glass lever (9, figure 4–47) on the filter housing controls a shade glass. By operation of the lever, the shade glass may be interposed in the optical system to reduce the intensity of light when the ground image is too bright.

Pushbutton Switch. When pressed, the pushbutton switch (8, figure 4–47) on the transformer housing momentarily provides power to start the gyro.

Line-Of-Sight Handle. The line-of-sight handle (10, figure 4–47) on the driftmeter turns a prism at the bottom of the driftmeter tube and directs the operator's line-of-sight away from the vertical.

Line-Of-Sight Dial. The line-of-sight dial (11, figure 4–47) on the driftmeter is graduated in 1-degree increments over a range of from 16 degrees forward to 87 degrees rearward of the vertical.

Azimuth Scale. The azimuth scale (7, figure 4–47), graduated in 1-degree increments through 360 degrees, is on the driftmeter. This scale remains fixed when the instrument is rotated.

Operation Instructions Of The B-3 Driftmeter

Before Takeoff

a. See that the window in the objective end of the instrument and the top lens of the eyepiece are clean. For cleaning purposes, use a clean cotton or linen cloth. To remove sand or grit, brush the surfaces lightly with a small, clean paint brush, or a loose fold of cloth. Do not attempt to clean any other glass surfaces in the instrument.

b. To prevent possible breakage of the driftmeter glass by stones, set the instrument at zero on the drift scale before takeoff (or landing).

c. Keep the gyro switch in the OFF position and the gyro caged. To cage the gyro, pull out the caging knob and move it as far as possible toward the caged position. Pull the knob out gently—heavy handling will strain the caging mechanism.

In Flight

a. Turn on the power supply.

b. Turn on the gyro, and allow it to run from 3 to 5 minutes before uncaging.

c. Uncage the gyro by pulling out the caging knob and moving it to the uncaged position. Do not uncage the gyro when the gyro motor is stationary or running slowly, since the gyro and reticle moving freely in the housing may become damaged. If a turn is started while the gyro is uncaged, do not attempt to cage it during the turn. Wait until the turn is completed, then cage the gyro. To prevent damage to the gyro, it is advisable to cage it before the driftmeter is tipped more than 15 degrees from the vertical. To bring the gyro back to vertical if it has been tipped more than 15 degrees in a flight maneuver, it is necessary to run through cage-uncage cycle.

d. Always cage the gyro before turning off power to the instrument and keep it caged when it is not in use.

e. When sighting through the eyepiece, turn the rheostat knob to adjust the illumination of the reticle lines.

f. By means of the ocular housing holder on the upper gyro housing, adjust the focus of the eyepiece until the reticle lines are sharp and clear.

g. Upon completion of driftmeter observations, cage the gyro. Turn the gyro switch off, and then switch off the power supply.

Note

A chart indicating K factors for ground speed timing of zero angle method for the B-3 driftmeter is as follows:

K Factors For Ground Speed By Timing Zero Angle Method (B-3 Driftmeter)

RETICLE ANGLE IN DEGREES	FACTOR K (FOR GROUND SPEED IN KNOTS)
16.9	0.176
16.8	0.175
16.7	0.174
16.6	0.173
16.5	0.172
16.4	0.171
16.3	0.170
16.2	0.169
16.1	0.167
16.0	0.166
15.9	0.165
15.8	0.164
15.7	0.163
15.6	0.162
15.5	0.161
15.4	0.160
15.3	0.159
15.2	0.158
15.1	0.157
15.0	0.156
14.9	0.155
14.8	0.154
14.7	0.153
14.6	0.152
14.5	0.151
14.4	0.150
14.3	0.148
14.2	0.147
14.1	0.146
14.0	0.145
13.9	0.144

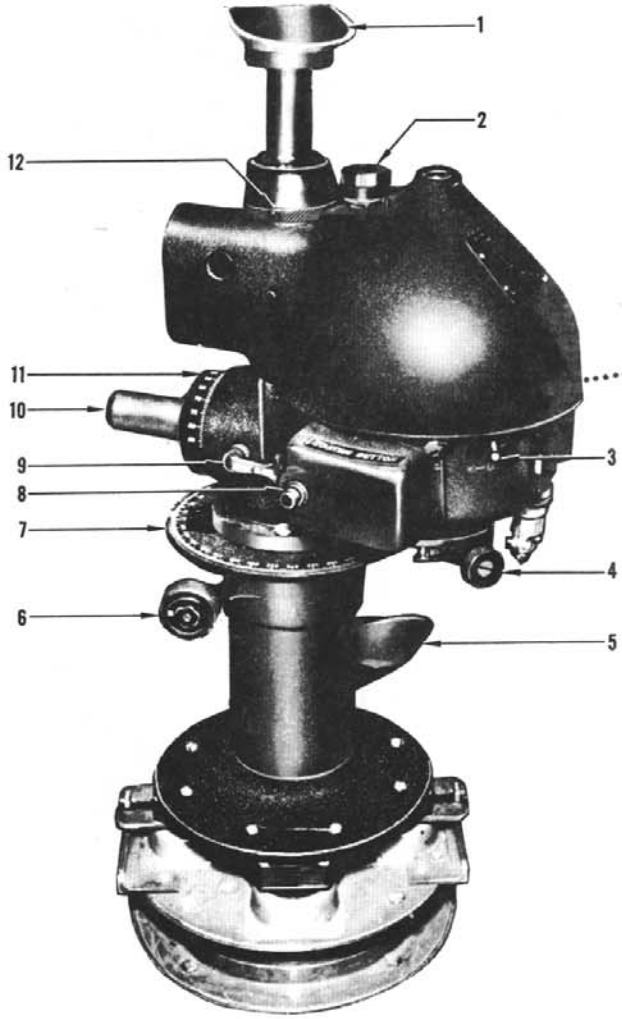
FORMULA:

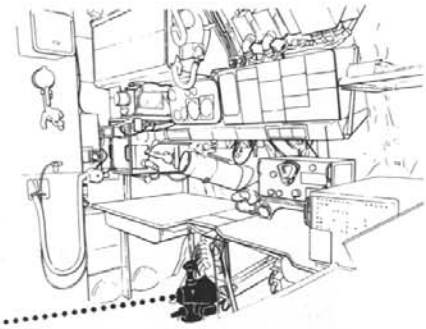
1. Factor for 0 = 1.184 X 1/2 TAN RETICLE ANGLE
2. $\frac{\text{ABSOLUTE ALT}}{\text{Time in Seconds}}$ $\frac{\text{GS in Knots}}{\text{Factor K}}$

B-6A Driftmeter

Operation of the B-6A driftmeter is dependent upon seven controls: the rotary switch located on the box side of the stationary pedestal case; the reticle light switch on the upper gyro case; the gyro caging knob on the underside of the lower gyro case; the azimuth drive knob on the box side of the pedestal case; the rotating handle protruding from the side of the line-of-sight case; a filter selector knob and handle mounted on the line-of-sight case; and an eyepiece adjusting ring assembled under the eyepiece of the optics case. Purpose and operation of these seven controls is as follows:

Rotary Switch. The rotary switch (5, figure 4–48) on the stationary pedestal case activates the gyro and erection system. A switch plate, mounted under the knob, establishes the central position as OFF, the left position of the





17260 ▶ 22628

1 EYEPIECE
2 RHEOSTAT KNOB
3 GYRO SWITCH
4 GYRO CAGING KNOB
5 HIGH ALTITUDE EYEPIECE
6 SLOW-MOTION KNOB
7 AZIMUTH SCALE
8 PUSHBUTTON SWITCH
9 SHADE GLASS LEVER
10 LINE-OF-SIGHT HANDLE
11 LINE-OF-SIGHT DIAL
12 EYEPIECE ADJUSTMENT RING

B-3 DRIFTMETER

Figure 4–47

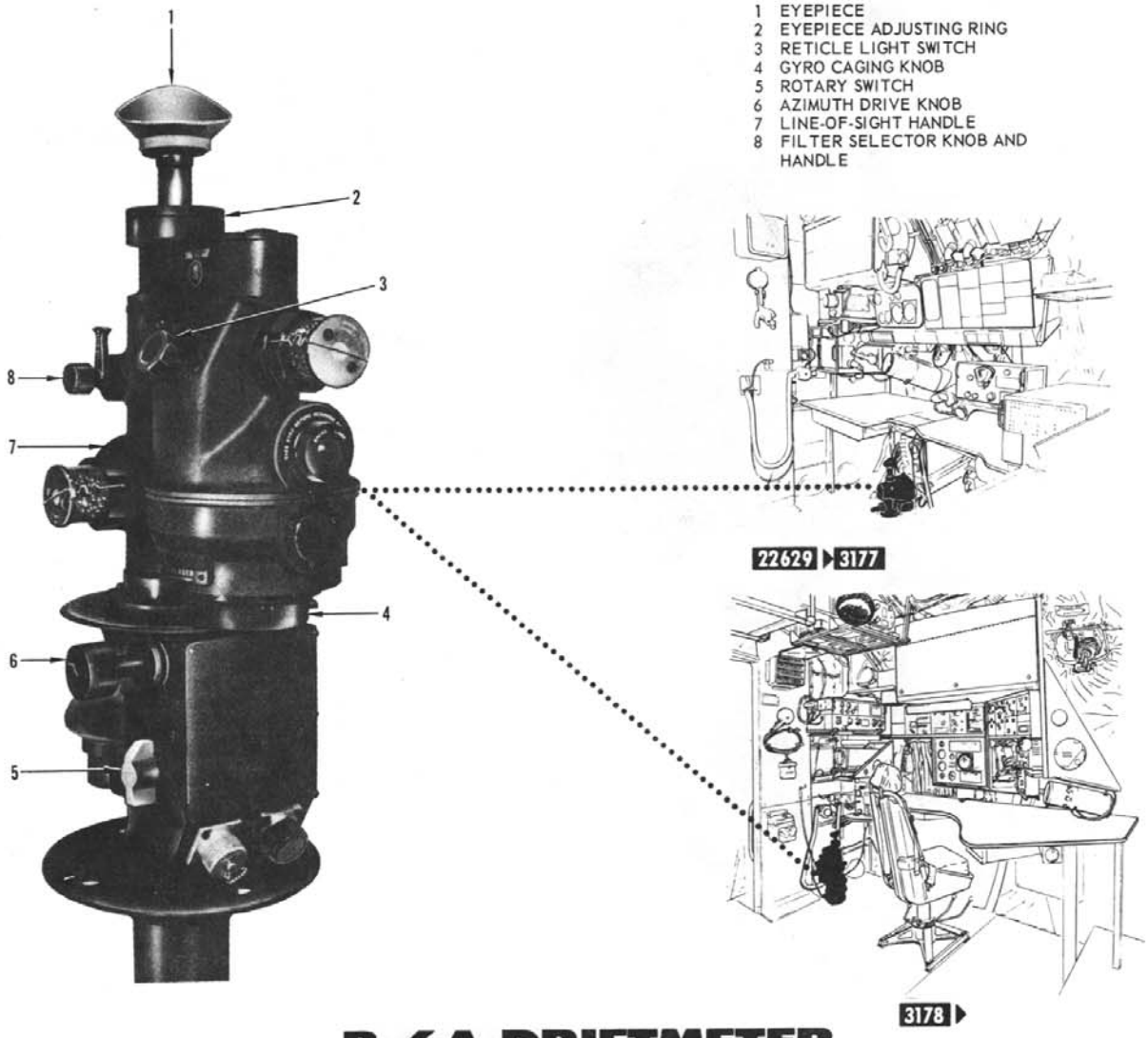
pointer knob as ON, 28 volts dc, and the right position as ON, 115 volts ac. A detent stop, secured to the underside of the selector knob limits the switch operation to the applicable and corresponding power source. To put the driftmeter in operation, turn switch to applicable ON position and allow a 10-minute warmup period prior to uncaging the gyro.

Reticle Light Switch. The reticle light switch (3, figure 4–48) on the pedestal case operates a rheostat to control the brightness of the reticle field. The switch knob turns left to dim and right to brighten the reticle lights. A switch plate under the knob identifies the DIM and BRIGHT positions with corresponding arrows. Adjust lighting as observation conditions require.

Gyro Caging Knob. The gyro caging knob (4, figure 4–48) is on the underside of the gyro case between the gyro case and the electrical box of the pedestal case. Except when the driftmeter is in use, the gyro must remain caged. When gyro is caged, gyro caging knob is turned fully right. Turn the knob left to uncage. Uncage the gyro 10 minutes after rotary switch has been turned on.

CAUTION

The driftmeter is designed for use during reasonably level flight. Do not uncage the gyro during taxi, takeoff, or landing. Do not uncage gyro when roll or pitch exceeds 35 degrees.



B-6A DRIFTMETER

Figure 4–48

Azimuth Drive Knob. The azimuth drive knob (6, figure 4–48) is on the side of the pedestal case and is mounted on a wormgear shaft. When the wormgear is normally engaged, the entire mobile section of the driftmeter is held stationary. Turning the azimuth drive knob revolves the worm gear, permitting fine adjustment after the general line of sight is obtained. Pull out the azimuth drive knob and move the shaft through the keyway to disengage the gear. This permits the rotating section to swing free in the pedestal case and rotate until the desired line of sight is obtained. Replace knob in original position to engage gears and obtain final fine adjustment by turning knob.

Line-Of-Sight Handle. The line-of-sight handle (7, figure 4–48), which protrudes from the line-of-sight case, mounts a calibrated dial and contains a detent arrangement where a spring-mounted ball assembly attached to the line-of-sight case registers at three points. These points are located at 0, 50, and 70.9 degrees. When the dial on the handle registers zero at the lubber line at the base of the handle, prisms in the objective head of the driftmeter reflect an image which is straight down and perpendicular to the centerline of the airplane. A pulley assembly in the handle connects with extension rods which operate the prisms mounted in the main bracket at the objective end of the driftmeter. When the dial on

the handle registers 35 degrees, the cables of the pulley assembly are of equal lengths.

Filter Selector Knob And Handle. Mounted on the line-of-sight case are the filter selector knob and handle (8, figure 4—48) which permit selection between polarized and clear filters and adjustment to the amount of polarization required for any given flight condition. The clear glass and polarized filters are mounted perpendicular to each other in the line-of-sight case. Movement of the handle alternates the use of clear or polarized filter. Imprints on the handle identify the two positions as SHADE GLASS. With the polarized filter in position, movement of the knob, turning a wormgear, controls the amount of polarization desired at a specified time.

Eyepiece Adjusting Ring. Mounted on the top of the gyro optics case, and holding whichever of the alternate eyepiece assemblies is in use, is the eyepiece adjusting ring (2, figure 4—48). Turn as required for clarity of focus.

B-3 And B-6A Driftmeter Alignment Check

To obtain maximum accurate utilization of the driftmeter, it is necessary to check for proper alignment with the longitudinal axis of the airplane. This may be accomplished by cross checking the driftmeter alignment with the alignment of the periscopic sextant after the sextant has been properly aligned on the vertical stabilizer of the airplane. The following steps apply in accomplishing this alignment.

a. Correctly align the periscopic sextant as outlined in this section.

b. Set 000.0 degrees in azimuth counter of periscopic sextant.

c. Sight on object approximately 045 degrees left of the nose, at least 400 feet from the airplane, using the periscopic sextant. Retord the bearing and subtract from 360 degrees.

Note

The object should be at least 400 feet from the airplane to minimize the error to less than 1 degree. Using this distance will compensate for the offset distance of the driftmeter location from the sextant mount.

d. Rotate trail angle knob of driftmeter to maximum trail position.

e. Disengage azimuth drive knob and sight on previously selected object.

f. Compare this bearing with relative bearing obtained from periscopic sextant.

g. If bearings do not agree, loosen setscrews on driftmeter pointer and adjust to read same bearing obtained from periscopic sextant.

h. The difference may be applied to all drift readings as a correction if it is not practical to adjust driftmeter pointer prior to flight.

The following is a sample problem showing the figures obtained and the manner in which corrections are applied:

a. Bearing obtained from periscopic sextant is 045 degrees to the left of the nose.

b. 360 minus 045 equals 315 degrees relative bearing.

c. Bearing obtained from driftmeter is 313 degrees relative bearing.

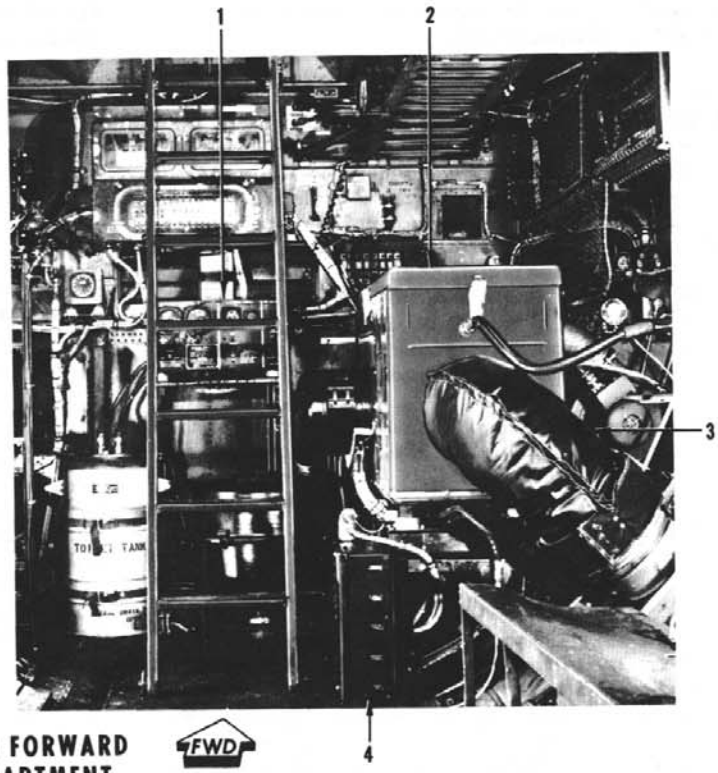
d. Correct pointer of driftmeter to read 315 degrees or apply 2 degrees right correction to all drift correction readings obtained in flight; i. e., —4 drift correction becomes —6, a +4 drift correction becomes + 2.

AUXILIARY POWER UNIT

A turbine-driven auxiliary power unit (figure 4—49) is in the lower forward compartment. The APU drives a 28-volt, 500-ampere, direct current generator which is also used as a starting motor. The APU will operate to altitudes of 20,000 feet with generator output of 14 kilowatts at 28 volts dc. At altitudes under 10,000 feet, the generator can provide a 5-minute supply of 17.4 kilowatts at 28 volts dc (approximately 620 amperes). Fuel is supplied from the No. 2 tank or from the fuel manifold and is automatically shut off when the APU is not operating. The APU has a self-contained oil supply. An air intake duct allows air to flow to the turbine compressor, while an exhaust duct provides means for exhausting products of combustion. A valve in each duct is connected by a rod and linkage to operate together (open or close) from a manual control handle next to APU. The handle is spring-loaded to the OPEN or to the CLOSED position to prevent valve gates from creeping. The intake duct valve actuates a microswitch in the control circuit to prevent APU operation with the intake and exhaust ducts closed. The APU provides necessary electrical power to operate a blower unit in each outboard nacelle. These blowers are used in conjunction with wing anti-icing heaters for preheating the airplane engines. By preheating the engines, engine starts may be made at ambient temperatures of —65°C (—85°F). For cold weather engine preheating instructions, refer to COLD WEATHER PROCEDURES, Section IX. The APU can also be used as a standby electrical power source for takeoff and landing, or as an emergency power source during flights up to 20,000 feet. (The cabin must be depressurized.) A blower is installed in the airplane to pressurize the turbine compartment. The turbine compartment is pressurized to prevent exhaust fumes from entering the control cabin. The blower also aids in cooling the APU compartment. The blower may be ground operated. The control circuit protection for the APU is on the auxiliary power unit circuit breaker panel (6, figure 1—37). The generator load protection is provided through two 325-ampere current limiters wired in parallel, giving a total of 650 amperes circuit protection. The APU generator will continuously deliver 500 amperes. Fuel consumption is between 8 and 12 gallons per hour, dependent upon the generator load.

Note

When operating continuously, shut down and check oil level once daily.



1 APU CONTROL PANEL
2 AUXILIARY POWER UNIT
3 EXHAUST DUCT
4 APU CIRCUIT BREAKER PANEL

AUXILIARY POWER UNIT

Figure 4–49

APU CONTROLS AND INDICATORS

The operating controls and indicators for the APU are located on a panel below the forward power panel. The APU control panel (figure 4–50) is divided into three sections: engine control, generator control, and fire control. The engine control section governs the operation of the turbine, while the generator control section provides for starting and stopping the generator and provides visual indication of generator voltage level, load level, and failure. The fire control section provides fire warning and a switch for actuating the APU fire extinguisher.

APU Switch

An OFF–RUN APU switch (54, figure 1–21) on the engineer's instrument panel controls power to the APU. With the switch in RUN position, the battery switch (1, figure 1–11) and electrical master switch (41, figure 1–11) on the overhead panel in ON positions, and the duct valves open, 28-volt dc power from the forward power panel will energize the APU circuit. Power from the forward power panel through the APU switch will also actuate the blower relay, supplying power from the forward power panel to operate the blower for pressurization and cooling of the APU. The blower will operate while the airplane is on the ground or in the air. With the APU switch at OFF, the APU circuit is deenergized.

Engine Start–Stop Switch

The engine start–stop switch (11, figure 4–50) on the APU control panel controls the operation of the turbine. In the START position, the generator functions as a motor to start the turbine, provided the APU switch (54, figure 1–21) on the engineer's instrument panel is in the RUN position, the battery switch (1, figure 1–11) is in the ON position, and the electrical master switch (41, figure 1–11) on the overhead panel is in the ON position. Once the turbine is energized, the switch is returned to a center neutral position. In the STOP position, the switch stops the turbine. The switch is spring-loaded to return to the center neutral position unless manually held in place.

Generator Control Switch

The ON–OFF–RESET generator control switch (8, figure 4–50) on the APU control panel is a three-position toggle switch with a momentary function in the reset direction. When the turbine is operating at full speed and the switch is placed in the RESET, then in the ON position, the generator will deliver full load to the airplane dc bus. If the generator has failed, the switch must be placed in the RESET position momentarily, and then to the ON position. With the generator control switch in the ON position, the blower will energize through the oleo relay switches when the airplane is in flight or on the ground.

Tachometer

The tachometer (3, figure 4–50) on the APU control panel presents the speed of the turbine in percentage of rated speed.

Turbine Discharge Temperature Indicator

The turbine discharge temperature indicator (1, figure 4–50) on the APU control panel provides a visual indication of turbine exhaust temperature. If the turbine discharge temperature exceeds 600°C, as indicated by the indicator, the APU will automatically shut off.

DC Loadmeter

The dc loadmeter (5, figure 4–50) on the APU control panel is a dc ammeter calibrated from –0.1 through 0 through 0.5 through 1.0 to 1.25. The meter is read as percentage of full load; the 1.0 position being 100 percent of full-load indication.

DC Voltmeter

The dc voltmeter (4, figure 4–50) on the APU control panel is calibrated from 0 to 30 volts. The meter will indicate approximately 28 volts when the generator is supplying current to the airplane.

Generator Warning Light

The red, press-to-test generator warning light (9, figure 4–50) on the APU control panel will illuminate when the generator has failed.

Oil Pressure, Oil Temperature, And Fuel Pressure Warning Lights

The APU has warning lights instead of gages for oil temperature, oil pressure, and fuel pressure. These red press-to-test lights are operative when the APU switch (54, figure 1–21) on the engineer's instrument panel is in the RUN position, the battery switch (1, figure 1–11) and electrical master switch (41, figure 1–11) on the overhead panel are in the ON positions, and the duct valves are open. The fuel low-pressure and oil low-pressure warning lights (10 and 12, figure 4–50) will remain illuminated until fuel and oil pressures build up during starting. Illumination of either one of these two warning lights while the APU is operating will be accompanied by automatic shutdown of the APU. If the oil high-temperature warning light (2, figure 4–50) comes on, the APU must be shut down manually. (High oil temperatures will usually be caused by engine malfunctioning and will eventually result in automatic shutdown of the engine.)

APU OPERATION

The APU can be operated only with the cabin depressurized and at altitudes up to 20,000 feet. No external dc power source is required, as the APU will operate off battery power. In general, the APU is started before the nacelle covers and blower hoses are installed.

Starting Instructions (Ground And In Flight)

WARNING

When the airplane is descending, the APU can be started only after the cabin has been depressurized.

a. Clear exhaust path of personnel, equipment, or foreign material and install exhaust deflector if required.

b. Check that electrical master switch is ON.

c. Check that battery switch is ON.

d. Place APU switch on the engineer's instrument panel to RUN.

e. Check battery voltage and, if below the minimum of 22.5 volts, provide external power source (ground only).

f. Open APU inlet and exhaust valves.

g. Check that generator control switch is OFF.

h. Press engine START-STOP switch to START position and release. When the turbine reaches 98 to 101 percent and stabilizes, as shown on the tachometer, place the generator control switch momentarily at RESET, then to ON. The

blower unit operates on the ground and in flight. Check that the blower unit is operational.

CAUTION

The generator control switch must not be placed to RESET then ON until turbine speed has reached 98 to 101 percent and stabilizes.

Shutdown Procedures (Ground And In Flight)

Engineer's Position

a. Place APU switch to OFF.

APU Control Panel

a. Press engine START-STOP Switch to the STOP position and release.

b. Close inlet and exhaust valves when APU has stopped.

c. Place engineer's APU switch to OFF when inlet and exhaust valves are closed.

CAUTION

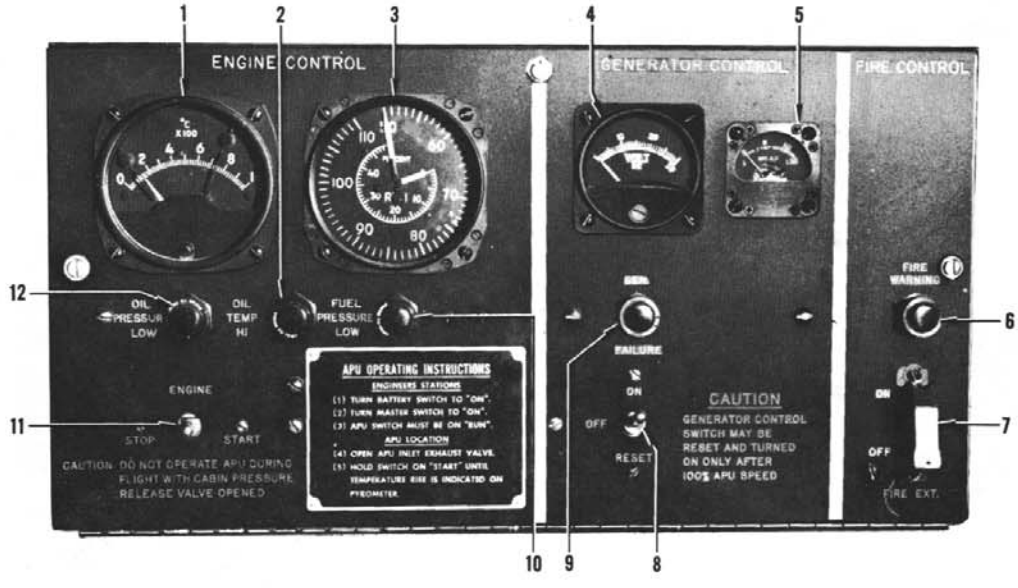
- Prior to closing air inlet and exhaust valves, allow sufficient time for the turbine and compressor to come to rest. This will normally occur 10 to 20 seconds after shutdown.
- When the airplane is ascending, the APU must be stopped when airplane approaches cabin pressurizing altitude.
- When opening or closing the inlet and exhaust valves, extreme care must be taken so as not to damage the equipment in such a way that the microswitch is not tripped. If this microswitch is not tripped, it is possible to actuate the start circuit of the APU with both the air inlet and exhaust valves closed. This could result in the collapsing of the inlet duct and overheating of the turbine and the exhaust system.

CARGO LOADING EQUIPMENT

The principal function of these airplanes is to refuel other airplanes in flight. They can also be used to carry cargo and troops with the refueling equipment installed. The compact arrangement of the refueling tanks in the airplane leaves considerable space in the main compartment for cargo and troops. (See figures 4–53 and 4–54.) There is sufficient cargo space available to carry large items of cargo. The location of tanks on the left side of the compartment leaves an adequate number of tiedown fittings available, an unobstructed forward cargo door, access to all escape hatches, and a dc electrically operated cargo hoist that can be used in loading cargo. The cargo hoist can be conveniently used as the necessary towing force to pull cargo into the compartment. The cargo hoist is capable of lifting 2500 pounds with a single line or 5000 pounds with a double line, and is capable of producing a towing force of 7500 pounds with a triple line configuration. The double line is rigged by hooking the hoist cable into the cross bar at the end of the trolley and installing a snatch block on the cable. The triple line is rigged by first traversing the trolley to station 726 and locking in place and rigging the cable with two snatch blocks. With the adequate number of tiedown rings, the cargo should always be secured to avoid shifting. Shifting cargo can be hazardous to the extent of moving the airplane CG out of prescribed limits while in severe turbulence, or can be hazardous to crewmembers if it should happen to move forward into the control cabin during very rapid deceleration periods such as crash landings and ditching operations. For more detailed information concerning cargo loading and tiedown, refer to the latest technical order titled, Manual of Cargo Loading Instructions, T. O. 1C-97D-9. Other information applicable to cargo loading can be found in the Manual of Weight and Balance Data, T. O. 1-1B-40. Also refer to Section V of this manual for weight and CG limitations.

FORWARD CARGO DOOR CONTROLS AND OPERATION

The forward cargo door is located on the right side of the main compartment. See figure 4–52 for the controls. A web strap safety gate is provided for installation across the door opening to protect personnel from accidentally falling out of the airplane. It should always be placed across the opening while the door is open and not being used for loading. It is stowed on the aft edge of the door frame when it is not in use; however, it can be left in place when the door is closed. The door is operated by an independent hydraulic system. Hydraulic pressure is supplied by a handpump. The system is controlled by an OPEN–NEUTRAL–CLOSE selector handle (2, figure 4–52) located adjacent to the door. The door is opened from a closed and locked position by placing the door lock handles at the bottom of the door from a full up position to a full down position, placing the selector handle to OPEN, and operating the handpump until the door stops moving up. Closing the door is accomplished by placing the selector handle to NEUTRAL and letting the door fall slowly closed to a free hanging position. By placing the selector handle in CLOSE and operating the handpump, the door will move to a fully closed position where the door lock handles can be rotated to a full up position to lock the door securely. The door can be stopped at any time during the closing travel by placing



1 TURBINE DISCHARGE TEMPERATURE INDICATOR
2 OIL HIGH-TEMPERATURE WARNING LIGHT
3 TACHOMETER
4 DC VOLTMETER
5 DC LOADMETER
6 FIRE WARNING LIGHT
7 CO_2 RELEASE SWITCH
8 GENERATOR CONTROL SWITCH
9 GENERATOR WARNING LIGHT
10 FUEL LOW-PRESSURE WARNING LIGHT
11 ENGINE START-STOP SWITCH
12 OIL LOW-PRESSURE WARNING LIGHT

APU CONTROL PANEL

Figure 4–50

the selector handle back to OPEN. There are electrical switches on the door which will illuminate a door open light on the pilots' instrument panel if the door is not completely closed and locked; however, electrical dc power must be on.

CAUTION

During flight, the door selector handle should be in CLOSE position, and hydraulic pressure up.

DOOR WARNING SYSTEM

A door warning system indicates when the forward entry door, forward cargo door, or aft entry door is not closed and locked. The forward and aft entry doors each have one door closed warning switch and one door locked warning switch. The forward cargo door has two door locked and two handle closed warning switches and two door latch switches. All are pushbutton switches wired in parallel, and are in the open position when all doors are closed. If any switch is left closed, a door warning light (28, figure 1–8) on the pilots' instrument panel will illuminate. The door warning circuit is pro-

CARGO LOADING

Figure 4–51

tected by a circuit breaker on the overhead circuit breaker panel (1, figure 1-37). Prior to takeoff, check that all doors are closed and locked. If a warning light illuminates before take-off, all engines will be shut down and all doors will be unlocked, opened, closed and locked. If the door warning light remains illuminated following these checks, the aircraft will not be flown until the malfunction has been corrected. If the door warning light illuminates during flight, decrease the cabin differential pressure by selecting a higher cabin altitude. If visual inspection of the door locking mechanisms indicates that the doors are locked, pressurized flight may be continued at reduced pressure.

MAIN COMPARTMENT

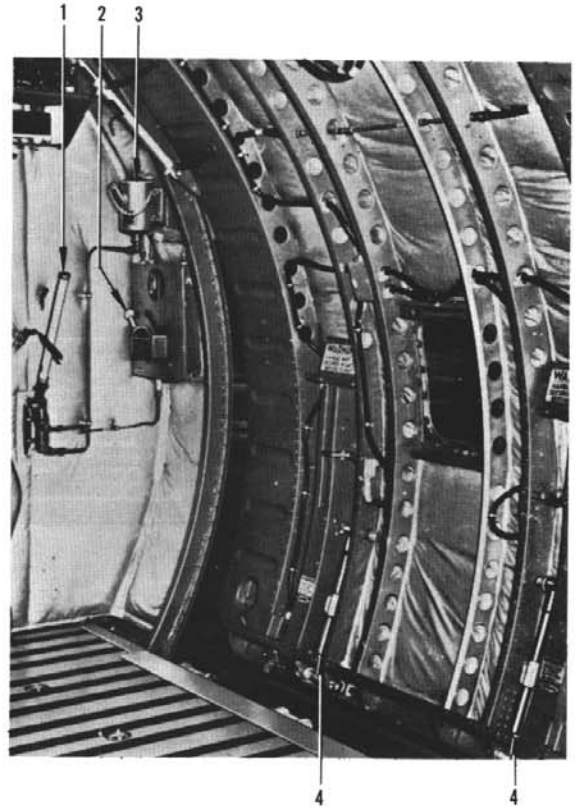
The manner in which the A/R tanks are installed on the left side of the main compartment leaves room for carrying cargo or troops while the airplane is fully equipped with refueling provisions. Figure 4–53 illustrates the basic dimensions of available cargo space.

CAUTION

Cargo and personal equipment will not be placed closer than 6 inches to heater ducts in the main compartment.

CARGO LOADING SUPPORT STRUT

The cargo loading support strut is provided for support of the fuselage at the tail skid jacking pad when loading cargo. The jack-strut base is stowed in the aft stowage



1 HANDPUMP
2 SELECTOR HANDLE
3 RESERVOIR
4 LOCK HANDLE (2 PLACES)

FORWARD CARGO DOOR CONTROLS

Figure 4–52

compartment, and the support strut is stowed on the ceiling of the rear end of the lower aft compartment. The support strut should be used as a support only.

Installation of cargo loading support strut is as follows:

a. Fully extend jack.

b. Adjust cargo loading support strut to desired length and attach to tail skid jacking pad and jack-strut base.

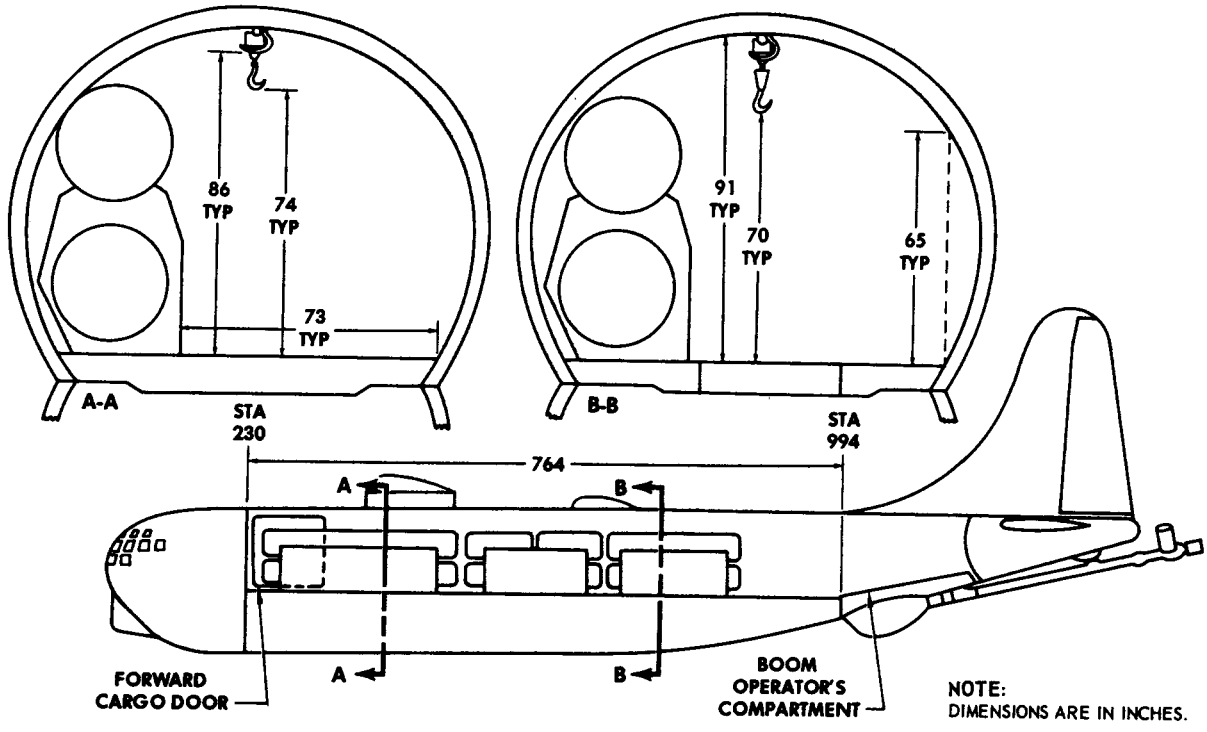
Removal of cargo loading support strut is as follows:

a. Lower jack by releasing hydraulic pressure.

b. Remove and stow cargo loading support strut.

CARGO FLOOR

The floor in the main compartment is subjected to great stresses imposed by heavy cargo and rough cargo handling. The floor has load limits which should not be exceeded. Various types of cargo could exert loads on the



MAIN COMPARTMENT DIMENSIONS

Figure 4–53

floor which could dent or puncture floor panels and distort the floor beams if it is resting on small contact areas or in the center of a single beam. The floor in the main compartment can be loaded up to 200 pounds per square foot. The floor in the lower forward and lower aft compartments can be loaded up to 100 pounds per square foot. The main compartment floor can also support concentrated loads of 200 pounds per square inch without damage to the floor panels or floor beams if the concentrated loads do not exceed the floor beam capacities. The floor beam capacities will vary depending on where the concentrated load is applied to the beam, number of beams used, and the location of the beams in the fuselage.

CARGO TIEDOWN FITTINGS AND DEVICES

There are tiedown fittings of nine different types located throughout the airplane. Cargo is tied down with standard Air Force tiedown devices. Four different types are used to secure the cargo from moving. There are the 1250-pound capacity type A-1 web straps, the 5000-pound capacity B-1 cables, the 10,000-pound capacity type C-2 chains with turnbuckles, and the 25,000-pound capacity type D-1 chains with turnbuckles. Stowage is provided for all devices. The A-1 devices hang on the sidewall, the B-1 devices are stowed in fabric bags on the sidewall, and the C-2 and D-1 devices are stowed in a wooden box at the aft end of the main compartment. Periodic testing is required on all tiedown devices.

CARGO HOIST

The airplane is equipped with a cargo hoist which is mounted at the top of the fuselage at the forward end of the main compartment. The dc electrically operated hoist has two cable systems; one drives a trolley along a monorail at the top of the main compartment, and the other hoists loads from the trolley. The hoist is controlled by a portable control box which can be plugged into any one of three receptacles along the right side of the fuselage. This box has pushbuttons, UP–DOWN–FWD–AFT–EMERGENCY STOP, which operate the cargo hoist for respective operations. On and off controls are on the cargo hoist shield directly below the hoist motor. The cargo hoist has manual operation features in case of electrical failure. The loading capacity of the hoist is 2500 pounds on a single cable. If increased capacity is needed, a mechanical advantage will have to be used. This is done by the use of a snatch block to make a double line configuration of the hoisting cable between the load and the cargo hoist trolley. With this arrangement, the hoist will have a hoisting capacity of 5000 pounds, which is the absolute maximum for hoisting and should never be

FORWARD CARGO FLOOR HATCH

INCHES

INCHES	4	8	12	16	20	24	28	32	36	40	42
4	168	168	167	167	167	166	166	90	80	72	69
8	168	166	166	166	165	165	164	90	80	72	69
12	167	166	153	152	152	151	150	89	80	72	69
16	167	166	152	132	132	131	130	89	79	72	68
20	167	165	152	132	117	117	116	88	79	71	68
24	166	165	151	131	117	105	104	88	79	71	68
28	166	164	150	130	116	104	96	87	78	70	67

AFT CARGO FLOOR HATCH

INCHES

INCHES	4	6	12	16	20	24	28	32	36
4	155	155	155	155	155	155	155	155	150
8	155	130	130	130	130	130	125	125	125
12	155	130	110	110	110	110	105	105	105
16	155	130	110	95	95	95	95	95	95
20	155	130	110	95	85	85	80	80	80
24	155	130	110	95	85	70	70	70	70
26	155	130	110	95	85	70	55	55	55

FORWARD CARGO DOOR

WIDTH IN INCHES

HEIGHT IN INCHES	6	12	18	24	30	36	42	48	54	60	66	72
6	709	408	300	234	192	166	142	127	114	103	92	85
12	709	405	297	232	191	165	141	126	113	102	91	85
18	709	403	295	230	190	163	140	125	112	101	90	85
24	709	390	288	228	188	161	139	124	111	100	89	84
30	570	376	281	223	186	159	138	123	110	99	88	83
36	535	361	272	217	182	157	137	122	109	98	87	82
42	493	344	262	212	178	154	136	121	108	97	86	81
48	454	323	250	205	173	151	133	119	107	96	85	80
54	418	304	240	197	168	147	131	117	106	95	84	79
60	382	285	228	189	163	143	128	113	103	93	83	77
66	350	268	217	182	158	139	125	110	101	91	82	76
72	242	202	172	149	133	121	106	92	83	77	76	66
76	242	202	172	149	133	121	106	92	83	74	68	62

EXPLANATION

This chart represents the approximate maximum width, height, and length of any rectangular shaped object that can be loaded thru the forward cargo door. The chart is based on the internal dimensions of the KC-97L airplane with no allowance being made for handling difficulties and for protruding items except the door actuator brackets. Other protruding items such as fire extinguishers and first aid kits may be removed if necessary.

NOTE

Due to the configuration of the airplane and the varying methods of loading, the dimensions are not the absolute maximum. If a cargo's dimensions are close to those defined by the table, it is advisable to make a trial loading before deciding whether the cargo item may be loaded or not.

USE OF CHART

The left side of the chart contains values for the vertical dimension as cargo enters the door. The top of the chart contains values for the horizontal dimension as cargo enters the door. It will be noted that a 30 inch high by 60 inch wide box cannot exceed approximately 99 inches in length while a 60 inch high by 30 inch wide box cannot exceed approximately 163 inches in length. Irregular shaped objects can be approximated by entering the chart with the outside dimensions of the objects concerned.

PACKAGE DIMENSIONS

Figure 4–54

exceeded. An additional snatch block is furnished so a triple line configuration can be used for towing loads up to 7500 pounds; however, the trolley has to be positioned at station 726 and the trolley lock on top of monorail engaged at all times.

Cargo Hoist Controls

Brake Release Lever. The brake release lever (29, figure 4–55) on the left end of the hoist motor can be lifted to release the friction disc brake to lower a load on this hoist manually.

CAUTION

Always lift the brake release lever slowly to avoid dropping a load. Do not lower a load at more than the normal rate.

Handcrank. The cargo hoist handcrank (2, figure 4–55) is used when the hoist is operated manually by inserting the handcrank into the receptacle on the handcrank drive (27, figure 4–55) and rotating it in either a clockwise or counterclockwise direction. The handcrank is stowed on the left side of the forward bulkhead of the main compartment when not in use.

Clutch Thrust Screw Arm. The clutch thrust screw arm (21, figure 4–55) on the right end of the hoist positions the clutches in the hoist for each operation. The clutches are in the hoist position when the clutch thrust screw arm is up and in the traverse position when the clutch thrust screw arm is down.

Emergency Stop Button. An EMERGENCY STOP button (Detail I, figure 4–55) is located on the cargo hoist shield and another is located on the portable control box (Detail II, figure 4–55). These buttons, if pressed, stop all cargo hoist operation regardless of what action is taking place.

Power Reset Button. The power reset button (Detail I, figure 4–55) is located on the cargo hoist shield and must be pressed in for the cargo hoist to operate. If the emergency stop button (Detail I, figure 4–55) is used, the power reset button must be pressed to restore power to the hoist.

Control Circuit Breaker Switch. Circuit protection for the cargo hoist controls on 22629 ▶ 22736 is through a circuit breaker on the forward power panel (5, figure 1–37). On all other airplanes, control circuit protection is on the cargo hoist shield (Detail I, figure 4–55) through an ON–OFF, switch-type circuit breaker.

Power On Indicating Light. An amber power on indicating light (Detail I, figure 4–55) on the cargo hoist is in use if the power reset button is in and the circuit breaker switch is on.

Cargo Hoist Electrical Operation

WARNING

- The cargo hoist motor has sufficient power to break the hoist cable in the event of an overload or a malfunction. Cargo hoist assemblies with part numbers 7H740-4, -5, -6, and -7 are equipped with a torque limiting clutch which will allow slippage and thus act to prevent overload. Hoist assemblies with part number 7H740 do not have this torque limiter and can be overloaded more easily. Cable breakage can cause personnel injury and airplane damage. Observe precautions outlined in T. O. 1C-97D-9, CARGO LOADING INSTRUCTIONS.
- Do not operate cargo hoist when fuel fumes are present.

The cargo hoist is operated from either an external dc power source or the airplane auxiliary power unit. With dc power on the airplane, the cargo hoist is turned on and operated as follows:

a. On the cargo hoist shield, position the control circuit breaker switch to ON and press power reset switch. The amber power on indicating light will illuminate.

b. Remove the portable control box from its stowage on the bulkhead below the cargo hoist and connect to any of the three receptacles on the right side of main compartment. The cargo hoist is now ready to operate.

c. To operate the hoist, press the desired pushbutton switch on the portable control box to get the respective hoisting or traversing action. If the emergency stop button is pressed, cargo hoist operation will stop regardless of what action is taking place. To restore power to the hoist, press power reset button on cargo hoist shield.

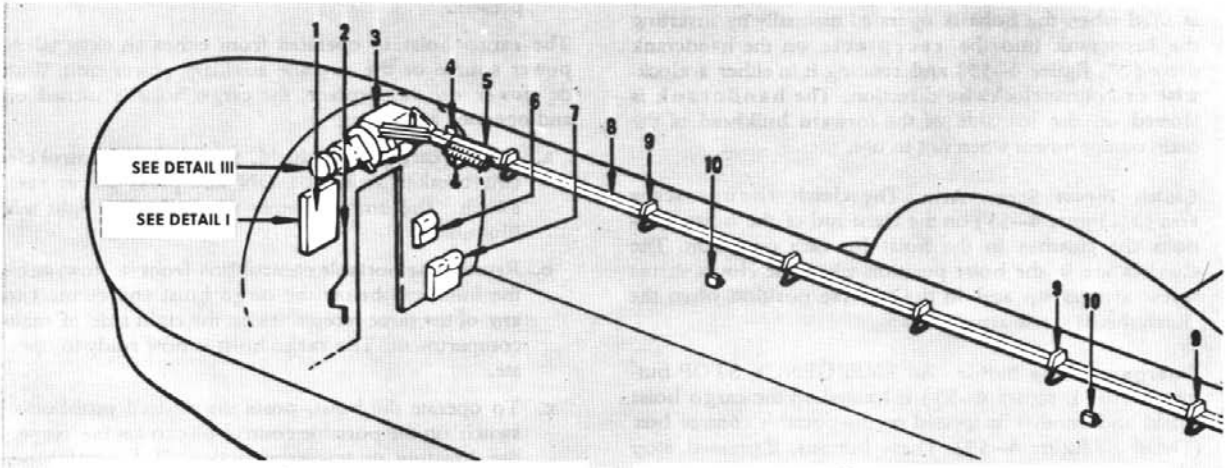
d. Always maintain sufficient cable tension on hoisting cable when operating the hoist under no-load condition. The cable will foul on the drum if no tension is held on the cable.

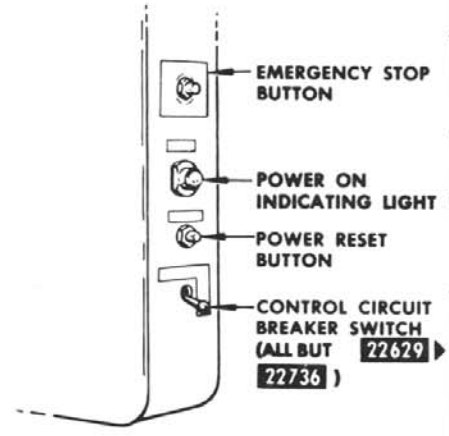
e. There is a limit switch located at the fore and aft ends of the monorail to stop trolley travel. Check the switch operation the first time the trolley approaches its fore or aft limit.

f. Do not jam hoisting hook against the trolley.

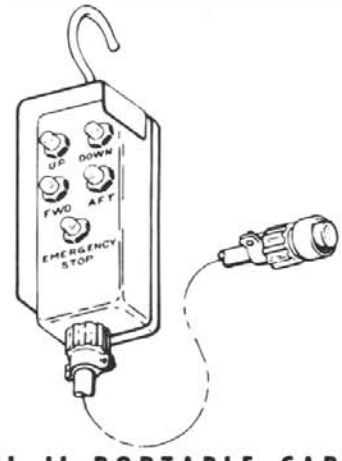
g. There is a limit switch located on each side of the hoisting drum to stop unwinding all but two wraps of hoisting cable, or to stop cargo hoist operation when the hoisting drum is fully wound with cable. Check switch operation the first time all of the hoisting cable is let out or taken in.

1 CARGO HOIST SHIELD
2 CARGO HOIST HANDCRANK (STOWED)
3 CARGO HOIST
4 FORWARD TROLLEY LIMIT SWITCH
5 CARGO HOIST TROLLEY
6 PORTABLE CARGO HOIST CONTROL BOX CONTAINER
7 SNATCH BLOCK CONTAINER
8 MONORAIL
9 CABLE SUPPORT HOOK (5 PLACES)
10 PORTABLE CARGO HOIST CONTROL BOX RECEPTACLE (3 PLACES)
11 CARGO HOIST TROLLEY LOCK
12 PORTABLE CARGO HOIST CONTROL BOX
13 AFT TROLLEY LIMIT SWITCH
14 TRAVERSING CABLES (2 PLACES)
15 TRAVERSING CABLE TENSION SPRINGS
16 CABLE SHEAVE
17 HOISTING CABLE (2 PLACES)
18 HOISTING HOOK
19 ROTARY ACTUATOR
20 ROTARY ACTUATOR EXTENSION ARM
21 CLUTCH THRUST SCREW ARM
22 TRAVERSING DRUM
23 LEVEL WINDER
24 LIMIT SWITCH BOLT
25 HOISTING DRUM
26 LEVEL WINDER LIMIT SWITCH
27 HANDCRANK DRIVE
28 CARGO HOIST MOTOR
29 BRAKE RELEASE LEVER





DETAIL I
CARGO HOIST SHIELD



DETAIL II PORTABLE CARGO HOIST CONTROL BOX

CARGO HOIST SYSTEM

Figure 4–55 (Sheet 1 of 2)

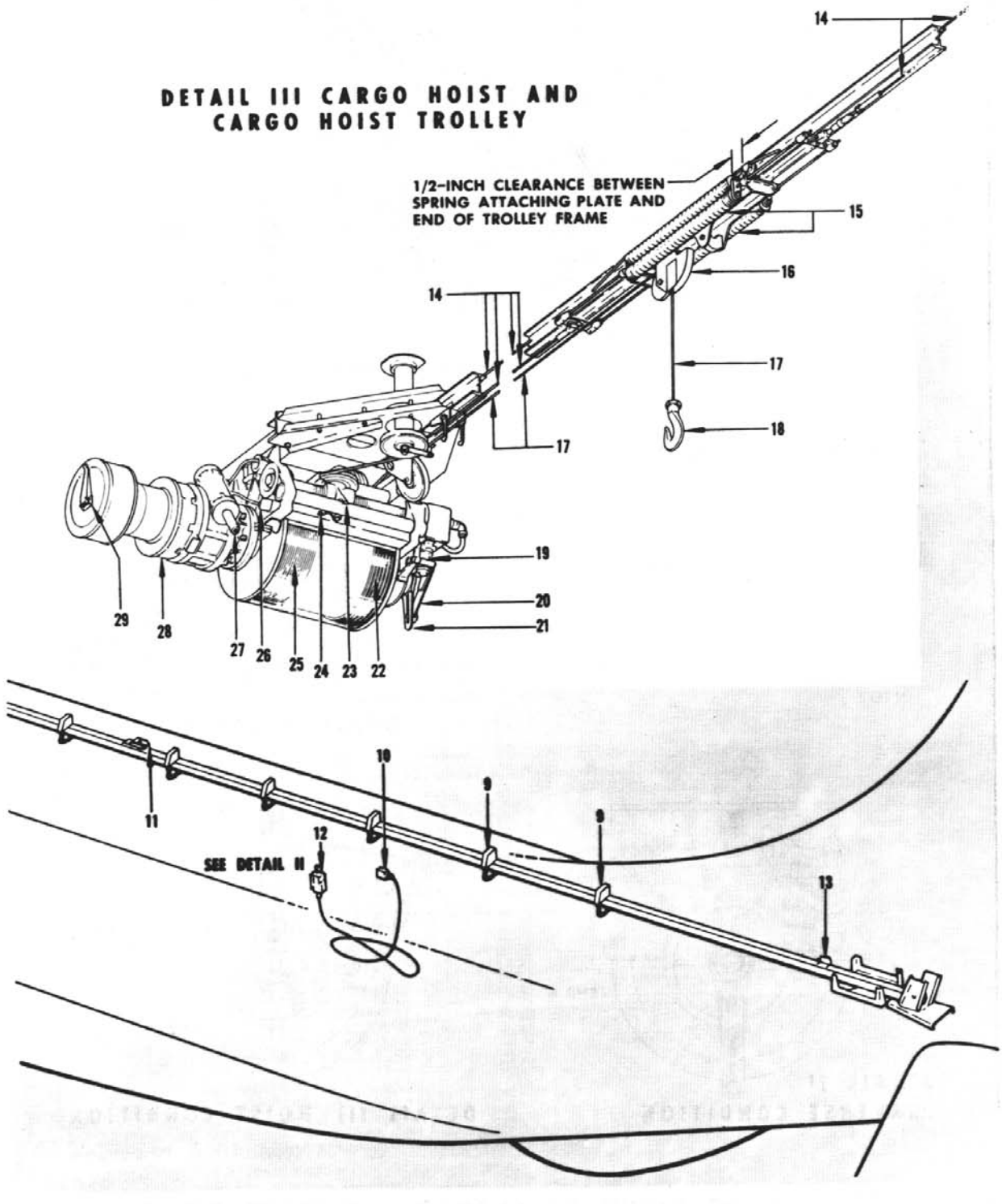
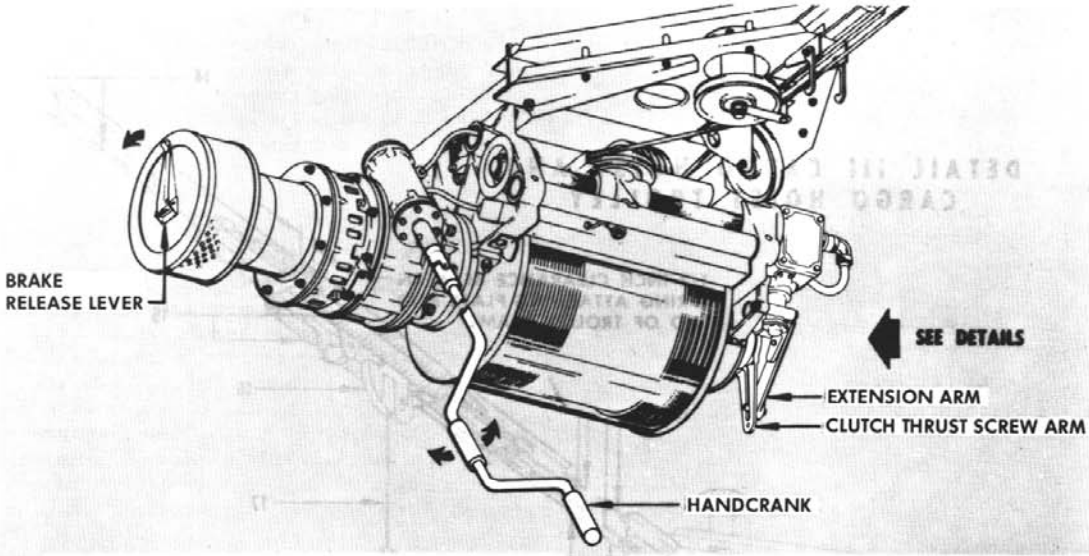


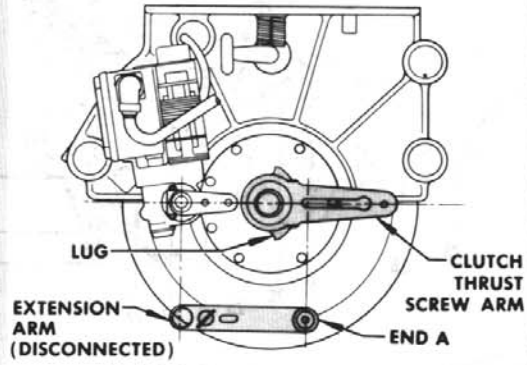
Figure 4–55 (Sheet 2 of 2)



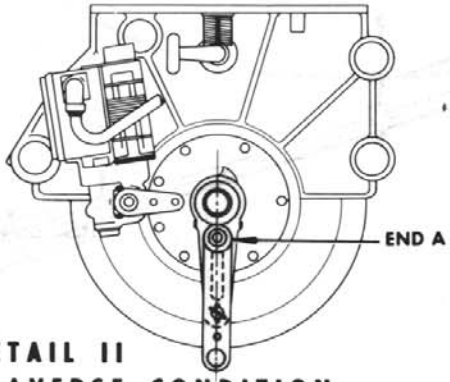
MANUAL OPERATION

1. Remove extension arm.
2. Position clutch thrust screw arm to desired condition.
3. Install end A behind lug to hold clutch thrust screw arm in desired position.
4. Operate handcrank or pull out release lever.

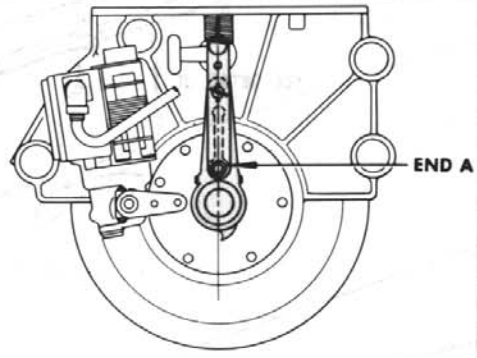
NOTE:
REFER TO CARGO HOIST MANUAL OPERATION IN TEXT.



DETAIL I NEUTRAL



DETAIL II
TRAVERSE CONDITION



DETAIL III HOIST CONDITION

CARGO HOIST MANUAL OPERATION

Figure 4–56

h. Before lifting a heavy load over 6 inches, change from a hoisting cycle to a traversing cycle. If the load does not settle over 1/2 inch, continue operating. If excessive settling or dropping is noticed, stop operating hoist until it is properly adjusted.

Note

- If there are more than six strands of cable broken in any 1 inch length, hoist is not safe to operate under maximum rated load. Cable replacement is necessary.
- Intermittent operation of the cargo hoist will trip the power circuit breaker on the forward power panel.

i. Cargo hoist power is turned off by positioning the control circuit breaker switch to OFF. Place the portable control box to its stowed position.

Cargo Hoist Manual Operation

The cargo hoist can be manually operated to relieve the load from the hoisting cable in event of a power failure or a malfunctioning electrical circuit. Before deciding the electrical circuit is malfunctioning, press the cargo hoist circuit breaker on the forward power panel. If this does not restore power to the cargo hoist shield, the hoist will have to be operated according to one of the following procedures:

a. If the load is in a desired location for lowering and was being hoisted at the time of failure, pull out on the brake release lever on the end of the cargo hoist motor and load will lower at a moderate lowering speed.

b. If the load is in a desired location for lowering but was being traversed at the time of failure, position the clutch thrust screw arm on the right end of the cargo hoist as shown in Detail III, figure 4–56. Pull out on the brake release lever on the end of the cargo hoist motor and the load will lower at a moderate lowering speed.

c. If the load is not in a desired location for lowering and was being traversed at the time of failure, attach and operate the handcrank to traverse the load as needed. When in desired location, reposition the clutch thrust screw arm to hoist condition as shown in Detail III, figure 4–56, and follow procedure in step a above.

d. If the load is not in a desired location for lowering and was being hoisted at the time of failure, position the clutch thrust screw arm on the right end of the hoist as shown in Detail II, figure 4–56. Attach and operate the handcrank to position load at desired location. Reposition the clutch thrust screw arm to a hoisting condition as shown in Detail III, figure 4–56. Pull out on the brake release lever on the cargo hoist motor and the load will lower at a moderate lowering speed.

Note

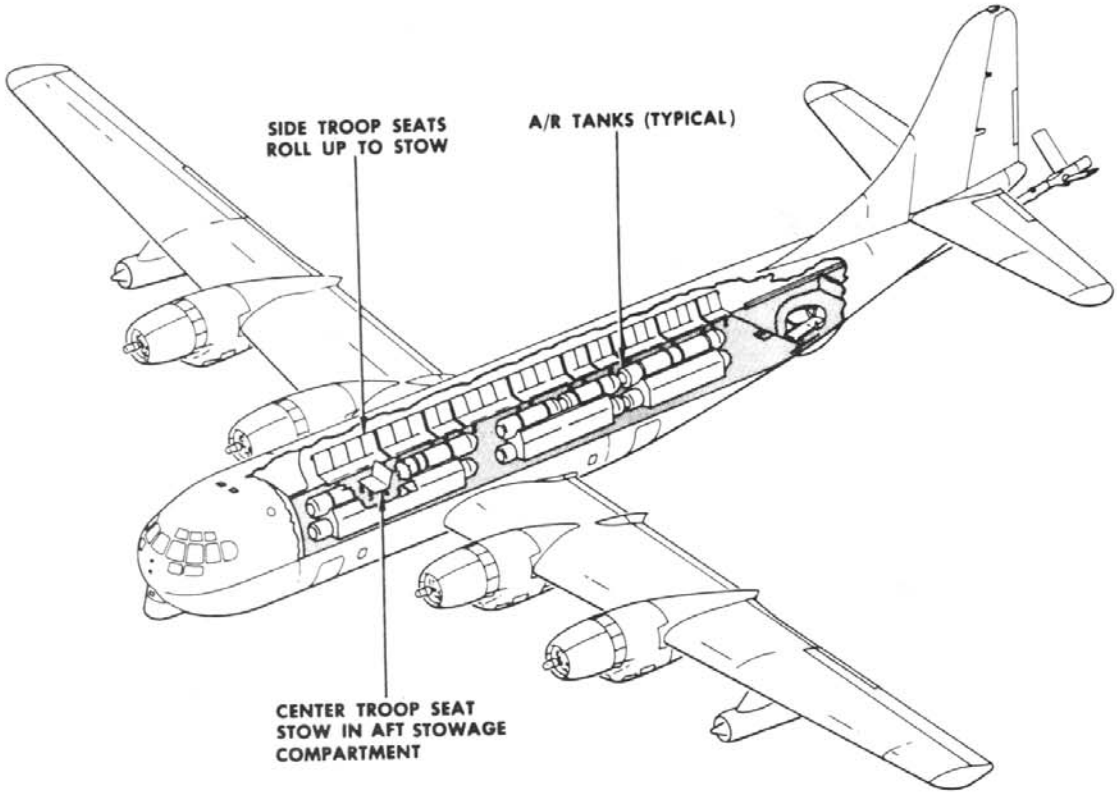
When the clutch thrust screw arm is in the position shown in figure 4–56, Detail III (hoist condition), operating the handcrank as shown in figure 4–56, Detail I will provide slack in the hoisting cable to disconnect the hoisting hook.

TROOP CARRYING EQUIPMENT

In addition to carrying cargo, troop seats may be installed to carry personnel. There are permanently installed, roll-up type troop seats attached to the right side of the fuselage and fold-up type troop seats which can be installed in the center of the main compartment next to the refueling tanks. Due to the installation of A/R tanks in the lower forward and lower aft compartments, no space is available to carry troops in these sections. The total seating capacity of the airplane is 63. Each seat is fitted with a safety belt. For troop seating arrangement, see figure 4–57.

AIR REFUELING (A/R) SYSTEM

The airplane is equipped to transfer fuel to receiver-type airplanes in flight by means of the A/R system. The major A/R system components are: A/R fuel system (figure 4–66), A/R hydraulic system (figure 4–58), A/R boom hydraulic system (figure 4–60), and the A/R signal system (figure 4–63). Fuel is carried in 15 fuselage tanks. The fuel tanks are also interconnected to form two tank systems. Additional fuel can be pumped into the A/R tanks from the main tanks and center wing tank, provided certain valves are properly positioned. Two hydraulically driven fuel pumps (A-1 pumps) are used in the A/R system to transfer fuel through the boom at a maximum rate of approximately 5400 pounds per minute. These pumps are gravity fed from the two tank systems. Except for emergency fuel dumping, the output of these pumps should be limited to a total of 5400 pounds per minute (830 gpm of JP-4 or 900 gpm of aviation gasoline). The two pumps are controlled by a hydraulic metering valve which is actuated by the isodraulic (isolated hydraulic) system (figure 4–58). Fuel flows from the pumps through a series of: check valves, control valves, a flow measuring venturi, and out through a self-sealing poppet valve in the boom nozzle. The boom, when not in contact with a receiver airplane, can be extended or retracted hydraulically by the boom operator. Lowering and hoisting of the boom within 8 degrees of the stowed position is also done hydraulically. Movement of the boom when in a lowered position is controlled by the boom operator by actuating a control stick which is mechanically linked to the ruddevator surfaces. The A/R electrical system operates on power received from the airplane 28-volt dc system and the 115-volt ac system. The A/R hydraulic system can be more readily understood if considered as four



TROOP SEATING ARRANGEMENT

Figure 4–57

component systems: hydraulic pressure system, hydraulic fuel pump system, isodraulic system, and the A/R boom hydraulic system. See figure 4–58 for the interrelationship of these systems.

17260 ▶ 22736

The A/R hydraulic system (figure 4–58) is independent of the airplane main hydraulic system and is used to pump fuel and to pressurize the A/R boom hydraulic system.

22737 ▶

The A/R hydraulic system and the A/R boom hydraulic system are separated into two integral parts. The A/R hydraulic system provides pressure to drive the fuel pumps (figure 4–58). Hydraulic pressure from the airplane main hydraulic system drives a hydraulic motor that in turn drives a hydraulic pump which provides the high level pressure required for boom operation.

A/R HYDRAULIC PRESSURE SYSTEM

The basic components of the A/R hydraulic pressure system (figure 4–58) are a reservoir which supplies hydraulic fluid to two engine-driven pumps, one on each of the outboard engines; two oil coolers, one each in No. 1 and No. 4 nacelles, that automatically control the oil temperature; and a jet-type hydraulic pump (17, figure 4–59) to provide at least 50 psi of hydraulic oil to the engine-driven pumps. There are surge accumulators installed in the A/R hydraulic system. On **17260 ▶ 22736** , the hydraulic reservoir capacity is 8 US gallons and is serviced to a maximum of 6 gallons, and on **22737 ▶** , the reservoir capacity is 4.24 US gallons and is serviced to a maximum of 3.36 US gallons.

CAUTION

Hydraulic drain valves must not be opened during flight because discharged hydraulic fluid will deteriorate the pod seals and cloud the boom operator's window.

A/R Hydraulic Oil Supply Valve Switches

An A/R hydraulic oil supply valve switch controls a shutoff valve located in the supply line of each engine-driven A/R hydraulic pump. The valves will shut off the flow of oil to the pumps in case of fire in the power package. Operation of the valves is rapid and they will remain in either the open or closed position without continuous application of power. Two NORMAL–FIRE switches (16, figure 1–11) on the overhead panel control the shutoff valves. Refer also to POWER PACKAGE FIRE SWITCHES, Section I. The valves can be closed with the two hydraulic oil supply valve switches (3, figure 4–65) on the engineer's A/R panel. The switches have OPEN–CLOSE positions and are guarded to OPEN. Power for all four switches is 28 volts dc.

A/R Hydraulic System Pressure Gages

A hydraulic pressure gage in the pressure line of each engine-driven pump indicates system pressure in psi. These two gages are located on the engineer's A/R panel (figure 4–65). On 17260▶ 28934 , the gages are direct reading and on 28934▶ , the gages are electrically operated. Power for the electrically operated gages is 26 volts ac protected by a fuse on the engineer's A/R panel.

Engine Pump Supply Pressure Gage

A pressure gage (13, figure 4–59) in the lower aft compartment indicates engine pump supply pressure. Pressure reading during cruise operation should be above 50 psi.

A/R Hydraulic Oil Temperature Gage

The A/R hydraulic oil temperature gage (30, figure 1–21) on the engineer's instrument panel shows the temperature of the return oil in the A/R hydraulic system. The temperature bulb (12, figure 4–59) is located in the oil return line.

A/R FUEL PUMP AND ISODRAULIC HYDRAULIC SYSTEMS

Hydraulic system pressure is used to drive two hydraulic motors (figure 4–58) which are mechanically engaged to the two fuel pumps. Each pump and motor unit is enclosed in a fuel pump chamber. A pump chamber is located under the cat walk in each of the lower compartments. Fluid flow to the motors is through the fuel pump metering valve, A/R fuel pump selector valve, and flow limiters. Fluid flow from the fuel pump motors is returned to the pressurized engine-driven pump supply system. There are three basic units in the isodraulic (isolated hydraulic) system. The control unit, functioning as a hydraulic pump, forces fluid through a compensator and into a slave actuator (8, figure 4–59), which actuates the fuel pump metering valve through a mechanical linkage. The compensator acts as a reservoir and pressure accumulator, and the slave actuator acts as a simple actuating cylinder.

A/R Hydraulic System Bleed Valve

The A/R hydraulic system manually operated bleed valve is located on the A/R hydraulic panel in the system return line downstream of the 40 gpm filter. (See figure 4–58.) This bleed valve has a bleed hole between the tank and supply port, providing the main A/R system with self-bleeding capabilities. By slowly actuating the bleed valve, the full volume of the return line can be directed to the reservoir for complete bleeding.

Isodraulic Handle

The isodraulic handle (4, figure 1–19, and figure 4–58) is part of the isodraulic control unit and is located at the aft end of the engineer's instrument panel. Movement of the handle through positions numbered 1 through 10 hydraulically controls the fuel pump metering valve (figure 4–58) which, in turn, controls the fuel pump rpm. The handle also has an OFF position.

A/R Fuel Pump Selector Valve Handle

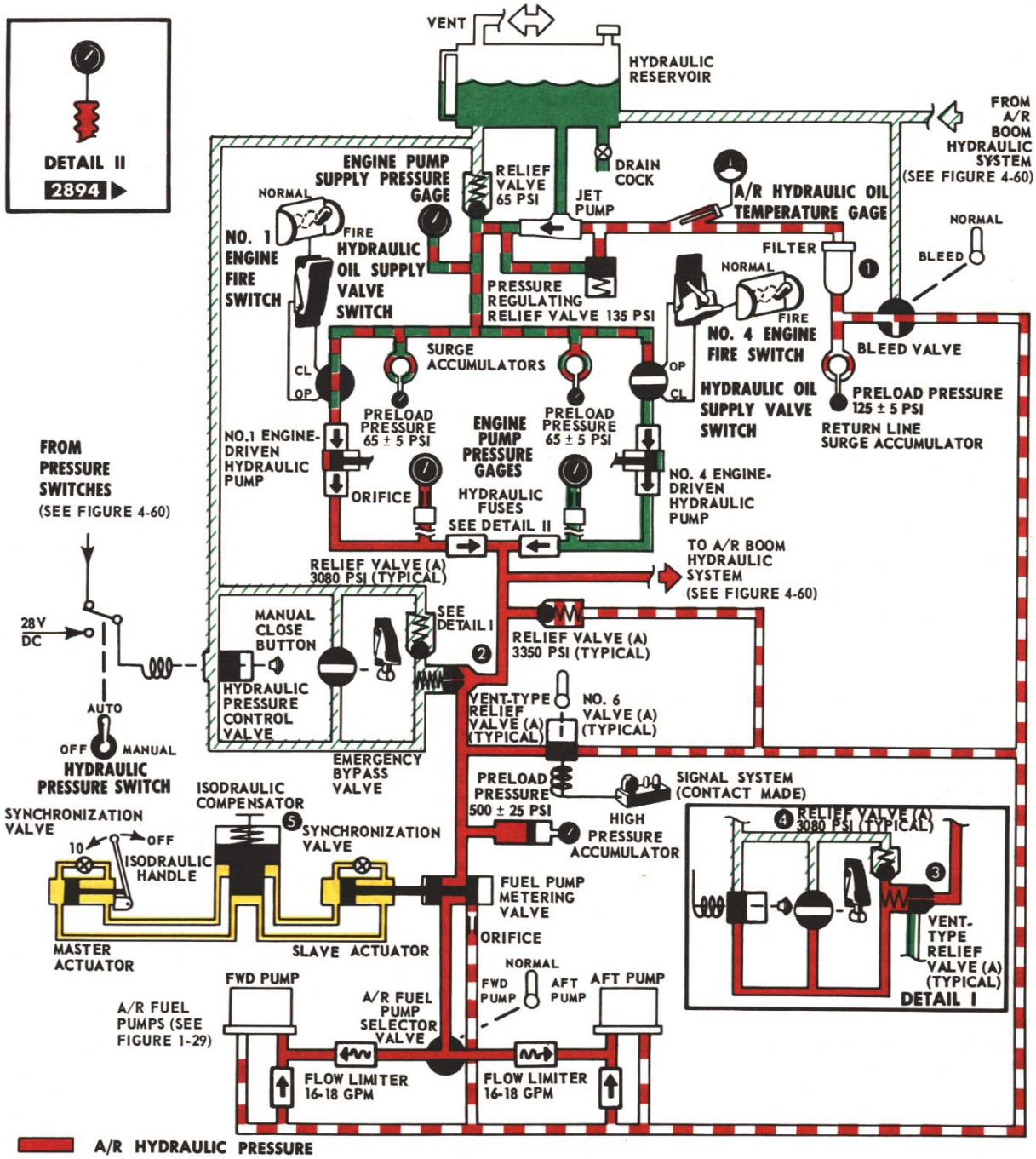
This handle (5, figure 4–59) is located in the lower aft compartment. This handle operates a selector valve that controls hydraulic fluid flow from the fuel pump metering valve to the forward, the aft, or both fuel pump hydraulic motors. This selector valve cannot be positioned to shut off fluid flow to both pump motors simultaneously. Handle positions are FWD PUMP–NORMAL–AFT PUMP.

A/R BOOM HYDRAULIC SYSTEM

28334▶ 22718

The A/R boom hydraulic system (figure 4–60) is pressurized by the A/R hydraulic system. If boom system pressure falls below normal, the boom hydraulic pressure switch will energize the hydraulic pressure control valves in the pressure system, causing two vent-type relief valves to restrict hydraulic fluid flow to the fuel pump motors. These two vent-type relief valves (3, figure 4–59) assure a constant pressure supply to the A/R boom hydraulic system. A manually operated emergency bypass valve handle (1, figure 4–59) is provided to permit opening of the vent-type relief valves in case a malfunction of the solenoid-operated pressure control valve holds them in the closed position. If the solenoid valve will not actuate to the closed position, it can be held closed manually by the manual close button on the hydraulic pressure control valve (6, figure 4–59).

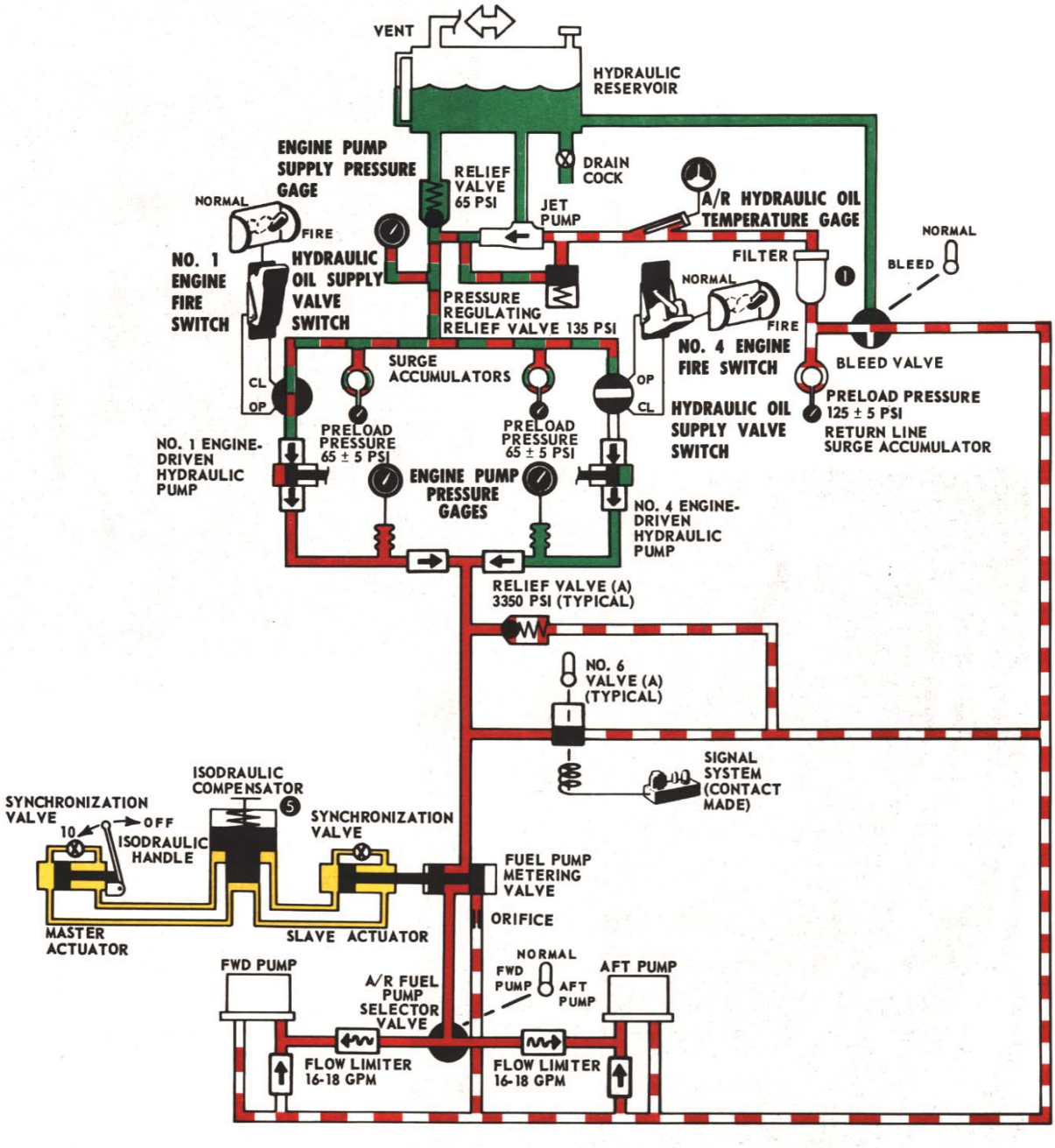
Fluid pressure is used to hoist the boom through its upper 8 degrees of travel and to extend and retract the boom. Two hydraulic motors are mechanically connected to the boom hoist cable drum. One motor is used to hoist and lower the boom; the other motor is used to maintain a constant tension on the boom cable. The rate at which the boom can be lowered is controlled by the ruddevator control stick. Extension and retraction of the boom is accomplished by the telescope motor which is mechanically linked to the boom by a chain and cable system. Hydraulic pressure is also used to actuate a mechanical linkage which will unseat the boom nozzle



17260 ▶ 22736

A/R HYDRAULIC SYSTEM

Figure 4–58 (Sheet 1 of 2)

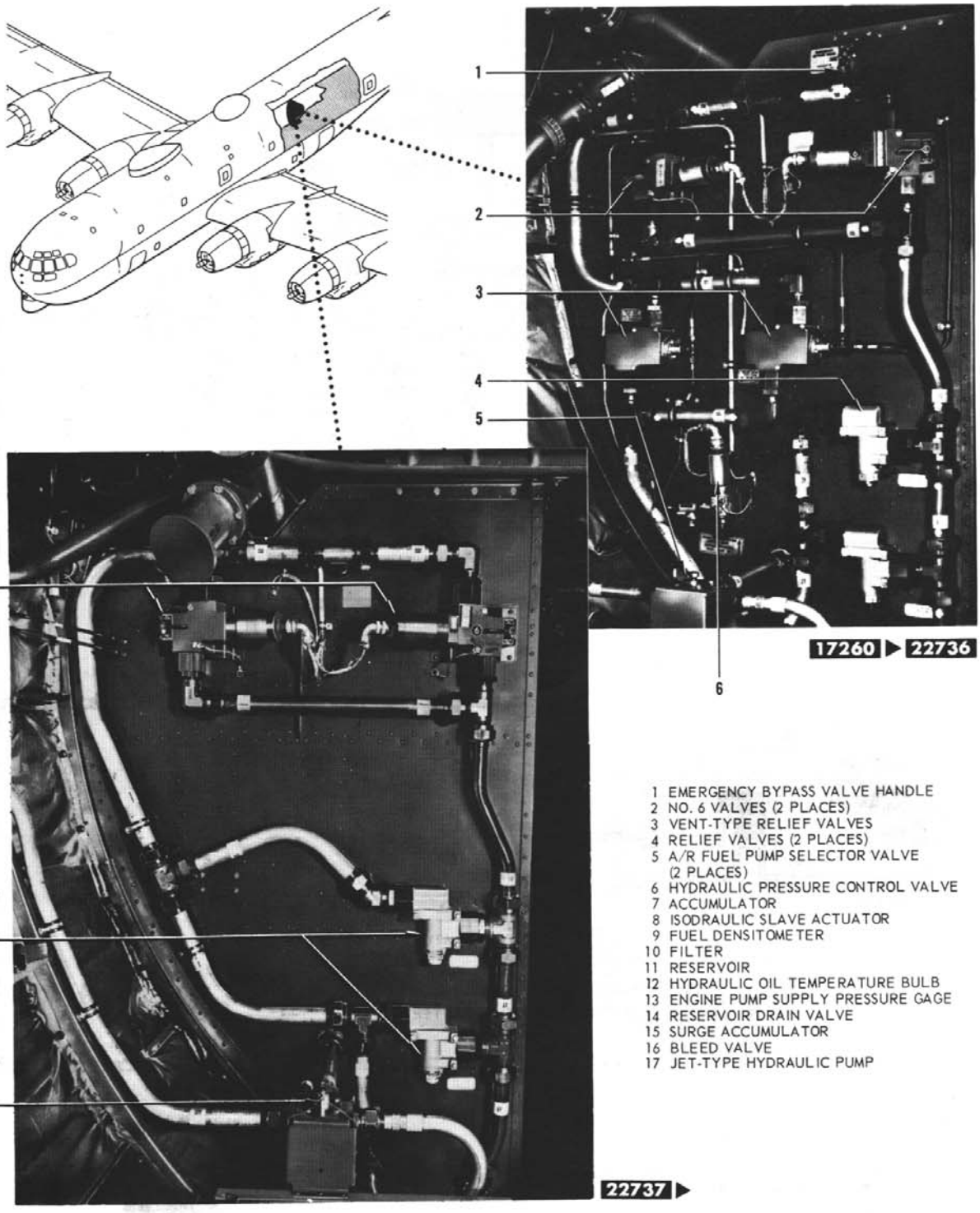


NOTE:

1. Filter contains internal bypass valve which opens when pressure drop across filter exceeds 35 psi.
2. Fluid bled thru vent creates a differential pressure and A/R hydraulic pressure holds valve open.
3. When hydraulic pressure control valve closes, fluid bled thru the vent equalizes pressure allowing spring to momentarily close vent-type relief valve. Maximum system pressure is then available to pressurize A/R boom hydraulic system.
4. Relief valve opens when system pressure reaches 3080 psi; flow thru vent creates differential pressure which opens vent-type relief valve. This cycle will continue until hydraulic pressure control valve opens.
5. Proper extension for indicator bolt is 3/8 to 7/8 inch.

22737 ▶

Figure 4–58 (Sheet 2 of 2)



1 EMERGENCY BYPASS VALVE HANDLE
2 NO. 6 VALVES (2 PLACES)
3 VENT-TYPE RELIEF VALVES
4 RELIEF VALVES (2 PLACES)
5 A/R FUEL PUMP SELECTOR VALVE (2 PLACES)
6 HYDRAULIC PRESSURE CONTROL VALVE
7 ACCUMULATOR
8 ISODRAULIC SLAVE ACTUATOR
9 FUEL DENSITOMETER
10 FILTER
11 RESERVOIR
12 HYDRAULIC OIL TEMPERATURE BULB
13 ENGINE PUMP SUPPLY PRESSURE GAGE
14 RESERVOIR DRAIN VALVE
15 SURGE ACCUMULATOR
16 BLEED VALVE
17 JET-TYPE HYDRAULIC PUMP

A/R HYDRAULIC PANELS

Figure 4–59 (Sheet 1 of 2)

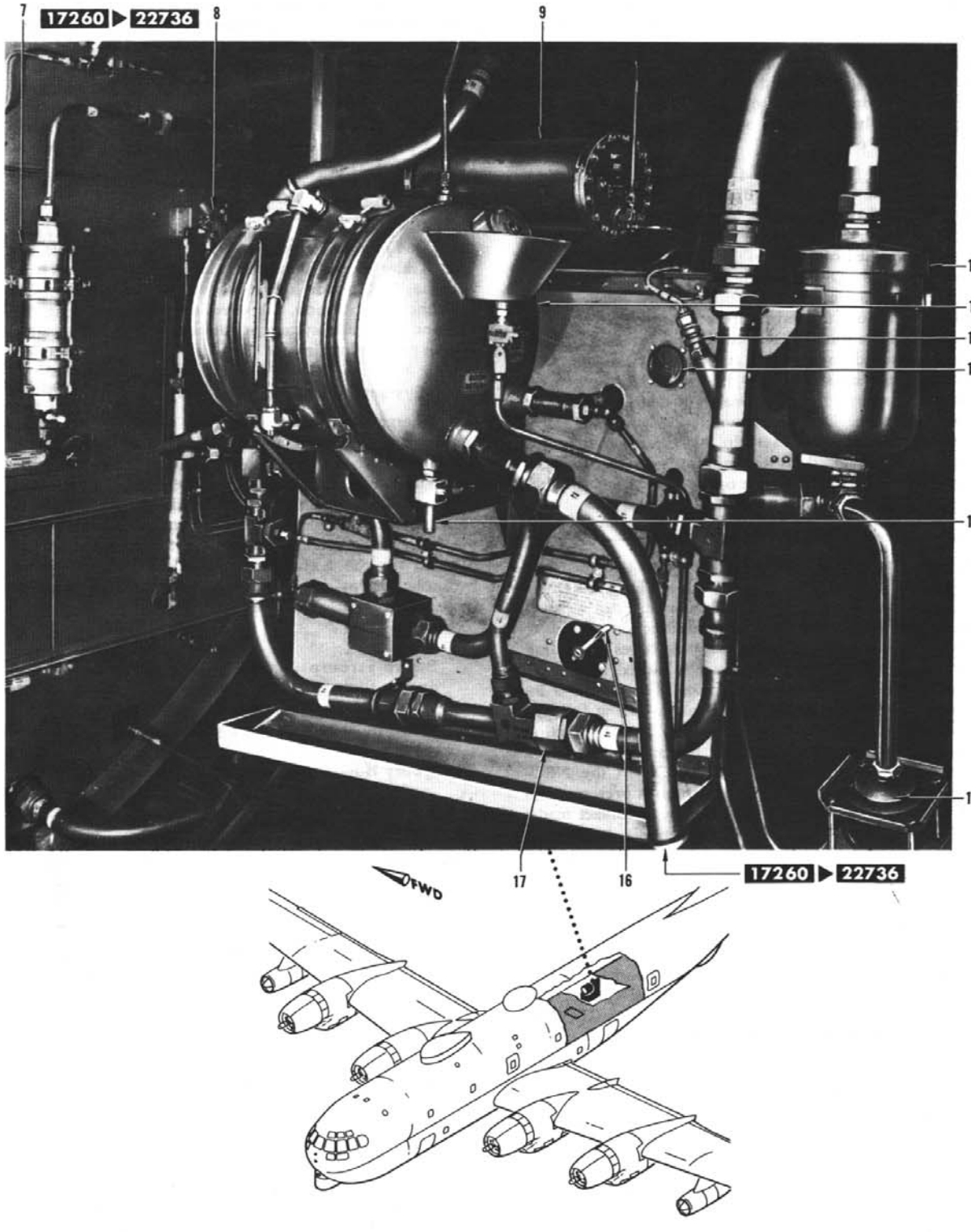


Figure 4–59 (Sheet 2 of 2)

poppet, permitting fuel to be dumped should an emergency condition exist. Fuel trapped in the extended boom is returned to the tanks through a hydraulically actuated fuel bypass valve as the boom retracts. Provisions are made to hoist and retract the boom by actuating a handpump located in the boom operator's compartment. This operation will be performed only if failure of the hydraulic system should occur.

The boom hoist lever (figure 4–60 and 43, figure 4–64), located to the left of the boom operator's panel, has DOWN–OFF–UP positions. The hoist lever controls the direction and rate of flow of fluid to or from the hoist motor. With the hoist lever in the UP position, the motor raises the boom. OFF hydraulically locks the hoist motor, and vertical motion of the boom is prevented. In the DOWN position, the lever allows the motor to rotate in the reverse direction as gravity lowers the boom. In flight, a boom-actuated snub switch automatically transfers control from the hoist lever to the ruddevators when the boom is lowered approximately 8 degrees below the stowed position. On the ground, full elevation travel is controlled by the hoist lever. In this condition, the snub switch is deenergized by the landing gear oleo-actuated relays, even though the boom operator's master switch is ON.

Boom Telescoping Lever

The boom telescoping lever (figure 4–60 and 3, figure 4–64), with RETRACT–NEUTRAL–EXTEND positions, is on the left side of the boom operator's panel. This lever controls the fluid rate and direction of flow to a reversible hydraulic motor which telescopes the sliding member of the boom. As the lever is moved in the EXTEND direction, the rate of extension of the boom is increased, reaching a maximum extension rate at full EXTEND. Movement of the lever in the RETRACT direction increases the rate of retraction of the boom, reaching a maximum retraction rate at RETRACT. In the NEUTRAL position, telescoping of the boom is prevented unless the tanker and receiver airplanes are in contact made; in this condition, the telescoping control is inoperative, and the boom is allowed to extend and retract according to the relative displacements of the two airplanes.

Boom Hydraulic System Depressurization Valve Handle

A boom hydraulic system depressurization valve handle (16, figure 4–61), with OPEN–CLOSED positions, is in the boom operator's compartment. The handle provides for depressurization of the boom hydraulic system. The normal operating position of the handle is the CLOSED position which allows the system to be pressurized.

Note

This valve handle must be at CLOSED to provide hydraulic pressure to actuate the boom nozzle poppet valve for fuel dumping and to provide hydraulic pressure for boom operation.

Boom Hydraulic Pressure Switch 17260▶22736

An AUTO–OFF–MANUAL boom hydraulic pressure switch (7, figure 4–64) on the boom operator's panel provides control to pressurize the boom hydraulic system. The switch is spring-loaded to OFF from the MANUAL position. With the switch in AUTO, the boom hydraulic system pressure will be maintained between 2700 psi and 2950 psi. If the system pressure cannot be maintained due to malfunction of the hydraulic pressure switch or clogging of the flow limiter, the boom system pressure can be maintained by holding the switch in MANUAL as required.

22737▶

An ON–OFF boom hydraulic pressure switch (7, figure 4–64) on the boom operator's panel controls the No. 7 valve located between the airplane hydraulic system and the A/R boom hydraulic system. When the switch is in the ON position, the valve is opened, allowing the airplane hydraulic system to drive the boom hydraulic system pressurizing motor.

Boom System Emergency Handpump

The emergency handpump (14, figure 4–61) in the boom operator's compartment can be used to retract, extend, and hoist the boom in the event of failure of the boom hydraulic system. On 17260▶22736, the handpump supply reservoir is in a closed system. The reservoir contains enough fluid for one complete operation of the hoist and telescope motors. On 22737▶, the supply of fluid for the handpump is taken from the boom hydraulic system reservoir through a standpipe or sump with a capacity of 1.5 US gallons.

Note

Before attempting to hoist or retract boom during flight using the boom system emergency handpump, the boom operator's A/R master switch must be in the OFF position.

Emergency Handpump Selector Valve Knob

The emergency handpump selector valve knob in the boom operator's compartment is used to control the flow of fluid from the emergency handpump. It can be positioned from its OFF position to the HOIST or TELESCOPE position. The selector knob is mechanically linked to the selector valve.

Boom Hydraulic Pressure Gage

A boom hydraulic pressure gage (6, figure 4–64), graduated in 100-psi increments, on the boom operator's panel indicates boom hydraulic system pressure. Normal operating pressure range of the boom hydraulic system is 2700 to 2950 psi. On 17260▶2893, the pressure gages are direct-pressure reading, and on 2893▶, the gages are electrical. Power for the electrical gages is supplied from the 26-volt ac instrument transformer.

Boom Hydraulic Low-Pressure Warning Light

An amber boom hydraulic low-pressure warning light (5, figure 4–64) on the boom operator's panel will illuminate when boom system pressure falls below 2500 ± 50 psi and goes out when boom system pressure returns

to 2625 + 75 or −50 psi. The light is supplied 28-volt dc power from the aft power panel (10, figure 1−37).

A/R BOOM

The A/R boom consists of two concentric tubular sections which will extend from a minimum length of 28 feet to a maximum length of 47 feet. To permit movement in azimuth and elevation, a yoke and trunnion attachment is used to attach the boom to the underside of the fuselage near the tail. A flexible hose couples the high capacity fuel system with the boom. A boom operator controls the boom with an airplane-type control stick which is connected by cables to the ruddevator surfaces. The slipstream, acting on these control surfaces, provides the necessary force to position the boom while in flight. Telescoping of the boom is accomplished through a reversible hydraulic motor. During the contact-made condition, the boom actuates limit switches which automatically initiate disconnect when the boom reaches the boundary of the operating envelope. Voluntary disconnects may be initiated by either the receiver pilot or the boom operator. The receiver director lights, which are installed on the underside of the fuselage, are also boom actuated. These lights direct the receiver pilot toward a smaller operating envelope known as the nominal contact position. Raising and lowering the boom on the ground and raising the boom through the last 8 degrees upward travel while in flight are accomplished with a hydraulically operated hoist. A hydraulic cable tension motor maintains tension on the hoist cable while the boom is being controlled aerodynamically.

Ruddevator Control Stick

In flight, the ruddevator control stick (figure 4−62), located to the right and slightly below the boom operator's platform, provides aerodynamic control of elevation and azimuth boom position. A control lock is provided and should be engaged when the boom is stowed. To assist the boom operator in controlling the boom, while in the area of greatest deflection, an elevation assist trim wheel has been incorporated to relieve pressures on the ruddevator control stick. Turning the elevation assist trim wheel downwards will increase the boom assist by placing increased tension on the load reduction spring. This will be shown by an indicator pin, mounted integrally with the elevation assist trim wheel housing, moving to the right. Rotating the elevation assist trim wheel upwards will decrease the boom assist. When boom is within approximately 10 degrees of stowed position, care should be exercised by the boom operator because of the aerodynamic forces on ruddevators.

CAUTION

- The boom operator should insure that the elevation assist trim wheel is in the full decrease position prior to stowing the boom. Failure to do so may result in structural damage to boom and stowage support.
- With the elevation assist trim wheel in any position other than full decrease, boom control is unreliable in the lower limits.

Ruddevator Control Stick Lock

The ruddevator control stick lock on the bulkhead aft of the ruddevator control stick locks the ruddevator control stick in a neutral position. To lock the control stick, the control lock is pulled forward and the control stick is moved into a recess in the lock.

Boom Latching Lever

The latching lever (28, figure 4−64), with BOOM LATCHED−BOOM UNLATCHED positions, controls a cable-actuated latch which secures the boom. With the boom hoisted against the stowage support, placing the lever in the BOOM LATCHED position secures the boom. To release the boom, it is necessary to apply a hoisting force on the boom to release pressure on the latch before moving the lever to the BOOM UNLATCHED position. The latching lever is located on the right side of the boom operator's panel.

Boom Position Indicators

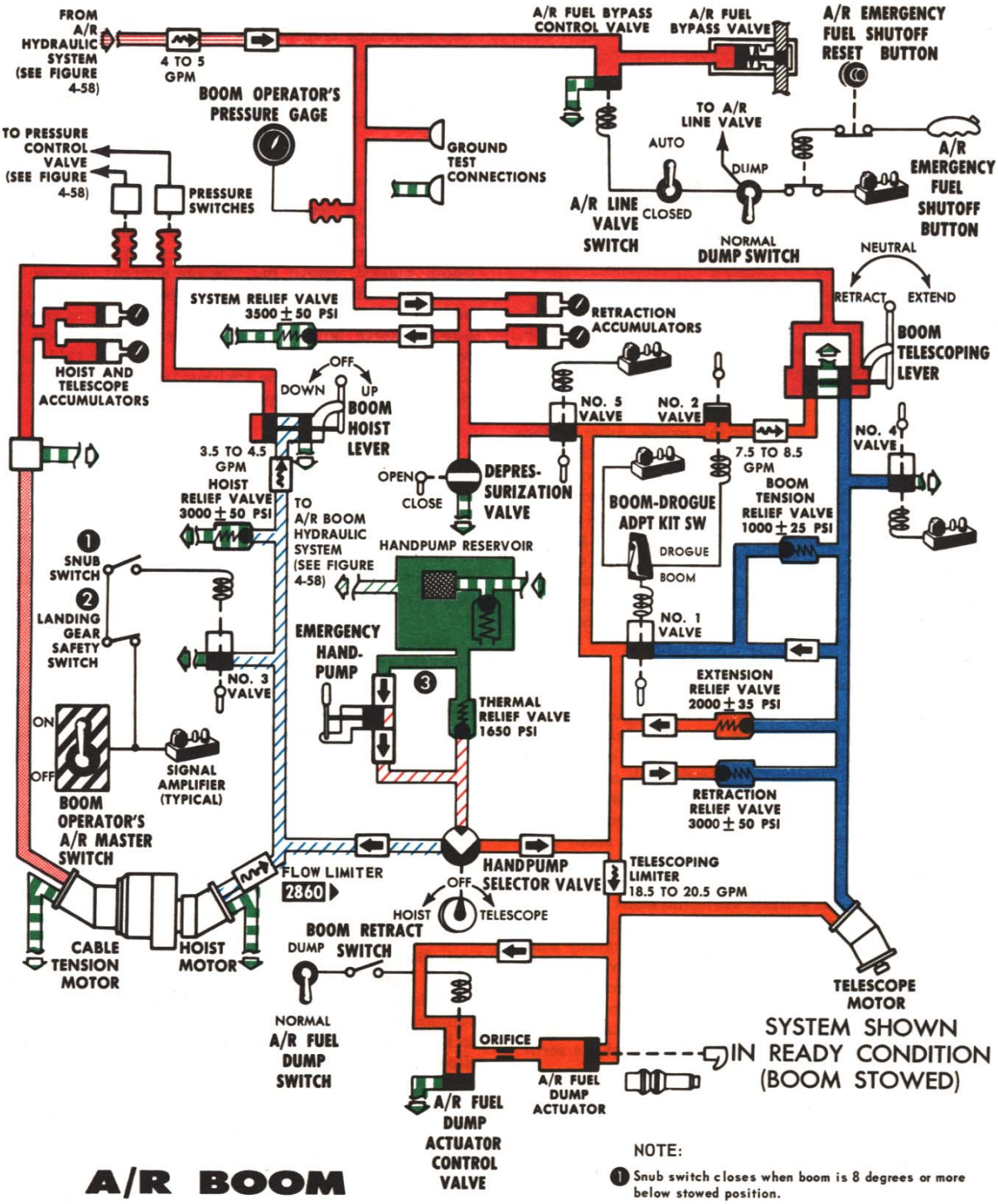
Three boom position indicators (9, 11, and 13, figure 4−64) on the boom operator's panel indicate azimuth, elevation, and telescoping positions of the boom. A circuit breaker on the boom operator's panel protects the electrical circuit connecting the indicators and their respective transmitters.

A/R ELECTRICAL SYSTEM

The A/R electrical system operates on power received from the airplane main 28-volt dc system and the 115-volt ac system. Electrically powered units in the A/R system include fuel shutoff valves, hydraulic valves, lighting, and a signal amplifier.

A/R Signal System

The tanker signal system (figure 4−63) is an electrical system which works in conjunction with a signal system in the receiver airplane to set up the automatic features of the boom hydraulic and fuel systems for contact made and disconnect. In the ready-for-contact condition, the tanker signal system deenergizes the fuel pump and the line valve circuits. Upon contact made, the signal amplifier completes the fuel pump and line valve circuits and also locks the telescope control out of the hydraulic system to allow the boom to extend or retract as necessary. During contact made, coils in the boom nozzle and in the receiver receptacle inductively couple the two signal systems so that signals originating in either system may be transmitted to the other. The coupling of the signal systems allows either the receiver pilot or the boom operator to initiate a disconnect. If one of the boom position limit switches or the fuel pressure limit switch is actuated, an automatic disconnect is initiated. At disconnect, the signal system automatically controls the fuel cutoff and returns telescoping control to the boom operator; if the telescope-at-disconnect switch (8, figure 4−64) is in AUTO, the boom will automatically retract.



A/R BOOM HYDRAULIC SYSTEM

NOTE:

1. Snub switch closes when boom is 8 degrees or more below stowed position.
2. Landing gear safety switch opens when landing gear is on ground and oleos are compressed.
3. Supply to handpump is by handpump suction.

Figure 4–60 (Sheet 1 of 2)

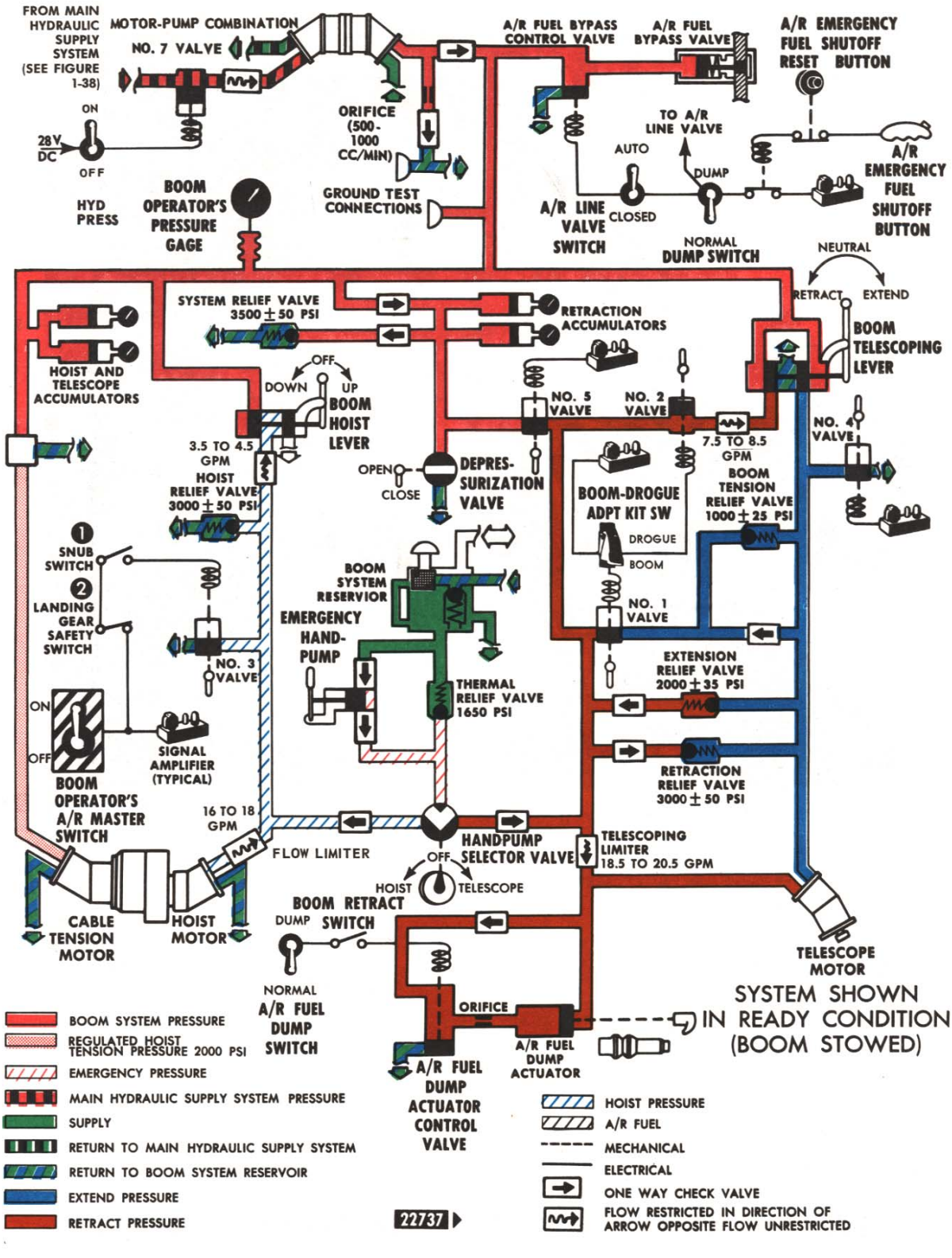
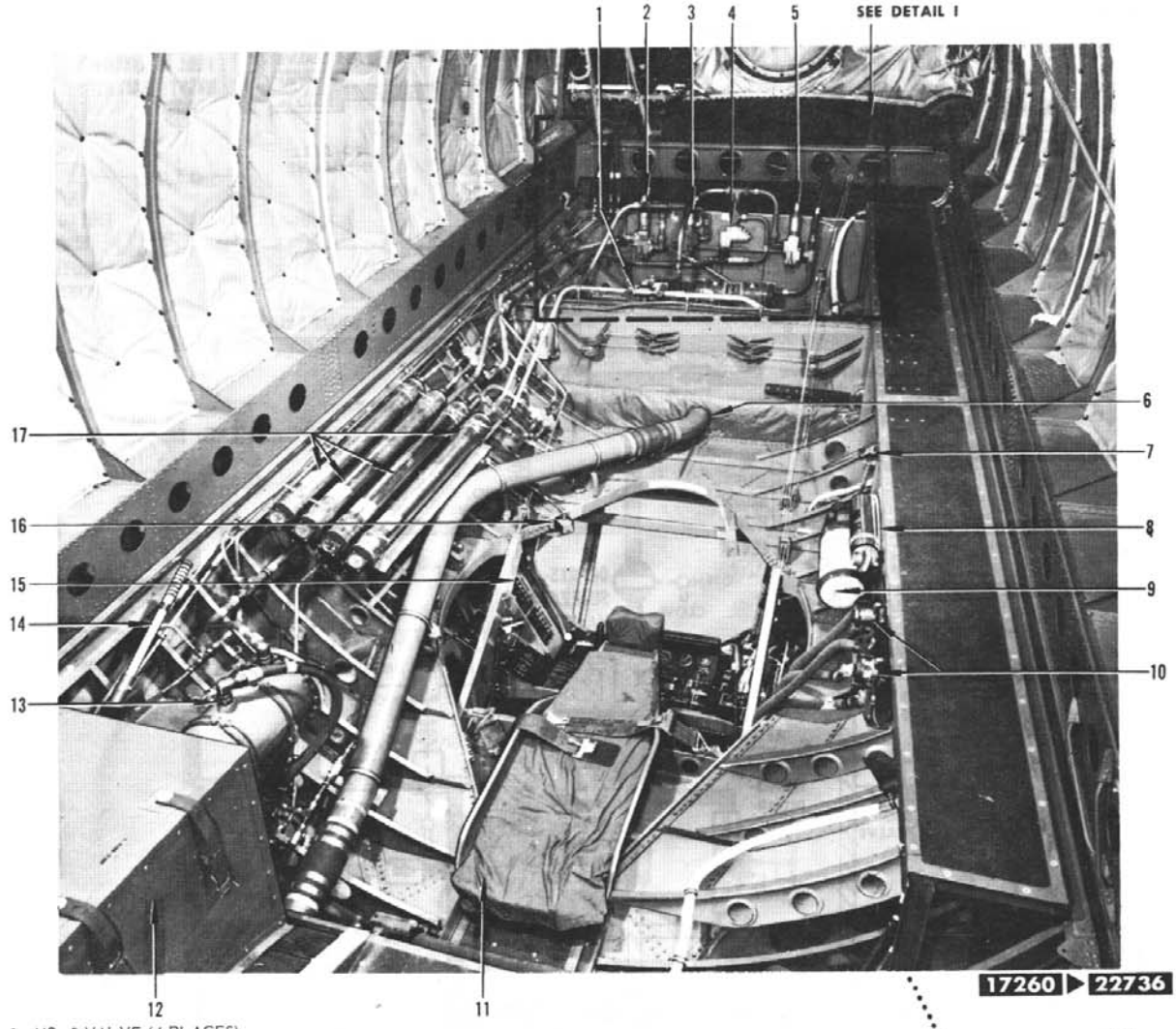
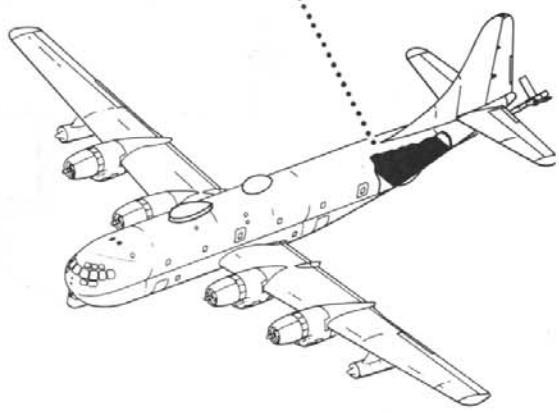


Figure 4–60 (Sheet 2 of 2)



1 NO. 2 VALVE (4 PLACES)
2 NO. 5 VALVE (4 PLACES)
3 NO. 1 VALVE (4 PLACES)
4 BOOM TENSION RELIEF VALVE (1000 PSI) (2 PLACES)
5 NO. 4 VALVE (4 PLACES)
6 FUEL LINE TO BOOM (2 PLACES)
7 OXYGEN BOTTLE RECHARGER (2 PLACES)
8 FIRE EXTINGUISHER (2 PLACES)
9 OXYGEN CYLINDER (2 PLACES)
10 OXYGEN REGULATORS (2 PLACES)
11 BOOM OPERATOR'S PLATFORM (2 PLACES)
12 CARGO TIEDOWN EQUIPMENT STOWAGE (2 PLACES)
13 BOOM SYSTEM EMERGENCY HANDPUMP RESERVOIR
14 BOOM SYSTEM EMERGENCY HANDPUMP (2 PLACES)
15 INTERPHONE CONTROL PANEL(S) (2 PLACES)
16 BOOM HYDRAULIC SYSTEM DEPRESSURIZATION VALVE HANDLE (2 PLACES)
17 ACCUMULATORS (2 PLACES)
18 BOOM SYSTEM HYDRAULIC RESERVOIR (2 PLACES)
19 NO. 7 VALVE (2 PLACES)
20 MOTOR-PUMP COMBINATION (2 PLACES)
21 INSTRUMENT PANEL AND CONTROLS
22 AZIMUTH TRANSMITTER
23 FUEL PRESSURE TRANSMITTER



BOOM OPERATOR'S COMPARTMENT

Figure 4–61 (Sheet 1 of 3)

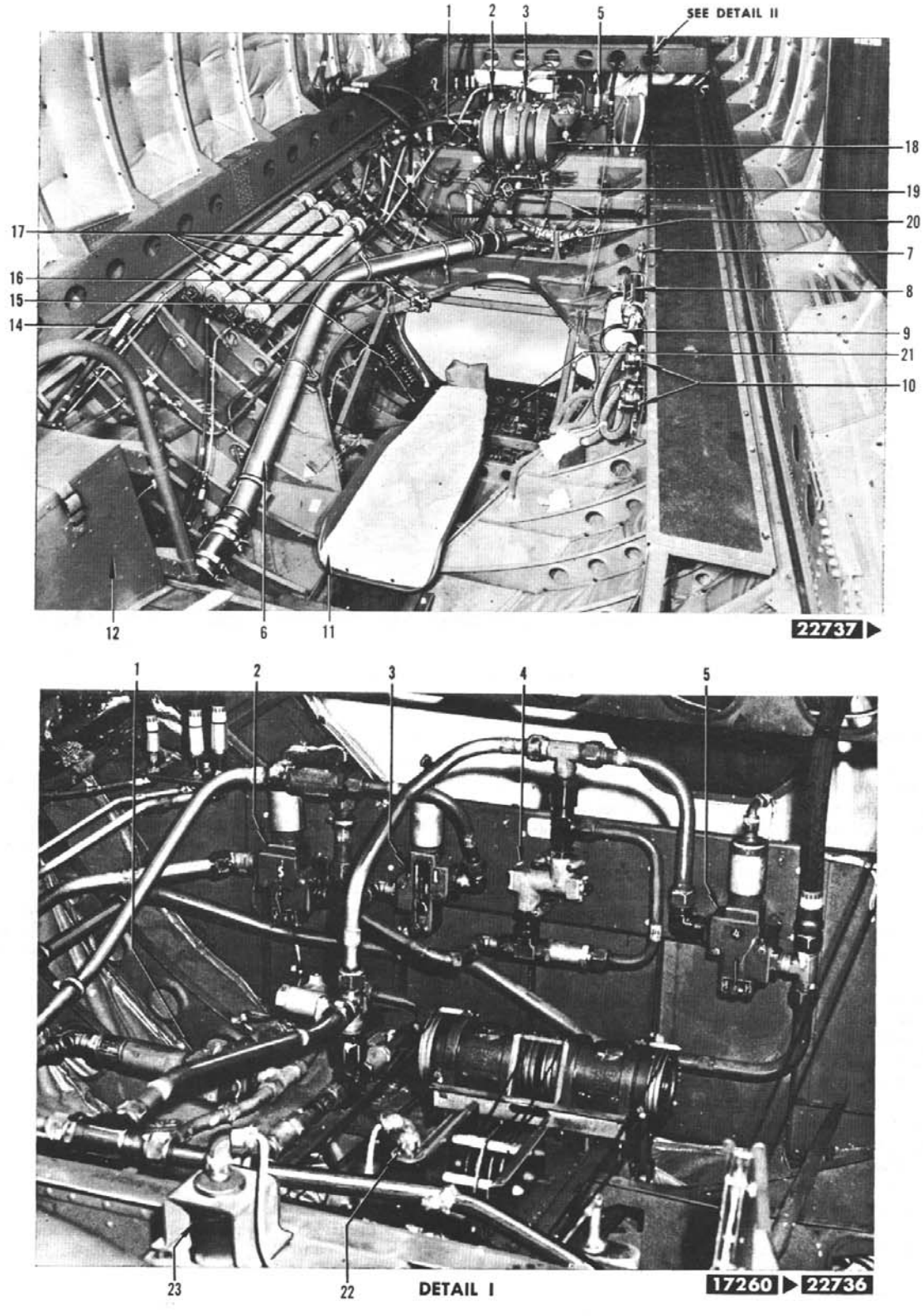


Figure 4–61 (Sheet 2 of 3)

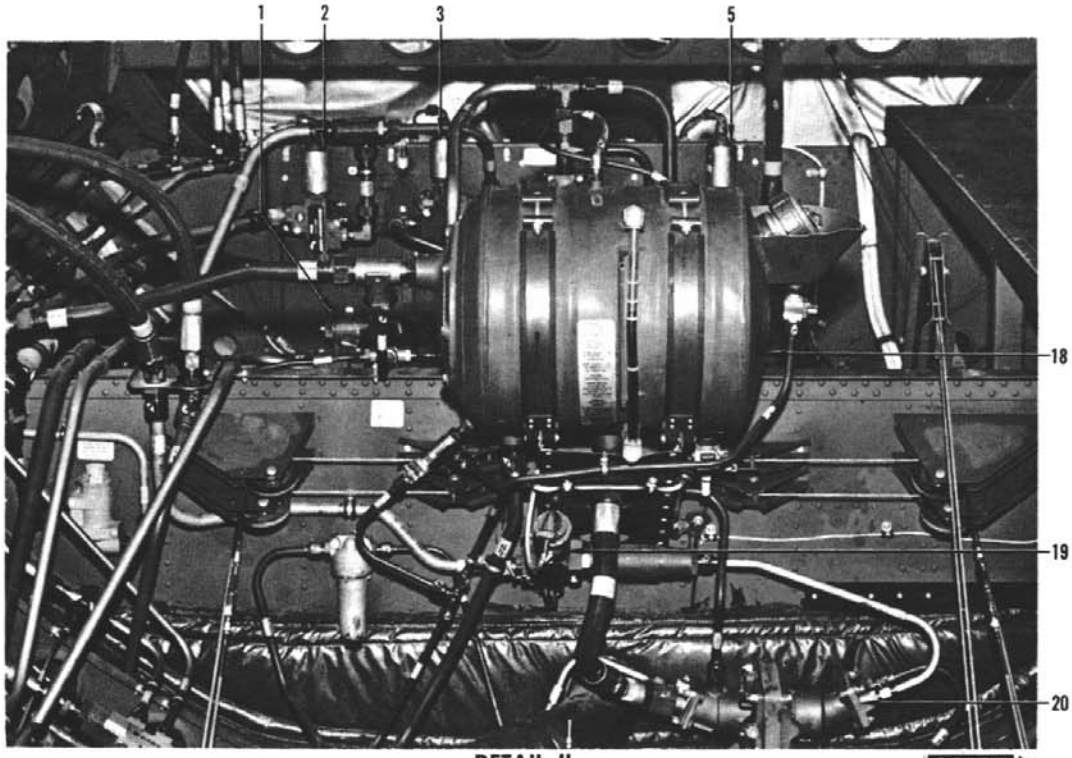


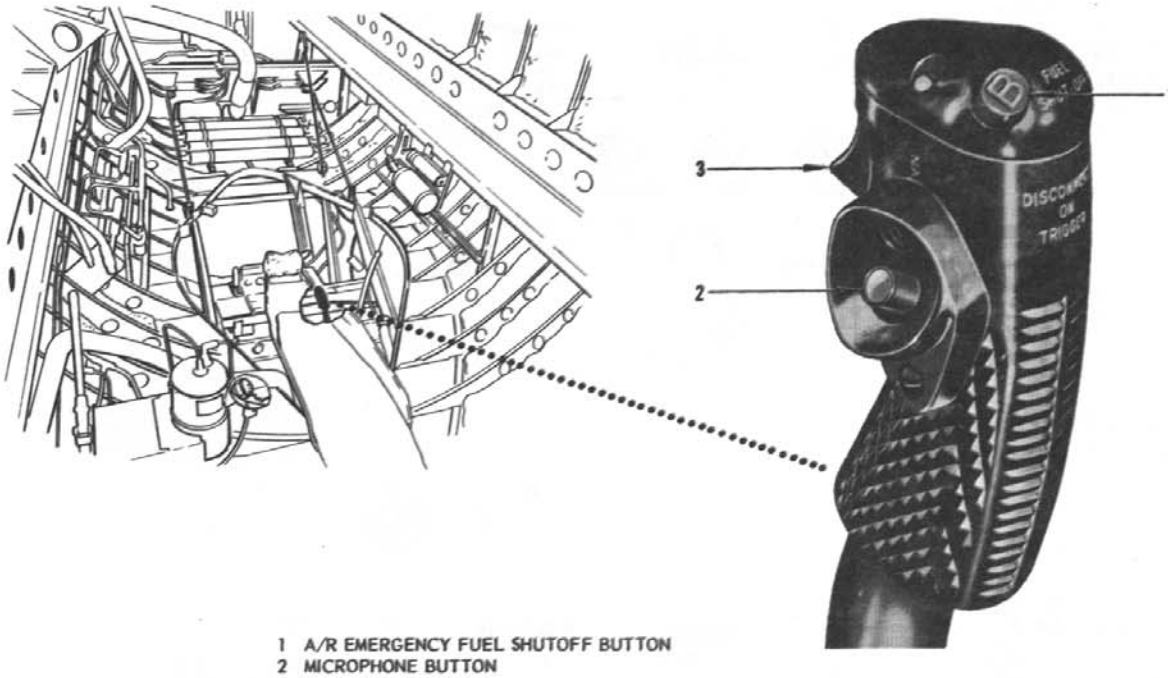
Figure 4–61 (Sheet 3 of 3)

A/R Numbered Valves

A/R numbered valves No. 1, 2, 4, and 5, in conjunction with the boom operator's telescoping lever, control the extension and retraction of the boom. Since these valves are controlled by the signal system, and since their functions are related, they should be considered simultaneously. Solenoid valves No. 1 and 5 are normally closed, and open when energized by the signal system. Valves No. 2, 4, and 6 are normally open, and close when energized. When the signal system is in the contact-made condition, valves No. 1 and 4 are open and valves No. 2 and 5 are closed. In this condition, the boom cannot be extended or retracted manually with the boom telescoping lever. When the signal system is in the disconnect condition, with the boom operator's telescope-at-disconnect switch in the AUTO position, valves No. 1 and 2 are closed and valves No. 4 and 5 are open. In this condition, the boom is retracted automatically and the boom cannot be extended or retracted manually. On airplanes having a boom signal coil test voltmeter, with the telescope-at-disconnect switch in the MANUAL position, valves No. 1, 2, and 4 are closed and valves No. 5 and 6 are open. In this condition, the boom does not retract automatically but may be manually retracted. In this condition, the boom cannot be manually extended. On airplanes without a boom signal coil test voltmeter, with the telescope-at-disconnect switch in MANUAL, valves No. 1, 4, and 5 are closed and No. 2 and 6 are open. In this condition, the boom can be manually extended or retracted. (See figures 4–58 and 4–60.) On all airplanes, hoisting of the boom is controlled by the normally closed valve No. 3, snub switch, and the boom operator's hoist control lever. While in flight, and the signal system is in either the ready or disconnect condition, the boom is lowered approximately 8 degrees from the stowed position with the hoist motor. Beyond this 8-degree point, the snub switch is closed to actuate valve No. 3 to the open position, bypassing the hoist motor and allowing boom movement to be controlled by the ruddevators. As the boom is flown up to within approximately 8 degrees below the stowed position, valve No. 3 again closes, due to the action of the snub switch, and the boom may be hoisted to its stowed position. See figure 4–63 for the valve positions under various conditions.

Fuel Bypass Control Valve

The fuel bypass control valve, wired through the engineer's A/R master switch, when energized, allows hydraulic pressure to close the fuel bypass valve. When the control valve is deenergized, hydraulic pressure to the fuel bypass valve is relieved to the system return line through the fuel bypass control valve, allowing the fuel bypass valve to open.



1 A/R EMERGENCY FUEL SHUTOFF BUTTON
2 MICROPHONE BUTTON
3 DISCONNECT SWITCH

RUDDEVATOR CONTROL STICK

Figure 4–62

A/R Signal System Override

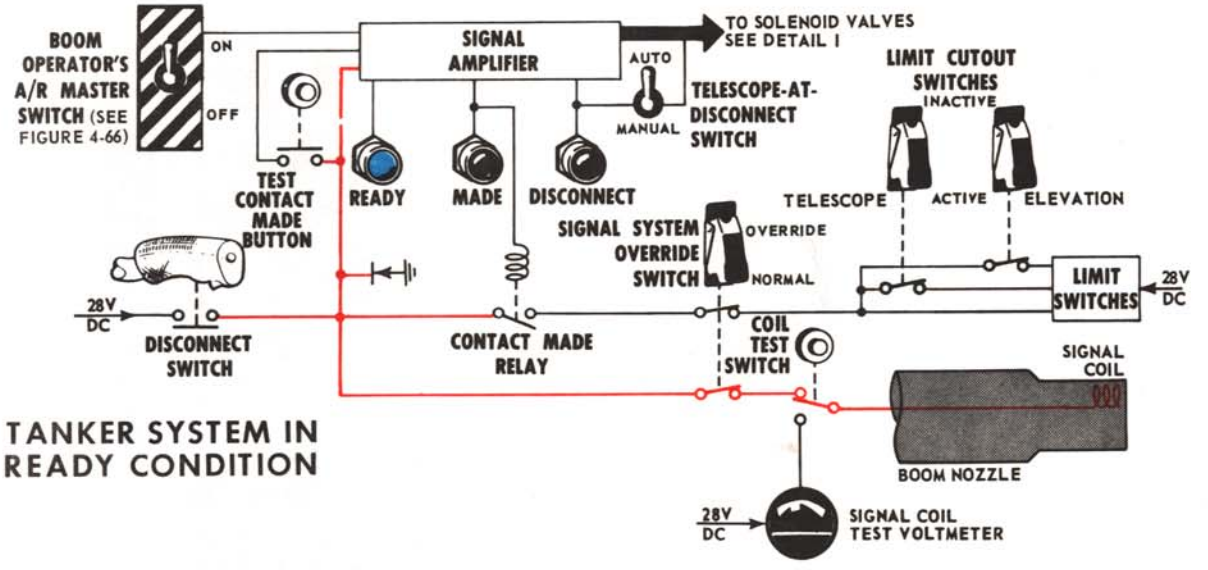
A signal system override has been installed to serve as a secondary system in event of failure of the signal system. An override switch on the boom operator's panel, when placed at OVERRIDE, will allow manual control of the refueling operation by the boom operator, thus replacing the signal amplifier's duties. With the signal system override in effect, refueling operations may continue without use of the signal amplifier, the restrictions of the boom limit switches, or the signal coil in the nozzle, since all normal limit switches are inactive. The boom operator must watch the boom position instruments and give corrective information to the receiver pilot to keep the boom within its flight envelope while in contact. Contact is established in the tanker signal system by depressing the signal system manual contact switch on the telescoping lever as soon as it is ascertained that the nozzle is properly contacted in the receptacle. Disconnect is accomplished in the conventional manner by depressing the disconnect switch on the ruddevator control stick; however, only the tanker system will go into a disconnect, since the signal amplifier is out of the circuit. Release of the nozzle from the receptacle can only be accomplished by initiating a disconnect in the receiver airplane. After a disconnect, the signal system override does not affect boom movement as it would if the telescope at disconnect switch were at AUTO. The signal system override does not affect the normal operation of the hydraulic and fuel systems, and they will react normally whether the signal system manual override switch is in either OVERRIDE or NORMAL. In flight on 17260 ▶ 22736 , turning the boom operator's A/R master switch off will remove power from the snub switch, consequently closing the No. 3 valve. Hoist motor control of the boom is then possible for hoisting the boom from any position to the stowed position, provided hydraulic pressure does not become depleted. During ground operation, the landing gear oleo-actuated relays prevent the valve from opening, allowing the boom to be lowered or hoisted to any position. System pressure should be recharged by using the manual plunger on the hydraulic pressure control valve. On 22737 ▶ , turning the boom operator's A/R master switch off not only removes power from the snub switch and the No. 3 valve, but also from the No. 7 valve which controls hydraulic pressure to the boom system. To prevent accumulators from becoming depleted and to insure system pressure is available, manually override the No. 7 valve.

CAUTION

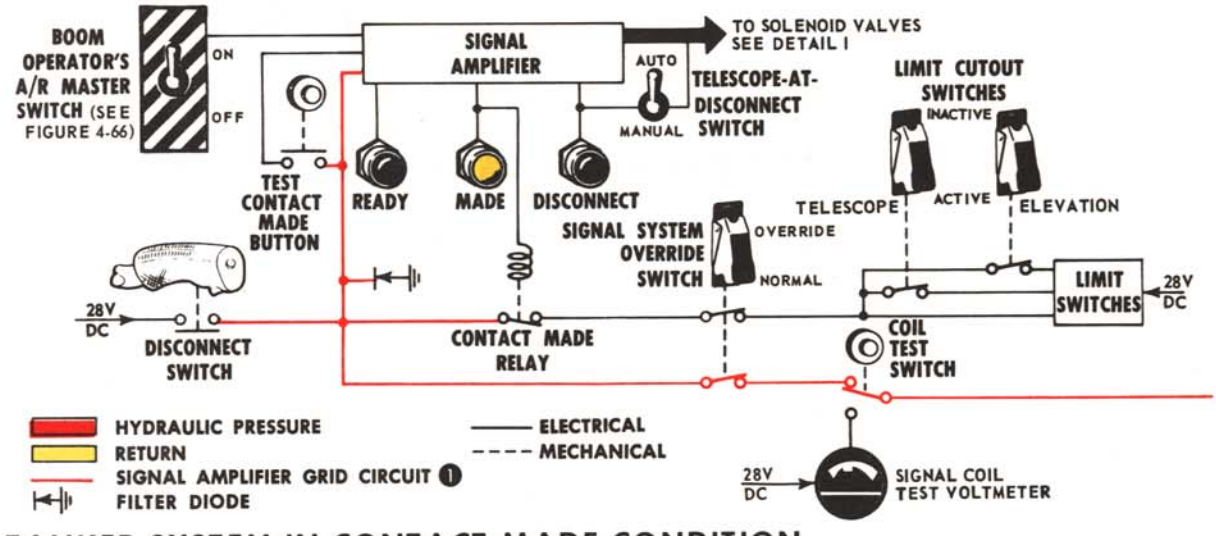
On airplanes 22737 ▶ , a hydraulic leak in the boom system or the depressurization valve in the open position will deplete the airplane main hydraulic system pressure if No. 7 valve is manually overridden.

Filter Diode

A filter diode (figure 4–63) is installed in the signal amplifier grid circuit. This diode bypasses transient or



TANKER SYSTEM IN READY CONDITION



TANKER SYSTEM IN CONTACT MADE CONDITION

VALVE NO.	NORMAL DEENERGIZED POSITION	READY FOR CONTACT	CONTACT MADE	TOWING RECEIVER	EMERGENCY FUEL DUMP	MANUAL DISCONNECT	MANUAL DISCONNECT	AUTO DISCONNECT	DROGUE CONTACT MADE
1	Closed	Closed	Open	Open	Closed	Closed	Closed	Closed	Closed
2	Open	Open	Closed	Closed	Closed	Open	Closed	Closed	Open
3	Closed	▷	Open	Open	Open	▷	▷	▷	Open
4	Open	Closed	Open	Open	Open	Closed	Closed	Open	Closed
5	Closed	Closed	Closed	Closed	Open	Closed	Open	Open	Closed
6	Open	Open	Closed	Closed	Closed	Open	Open	Open	Closed

DETAIL I

A/R NUMBERED VALVE POSITIONS
SEE FIGURES 4-58 AND 4-60

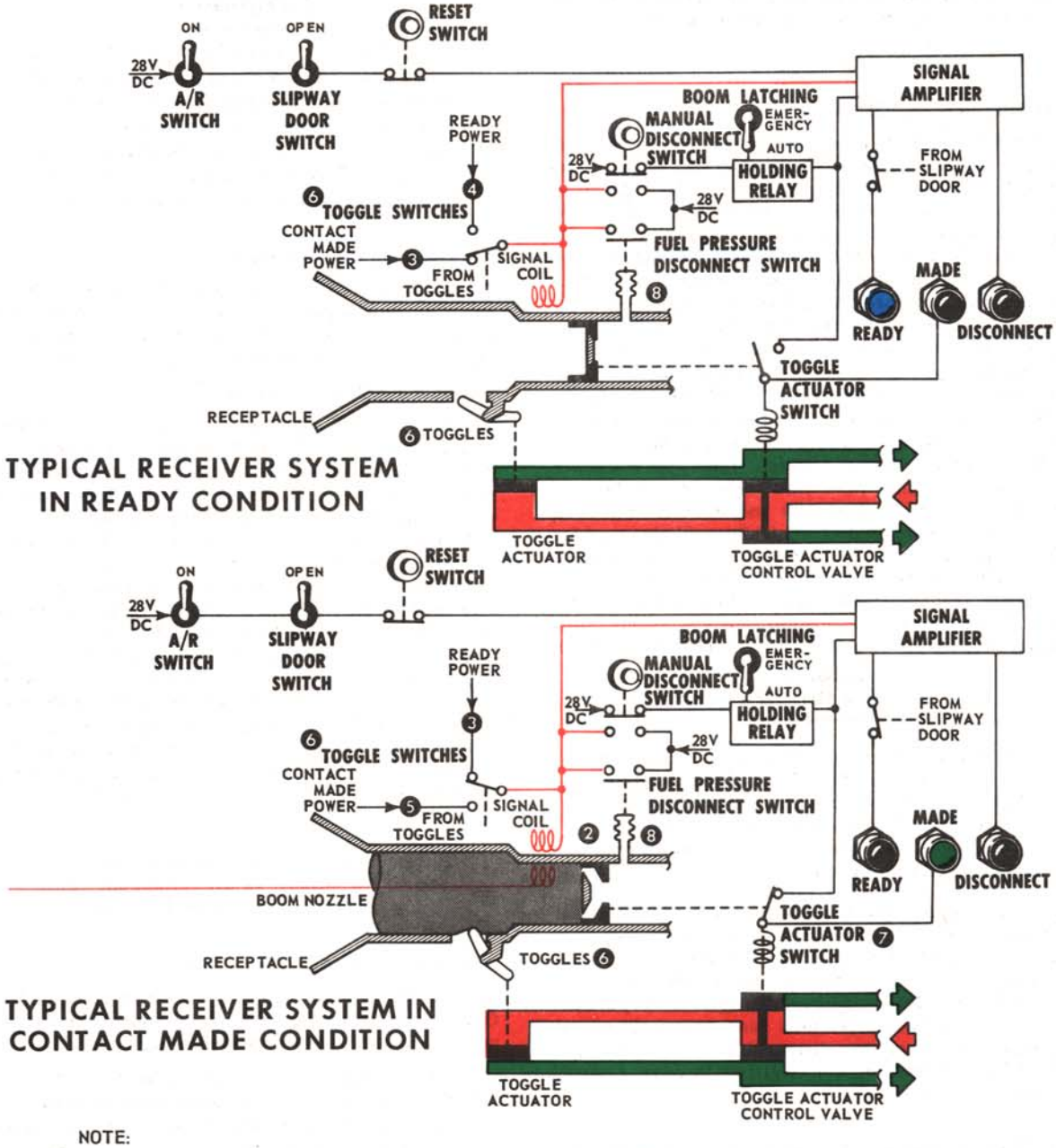
▷ Open in flight when boom is more than 8 degrees below stowed position; closed at all times on ground.

◥ Applicable to airplanes without signal coil test voltmeter.

◣ Applicable to airplanes with signal coil test voltmeter.

A/R SIGNAL SYSTEM

Figure 4–63 Sheet 1 of 2)



NOTE:

1. Signal applied to this circuit causes signal amplifier to cycle to next condition.
2. Signal from either airplane transmits inductively and cycles the other signal amplifier.
3. No signal in this condition.
4. READY power signal cycles systems to contact made when switch is actuated.
5. CONTACT MADE power signal cycles systems to disconnect in event of brute force pullout when toggles retract.
6. Only one toggle and toggle switch shown for clarity.
7. When boom nozzle bottoms, toggle actuator switch closes. When toggles are seated, toggle switches allow READY power to cycle systems to contact made.
8. Receiver pressure disconnect settings: F/RF-84-78 ±2 PSI.

Figure 4–63 Sheet 2 of 2)

spurious electrical currents which would otherwise cause the signal amplifier to cycle to the next condition.

A/R EXTERIOR LIGHTS

Lights (figure 4–36) are installed on the fuselage to illuminate the exterior of the airplane for night operations. Four flush-mounted lights in the fuselage illuminate the underside of the wing and the inboard nacelles. Three lights, mounted on the aft receiver director light pod, illuminate the outboard engine nacelles, trailing edges of the wings, and the underside of the fuselage. These lights are controlled by rheostats (33 and 34, figure 4–64) on the boom operator's panel. Two sets of anti-collision lights, one set on top and one set on bottom, are mounted on the fuselage. The anti-collision light switch (20, figure 1–11) on the overhead panel has UPPER ON–OFF–BOTH ON positions. The anti-collision light color select switches (19, figure 1–11) provide a means for individual or multiple colors selection. The upper and lower color select switches have three positions, COLOR A–BOTH–COLOR B. The light and color combinations are self-explanatory as decaled. Additional lights used for air refueling are two rendezvous beacon lights, mounted in the tail cone vertically, and one horizontally. Two sets of various color filters are provided for ground changing only. These lights are controlled by a rendezvous lights switch (37, figure 4–64) on the boom operator's panel.

CAUTION

To prevent blistering of the plastic tail cone due to excessive heat from the rendezvous beacon lights, do not operate these lights for more than 1 minute while the airplane is on the ground. These lights have six colored discs which may be changed on the ground only.

Receiver director light assemblies, which provide visual command signals for the receiver pilots, are mounted on the underside of the fuselage. Receiver director lights are actuated automatically during contact made by movements of the boom. Manual switches (1, figure 4–64) are installed on the boom operator's panel to permit manual operation of the receiver director lights during precontact. Circuit protection is provided through a circuit breaker on the aft power panel.

The boom ice shield contains lights to illuminate the boom markings, and the boom nozzle. These lights are controlled by rheostats and a switch (31, 32, and 35, figure 4–64) on the boom operator's panel. A flush-mounted boom chock light illuminates the stowage chock. This light is controlled by a switch (29, figure 4–64) on the boom operator's panel. The boom operator also has an ON–OFF switch to operate the main compartment dome lights.

CAUTION

To preclude the possibility of fire, the boom nozzle and boom marking lights will not be illuminated during a fuel dumping operation. When dumping of A/R fuel is required and these lights are illuminated, a short time period should be allowed, if practical, to turn off the lights and allow bulbs to cool prior to dumping fuel.

A/R Electrical Circuit Protection

Circuit breakers for the A/R equipment are located on the boom operator's panel, the engineer's A/R panel, the ac power panel, the forward power panel, overhead circuit breaker panel, and the aft power panel. (See figure 1–37.)

Engineer's A/R Master Switch

When in the ON position, the engineer's A/R master switch (1, figure 4–65) on the engineer's A/R panel supplies power to all switches and indicator lights on the panel, except for the three boom contact lights, leveling valve switches, leveling valve indicating lights, and the A/R hydraulic system pressure gages. This switch also controls power to the fuel bypass control valve. Energizing the fuel bypass control valve allows hydraulic pressure to close the fuel bypass valve. When the fuel bypass control valve is deenergized, hydraulic pressure to fuel bypass valve is relieved to the system return line through the fuel bypass control valve, allowing the fuel bypass valve to open. All controls and indicators on the engineer's A/R panel are deenergized (except the leveling valve switches, leveling valve indicating lights, and ac continuous reading hydraulic pressure gages on airplanes 2894 ▶) when the A/R master switch is OFF.

NOTE

The engineer's A/R panel must be thoroughly checked for proper switch positioning before placing the A/R master switch in the ON position.

Boom Operator's A/R Master Switch

When in the ON position, this circuit breaker-type ON-OFF switch (41, figure 4–64), located on the boom operator's panel, performs the following functions:

a. Supplies power to the signal amplifier.
b. Illuminates the ready for contact indicator light.
c. Energizes solenoid valve No. 4, permitting manual telescoping of the boom.
d. Energizes solenoid valve No. 3, provided the elevation snub switch and left landing gear safety switch are closed, thus permitting free fall of the boom.
e. Supplies power to the A/R hydraulic circuitry.

Boom-Drogue Adapter Kit Switch

A guarded boom-drogue adapter kit switch (30, figure 4–64) on the boom operator's panel provides manual extension and retraction of the boom when in the contact-made condition, provided the No. 4 solenoid valve has been overridden to the closed position. When the switch is placed in the DROGUE position, the electrical circuit

to the No. 1 and No. 2 solenoid valves (located in the A/R boom hydraulic system) is broken, deenergizing the valves. (See figure 4-60.) When the switch is returned to the BOOM position, the No. 1 and No. 2 solenoid valves are again energized. Provided the No. 4 solenoid valve is in the normal position, the boom hydraulic system will be in the normal boom refueling configuration.

Signal System Manual Contact Switch

The trigger-type signal system manual contact switch (4, figure 4-64) on the telescope control handle is used to manually put the signal system into a contact-made condition when the signal system manual override switch is placed in the OVERRIDE position. The manual override switch permits the signal system to operate without the use of the signal amplifier, boom limit switches, and signal coil in the boom nozzle.

Disconnect Switch

Pressing this trigger-type disconnect switch (3, figure 4-62) on the hand grip of the ruddevator control stick initiates a disconnect in the signal system whether in ready-for-contact or contact-made condition.

Signal Amplifier Test Button

A push-to-test signal amplifier test button (40, figure 4-64) on the boom operator's panel, when depressed, advances the signal system to a contact-made condition for an operational check of the signal system.

Signal System Reset Button

A push-to-reset signal system reset button (38, figure 4-64) on the boom operator's panel, when depressed, will advance the signal system to the ready-for-contact condition from either the contact-made or disconnect condition.

Limit Cutout Switches

Two guarded limit cutout switches (18, figure 4-64) on the boom operator's panel, when in the INACTIVE position, will cut out the elevation, extension, and retraction limits on the boom for ground test purposes. Neither switch will cut out the azimuth limit switches. The ACTIVE position is used during all flight operations to restore the limits and prevent structural damage.

CAUTION

When the extension limit cutout switch is positioned to INACTIVE, the retraction and extension limit switches are deactiviated.

Telescope-At-Disconnect Switch

The telescope-at-disconnect switch (8, figure 4-64) on the boom operator's panel selects control of boom telescoping at disconnect. The AUTO position results in automatic telescoping of the boom when the signal system advances to a disconnect condition. When in the MANUAL position at disconnect, the boom will remain static until the boom telescoping lever is moved to the RETRACT position. Regardless of the position of the AUTO-MANUAL telescope switch, the boom cannot be extended at disconnect.

CAUTION

- With the boom empty, do not select automatic retracting with less than 6 feet of the boom either extended or stowed. This insures that the peak retracting rate has dropped off before the boom strikes the stop. With manual control of the boom, do not allow the boom to strike the stops at high retraction rates.

- The telescope-at-disconnect switch will be in the MANUAL position for all fighter refuelings.

Signal System Override Switch

The signal system override switch (2, figure 4-64) is on the boom operator's panel. When the switch is in the OVERRIDE position, manual control by the boom operator replaces the signal amplifier's duties, and refueling operation may continue without use of the boom limit switches and the signal coil in the boom nozzle. When the switch is in the NORMAL position, the function of the signal amplifier is restored. The switch receives 28-volt dc power through a circuit breaker on the boom operator's panel (12, figure 1-37).

Boom Signal Coil Test Voltmeter

The boom signal coil test voltmeter (26, figure 4-64) is used in conjunction with the push-to-test signal coil button (27, figure 4-64) to determine if the boom signal coil circuit is operating properly. The instrument face is marked to indicate whether the signal coil is electrically open, good, or shorted when the test button is depressed.

Contact Lights

Three contact lights (12, figure 4-65) on the engineer's A/R panel, three contact lights (10, figure 4-64) on the boom operator's panel, and three lights aft of the aft receiver director lights panel indicate the condition of the A/R system. When the blue ready light is illuminated, the tanker A/R system is ready for contact with a receiver airplane. When the green made light is illuminated, contact has been made and fuel can be transferred to a receiver airplane. When the amber disconnect light is illuminated, the tanker and receiver airplanes have broken contact and the fuel flow in the tanker A/R system is stopped. Circuit protection is through the signal amplifier circuit breaker on the boom operator's panel (12, figure 4-64) when the signal system override switch is in the normal position and through the boom operator's A/R Master switch on the boom operator's panel (41, figure 4-64) when the signal system override switch is in the override position.

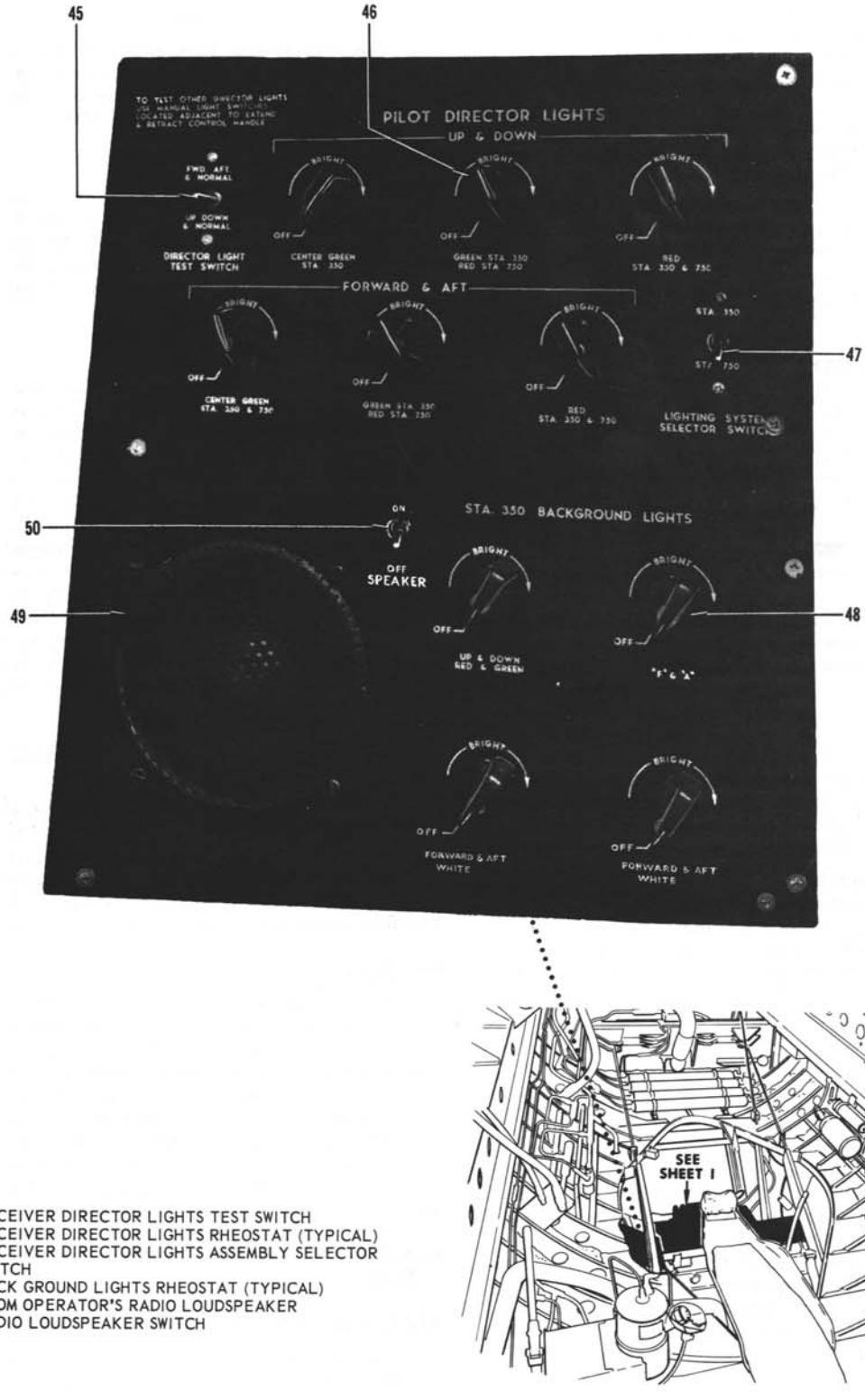
A/R FUEL SYSTEM

A/R fuel is carried in 15 fuselage tanks (21, figure 1-4) with usable capacity of 5819 US gallons. Additional fuel

1 DIRECTOR LIGHTS MANUAL SWITCHES
2 SIGNAL SYSTEM OVERRIDE SWITCH
3 BOOM TELESCOPING LEVER
4 SIGNAL SYSTEM MANUAL CONTACT SWITCH
5 BOOM HYDRAULIC LOW-PRESSURE WARNING LIGHT
6 BOOM HYDRAULIC PRESSURE GAGE
7 BOOM HYDRAULIC PRESSURE SWITCH
8 TELESCOPE-AT-DISCONNECT SWITCH
9 BOOM AZIMUTH INDICATOR
10 CONTACT LIGHTS
11 BOOM TELESCOPING INDICATOR
12 CIRCUIT BREAKERS
13 BOOM ELEVATION INDICATOR
14 WINDOW ANTI-ICE SWITCH
15 A/R EMERGENCY FUEL SHUTOFF RESET BUTTON
16 A/R FUEL PRESSURE GAGE
17 A/R FUEL EMERGENCY SHUTOFF WARNING LIGHT
18 LIMIT CUTOUT SWITCHES
19 INTERPHONE LIGHTS RHEOSTAT
20 PANEL LIGHTS SWITCH
21 CIRCUIT BREAKERS
22 DOME LIGHTS SWITCH
23 WINDOW ANTI-ICE FUSE 17260
24 PANEL LIGHTS RHEOSTAT
25 OXYGEN PANEL LIGHTS RHEOSTAT
26 BOOM SIGNAL COIL TEST VOLTMETER
27 PUSH-TO-TEST SIGNAL COIL BUTTON
28 BOOM LATCHING LEVER
29 CHOCK LIGHT SWITCH
30 BOOM-DROGUE ADAPTER KIT SWITCH
31 BOOM MARKING LIGHTS RHEOSTAT
32 BOOM MARKING LIGHTS SELECTOR SWITCH
33 UNDERWING LIGHTS RHEOSTATS
34 UNDERBODY LIGHTS RHEOSTAT
35 BOOM NOZZLE LIGHTS RHEOSTATS
36 RECEIVER DIRECTOR LIGHTS CIRCUIT BREAKERS
37 RENDEZVOUS LIGHTS SWITCH
38 SIGNAL SYSTEM RESET BUTTON
39 RENDEZVOUS BEACON LIGHTS CIRCUIT BREAKERS
40 SIGNAL AMPLIFIER TEST BUTTON
41 BOOM OPERATOR'S A/R MASTER SWITCH
42 CHECKLIST
43 BOOM HOIST LEVER
44 RECEIVER DIRECTOR LIGHTS RHEOSTAT

BOOM OPERATOR'S PANEL (TYPICAL)

Figure 4–64 (Sheet 1 of 2)



45 RECEIVER DIRECTOR LIGHTS TEST SWITCH
46 RECEIVER DIRECTOR LIGHTS RHEOSTAT (TYPICAL)
47 RECEIVER DIRECTOR LIGHTS ASSEMBLY SELECTOR SWITCH
48 BACK GROUND LIGHTS RHEOSTAT (TYPICAL)
49 BOOM OPERATOR'S RADIO LOUDSPEAKER
50 RADIO LOUDSPEAKER SWITCH

Figure 4–64 (Sheet 2 of 2)

may be transfered into the A/R fuel system from the center wing tank, giving a total usable A/R fuel capacity of 7029 US gallons. Fuel may also be transferred from the airplane fuel system to the A/R system. Each of the two tank systems has a fuel pump chamber located in the lower compartments into which fuel is gravity-fed from the tanks. A fuel leveling line between the pump chambers interconnects the two systems.

The normal flow of A/R fuel is from the pumps through check valves, a line valve, a flow measuring venturi, and out through a self-sealing poppet valve in the boom nozzle. An automatic bypass valve protects the A/R fuel system at disconnect by allowing the fuel to flow back to the aft tank system as soon as a disconnect is initiated, and prevents fuel flow into the aft tank system during fuel transfer. On 17260 ▶ 22664 , two A/R transfer valves isolate the A/R tanks from the other fuel tanks when fuel is not being transferred. On 22665 ▶ , the external tank manifold shutoff valve isolates the A/R tanks from the other airplane fuel tanks.

WARNING

When fuel unsuitable for R-4360 engines is carried in the A/R tanks only, the A/R transfer valve switches must be in the CLOSED position at all times, except when required to be opened to accomplish fuel transfer.

Note

In the event of a ruptured flex hose or fuel leak during ground operation, the boom operator will actuate emergency fuel shutoff button and inform pilot. Pilot will call tower and request fire fighting equipment and direct engineer to cut engines and master switches.

All electrical controls and indicators receive 28-volt dc power, except the fuel pressure gages which receive 26-volt ac power and the fuel flow and totalizer and fuel quantity gages which receive 115-volt ac power. The fuel dump switch normally receives 28-volt dc power. If a power failure occurs in this circuit, the fuel dump circuit will automatically receive power from the battery.

A/R Fuel Leveling Valve Switches

Two A/R fuel leveling valve switches (7 and 15, figure 4–65) on the engineer's A/R panel are used to open and close the leveling valves between the forward and aft A/R tanks. The switches are guarded in the CLOSED position. When both A/R fuel leveling valve switches are in the OPEN position, the fuel in the forward and aft A/R tanks will seek to reach the same level in both tanks. These switches provide selection of jet engine fuel from the forward or aft A/R systems. Opening the aft leveling valve and closing the forward leveling valve allows fuel flow from the aft A/R system only; closing the aft leveling valve and opening the forward leveling valve allows fuel flow from the forward A/R system only.

Note

One fuel leveling valve should be kept closed except during operations requiring leveling. This will prevent CG shifts due to fuel flowing between tanks during climbs or letdowns.

A/R Line Valve Switch

The A/R line valve switch (11, figure 4–65) on the engineer's A/R panel controls the A/R line valve during contact made. If the switch is positioned to AUTO, the valve will open at contact made. At disconnect, the valve will automatically close. When the switch is positioned to CLOSED, the No. 6 valve will open.

A/R Fuel Bypass Valve

The A/R fuel bypass valve is a spring-loaded open, hydraulically operated, gate-type valve. It is located between the A/R fuel manifold (downstream of the line valve) and the aft tank system. The purpose of this valve is to permit fuel trapped in the boom at disconnect to be returned to the aft tank system, during boom retraction. When the engineer's A/R master switch is placed in the ON position, the A/R fuel bypass valve is hydraulically closed by actuation of the solenoid-controlled A/R fuel bypass control valve. The bypass valve remains closed during ready-for-contact and contact-made conditions, and is opened at disconnect condition. The bypass valve is also opened by the emergency fuel shutoff button when in contact-made condition, and remains open until the emergency fuel shutoff reset button is depressed. See figure 4–66.

A/R Transfer Valve Switches 17260 ▶ 22664

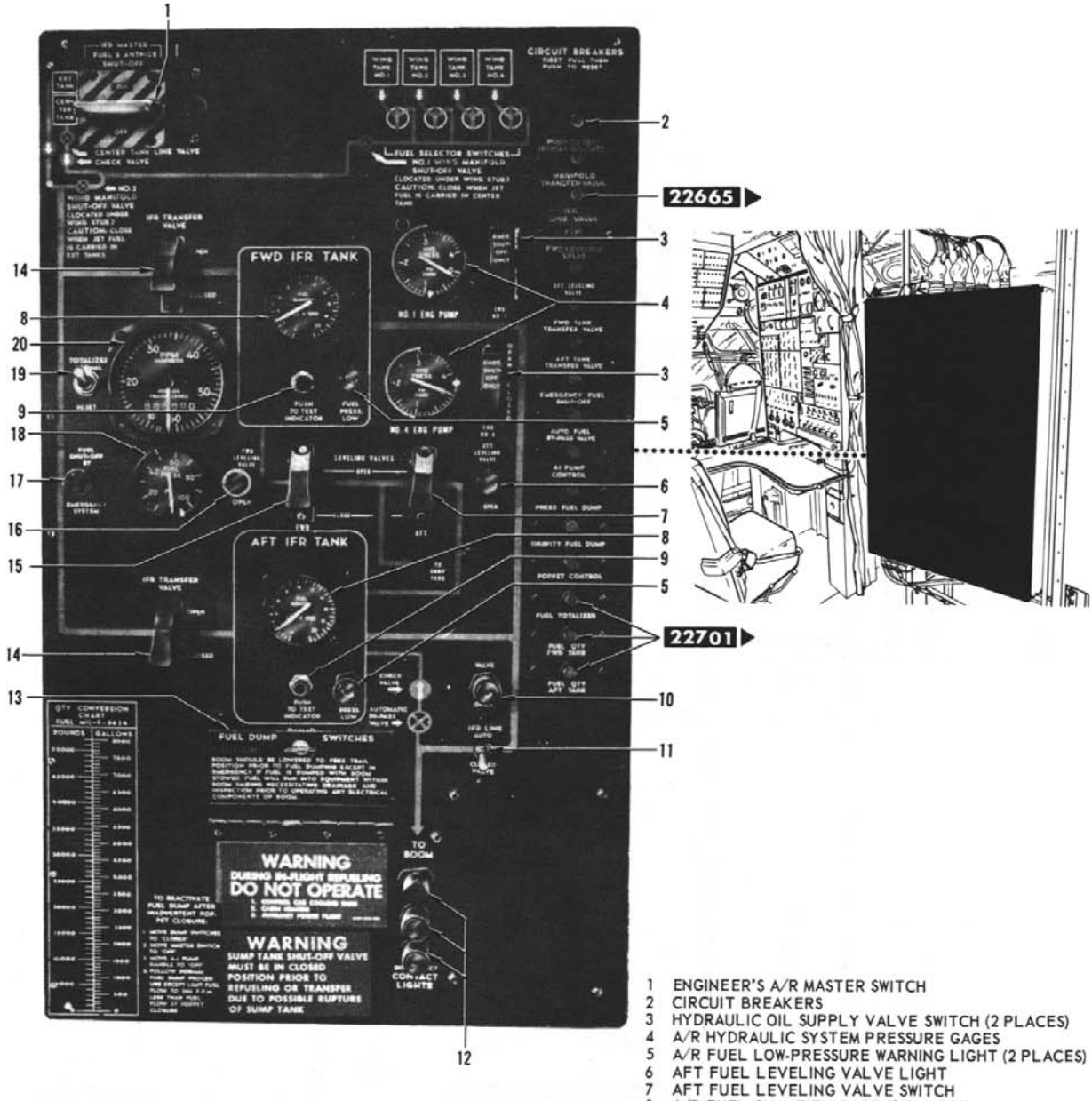
Two A/R transfer valve switches (14, figure 4–65) on the engineer's A/R panel control the A/R tank transfer valves. When both the switches are in the OPEN position, the valves are opened and fuel can be transferred from the airplane fuel system to the A/R tanks. Positioning the valve switches to CLOSED closes the valves and prevents fuel flow between the manifold system and the A/R tanks.

22665 ▶

The A/R transfer valve switches control the secondary valves of the A/R single point refueling system. The forward transfer valve switch controls the forward tank system secondary valve, and the aft transfer valve switch controls the aft tank system secondary valve. To transfer fuel from the airplane system to the A/R tanks, the A/R transfer valve switches must be at OPEN. When either transfer valve switch is positioned to OPEN, the respective secondary valve located between the manual fuel shutoff valves and the A/R tank system are opened, allowing fuel flow. Fuel flow is then dependent upon the position of the manual fuel shutoff valves and the fuel level in the A/R fuel tanks.

A/R Fuel Quantity Gages And Push-To-Test Buttons

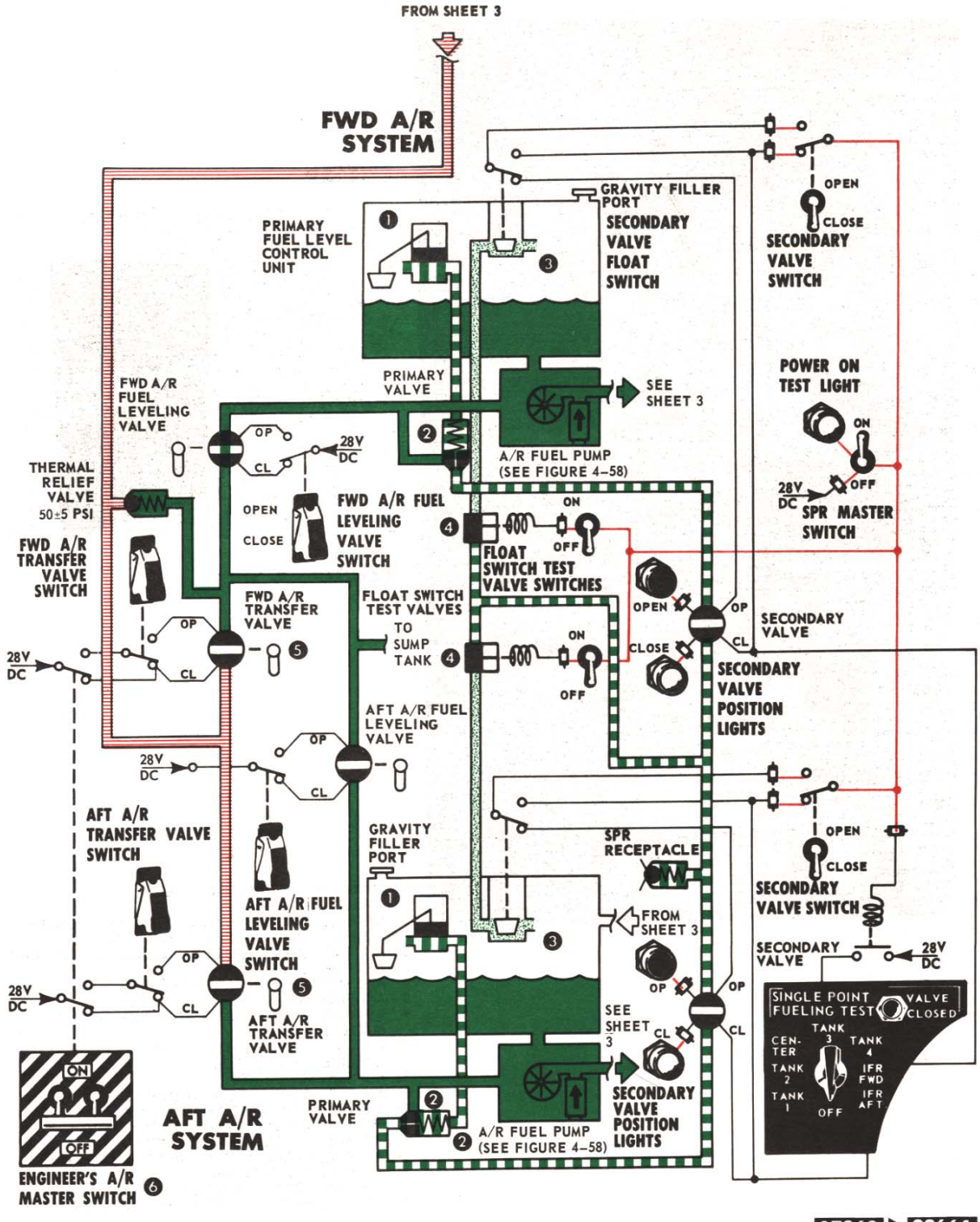
Two A/R fuel quantity gages (8, figure 4–65) on the engineer's A/R panel indicate the quantity of fuel in



1 ENGINEER'S A/R MASTER SWITCH
2 CIRCUIT BREAKERS
3 HYDRAULIC OIL SUPPLY VALVE SWITCH (2 PLACES)
4 A/R HYDRAULIC SYSTEM PRESSURE GAGES
5 A/R FUEL LOW-PRESSURE WARNING LIGHT (2 PLACES)
6 AFT FUEL LEVELING VALVE LIGHT
7 AFT FUEL LEVELING VALVE SWITCH
8 A/R FUEL QUANTITY GAGE (2 PLACES)
9 A/R FUEL QUANTITY INDICATOR PUSH-TO-TEST BUTTONS (2 PLACES)
10 A/R LINE VALVE POSITION LIGHT
11 A/R LINE VALVE SWITCH
12 A/R CONTACT LIGHTS
13 A/R FUEL DUMP SWITCHES (BEHIND COVER)
14 A/R TRANSFER VALVE SWITCH (2 PLACES)
15 FWD FUEL LEVELING VALVE SWITCH
16 FWD FUEL LEVELING VALVE LIGHT
17 A/R FUEL EMERGENCY SHUTOFF WARNING LIGHT
18 A/R FUEL PRESSURE GAGE
19 A/R FUEL TOTALIZER RESET SWITCH
20 A/R FUEL FLOW AND TOTALIZER INDICATOR

ENGINEER'S A/R PANEL (TYPICAL)

Figure 4–65



A/R FUEL SYSTEM

Figure 4–66 (Sheet 1 of 4)

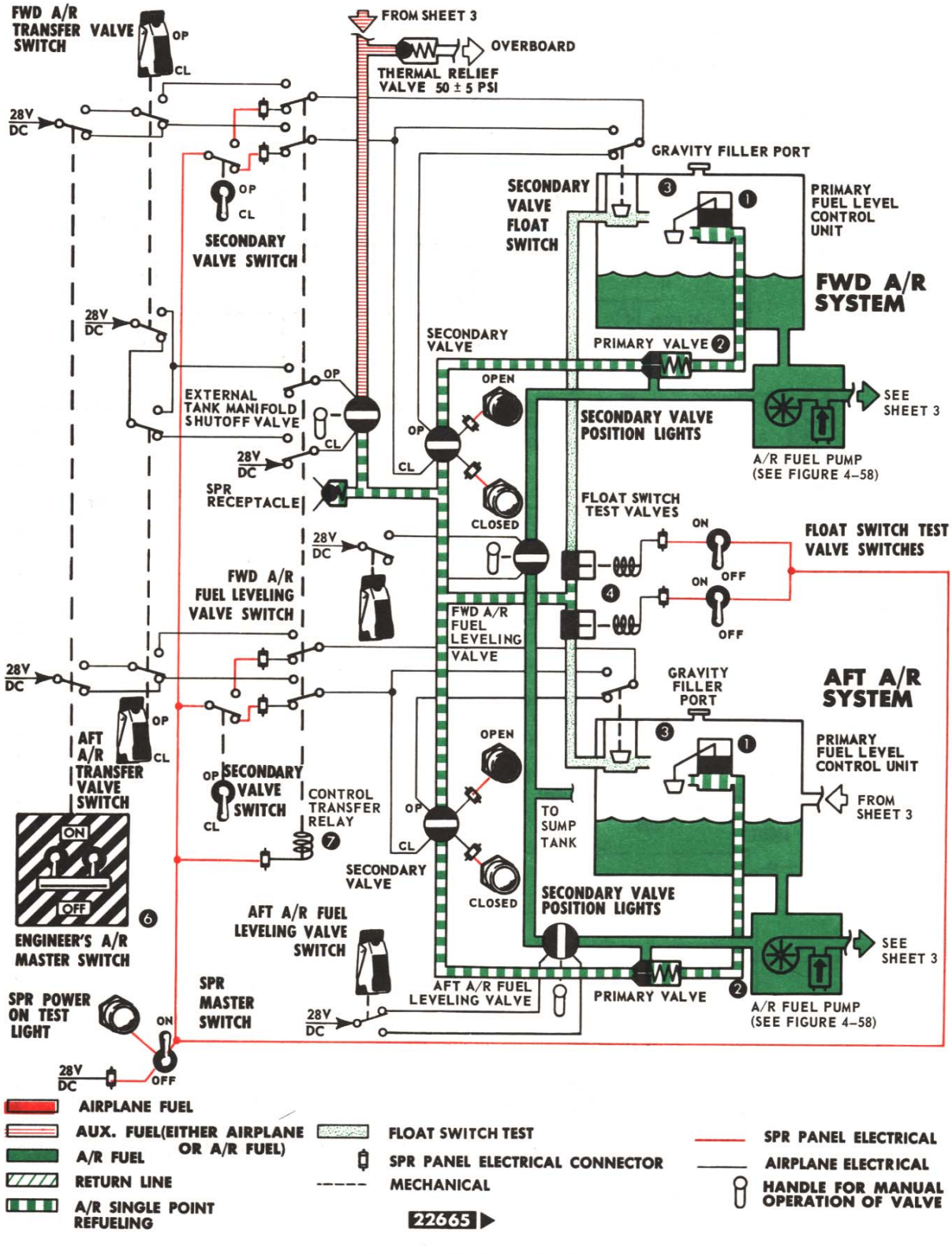


Figure 4–66 (Sheet 2 of 4)

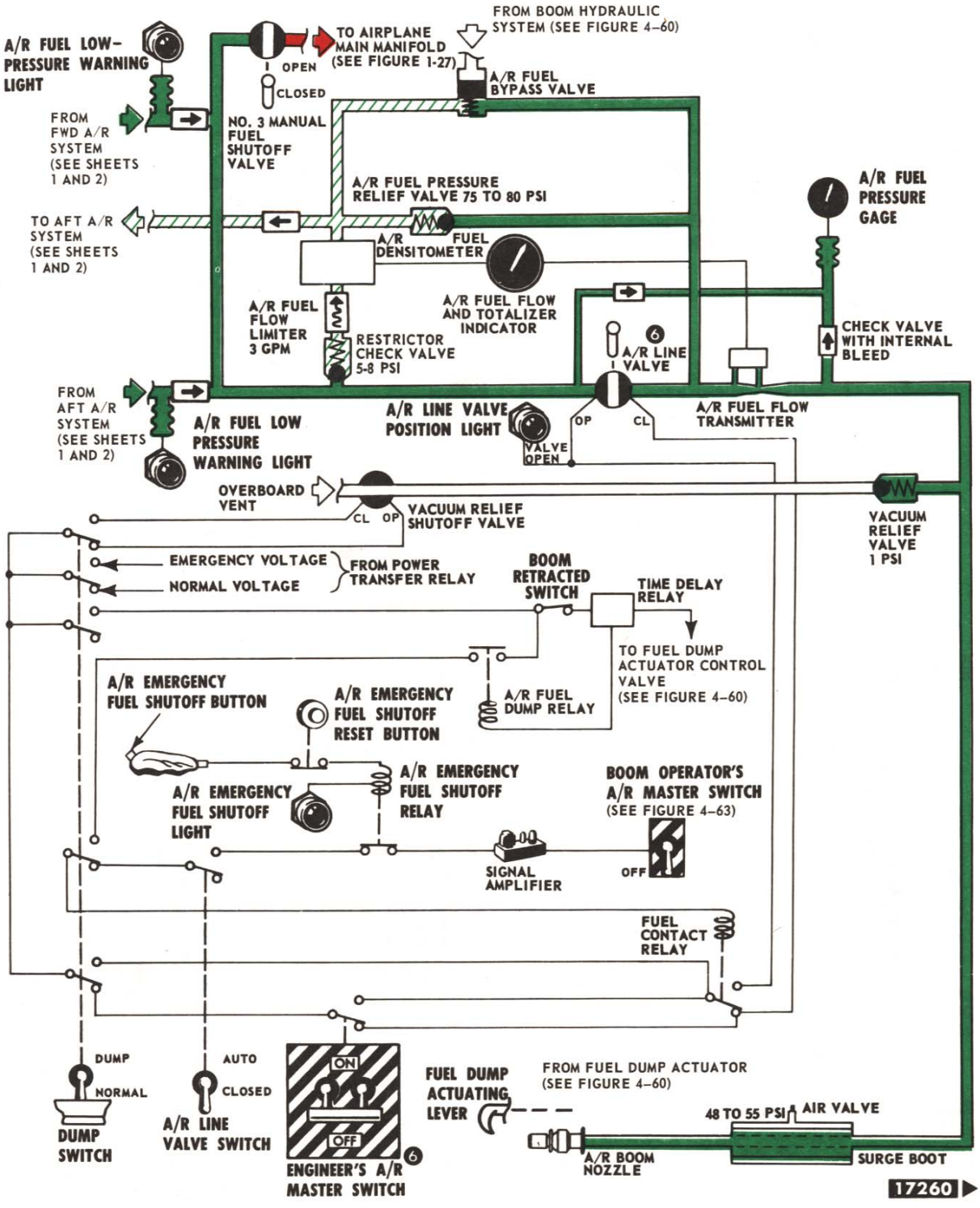


Figure 4–66 (Sheet 3 of 4)

1. Fuel bled thru the primary fuel level control unit creates a differential pressure allowing fuel pressure to open primary valve.
2. When the primary fuel level control unit closes, equalization of pressures allows spring to close primary valve.
3. If primary valve fails to shut off fuel flow, secondary valve float switch actuates and electrically closes secondary valve.
4. If float test valve is opened, fuel will flow into the secondary valve float switch chamber faster than it will empty, thus actuating the float switch.
5. A. R transfer valves must be closed when using A. R SPR system as SPR fuel pressure might otherwise open thermal relief valve and contaminate airplane fuel in the center wing tank.
6. The engineer's A. R master switch does not shut off electrical power when in the OFF position, but directs power to close the A. R fuel transfer valves, and A. R line valve by bypassing the individual valve switches.
7. With SPR master switch on, control of A. R transfer and secondary valves is switched from the engineer's A. R panel to the SPR panel.

Figure 4–66 (Sheet 4 of 4)

pounds in the two A/R tank systems. An A/R fuel quantity indicator push-to-test button (9, figure 4–65) is located adjacent to each quantity gage.

Manual Fuel Shutoff Valves

These OPEN–CLOSED manual fuel shutoff valves are manually operated. The No. 1 manual fuel shutoff valve (figure 4–66) controls fuel flow from the center wing tank to the main airplane fuel manifold. The No. 2 manual fuel shutoff valve controls fuel flow from the center wing tank to the A/R tanks. The No. 3 manual fuel shutoff valve controls fuel flow from the A/R fuel pumps to the main airplane fuel manifold. The sump tank manual shutoff valve controls fuel from the fuel leveling line to the sump tank to operate the jet engines on A/R tank fuel.

A/R Emergency Fuel Shutoff Button

A thumb-operated A/R emergency fuel shutoff button (1, figure 4–62) on the hand grip of the ruddevator control stick provides the boom operator with a fuel shutoff control during contact made. A momentary depression of this button shuts off the A/R pumps, closes the line valve, and opens the bypass valve.

A/R Emergency Fuel Shutoff Reset Button

The A/R emergency fuel shutoff reset button (15, figure 4–64) on the boom operator's panel is used to restart fuel flow which has been shut off by the emergency fuel shutoff button.

Manual Override Handles

The A/R line valve and leveling valves are motor-driven, sliding-gate type valves equipped with CLOSED–OPEN manual override handles. By means of these override handles, which also serve as valve position indicators, the valve can be placed in full OPEN or full CLOSED, provided there is no electrical power to the valves.

A/R Fuel Pressure Gages

Two A/R fuel pressure gages (18, figure 4–65, and 16, figure 4–64), on the engineer's A/R panel and the boom operator's panel respectively, indicate the fuel pressure in pounds per square inch in the A/R fuel line.

A/R Fuel Flow And Totalizer Indicator

A combination A/R fuel flow and totalizer indicator (20, figure 4–65) is mounted on the engineer's A/R panel. Fuel flow is indicated in pounds per minute and the fuel totalizer indicates the quantity of fuel transferred in pounds. An A/R fuel totalizer reset switch (19, figure 4–65) is adjacent to the fuel flow and totalizer indicator. The switch must be in the NORMAL position for the totalizer to indicate the quantity of fuel transferred. Placing the switch in the RESET position resets the totalizer to zero.

A/R Fuel Emergency Shutoff Warning Lights

Two amber lights will illuminate when the fuel flow in the A/R system has been shut off by depression of the boom operator's emergency fuel shutoff button. One A/R fuel emergency shutoff warning light (17, figure 4–64) is on the boom operator's panel and one A/R fuel emergency shutoff warning light (17, figure 4–65) is on the engineer's A/R panel.

A/R Fuel Low-Pressure Warning Lights

Two amber A/R fuel low-pressure warning lights (5, figure 4–65) on the engineer's A/R panel will illuminate when the fuel pressure drops below 10 psi at the forward and aft A/R fuel pumps.

A/R Line Valve Position Light

An amber A/R line valve position light (10, figure 4–65) on the engineer's A/R panel will illuminate when the A/R line valve is open.

A/R Fuel Leveling Valve Lights

Two A/R fuel leveling valve lights (6 and 16, figure 4–65) on the engineer's A/R panel will illuminate when the respective fuel leveling valve is open.

FUEL DUMP SYSTEM

Provisions have been made to dump A/R fuel from the A/R fuel tanks in cases of emergency. Fuel is pumped through the boom nozzle in the same manner as fuel is

transferred to a receiver airplane. The fuel dump system is hydraulically and electrically controlled.

Fuel Dump Hydraulic System

The fuel dump hydraulic system consists of a hydraulically actuated cylinder, a solenoid-actuated hydraulic valve, and the necessary tubing interconnecting the system with the boom hydraulic system. With the fuel dump control valve in the deenergized position, fluid pressure is applied to both sides of the two-port actuating cylinder, causing the piston to move aft due to the larger area on the forward side of the piston. When the fuel dump control valve is energized, fluid pressure is relieved from the forward side of the actuating cylinder piston, causing the piston to move forward. This movement of the piston actuates the dump finger which depresses the nozzle poppet valve. When the piston moves aft, the nozzle poppet is released and the actuating linkage is locked in the stowed position.

Fuel Dump Electrical System

The forward power panel (5, figure 1–37) normally supplies 28-volt dc power to the dump circuit; however, in case of any failure of the forward power panel, power is automatically supplied to the fuel dump circuits directly from the battery. The system consists of a fuel dump switch, two fuel dump relays, a time-delay relay, a power transfer relay, and a solenoid-operated valve.

A/R Fuel Dump Switches

Three A/R fuel dump switches (13, figure 4–65), guarded to the NORMAL position, are located on the engineer's A/R panel. Circuit protection is through three circuit breakers on the engineer's A/R panel. Actuation of the fuel dump switch automatically overrides any existing condition of the A/R signal system. When the dump switch is placed in the DUMP position, the following occurs:

a. 28-volt dc power from the forward power panel (5, figure 1–37) or the 24-volt dc battery will supply the electrical power.

b. The boom hydraulic system will become pressurized.

c. Power will be provided to snub switch.

d. Boom disconnect relay will be energized which:

(1) Interrupts power to No. 4 valve (open).

(2) Energizes the No. 2 valve (closed).

(3) Energizes the No. 5 valve (open).

(4) Interrupts power circuit of contact-made relay. (At this time the boom will automatically retract, provided the boom hydraulic system depressurization valve is closed.)

e. When the boom is retracted and the fuel dump relay No. 2 is energized, the following happens:

(1) Boom nozzle poppet valve opens (hydraulically).

(2) Fuel bypass valve closes.

(3) Contact fuel relay is energized which:

(a) Energizes the A/R fuel pump pressure warning light circuits.

(b) Energizes the fuel line valve (open).

Fuel Dumping

For fuel dumping procedure refer to FUEL DUMPING, Section III.

SINGLE POINT REFUELING (SPR)

The airplanes are equipped with a single point pressure refueling system in addition to individual filler necks on each tank. The single point refueling system (figures 4–66 and 4–69) provides a means for refueling all the fuel tanks in the airplane from two filler ports (receptacles) located on the lower left side of the fuselage aft of the left wing rear spar. The forward receptacle (6, figure 4–67) is for the main fuel system (No. 1 main, No. 2 main, No. 3 main, No. 4 main, and center wing tanks). These fuel tanks may be filled simultaneously or selectively. The aft receptacle (5, figure 4–67) is for the A/R tank system. The system consists of: a filler port, an enlarged manifold capable of carrying 600 gallons of fuel per minute at a maximum pressure of 50 psi, a primary and secondary valve in the supply line to each tank, primary and secondary fuel level control units in each tank, solenoid-operated valves for testing secondary valve float switches, a portable single point refueling panel (figure 4–68) with which the operator can control the entire refueling operation, and the necessary fuel lines and electrical wiring. Power for the single point refueling panel (exterior operation) is controlled by the sump tank shutoff valve.

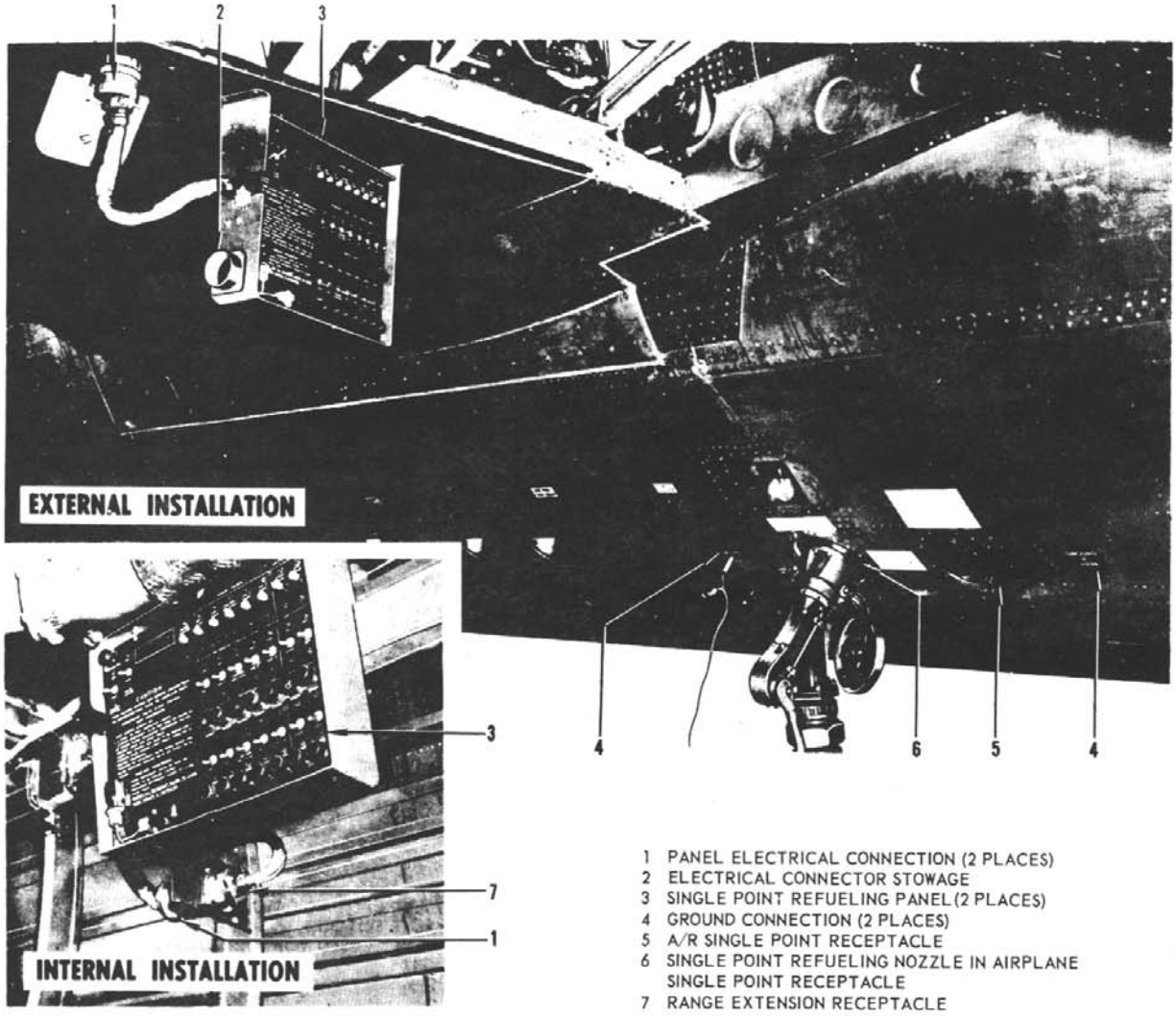
SINGLE POINT REFUELING EQUIPMENT

CAUTION

If jet fuel is to be carried in the center wing tank, this tank must be gravity-filled to avoid contaminating the airplane main fuel manifold.

Single Point Refueling Panel

To control the refueling operation, a portable single point refueling panel must be mounted forward of the trailing edge of the wing and inboard of the No. 2 nacelle by four quick-disconnect fasteners. A panel electrical receptacle for the single point refueling panel is located on the underside of the left wing inboard of the No. 2 nacelle. (See figure 4–67.) On 22635▶, when the single point refueling panel is connected electrically, transfer relays automatically disconnect control of the secondary valves from the transfer valve switches on the engineer's A/R panel. An electrical receptacle is installed in the lower aft compartment. The receptacle provides electrical connection to the single point refueling panel so the switches controlling the main wing and center wing tank valves may be monitored inside the airplane. The main purpose is to provide for transferring fuel from the A/R tanks into the main tanks.



1 PANEL ELECTRICAL CONNECTION (2 PLACES)
2 ELECTRICAL CONNECTOR STOWAGE
3 SINGLE POINT REFUELING PANEL (2 PLACES)
4 GROUND CONNECTION (2 PLACES)
5 A/R SINGLE POINT RECEPTACLE
6 SINGLE POINT REFUELING NOZZLE IN AIRPLANE SINGLE POINT RECEPTACLE
7 RANGE EXTENSION RECEPTACLE

SINGLE POINT REFUELING

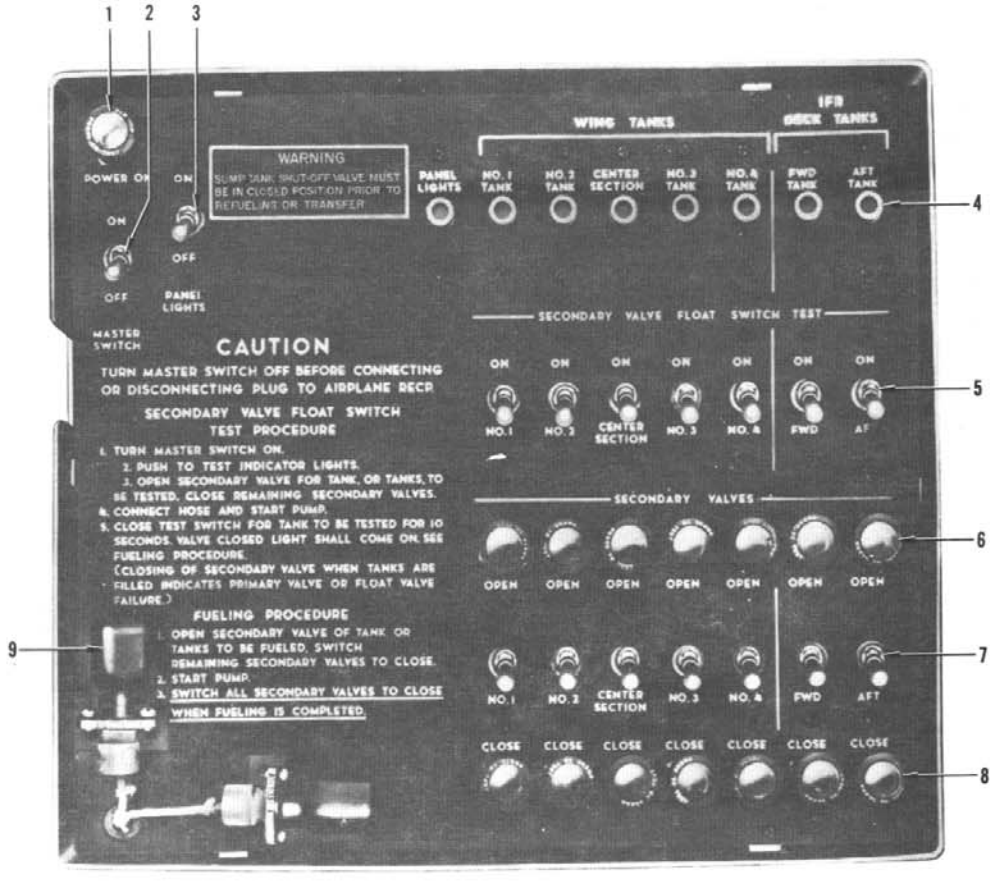
Figure 4–67

Fuel Flow Control

As fuel enters the single point refueling ports, its flow is controlled by the following units: a primary and secondary valve in the supply line of each tank and a fuel level control assembly, containing a primary and secondary unit in each tank. If the primary valve, which is float-controlled, fails to close, the secondary valve float switch is energized, closing the circuit to the secondary valve. The secondary valve then closes, stopping the flow into the tank, and the secondary valve closed light on the single point refueling panel will illuminate.

WARNING

When carrying jet fuel or contaminated grade AVGAS in the center wing tank, the No. 1 manual fuel shutoff valve must be safety wired in the closed position. This is to prevent contamination of the airplane fuel system. When it is desired to use the center wing tank for the airplane system, all contaminated fuel must be drained and flushed out before refilling with grade AVGAS.



1 SPR POWER ON LIGHT
2 SINGLE POINT (SPR) MASTER SWITCH
3 SPR PANEL LIGHT SWITCH
4 SPR CIRCUIT BREAKERS
5 SECONDARY VALVE FLOAT SWITCH TEST SWITCHES
6 SECONDARY VALVE OPEN INDICATOR LIGHTS
7 SECONDARY VALVE SWITCHES
8 SECONDARY VALVE CLOSED INDICATOR LIGHTS
9 SPR PANEL LIGHTS

SINGLE POINT REFUELING PANEL

Figure 4–68

Single Point (SPR) Master Switch

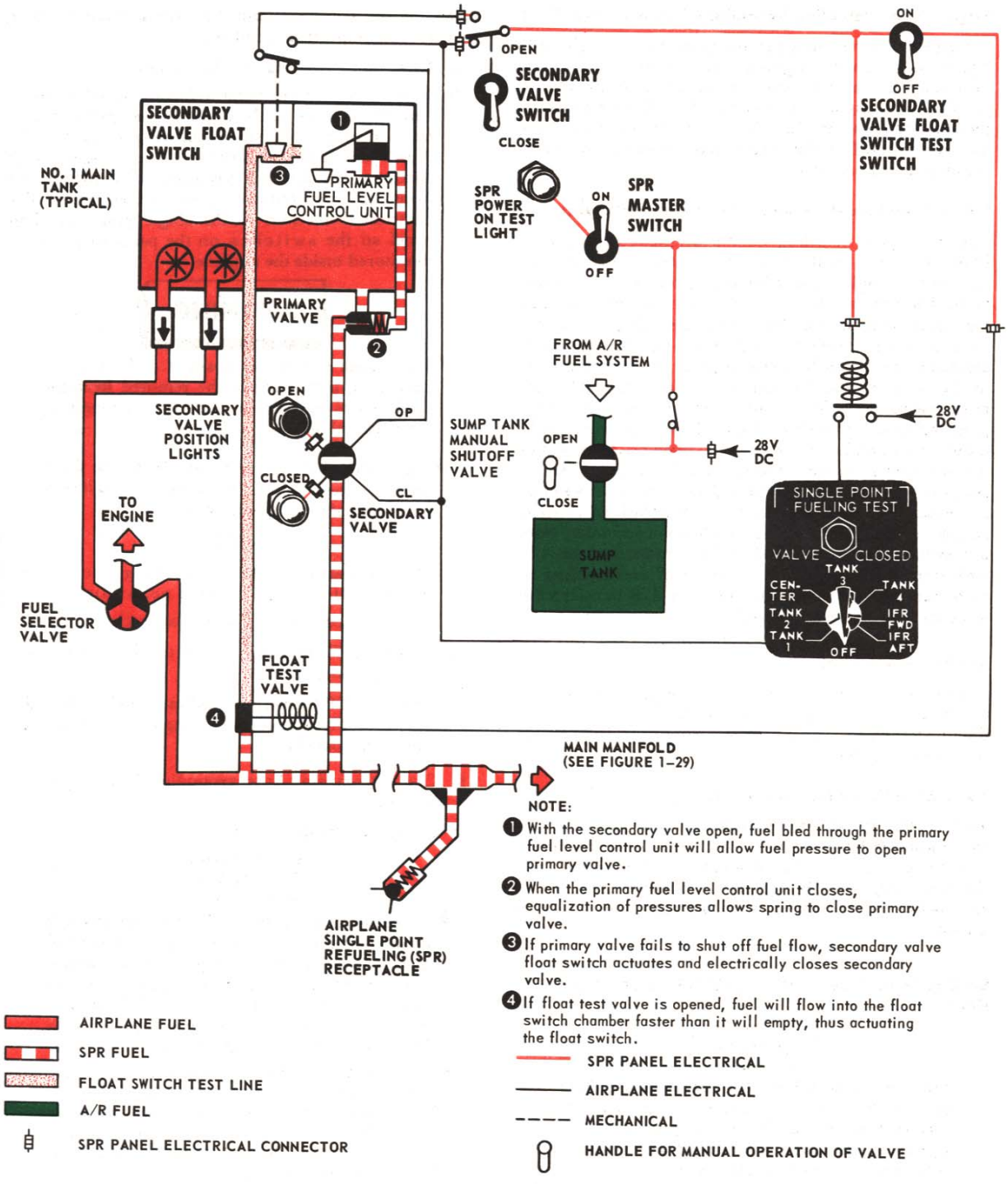
The SPR master switch (2, figure 4–68) on the single point refueling panel has ON–OFF positions. When the switch is placed ON, the controls on the SPR panel are energized.

Secondary Valve Switches

Each secondary valve switch (7, figure 4–68) on the SPR panel has OPEN–CLOSE positions. With the SPR master switch ON, the secondary valve can be: opened or closed by the secondary valve switch, closed by the single point secondary valve test switch on engineer's instrument panel, and closed by the secondary valve float switch during single point refueling. On 22665 ▶, opening and closing of the secondary valves is controlled either by the A/R transfer valve switches on the engineer's A/R panel or by the secondary valve switch. With SPR panel connected and SPR master switch ON, a control transfer relay is actuated and the A/R transfer valve switches are disconnected from the circuit. (See figure 4–66.) With the SPR master switch OFF, the secondary valve is open or closed by the A/R transfer valve switches.

Secondary Valve Float Switch Test Switches

Each secondary vaive float switch test switch (5, figure 4–68) on the single point refueling panel has ON–OFF positions and is spring-loaded to OFF. When the switch is in the ON position, the float test valve is energized open. Opening the float test valve allows fuel to flood the secondary fuel level control unit, simulating a full tank condition.



NOTE:

1. With the secondary valve open, fuel bled through the primary fuel level control unit will allow fuel pressure to open primary valve.
2. When the primary fuel level control unit closes, equalization of pressures allows spring to close primary valve.
3. If primary valve fails to shut off fuel flow, secondary valve float switch actuates and electrically closes secondary valve.
4. If float test valve is opened, fuel will flow into the float switch chamber faster than it will empty, thus actuating the float switch.

- AIRPLANE FUEL
- SPR FUEL
- FLOAT SWITCH TEST LINE
- A/R FUEL
- SPR PANEL ELECTRICAL CONNECTOR
- SPR PANEL ELECTRICAL
- AIRPLANE ELECTRICAL
- MECHANICAL
- HANDLE FOR MANUAL OPERATION OF VALVE

SINGLE POINT REFUELING SYSTEM (AIRPLANE)

Figure 4–69

Single Point Refueling Secondary Valve Closed Light

A single point refueling secondary valve closed light (60, figure 1–21) on the engineer's instrument panel is used to indicate that all the secondary valves are in the closed position. The light is controlled by the single point refueling test switch. Illumination of the light indicates the valve selected by the single point refueling test switch is in the closed position.

Single Point Refueling Secondary Valve Test Switch

The single point refueling secondary valve test switch (61, figure 1–21) is on the engineer's instrument panel adjacent to the single point refueling secondary valve closed light. The test switch is used to test the position of each secondary valve in the single point refueling system. By rotating the test switch to different tank positions, each secondary valve can be tested to determine whether it is in the open or closed position. If a secondary valve has been inadvertently left in the open position, the single point refueling valve closed light will not illuminate, indicating the secondary valve is in the open position. Holding the switch in the desired position will close the secondary valve and the light will illuminate. This switch is inoperative when the single point refueling panel is connected. On 22665▶, the single point secondary valve test switch is not connected to the forward and aft A/R tank systems. The engineer's control of the combination secondary transfer valves is through the A/R transfer valve switches (14, figure 4–65) only.

SPR Power On Light

A push-to-test SPR power on light (1, figure 4–68) above the master switch on the single point refueling panel illuminates when power is being supplied to the single point refueling panel.

Secondary Valve Indicator Lights

Each secondary valve has two push-to-test type valve position indicator lights on the single point refueling panel. The upper light (6, figure 4–68) is illuminated when the secondary valve is open and the lower light (8, figure 4–68) is illuminated when the secondary valve is closed.

SINGLE POINT REFUELING SYSTEM NORMAL OPERATION

CAUTION

Do not exceed a fuel flow rate of 600 gallons per minute or a fuel pressure of 50 psi (whichever occurs first) during single point refueling operation, as surge pressure at valve closure may cause airplane fuel valve failure.

Refueling the airplane by use of the single point refueling system is accomplished as follows:

a. Close sump tank manual shutoff valve.

b. Remove the single point refueling panel from its stowed position in the lower aft compartment and fasten it to the underside of the wing inboard of the No. 2 nacelle by means of the four quick-disconnect fasteners. An electrical receptacle is installed in the lower aft compartment. This receptacle provides electrical connection to the single point refueling panel so the switches on the panel may also be monitored inside the airplane.

WARNING

- To prevent arcing and possible subsequent explosion, power should be removed from the airplane bus before connecting or disconnecting the electrical plug.

- Check that SPR master switch on single point refueling panel is in OFF position before inserting electrical plug in receptacle.

NOTE

Battery power may be used for single point refueling if external power is not available.

c. Insert the electrical plug in the receptacle.

d. Position SPR master switch on the single point refueling panel to ON.

e. Check the SPR power on indicator light. The light should be illuminated, indicating that power is supplied to the panel.

f. Connect refueling hose grounding lead to grounding jack.

g. Insert the refueling nozzle.

CAUTION

- Before starting to refuel the airplane through the single point refueling system, check that fuel selector switches on the engineer's instrument panel are at OFF and jet engine fuel selector valve switches are at JP-4. This will isolate the engines from the manifold line, thus relieving the carburetors from undue pressure.

- Before servicing the A/R system, check that sump tank manual shutoff valve is closed. Check that forward and aft leveling valves are closed, and vent valve is open (if applicable). Fuel load in aft tank system must not exceed that in forward tank system.

h. Press all circuit breakers on the single point refueling panel.

i. Position secondary valve switch to OPEN for tank or tanks to be filled; remaining secondary valve switches to CLOSE.

j. Start fuel flow. The fuel will flow into the tanks selected.

k. Hold secondary valve float switch test switch ON for tanks to be tested for 10 seconds. The secondary valve close light should illuminate.

Stopping Fuel Flow

As the fuel level rises in the tank, the primary float control unit or the secondary valve float switch will close the primary or secondary valve respectively. This stops the fuel flow and leaves the proper amount of expansion space in the tank. Closing of a secondary valve (indicated by illumination of secondary valve closed light) when tanks are filled indicates failure of the primary valve or the primary valve float control unit. The secondary valve switches must be positioned to CLOSE when refueling is complete.

Partial Filling

For tanks that are to be partially filled, the fueling operation is controlled by the hydrant valve only. When the desired quantity of fuel has been delivered to the tank or tanks being fueled, place the hydrant valve to CLOSE.

WARNING

- Place SPR master switch on single point refueling panel OFF before removing electrical plug from receptacle. With SPR master switch ON, possible arcing at receptacle may cause an explosion if fuel fumes are present.
- Drain approximately 1 quart of fuel from the aft single point refueling receptacle drain line to provide thermal relief.

After Single Point Refueling

After all tanks have been filled, accomplish the following:

a. Open No. 1 manual shutoff valve.

b. Close No. 2 manual shutoff valve.

c. Open sump tank manual shutoff valve.

d. Position fuel selector switches to TANK TO ENGINE.

SECTION V
OPERATING LIMITATIONS

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SCOPE

This section covers the operating limitations of the airplane which must be observed during normal operation. Special attention should be given to the instrument markings (figure 5–1), since these limits are not necessarily repeated under their respective sections. The instrument markings are used to indicate to the pilot, at a glance, that flight operation is being accomplished in a safe, desirable, or unsafe region. The instrument marking system consists of four colors and intermediate blank spaces. Red, if used as a minimum limit marking, indicates a dangerous condition exists if operated below this marking. If used as a maximum range marking, red prohibits operation above this marking. Green indicates the region for continuous operation when used without a blue marking. When used in conjunction with blue markings, green indicates the region where auto-rich operation is required. Blue indicates the region where auto-lean operation is permitted. Yellow indicates caution or that danger may exist in this region under certain conditions. Instrument markings are further explained by the use of notes in figure 5–1. All instruments that indicate operating limits are shown in figure 5–1. Care should be taken not to exceed these limits, as damage can result to both the equipment and the airplane.

MINIMUM CREW REQUIREMENTS

The minimum crew requirements for this airplane are a pilot, copilot, engineer and boom operator. Refer to Section I for normal operation crew complement.

ENGINE LIMITATIONS

OVERSPEED

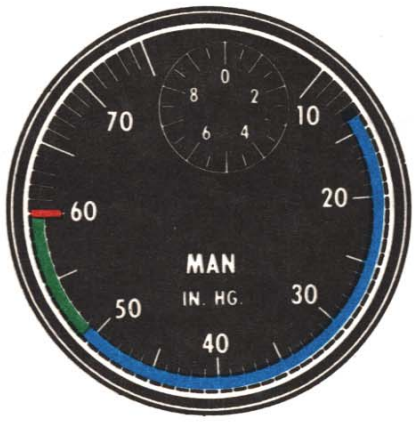
Any rpm in excess of 3300 is considered an overspeed and the following information must be noted in the appropriate section of the Form 781: the maximum rpm which was obtained during flight, the duration in minutes of the overspeed condition and reason for the overspeed if known.

OVERBOOST

When overboost occurs, combustion temperatures rise. If overboost of sufficient magnitude exists, detonation and preignition may result and cause physical damage to the engine, possibly in a matter of seconds. The manifold pressure for maximum power is the only manifold pressure to be considered insofar as overboost is concerned. At any rpm, if manifold pressure exceeds that specified for maximum power for the grade of fuel being used (60 inches Hg with grade 115/145 fuel or 56.5/56.0 (wet/dry) inches Hg with grade 100/130 fuel), the engine has been overboosted.

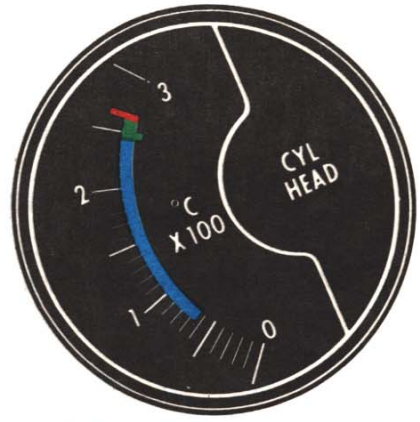
a. An overboost of 1 to 5 inches Hg for periods up to 5 seconds requires no action.

b. All other overboost conditions require maintenance action and must be carefully recorded on Form 781, noting (if possible) the MP, rpm, TPSI, mixture



MANIFOLD PRESSURE

- 14 IN. HG . . . . . MINIMUM IN FLIGHT
- 14 TO 50.5 IN. HG . . . . . AUTO LEAN PERMITTED
- 50.5 TO 60 IN. HG . . . . . AUTO RICH REQUIRED
- 60 IN. HG . . . . . TAKEOFF (WET OR DRY)



CYLINDER HEAD TEMPERATURE

- 65°TO 243°C. . . . . AUTO LEAN PERMITTED
- 243°TO 265°C. . . . . AUTO RICH REQUIRED
- 265°C. . . . . MAXIMUM

NOTE: Maximum CHT for 4-engine level flight below 30,000 feet is 255°C. Maximum CHT at 1850 BHP or less is 243°C. Maximum CHT for 4-engine level flight above 30,000 feet is 265°C.

FUEL GRADE 115/145

TORQUEMETER

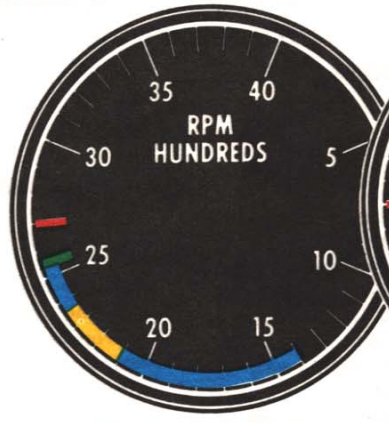
- 50 PSI . . . . . MINIMUM FOR FLIGHT
- 50 TO 198 PSI . . . . . AUTO LEAN PERMITTED
- 198 PSI . . . . . MAXIMUM CONTINUOUS AUTO LEAN OR AUTO RICH

NOTE: Operation above this pressure limited to 30 minutes in AUTO RICH.

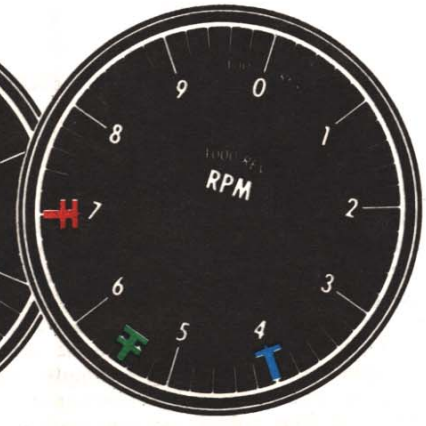
- 230 PSI . . . . . MAXIMUM DRY

NOTE: 247 psi maximum dry power for takeoff can be obtained when CAT is minus 24°C or below.

- 247 PSI . . . . . MAXIMUM WET



PILOT'S TACHOMETER



ENGINEER'S TACHOMETER

- 1300 TO 1400 RPM. . . . . ALLOWABLE FOR CRUISING

NOTE: Operation below 1400 rpm not recommended because of propeller inefficiency.

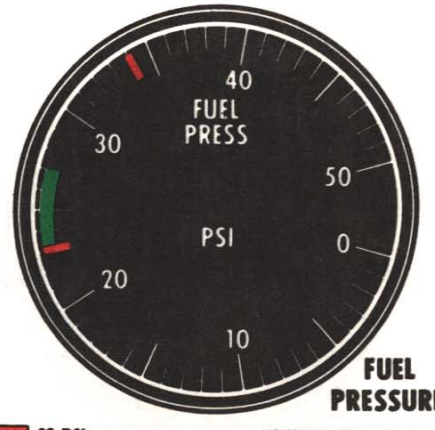
- 1401 TO 2550 RPM . . . . . AUTO LEAN PERMITTED (MARKED ON PILOTS' TACHOMETERS ONLY)
- 2100 TO 2350 RPM . INFLIGHT OPERATION PROHIBITED EXCEPT WHILE PASSING THROUGH THIS RANGE. REFER TO TEXT FOR GROUND RESTRICTIONS.
- 2550 RPM (METO) . . . . . MAXIMUM CONTINUOUS AUTO LEAN OR AUTO RICH

NOTE: Operation above this rpm limited to 30 minutes in AUTO RICH.

- 2700 RPM. . . . . MAXIMUM

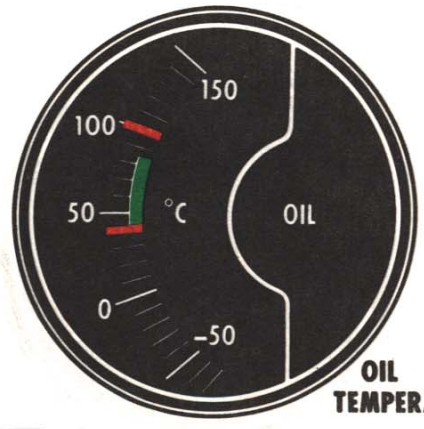
INSTRUMENT MARKINGS

Figure 5–1 (Sheet 1 of 8)



FUEL PRESSURE

23 PSI	MINIMUM FOR FLIGHT
23 TO 27 PSI	CONTINUOUS OPERATION
34 PSI	MAXIMUM ALLOWABLE (engine operating)



OIL TEMPERATURE

40° C	MINIMUM FOR FLIGHT
40° TO 85° C	CONTINUOUS OPERATION
100° C	MAXIMUM

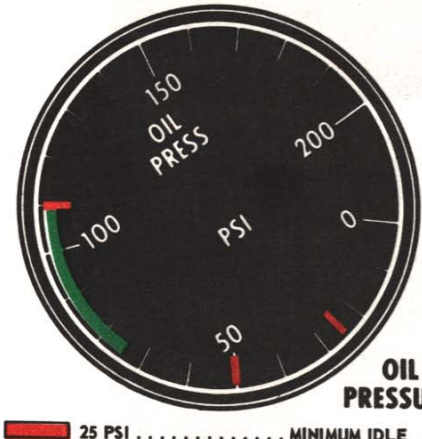
NOTE: Refer to COLD WEATHER PROCEDURES, Section IX, for other limitations.

CAUTION

150° to 160°C during flight is limited to 2 minutes. 160°C is maximum for continuous ground operation. 160° to 190°C during ground operation is limited to 5 minutes. 190° to 227°C during ground operation is limited to 1 minute and over 227°C requires turbo shutdown.

TURBO BEARING TEMPERATURE

160°C	MAXIMUM DURING FLIGHT
40° TO 150°C	CONTINUOUS OPERATION DURING FLIGHT

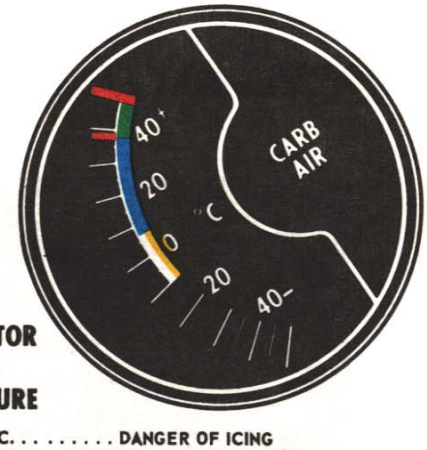


OIL PRESSURE

25 PSI	MINIMUM IDLE
50 PSI	MINIMUM FOR FLIGHT OPERATION ABOVE 1200 RPM ON THE GROUND
75 PSI	MINIMUM FOR TAKEOFF
75 TO 110 PSI	CONTINUOUS OPERATION
110 PSI	MAXIMUM

NOTE: An indication of 25 psi is the minimum oil pressure during engine idle rpm.

75 psi is required during takeoff to minimize bearing wear.

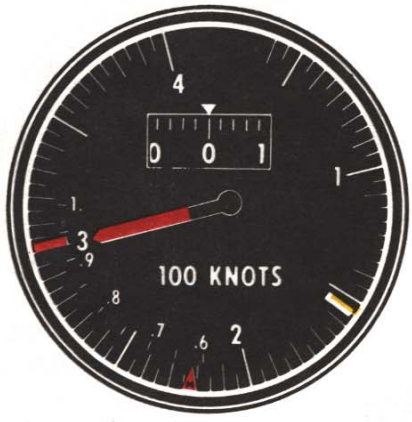


CARBURETOR AIR TEMPERATURE

-10° TO 7° C	DANGER OF ICING
7° TO 38° C	CONTINUOUS OPERATION (AUTO RICH OR AUTO LEAN) (Desired Operation is +20° C)
38° C	MAXIMUM OPERATION (Auto Lean)
38° TO 50° C	MAXIMUM CONTINUOUS OPERATION WITH CARBURETOR PREHEAT
50° C	MAXIMUM DANGER OF DETONATION

NOTE: 38° to 50°C AUTO RICH permitted during extended climbs or when operating conditions demand. Other engine operating limits must be observed. Manifold pressure must not be increased except to compensate for CAT corrections up to 50°C as required to maintain power as shown in the Appendix Power Schedule Charts to recover TPSI loss when operating in the green range.

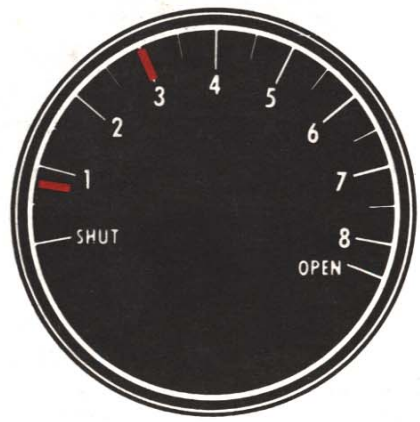
Figure 5-1 (Sheet 2 of 8)



MAXIMUM ALLOWABLE AIR SPEED

155 KNOTS. . FULL FLAPS (LANDING GEAR 200 KNOTS)
302 KNOTS. . . . . MAXIMUM AIRSPEED

NOTE: This instrument setting is such that the red pointer will move to indicate a limiting structural airspeed of 302 knots or the airspeed representing the limiting Mach Number of 0.62, whichever is less.



COWL FLAP INDICATOR

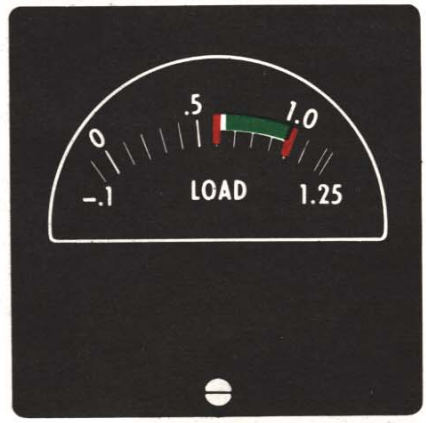
0.75 INCHES. . . . . MINIMUM OPENING FOR FLIGHT
3.0 INCHES . . . . . MAXIMUM OPENING FOR FLIGHT

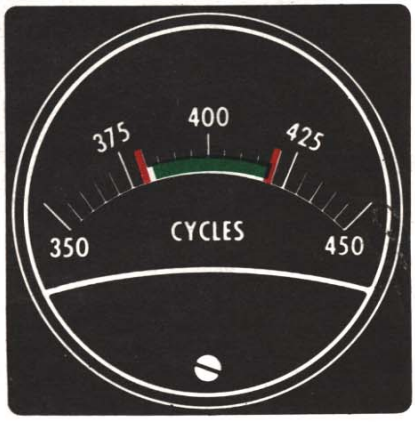
(SEE FIGURE 7-4 FOR OTHER COWL FLAP LIMITS)

PROPELLER DEICING LOADMETER

22629 ▶

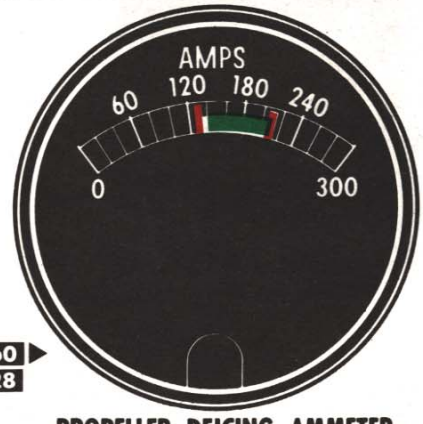
0.6 PER CYCLE. . . . . MINIMUM
0.6 TO 1.0 PER CYCLE. . . . . NORMAL
1.0 PER CYCLE. . . . . MAXIMUM





FREQUENCY METER

380 CYCLES PER SECOND. . . . . MINIMUM
380 TO 420 CYCLES PER SECOND . . . . . NORMAL
420 CYCLES PER SECOND. . . . . MAXIMUM

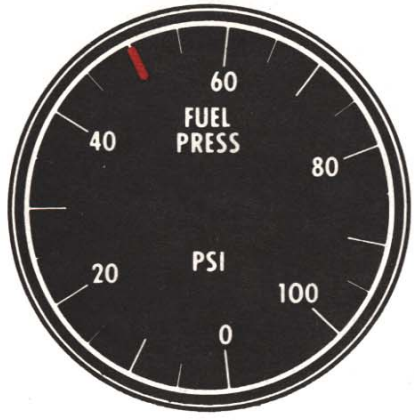


17260 ▶
22628

PROPELLER DEICING AMMETER

130 AMP PER CYCLE. . . . . MINIMUM
130 TO 215 AMP PER CYCLE . . . . . NORMAL
215 AMP PER CYCLE. . . . . MAXIMUM

Figure 5–1 (Sheet 3 of 8)



A/R FUEL PRESSURE

50 PSI . . . . . MAXIMUM A/R FUEL PRESSURE

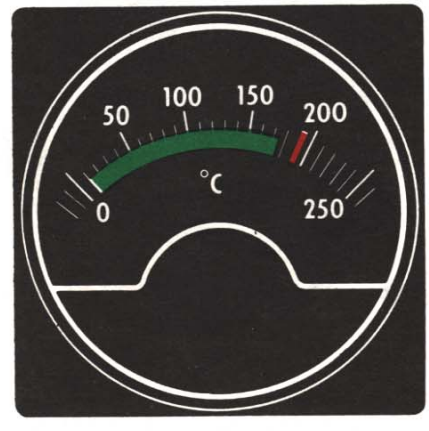
CABIN AIR FLOW

1 TO 3 IN. HG. . . . . NORMAL

NOTE: At certain power settings and cabin pressurization requirements an indication of cabin airflow somewhat above the green (NORMAL) range may be expected.

ANTI-ICING TEMPERATURE

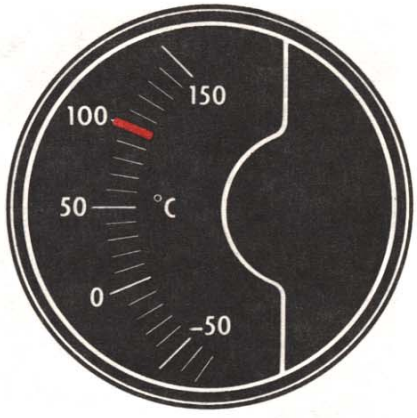
190°C. . . . . MAXIMUM DUCT TEMPERATURE
227°C. . . . . MAXIMUM HEATER TEMPERATURE



BODY HEATER TEMPERATURE

10° TO 176°C. . . . . NORMAL
193°C . . . . . MAXIMUM

Figure 5–1 (Sheet 4 of 8)



AIR REFUELING HYDRAULIC OIL TEMPERATURE

100°C ..... MAXIMUM

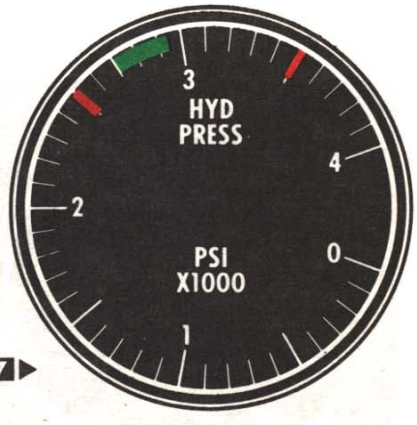
NOTE: Reduce refueling flow or shut down as necessary to stay below this limit.

17260 ▶ 22736

ELECTRICAL GAGE

BOOM HYDRAULIC SYSTEM PRESSURE

2500 PSI ..... MINIMUM
2700 TO 2950 PSI ..... NORMAL
3080 PSI ..... MAXIMUM



22737 ▶

ELECTRICAL GAGE

BOOM HYDRAULIC SYSTEM PRESSURE

2500 PSI ..... MINIMUM
2700 TO 2950 PSI ..... NORMAL
3500 PSI ..... MAXIMUM

17260 ▶ 2893

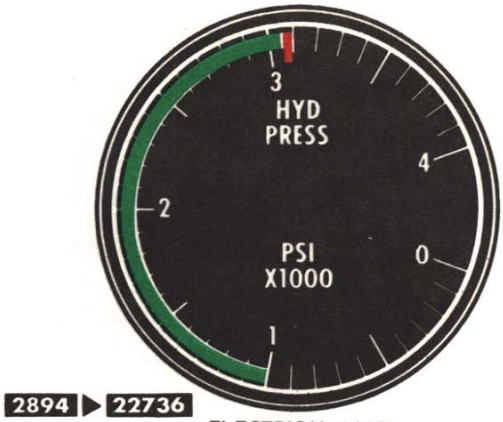
DIRECT READING GAGE

ENGINE-DRIVEN AIR REFUELING HYDRAULIC PUMP PRESSURE

1000 TO 3080 PSI ..... NORMAL
3080 PSI ..... MAXIMUM

NOTE: An indication of 50 to 500 psi during cruise conditions is normal.

Figure 5–1 (Sheet 5 of 8)

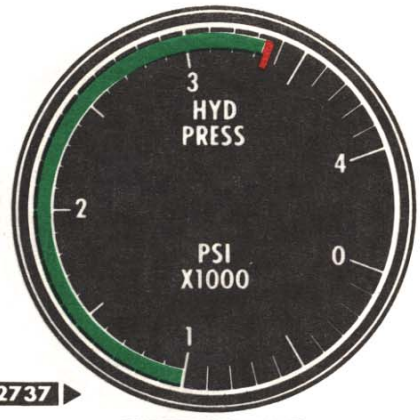


2894 ▶ 22736

ELECTRICAL GAGE

ENGINE-DRIVEN AIR REFUELING HYDRAULIC PUMP PRESSURE

1000 TO 3080 PSI ..... NORMAL
3080 PSI ..... MAXIMUM
NOTE: An indication of 50 to 500 psi during cruise conditions is normal.



22737 ▶

ELECTRICAL GAGE

ENGINE-DRIVEN AIR REFUELING HYDRAULIC PUMP PRESSURE

1000 TO 3350 PSI ..... NORMAL
3350 PSI ..... MAXIMUM
NOTE: An indication of 50 to 500 psi during cruise conditions is normal.

EMERGENCY BRAKE HYDRAULIC PRESSURE

520 PSI . . . . ONE BRAKE APPLICATION REMAINING
1825 PSI . . . . . MAXIMUM

SERVICE BRAKE HYDRAULIC PRESSURE

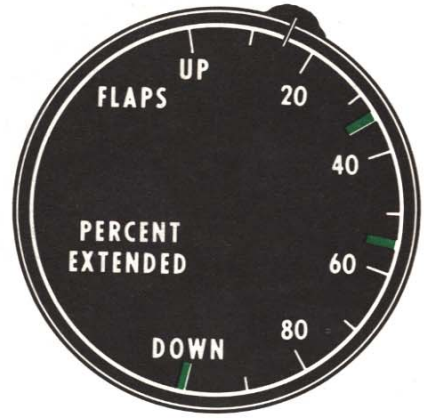
520 PSI . . . . ONE BRAKE APPLICATION REMAINING
1500 TO 1650 PSI . . . . . NORMAL
1825 PSI . . . . . MAXIMUM

Figure 5–1 (Sheet 6 of 8)

MAIN HYDRAULIC PRESSURE

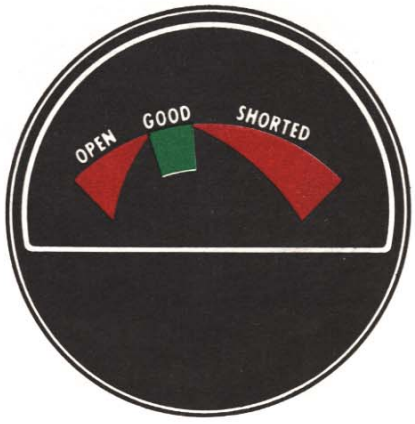
1500 TO 1650 PSI . . . . . NORMAL
1825 PSI . . . . . MAXIMUM

SLIPPAGE INDEX MARKER



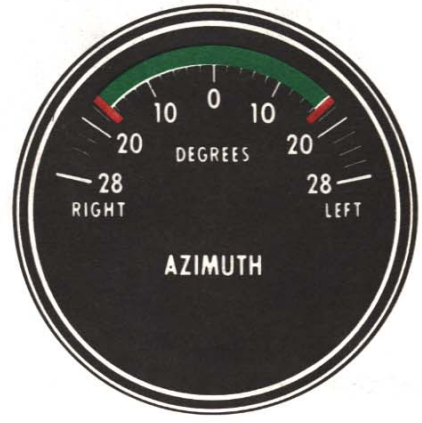
WING FLAP POSITION INDICATOR

NOTE: Green lines identify 33, 55, and 100% flap positions.



BOOM SIGNAL COIL TEST VOLTMETER

OPEN . . . . . BOOM SIGNAL COIL CIRCUIT OPEN
GOOD . . . . . BOOM SIGNAL COIL CIRCUIT GOOD
SHORTED . . . .BOOM SIGNAL COIL CIRCUIT SHORTED



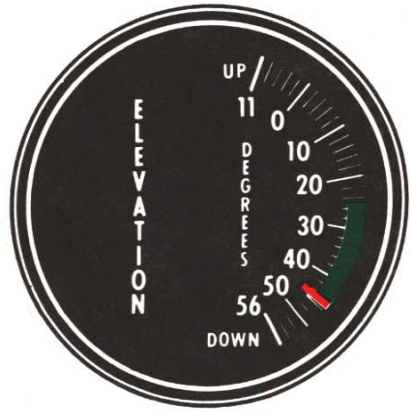
BOOM AZIMUTH

17°L TO 17°R . NORMAL ENVELOPE (Automatic Operation)
17°L AND 17°R . . . . . MAXIMUM

Figure 5–1 (Sheet 7 of 8)

BOOM TELESCOPE

6 FT	MINIMUM
6 TO 18 FT	NORMAL ENVELOPE (Automatic Operation)
18 FT	MAXIMUM



BOOM ELEVATION

25° TO 45° DOWN	NORMAL ENVELOPE (Automatic Operation)
45° DOWN	MAXIMUM

JET ENGINES

EXHAUST GAS TEMPERATURE

200°C	MINIMUM OPERATION
200° TO 690°C	NORMAL OPERATION
690°C	MAXIMUM IN FLIGHT
950°C	MAXIMUM FOR STARTING
575°C	COMPRESSOR STALL RANGE

OIL PRESSURE

1 PSI	MINIMUM IDLE RPM
8 TO 18 PSI	NORMAL OPERATION FOR 88 PERCENT RPM
22 PSI	MAXIMUM 100 PERCENT RPM

NOTE: The oil pressure gage markings and bar values shown above are only at idle, 88 and 100 percent RPM. For oil pressure characteristics at other RPMs refer to figure 5–2A.

FUEL GRADE
115/145 JP-4

TACHOMETER

40 TO 100 PERCENT	NORMAL OPERATION
100 PERCENT	MAXIMUM
65 TO 85 PERCENT	COMPRESSOR STALL RANGE

NOTE: If EGT is above 575°C for more than 10 seconds while rpm is in compressor stall range of 65 to 85 percent, the engine is in compressor stall. The throttle should be retarded to IDLE to eliminate the stall.

Figure 5-1 (Sheet 8 of 8)

setting, altitude, turbosupercharger operation, and duration of overboost.

CAUTION

Continued operation of an overboosted engine should be kept under close surveillance. Consideration should be given to reduced power operation or complete shutdown, dependant upon the severity of the overboost, mission requirements, and flight safety.

CYLINDER HEAD TEMPERATURE LIMITATIONS

During METO power climbs and level flight, cylinders A-1, and/or B-1 tend to be the hottest cylinders. However, during static ground run, cylinders A-1 and B-1 are approximately 30°C cooler than the hottest cylinders. Every effort should be made to keep the CHT at or below 180°C prior to takeoff run to prevent other cylinders from exceeding 265°C. Once the airplane is moving or airborne, cylinders A-1 and B-1 give more accurate indications of maximum CHT.

POWER TIME LIMITS

METO power is the maximum power at which the engine may be operated continuously. At engine ratings above METO power, specific time limits are imposed. Operation at maximum power (3500 BHP WET or 3250 BHP DRY) is limited to 5 minutes. Maximum dry power setting, however, may be maintained for 30 minutes if necessary, in which case it is designated military power. The distinction is entirely in the time limit. In an emergency, the engine may be run continuously under overload conditions of military power for a much longer period than the 30-minute time limit. However, the period of reliable operation is thereby reduced to an unreasonably short time. By imposing a 5-minute time limit for maximum power, the cumulative effect of the overloads is distributed evenly over the period between engine overhauls, and the useful life of the engine is lengthened accordingly. When use of military power is absolutely required for longer than 30 minutes, a notation must be made in Form 781.

TURBO LIMITATIONS

The maximum allowable continuous turbine wheel speed (20,000 rpm) is reached at the engine power settings shown in figure 5–2. Operation above these limits should be used as required but held to an absolute minimum.

ALTERNATE FUEL GRADE OPERATING LIMITATIONS

The R-4360-59B engine requires either grade 115/145 or grade 108/135 fuel to develop maximum power ratings without exceeding detonation margins. Grade 115/145 is the recommended fuel and grades 108/135 and 100/130 are first and second alternates. If the second alternate fuel grade (100/130) is used in any proportion, the power ratings must be reduced as shown in figure 5–3 by manually limiting manifold pressure to avoid detonation.

ALTITUDE (FEET)	BHP
23,500	2650
25,000	2450
26,000	2350
27,000	2250
28,000	2160
29,000	2070
30,000	1985

CONDITIONS: 32 Degrees CAT
155 Knots IAS

TURBO LIMITATIONS

Figure 5–2

JET ENGINE LIMITATIONS

JET ENGINE OVERSPEED

The J-47-25 jet engine is designed to develop a maximum of 101 percent rpm. If the engine develops an rpm in excess of 101 percent, an overspeed condition exists. An overspeed condition exceeding 104 percent rpm necessitates a turbine wheel change before further operation. If overspeeding in excess of 108 percent occurs, the engine must be replaced. The engine is designed for 100% rpm continuous operation.

JET ENGINE ALTERNATE FUEL GRADE LIMITS

The jet engine should normally operate on JP-4 or commercial jet B fuel. AVGAS grades 115/145, 108/135 or 100/130, or JP-5 fuel may be used if proper precautions are exercised. The operating limits are identical for all types of fuel. Repetitive operation on AVGAS will result in tetraethyl lead deposits on hot parts, disturbing air flow. These deposits can also cover cracks and other defects in hot parts, making it difficult to detect them. The engines are conditioned on JP-4 fuel, thus operation on AVGAS, which has fewer BTU s per gallon, will result in a slightly lower RPM and EGT for a given throttle sitting. The acceleration rate on AVGAS will be slower. Operation on JP-5, which has more BTU s per gallon than JP-4, results in higher EGT and RPM and faster acceleration. When using JP-5, caution should be exercised to avoid overtemperature, overspeed and compressor stall. Operation on JP-5 fuel results in heavy carbon buildup on igniter plugs and fuel nozzles which will often prevent the engine from starting on subsequent attempts. When operating on JP-5 fuel, the last 30 minutes of operation prior to shutdown should be conducted on AVGAS if available. Operation on AVGAS, which produces little carbon formation, will remove some of the carbon deposited during the JP-5 operation. Subsequent start attempts should be made on AVGAS which is more volatile than JP-5. Since the -51°F freeze point of JP-5 is higher than the -72°F JP-4 freeze point, avoid altitudes where indicated OAT is below the freeze point.

JET ENGINE OVERTEMPERATURE LIMITS

In the event of jet engine overtemperature conditions, the following action should be taken:

CAUTION

A Form 781 entry is required for the overtemperature condition listed below. If a Form 781 entry is not made, the required maintenance inspection may not be performed, and further operation of the engine could result in turbine failure and possible engine loss.

A. CONDITION - ENGINE STARTS UP TO IDLE (within 2 minutes) - 950° C or above.

ACTION - Shut down engine and record degree and duration of overtemperature condition in Form 781. Engine must be replaced.

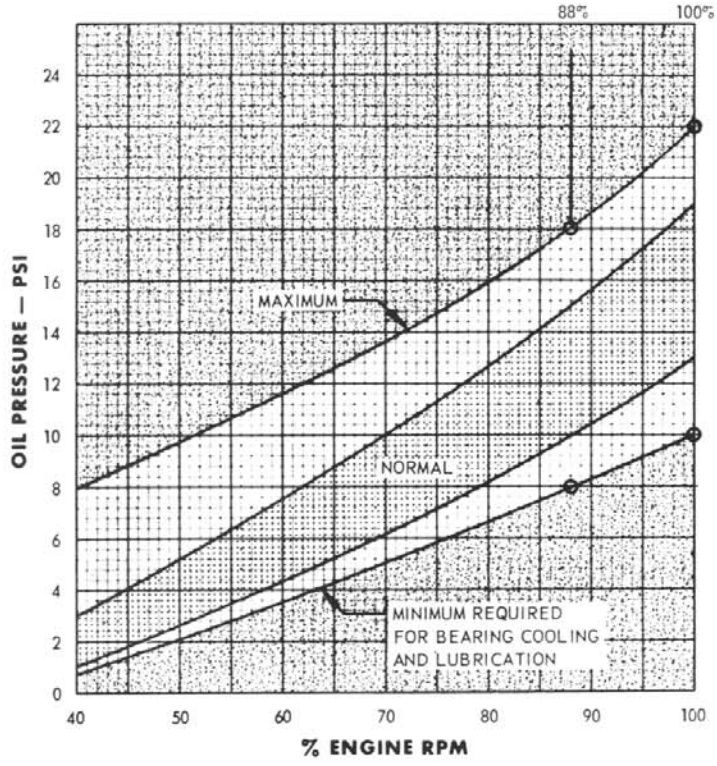
B. CONDITION - ALL OTHER ENGINE OPERATION EXCEPT STARTS - 690° to 750° C for 40 seconds or more. 750° to 800° C for 10 seconds or more. Above 800° C for 2 seconds or more.

ACTION - Record degree and duration of overtemperature condition in Form 781. Engine must be inspected.

JET ENGINE OIL PRESSURE LIMITATIONS

Engine oil pressure varies directly with engine RPM, and an oil pressure deficiency is serious at any RPM. Figure 5-2a shows maximum and minimum oil pressure at various operating speeds. During stabilized flight conditions a change in pressure, even though within limits, is cause for a thorough check of the system. The following check procedure is recommended:

1. If oil pressure on a particular engine appears abnormally high or low in comparison with the other engine at the same RPM, adjust throttle to obtain 88% or 100% RPM on the engine, depending on operating conditions, and check the oil pressure.



JET ENGINE OIL PRESSURE CHARACTERISTICS

Figure 5-2A

2. If oil pressure is within limits (8 to 18 psi at 88% RPM; 10 to 22 psi at 100% RPM) at check RPM, continue operation of the engine, but maintain close surveillance of the oil pressure. A definite change in excess of 5 psi or a pronounced fluctuation of more than 3 psi in the indicated oil pressure after stabilization at a given power condition, even though oil pressure remains within limits, signifies a probable interruption of proper oil circulation and requires engine shutdown. This does not apply during takeoff where fluctuation is normal.

3. If oil pressure is out of limits at check RPM, shut down the engine until the cause of the discrepancy can be determined. An increase in oil pressure may indicate some impedance in the lines such as a clogged oil jet. However, during extreme cold weather operation, the oil pressure may exceed the maximum limits until the oil temperature reaches normal. A decrease in oil pressure may indicate an insufficient oil supply or a broken tube or oil jet.

CAUTION

The engine oil pressure should be closely observed during flight at high speeds. Loss of oil pressure at high engine RPM can result in engine seizure and twist-off within five minutes.

ENGINE OIL PRESSURE

ENGINE RPM (PERCENT)	MINIMUM (PSI)	MAXIMUM (PSI)
100	10	22
88	8	18
38 to 41 (Windmilling)	Pressure indication	8

CONDITION	RPM	BHP	TPSI	APPROX IN. MP	MAX CHT	DESIRED CHT	MAX CAT	DESIRED CAT	MIXTURE POSITION
MAX POWER (Wet)	2700	3250	230	56.5	265°C	-	38°C	-	AR
MAX POWER (Dry)	2700	3000	214	56.0	265°C	-	38°C	-	AR
METO POWER	2550	2500	187	48.1	255°C	240° - 255°C	38°C	7° - 38°C	AR
MAX AUTO LEAN	2100	1735	158	-	243°C	225° - 243°C	38°C	7° - 38°C	AL

FOR MIL-G-5572, GRADE 100/130 FUEL

CONTINUOUS OPERATION WITH ALTERNATE FUEL

Figure 5-3

PROPELLER LIMITATIONS

Ground operation between 1250 and 1650 rpm and 2100 and 2650 rpm is prohibited except for passing through these ranges. Do not use reverse thrust for ground maneuvering. Flight operation between 2100 and 2350 rpm is prohibited except while passing through this range. If takeoff rpm (2700 rpm) is exceeded by 20 percent (3240 rpm), an entry will be made in Form 781.

CENTER OF GRAVITY LIMITATIONS

a. Forward CG limit is 18.5 percent of MAC.

b. Rearward CG limit is 30.5 percent of MAC.

When the airplane is operated within these limits, all control characteristics during taxiing, takeoff, flight, and landing are normal.

Note

The operating limitations noted in the existing weight and balance technical manual (T.O. 1-1B-40) and attendant computer (C/KC-97A through G) are not applicable for gross weights under 105,000 pounds.

The following is applicable for gross weights under 105,000 pounds.

c. The forward CG limit for takeoff and landing of the airplane has been established at 15 percent MAC at airplane gross weights below 105,000 pounds.

d. The rear CG limit for all flight conditions remains unchanged.

e. When landing at 15 to 18.5 percent MAC, wing flaps are limited to 80 percent on final approach and touchdown. Reduce airspeed to cross threshold at 5 knots above minimum approach speed. Minimum power must be maintained at 15 inches manifold pressure on final and throughout the flare, where a gradual reduction of power is made to contact the ground with main gear first in a slightly nose-up attitude.

BRAKE LIMITATIONS

The brakes absorb energy by converting the kinetic energy of the airplane (energy of motion) into heat which is then dissipated into the atmosphere. The temperature at which the brakes will still operate and the rate of heat dissipation impose limits upon brake usage. The heat added to the brakes for each braking effort is cumulative and is determined by the speed and gross weight of the airplane at the time of brake application. Kinetic energy absorbed per brake may be determined by using figure 5-4 for landing and taxi and figure 5-4A for refused takeoffs. These charts are for brakes only, and does not include the effects of propeller reversing; however, at lower speeds (less than 50 knots), the effect of propeller reversing is small and the chart will give realistic values even if the propellers are still in reverse pitch while the brakes are being applied. (Refer to LANDING, Section II.) Observe cooling requirements as follows:

The pilot will note in Form 781 the foot-pounds of kinetic energy absorbed per brake for all stops of 16 million foot-pounds or greater.

Note

- The effect of aerodynamic braking has been considered in the brake limits charts, figure 5-4 and 5-4A. This aerodynamic braking will slow the airplane essentially the same amount whether the brakes are applied steadily or in short applications.

- The same amount of heat is generated by the brakes in stopping the airplane, regardless of whether the brakes are applied in one steady application or in a series of short applications. The internal heat generated by the brakes does not reach the outer surface of the brake assembly for several minutes, whereas the landing ground roll requires only a few seconds; therefore, all the heat generated by the brakes will remain in the brake assembly for the duration of the landing ground roll.

REFUSED TAKEOFF

Determine the amount of kinetic energy absorbed per brake from figure 5-4A. If this does not exceed 7 million foot-pounds, another takeoff may be attempted immediately.

Note

If low energy stops up to 7 million foot-pounds are made, brake parts will get hot but the heat will be dissipated more rapidly than it can accumulate between flights. This does not include making a rapid series of such stops in the course of taxiing the airplane.

If the amount of kinetic energy absorbed exceeds 7 million foot-pounds per brake, it is recommended that the takeoff be delayed up to 1 hour. When the urgency of the mission demands another takeoff, and the energy exceeds 7 million foot-pounds but is less than 16 million foot-pounds, a normal takeoff may be made with the exception that the landing gear must be extended for brake cooling immediately after the flaps are fully retracted. Hold 150 knots for best gear-down rate of climb, and leave gear extended 2 minutes for each 1 million foot-pounds in excess of 7 million foot-pounds.

WARNING

Before a second takeoff is attempted, the possibility of a second refused takeoff must be considered. The cumulative effect of two refused takeoffs may exceed the brake energy limits, causing tire explosion and fire which could endanger the crew and airplane.

FULL STOP LANDING

Determine the amount of kinetic energy absorbed per brake from figure 5-4. If this does not exceed 7 million foot-pounds, another takeoff may be attempted immediately. If this exceeds 7 million foot-pounds but is less than 16 million foot-pounds, takeoff should be delayed 7 minutes for each 1 million foot-pounds in excess of 7 million foot-pounds.

HIGH ENERGY REFUSED TAKEOFFS OR BRAKED LANDINGS

Any braking effort between 16 and 18 million foot-pounds must be handled with caution. Park airplane and do not set brakes.

WARNING

If a second braking attempt is made before heat is dissipated from the first attempt, the brake energy limits may be exceeded, causing tire explosion and fire which could endanger the crew and airplane.

Note

Peak temperatures are reached in the brake housing approximately 15 to 20 minutes after braking.

Do not approach the overheated brakes for at least 1/2 hour. Visually check brakes for hydraulic leaks and tire damage. Have brakes inspected per T.O. 1C-97(K)E(C)-2-7 brake wear check. Delay takeoff for 1-1/2 hours or until hand can be held on brake housing. Braking efforts above 18 million foot-pounds will probably cause brake damage, tire explosion, and fire. Approach only from front or rear for fire fighting. Hydraulic fluid fire and tire explosion may be imminent. Use dry chemical fire extinguisher if possible; however, if other extinguisher must be used, apply as fog or foam and do not spray directly on wheels. After brakes have cooled, they should be removed and replaced.

GIVEN:

Full stop landing

Gross weight = 130,000 LB

Airspeed when brakes applied = 65 knots IAS

Tower reported wind velocity = 5 knots tailwind

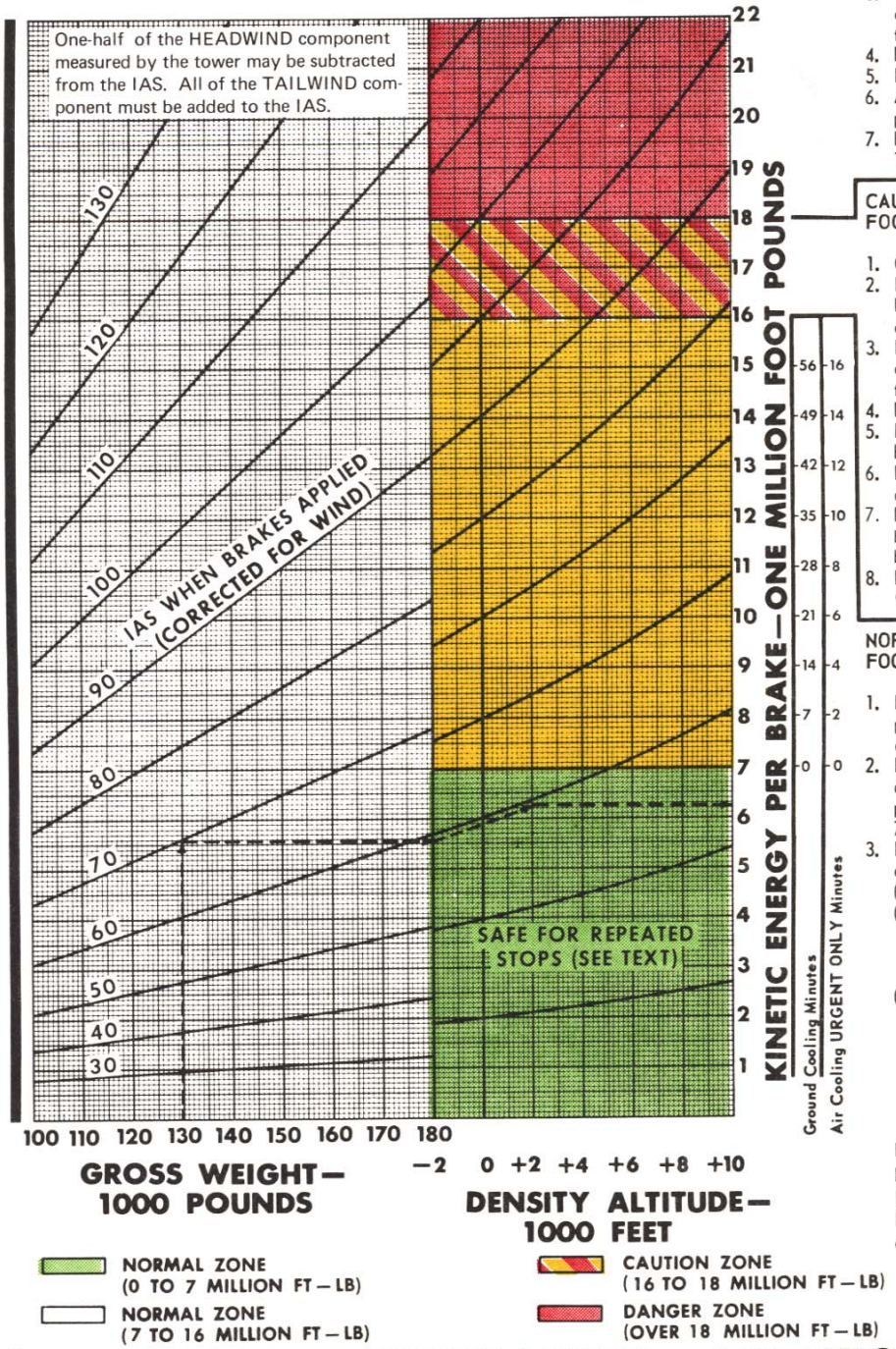
Density altitude = +2000 FT

FIND:

Are brakes safe for another takeoff?

SOLUTION:

Following example line, the K E per brake = 6.3 million foot-pounds. The brakes are safe for an immediate takeoff.



DANGER ZONE - OVER 18 MILLION FOOT-POUNDS

1. Clear runway; do not set brakes.
2. Request fire fighting equipment. Hydraulic fluid fire and tire explosions are imminent.
3. Evacuate airplane thru either crew entrance door, moving forward or aft to avoid going near main gear wheels.
4. Leave immediate vicinity.
5. Enter K E /brake in form 781.
6. After brakes have cooled, have replaced per T.O. 1C-97(K)E(C)-2-7.
7. Have tires removed and checked per T.O. 4T-1-3.

CAUTION ZONE - 16 TO 18 MILLION FOOT-POUNDS

1. Clear runway; do not set brakes.
2. Request fire fighting equipment. Hydraulic fluid fire and tire explosions are possible.
3. Evacuate airplane thru either crew entrance door, moving forward or aft to avoid going near main gear wheels.
4. Leave immediate vicinity.
5. Do not approach airplane for 1/2 hour.
6. Have main gear inspected for tire damage and hydraulic leaks.
7. Delay subsequent takeoff for 1-1/2 hours or until hand can be held on brake housings.
8. Have brakes inspected per T.O. 1C-97(K)E(C)-2-7, BRAKE WEAR CHECK.

NORMAL ZONE - UP TO 16 MILLION FOOT-POUNDS

1. If stop does not exceed 7 million foot-pounds, no special procedure is required.
2. If stop exceeds 7 million foot-pounds, delay subsequent takeoff 7 minutes per million foot-pounds in excess of 7 million.
3. If stop exceeds 7 million foot-pounds and immediate takeoff is made;
   (A) Make normal takeoff.
   (B) After flap retraction, extend gear and leave down for 2 minutes per each million foot-pounds in excess of 7 million.
   (C) Climb at best rate of climb speed, approximately 150 knots IAS.

NOTE:

Braking energy during taxi is cumulative and must be added to total K E per brake. Refer to text for example calculation.

BRAKE LIMITS — LANDING

Figure 5–4

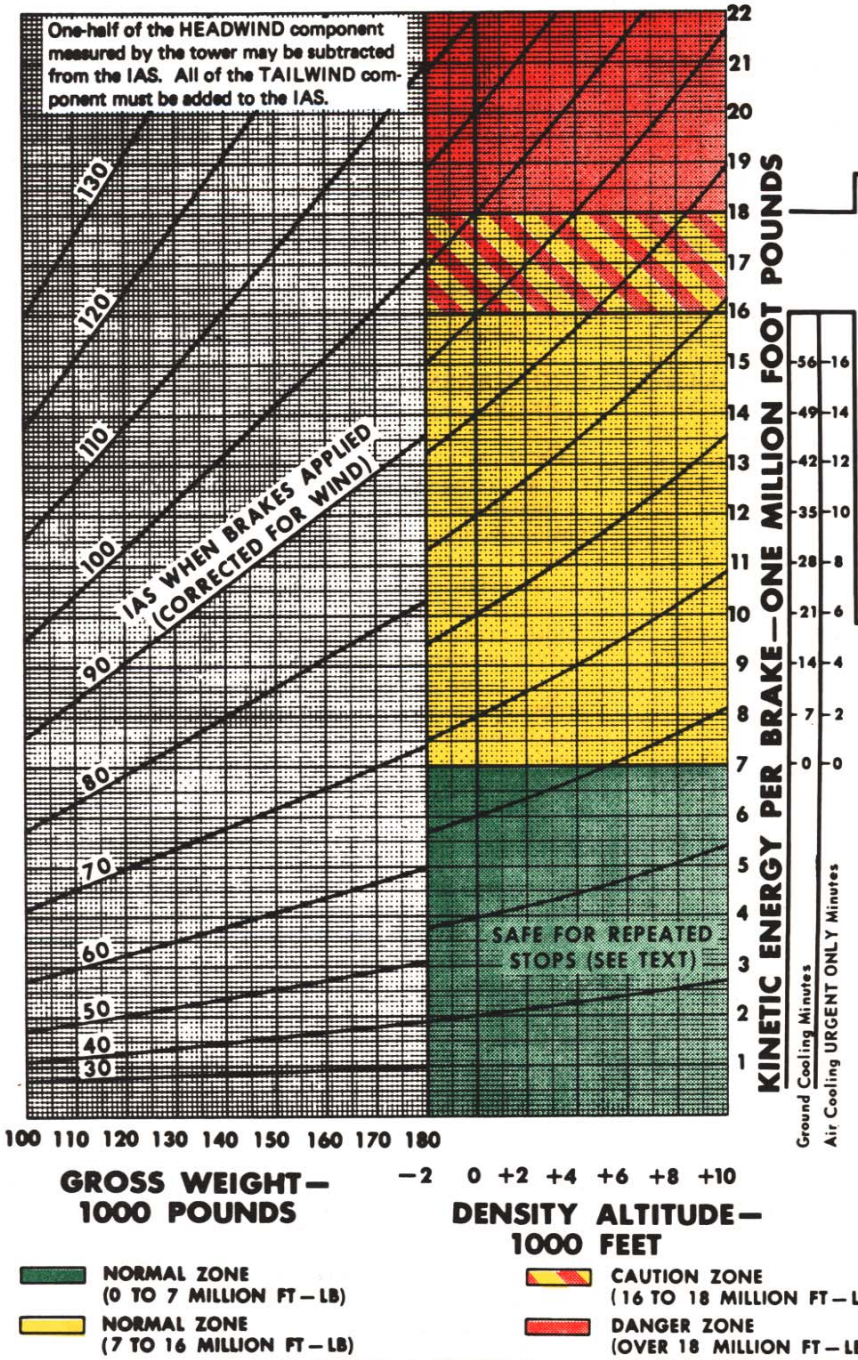


Figure 5-4A

DANGER ZONE - OVER 18 MILLION FOOT-POUNDS

1. Clear runway; do not set brakes.
2. Request fire fighting equipment. Hydraulic fluid fire and tire explosions are imminent.
3. Evacuate airplane thru either crew entrance door moving forward or aft to avoid going near main gear wheels.
4. Leave immediate vicinity.
5. Enter K.E./brake in form 781.
6. After brakes have cooled, have replaced per T.O. 1C-97(K)E(C)-2-7.
7. Have tires removed and checked per T.O. 4T-1-3.

CAUTION ZONE - 16 TO 18 MILLION FOOT-POUNDS

1. Clear runway; do not set brakes.
2. Request fire fighting equipment. Hydraulic fluid fire and tire explosions are possible.
3. Evacuate airplane thru either crew entrance door, moving forward or aft to avoid going near main gear wheels.
4. Leave immediate vicinity.
5. Do not approach airplane for 1/2 hour.
6. Have main gear inspected for tire damage and hydraulic leaks.
7. Delay subsequent takeoff for one and 1/2 hours or until hand can be held on brake housings.
8. Have brakes inspected per T.O. 1C-97(K)E(C)-2-7 BRAKE WEAR CHECK.

NORMAL ZONE - UP TO 16 MILLION FOOT-POUNDS

1. If stop does not exceed 7 million foot-pounds, no special procedure is required.
2. If stop exceeds 7 million foot-pounds, delay subsequent takeoff 7 minutes per million foot-pounds in excess of 7 million.
3. If stop exceeds 7 million foot-pounds and immediate takeoff is made;
   (A) Make normal takeoff.
   (B) After flap retraction, extend gear and leave down for 2 minutes per each million foot-pounds in excess of 7 million.
   (C) Climb at best rate of climb speed, approximately 150 knots IAS.
   (D) Loss in rate of climb of approximately 350 feet per minute can be expected.

NOTE

Braking energy during taxi is cumulative and must be added to total K E per brake. Use figure 5-4 to determine brake energy during taxi.

BRAKE USE DURING TAXI

Normally, during a series of successive landings, a minimum of 15 minutes should elapse between landings where the landing gear remains in the slipstream, and a minimum of 30 minutes between landings with the landing gear retracted, to allow adequate cooling time between brake applications. This time reduction is not applicable when touch-and-go type landings are authorized and no brake application is involved. Cumulative brake energy, and thus cooling time between landings, may be computed in the following manner:

a. Use 0.6 million foot-pounds per brake application at speeds up to 20 knots.

b. Use 0.8 million foot-pounds per brake application at speeds between 20 and 30 knots.

c. For speeds in excess of 30 knots, compute energy from speed change on figure 5–4.

For the first takeoff, no brake cooling is required since runup time is sufficient to compensate for brake usage during taxi to runup pad. For a second takeoff, or during transition, all brake usage between touchdown and takeoff is cumulative. To demonstrate a problem where braking during taxi would cause delay in takeoff, assume the airplane has stopped per the example given in figure 5–4. In addition, assume six brake applications during taxi, five applications at less than 20 knots, and one application at 40 knots sufficient to slow airplane to 30 knots. In figure 5-4, read 2.0 million foot-pounds at 40 knots, and 1.1 million foot-pounds at 30 knots. The difference between these values, 0.9 million foot-pounds, is the energy imparted to the brakes in slowing from 40 to 30 knots. Total energy during taxi would be 5 x 0.6 + 0.9 = 3.9 million foot-pounds. Total cumulative energy would be 6.3 + 3.9 = 10.2 million foot-pounds. It can be seen from figure 5-4 that approximately 23 minutes ground cooling, or 6.5 minutes geardown air cooling, would be required.

Note

Under extreme conditions a normal traffic pattern would not be sufficient, timewise, for geardown air cooling.

AIRSPEED LIMITS

Note

The following limits supplement those shown in figure 5–1. Refer also to Appendix, T. O. 1C-97(K)L-1-1.

Landing Gear – Do not exceed 200 knots IAS with landing gear extended, because retracting mechanism and wheel well doors will be overstressed at higher speeds.

Flaps – Do not begin to lower flaps above 190 knots IAS. Do not exceed 190 knots IAS with up to 55 percent flaps. Do not exceed 155 knots IAS with 55 to 100 percent flaps. Exceeding any of these conditions can result in damage to flaps and flap operating mechanisms.

Landing Light – Do not exceed 200 knots IAS when extending landing lights, because extension mechanism will be overstressed at higher speeds.

Sheltered Air Door – Do not exceed 190 knots IAS when actuating sheltered air doors. Do not exceed 210 knots IAS when operating in the sheltered position. Operating mechanism will be overstressed at higher speeds.

A/R Boom – Do not exceed 260 knots IAS with boom unlatched because of possible damage to the boom or the boom supports. Caution should be exercised when 220 knots IAS is exceeded as ruddevator control becomes critical.

FLIGHT RESTRICTIONS

a. All acrobatics are strictly prohibited.

b. Operate cowl flaps as shown in figure 7–4.

HIGH GROSS WEIGHT STRUCTURAL AND PERFORMANCE LIMITATIONS

Every airplane has structural and flight limitations which vary according to its type and size. These limitations must be established when the airplane is designed in order to obtain maximum utility by a satisfactory combination of structural strength, weight, and flight characteristics. Gross weight is an important factor in determining the structural and performance limitations of an airplane. Added gross weight results in a decreased structural margin of safety and climb rate, longer takeoff and landing rolls, and greater control forces. If established weight limits are exceeded, the airplane strength and performance may be inadequate. In the military design specifications, certain criteria have been established to define the maximum overload and maximum normal takeoff weights for any type airplane. The least weight determined by these criteria is usually adopted for normal operating purposes. Under these specifications, the overload and normal takeoff weights for this airplane are determined by structural criteria because the performance limitations occur at higher weights. The performance limitations discussed here do not account for all variations in operating conditions. The operating takeoff performance and field length limits, based on equivalent performance weights, are discussed in the Appendix, T. O. 1C-97(K)L-1-1.

HIGH GROSS WEIGHT LANDING SINKING SPEEDS

The airplane structure is designed for normal landing with a payload up to 30,000 pounds to normal gross landing weight. At 130,000 pounds gross weight, the airplane is designed for a 10 FPS limit contact sinking speed with 0.67 G wing air lift (a condition which occurs frequently).

CAUTION

Taxi or takeoff gross weights will not exceed 175,000 pounds, or the 2.0 G line, whichever is least, because of possible structural damage to the main landing gear axle.

It is possible to land at any gross weight without structural damage; however, maximum permissible sinking speeds reduce as gross weights increase, as shown in figure 5–5. More precision will be necessary in maintaining allowable sinking speeds at high gross weights than at low gross weights, but the chart shows that a much harder than average normal landing is necessary at any weight to cause structural damage.

WING FUEL LOADING AND USAGE RESTRICTIONS

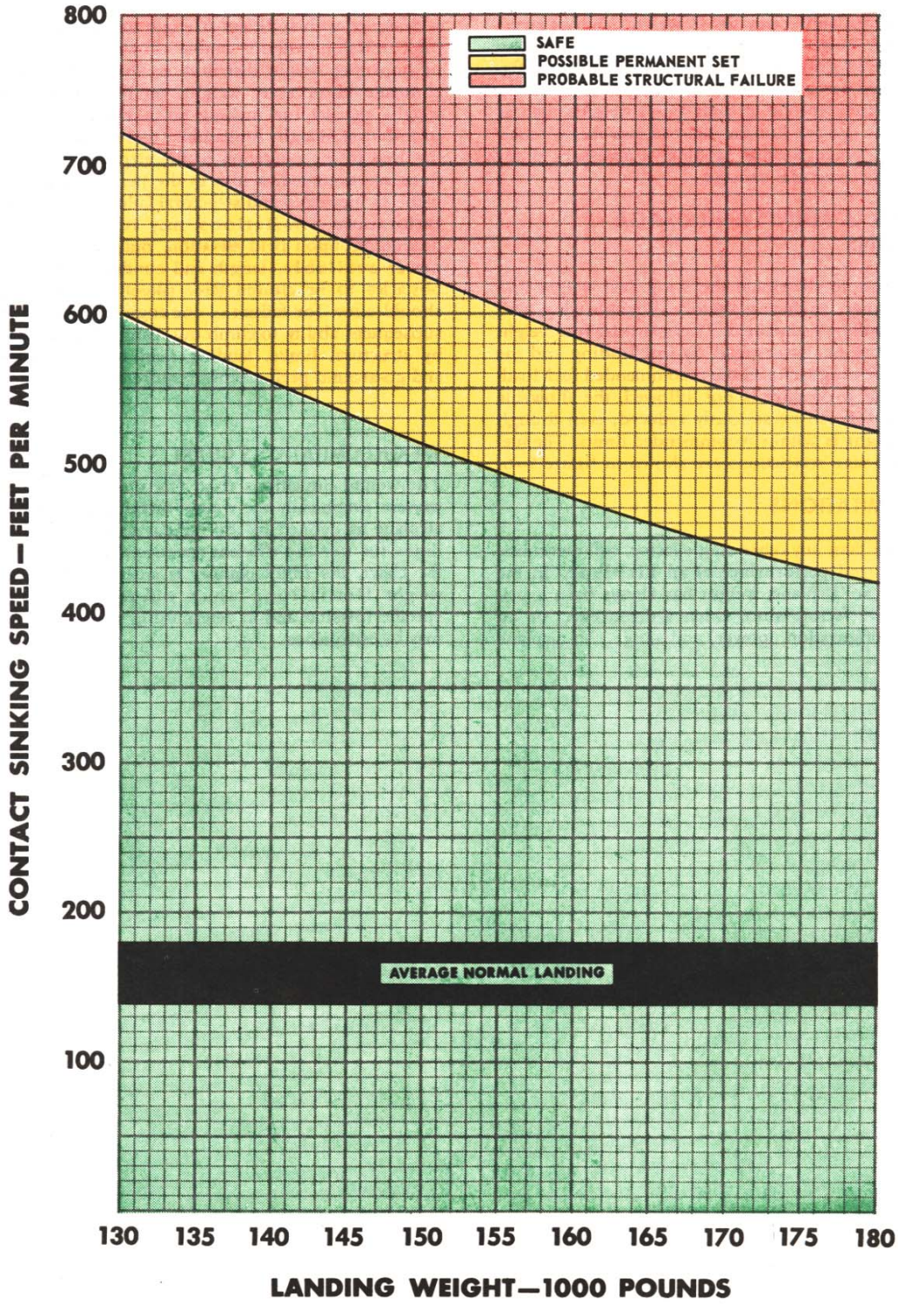
It is important to distribute the wing fuel weight in a spanwise manner, so that satisfactory allowable wing limit load factors will be maintained. This spanwise fuel-weight distribution can be governed by fuel loading and the usage from the wing tanks. If the recommended fuel loading and usage procedure is not followed, the allowable limit load factor can be seriously reduced, even though the gross weight is within recommended limits. The fuel loading and usage restrictions are shown in figure 5–6.

WEIGHT LIMITATIONS

Weight, more than any other single factor, will determine the capability and performance of an airplane. In the designing of an airplane, weight has always been a primary restrictive factor, since it has a direct effect on an airplane's configuration, power, and range. An airplane is designed with sufficient strength to accomplish a certain basic mission without undue allowance for overloading or improper weight distribution. Every effort is made to eliminate unnecessary weight; on the other hand, the weight penalty for making an airplane foolproof is prohibitive. Weight limitations, therefore, are necessarily involved in the operation of the airplane. If these limitations are exceeded, a loss in the performance of the airplane is inevitable and structural failure is quite probable. Performance limitations may restrict takeoff weight depending upon field elevation, outside air temperature, power available, length and condition of runway, and obstacles to be cleared after takeoff. Normal operation should allow for failure of one engine during takeoff and subsequent ability to climb out. Landing weight is limited by structural limits, landing field length requirements, and go-around performance requirements.

WEIGHT LIMITATIONS CHART

The weight limitations chart (figure 5–7) is intended to present graphically the weight-carrying capabilities of the airplane as defined by the various criteria which provide limits for safe and efficient operation. Through the use of the chart, the flight planner is aided in recognizing the weight limitations which will restrict operation in a specific mission and in determining what margin of safety may be established.



HIGH GROSS WEIGHT LANDING CHART

Figure 5–5

	FUSELAGE LOADING FOR 100,000 POUNDS OPERATING WEIGHT EMPTY (POUNDS) (2) (3)	AIRPLANE GROSS WEIGHT (POUNDS)	FUEL LOADING RESTRICTIONS (6)	FUEL USAGE SEQUENCE (1)
RECOMMENDED LOADING ALLOWABLE LIMIT LOAD FACTOR IS 2.5 OR GREATER (5)	UP TO 34,100	UP TO 153,000	EQUAL FUEL DISTRIBUTION (ALTERNATE) Fuel in tanks 1 and 4 must be equal to or greater than fuel in tanks 2 and 3.	1 USE CENTER WING TANK (4) 2 USE MAIN WING TANK (4) Fuel in tanks 1 and 4 must always be equal to or greater than fuel in tanks 2 and 3.
	UP TO 38,100	UP TO 153,000	UNEQUAL FUEL DISTRIBUTION (OPTIMUM) Not over 1200 pounds (200 gallons) each in tanks 2 and 3 unless tanks 1 and 4 are full.	1 USE CENTER WING TANK (4) 2 USE OF MAIN TANKS (4) For weight limitations with optimum flight limit load factors (figure 5–7), use fuel in tanks 2 and 3 until 1200 pounds (200 gallons) remain in each; then use fuel in tanks 1 and 4.
ALLOWABLE LIMIT LOAD FACTOR IS LESS THAN 2.5	OVER 38,100	All gross weights within the yellow cautionary range of weight limitations chart, figure 5-7.		

NOTE:

(1) For landing gross weights see figure 5–5.

(2) Fuselage load includes weight of center wing tank fuel and air refueling rank fuel or cargo. Fuselage loading must be corrected for operating weight empty.

(3) Refer to Manual of Weight and Balance Data, T.O. 1-1B-40, for additional weights, restrictions, and limitations.

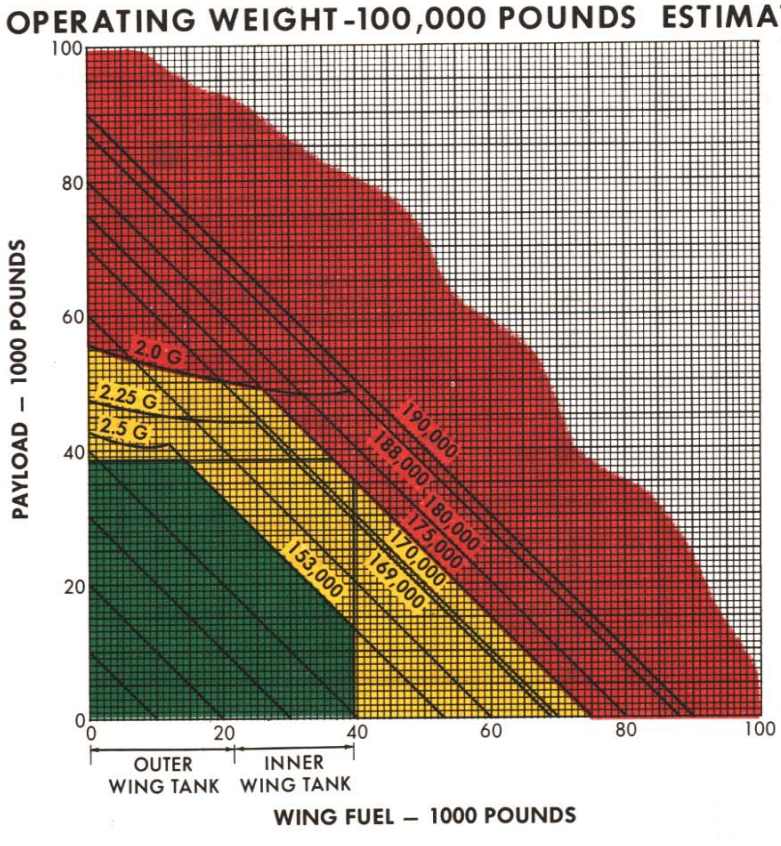
(4) Use fuel in center wing tank as soon as possible, except when loaded with air refueling fuel.

(5) Compliance with this chart is recommended to maintain 2.5 allowable limit load factors within the range of maximum design weights or to maintain the highest possible limit load factors for alternate weights.

(6) A/R fuel must be evently distributed between forward and aft tank sets.

FUEL LOADING AND USAGE RESTRICTIONS

Figure 5–6



RECOMMENDED LOADING

CAUTIONARY LOADING – OPERATE AT THESE WEIGHTS ONLY WHEN A HIGH GROSS WEIGHT MISSION IS NECESSARY OR THE AIRPLANE MAY BE SAFELY OPERATED IF FLOWN WITH CAUTION ESPECIALLY WHEN MAKING TURNS OR PULL OUTS OR FLYING THROUGH TURBULENT AIR.

LOADING NOT RECOMMENDED – AIRPLANE SHOULD BE OPERATED IN THIS RANGE ONLY UNDER CONDITIONS OF EXTREME EMERGENCY

OPTIMUM FLIGHT LIMIT LOAD FACTORS

GROSS WEIGHT CONDITIONS:

STRUCTURAL LIMITS

188,000 LB Allowable flight limit load factor is 2.0 g (with payload equal to or less than 55,700 LB).
175,000 LB Allowable landing gear limit load factor is 2.0g.
169,000 LB Allowable flight limit load factor is 2.25g (with payload equal to or less than 47,200 LB).
153,000 LB Allowable flight limit load factor is 2.50g (with payload equal to or less than 42,300 LB).
130,000 LB Allowable limit landing sinking speed is 10 fps.

WEIGHT LIMITATIONS CHART

Figure 5–7 (Sheet 1 of 2)

TAKEOFF PERFORMANCE

SIX-ENGINE OPERATION (JETS AT 100 PERCENT RPM)

No takeoff performance weight limitations on the loss of either one jet or one reciprocating engine.

FOUR-ENGINE OPERATION (JETS INOPERATIVE)

178,000 LB 8000 feet takeoff ground run, sea level, standard day (3500 bhp per engine).
167,000 LB In 10,000 feet distance takeoff, climb to 50 feet and accelerate to a speed which allows 100 fpm rate of climb with one reciprocating engine inoperative, propeller feathered, gear up, flaps set for takeoff; sea level, hot day, 3380 bhp per engine.

FLIGHT PERFORMANCE

SIX-ENGINE OPERATION (JETS AT 100 PERCENT OR 98.1 PERCENT RPM AS APPLICABLE)

No flight performance weight limitations.

FOUR-ENGINE OPERATION (JETS INOPERATIVE)

190,000 LB 100 fpm rate of climb, sea level, standard day, one reciprocating engine inoperative, propeller feathered, gear up, flaps up, maximum power (3500 bhp per engine).
161,500 LB 500 fpm rate of climb, sea level, hot day, all reciprocating engines operating, gear up, flaps up, METO power.
154,000 LB Long range cruise capability of pressure altitude of 5000 feet,70 percent of METO power, hot day.

PAYLOAD CONDITIONS:

38,100 LB Design fuselage payload (includes center wing tank fuel).
47,800 LB Fuselage payload (includes center wing tank fuel); maximum allowable flight limit load factor is 2.25g.
55,700 LB Fuselage payload (includes center wing tank fuel); maximum allowable flight limit load factor is 2.0g.

Figure 5–7 (Sheet 2 of 2)

SECTION VI
FLIGHT CHARACTERISTICS

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CHARACTERISTICS

The flight characteristics are excellent for a heavy airplane. Maneuvering and control of the airplane does not require undue force by the pilot. The airplane is very stable and trims out very easily. Up to four units of opposite aileron trim may be required for some off-center fuel loadings, which may be rolled in easily during takeoff and climbout. Only small changes in trim are required for normal operation to maintain the desired airplane attitude. Rudder control is excellent with the rudder boost switch ON. Response to power changes is immediate and very positive.

STALLS

The stall characteristics of the airplane are good. Recovery from stalls should present no problem to the average pilot, providing the recommended recovery procedures are followed and the proper precautions are observed. The stalling speed increases with the angle of bank as shown in the stall speed chart, figure 6–1; therefore, care must be exercised in banking the airplane at low airspeeds or with a nose-high attitude.

Note

During stalls, at a medium gross weight, the airplane can be expected to lose at least 750 feet of altitude before being returned to level flight, if the proper recovery procedures are begun immediately after the complete stall has been reached.

STALL WARNING

Warning of the impending power-on or power-off stall comes in the form of a comparatively mild buffeting of the horizontal stabilizer and elevator and occasional light buffeting of the ailerons. Severity of the buffeting increases as the complete stall is approached. With flaps up, the warning begins approximately 17 knots above the stall; with flaps down, buffeting begins approximately 6 knots above stall speed. The buffeting range is reduced as the angle of bank is increased. Accelerated stalls give the same warnings as the normal stall, but impose much heavier strains on the airplane, and, at higher gross weights, may result in structural damage.

CAUTION

Should stall warning occur during flight, act immediately to avoid completely stalling the airplane. If in level flight, increase the airspeed; in a turn decrease the angle of bank.

IN THE STALL

At the full and complete stall, if a rapid roll occurs, the control wheel might momentarily move hard over, placing the ailerons in their maximum travel position, and remain there until flying speed is regained. A reversal of elevator force may take place during a complete stall, but the force tending to keep the control column back is usually comparatively light and should present no problem to the pilot in pushing the control column forward to recover from the stall. However, with deliberate attempt by the pilot to obtain a very high angle of attack, and under an abnormal combination of conditions, such as a rearward CG position, power on the engines, and wing flaps up, it might be possible to encounter a somewhat high elevator force reversal, which would require considerable force by the pilot to push the control column forward during stall recovery. A combination of these conditions, which might induce a high elevator force, is considered to be far out of the normal operating range. The boom in the stowed or unstowed position does not affect the stall characteristics. However, stalls should be avoided with the boom unstowed, due to the danger of it snapping

CONDITION		WING FLAPS UP			WING FLAPS 33 PERCENT			WING FLAPS 55 PERCENT			WING FLAPS 100 PERCENT		
BANK ANGLE DEGREES		0	30	45	0	30	45	0	30	45	0	30	45
ACTUAL GROSS WEIGHT —POUNDS	180,000	146	157	173	136	146	162	126	135	150	117	126	139
	160,000	138	147	163	128	138	152	119	128	142	111	119	131
	140,000	128	137	152	120	128	142	111	120	132	103	111	123
	120,000	118	127	140	111	119	132	103	111	122	96	103	114
	100,000	108	116	129	101	109	120	95	102	113	88	94	104

LANDING GEAR DOWN

REMARKS:
1. For stall speeds with landing gear up, subtract 1 knot for zero bank angle and subtract 2 knots for bank angles of 30 and 45 degrees.
2. Power will lower stall airspeeds up to 5 knots.
3. Due to rapid changes in airspeed position correction at speeds below moderate buffet, the indicate airspeed will tend to remain constant even though the airplane is approaching the stalling speed.

POWER-OFF STALLING SPEEDS (INDICATED AIRSPEED-KNOTS)

Figure 6–1

up into the fuselage. Normally no abrupt rolling action either precedes or accompanies a power-off or low power-on stall. However, as in the case of most four-engine airplanes, stalls encountered with unsymmetrical or high power on the engines will result in an abrupt roll either just before or at the stall.

WARNING

Never use power and a nose-high approach to reduce the landing speed, except when required in emergency procedures. Under these conditions, sufficient power should be used to maintain a safe airspeed above the stall warning speed.

The ailerons are effective up to the point of stall. Use of the ailerons in the stall will not aggravate the stall as is experienced in some types of airplanes. With boost on, rudder control is effective through the stall range with all engines operating. With inoperative engine(s), minimum directional control speed may exceed the stall speed for some gross weights. With boost off, rudder control is similar to that of large airplanes with conventional or unboosted controls.

STALL RECOVERY

When the airplane is stalled, recovery should always be made by nosing the airplane down sufficiently to regain flying speed with minimum loss of altitude. In general, recovery from stalls at safe altitudes with low cruise powers should be made by leaving the power unchanged, or by closing the throttles if serious difficulty is encountered. If the airplane is stalled with a large amount of power on, the power should be chopped immediately to prevent roll and an excessive loss of altitude during recovery. A stall with unbalanced power could cause a rapid roll; under this condition, the power should be chopped immediately. If power is required for recovery, use symmetrical power. Only at lower altitudes, when recovery with a safe altitude margin is questionable, should power be applied during recovery. Avoid excess airspeeds, abrupt pull-outs, and rough handling of controls during recovery; any or all may result in an accelerated secondary stall.

PRACTICE STALLS

For both power-off and power-on stalls, set propellers at 2000 rpm. For power-on stalls, set throttles at 30 inches MP; power-off stalls, 20 inches MP. Monitor CHT closely during extended stall practice, since low airspeeds and turbulent airflow will hinder proper engine cooling. Practice all stalls with and without rudder boost operating. Conduct all stall practice at least 5000 feet above terrain altitude. To further reduce excessive structural stresses which may be imposed during recovery from a complete stall, it is recommended that the airplane not be stalled completely when practicing stalls. It is necessary only to note the stall warning feel and the airspeeds at which they occur for each configuration.

WARNING

Stall characteristics are greatly affected by CG position and gross weight. Do not practice stalls when the CG is near the aft limit, or when the gross weight is over 120,000 pounds.

To become completely familiar with the stalling characteristics of the airplane, practice stalls may be made with the wing flaps up, wing flaps full or partially down, landing gear up, landing gear down, power on, power off, or any combination of the above configurations. When making power-on stalls, avoid abrupt pull-outs. To minimize rolling tendencies, avoid excessively nose-high attitudes during the approach to the stall. Since the rolling tendency is most pronounced in a turn, it is recommended that all stall practice be conducted straight ahead. Stalls may be practiced up to the buffeting point, under engine inoperative conditions, if the principle of maintaining trim by reduction of power on the operating engines is observed. Approaches to the stall with unsymmetrical power may result in abrupt rolling tendencies, so care should be exercised in this practice maneuver.

SPINS

Spins are one of the prohibited maneuvers and must never be done intentionally. However, in case a spin is entered accidentally, if any power is on, throttles should be chopped immediately. Do not attempt to raise landing gear and wing flaps if they are down when the spin is entered. Use normal recovery procedure to stop rotation and regain level flight. Avoid abrupt pull-outs and the possibility of a secondary stall.

FLIGHT CONTROLS

The flight controls enable the airplane to be controlled without undue effort by the pilot under any reasonable load, flap, and power combination. No unusual reactions of any controls will be experienced, except for possible light elevator reversal during power-on stalls. The rudder is effective with or without rudder boost on; however, with rudder boost off, considerably higher rudder pedal forces will be required. Wing flap position changes have little effect on the trim requirements of the airplane, since the left-hand elevator tab is used to provide automatic trimming during changes in flap position. Trim requirements on all controls are slight during normal operation of the airplane. To properly trim, set up the flight attitude, power, and airspeed desired; relieve all elevator pressure first, then rudder pressure, and finally aileron pressure. Minimize the use of aileron trim; use it only when elevator and rudder trim are not completely effective.

WARNING

Use of excessive trim during letdowns or approaches is dangerous, since power changes result in high control forces until the airplane is retrimmed.

LEVEL FLIGHT CHARACTERISTICS

SLOW FLYING

No control abnormalities will be discovered during low speed flight. Maintain a close watch on engine CHT due to poor cooling air flow and be alert for possible engine malfunction, since engine failure during low speed flight will result in a dangerous condition. Turns at low speeds are critical and controls should be well-coordinated at all times.

CRUISING FLIGHT

No control or other flight peculiarities are evident during cruising flight. Avoid abrupt control movements at all times. Lowering the landing gear will increase the airplane drag and should be accompanied by a symmetrical increase in power to counteract this effect. Slight nose-up trim will also be required. Wing flap position will have little effect on trim, but will greatly increase the airplane drag when between the 55 and 100 percent down positions. Oil cooler flap, intercooler flap, and cowl flap positions affect airplane performance, resulting in a loss of airspeed when open. Cowl flap drag is very apparent and unsymmetrical cowl flap operation will require changes in airplane trim. Cowl flap opening in flight is limited to a maximum of 3 inches due to excessive buffeting at larger openings. Lowering the A/R boom will slow the airplane down about 5 knots and cause a slight nose heaviness. Some trim and additional power will be required to return the airplane to the boom stowed flight condition.

DIVING

Diving is prohibited. If the airplane inadvertently enters a dive, extreme caution should be used during recovery when at or near the limiting airspeed. Avoid abrupt pull-outs at any time.

WARNING

The high Mach number characteristics of the airplane are poor. Caution should be observed to avoid exceeding 0.55 Mach. This speed is easily reached in descent from high altitude. If 0.58 Mach is reached, a large sudden nose-down trim change will occur together with increased elevator force gradient, and a decrease in elevator power. There will also be moderate aileron snatch. Recovery should be made by reducing jet engine power to idle, reciprocating engine power to minimum, and applying up elevator.

BUFFETING

Buffeting from various causes can result in considerable control difficulty accompanied by severe airplane vibration. Some of the causes of buffeting which may occur during normal flight are:

a. Damage to wing leading edge, including loose or missing leading edge gap seals.

b. Parts of cowling loose, damaged, or missing.

c. Excessive cowl flap openings, or missing cowl flaps.

d. Windmilling propeller.

e. Objects lodged against wing leading edge.

f. Body damage or hatches open in the region of the wing upper surface.

If buffeting is experienced on takeoff, the cowl flap settings should be checked immediately, since leaving the cowl flaps open more than 3 inches will materially reduce takeoff performance and control effectiveness upon retraction of wing flaps. If, upon retraction of wing flaps, the buffeting increases, advisability of abandoning the airplane should be considered, since the damage is probably not limited to the wing leading edge, cowling area, or both.

Note

If severe tail buffeting is experienced on takeoff, do not hesitate to maintain maximum or emergency power. High power settings have not been known to increase the severity of tail buffeting, and the vibration is not of the frequency or magnitude to cause immediate failure of any primary structure essential to continued flight.

In the cruise configuration, buffeting from these causes is not usually confined to the wing alone. The empennage is usually affected in proportion to the severity of the turbulence, due to the airflow into the region of the horizontal tail surfaces. Tail buffeting can occur from disturbances as far outboard as the outboard nacelles. Severe tail buffeting is usually accompanied by loss of elevator effectiveness and severe airplane vibration. However, the vibration is not of a frequency or magnitude which will cause immediate failure of any primary structure essential to continued flight of the airplane. The following procedures are recommended to improve the flying characteristics sufficiently to allow a safe landing to be made.

a. Maintaining a speed between 155 and 175 knots will usually result in a minimum buffeting effect with flaps up, since decreasing speed will lower the tail further into the turbulence and increasing the speed will increase the degree of turbulence. However, each situation is different. Try all speeds within the speed range, in combination with flaps as in step b, until buffeting is sufficiently reduced. High power settings may be used to maintain the required airspeed, as even emergency power has not been known to increase the severity of tail buffeting. Furthermore, any yawing tendency of the airplane should be held to a minimum by utilization of even full rudder. Rudder boost should be on.

b. Lowering the wing flaps increases the downwash and raises the tail. In many cases this will result in a very effective reduction in buffeting. Usually 10 to 20 percent of wing flaps is sufficient to eliminate all but extremely severe buffeting, but more may be required. In some cases, this may even reduce the turbulent drag and improve performance. With sufficient flap extension to eliminate buffeting, elevator control effectiveness will usually return to normal. In a particular case, if buffeting is not reduced with flap extension, the flaps should be retracted to minimize performance losses. In very severe cases and where the extent of damage is not known, it is advisable, before landing is attempted, to check control of the landing configuration to be sure that both elevator and aileron control are adequate.

WARNING

If the buffeting increases when the flaps are lowered, and retraction to the previous flap setting does not improve the condition, an immediate decision should be made regarding the advisability of abandoning the airplane, since the damage is probably not limited to the wing leading edge or the engine cowling.

SECTION VII
SYSTEMS OPERATION
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ENGINE

OPERATING CONSIDERATIONS

Engine Ratings

Engine ratings, or the restrictions placed on engine operation, must be one of the primary concerns of the pilot and engineer. It is possible to operate the engine under conditions which exceed the limits set by the ratings. Failure to observe cylinder head or oil temperature limits, or operation without proper regard to oil and fuel pressures or to fuel-air ratio, will create a situation that can only lead to lowered reliability and possible engine failure. The basic engine operating problem consists of combining engine rpm and cylinder pressure in order to obtain power. The way in which these two factors are combined, together with the maintenance of suitable conditions of cooling, lubrication, and mixture strength, determines the efficiency of operation and the length of time between engine overhauls.

Performance Data And Charts

The performance data and charts have been developed primarily to obtain long range operation using optimum engine performance. The operating limits shown are those above which an unacceptable rate of engine failures would be experienced. More conservative operation will increase engine life. Experience indicates that engine operating temperature is one of the prime factors governing engine operation. Examination of figure 7–1 will show the relationship between brake horsepower and exhaust gas temperature, as influenced by mixture ratio. Exhaust gas temperature is closely related to CHT, since it is a direct measure of the conditions in the cylinder. High EGT will result in excessive valve, exhaust system, and turbosupercharger operating temperatures.

Engine Cooling

CAUTION

Gradual power reductions should be made to prevent sudden decrease in cylinder head temperatures. Failure of exhaust valve seats may result from sudden changes in cylinder head temperatures.

In figure 7–1 the dropoff in temperature at lower powers is due to the lower energy (heat) being developed per unit of time than at higher powers. The high power dropoff is due to the cooling effect of the excess fuel added by the power enrichment valves of the carburetor. It will be noted that operation with the mixture control in auto lean detent results in the hottest condition under all power ranges. Auto rich operation results in an EGT 22° to 52°C lower than auto lean. Manual leaning provides a slightly cooler operation than auto lean. Figure 7–1 indicates that for lowered engine cooling requirements, engine operation throughout its power range should be as follows:

a. Below 1850 BHP, mixture as required.

b. 1850 to 2050 BHP, auto rich required.

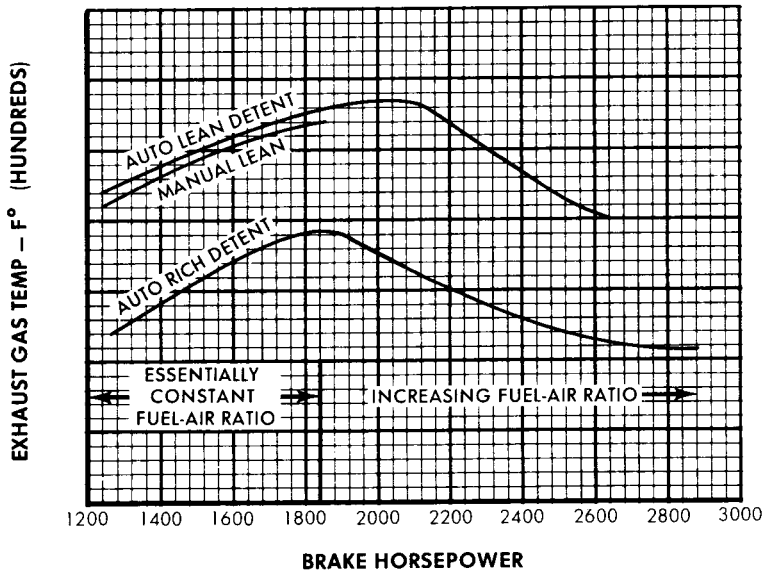
c. Above 2050 BHP, (for maximum range) auto lean; (for improved engine durability) auto rich.

The decision of the limits and type of operation to be employed should be made in advance to fill the requirements of the mission and provide the greatest economy of airplane operation.

STARTING

Causes Of Hydraulic Lock

An engine which has not been shut down properly will retain an excess of oil in the crankcase due to failure of



EXHAUST GAS TEMPERATURE VS BRAKE HORSEPOWER

Figure 7–1

the scavenge pumps to remove all the oil satisfactorily. When the engine is not running, this oil may collect in the lower cylinders. Similarly, overpriming will cause excess fuel to flow into the combustion chambers of the lower cylinders. With liquid in the combustion chamber, the compression ratio will be raised, causing extremely high pressure in the cylinder when the engine is turned over. In extreme cases, the piston may actually bottom against the imcompressible liquid. In either case, it is possible that the cylinder head, piston, or connecting rod may be damaged.

Procedure To Clear And Lubricate Engine

To clear fluid from the cylinders and the lower induction system, and to provide sufficient lubrication of the engine and reduction gear bearings, turn the engine over continuously with the starter for 20 blades. Hydraulic lock should show during the first two revolutions (eight blades) of the engine, as each cylinder is then exposed to a compression stroke. At any sign of hesitation or stoppage, disengage the starter, turn off the fuel boost pump, and investigate. Only eight blades continuous cranking is required for engine starts made within 1 hour of the last shutdown, as the engine is still well-lubricated.

CAUTION

If, during cranking of the engine, there is evidence of hydraulic lock, release the starter switch immediately and investigate.

Procedure For Starting

The priming system feeds fuel into the induction system below the carburetor to provide a rich mixture for the initial firing charge; however, the ignition must be on before priming. As the engine is being turned over by the starter, more air is introduced, leaning out the mixture until spark ignition occurs. The amount of priming to be used during this phase depends upon carburetor air temperature, oil temperature, and cylinder head temperature.

If the engine does not fire in a reasonable time (5 to 10 seconds), discontinue priming but continue cranking, since the mixture in the cylinders was probably too rich for starting. As the engine is further cranked without prime, the excess of air will provide the proper mixture using the fuel already in the manifold, and the engine should start. When the engine starts, use prime as required to bring engine rpm up to 1000. Slowly ease the mixture control out of FUEL CUTOFF to the AUTO RICH position and discontinue priming when rpm begins to fall off. It may be 2 to 5 seconds before the rpm begins to fall off, especially if the engine is hot, because of vapor lock. Too early or too rapid movement out of the FUEL CUTOFF position may drown out the engine due to a surge of fuel. If the engine tends to become overloaded, it may often be saved by momentarily returning the mixture control to FUEL CUTOFF. Do not attempt to assist the start by pumping the throttle. Flooding of the engine, torching, and afterburning may result. When starting a hot engine after the preliminary crank-through has been completed, begin cranking with the ignition switch on, without prime, since there may already be a suitable starting mixture available in the manifold. If the engine does not start, it is probably because the mixture is too lean. Apply prime for 2 seconds while cranking. This will enrich the mixture and, with further cranking, will most likely give a good start. If the engine fails to start after using the above procedures, it is probably because the mixture is too rich; therefore,

discontinue priming. If engine does not start after cranking 5 to 10 blades, repeat the above procedure.

Throttle Position After Starting

Smooth operation after starting depends upon the throttle position. On this engine, the carburetor furnishes fuel for idling entirely as a result of the position of the idle valve, which is directly linked to the throttle. Air flow has no appreciable effect on the quantity of fuel discharged. If the throttle is opened too wide, the mixture will be too lean, resulting in backfiring. With the throttle retarded too much, the mixture will be too rich for continued running.

WARMUP AND GROUND TEST

Warmup

The engines should be operated on the ground only as necessary for warmup, preflight check, and taxiing. Operating time should be held to a minimum. Use of auto lean will not accelerate the warmup. At warmup speed, there is practically no difference in the mixture supplied to the engine, whether the mixture control is in the AUTO LEAN or AUTO RICH position, since metering in this power range is governed by the throttle position. Do not fully close the cowl flaps to accelerate the warmup, regardless of OAT or the cylinder head temperature indication, because heat from the exhaust system can cause damage to the ignition leads. The engines must not be operated within the critical rpm range of the propellers, except to pass through this range. If an excessive amount of dust is present, sheltered air should be used, when possible, to aid in filtering dust particles from the inlet air. At first indication of spark plug fouling, as evidenced by erratic torque indication, magneto drop, backfiring, or ignition analyzer patterns, clean spark plugs as outlined in DEFOULING PROCEDURES ON THE GROUND, this section.

Preflight Engine Check

The PREFLIGHT ENGINE CHECK, outlined in Section II, is for the purpose of answering the following questions before a takeoff is attempted:

a. Is the engine in proper mechanical condition?

b. Is the oil system functioning properly?

c. Is the ignition system functioning properly?

d. Is the fuel system delivering fuel to the engine in the required amounts at the desired pressure?

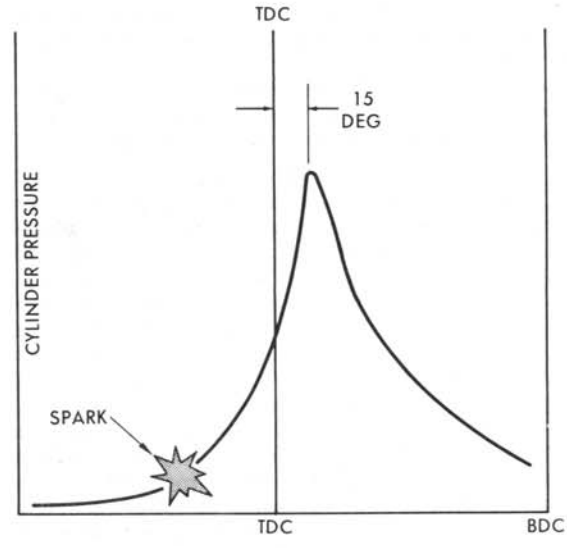
e. Is the propeller system functioning properly?

f. Are engine instruments reliable?

Close adherence to the preflight engine check procedure will answer all the above questions.

TAKEOFF

Due to the high energy output of the engine at maximum power, cooling is critical and engine wear is at a maximum. Every effort must be made to observe engine temperature limits at the start of takeoff. Full power should be used to insure a safe takeoff with ample climb airspeed and height above obstacles before the first power reduction. However, maximum power should not be extended unnecessarily because of the above mentioned effects.



CYLINDER PRESSURE VARIATION

Figure 7–2

CLIMB

Climb performance for METO power is shown in the Appendix, T. O. 1C-97(K)L-1-1.

CRUISING FLIGHT

During normal flight operations, the engine should be operated at power settings obtained from the data in the Appendix, T. O. 1C-97(K)L-1-1. The Appendix charts give optimum performance data, taking into consideration all the factors which influence engine operation. Proper selection of power settings will result in long range operation of the airplane. This is obtained by using the manual leaning procedures outlined in MANUAL LEAN FUEL CONTROL, this section. However, this procedure cannot be used above specified brake horsepowers, as internal damage to the engine from overheating or detonation may result. Adherence to specified operating limits of cylinder head temperature and carburetor air temperature is necessary if suitable performance is to be obtained. The engineer should be alert to notice any indication of spark plug fouling, as evidenced by erratic torque pressure indication or ignition analyzer pattern, and take immediate corrective action. The engineer can control the mixture, manifold pressure,

rpm, carburetor air temperature, and cylinder head temperature. These controllable factors have an effect upon the charge density, flame speed, and rate of air flow through the engine. Engine performance is limited by three main considerations: engine temperature limits, propeller efficiency, and fixed position ignition.

In order to prolong the service life of an engine, it is necessary to specify the engine rpm settings for various brake horsepowers in the power range which is affected by the inflight propeller restriction of 2100 to 2350 rpm; to prescribe mixture control settings for various cruise powers and cylinder head temperatures; and to correlate cruise and climb cylinder head temperature limits with cowl flap settings. Therefore, the in-flight engine rpm restriction between 2100 and 2350 rpm makes it necessary to operate at higher than the normal 150 BMEP for powers between 1735 and 1900 BHP at 2100 rpm. This assures adequate gas loads on the pistons and protects the engine from possible master rod bearing failure. To avoid detonation in this range, careful attention must be paid to mixture setting, cylinder head temperature, and carburetor air temperature. Desired operating temperatures are considerably less than maximum allowable limits. By operating at or close to desired temperatures, detonation-free service is practically assured. The extended use of high BHP and CHT is known to contribute materially to the reduction of the service life of an engine. Mission planning can aid in reducing engine time at high power settings. A secondary climb to orbit altitude, after an initial cruise at some lower altitude, results in less total time at climb power than does a single climb to orbit altitude immediately after takeoff. Cruise power settings are lower at the lower altitudes and desired CHT's are more easily maintained. It has been determined that, in level flight, optimum CHT is approximately 230°C.

In order to accomplish the intent of the foregoing, it is recommended that the following be adhered to:

RPM And Mixture Settings

a. For power settings from 1735 to 1900 BHP, use 2100 rpm. For power settings above 1900 to 2050 BHP, use 2350 rpm.

b. When operating at 1850 BHP or below, auto lean or manual lean mixture settings are permissible if the CHT limit is not exceeded; otherwise, auto rich is required.

c. When operating at 2050 BHP and up to 2650 BHP in level flight, auto lean is permissible if the CHT limit is not exceeded; otherwise, auto rich is required.

d. When operating between 1850 and 2050 BHP, auto rich is required.

e. When operating with alternate grade fuel, auto rich is required for all power settings above 1735 BHP.

Cylinder Head Temperature Limits And Cowl Flap Settings. (See figure 7–5.)

a. A concentrated effort should be made to maintain CHT at or near 230°C in level flight at all power and mixture settings, if cowl flap opening does not exceed 1.5 inches.

b. Maximum CHT in level flight, at all power and mixture settings, is 243°C for cowl flap openings of 2 inches or less.

c. Maximum CHT in level flight, at powers up to and including 1850 BHP (70 percent METO), is 243°C for cowl flap openings of 2 to 3 inches.

d. Maximum CHT in level flight, at powers above 1850 BHP, is 255°C for cowl flap openings of 2 to 3 inches. Auto rich is required.

e. Maximum CHT in climb is 243°C for cowl flap openings of 2 inches or less and 170 knots IAS. Auto rich is required.

f. Maximum CHT in climb is 255°C for cowl flap openings of 2 to 2.5 inches and 170 knots IAS. Auto rich is required.

g. If the CHT on one or more engines cannot be maintained at 255°C in climb by opening cowl flaps 2.5 to 3 inches, increase airspeed as required up to 180 knots IAS to maintain 255°C. Auto rich is required. Never allow CHT's to exceed 265°C.

h. Maximum CHT for three-engine climb is 265°C. Refer to the Appendix, T. O. 1C-97(K)L-1-1, for climb speed schedule and related Note.

Mission Planning

a. When mission requirements permit, plan the mission for initial cruise at as low an altitude as practicable, using a second climb to arrive at the orbit point and altitude.

b. When practicable, select cruise altitudes so that required power settings will be in the lean mixture range (1850 BHP or less).

c. It is recommended that the planned equivalent airspeeds for cruise and orbit not exceed the airspeeds shown by the "50 Knot Headwind" lines on the Nautical Miles Per Pound Fuel Charts. Refer to the Appendix, T. O. 1C-97(K)L-1-1.

Factors Which Influence Engine Operation

Ignition Timing. The amount of power derived from combustion of the fuel-air mixture in a cylinder depends upon many factors, among which is the ignition timing. To obtain the best power from any given charge, the spark must be timed so that the peak pressure in the cylinder occurs approximately 15 degrees past top dead center (figure 7–2). If this pressure is reached before the 15-degree point, too much of the useful work has

acted to oppose the rise of the piston to TDC. If the peak pressure is reached after this point, the piston has retreated too far into the cylinder, increasing the volume and reducing the peak pressure obtained. In both cases, power has been lost. Improper magneto timing may be suspected if an engine tends to run hot and develop less TPSI than the other engines when at equal power settings. This may be verified by use of the ignition analyzer.

Mixture. The carburetor measures the rate of air flow through the engine and adds fuel to this air in a given ratio. The mixture levers may be set in AUTO RICH, AUTO LEAN, or manual lean in accordance with the power schedules given in the Appendix, T. O. 1C-97(K)L-1-1. Mechanical tolerances may cause up to plus or minus 4 percent variation in the fuel-air ratio delivered by the carburetors.

Manifold Pressure. The manifold pressure is controlled by the throttle position and TBS lever setting. At sea level pressure, maximum manifold pressure can be obtained without turbo. The turbosupercharger can maintain desired manifold pressures at METO power, up to the altitude limits shown in figure 5–2.

RPM. The rpm can be controlled by either the automatic propeller synchronizing system or the propeller governor selector switches. (See figure 1–23.) Increasing the rpm increases the horsepower which the engine can develop, but is limited during cruise by propeller efficiency. The propeller develops thrust in the same manner that a wing develops lift. Therefore, there is an ideal propeller blade angle of attack, which is a function of the airspeed and the airplane gross weight.

Carburetor Air Temperature (CAT.). The CAT. can be partially controlled by use of the turbosupercharger and intercooler. However, the outside air temperature limits the minimum CAT. obtainable. CAT. has a primary effect upon the maximum charge density which can be obtained. Increase in the CAT. causes a reduction of the charge density. A high CAT. limits the horsepower avialable because of detonation and cylinder head temperature limits.

CAUTION

CAT. in excess of 50°C for any length of time may cause severe engine damage.

Cylinder Head Temperature (CHT). The CHT is primarily controlled by the cowl flap setting. Excessive CHT can cause rapid engine wear and severe engine damage.

Charge Density. Charge density is a measure of the amount of fuel and air contained within the cylinder prior to compression, and determines the maximum amount of energy available to the engine. Charge density varies inversely with the pressure altitude and inversely with the square root of the CAT. during unsupercharged operation. Turbo boost can maintain the charge density at a constant value within altitude and temperature limits of the engine. The fuel-air ratio, CAT., and CHT limit the maximum usable charge density.

Flame Speed. Flame speed is a function of the charge density, charge temperature, and fuel-air ratio. High charge density causes high flame speed because the fuel and air molecules are packed closely together. High charge temperature causes high flame speed because less heat is needed to ignite successive fuel and air molecules. The relation between fuel-air ratio and flame speed is not so simple. The maximum flame speed will occur at a fuel-air ratio of approximately 0.077. Leaning the mixture below this value reduces flame speed because of the shortage of fuel molecules. Enriching the mixture above this value reduces the flame speed because of the shortage of air molecules. Mixture is the most positive control for adjusting the flame speed.

Rate Of Air Flow. The rate of air flow through the engine is controlled by the charge density and rpm. Use of turbo boost when the throttle is retarded or use of sheltered air causes losses, which will reduce the rate of air flow for given conditions. Brake horsepower is proportional to the rate of air flow through the engine.

Outside Air Temperature (OAT). The spacing between air molecules increases as the temperature increases. This limits the charge density. The OAT also limits the minimum CAT. obtainable and the minimum cowl flap setting.

Humidity. Warm air can hold more water vapor than cold air. The water vapor takes up space and reduces the charge density. The water vapor does not help to internally cool the engine, as in water injection. Water injection cools the engine because the injected water droplets absorb 1000 times as much heat as the same weight of water vapor. The humidity will also affect the actual fuel-air ratio. The water vapor affects the fuel metering in the same manner that dry air does, so that the carburetor actually meters a fuel-to-air plus water vapor ratio which makes the actual fuel-air ratio rich.

Manual Lean Fuel Control

As illustrated in figure 7–1, high exhaust gas temperatures result from auto lean mixtures. Where possible, high power auto rich operation is preferred. The procedure for entering manual lean fuel control is shown in figure 7–3.

Power Adjustment

Once the mixture adjustment is established, minor power adjustments may be made with the throttle (1 inch MP maximum), and larger adjustments by changing rpm (100 rpm maximum) within the range of 1900 to 2100 rpm. No change in mixture adjustment should be made for these minor power changes, as the carburetor will act to maintain constant fuel-air ratio in this region. Auto rich mixture is required at 2100 and 2350 rpm between 1850 and 2050 BHP.

Plug Fouling Tendencies

To minimize spark plug fouling, return to AUTO RICH for 2 minutes each hour at cruise powers. Flight engineers should be alert for erratic torque as the first indication of spark plug fouling. Use the spark plug defouling procedure described in this section as often as necessary.

STEP PROCEDURE	EXPLANATORY NOTES
1 Set all engines at the desired cruise power with the mixture control lever at AUTO RICH.	1 Make all preliminary settings at this point prior to starting the leaning procedure.
a. Allow air speed to stabilize.	
b. Adjust cowl flaps to set approximately 230°C CHT.	(b)(c) Although limits of 243°C CHT and 38°C CAT. are allowed for cruise, 230°C CHT and 20°C CAT. will give a safer margin between critical points of the procedure and the engine detonation limit.
c. Adjust intercooler flaps to set approximately 20°C CAT.	
d. Adjust TBS for cabin air flow and part throttle as required.	(d) Since the following steps specify that power advance be accomplished by use of the throttle on one engine at a time, sufficient part throttle should be established to allow a 4-inch MP rise. This will usually be obtained by setting the TBS lever for desired cabin air flow at altitude, or by retarding throttle at the end of METO power climb.
e. Check MP reading within 2 inches Hg of those specified by the power schedule charts in the Appendix, corrected for CAT. If desired torque cannot be obtained within 2 inches MP of the schedule, record the resulting torque as the base setting for use during the procedure. A low power engine should be monitored carefully.	(e) If an engine is low in power, spark plug fouling should be checked with the ignition analyzer and, if necessary, cleared in accordance with the spark plug defouling procedure in this section. Abnormally rich or lean carburetors may also cause low engine power; therefore, check fuel flow. If desired torque cannot be obtained, it is necessary to limit the base torque to observe MP not over 2-inch Hg above the schedule, since increasing MP further may cause detonation.
The following steps should be accomplished on one engine at a time until desired cruise mixture is established in Step 4 or 6.	
2 Set 109% base torque with the throttle and note cooling is within limits.	2 Base torque was established in step 1 and will be 158 TPSI or less depending upon MP limits (109% of 158 is 172).
3 Establish best power mixture by slowly moving the mixture control lever from AUTO RICH 1 inch of lever movement (one knob width) while carefully observing TPSI.	3 This observation of TPSI should be made while leaning one knob width. One knob width is equivalent to 50 pounds per hour fuel flow. If leaned too far, TPSI will always drop, giving an erroneous indication of carburetor metering. Fuel flow should be noted before and after leaning as a check on the amount of mixture control lever travel required.
CASE I. NORMAL CARBURETOR	If TPSI remains constant, AUTO RICH is best power.
	a. Proceed with step 4 below.
CASE II. RICH CARBURETOR	If TPSI rises, then AUTO RICH is richer than best power.
	a. Adjust mixture control lever to point of highest TPSI. b. Retard throttle to reestablish 109% of base torque. c. Proceed with step 4 below.
CASE III. LEAN CARBURETOR	If TPSI drops rapidly, AUTO RICH is leaner than best power.
	a. Hold primer switch in to apply prime. b. Immediately adjust mixture control lever to point of highest TPSI. c. Retard throttle to reestablish 109% of base torque. d. Return mixture control lever to AUTO RICH. e. Release primer switch and proceed with step 4 below.
4 Manually lean the mixture with the mixture control lever until base torque has been accurately established.	

NOTE:
If sluggish torquemeter response is noted in steps 2 and 4 (due to low temperature causing oil congealing), all attempts to employ manual mixture control should be abondoned. Return to AUTO RICH or AUTO LEAN setting until warmer air has restored torquemeter sensitivity.

MANUAL LEAN FUEL CONTROL

Figure 7–3 (Sheet 1 of 2)

The mixture setting now established is the engine best economy mixture. Cruising at this mixture position may be accomplished by adjusting power and cooling as noted in step 7 below. If operation at this point is desired, 1 inch MP should be subtracted from the spark advance values given in the Appendix power schedule curves to obtain correct MP limits. For greater overall airplane cruise performance due to a decrease in cooling drag during strategic missions, continue the procedure with steps 5 and 6 below. In this case, note the position of the mixture control lever as established in step 5 as a reference position to aid in rough operation adjustment as described below.

❺ Increase manifold pressure 1 inch Hg with the throttle.	❺ Accomplish this step smoothly and accurately, since end mixture is dependent on the measured rise.
❻ Lean the mixture further with the mixture control lever until base TPSI has been accurately restored	❻ The accuracy of the end mixture depends upon accurate reading of the base TPSI. See step 5 above.

Maximum range cruise mixture setting has now been established on one engine. Repeat steps 2 through 6 for the remaining engines

❼ Final cruise settings. a. Adjust cowl flaps so that the CHT will not exceed 243°C. b. Adjust intercooler flaps to give 20° to 38°C CAT. c. Adjust TBS lever for cabin air flow as desired and set throttles to avoid excessive part throttle operation. d. Check manifold pressure spread on all engines to agree within 2 inches Hg.	❼ (a)(b) If difficulty in cooling any engine is noted and mixture control lever position and fuel flow indicate a rich mixture, repeat steps 2 through 6. If satisfactory cooling still cannot be obtained, return to automatic mixture setting. (d) Occassionally, poor engine maintenance or leaning in excess of the above procedure may precipitate minor roughness or backfire due to too lean a mixture. The engineer should be alert for early indications of trouble and if necessary enrich the mixture toward, but not beyond, the best economy point established in step 4, and readjust throttle to maintain cruise power.

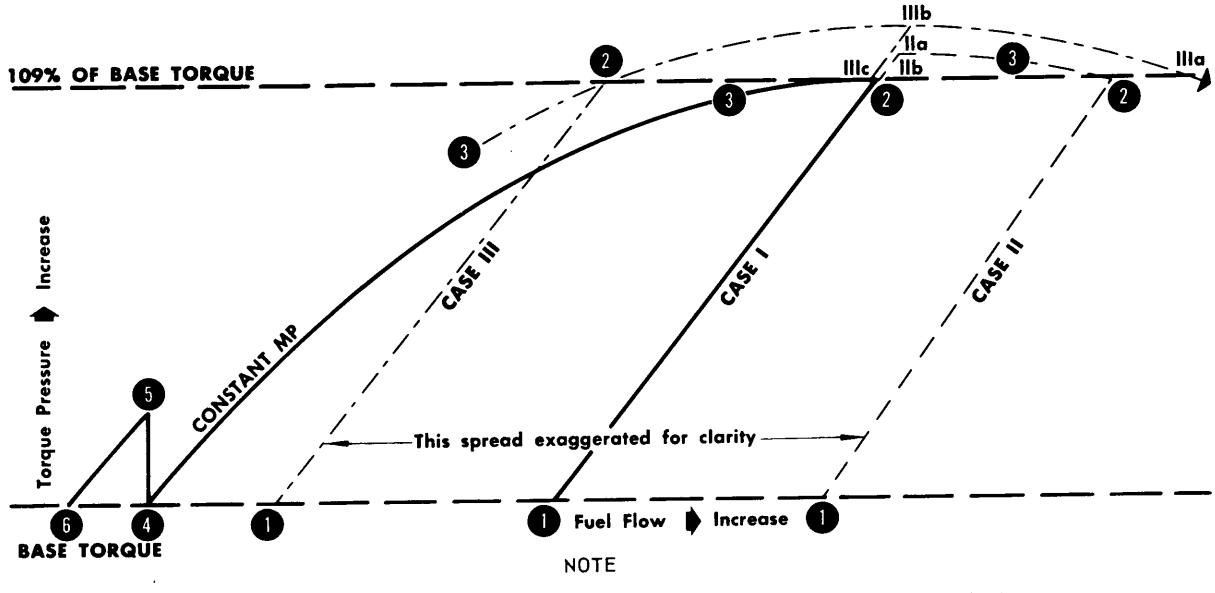


Figure 7–3 (Sheet 2 of 2)

Engine Cooling

Primary Means. The primary source of engine cooling is the flow of ram air around the cylinders. This air flow is regulated by positioning of the cowl flaps. Maximum operating limits of the cowl flaps and cylinder head temperature for all flight conditions are given in figure 7–4.

Secondary Means. A secondary means of cooling the engine is provided by the mixture of fuel and air supplied to the engine. A chemically correct mixture of fuel and air is a mixture in which both of the components of combustion, gasoline and oxygen in this case, are completely consumed in the chemical reaction, or burning of the gasoline. Such a reaction would result in very hot exhaust gases in the combustion chamber. This is undesirable for good cooling because of the large amount of heat that must be removed through the cylinder walls. Therefore, during high powers, the fuel-air mixture is supplied to the cylinders with an excess of fuel beyond the ideal mixture for best power settings. This causes maximum consumption of the oxygen in the cylinders, with the excess fuel absorbing some of the heat of combustion, resulting in lower cylinder temperatures. During auto lean cruising, the chemically correct mixture is being burned, resulting in the high temperatures shown in figure 7–1. Under these conditions, cruise cooling requirements will be at their peak. When operating the engine at best economy, an excess of air beyond the ideal mixture is supplied to the cylinders. This causes maximum combustion of the fuel, with the excess air absorbing part of the heat of combustion. By lowering the combustion chamber temperatures, the external cooling air required is reduced, which permits less cowl flap opening, resulting in less drag. By lowering the carburetor air temperature, the fuel-air mixture enters the cylinders at a lower temperature. The cooler mixture provides additional cooling in the combustion chamber through its ability to absorb more heat. Proper adjustment of the carburetor air temperature and cylinder head temperature will enable satisfactory engine operation with a minimum of drag from the cowl flaps and intercooler flaps.

DESCENT

Flying conditions permitting, adjust throttle and propeller to maintain cruising speed during descent. It is important, however, to cushion the high inertia loads on the master rod bearings which occur at conditions of high rpm and low manifold pressure. It is well to remember that each 100 rpm requires at least 1 inch Hg manifold pressure; for example, 23 inches Hg at 2300 rpm. (Refer to Section III.) Operation at high rpm and low manifold pressures should be kept to a minimum.

STOPPING

The ratio of the scavenging pumps intake to oil pressure pump output is a maximum at approximately 1000 rpm. Running at 1000 to 1200 rpm after CHT stabilizes at 180°C or below for 1 minute before shutdown will reduce the number of instances of hydraulic lock during the subsequent start, since the amount of oil remaining in the engine will be at a minimum.

Types Of Fouling

There are several types of spark plug fouling, some of which come from lack of preventative procedures, others from lack of care in maintenance or preflight operation, and still others that come from operating time and the need for spark plug replacement. Carbon fouling and lead fouling are the most prevalent and are covered in this discussion. Lead fouling may be residual from a previous flight. Carbon fouling is usually due to prolonged ground running at idle, particularly when the idle mixture is richer than the best power; excess carbon from the rich mixture and engine oil in combustion tend to build up as fouling deposits. The symptoms of such fouling usually include excessive magneto drop at the power check at field barometric manifold pressure.

Carbon Fouling

Carbon fouling from fuel is associated with mixtures too rich to burn well or so lean as to cause intermittent firing and consequent accumulation of oil and carbon on the misfiring spark plugs. A rich mixture is evidenced by soot or black smoke coming from the exhaust and by an increase in the rpm when the mixture is manually leaned to best power at idle throttle setting. When the turbulence and heat are as low as they are in idling, this soot settles out on the inside surfaces of the combustion chamber as well as in the exhaust system. At higher rpm and/or power settings, the soot is swept out or does not condense out of the charge in the combustion chamber, even though it shows up as black smoke in the exhaust during takeoff. During idling, there is a tendency for oil to be sucked into the combustion chamber, mix with the soot, and form on the spark plugs, shorting out the gap. The oil also burns poorly in an already rich mixture and adds carbon.

Indication Of Fouling

Magneto checks and power checks will give indications of malfunctions in the ignition system. Fouling, however, is concerned with the combustion end of the spark plug, and standard checks will not always point immediately to the source of trouble. Regular monitoring of the spark plugs with the ignition analyzer, while operating under power settings conducive to fouling, provides a valuable means of determining the degree of fouling affecting spark plug operation.

CONTROLLED SPARK PLUG DEFOULING AND ANTI-FOULING PROCEDURES

These procedures are to aid in reducing spark plug fouling due to oil or excessively rich idle mixtures. Importance of maintaining correct idle mixture setting and proper assembly of idle mixture linkage cannot be overemphasized as the most important factors to be considered in providing protection against carbonaceous spark plug fouling.

Antifouling Procedures For Ground Operation

Changes in altitude and climatic conditions will alter the idle mixture strength. When an airplane is at its home station and the idle mixture is noted out of adjustment,

an airplane form entry will be made. However, when an airplane is operating away from its home station, no form entry should be made, as the mixture strength may be correct when the airplane returns. During all ground idle and taxi between minimum and 1200 rpm, the mixture will be manually leaned to produce a mixture 20 to 40 rpm leaner than best power. After each 10 minutes of ground operation following completion of power and ignition system checks, slowly advance the throttles to field barometric pressure. Hold this power for 1 minute, but do not exceed maximum CHT for ground operation. Retard throttle to idle rpm range and manually lean to produce a mixture 20 to 40 rpm leaner than best power.

Immediately prior to takeoff, slowly increase manifold pressure to field barometric pressure. This will increase spark plug core tip temperature and decrease marginal spark plug performance during takeoff.

Defouling Procedures On The Ground

When unacceptable spark plug performance is experienced, engine speed will be reduced to 800 to 1000 rpm. Operate engine at this rpm for 2 minutes with a mixture slightly leaner than best power. Best power is obtained by slowly manually leaning the mixture until maximum rpm is obtained. Further lean mixture until 20 to 40 rpm decrease from best power is noted. This will result in mixture slightly leaner than best power. Cylinder head temperature must be between 175° and 200°C to obtain optimum results. If necessary, adjust cowl flaps to maintain this temperature. This leaning procedure will increase the oxygen-to-fuel ratio within the cylinder to support chemical oxidation removal of carbonaceous material from the spark plug core tip. After 2 minutes at this power setting, return the mixture control to AUTO RICH and check engine performance at field barometric pressure. If engine performance check is not satisfactory, repeat the spark plug defouling procedure. In event second attempt to clear the spark plugs fails to produce desired results, replace only those spark plugs found defective by engine analysis procedures, utilizing the ignition analyzer as a basic tool.

Note

Too much emphasis cannot be placed on slow movement of the manual mixture control required to obtain best power mixture. "Slowly" may be defined as rate of movement which would require 12 to 15 seconds to move the manual mixture control from AUTO RICH to best power.

CONDITION		COWL FLAP SETTING
ALL GROUND OPERATIONS		Full open. Do not exceed CHT of 220°C. Observe engine shutdown CHT limitation of 180°C.
TAKEOFF		1.5-inch gap for OAT up to 15°C 2.0-inch gap for OAT 15° to 25°C 2.5-inch gap for OAT 25° to 35°C 3.0-inch gap for OAT above 35°C Do not exceed 3.0-inch gap at takeoff.
DURING FLIGHT	AUTO RICH	0.75-inch minimum gap, gear and wing flaps up 1.0-inch minimum gap, gear and wing flaps down 3.0-inch maximum gap to avoid excessive vibration and buffeting Level flight above 1850 BHP max CHT is 255°C except: 4-engine level flight at 30,000 feet max CHT is 265°C 2- & 3- engine operation above 1850 BHP max CHT is 265°C 3-engine climb max CHT is 265°C Below 1850 BHP do not exceed CHT of 243°C.
	MANUAL LEAN AUTO LEAN	Cruise: Do not exceed CHT of 243°C.
	ENGINE SHUTDOWN	Maximum CHT for engine shutdown is 180°C.

NOTE:

- To avoid exceeding CHT of 265°C during takeoff, reduce CHT to as low a value as possible, 180°C or less, prior to takeoff. Refer to Section IX for additional cold weather CHT limits.
- Cylinder A-1 is usually the hottest for ground operation and either A-1 or B-1 may be hottest for flight operation.

COWL FLAP OPERATION

Figure 7–4

Fouling Protection During Cruise Operation

After each hour of operation below 1300 BHP, move mixture control to AUTO RICH. Advance power slowly to set 1800 BHP; move throttles slowly (5 seconds per 1 inch manifold pressure). Hold 1800 BHP for 2 minutes. Return to cruise setting. Prior to final landing, engines will be operated at 1800 BHP for 5 minutes. Move mixture to AUTO RICH and set rpm and manifold pressure for 1800 BHP according to applicable power schedule in the Appendix, T. O. 1C-97(K)L-1-1, and hold for 5 minutes. Set up power for letdown and hold a minimum of 150°C cylinder head temperature.

Note

Cylinder head temperature will be kept above 150°C during letdown procedure and during landing approach.

CARBURETOR ICING

Carburetor Icing On The Ground

If a cold-soaked carburetor gives evidence of an overly rich or overly lean mixture during engine ground run-up, the trouble is probably ice in the carburetor chambers. A rich mixture is caused by ice forming in the lower mixture control bleed between A and B chambers. This can be eliminated by manual leaning to a fuel flow that will permit a combustible mixture, then running the engines at a higher rpm and applying carburetor preheat. Other types of icing may result in an excessively lean mixture and may require priming for smooth engine operation to accelerate to a power where carburetor preheat is available.

CAUTION

Do not take off until the carburetor is metering properly.

Carburetor Icing In Flight

Indications Of Carburetor Icing. Under conditions of high atmospheric humidity, carburetor icing can occur with carburetor air temperature between −10° and 7°C. If icing does occur, it will be indicated by one or more of the following:

a. Change in fuel flow and change in torquemeter pressure.

Note

This is indicative of icing of the carburetor metering elements and, when experienced at all, is usually encountered on takeoff. This usually results in a very rich mixture.

b. Falling off of manifold and torquemeter pressures while maintaining constant throttle, TBS lever setting, and rpm.

c. Jamming of the throttle in some cases.

Elimination Of Carburetor Ice. If carburetor icing occurs, proceed as follows:

1. Mixture – ADJUST (TO OBTAIN A NORMAL AUTO RICH FUEL FLOW).

Note

Usually the mixture is enriched, in which case lean manually. During takeoff or climb, lean the mixture to obtain predicted TPSI; this will result in a mixture approximating the AUTO RICH mixture. During cruise, lean the mixture through maximum TPSI until a drop of approximately 8 TPSI is obtained; this will result in a mixture approximating the auto lean mixture. The resulting mixtures may be cross-checked with the fuel flow meter if it is operating.

If the mixture becomes lean, the AUTO RICH position may be sufficient, or prime may be required to keep fuel flow up.

If turbos are not operating, bring in the turbos as soon as the power level (METO or less) or the situation permits.

2. Intercoolers – CLOSE.
3. If Necessary:
   a. TBS Setting – INCREASE.
   b. Throttle – RETARD (TO MAINTAIN MANIFOLD PRESSURE WITHIN LIMITS).
4. As Ice Is Removed:
   a. Engine Instruments – MONITOR (CAREFULLY).
   b. Engine Controls – ADJUST.

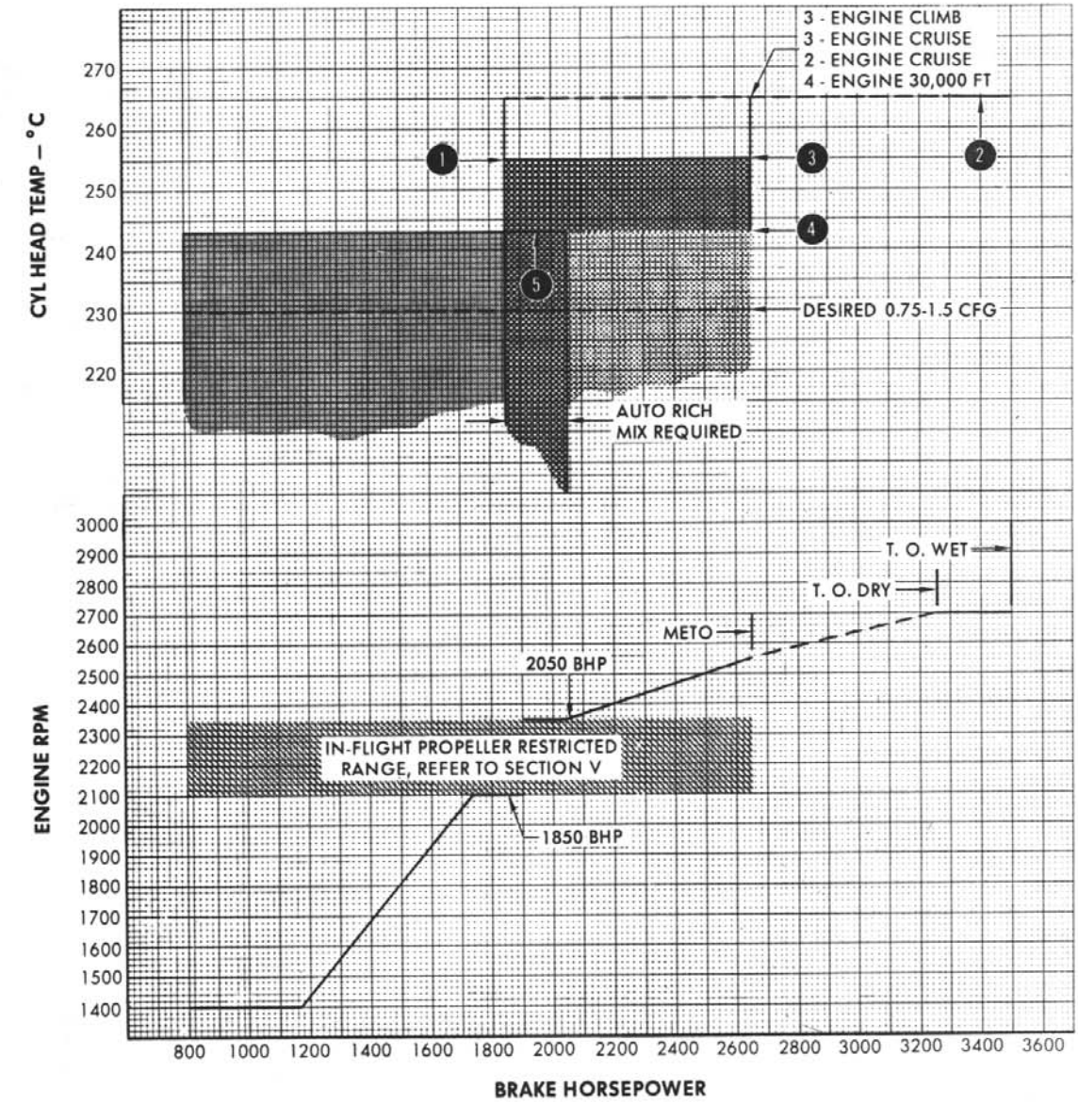
Prevention Of Carburetor Icing

If icing is anticipated on takeoff, use sheltered air. In flight, icing may be prevented with the turbo on by maintaining a carburetor air temperature of 15°C. If the icing conditions are extreme, the carburetor air temperatures may, if desired, be maintained between 35° and 38°C. The amount of heat available in the following steps is directly proportional to the amount of turbo applied:

1. Intercooler Flap – CLOSE.
2. TBS Setting – INCREASE (AS DESIRED).
3. Carburetor Air Switches – SHELT.
4. Power – REESTABLISH.

Note

If a drop in manifold pressure is experienced while operating on sheltered air, with filters installed, open intercooler flaps 2 inches. This will provide an alternate air intake.



AUTO RICH ONLY

AUTO RICH OR AUTO LEAN

AUTO RICH, AUTO LEAN, OR MANUAL LEAN

NOTE:

1. Auto rich cruise, 2.0 – 3.0 inches CFG.
2. Takeoff 3.0 Max inches CFG.
3. Auto rich climb, 170 knots IAS, 2.0 – 2.5 inches CFG. Auto rich climb, 180 knots IAS, 2.5 – 3.0 inches CFG.
4. Auto rich climb, 170 knots IAS, 2.0 or less inches CFG. Auto lean cruise, 2.0 or less inches CFG.
5. Auto rich cruise, 2.0 inches CFG.

CYLINDER HEAD TEMPERATURE IN-FLIGHT RECOMMENDATIONS

Figure 7–5

TURBOSUPERCHARGER SYSTEM

NORMAL OPERATING PROCEDURES

Ground Operation

When it is necessary to run an engine on the ground for extended periods, the turbosupercharger shall be operated for a period of 1 minute at 1000 rpm, every 10 minutes. This 1-minute operation will be accomplished by switching turbo to MANUAL and closing the wastegate until it is fully closed. This operation is necessary in order to insure priming of the turbo oil pump and proper lubrication of the bearing during ground run turbo windmilling.

Manual To Automatic Control

ALL TURBOS. To place the turbos in automatic control:

1. TBS Lever – 0.
2. Turbo Override Switches – OPEN (GUARDS DOWN).
3. Turbo Switches – AUTO (ONE AT A TIME).

   Monitor manifold pressure and cabin air flow closely to guard against inadvertent overboost.
4. Intercoolers – OPEN 2 INCHES.

   Open intercoolers before advancing the TBS lever to anticipate carburetor air temperature rise when turbo is added.
5. TBS Lever – ADVANCE (CAREFULLY).

CAUTION

Do not exceed CAT. limits when using turbos.

When setting up turbos, always advance the TBS lever carefully until a definite rise in manifold pressure or cabin air flow is noted. No rise means malfunction. If malfunction occurs, return the turbo switch for the affected engine to MAN. Investigate, when safe altitude is reached, by using the TURBOSUPERCHARGER EMERGENCY OPERATION in Section III.

6. Carburetor Air Temperature – CONTROL WITH INTERCOOLER FLAP.

ONE OR MORE TURBOS. For each turbo to be returned from manual to automatic control while other turbos are in automatic, accomplish the following:

1. Turbo Calibrating Knob – FULL CCW.
2. Turbo Override Switch – OPEN (GUARD DOWN).
3. Throttle (Affected Engine) – RETARD.
4. Turbo Switch – AUTO.
5. Throttle (Affected Engine) – INCREASE SLOWLY TO ALIGN WITH OTHERS.
6. Turbo Calibrating Knob – TURN CW TO DESIRED MANIFOLD PRESSURE.

During Normal Climb. When setting up power following the first power reduction, use throttle only. Leave the turbo switches at MAN until wide open throttle has been reached and a definite drop in manifold pressure, due to altitude gain, has been noted. Then switch to automatic control using the procedure given under MANUAL TO AUTOMATIC CONTROL, this section.

Note

At certain power settings and cabin pressurization requirements, an indication of cabin air flow somewhat above the green (normal) range may be expected.

Turbo Immediately After Takeoff. Under conditions which require turbo immediately after takeoff, such as for carburetor preheat or cabin air flow, proceed as follows: Decrease the manifold pressure a noticeable amount with the throttles. Using the procedure given under MANUAL TO AUTOMATIC CONTROL, this section, restore the manifold pressure. Proper restoration of manifold pressure will indicate a normally functioning turbo automatic control system. Adjust part throttle or preheat as desired.

Automatic To Manual Control

To switch all turbos from automatic to manual control during normal operation:

1. TBS Lever – RETARD TO 0.
2. Turbo Override Switches – CHECK OPEN (GUARDS DOWN).
3. Turbo Switches – MAN (ONE AT A TIME).

   Monitor the manifold pressure to guard against inadvertent overboost.
4. Turbo Override Switches – HOLD OPEN FOR 10 SECONDS, THEN OFF (OVERRIDE SWITCH GUARDS UP).

Cruise

Set up cruise power using part throttle and turbo, using no more part throttle than required to maintain cabin air flow within the green (normal) range.

Descent

Throttle engines as required for descent and advance TBS lever to keep the cabin air flow indicator within green range. If full turbo is inadequate for cabin requirements with symmetrical power, advance power on inboard engines and reduce outboard engine power to obtain desired air flow.

Turbosupercharger Manual Control

The manual control system may be used for extended periods of time if the automatic control system is inoperative and the pilot decides that conditions are such that manual operation is necessary. Make manual adjustments of turbo for one engine at a time as follows:

1. To Increase Turbo Boost:
   a. Manifold Pressure (ON DESIRED ENGINE) – REDUCE (BY MEANS OF THROTTLE).
   b. Turbo Override Switch (Corresponding) – NUDGE TO CLOSE POSITION AND RELEASE.
   c. Throttle – ADVANCE (SLOWLY TO DESIRED POSITION).

Be alert for possible overboost.

   d. Above Steps – REPEAT (UNTIL WITHIN ABOUT 2 INCHES HG OF DESIRED MANIFOLD PRESSURE).
   e. Final Manifold Pressure Adjustment – USE THROTTLE.

2. To Decrease Turbo Boost:
   a. Decrease Turbo Override Switch – NUDGE TO OPEN POSITION AND RELEASE.

Repeat until within about 2 inches Hg of the desired manifold pressure.

   b. Final Manifold Pressure Adjustment – USE THROTTLE.

NOTE

The wastegate motors are fast-acting; therefore, care must be exercised when using the turbo manual override switches. Sensitivity of the manual system varies. When the turbo manual override switches are used with the wastegate near the fully open position, large changes in wastegate position will produce small manifold pressure changes. Near the closed wastegate position, small changes in the gate position cause large changes in manifold pressure and care must be taken not to cause an overboost.

Use the throttle to make minor adjustments of manifold pressure and the turbo manual override switches to make the large adjustments, such as those resulting from large changes in altitude, airspeed, or power requirements. The turbo governor does not function with the turbo switch in MAN; therefore, it is possible to overspeed the turbine wheel. This is particularly true above 23,500 feet, where maximum allowable continuous turbine wheel speed (20,000 rpm) is reached at the engine power settings shown below.

ALTITUDE (feet)	BHP
23,500	2650
25,000	2450
26,000	2350
27,000	2250
28,000	2160
29,000	2070
30,000	1985

CONDITIONS

32°C CAT., 155 knots IAS

NOTE

A carburetor air temperature and/or cabin air flow higher than the rest may be indicative of an overspeeding turbine if the intercooler and power settings are symmetrical for all engines.

EMERGENCY OPERATION

Refer to Section III.

TURBO BEARING TEMPERATURE GAGE INDICATIONS

The turbo bearing temperature gages should be monitored periodically while the turbos are in operation. See figure 5–1 for temperature limitations. The gages will normally stabilize and indicate in the low or mid green range and may vary 10° to 15°C between turbos; however, this variation should remain constant. A variation of plus or minus 20°C on any one gage from the mean average of the other three gages, is indicative of an impending turbo malfunction and eventual failure. A plus 20°C variation indicates rough turbo bearings or a slightly cracked nozzle box and that turbo should be shut down to prevent further damage. Refer to TURBINE WHEEL BEARING FAILURE, Section III. The plus 20°C variation is only indicative of an impending failure. There may be a time lag of 5 minutes to an hour before complete failure occurs. If the mission requires high power on all four engines, and the turbo is left in operation, monitor the high reading gage constantly for a rapid steady rise or a plus variation of over 30°C. If either of these indications should occur, the turbo must be shut down immediately. A minus 20°C variation is

indicative of a lubrication failure, and that turbo should be shut down to prevent further damage. Refer to TURBO LUBRICATION FAILURE, Section III. There may be a time lag of 5 to 30 minutes before complete failure occurs. Usually, the complete failure is preceded momentarily by a rapid steady rise in bearing temperature. If the mission requires high power on all four engines, and the turbo is left in operation, the low reading gage must be monitored constantly for an indication of a rapid temperature rise. At the first sign of rapid rise, the turbo must be shut down immediately. If a turbo is shut down due to temperature variation, an entry should be made in the Form 781, including the differential temperature noted and the suspected cause.

PROPELLER SYSTEM

OPERATION DESCRIPTION

Operating Mechanism

The operating mechanism of the 34G60 propeller is a mechanical-hydraulic system in which hydraulic forces acting on a piston are transformed into mechanical twisting forces acting upon the blades. Piston movement causes rotation of a cam and bevel gear. This bevel gear, meshing with bevel gear segments attached to the butt ends of the blades, turns the blades. The hydraulic pressures which act upon the piston are controlled by a flyweight governor which moves the pilot valve to direct hydraulic pressure to move the piston as required by the operating condition. The propeller governor is adjusted by a stephead motor which changes the governor spring tension opposing the flyweight force and selects the rpm. The stephead motors may be controlled manually by use of the governor selector switches or automatically by use of the master propeller synchronizer lever. (See figure 1–23.)

Pitch Lock. The propeller mechanism contains a flyweight valve which actuates at 2535 to 2665 rpm and traps oil on the forward side of the piston to prevent overspeed. The bleed valve in the piston, however, will allow the trapped oil to bleed out slowly and the rpm to increase at a controlled rate. The bleed valve closes at 3000 to 3100 rpm and prevents further piston movement to increase rpm. Hydraulic pressure will cause the bleed valve to remain closed until the power is reduced to 1500 to 1700 rpm. Decrease rpm pressure or feathering pressure will override the flyweight valve. (See figure 1–23.)

Synchronizer

The synchronizer is used to automatically correct for governor setting tolerances which may cause engine speeds to vary slightly. For synchronization, either one or two engines may be selected as a master for the other engines to follow. Once the master engine and its speed have been selected (governor set) with the propeller auto control switch and the master lever, the other engines act as slaves and synchronize their speeds to it. The master engine drives a small electric generator through its tachometer drive. The frequency of this generator varies with the speed of the engine. Its output drives one of two synchronous motors in each of the slave differential motors. The other synchronous motor is driven by its slave engine. Between each synchronous motor set is a differential drive. If the slave engine is turning at a different speed than the master, the differential drive rotates in a direction depending on overspeed or underspeed. Each differential drive is geared to a commutator switch for its slave engine. When the switch is rotated, the stepmotor on the slave engine is energized to reset the governor. When the slave engine's speed is the same as the master, the differential drive equalizes and relative motion stops.

Synchronizer Control. The master propeller synchronizer lever is used for ease of operation; it merely allows all four propellers to be controlled simultaneously. The master lever is independent of the toggle switch system, but both use the same stepmotor heads at the governors. The master lever changes all engine speeds in the following manner. When the lever is moved, a rotary contact touches a brush of a followup arm. This connection starts a dc motor turning in the direction the master lever has been moved. The followup arm rotates with the dc motor until its brush moves off the rotary contact. The dc motor operates a commutator switch which supplies pulsating dc voltage to each stepmotor head. The stepmotor heads turn revolution for revolution with each turn of the commutator switch, thus changing all governor settings simultaneously. Every time the master lever is advanced to takeoff position, all governors are set to their positive high rpm stops. This action is called calibrating. At calibration and during movement of the master lever, synchronizing is momentarily cut out.

Safety Device

A safety device is incorporated between the commutator switch and differential motor of each slave engine to prevent master engine failure from dragging down slave engine speed. This feature allows the master engine to control the speed of the slaves only within the range of approximately ± 3 percent of cruise rpm. It consists of a stop gear incorporating a notch which restricts the differential motor from turning either way more than the 3-percent rpm range by means of a peg through the notch. A locking claw holds the stop gear in position. When the peg has moved to the limit of the notch (3 percent rpm), it can go no further until the locking claw is released. When this is released, the stop gear (and notch) is recentered by spring action. Another 3-percent correction can then be made by the differential motor, and so on. The locking claw is actuated by the resynchronizer switch which also breaks the circuit from the tachometer generators to the differential motors. The resynchronizer switch must be held momentarily to allow the stop gear to recenter; too rapid action may cause the claw to catch the stop gear at some point other than the center position. Selector switch operation of the individual propellers, while the propellers are in automatic operation, will be followed by an approximate 3-percent rpm springback toward master engine rpm when the switch is released. No synchronizer action will be experienced with the propeller auto control switch in the OFF position.

Reducing RPM

In the event that it is not desired to draw maximum power from an engine for any reason, it is also possible, once the governors are set to high rpm by the master propeller synchronizer lever, to readjust one or more of them downward by means of its governor selector switch. After takeoff has been accomplished, movement of the master propeller synchronizer lever to reduce rpm will produce equal movement in all governors so that if the governors were within the synchronizing range at the full high rpm position, they will remain within the range and automatic synchronizing will result. If any governor has been reduced from its high rpm position at takeoff, its rpm would be reduced by a proportional amount (less 3 percent springback) so that it will be set for a lower rpm than the rest of the system.

PROPELLER OPERATION

For ground operation and checks, refer to Section II.

Normal Operation

Propeller Limitations. For power settings at 2350 rpm, the lowest indicating tachometer will be set at 2350 rpm, resulting in none of the four tachometers indicating less than 2350 rpm. For power settings at 2100 rpm, the selected master engine will be used to determine the 2100 rpm setting. For brake horsepower settings of 1735 through 1900 BHP, the alternate power schedule will be utilized. (Refer to the Appendix, T. O. 1C-97(K)L-1-1.) Maximum cowl flap opening up to 3 inches will be used to attain the desired cylinder head temperature.

Takeoff. Move the master propeller synchronizer lever to full INCREASE RPM and adjust the engine controls to maximum power.

Climb. For the climbing operation immediately following takeoff, set the engine and the propeller controls to the climb power specified in the Appendix, T. O. 1C-97(K)L-1-1.

Economical Cruising. Once the engine rpm has been adjusted, it will be held constant by the propeller governor. Changes in the attitude and altitude of the airplane, as well as changes in the engine manifold pressure, can be made without altering the rpm. Loss of electrical power will prevent rpm adjustment. However, the propeller will maintain the preset rpm (within pitch change limits) by acting as a simple constant speed propeller regardless of attitude, manifold pressure, airspeed, or density changes.

Power-On Descent. Power-on descent operation, in which the power absorption limits of the propeller are not exceeded, is fully taken care of by the governor; that is, as the airspeed increases in the descent, the governor will move the propeller blades to a higher pitch in order to hold the rpm at the desired value. Set the master propeller synchronizer lever to obtain the correct rpm for the power selected. Maintain at least 1 inch manifold pressure per 100 rpm.

Power-Off Descent. Used for emergency descents only; refer to Section III.

Approach And Landing. Set the master propeller synchronizer lever to give approach rpm.

Reversing While Landing. Make a normal landing with the engine and propeller controls in their usual positions. After the airplane has touched down, open the throttle lock plate and move the desired throttle levers into the reversing position at the rear of their quadrants. When the propellers have reversed, the throttle levers may be adjusted within the reverse portion of the quadrant to set the amount of reverse thrust desired.

CAUTION

If a propeller oil quantity light is illuminated, do not attempt to reverse the corresponding propeller, as the oil quantity may be insufficient to accomplish propeller reversal.

Unreversing While Landing. To return to forward thrust, advance the throttle levers past the detent. While unreversing, it is important not to apply too much power, because ground speed may increase as the propellers go into positive pitch. Propeller unreversing is cut off at approximately 6 degrees above the low blade angle setting, and the governor assumes control at this time. Thus, with the throttle open too wide, the ground speed will be increased. If a propeller should fail to unreverse, shut down the engine immediately. Do not disturb propeller controls until the malfunction can be determined.

WARNING

During landing, when the airplane is in the three-point attitude on the runway and any propeller(s) has been placed in reverse thrust, the pilot will not attempt to place the propeller(s) in forward thrust and attempt a takeoff. This procedure, if attempted, can result in the propeller(s) staying in flat pitch and preventing acceleration to takeoff speed.

Stopping Engines. Move the master propeller synchronizer lever to full INCREASE RPM. Follow the procedure outlined in Section II to shut down the engines.

Feathering. For feathering procedure, refer to Section III. In connection with the feathering and unfeathering operations of the propeller, the following points are important.

Inadvertent Feathering. If the feathering switch should be closed inadvertently, the feathering action can be stopped and the propeller returned to governor control by pulling out the feathering button. If the accidental operation of the feathering switch has resulted in complete feathering, the propeller should be unfeathered in the normal manner. (Refer to Section III.)

After Feathering. Propeller oil pressure is not required to hold the blades in the full feathered position. Proper setting of the high pitch (feathered) stop can be checked by noting any tendency for the propeller to rotate. Once

the blades have been feathered and rotation stopped, torque-producing aerodynamic forces are in equilibrium and the propeller will not windmill. The feathering button should release after 18±2 seconds; if, for any reason, the feathering button fails to release after this time, it should be pulled out to the neutral position manually.

Inadvertent Engagement Of Pitch Lock. If an rpm surge has actuated the flyweight valve, decrease rpm oil pressure will override the flyweight valve and normal governing action will continue. If the overspeed has closed the bleed valve, a normal power reduction can be accomplished to bring the rpm below the flyweight valve setting, and governing action will appear to be normal.

Note

When the bleed valve is closed and the master propeller synchronizer lever is at takeoff setting, retarding the throttles or reducing the airspeed will result in a locked pitch condition. (The rpm will follow throttle movement and/or airspeed.) The flyweight valve will remain closed, even below 2535 to 2665 rpm, because the governor will be in an underspeed condition. The underspeed condition will cause oil pressure to be directed to the aft (increase rpm) side of the piston and lock the propeller in fixed pitch. When the master propeller synchronizer lever is moved to set rpm below 2535 to 2665 rpm so that the governor is no longer in an underspeed condition, governing action will resume and appear to be normal. A power reduction to 1500 to 1700 rpm will relieve the pressure caused by centrifugal twisting moment, so that the bleed valve will open and normal operation can be resumed.

Emergency Operating Procedure

Refer to Section III.

PROPELLER OPERATION DURING FLIGHT

PILOTS

1. Propeller Integral Control Unit – VISUALLY CHECK FOR LEAKS.
2. If Propeller Oil Quantity Light On (After 3 Minutes) – FEATHER PROPELLER.

   Feather the propeller if engine is not required. If engine operation is required, monitor rpm for erratic governor operation. If it is impossible to stop erratic governor operation by use of oil replenishment, a serious oil leak is indicated and the propeller must be feathered immediately to prevent runaway.

ENGINEER

1. Propeller Oil Refill Switches – CHECK OFF.
2. Propeller Oil Quantity Warning Lights – CHECK NOT ILLUMINATED.
3. If Propeller Oil Quantity Warning Light Illuminates – NOTIFY PILOT.
4. Propeller Oil Refill Switch – ON.
5. Propeller Oil Refill Switch – OFF.

   When the propeller oil quantity warning light goes out, turn propeller oil refill switch off. If the propeller oil quantity warning light does not go out after 3 minutes of replenishing, notify pilot, since insufficient propeller oil quantity with impending difficulties is indicated. Propeller oil replenishment may be repeated as often as necessary, provided that the propeller oil quantity warning light is extinguished within 3 minutes.
6. If Propeller Oil Replenished During Flight – ENTER IN FORM 781 NUMBER OF TIMES AND DURATION OF REPLENISHING.

Note

If engine oil has been used for replenishing propeller oil, congealing with resultant poor control may occur after the propeller has been at rest in cold temperatures.

IGNITION ANALYZER

ANALYZER OPERATION PRINCIPLES

It is necessary to discuss the operation of a typical airplane engine ignition installation to show the manner in which ignition faults are revealed by the ignition analyzer. At the instant the magneto breaker points open, the permanent magnet rotor is in position to effect a complete reversal of the magnetic field which was built up around the magneto coil. This reversal was prevented from taking place previously by the presence of the current in the primary winding of the magneto coil. The opening of the magneto breaker points breaks the flow of current, and the rapid flux reversal induces a high voltage in the secondary coil. It is this secondary high voltage that fires the spark plugs. At the time the magneto breaker points are open and the spark discharge is taking place across the spark plugs, the ignition analyzer makes an analysis of the ignition system. The discharge of high tension current across the gaps of the system sets in motion an oscillatory circuit. The circuit constants, the condition of the spark plugs, and cylinder pressures are all factors which determine the characteristics of this oscillatory circuit. In order that the oscillatory characteristics may be studied, a method of measurement of these oscillations must be determined. Ignition analyzer calibration is accomplished by checking the voltage appearing across the magneto breaker points during the open period. Visual evaluation of the primary voltage characteristics is made by observation of the primary wave forms as they appear on the cathode-ray tube screen. In the ignition system, all malfunctions are accompanied by some significant change in one or more of the electrical components constituting the oscillatory circuit. In this way, various ignition malfunctions can be found by studying the oscillations. Figure 7–7 shows various patterns for normal and malfunctioning ignition systems.

PATTERN SEQUENCE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CYLINDERS FIRED BY L_1 AND R_1 MAGNETOS	D1	B2	D3	B4	D5	B6	D7	B1	D2	B3	D4	B5	D6	B7
CYLINDERS FIRED BY L_2 AND R_2 MAGNETOS	A5	C6	A7	C1	A2	C3	A4	C5	A6	C7	A1	C2	A3	C4

L magnetos fire the left side spark plugs of cylinders **R** magnetos fire the right side spark plugs of cylinders

Pattern sequence chart for use with P & W R-4360-59B engines equipped with a low-tension ignition system

ANALYZER PATTERN SEQUENCE

Figure 7–6

ANALYZER OPERATION PROCEDURE

The following procedure is used to operate the ignition analyzer system.

a. With the engines running at operating temperature, the dc bus energized, and the secondary inverter operating to supply ac power, place the system power switch on the ignition analyzer switch panel to the ON position.

b. Place the analyzer power switch on the ignition analyzer to ON. The power indicator light should illuminate.

c. Allow approximately 1 minute for the analyzer tubes to warm up. A bright dot should appear on the analyzer screen. Allow this dot to stabilize at one position on the screen, then adjust the position switches until the dot is in the center of the screen.

d. If dot does not appear, operate the horizontal and vertical position switches on the analyzer until the dot appears.

CAUTION

To prevent burning a spot on the analyzer screen, the bright dot should not be held in one position on the screen for more than 2 minutes. When power is to be left on the analyzer for a longer period, select a pattern or shift the dot to the extreme side of the screen.

e. Set the analyzer magneto selector switch on the analyzer to the LEFT 1 position.

Note

The analyzer magneto selector switch remains in the LEFT 1 position throughout the operating procedure, as this position of the switch only is used in the circuit.

f. Rotate the engine and magneto selector switch to the engine and magneto position desired.

g. Check for abnormalities in the 14 patterns on the analyzer screen with the switch in the R and L positions. Cylinders which show abnormal patterns are determined by counting off from the first pattern and referring to the placard on the front of the analyzer switch panel.

h. Use the horizontal position, vertical position, and and horizontal gain control knobs to isolate and enlarge any abnormal pattern for more detailed study. Try to keep at least three patterns on the analyzer screen for comparison.

i. To check magneto synchronization of both sides of cylinder ignition, place the magneto selector switch to each of the RL positions. The patterns for any one cylinder viewed on the analyzer screen will be superimposed if magnetos are synchronized.

ANALYZER VOLTAGE CONTROL OPERATION

Use the voltage control switch on a ground check to determine condition of spark plugs before noticeable failure occurs. Operation of the voltage control switch is as follows:

a. Place the relay-resistor switch on the analyzer switch panel to the ON position for the engine to be tested.

CAUTION

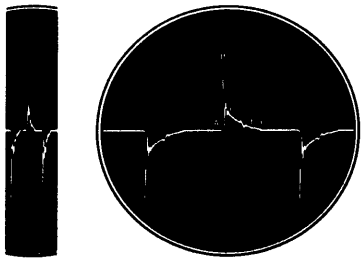
Guards for these switches should be down during flight to prevent possible cutting out of cylinders with inadvertent use of the voltage control and resultant damage to the engine by fire or backfiring within the manifold section.

b. Pull out and rotate the voltage control switch from OFF in the decrease direction, while viewing the pattern on the analyzer screen. Misfiring and, finally, complete stoppage of spark plug firing should occur.

Note

The voltage control switch will return to the inoperative position when released.

NORMAL



DETAIL I

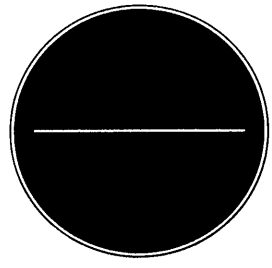
The shape of this normal wave form is the result of each component of the ignition system functioning normally, thereby causing ignition and resultant combustion within the cylinder.

1. Breaker point opening at A
2. Initial rise of voltage at B
3. Voltage ripple reflecting spark plug firing at C
4. Pulse occurring as spark plug firing at D
5. Gradual decay of voltage at E
6. Breaker point closing at F

WHEN ALL WAVE FORMS HAVE A NORMAL SHAPE, THE IGNITION SYSTEM DOES NOT REQUIRE SPECIAL MAINTENANCE OR REPAIR.

DETAIL II

SHORTED PRIMARY BEFORE DISTRIBUTION



A shorted primary wave form is the result of abnormally low resistance of the primary circuit short circuiting the magneto coil. This wave form will also be produced when the ignition switch controlling the circuit under analysis is in the OFF position.

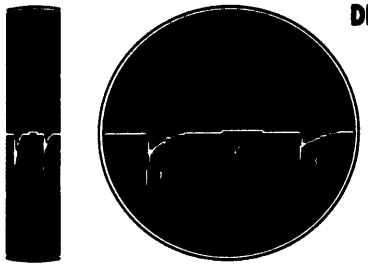
1. This condition produces a straight horizontal line on the analyzer screen

PROBABLE CAUSE.

1. Breaker points do not open
2. Shorted breaker points
3. Shorted primary points
4. Shorted distributor rotor
5. Shorted wire in magneto
6. Shorted harness wire
7. Shorted switch and booster lead
8. Shorted radio filter
9. Shorted ignition switch
10. Booster relay points stuck closed
11. Primary lead to analyzer disconnected
12. Vertical gain control setting of analyzer out of adjustment

NOTE: This will affect all ignition circuits being analyzed.

SHORTED PRIMARY AFTER DISTRIBUTION



DETAIL III

The shorted primary wave form as shown is the result of abnormally low resistance of the primary circuit between the distributor block and the transformer coil primary to ground.

1. Small bar shape of the wave form at ***Stage 2***
2. Smaller than normal wave form which follows the shorted primary wave form at ***Stage 3***

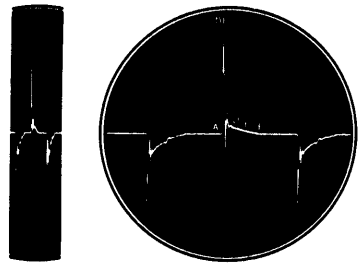
PROBABLE CAUSE.

1. Shorted primary wire in magneto
2. Shorted primary wire in ring manifold
3. Shorted primary wire in bank manifold

NOTE: ***Stage 1*** is normal.

DETAIL IV

OPEN PRIMARY



This wave form will occur when there is an open circuit in one of the transformer primary coil circuits. A single wave form will be affected when the trouble is after the distributor block. All wave forms for one circuit will be affected when the trouble is before the distributor block.

1. Extremely high amplitude at B
2. Low frequency oscillation B to D
3. Wave form has less width than normal

One wave form affected: (as illustrated)

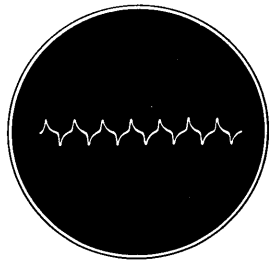
PROBABLE CAUSE.

1. Wire terminal broken off back of distributor block
2. Wire broken in ring manifold
3. Open circuit in bank manifold
4. Open in primary winding of transformer coil

IGNITION ANALYZER PATTERNS

Figure 7–7 (Sheet 1 of 4)

OPEN BREAKER CIRCUIT



This wave form results when primary current does not flow through breaker circuit.

1. All wave forms are affected
2. Absence of any indication of breaker point opening or closing
3. Symmetrical shape of wave forms
4. Low amplitude wave forms

PROBABLE CAUSE.

1. Breaker points not closing

DETAIL V

These wave forms are caused as a result of current flow across open breaker points in the form of an arc. The severity of this condition is proportional to the width of that portion of the wave form A preceding the initial high peak.

Stage 1 – Normal Breaker Arcing.

1. Slight arc at A. This condition intermittent

Stage 2 – Excessive Breaker Arcing.

1. Increased duration of arc at A
2. Spark plug firing; however, ignition is occurring late
3. Breaker points operating very hot
4. All wave forms affected

Stage 3 – Severe Breaker Arcing.

1. Increased duration of arc at A
2. Spark plug not firing
3. Breaker points burning severely
4. All wave forms affected

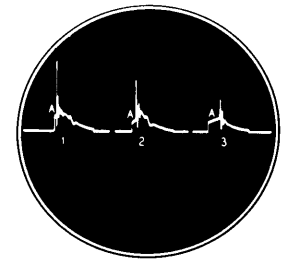
PROBABLE CAUSE.

1. Defective primary condenser
2. Primary condenser disconnected
3. Oil or foreign particles between breaker contacts

NOTE: Stage 1 is a tolerable condition.
Stages 2 and 3 require IMMEDIATE correction.

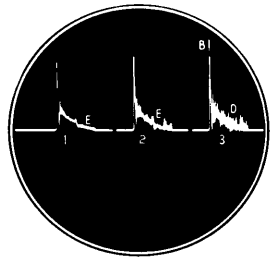
DETAIL VI

BREAKER POINT ARCING
(3 Stages)



DETAIL VII

DISTRIBUTOR ROTOR BRUSH ARCING
(3 Stages)



These wave forms are caused by the distributor rotor carbon brushes making intermittent contact with the distributor plate segments.

Stage 1 – Slight Brush Arcing.

1. Slight jagged variations in wave form preceding breaker point closing at E

Stage 2 – Moderate Brush Arcing.

1. Increased amplitude of variations at E

Stage 3 – Severe Brush Arcing.

1. Variations in initial voltage rise B may or may not be present
2. Increased amplitude of variations at D and E

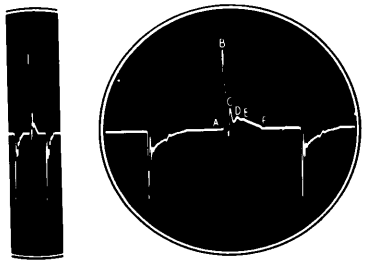
PROBABLE CAUSE.

1. Improper operation of magneto rotor and/or magneto plate

NOTE: Stages 1 and 2 are tolerable conditions and do not necessitate special maintenance.
Stage 3 requires IMMEDIATE maintenance to prevent ignition failure.

Figure 7–7 (Sheet 2 of 4)

OPEN SECONDARY



DETAIL VIII

An open secondary wave form is produced when the resistance of the high tension circuit is so great that there is no path for secondary current to flow.

1. High amplitude of voltage at B
2. Low frequency oscillation between B and C
3. Absence of pulse at D

This wave form is similar but should not be confused with an open primary.

PROBABLE CAUSE.

1. Spark plug lead disconnected or not making contact at spark plug. Cigarette spring missing or broken
2. Spark plug lead disconnected or not making contact at transformer coil
3. Open secondary circuit within transformer coil
4. Spark plug gap too wide
5. Magneto timing incorrect. Low energy output to spark plug

DETAIL IX

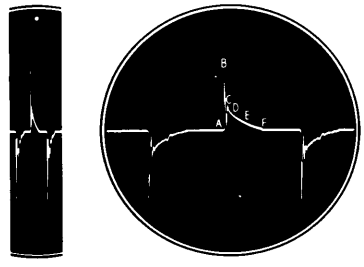
SHORTED SECONDARY

A shorted secondary wave form is produced when the resistance of the high tension circuit is abnormally low. This allows a high value of secondary current to flow at a relatively smooth rate.

1. Smooth voltage decay from C to F
2. Absence of ripple at C
3. Absence of pulse at D
4. Lower amplitude at B

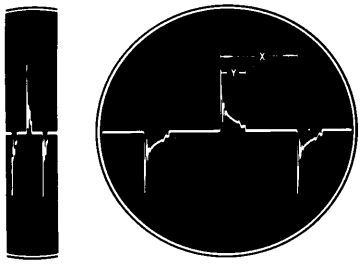
PROBABLE CAUSE.

1. Spark plug shorted
2. Shorted high tension lead
3. Shorted secondary winding in transformer coil
4. Cylinder condition



DETAIL X

BREAKER POINT OPENING INSUFFICIENT



Insufficient breaker point opening is the result of improper adjustment of the ignition breaker (insufficient lift of the cam follower).

1. Abnormally short breaker point open period Y
2. All wave forms affected
3. One complete wave form X

PROBABLE CAUSE.

1. Internal timing of magneto incorrect
2. Cam follower wear

DETAIL XI

BREAKER POINT OPENING EXCESSIVE

The excessive breaker point opening wave form is the result of excessive lift of the cam follower on the cam lobes.

1. Triangular tail on wave form F to G
2. Y dimension (points open period) is much greater than normal
3. All wave forms affected
4. One complete wave form X

PROBABLE CAUSE.

1. Internal timing of magneto incorrect
2. Extreme breaker point erosion

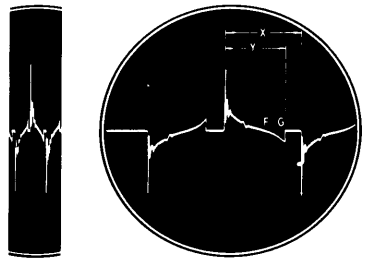
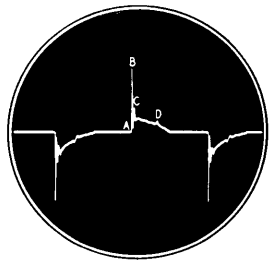


Figure 7–7 (Sheet 3 of 4)

LOW VOLTAGE FIRING



DETAIL XII

This wave form is produced by an ignition system that requires an abnormally small amount of energy to fire the spark plug or plugs. Misfiring will occur and the wave form will show a cease firing condition at a lower than normal reading on the ignition voltage control.

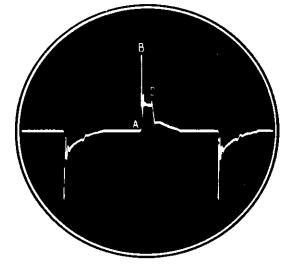
1. Lower than normal amplitude of wave form at B, C, and D
2. Longer period of plug firing indicated by length of A to D

PROBABLE CAUSE.

1. Narrow spark plug gap
2. Spark plug lead disconnected and arcing to ground across small gap
3. Cylinder condition

DETAIL XIII

HIGH VOLTAGE FIRING



This wave form is produced by an ignition system that requires an abnormally large amount of energy to fire the spark plug or plugs. Misfiring will occur and the wave form will show an open circuit condition at a higher than normal reading on the ignition voltage control.

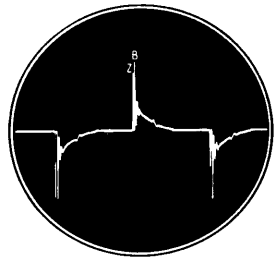
1. High amplitude of wave form at B and D
2. Shorter time of plug firing indicated by pattern width A to D

PROBABLE CAUSE.

1. Wide spark plug gap
2. Spark plug lead disconnected from plug but firing to ground across large gap
3. Cigarette spring missing from spark plug lead

DETAIL XIV

CAM FOLLOWER BOUNCE



This wave form is the result of a momentary opening of the breaker points which occurs just prior to the breaker open period.

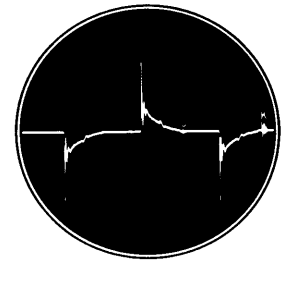
1. Premature pulse occurring at Z
2. Normal initial voltage rise at B
3. One or more wave forms may be affected

PROBABLE CAUSE.

1. Weak cam follower spring

DETAIL XV

BREAKER POINT BOUNCE



This wave form is caused by the untimely opening of the breaker points following their normal closing.

1. Slight voltage pulses at J
2. Increased amplitude of pulses at K

PROBABLE CAUSE.

1. Low main spring tension

NOTE: Intermittent voltage pulses J at high rpm may be considered normal. Does not affect engine operation Continuous voltage pulses K usually indicate a need for replacing breaker assembly

CAUTION: Do not confuse pickup from other magnetos with this trouble

Figure 7–7 (Sheet 4 of 4)

c. Note the value of the dial readings where misfiring and complete stoppage of firing occur. A low dial reading indicates ignition system in good condition.

Analyzer Patterns

The procedure to be followed when operating the ignition analyzer is the same, regardless of the purpose of the check or the suspected malfunction. Ignition system troubles are determined by proper identification of the patterns viewed on the analyzer screen. If any malfunction exists in the ignition of any one cylinder being fired, it can be noted by a deviation from the standard pattern form. By noting the position of this deviation on the complete wave form, the particular cylinder where malfunction occurs can be determined. (See figure 7–6.) Single detailed patterns of normal firing and common ignition troubles are shown in figure 7–7 as a guide to pattern interpretation. The detailed patterns have been coded with numbers I through XV together with explanatory text following each detail. The exact size and shape of the patterns may vary from those viewed on the analyzer control settings. These detailed patterns approximate those on the analyzer screen when the controls are adjusted to show the pattern for only one cylinder. A malfunction of the analyzer does not appear to the operator as an ignition malfunction, but rather, the lack of interpretable patterns. If all patterns exhibit the same type of ignition malfunction, the difficulty lies in the magneto. If only one or two patterns indicate a particular ignition defect, the difficulty lies either in the spark plug itself or at some point between the spark plug and the magneto. The patterns shown are for fine wire spark plugs and differ slightly from those for massive electrode spark plugs which have less vertical activity and more horizontal activity at the hash (point where firing occurs).

CAUTION

If both spark plugs of any cylinder show shorted secondary patterns, consideration should be given to shut the engine down unless it is needed to sustain flight. Often both spark plugs showing shorted secondary patterns are the result of piston or valve failure which may be followed by engine failure.

Note

Analyzer patterns appear alternately above and below the horizontal line.

JET ENGINE OPERATION

The jet engines on the airplane are provided to give additional power for takeoff, climb, refueling operation, and any other operation where additional power is needed. Operation of the jet engines presents no problem if the jet engine limitations and the recommended operating instructions are followed.

ERRATIC OPERATION

Compressor Stall

Rapidly executed throttle changes, decrease-increase-decrease, can cause compressor stall. Stalls are characterized by rpm hangup between 65 and 85 percent rpm and EGT in excess of 575°C. When EGT exceeds 690°C, serious damage to the turbine section can occur, resulting in engine failure. To prevent compressor stalls, avoid rapidly executed throttle changes by using the reciprocating engines when frequent power adjustments are required for inflight maneuvers; i.e., formation, refueling approaches, etc. If stall occurs and duration exceeds 40 seconds, or if duration is unknown and/or EGT exceeds 690°C, initiate normal shutdown procedure immediately. If above limits are not exceeded, clear stalls by retarding throttle to IDLE position. Allow EGT to stabilize by operating at this setting for at least 3 minutes, then return throttle to obtain desired rpm. If setting is accomplished without recurrence of a stall, operate engine in normal manner. If stall does recur, shut down engine. Record maximum EGT and duration of all stalls in Form 781. If duration is unknown, make a statement to this effect.

Acceleration Hangup

Lack of fuel can prevent engine acceleration to speeds above a fixed point. This malfunction is characterized by rpm hangup and low EGT for the throttle setting. Engine shutdown is necessary.

RPM Droop

Some rpm droop at altitude is normal. With compressor stall prevention switch ON, droop to 93 percent engine speed is acceptable. If greater rpm droop is experienced, shut down engine.

COMPRESSOR STALL PREVENTION SYSTEM OPERATION

The compressor stall prevention system is provided as an aid in correcting or avoiding compressor stall. Compressor stall ordinarily occurs during rapid throttle advancement at low temperature.

The compressor stall prevention switch controls the compressor stall prevention systems of both jet engines. If the switch remains ON, the engine will lose rpm. Maximum obtainable rpm may be as low as 93 percent. In addition, the compressor stall prevention switch will be positioned to ON prior to takeoff before moving the throttles out of the idle range. The switch will be left in the ON position until rpm passes 80 percent, then positioned to OFF. A slight rise in rpm should be noted when the switch is positioned to OFF.

Note

The compressor stall prevention solenoid valve is held closed (switch in OFF position) by dc power. The valve will open and remain open in the event of dc power failure. The compressor stall prevention system will operate continuously until dc power is restored.

STARTING TECHNIQUES

Making a satisfactory start consists in getting to idle speed in a reasonable length of time with no undue load on the starter and with exhaust gas temperature within limits throughout the start. If throttle manipu-

lation provides too little fuel, acceleration will be too slow and the starter will be overworked; if it provides too much fuel, overtemperature is likely to occur.

The primary concern during engine starts is thermal shock to engine hot parts, especially the leading edge of turbine buckets. Previous experience has demonstrated that starting EGT's in excess of 800°C adversely affect turbine buckets and hot parts life. Once a crack has been induced in the leading edge of a bucket by hot starts, it's only a matter of time until the outer half of the bucket breaks off and is thrown through the engine.

Setting of the start detents on the throttles helps to govern good starts. The maintenance technical orders specify that a start detent should be adjusted to provide initial peak starting temperatures of 550°C to 750°C. Once set, the detent does not need to be readjusted unless the starting temperature consistently exceeds 800°C or exceeds 850°C on a one time basis.

If an EGT of 950°C or above is encountered during engine starts, the pilot will shutdown the engine and record the overtemperature on Form 781. Maintaining start temperatures of 750°C or below will result in at least 900 percent increase in bucket life when compared to 950°C starts.

Good starting technique calls for observation of both EGT and fuel flow. If fuel flow has stabilized at a reasonable value and the EGT tends to overshoot past 750°C but showing definite signs of a reducing rate of increase, throttle action at this time will probably only produce engine deceleration and resulting difficulty in continuing a smooth starting process. However, if fuel flow is continuing to increase or has approached excessive values (750 to 1000 PPH) throttle retarding is warranted, not to control temperature below 750° but to prevent excessive overtemperature.

The importance of utilizing both the starter and the engine turbine capability in performing a smooth, rapid start cannot be overemphasized. The difficulty arises during high OAT starts because of the limited torque that can be developed by the turbine using acceptable EGT's. Starts can be made utilizing a 450°C to 550°C peak EGT with acceleration to idle using similarly low EGT values. This is not objectionable provided reasonable judgement is used. Experience shows an improvement in hot parts life when EGT's are held in this range. Remember, however, that particularly low exhaust gas temperature results in greater load distribution to the engine starter, thus tending to reduce the probable starter life. On high-temperature days the engine will probably not accelerate once the starter had dropped out if these low exhaust temperatures are maintained. If the engine can be accelerated to idle within the two minute limit, the lower temperatures are considered acceptable. From the standpoint of time-to-idle it should be obvious that the lower the exhaust gas temperature, the longer the time involved. For high OAT starting, low EGT starts are not recommended because invariably the engine refuses to accelerate smoothly, and the start becomes a series of throttle manipulations and EGT peaks into idle.

FUEL SYSTEM MANAGEMENT

USE OF FUEL BOOST PUMPS

For fuel loading and usage sequence and restrictions refer to Section V. Normally, for TE operation, one boost

pump per tank will be on NORMAL. Follow fuel usage sequence as outlined in Section V if restrictions apply; otherwise, balance uneven fuel quantities in the main tanks to provide the optimum weight distribution. Select the tank required or the tank with the greatest amount of fuel, and turn both boost pump switches to NORMAL or as required with the fuel selector switches in the TME position. Note engine fuel pressure increase with other main tank boost pump switches positioned one on NORMAL per tank. When the fuel quantities are as required or equal, resume TE operation. If sufficient fuel pressure is not maintained due to altitude, move one fuel boost pump switch per fuel tank to EMERGENCY to maintain fuel pressure.

WARNING

- During climb and while JP-4 is being supplied to the jet engines from the A/R system, select fuel from the forward A/R tanks or main fuel system if aft A/R tanks contain less than 5000 pounds of fuel.
- During descent and while JP-4 is being supplied to the jet engines from the A/R system select fuel from the aft A/R tanks or main fuel system if forward A/R tanks contain less than 2000 pounds of fuel.

CAUTION

- When changing the fuel selector switches or boost pump switches, watch the fuel pressure. A restoration of fuel pressure, after a drop, may result in engine overspeeding due to power variation. The overspeeding occurs so rapidly that it is necessary to have a hand on the throttles ready for immediate power reduction when making a boost pump or selector switch change. At cruising altitude, set at least one boost pump on NORMAL prior to accomplishing selector change. Always have at least one boost pump switch for each tank on NORMAL when using the manifold system.
- To prevent possible boost pump damage, do not allow a boost pump to operate in an empty tank.
- When a fuel selector switch is changed, watch for proper synchronization of the selector switch and selector valve. This is indicated by the warning light illuminating during the change and going out as synchronization is accomplished. If the valve does not move when the switch is moved in one direction (CW or CCW), move the switch to the desired position by turning it in the opposite direction, since there are independent power leads to the CW and CCW circuits. Reduce throttle prior to cycling through OFF position.
- Engineer will coordinate with pilot before initiating any fuel management procedures or in-flight contamination checks. When operating at other than TE configuration, the engineer's A/R panel fuel quantity gages and transfer valve switches will be checked periodically, with engineer's A/R master switch ON.
- The boom operator will coordinate with the engineer when positioning the manual fuel shutoff valve(s) and will report the position of the valve(s) after manual actuation.

Note

- Takeoffs and climbs are made usually with the fuel selector valve switches positioned to TE and jet engine fuel selector switches positioned to JP4 or GASOLINE (from center wing tank).
- When using emergency boost during fuel management procedures, the fuel pressure should not exceed 34 psi after the desired fuel routing is established. If, with fuel flow established, 34 psi fuel pressure is exceeded, discontinue emergency boost operation and place both boost pump switches for that tank to the NORMAL position. Turn off all other boost pumps; then select one boost pump switch for another tank and place to the NORMAL position to use for backup pressure.

JET ENGINE FUEL SYSTEM MANAGEMENT

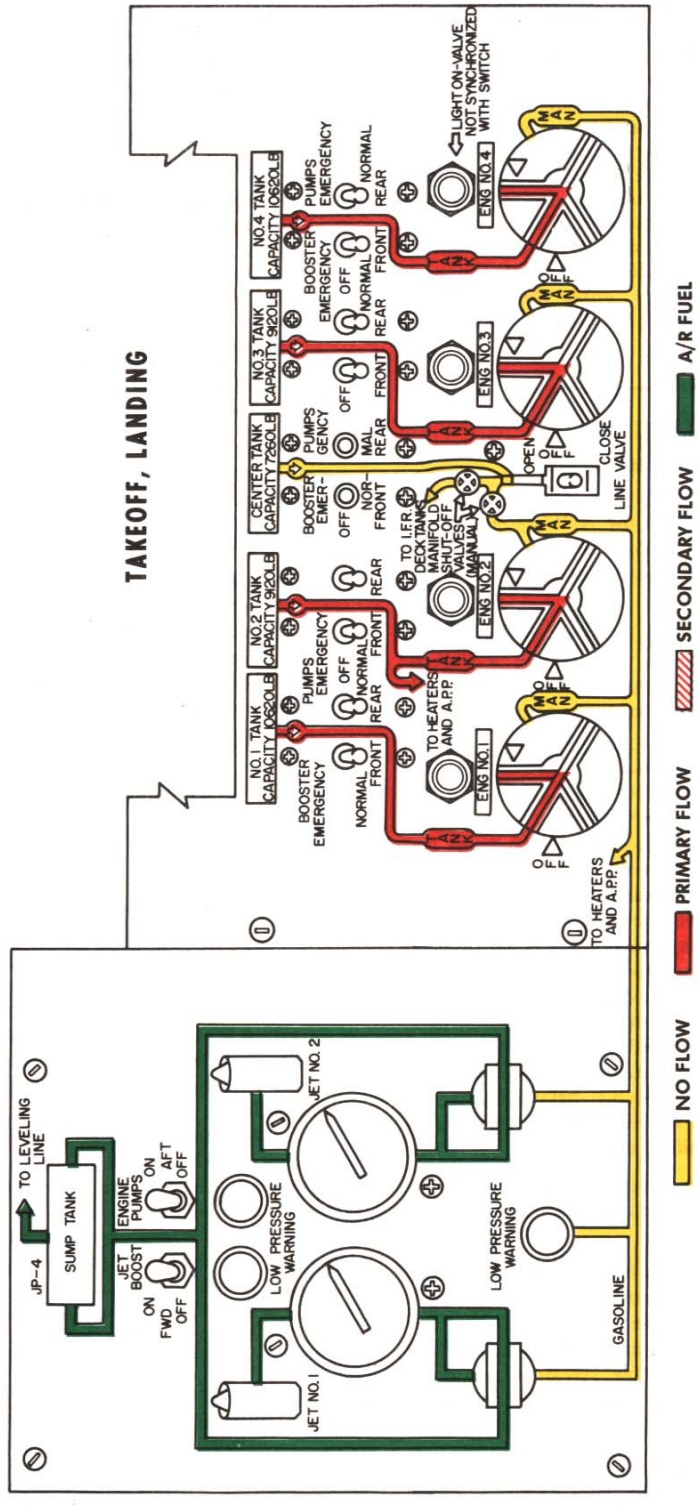
The jet engine may be operated on JP-4 supplied by the air refueling system or on gasoline supplied by the main fuel system manifold. (See figure 7–8.) To operate the jet engines on JP-4, one or both leveling valve switches must be positioned to OPEN, the jet engine sump tank shutoff valve must be open, the jet engine sump tank boost pump switches must be ON, and the jet engine fuel selector switches must be positioned to JP-4. To operate the jet engines on gasoline, the desired main fuel selector switches must be positioned to TME, the main tank fuel boost pump switches must be positioned to NORMAL, and the jet engine fuel selector switches must be positioned to GASOLINE. The jet engines can also be operated on gasoline from the center wing tank through the main fuel system manifold by positioning the main fuel selector switches to TE, closing No. 2 manual fuel shutoff valve, opening No. 1 manual fuel shutoff valve, positioning line valve switch to OPEN, turning CWT boost pump switches on, and positioning jet engine fuel selector switches to GASOLINE.

Note

The No. 1 manual fuel shutoff valve is safetied open and the No. 2 manual fuel shutoff valve is safetied closed for all normal fuel management.

To change jet engine fuel from JP-4 to gasoline during flight, proceed as follows:

1. Jet Engine Throttles - APPROXIMATELY 70%.



FUEL SYSTEM MANAGEMENT

Figure 7–8 (Sheet 1 of 3)

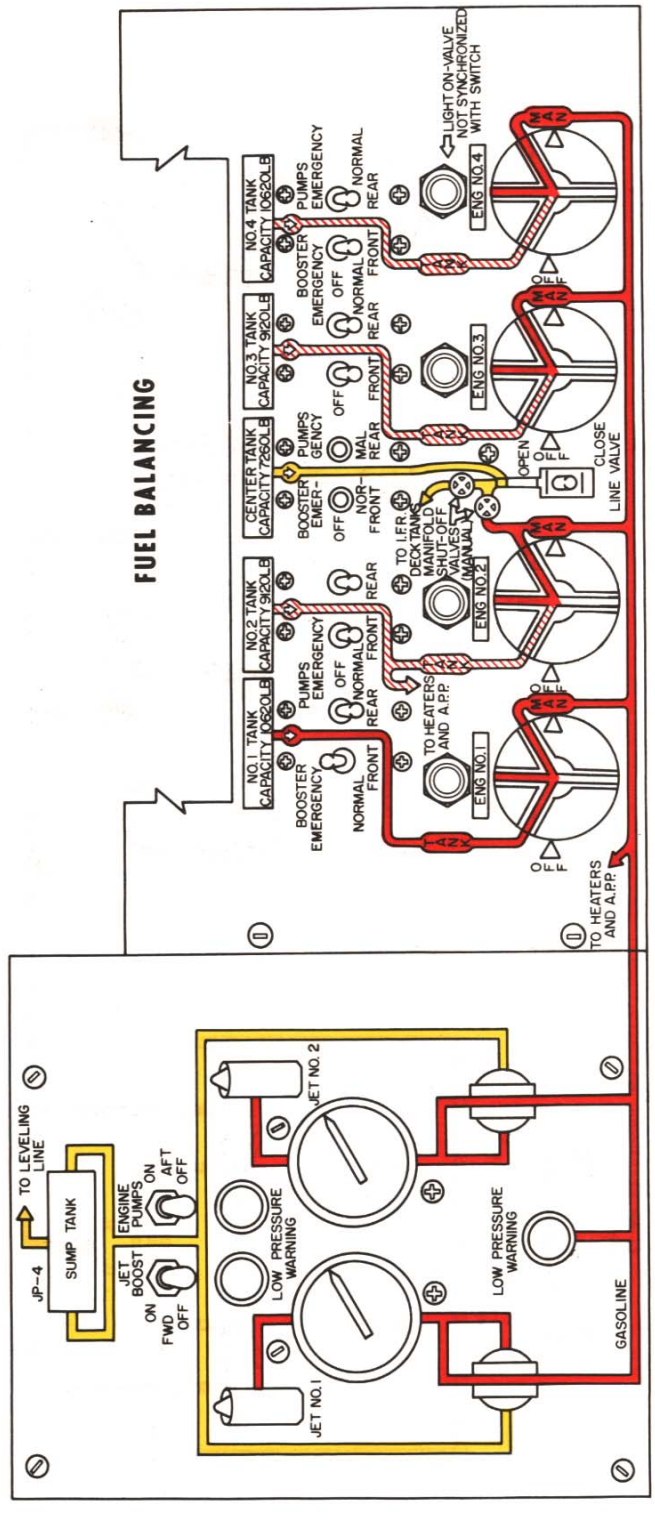


Figure 7–8 (Sheet 2 of 3)

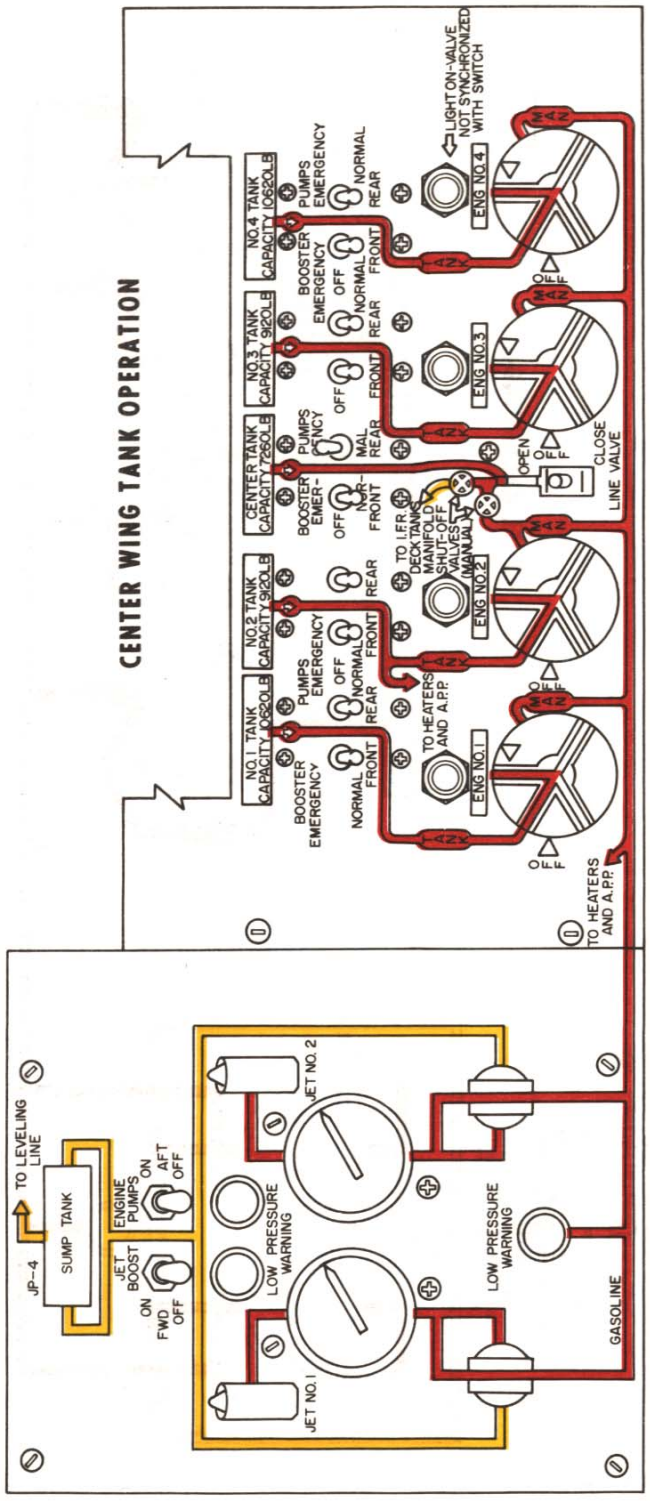


Figure 7–8 (Sheet 3 of 3)

2. Main Fuel Selector Switches – TME.
3. Main Tank Fuel Boost Pump Switches (Two Per Tank) – NORMAL.
4. Jet Engine Fuel Selector Switches – GASOLINE.
5. Sump Tank Boost Pump Switches – OFF.
6. Jet Engine Throttles – AS DESIRED.

To change jet engine fuel from gasoline to JP-4 during flight, proceed as follows:

1. A/R Fuel Leveling Valve Switches – AS REQUIRED.
2. Sump Tank Boost Pump Switches – ON.
3. Jet Engine Throttles – APPROXIMATELY 70%.
4. Jet Engine Fuel Selector Switches – JP-4.
5. Fuel Management – AS REQUIRED
6. CWT Line Valve Switch – CLOSED.
7. CWT Fuel Boost Pump Switches – OFF.

FUEL BALANCING PROCEDURES

Reciprocating Engine Operation

1. No. 1 And No. 4 Fuel Selector Switches - TME.
2. No. 1 or No. 4 Fuel Boost Pump Switches - BOTH ON NORMAL (OR AS REQUIRED FOR 5 MINUTES).

Note

This procedure will be accomplished prior to the initial use of fuel from the main manifold for reciprocating engines, but need not be re-accomplished thereafter unless contamination is suspected.

3. Fuel Management – AS REQUIRED.

Jet Engine Operation (Main Manifold)

1. No. 1 Or No. 4 Fuel Selector Switches – TME.
2. Selected Tank Boost Pump Switches – AS REQUIRED.
3. Jet Engine Throttles – APPROXIMATELY 70%. (E, P)
4. Jet Engine Fuel Selector Switches – GASOLINE.
5. Fuel Management – AS REQUIRED.
6. Jet Engine Sump Tank Boost Pump Switches – OFF.
7. A/R Fuel Leveling Valve Switches – CLOSED.

IN-FLIGHT USE OF AUXILIARY TANK FUEL FOR AIRPLANE

Center Wing Tank (CWT)

Jet Engine Operations.

1. CWT Fuel Boost Pump Switches – ON (AS REQUIRED).
2. CWT Line Valve Switch – OPEN.
3. Jet Engine Throttles – APPROXIMATELY 70%. (E, P)
4. Jet Engine Fuel Selector Switches – GASOLINE.
5. Jet Engine Sump Tank Boost Pump Switches – OFF.
6. A/R Fuel Leveling Valve Switches – CLOSED.

Reciprocating Engine Operation (Gasoline).

1. CWT Fuel Boost Pump Switches – ON (AS REQUIRED).
2. CWT Line Valve Switch – OPEN.
3. No. 1 Or No. 4 Fuel Selector Switch – TME (FOR 5 MINUTES TO CHECK FOR CONTAMINATED FUEL).
4. Fuel Management – AS REQUIRED.

FUEL TRANSFER (RANGE EXTENSION)

WARNING

This procedure will only be used if the air refueling tanks and boom have been flushed and serviced with AVGAS grade fuel.

Contamination Check

This procedure will not transfer any fuel to the wing tanks, but is only a test for contamination.

1. Jet Engine Fuel Selector Switches – JP-4.
2. Main Fuel Selector Switches – TE.
3. No. 3 Manual Fuel Shutoff Valve – HAVE MANUALLY OPENED.
4. No. 6 A/R Hydraulic Valves – HAVE MANUALLY CLOSED.
5. One Main Tank Fuel Selector Switch – TME.
6. Isodraulic Handle – ADVANCE. Advance handle until a definite rise in fuel pressure is noted on selected engine.
7. Monitor Selected Engine – 5 MINUTES.

WARNING

If, on the selected engine, the CHT begins to rise (and the other CHT's do not) and the exhaust smoke becomes black or the engine begins to run rough, immediately return the fuel selector switch to the TE position and turn the fuel boost pump switches to the NORMAL position. The above are indications of contaminated fuel. If contamination is evident, do not open any other fuel valves connecting the airplane manifold to the airplane system tanks or engines until system is purged.

If after 5 minutes of operation, all instruments are normal:

8. Isodraulic Handle – OFF.
9. Selected Fuel Selector Switch – TE.

If transfer from A/R tanks to main fuel tanks is desired at this time, steps 10 and 11 may be omitted.

10. No.6 A/R Hydraulic Valves - HAVE MANUALLY OPENED.
11. No. 3 Manual Fuel Shutoff Valve – HAVE MANUALLY CLOSED.

Transfer From A/R Tanks To Airplane Tanks

1. Jet Engine Fuel Selector Switches – AS REQUIRED.
2. No. 3 Manual Fuel Shutoff Valve – HAVE MANUALLY OPENED.
3. No. 6 A/R Hydraulic Valves – HAVE MANUALLY CLOSED.
4. SPR Panel – HAVE CONNECTED.
5. Secondary Valve Switches – HAVE OPENED (AS REQUIRED).
6. Isodraulic Handle – ADVANCE.

CAUTION

- Limit air refueling pressure gage reading to 30 psi.
- Do not fill any tank above the following levels:

Tanks 1 and 4	9700 lb
Tanks 2 and 3	8200 lb
Center Wing Tank	6200 lb

7. Termination of Procedure:
   a. Isodraulic Handle – OFF.
   b. Secondary Valve Switches – HAVE CLOSED.

   The engineer will monitor the fuel gages and instruct boom operator to close the secondary valves when the above noted quantity or less, if desired, is reached.

Note

Before the last secondary valve switch is closed, retard the isodraulic handle to OFF to avoid possible pressure surge.

   c. SPR Panel – STOWED.

   Have SPR panel removed and stowed when fuel transfer is complete and all secondary valves are closed.

   d. No. 6 A/R Hydraulic Valves – HAVE MANUALLY OPENED.
   e. No. 3 Manual Fuel Shutoff Valve – HAVE MANUALLY CLOSED.
   f. Fuel Management – AS REQUIRED.

FUEL TRANSFER TO A/R TANKS

WARNING

When carrying fuel other than uncontaminated AVGAS in the CWT, the No. 1 manual fuel shutoff valve must be safetywired in the closed position. This is to prevent contamination of the airplane fuel system. When it is desired to use these fuel tanks for the airplane system, all contaminated fuel must be drained and flushed out before refilling with AVGAS.

Note

Engineer will coordinate with pilot on all fuel transfer operations.

Main Fuel Tanks To Center Wing Tanks (CWT)

Note

If a contamination check has been accomplished, steps 1 and 2 may be omitted unless contamination is suspected.

1. No. 1 And No. 4 Fuel Selector Switches – TME.
2. No. 1 or No. 4 Fuel Boost Pump Switches - BOTH ON NORMAL (OR AS REQUIRED FOR 5 MINUTES).
3. Main Fuel Selector Switches – TIMES AS REQUIRED.
4. Main Tank Fuel Boost Pump Switches – AS REQUIRED.
5. CWT Secondary Valve – HAVE MANUALLY OPENED.
6. Fuel Quantity Gages – MONITOR.

CAUTION

Do not fill center wing tank above 6200 pounds.

7. Termination of Procedure:
   a. CWT Secondary Valve – CLOSE (WITH SPR TEST SWITCH).
   b. Fuel Management – AS REQUIRED.

Center Wing Tank (CWT) To A/R Tanks

1. Jet Engine Fuel Selector Switches – GASOLINE. Refer to JET ENGINE OPERATION (MAIN MANIFOLD), This section.
2. Jet Engine Sump Tank Manual Shutoff Valve – HAVE MANUALLY CLOSED.
3. No. 1 Manual Fuel Shutoff Valve – HAVE MANUALLY CLOSED.
4. A/R Master Switch – ON.
5. CWT Fuel Boost Pump Switches – EMERGENCY (OR AS REQUIRED).
6. CWT Line Valve – OPEN.
7. No. 2 Manual Fuel Shutoff Valve – HAVE MANUALLY OPENED.
8. A/R Fuel Leveling Valve Switch – AS REQUIRED. Forward leveling valve OPEN.
9. A/R Transfer Valve Switches – OPEN (AS REQUIRED).
10. Termination Of Procedure:
    a. A/R Transfer Valve Switches - CLOSED.
    b. No. 2 Manual Fuel Shutoff Valve - HAVE MANUALLY CLOSED.
    c. No. 1 Manual Fuel Shutoff Valve - HAVE MANUALLY OPENED and SAFETIED
    d. A/R Fuel Leveling Valve switches - CLOSED.
    e. A/R Master Switch - AS REQUIRED.
    f. CWT Line Valve Switch - CLOSED.
    g. CWT Boost Pump Switches - OFF.
    h. Jet Engine Sump Tank Manual Shutoff Valve - HAVE MANUALLY OPENED.

Main Fuel Tanks To A/R Tanks

WARNING

If the CWT contains fuel other than AVGAS, the following sequence of operation should be rigidly adhered to:

Note

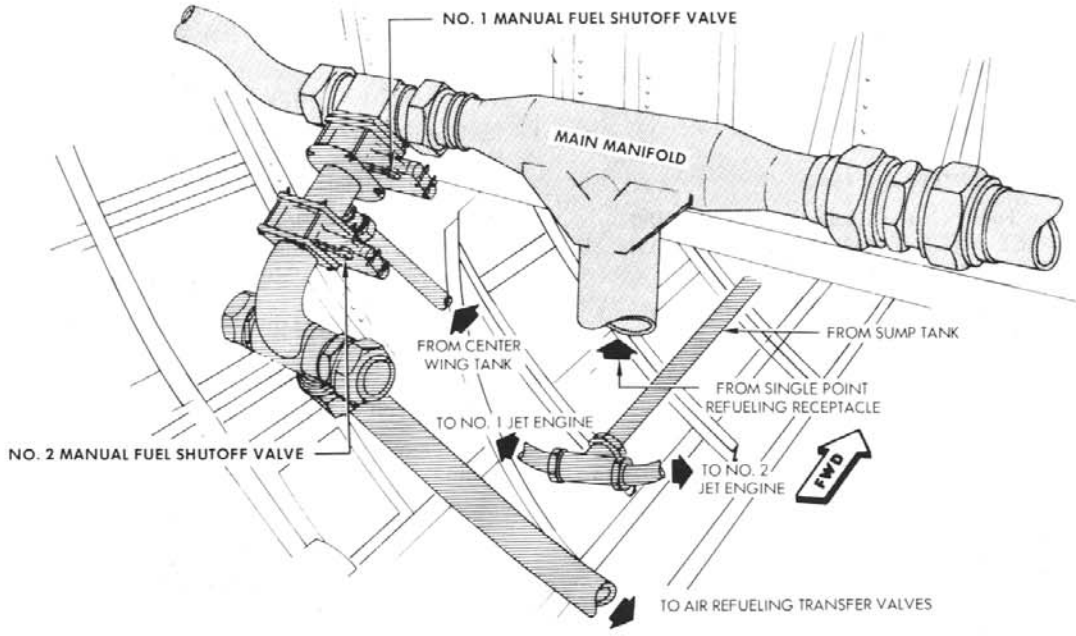
If a contamination check has been accomplished, steps 1 and 2 may be omitted unless contamination is suspected.

1. No. 1 and No. 4 Fuel Selector Switches - TME.
2. No. 1 or No. 4 Fuel Boost Pump Switches - BOTH ON NORMAL (OR AS REQUIRED FOR 5 MINUTES).
3. Jet Engine Fuel Selector Switches – GASOLINE. Refer to JET ENGINE OPERATION (MAIN MANIFOLD), this section.
4. Main Feul Tank Boost Pump Switches – ONE NORMAL, ONE EMERGENCY.
5. Fuel Selector Switches – TME OR AS DESIRED.
6. Jet Engine Sump Tank Manual Shutoff Valve – HAVE MANUALLY CLOSED.
7. No. 2 Manual Fuel Shutoff Valve – HAVE MANUALLY OPENED.
8. A/R Transfer Valve Switches – OPEN (AS DESIRED)

WARNING

- This transfer operation can cause the fuel low-pressure warning lights to illuminate due to insufficient engine-driven fuel pump inlet pressure. If this occurs, terminate transfer of fuel from the main fuel tanks to the A/R tanks; or, if transfer of fuel from the main fuel tanks to the A/R tanks is still necessary, move No. 2 manual fuel shutoff valve toward the closed position until the fuel low-pressure warning lights go out. Partially closing the No. 2 manual fuel shutoff valve will reduce the rate of fuel transfer from the main fuel tanks to the A/R tanks.
- When transferring fuel from the main fuel tanks to the A/R tanks, care must be taken to retain sufficient fuel in the main fuel tanks for a safe landing.

9. A/R Fuel Leveling Valve Switch – AS REQUIRED. Forward leveling valve OPEN.
10. Termination of Procedure:
    a. A/R Transfer Valve Switches – CLOSED.
    b. No. 2 Manual Fuel Shutoff Valve – HAVE MANUALLY CLOSED.
    c. Jet Engine Sump Tank Manual Shutoff Valve – HAVE MANUALLY OPENED.
    d. A/R Fuel Leveling Valve Switches – CLOSED.
    e. A/R Master Switch – AS REQUIRED.
    f. Fuel Management – AS REQUIRED.



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VIEWS IN LOWER AFT COMPARTMENT

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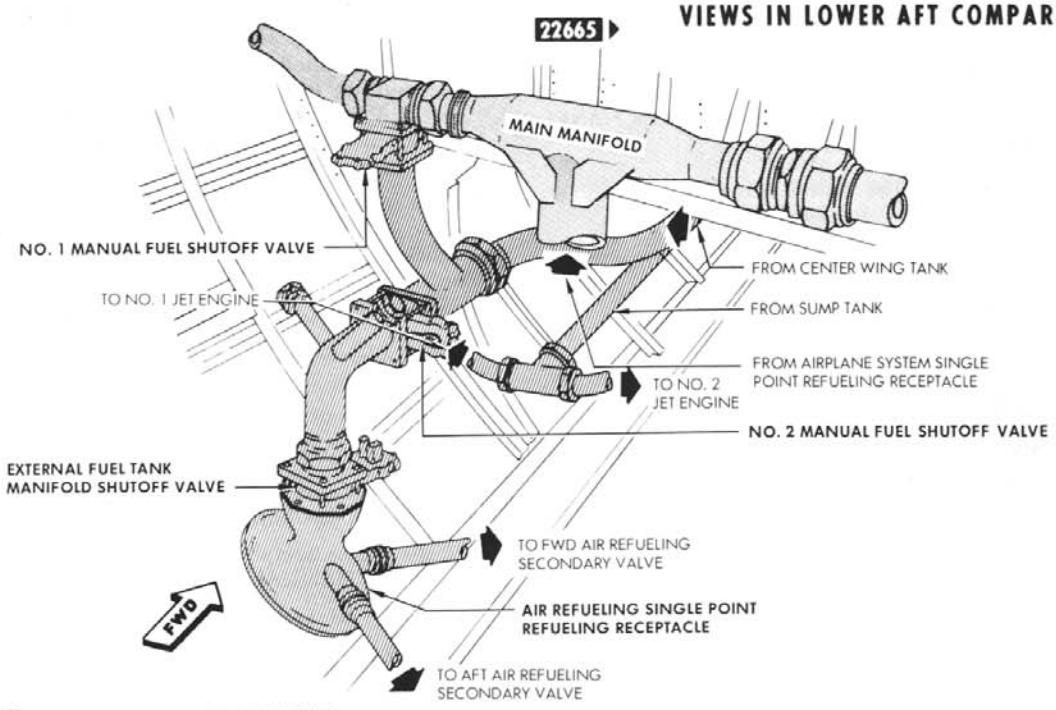
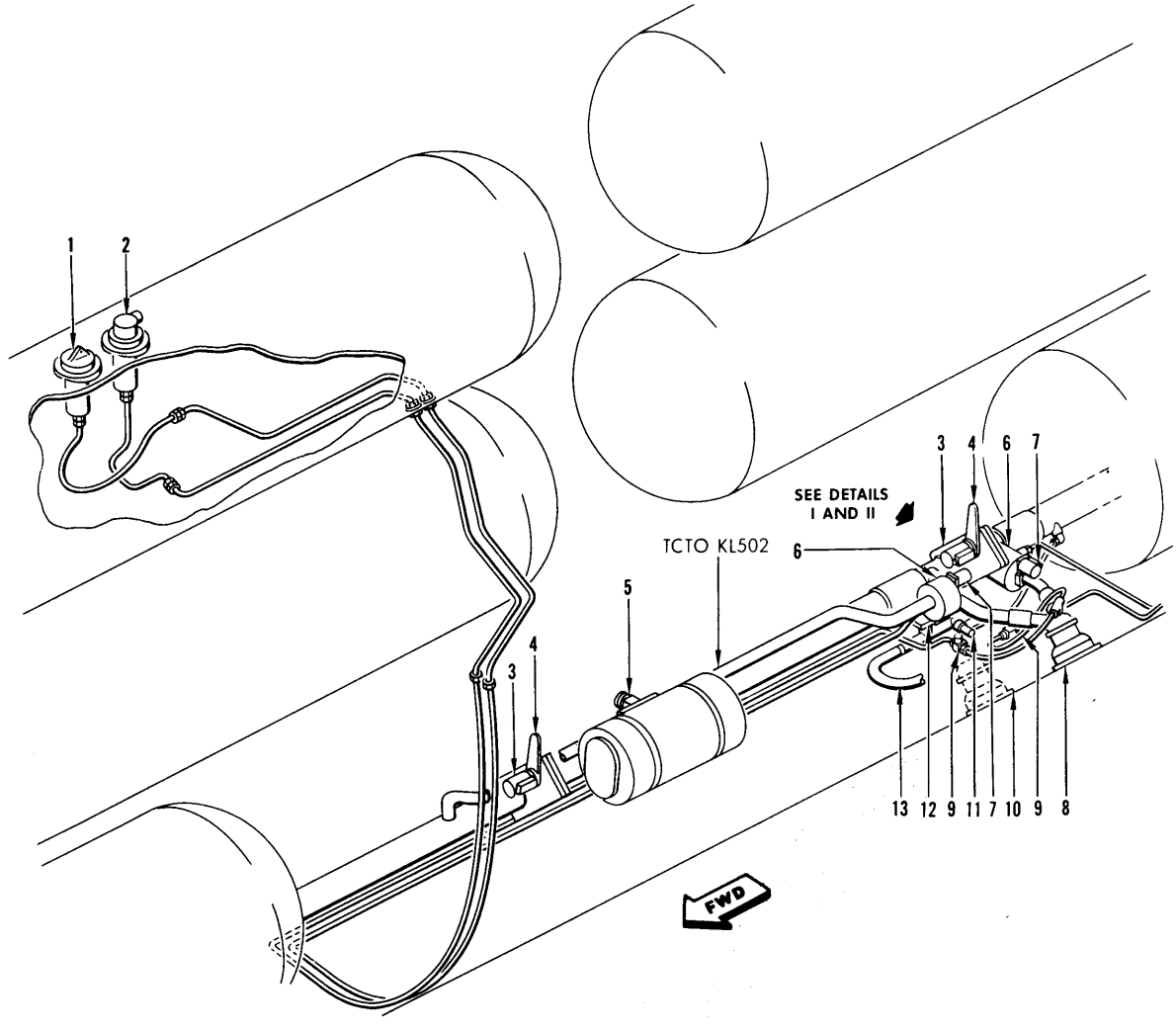


AIRPLANE MAIN FUEL MANIFOLD
AUXILIARY AND/OR AIR REFUELING LINES

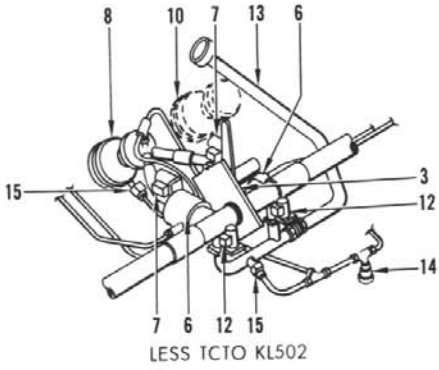
FUEL SYSTEMS INTERCONNECTION

Figure 7–9 (Sheet 1 of 3)



1 PRIMARY FUEL LEVEL FLOAT VALVE
2 SECONDARY FUEL LEVEL FLOAT SWITCH
3 FUEL LEVELING VALVE (2 PLACES)
4 LEVELING VALVE MANUAL CONTROL ARM (2 PLACES)
5 SUMP TANK MANUAL SHUTOFF VALVE
6 PRIMARY SHUTOFF VALVE (2 PLACES)
7 SECONDARY SHUTOFF VALVE (2 PLACES)
8 AIR REFUELING SINGLE POINT REFUELING PORT
9 SECONDARY FLOAT SWITCH TEST VALVE
10 MAIN FUEL SYSTEM SINGLE POINT REFUELING PORT
11 THERMAL RELIEF VALVE
12 TRANSFER VALVE 17260 ▶ 22664
13 LINE TO MAIN FUEL SYSTEM MANIFOLD 17260 ▶ 22664
14 FILLER PORTS AND TRANSFER LINE OVERBOARD DRAIN
15 DRAIN LINE SHUTOFF VALVE
16 TRANSFER LINE
17 THERMAL RELIEF VALVE 22665 ▶
18 LINE TO AIRPLANE FUEL SYSTEM MANIFOLD 22665 ▶
19 SECONDARY TRANSFER VALVE 22665 ▶
20 THERMAL RELIEF LINE
21 EXTERNAL TANK SHUTOFF VALVE 22665 ▶

Figure 7–9 (Sheet 2 of 3)



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DETAIL I

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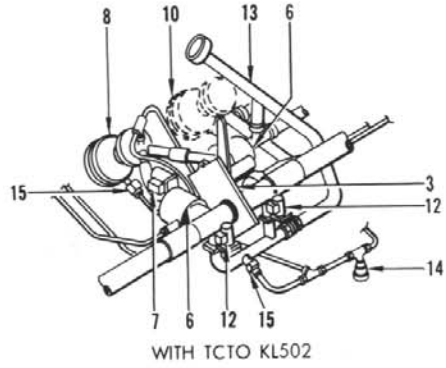
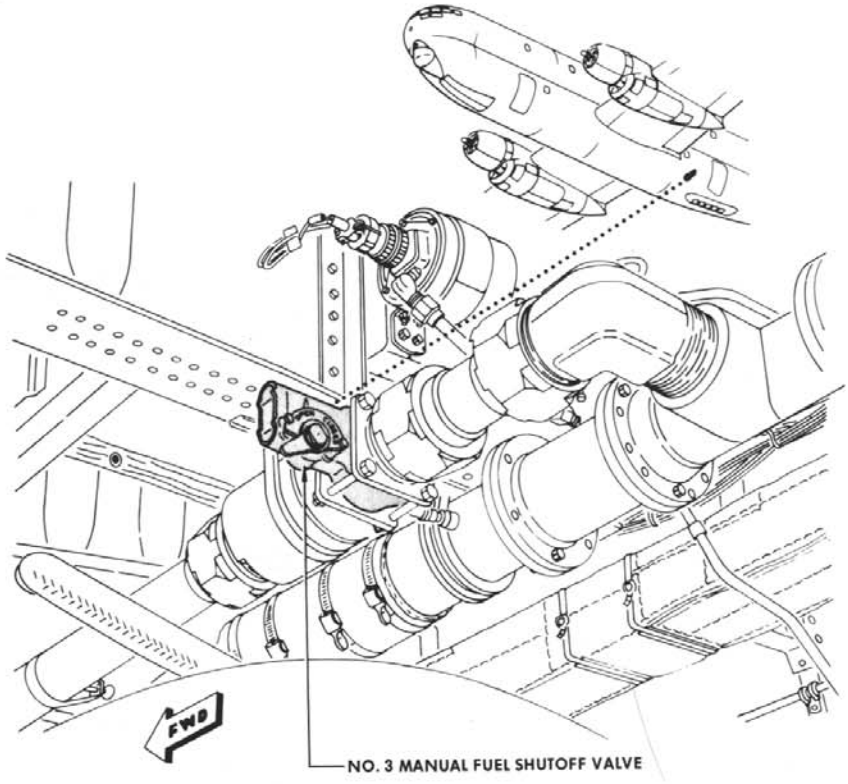
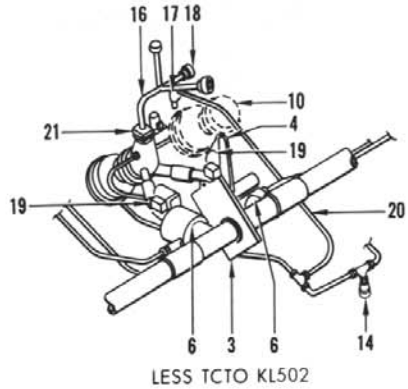


WITH TCTO KL502

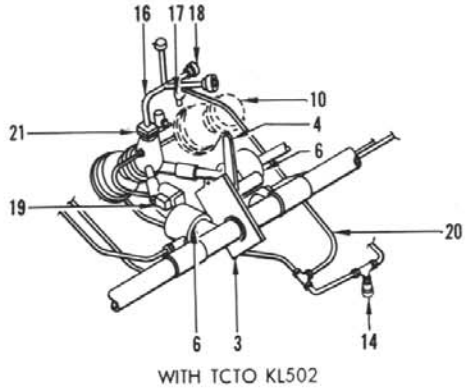




LESS TCTO KL502

DETAIL II

22665 ▶



WITH TCTO KL502

Figure 7–9 (Sheet 3 of 3)

DEFUELING AND RECOVERY

Ground Fuel Transfer

The A/R tanks can be defueled on the ground through the boom directly into the receiver receptacle or filler ports of an airplane or into a fuel truck. A ground fuel transfer hose and desired fittings are necessary to connect the boom to an airplane. Power for the operation is obtained from hydraulic and electric supply carts, or the airplane engines if carts are not available.

Note

When airplane power is used for transfer, both outboard engines are operated at 1000 rpm for electrical and hydraulic power. The number of engines operated depends upon the rate of transfer desired. Inboard engines are operated for hydraulic power to assure proper braking. On 707-320 the inboard engines also supply hydraulic pressure to the motor-pump combination for pressurizing the boom hydraulic system.

a. Position tanker airplane in the same relative position used in aerial contact in front of receiver airplane, and close enough to connect ground fuel transfer hose.

WARNING

Before and during transfer operations, all units should be statically grounded and all fire precautions complied with in order to reduce the fire hazard to a minimum. Portable fire extinguishers should be readied if a fire truck is not available.

b. Connect external power sources or, if not available, start airplane engines.

c. Place the boom operator's and engineer's A/R master switches in the ON position, the main inverter switch in the ESS. INV. position, the secondary inverter switch in the SEC. INV. position, and the telescope-at-disconnect switch in the MANUAL position.

d. Lower the boom to within reach of the ground and extend approximately 12 feet.

CAUTION

If available, an adjustable padded dolly should follow movement of the boom when it is raised or lowered during ground operation in case malfunction of the hoist system should occur.

e. Connect fuel transfer hose to boom and receiver airplane, air refueling receptacle or filler ports.

CAUTION

Care must be taken with dummy receptacle and spare nozzle to prevent scratches and nicks that will result in fuel leakage.

Note

A force greater than 100 pounds is necessary to fully bottom nozzle against spring-loaded sliding valve in receptacle. It may be necessary to actuate receptacle signal switch manually in order to engage toggle arms.

f. Advance signal system to CONTACT-MADE condition, and commence fuel flow by slowly moving the isodraulic handle in INCREASE direction.

CAUTION

Although a flow of 600 gpm is possible when transferring fuel into a receiver airplane through the air refueling receptacle, it is necessary to use a much lower rate of flow when using a nozzle to transfer fuel into airplane filler ports or a fuel truck to avoid damage to hose.

Note

If it is desired to operate one A/R pump, operate the aft pump to prevent a tail-heavy condition. After approximately two-thirds of the aft tank capacity has been removed, open the leveling valve and continue defueling until tanks are empty.

g. When tanks are empty, move isodraulic handle fully to OFF, return air refueling signal system to normal, and remove ground fuel transfer hose. Retract and stow the boom; place the boom operator's and engineer's A/R master switches in the OFF position.

h. If external power supply was used, place main inverter and secondary inverter switches in the OFF position, and disconnect external power. If airplane power was used, shut down engines if not required to supply power to receiver airplane.

Recovery

On the ground, airplanes are capable of supplying dc power to a receiver airplane. The feature is intended primarily for use when other external power sources are not available. The airplane should be positioned in front of the receiver airplane in the same relative position as used in aerial contact.

a. Check external power reset switch on forward power panel positioned to RESET.

b. Connect power cable to dc external power receptacles on both airplanes.

CAUTION

To supply starting current to receiver airplane both adjacent dc external power receptacles must be used.

c. Start engine.

d. Position external power relay switch to EXT PWR.

NOTE

Use only essential electrical services during period receiver airplane is starting engines.

After receiver airplane engines have started, switch external power relay switch to RESET and remove power cable.

WARNING

When using this procedure in conjunction with fuel transfer, extreme care must be taken to avoid the possibility of fire, as arcing may occur should the power cable be connected or disconnected without first insuring that electrical power has been removed from the dc external power receptacle.

OIL SYSTEM

OIL TRANSFER OPERATION

To replenish the engine oil tanks while in flight, the oil tank selector switch is set to the desired tank to be refilled, and the oil transfer pump switch is held in the ON position until the desired quantity is reached. Turn the tank selector switch to the next tank to be filled and repeat the procedure. Leave the tank selector switch on a selected tank when the oil transfer is completed.

NOTE

- The oil transfer pump transfers oil at a rate of 7 gallons per minute. Do not operate the pump longer than 8 minutes without a cooling period.
- When a pronounced oil pressure drop or fluctuation occurs any time during engine operation, 1 gallon of oil will be transferred into the engine oil tank immediately. This will aid in improving oil scavenging and decreasing aeration.

CAUTION

Replenishment to a selected engine oil tank should be discontinued, after a period of 30 seconds, if oil transfer is not clearly indicated. A broken line or a serious oil leak may be allowing oil to be pumped overboard.

a. During level flight maintain oil quantity between 15 and 24 gallons.

b. With central oil tank supply depleted, and any engine oil tank quantity less than 15 gallons, land at the nearest suitable base.

c. The restriction imposed in step a is not applicable during a 30-minute period prior to landing in order to permit servicing of the engine oil tank, if so desired.

CAUTION

- Due to the nose-down attitude in descent, the engine may swallow quantities of oil up to 20 gallons which will return to the tank when the airplane is in level flight again. If the tank is replenished while this oil is in the engine, it is possible to force large quantities of oil out of the vent and collapse the turbosupercharger oil tank when oil is returned to the engine oil tank. Therefore, during or immediately following a descent, when the tank level is 10 gallons, replenish to a maximum of 20 gallons.
- Feather engine if oil quantity drops below 10 gallons, except when power is a critical requirement. This action is necessary to prevent engine damage due to air entrainment.

ELECTRICAL SYSTEM

DIRECT CURRENT POWER SYSTEM

Major dc electrical loads are listed in figure 7–10. Average dc electrical loads and the number of generators required to meet these loads for various operating conditions are shown in figure 7–11. This illustration can be used as a guide to determine how many units can be operated in case of partial failure of the dc power generation systems.

Direct Current Power System Battery

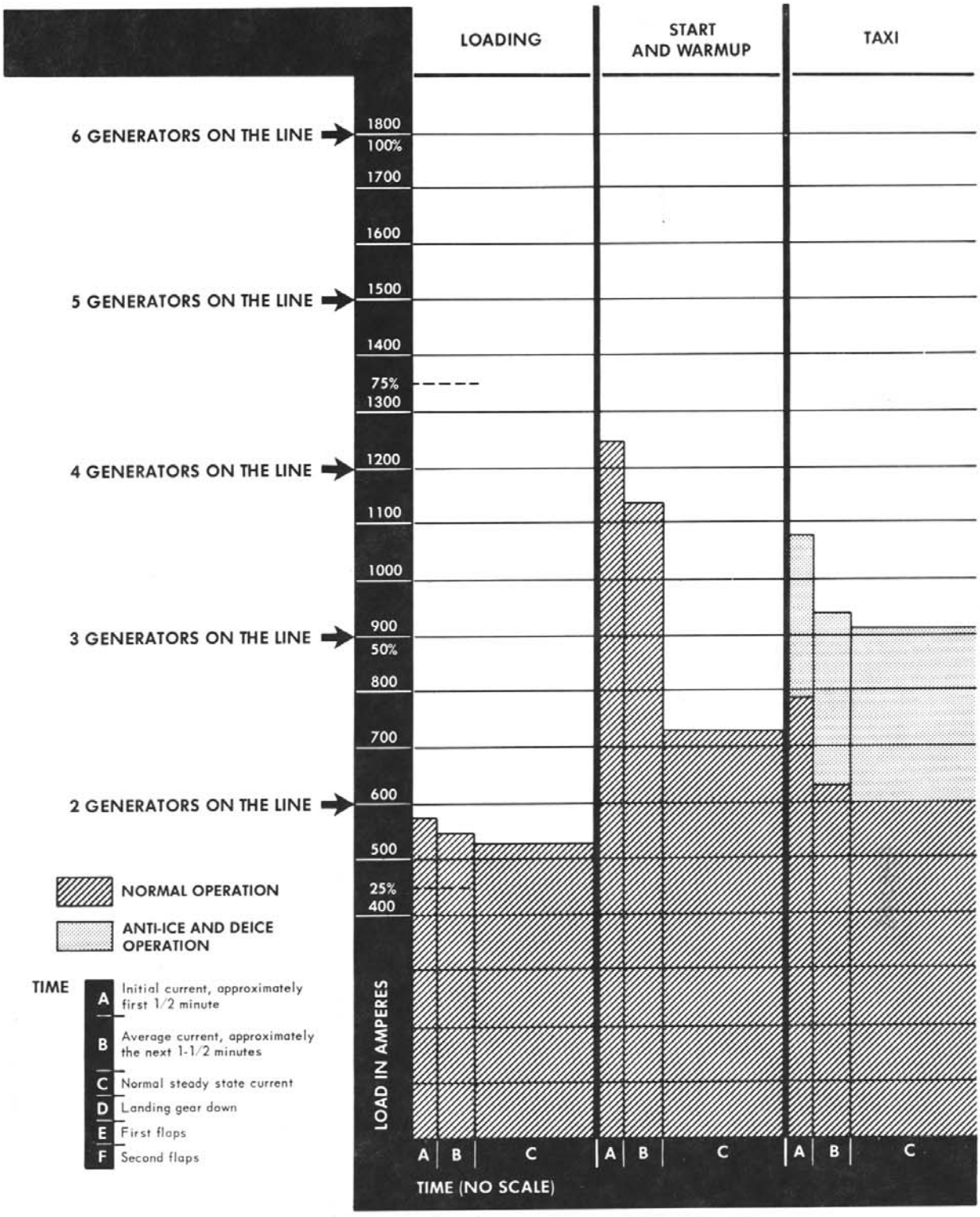
The battery can be charged at any time, whether on the ground or in flight, by placing the battery switch in the BAT CHG. position. The switch should be left on BAT CHG. during flight to assure a fully charged battery in an emergency. The life and capacity of a fully charged battery are greater than that of an undercharged battery. Charging current flows from the power distribution circuit through the reverse current relay to the battery. However, any flow of current from the battery to the power distribution circuit would be interrupted by opening of the reverse current relay, thus preventing the battery from supplying any power to the normal distribution system. To determine battery voltage, place the battery switch in the OFF position before placing the dc voltage selector switch in the BAT position. This is necessary because when the battery switch is in the BAT CHG. position, the reading will show bus voltage. For further information, refer to ELECTRICAL SYSTEMS, Section I.

EQUIPMENT	NO. UNITS	AMP PER UNIT	START TAXI	TAKEOFF CLIMB	CRUISE	LANDING
Anti-Icing						
Empennage Ground Blowers	1 Combustion	7				
	1 Ventilating	20	27			27
Propeller Drive	4	279	279	279	279	279
Static Source Heaters	**4**	**17**	**17**	**17**	**17**	**17**
Electrical Power						
Autopilot Inverter	1 1 Spare	42	42	42	42	42
DC Generator Field	6	7	42	42	42	42
Main Inverters	2 1 Spare					
Essential	1		107	107	150	150
Secondary	1		68	92	147	94
Engine Controls						
Propeller Feathering and Reversing	4	137				
Carburetor Air Actuator	4	17			68	
Carburetor Preheat Actuator	4	2.5			10	
Cowl Flap Motors	4	17	69	69	69	69
Propeller Throttle Lock	1	24				24
Starter Motors	4	200	205			
Starter Motors (Jet)	2	2200 Max				
Flight Controls						
Wing Flap Motor	1	160 Extend 170 Retract	165	175		165
Fuel and Oil						
ADI Pumps	2	15		30		
Fuel Boost Pumps	8	10 Normal 25 Emergency		83	42	
Fuel Boost Pumps (B-24)	2	65	65	130	65	65
Fuel Selector Valves (Jet)	4	1.5				
Fuel Shutoff Valves (Jet)	2	1.5				
Fuel Valves	12	0.55	11	11	11	11
Oil Shutoff Valves	2	1.7				
Oil Transfer Pump	1	140 Normal 160 Surge			141	
Heating and Ventilating						
Cabin Fans	2	6	12	12	12	12
Ground Blowers	2	42	85			85
Suit Heaters 17260 ▶ 2859	5	16				
Landing Gear						
Main Gear Motors	2	235 Extend 260 Retract		412		470
Nose Gear Motor	1	129 Extend 92 Retract		92		129
Lighting						
Circuit Breaker Panel Lights (Jet)	2	0.4	20	10	10	10
Control Lamps	79	0.2 to 0.8	13	13	13	13
Dome Lights	16	0.8	48			48
Landing Lights	2	22	11			11
Taxi Lights	2	5	10			10
Wheel Well Lights	3	2				
Radio						
Interphone	**1**	**15**	**15**	**15**	**15**	**15**
HF (Arc-65)	**1**	**41**	**20**	**20**	**41**	**20**
UHF (Arc-27)	**2**	**25**	**25**	**25**	**25**	**25**
VHF (Wilcox 807)	**1**					
Transmitter		**7.5**	**7.5**	**7.5**	**7.5**	**7.5**
Receiver		**2.0**	**2.0**	**2.0**	**2.0**	**2.0**
VOR (ARN-14)	**1**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**
Search Radar (APS-42)	**1**	**22**	**22**	**22**	**22**	**22**
Rendz. Radar (APX-29)	**1**	**3.6**	**3.6**	**3.6**	**3.6**	**3.6**
AIMS/IFF (APX-72)	**1**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**
Air Refueling						
Fuel Boost Pump (Center Wing Tank)	2	32.5			65	

(Loads less than 1 percent of three-generator capacity are not included in this chart)

ELECTRICAL LOADS

Figure 7–10



DC ELECTRICAL LOADS

Figure 7–11 (Sheet 1 of 2)

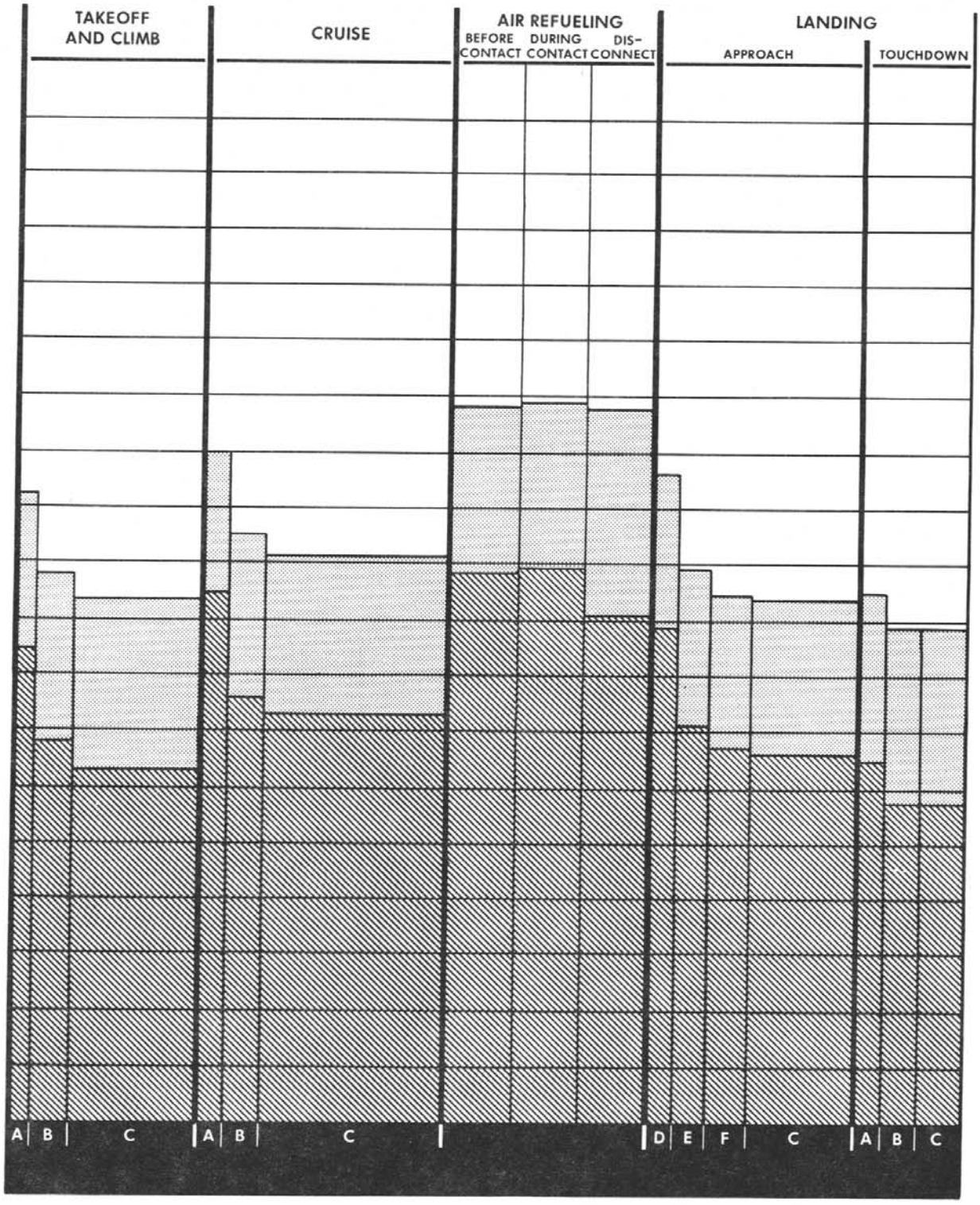


Figure 7–11 (Sheet 2 of 2)

ALTERNATING CURRENT POWER SYSTEM

The output from each alternator passes through the voltage regulator. The voltage regulators are used to excite the alternator fields and to maintain constant alternator output voltage. If an unregulated high voltage from the alternator occurs, the probable cause is a defect shorting out the carbon pile of the voltage regulator. The defect can be in the regulator or in the exciter leads to the regulator.

CAUTION

- If this condition exists, disconnect the wires from the voltage regulator. Extreme caution should be exercised while disconnecting the wires, as these wires are "hot". Failure to pull the wires from the voltage regulator could result in possible fire or damage to equipment connected to the alternator bus. Turning off the alternator switch will not stop the overvoltage.
- Wait 1 minute after turning an alternator off before switching it back on. Always switch the alternators off when engine is stopped.

USE OF LANDING WHEEL BRAKES

In order to slow or stop the airplane, the kinetic energy (energy of motion) of the airplane must be absorbed and dissipated. This may be accomplished by four factors: rolling friction, aerodynamic drag, propeller reversal, and braking action. (Refer to LANDING, Section II, for propeller reversal.) The relative effect of these factors depends upon the length of the landing roll and the touchdown speed. If runway length is sufficient, aerodynamic drag and rolling friction will slow the airplane to taxi speed at the expense of increased stopping distance.

There are three factors which limit the ability of the brakes to stop the airplane. These are: Braking friction available between the tire and the runway, method of brake application, and the kinetic energy limits of the brake. The braking friction available depends upon the weather and runway condition. The method of brake application is controlled by the pilot. The kinetic energy limits of the brakes are shown in figure 5-4 and 5-4A.

Incorrect or excessive use of the brakes results in undue wear of the brake components and tires. This adds to maintenance problems and increases the risk of tire and brake failure.

WARNING

Do not exceed braking limits shown in figure 5-4 or 5-4A, as this may cause tire explosions and fire that could endanger the crew and airplane.

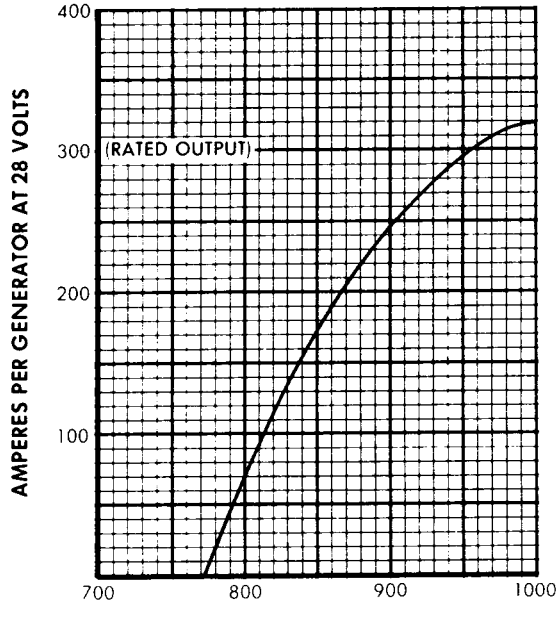
The brakes are to be treated with respect; however, they should be used when necessary. Operations should be planned to keep brake usage to a minimum.

The brake pedals and emergency brake levers are connected to control valves which meter hydraulic pressure to the brake components. (See figure 1–44.) Pumping the pedals serves no good purpose, and pedal pressure is not a good measure of the braking action in this type of system.

CAUTION

Do not make a rapid series of brake applications, as this may cause temporary loss of service brake pressure. When the engines are at idle, the accumulator can be depressurized faster than the hydraulic pumps can pressurize the system.

The proper method of application is a smooth, firm pressure, steadily increasing until desired braking action is obtained. The pilot must learn to judge braking action by sensing the deceleration of the airplane while applying pedal pressure. Maximum braking action will occur when the wheels are in the rolling skid and the wheel rpm is 85 to 90 percent of brakes-off rpm. Increasing the pressure above this value will cause breakdown of the tire surface which acts as a lubricant, and uncontrolled skidding or locking of the wheels will occur. This results in extreme loss of braking action and possible difficulties in directional control. To relieve such a condition, brake pressure must be released until the wheels come up to speed. The brakes may then be reapplied with more caution.



GENERATOR OUTPUT VS ENGINE SPEED

Figure 7–12

SECTION VIII
CREW DUTIES

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INTRODUCTION

The airplane is one that requires teamwork from its crew, and the pilot is the commander of the team. The success of the mission and the safety of the crew and airplane depend upon how well the team is organized and the manner in which it is led. The crew is made up of specialists, each one vitally important to the safety and effectiveness of the entire crew. The purpose of this section is to provide a compact collection of material wherein each crewmember can readily determine his duties relating to his specialty as a crewmember. Any discrepancy noted during preflight which would affect the accomplishment of the mission will be brought immediately to the attention of the pilot and maintenance personnel.

During thru flights, when engines are shut down and there is no change in the basic crew, only the checklist items preceded by an asterisk (*) must be accomplished before takeoff. Other checklist items may be accomplished at the pilot's discretion.

NOTE

The code G appears in this Section to provide for flight crew standardization. It identifies checklist items peculiar to C-97G airplanes assigned for support of air refueling operations.

CREW COORDINATION

Coordination of actions within a crew is of prime importance to insure the optimum degree of mission success and safety during all phases of operation. This coordination is not necessarily limited to actions alone. Complete familiarity with one's crew position, the responsibilities thereof, and a working knowledge of the other crewmembers' duties will contribute immeasurably toward crew coordination. Each crewmember must be constantly on the alert and should notify the responsible crewmember of any deviation or discrepancy which will affect successful accomplishment of the mission. Liaison between individuals concerned must be established prior to initiating any action or procedure which will alter airplane configuration or require correlation of activities between crewmembers. Prior to flight, the pilot must insure that all crewmembers are thoroughly familiar with all aspects of the assigned mission as pertaining to their crew specialty to include:

a. Applicable instructions in the Flight Information Publications.

b. Departure routes, altitudes, obstructions, and traffic procedures.

c. Route of flight.

d. Air refueling information.

e. Normal and emergency communications procedures.

f. Any special instructions or procedures pertaining to the mission.

NOTE

- It is imperative that the pilot, copilot, and navigator be thoroughly familiar with the letdown, approach, missed approach, landing patterns, altitudes, and obstructions at both destination and alternate airfields. Available aids such as current FLIP terminal and approach charts must be studied. A complete set of current approach charts must be available for inflight use by both the pilot and the navigator. The navigator, as well as the pilot not at the controls of the airplane, will closely monitor all letdowns and approaches. The pilot at the controls will be notified immediately of any deviation from published procedures.
- Positive measures must be taken to insure that safety of personnel and airplane are not jeopardized. Flight attitude of the airplane must be carefully monitored by both pilot and copilot at all times. During any critical phase of flight, especially under night and/or weather conditions, the pilot not at the controls of the airplane will maintain visual contact with the ground insofar as possible, closely monitor his flight instruments, and cross-check them against those of the other pilot. Any apparent error in flight attitude or airspeed will be immediately brought to the attention of the pilot at the controls of the airplane. This pilot will initiate immediate and appropriate corrective action, if required.

- Prior to accomplishment of any of the following, verbal coordination between applicable crewmembers will be required when:

1. Control of airplane is transferred between pilot and copilot.
2. Changing fuel control settings.
3. A crewmember leaves position or leaves interphone.
4. A crewmember goes off oxygen and resumes oxygen use during flight when oxygen is required.
5. Any electrical power source is changed.
6. It is necessary for the pilot at the controls of the airplane to transfer control of the airplane to the other pilot when he is required to do something which will divert his attention from flying, such as check oxygen, tune radios, change fuel control settings, etc.
7. The pilot intends to perform any critical maneuver, at which time all crewmembers will be secured in their respective positions.

- All applicable crewmembers will acknowledge that the intended course of action is understood prior to actual accomplishment and will conduct themselves accordingly. All applicable crew positions, when practical, should monitor all communications outside the airplane by use of mixer switches during air refueling, takeoffs, landings, and instrument approaches. Extreme care must be exercised by the pilots, when leaving seats, to avoid inadvertent operation of switches or controls on the control stand or overhead panel. When a safety belt is unfastened in flight or on the ground, place the belt carefully so as not to inadvertently operate any switches or damage equipment.

INTERPHONE PROCEDURES

To implement standard interphone procedures and phraseology, the following will be used during all ground operations. The CALL position of the interphone will be used when required to report emergencies.

NOTE

- With the rotary interphone selector switch in the CALL position, transmissions will be limited to interior of airplane.
- When any crew member cannot be contacted by normal interphone procedures, the CALL position will be used.

NOMENCLATURE

For purposes of identification of crewmembers, the following list is submitted.

1. Pilot – The occupant of the left seat in the pilots' compartment, regardless of his position on the crew.
2. Copilot – The occupant of the right seat in the pilots' compartment, regardless of his position on the crew. Frequently, during training, the instructor pilot or the student pilot will occupy the right seat; regardless, he will be referred to as the copilot.
3. Navigator – The occupant of the navigator's seat in the forward compartment.
4. Engineer – The crewmember seated at the engineer's panel.
5. Boom Operator – The crewmember occupying the boom pod or who is performing boom operator duties at the time.
6. Ground Crewman – That individual on the ground designated to assist the crew during engine start and ground operation until specifically released by the pilot.

IDENTIFICATION

The crewmember who is being called will be identified first, followed by the identification of the transmitter; e.g., "Engineer from pilot." All crewmembers will advise the pilot when leaving or returning to their respective crew positions. Interphone conversation will be held to the absolute minimum during the following: Rendezvous and air refueling, flight under adverse weather conditions, instrument approaches, formation flying, takeoffs, and landings.

PHRASEOLOGY

The following phraseology will be used in coordinating activities with other crewmembers:

Call For	To Obtain
MAX POWER	RPM 2700 – 60 Inches Hg, Manifold Pressure Or 247 TPSI, Whichever Occurs First; Jets 100 Percent
METO POWER	RPM 2550 - TPSI Not To Exceed 198; Jets 100 Percent
CLIMB POWER	RPM 2350 - TPSI Not To Exceed 197; Jets 100 Percent
RPM – TWENTY-THREE FIFTY	Propellers Set At 2350 RPM
MANIFOLD TWO-FIVE	Manifold Pressure Set At 25 Inches Hg
FLAPS THIRTY-THREE PER-CENT	Wing Flaps Set At 33 Percent
FLAPS UP	To Retract Wing Flaps
JETS SEVENTY-FIVE	Jet Engines Set At 75 Percent
ABORT	A Term Used Only By The Pilot (Or Instructor Pilot) To Notify The Crew During Takeoff That Takeoff Is To Be Discontinued.
REJECT	A Term Used By Crewmembers To Notify The Pilot During Takeoff That They Have Detected A Condition Serious Enough To Be A Hazard To Flight.

NOTE

Do not call wing flaps "THREE-THREE OR FIVE-FIVE", to avoid confusion with manifold pressure.

ACKNOWLEDGEMENT

When the pilot calls for a checklist all crewmembers will acknowledge by crew position.

Every command will be acknowledged by the receiving crewmember prior to execution to assure proper understanding of the transmission. If not certain what the command was, the crewmember will momentarily press his mike button and state, "Say again." The crewmember will then repeat his original transmission.

NOTE

- On a radar approach, the pilot may direct the crewmembers not to acknowledge his command to prevent interphone transmission from interfering with the ground controller's instructions.
- Under emergency conditions, brevity on the interphone is essential to avoid interruption of procedures.

PERSONAL EQUIPMENT REQUIREMENTS

Personal equipment plays an important part in the safety and comfort of the crew during a flight. It is the responsibility of the pilot, prior to each flight, to insure that all crewmembers and passengers have the necessary personal equipment as prescribed by current directives to safely accomplish the mission.

PILOT

The overall effectiveness of the airplane and its crew is the responsibility of the pilot. Aside from the responsibility for the airplane, the pilot must make certain that crewmembers are proficient in the performance of all their duties and in normal and emergency operation of their equipment. Also, he should make certain that crewmembers are briefed on and understand the mission to be flown. The pilot should be thoroughly familiar with the status of the airplane at all times.

COPILOT

The copilot, being second in command of the airplane, must be able to assume the duties of the pilot. In addition to assisting the pilot, the copilot is the operator of the radio equipment. He must be thoroughly familiar with emergency procedures as they pertain to the airplane and to his duties as copilot.

NAVIGATOR

The nature of the air refueling mission demands the utmost proficiency. The navigator must have a thorough knowledge of navigational equipment and procedures as well as the electronic and rendezvous equipment. He will aid the pilot in all matters pertaining to mission planning and other assigned duties. He is responsible for navigating the airplane, using all means available to successfully accomplish the mission. He must be thoroughly familiar with designated emergency procedures as they pertain to the airplane, the mission, and to his duties as navigator. The navigator's procedures are in this section as amplified checklists.

NAVIGATORS PREFLIGHT INSPECTION

INTERIOR INSPECTION – POWER ON

1. Oxygen Equipment – CHECKED AND STOWED.

   For oxygen equipment check, refer to Section IV.
2. Personal Navigation Equipment And Celestial Tables – CHECKED AND STOWED
3. Power Clearance – RECEIVED.
4. N-1 Compass – SYNCHRONIZE.
5. Check Navigation Equipment (AS REQUIRED).
   a. Search Radar
   b. Rendezvous Radar

c. Driftmeter

d. Loran

e. Absolute Altimeter

f. Sextant

6. Time Hack – OBTAINED AND GIVEN (IF REQUIRED).

STARTING ENGINES

*1. Radios – MONITOR.

*2. Power Clearance – RECEIVED.

Engineer will announce over interphone, "Inverters ON."

*(3.) N-1 Compass – SYNCHRONIZE. (N, CP)

*4. Equipment – ON (AS REQUIRED).

a. Radar Pressurizing Switch

b. Search Radar – STANDBY.

c. Absolute Altimeter

d. Rendezvous Radar

e. Driftmeter

f. APN-69 Radar Beacon

*(5.) Altimeter – SET AND CHECKED. (N,P)

Acknowledge altimeter setting over the interphone. Navigator will set station pressure. Check all three pointers on the altimeter to assure proper indication.

*(6.) Taxi Report – "NAVIGATOR READY." (N, P)

Copilot sounds alarm bell and pilot announces, "Taxi Report." Crew reports in the following order: BO, N, E. Navigator responds, "Navigator ready."

If the boom operator is not on interphone, he may give a visual signal to the navigator to signify that alarm bell checked and boom operator is ready to taxi. Upon receipt of this signal, the navigator will also report, "Boom operator ready."

7. Search Radar – TUNE.

BEFORE TAKEOFF

(1.) Flight Clearance – MONITOR, RECORD, AND ACKNOWLEDGE. (N, CP)

Navigator will acknowledge receipt of ATC clearance after copilot's " read back" to tower is confirmed.

(2.) Acceleration Check Timing Information – ACKNOWLEDGE. (N,P)

3. Safety Belt And Shoulder Harness – FASTEN AND LOCK.

(4.) Takeoff Report – "NAVIGATOR READY." (N,P)

TAKEOFF

During the takeoff roll, the navigator will coordinate with the pilots on completing the acceleration check. After the pilot's briefing, the navigator will acknowledge the number of seconds to be timed during the acceleration check. As the airplane accelerates to 65 knots, the copolit will announce over interphone, "70 knots - - - - -", and at 70 knots will state "Now." At this instant, the navigator will start his stop watch. The master or hack watch will be used as a backup. Four seconds before the time has expired, the navigator will alert the pilots by announcing over interphone, "Time." At the expiration of the time, the navigator will call, "Hack." Both pilots will check their IAS at this instant. The navigator will record the takeoff time as brake release time or time of entering the runway for a rolling takeoff.

NOTE

The navigator may turn his UHF/VHF interphone mixer switches OFF during the takeoff run if it appears that transmissions will interfere with the acceleration time check. Immediately after completion of the acceleration time check, the UHF/VHF interphone mixer switches will be turned ON.

AFTER TAKEOFF, CLIMB, AND CRUISE

Monitor departure instructions to determine the route of departure to be flown. If flying in cell formation, locate and identify reference airplane and keep pilot advised of relative position. Upon completion of climb phase, determine airplane position.

NOTE

When two or more airplanes are flying in close proximity (formation, A/R rendezvous, etc), the signals from electronic equipment in one airplane can cause interference with similar electronic equipment in other airplane(s). The interference between two radio altimeters makes indications unusable.

DESCENT

(1.) Crew Briefing – ACKNOWLEDGE. (N,P)

(2.) Altimeter – SET. (N, P)

Acknowledge altimeter setting over interphone.

3. Periscopic Sextant And Sighting Platform – STOW.

4. Electrical Equipment – OFF (IF NOT REQUIRED).

(5.) Crew Report – NAVIGATOR DESCENT CHECKLIST COMPLETE (N, P)

BEFORE LANDING

(1.) Nose Gear – VISUALLY CHECKED DOWN. (N, E)

Report to engineer when nose gear is visually checked down.

NOTE

Navigator will determine nose gear extension by visually checking landing gear by using the driftmeter or nose wheel inspection window, and report to the Engineer when nose gear is checked down.

2. Safety Belt And Shoulder Harness – FASTEN AND LOCK.
3. Airplane Position And Altitude – MONITOR.

WARNING

- All available navigation aids will be utilized to the maximum extent throughout the approach to insure proper airplane altitude and position.
- Upon reaching the leveloff altitude specified for the instrument letdown, the navigator will monitor the airplane around the normal approach pattern for the active runway, advising the pilot of deviations in altitudes or headings. The airplane should be no lower than 1000 feet above the terrain until reaching the glide path.

AFTER LANDING

WARNING

Location of AIMS system pitot-static tubes is extremely dangerous to personnel departing the aircraft as they are located at eye level height. Care must be taken to insure personnel have enough clearance from the fuselage, before moving toward rear of the aircraft on the left side.

1. Electrical Equipment – OFF.

   Insure the following equipment is turned off: Loran, search radar, rendezvous radar, APN-69 beacon, radio compass, radio altimeter, and driftmeter.

2. Form 781 – COMPLETE.

Note

- All items on the navigator's AFTER LANDING checklist should be performed only for the final landing.
- The navigator's normal procedures also appear in T.O. 1C-97(K)L-1CL-3, which is an abbreviated checklist. The abbreviated checklist has each numbered step (and some substeps) of the normal and emergency procedures.

NAVIGATOR'S EMERGENCY PROCEDURES

Refer to NAVIGATOR'S EMERGENCY PROCEDURES, Section III, and T.O. 1C-97(K)L-1CL-3.

ENGINEER

The engineer will perform his portion of the preflight inspection prior to flight and determine that the condition of the airplane is satisfactory for the mission. He will also be responsible for synchronizing the N-1 compass when the navigator is not aboard. He must be thoroughly familiar with emergency procedures as they pertain to the airplane and his duties as engineer.

WARNING

To prevent accidental opening of the fuel transfer valves, the A/R master switch must be in the OFF position at all times when the engineer's A/R panel is stowed. The airplane cg could be adversely affected with these fuel valves open.

ENGINEER'S FUEL MANAGEMENT PROCEDURE

Refer to FUEL SYSTEM, Section VII.

Note

The boom operator will coordinate with the engineer when positioning the manual fuel shutoff valve(s) and will report the position of these valve(s) after manual actuation.

BOOM OPERATOR

The duties of the boom operator require that he maintain proficiency in:

a. The skillful operation of assigned air refueling equipment.

b. Cargo and passenger loading, including preparation of Form 365F.

c. Inflight maintenance of assigned air refueling equipment.

d. The knowledge and performance of emergency procedures as they pertain to his duties as boom operator.

MISSION PLANNING

Use Of Form 365F

The Form 365F is the summary of the actual disposition of load in the airplane and will be completed for all flights. Normally two copies will be prepared, one of which is retained by the clearing authority and the other taken on the assigned mission by the flight crew. Normally the load adjuster will be used to complete the individual indexes and the takeoff center of gravity entries; however, for training purposes or when a load adjuster is not available, the form may be completed using the Chart E. There are two versions of the Form 365F: TRANSPORT and TACTICAL. They are designed for the respective loading arrangement. A sample form for TACTICAL, with applicable instructions and explanations for the completion of the form, is presented in this section. See figure 8–1.

The TACTICAL version of the Form 365F will be used for all tactical missions, except when the space in reference 3, DISTRIBUTION OF LOAD, is insufficient to list all weights by compartment. The Form 365F will be accomplished prior to mission briefing.

Planning Factors Guide

The information presented is to be used as a guide in accomplishing the Form 365F. For the weights of various items, consult local operating procedures and PLANNING FACTORS, this section. The E-1035 computer plate was used to complete figure 8–1.

Note

The REMARKS column contains some abbreviations, which are defined as follows:

I	Inboard Fuel Tanks
O	Outboard Fuel Tanks
C	Center Wing Tank
TOT	Total Fuel
RT	Run up and Taxi
TOT	Total Fuel for Takeoff

Weight And Balance Clearance Form F (Tactical), Form 365F

The following information refers to figure 8–1.

1. FORM HEADING: Enter necessary identifying information at top of form.
2. BASIC AIRPLANE: (Ref 1) Enter the basic weight and index obtained from last entry of Chart C of T. O. 1-1B-40, Handbook of Weight and Balance Data.
3. OIL: (Ref 2) Enter the weight of engine oil, 1230 pounds.
4. DISTRIBUTION OF LOAD: (Ref 3) Enter load by compartment including passengers, emergency equipment, and cargo. The crew for this sample consists of a pilot, copilot, navigator, engineer, boom operator, and an additional crewmember. These crewmembers are assumed to weigh 220 pounds each with professional equipment, and are listed by compartment. Crew parachutes and spare parachutes will be listed in the applicable compartments in which they are stowed.
5. OPERATING WEIGHT: (Ref 4) The operating weight entry will be the sum of the weights entered above in references 1 through 3.
6. FUEL: (Ref 7) Enter the weight and index of fuel as follows:

   Built In: Enter total weight of fuel as determined in the REMARKS section.
   A/R Tanks: Enter fuel, as applicable, in tanks.
7. WATER INJ. FLUID: (Ref 8) This item is included in the basic weight of the airplane.
8. TAKEOFF CONDITION (Uncorrected): (Ref 10) This entry will be the total of all weights entered in references 4 and 7.
9. CORRECTIONS (If required): (Ref 11) After the Form 365F has been completed, if a change in loading occurs, the corrections will be listed individually in the CORRECTIONS section. The net difference will then be entered, with the proper plus or minus sign, on the CORRECTIONS line with the applicable index.
10. TAKEOFF CONDITION (Corrected): (Ref 12) The weight correction (Ref 11), subtracted from or added to takeoff weight uncorrected (Ref 10), will give takeoff weight corrected. The index correction (Ref 11) will also be entered on the TAKEOFF CONDITION (Corrected) line (Ref 12).
11. TAKEOFF C.G. IN % M.A.C.: (Ref 13) The takeoff gross weight and index will be used to compute the cg in % MAC from the load adjuster. If a correction is necessary, delete the figure previously listed and enter the corrected % MAC.
12. LESS EXPENDABLES: (Ref 14) Indicate fuel and A/R fuel expended, by weight and index.
13. ESTIMATED LANDING CONDITION: (Ref 15)

Note

- For corrections made prior to the original Form 365F being filed, subtract the total of reference 14 from the final TAKEOFF CONDITION (Corrected) (Ref 12).
- Corrections made after the original Form 365F has been filed need not be reflected on precomputed ESTIMATED LANDING CONDITION (Ref 15).

14. ESTIMATED LANDING C.G. IN % M.A.C.: (Ref 16) The landing gross weight and index shown in reference 15 will be used to compute the cg in % MAC from the load adjuster.
15. LIMITATIONS: Enter the permissible gross weight for takeoff and landing. Enter the permissible cg for takeoff and landing.

Note

The forward cg limit for takeoff and landing of the airplane has been established at 15% MAC at airplane gross weight below 105,000 pounds.

16. REMARKS: For mission planning purposes, enter the planned fuel load: 875 pounds are normally used for runup and taxi fuel.

Planning Factors

The following list of mission planning factors will be used for all missions when the actual weights of individual items are not available.

1. BASIC AIRPLANE WEIGHT AND INDEX. Obtained from Chart C or other authentic source.
2. OIL. 27 gallons per engine x 4 equals 108 gallons, plus 56 gallons in central oil tank, for a total of 164 gallons x 7.5 pounds per gallon equals 1230 pounds total.

WEIGHT AND BALANCE CLEARANCE FORM F

TACTICAL

(USE REVERSE FOR TRANSPORT MISSIONS)

FOR USE IN T. O. 1-1B-40 & AN 01-1B-40

DATE	AIRPLANE TYPE	FROM	HOME STATION
21 JAN 65	KC-97L	LANGLEY AFB, VA	DALLAS NAS, TEX.
MISSION/TRIP/FLIGHT/NO.	**SERIAL NO.**	**TO**	**PILOT**
A/R NAV.	53-243	DALLAS NAS, TEX.	CAPT DOE

REMARKS

BUILT IN:

FUEL	WT
I	18240
O	21240
C	1725
TOT	41205
RT	875
TOT	40330

COMPUTER PLATE NO. *(If used)*: E-1035

REF	ITEM	WEIGHT	INDEX
1	BASIC AIRPLANE *(From Chart C)*	98570	713
2	OIL (164 Gal.)	1230	679
3	DISTRIBUTION OF LOAD		

COMPT.	CREW NO.	CREW WEIGHT	BAGGAGE	CARGO AND MISC		INDEX
A	4	880			880	609
B				25	25	608
C				50	50	605
D				50	50	604
M				25	25	606
N	2	440		50	490	641
MM				64	64	646

REF	ITEM			WEIGHT	INDEX
4	OPERATING WEIGHT			101384	646
5	AMMUNITION	COMPT.	POUNDS	CALIBER	
6	BOMBS, ROCKETS, ETC. — FORWARD				
	AFT				
	EXTERNAL				
	ROCKETS				
7	FUEL — BUILT IN (Gal.)			40330	671
	BOMB BAY (Gal.)				
	EXTERNAL (Gal.)				
	A/R TANKS			30000	637
8	WATER INJ. FLUID (Gal.)				
9	JATO OR RATO				
10	TAKEOFF CONDITION *(Uncorrected)*			171714	637
11	CORRECTIONS *(If required)*			-7555	628
12	TAKEOFF CONDITION *(Corrected)*			170959	628
13	TAKEOFF C. G. IN % M. A. C.			~~23.7~~ 23.3	
14	LESS EXPENDABLES — JATO OR RATO				
	BOMBS				
	AMMUNITION				
	FUEL			37330	611
	A/R TANKS			30000	647
15	ESTIMATED LANDING CONDITION			104384	647
16	ESTIMATED LANDING C. G. IN % M. A. C.			19.5	

Pertinent instructions to the pilot for shifting load and crew during takeoff and landing should be noted above.

CORRECTIONS *(Ref. 11)*

COMPT	ITEM	CHANGES (+ or −) WEIGHT	CHANGES (+ or −) INDEX
D	CREWMEMBER+CHUTE	+245	62.9
G	OUT'BD FUEL	-1000	62.8
TOTAL WEIGHT REMOVED		-1000	-
TOTAL WEIGHT ADDED		+245	+
NET DIFFERENCE *(Ref. 11)*		-755	62.8

LIMITATIONS

[3] GROSS WT. TAKEOFF (lb.)	[3] GROSS WT. LANDING (lb.)
175000	175000

	FROM	TO (% M. A. C.)
[3] PERMISSIBLE C. G. TAKEOFF	18.5	30.5
[4] PERMISSIBLE C. G. LANDING	15.0	30.5

[1] *Enter constant used.*
[2] *Enter values from current applicable T. O.*
[3] *Applicable to gross weight (Ref. 12).*
[4] *Applicable to gross weight (Ref. 15).*

COMPUTED BY *(Signature)*: /S/ ROBERT A. JONES TSGT. USAF

WEIGHT AND BALANCE AUTHORITY *(Signature)*:

PILOT *(Signature)*: /S/ ALLEN T. DOE CAPT. USAF

SAMPLE

DD FORM SEPT 54 365F

Figure 8–1

3. CREW. Example to use:

Man	180 pounds
Professional Equipment	40 pounds
	220 pounds per man

4. CREW'S BAGGAGE. (IF APPLICABLE).
5. EMERGENCY EQUIPMENT.
   a. 20-man life raft..... 155 pounds each
   b. 1-man life raft..... 20 pounds each
   c. Life vest or RI suit..... 5 pounds each
   d. Individual survival kit..... 40 pounds each
   e. Crew survival kit..... 360 pounds each
   f. Parachute..... 25 pounds each
   g. Survival radio..... 6 pounds each
6. EXTRA EQUIPMENT.
   a. Tool box..... 75 pounds each
   b. Hydraulic fluid..... 8 pounds per gallon
   c. Airplane chocks..... 25 pounds each
   d. IF rations (case)..... 35 pounds each
   e. Water jugs (full)..... 25 pounds each
7. FUEL LOADING. The following fuel weights of 115/145 aviation gasoline and JP-4 jet fuel will be used when actual fuel densities are unknown or unavailable:
   a. 115/145 aviation gasoline at 5.85 pounds per gallon (average)
   b. JP-4 jet fuel at 6.4 pounds per gallon (average)
   c. AVGAS Fuel for runup and taxi. 50 lb/min for 15 min 25 lb/min thereafter
   d. Jet Fuel JP-4 for Runup and Taxi. 45 lb/per min.

   (Time dependent on local conditions.)

BOOM OPERATORS PREFLIGHT INSPECTION

Upon arrival at the airplane, notify the ground crew of proper color rendezvous beacon light lens to be installed (if applicable).

INTERIOR INSPECTION

(1.) Cargo And Loose Equipment — SECURITY. (BO, CG)

Check cargo and loose equipment in all compartments as INTERIOR INSPECTION progresses.

*2. Form 365F — CORRECT AS NECESSARY.

Cross-check planned Form 365F against actual airplane loading, as interior inspection progresses, and make changes as necessary. Inform engineer of any weight change in planned loading against actual airplane loading.

3. Boom Operator's Oxygen Supply Valve — OPEN.

*(4.) APU — START (IF REQUIRED). (BO, P)

5. Hatches And Doors — CHECK.

   a. Forward Cargo Door — CHECK CLOSED AND LOCKED.

   Check that selector handle is in the CLOSE position and the door hydraulic system is pressurized.

   b. Emergency Exit Hatches — CHECK.

   Perform operational check of release handles. Perform operational check of impact lights, if installed.

G c. Aft Cargo Door — CHECK CLOSED.

Move the selector handle to the "OFF" position after doors have closed and locked.

d. Tail Compartment Access Door — CHECK CLOSED.

6. No. 4 A/R Hydraulic Valve — NORMAL.

G 7. Water Ballast.

   a. Level — CHECK.

   b. Drain Valves — CHECK CLOSED.

8. Oxygen Equipment — CHECK.

   For oxygen system check, refer to Section IV.

9. Boom Operator's Panel — CONDITION.

   Check that switches are off (as required) and circuit breakers are set.

10. A/R Underwing And Underbody Lights — ON (AS REQUIRED).

*11. Boom Hydraulic System Depressurization Valve — CLOSED.

*12. Boom Operator's A/R Master Switch — ON.

*13. Boom Hydraulic Pressure Switch — AUTO 17260 ▶ 22736 or ON. 22737 ▶

14. Signal Coil — TEST. (AS REQUIRED)

15. Ruddevator Control Stick — CHECK STOWED.

(16.) Fuel Manifold — CONDITION. (BO, E)

Check with engineer to insure that the fuel systems are pressurized. Check fuel manifold as interior inspeciton progresses.

*17. Aft Entry Door — CLOSED AND LOCKED.

18. A/R Fuel Pump Selector Valve — NORMAL AND SAFETIED.

*19. Fuel Valves.

a. No. 3 Manual Fuel Shutoff Valve — CLOSED AND SAFETIED.

b. No. 1 Manual Fuel Shutoff Valve — OPEN AND SAFETIED.

c. No. 2 Manual Fuel Shutoff Valve — CLOSED AND SAFETIED.

d. Center Wing Secondary Valve — CLOSED.

e. Transfer Valves — CLOSED. 17260 22664

f. Aft Leveling Valve — CONDITION.

g. A/R Secondary Valves — CLOSED.

h. External Tank Manifold Transfer Valve — CLOSED. 22665

i. Jet Engine Sump Tank Manual Shutoff Valve — OPEN.

j. Forward Leveling Valve — CONDITION.

*(20.) APU — STARTED (IF APPLICABLE). (BO, E)

*21. Forward Entry Door — CLOSED AND LOCKED.

(22.) Interior Inspection — COMPLETED. (BO, E)

Notify engineer that Interior Inspection is completed.

STARTING ENGINES

*1. Scan Engines During Start.

*2. Retract Boom.

*3. A/R Master And Boom Hydraulic Pressure Switches — OFF.

Switches will be placed to OFF after all engines are started.

CAUTION

The A/R master switch and hydraulic pressure switch are placed OFF to prevent damage to the A/R pumps and gear boxes due to pressure surges at high engine rpm during takeoff and climb. The retraction accumulators will supply pressure to the fuel dump actuator for fuel dumping when the A/R master switch and the hydraulic pressure switch are OFF. The retraction accumulators are isolated by a one-way check valve.

*4. Nesa Heat — CLIMATIC.

* (5.) Taxi Report — "ALARM BELL CHECKED, BOOM OPERATOR READY." (BO, P)

Copilot sounds the alarm bell and pilot announces, "Taxi report." If the boom operator is not on interphone, he may give a visual signal to the navigator to signify the alarm bell is checked and boom operator is ready. Upon receipt of this signal, the navigator will also report, "Boom operator ready."

TAXI AND ENGINE RUNUP

*1. Scan — AS REQUIRED.

Report unusual conditions observed.

* (2.) Runup Report — "CLEAR FOR RUNUP." (BO, P)

Report after pilot announces, "Runup report."

*3. Hatches — INSTALLED (IF APPLICABLE).

The left rear hatch may be left open until wing flaps are set for takeoff.

JET ENGINE GROUND START

NOTE

Notify pilot if jet engines are not over hard surface.

(1.) Jet Engine Start Report — "CLEAR FOR JET START." (BO, P)

Report after pilot announces, "Clear area for jet start." Boom operator will scan J-1 engine and report any abnormal condition. The same procedure will be used for starting J-2.

* 2. APU Exhaust Port - CLOSED.

After APU is shut down, close APU exhaust port.

CAUTION

Prior to closing air inlet and exhaust valves, allow sufficient time for the turbine and compressor to come to rest. This will normally occur 10 to 20 seconds after shutdown.

3. Floor Hatches - CLOSED.

BEFORE TAKEOFF

* (1.) Wing Flap Position Report — "BOTH FLAPS __%." (BO, P)

* (2.) Takeoff Report — "COWL FLAPS SET, BOOM OPERATOR READY." (BO, P)

When pilot announces, "Set Cowl flaps," check all cowl flaps for position and report after pilot announces, "Takeoff report."

*3. Safety Belt — FASTENED.

TAKEOFF, CLIMB, AND CRUISE

If the airplane is to remain in the traffic pattern, omit step (2) after the initial Walk-Around.

NOTE

When staying in the traffic pattern for several approaches or landings, boom operator will check the lower aft compartment for fuel fumes or electrical odors by raising the floor hatch, when directed by the pilot.

1. Scan – AS REQUIRED.

   Report unusual conditions observed.

(2.) Walk-Around Inspection Report – "WALK-AROUND INSPECTION COMPLETE." (BO, E)

Walk-around inspection will be accomplished in this sequence: Check lower compartments and main compartment for fuel fumes and hydraulic leaks as soon as pilot calls for AFTER TAKE-OFF-CLIMB checklist. Check A/R hydraulic reservoir fluid level as walk-around progresses.

DESCENT

(1.) Passengers – BRIEF. (BO, P)

The boom operator will brief passengers on use of seat belts, ETA, smoking, and pertinent information after pilot completes crew briefing.

2. Cargo And Loose Equipment– CHECK SECURED.

   Cargo and loose equipment will be checked in main compartment.

3. Boom – STOWED AND LATCHED.

   When pilot calls for DESCENT checklist, boom operator will check boom stowed and latched by placing hoist lever to the DOWN position momentarily.

(4.) Crew Report – "DESCENT CHECKLIST COMPLETE." (BO, P)

When pilot announces, "Crew report", report, "Descent checklist complete."

BEFORE LANDING

(1.) Main Landing Gear Report – "BOTH MAIN GEAR DOWN." (BO, E)

(2.) Wing Flap Position Report – "BOTH FLAPS –%." (BO, P)

3. Safety Belt – FASTENED.

AFTER LANDING AND POSTFLIGHT

WARNING

Location of AIMS system pitot-static tubes is extremely dangerous to personnel departing the aircraft as they are located at eye level height. Care must be taken to insure personnel have enough clearance from the fuselage, before moving toward rear of the aicraft on the left side.

1. APU – START.
2. Urinal Tank Drain – OPEN (IF APPLICABLE).
3. Scan – AS REQUIRED.

   Report unusual conditions observed.

NOTE

Steps 4, 5, and 6 will be completed after engines are shut down.

4. A/R Hydraulic System – DEPRESSURIZED
5. Nesa Heat – OFF.
6. A/R Underwing And Underbody Lights – OFF (AS REQUIRED).
7. Ground Locks – CHECK INSTALLED.

BOOM OPERATOR'S EMERGENCY PROCEDURES

Refer to BOOM OPERATOR'S EMERGENCY PROCEDURES, Section III, and T. O. 1C-97(K)L-1CL-4.

RULES TO BE ENFORCED

PASSENGER BRIEFING

Passengers – BRIEF (IF APPLICABLE).

If passengers are carried, conduct passenger briefing in sufficient time to complete briefing prior to takeoff.

a. Introduce yourself.

b. Destination, time enroute, and altitude.

c. Survival equipment (if applicable).

   Explain use of equipment.

d. Parachute and spares (if applicable).

   Explain proper fit and use, location of parachutes, and location of spare(s).

e. Safety belts.

   Explain use of safety belts.

f. Emergency exits, main compartment, escape rope, and egress technique.

Show passengers location of escape rope, hatches, and egress technique for bailout, crash landing, and ditching. Assign exits and rafts (as applicable).

g. Emergency alarm bell.

h. Inflight discipline.

In the event of an inflight emergency, the passengers will proceed to and remain in their assigned places, unless specifically directed by a primary crewmember.

i. Smoking restrictions.

j. Use of portable electronic devices.

Portable radios and electronic razors will not be used. This restriction does not apply to hearing aids.

k. Relief facilities.

Latrine and air sickness containers.

l. Airplane cleanliness.

SMOKING

WARNING

- No smoking during ground operation, takeoff, or landings.
- No smoking in the main compartment during unpressurized flight.
- No smoking at any time when fuel fumes are detected.
- No smoking during air refueling or fuel dumping.

CAUTION

Never attempt to throw lighted material from the airplane.

Note

- The pilot will insure that all personnel aboard the airplane have been notified prior to initiating air refueling or fuel dumping.
- Smoking may be permitted in the main compartment during pressurized flight when only the lower fuselage tanks contain fuel.

PARACHUTES

The general rules on use of parachutes as prescribed by current directives will apply.

One additional parachute, or 10 percent of the required number of parachutes (whichever is greater), is required when more than four persons are making the flight. However, this number will not exceed 10 spare parachutes in any case. Spare parachutes will be stowed at the primary bailout exit.

PROPELLERS

WARNING

- Personnel will not walk through the propeller arc area at any time.
- Personnel will not leave or enter the airplane during ground operation when the propellers are turning, unless specifically ordered to do so by the pilot, and then only by the aft entry door.
- Location of AIMS system pitot-static tubes is extremely dangerous to personnel departing the aircraft as they are located at eye level height. Care must be taken to insure personnel have enough clearance from the fuselage, before moving toward rear of the aircraft on the left side.

USE OF OXYGEN AND PRESSURIZATION

Oxygen masks will be carried by crewmembers on all flights, regardless of altitude or duration of mission.

The copilot will initiate oxygen checks at appropriate time intervals when cabin altitudes are as shown below:

10,000 to 25,000 feet – every 15 minutes

25,000 feet and above – every 5 minutes

When copilot calls for an oxygen check, the crewmembers will note normal oxygen pressure, flow indicators operating, and regulator diluter lever in proper position.

Note

Above 25,000 feet, crewmembers will make continuous visual checks of personnel in their compartments to augment the above checks by the copilot.

The general rules on use of oxygen masks as prescribed by current directives will apply.

INTERPHONE

All crewmembers will wear headsets during the following conditions:

a. All ground operations (including engine starts), except when removal is required to accomplish certain duties.

b. During rendezvous and air refueling.

c. During flight under weather conditions.

d. Formation flying.

e. During all takeoffs and landings.

Interphone calls will be made by identifying the crew position being called and the crew position from which the call is originated. All crewmembers will advise the pilot when leaving or returning to their respective crew positions. Interphone conversation will be held to the absolute minimum during the conditions previously listed. Crewmembers will monitor interphone at all times, except as follows:

a. When crew duties necessitate leaving interphone.

b. At least one pilot will monitor interphone during climb, cruise, and descent.

SAFETY BELTS

All crewmembers and passengers will have safety belts and shoulder harnesses (if applicable) fastened on all takeoffs and landings and at any other time the pilot deems necessary. The pilot and copilot at the controls will have their safety belts fastened at all times when the airplane is in flight.

MAIN COMPARTMENT FLOOR HATCHES

During flight, the main compartment floor hatch(es) will be closed to prevent possible injury to personnel walking in the vicinity of these hatches, except for the following:

a. Forward floor hatch will be open during operation of the APU.

b. Respective hatch(es) will be left open while a crewmember is performing duties in a lower compartment.

c. Floor hatches will be closed prior to takeoff or landing.

CONTROLS AND SWITCHES

All crewmembers will visually check controls and switches before actuation.

SECTION IX
ALL WEATHER OPERATION

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INTRODUCTION

This section contains only those procedures which are in addition to the normal operating instructions in Section II regarding night, instrument flight, turbulent air flight, as well as cold weather, hot weather, and desert operation. Cold weather operation should only be attempted in those airplanes which have been winterized.

INSTRUMENT FLIGHT PROCEDURES

INSTRUCTIONS

The airplane is stable and easy to handle under all conditions of instrument flight. The following are recommended techniques for the airplane under instrument flight conditions, from takeoff to approach and landing, that differ from or are in addition to VFR procedures. Some items are repeated for emphasis.

BEFORE ENTERING THE AIRPLANE

Have all snow and ice removed from airplane.

INSTRUMENT TAKEOFF TECHNIQUE

The instrument takeoff and initial climb procedure should be the same as normal procedure, except leave the airplane firmly on the nose wheel until within 5 to 10 knots below takeoff speed (S_2), then smoothly and firmly increase the pitch of the miniature airplane on the attitude indicator by approximately 1-1/2 bar widths. Allow airplane to leave runway and establish and maintain initial climb in this attitude. Retract landing gear as soon as airplane is definitely airborne, as indicated by an increase in altitude on altimeter and vertical velocity indicator. Attitude indicator acceleration error should be anticipated. Acceleration error can be detected by cross-checking the attitude indicator with the vertical velocity and altimeter indicators.

CLIMB

Retrim for best climbing airspeed. Turns should be limited to a maximum bank of 30 degrees. If icing conditions are expected, turn on anti-icing equipment before entering icing conditions.

DURING INSTRUMENT CRUISING FLIGHT

Readjust miniature airplane on attitude indicator. During turns, cross-check attitude indicator with airspeed indicator and altimeter for proper pitch reference; limit banks to 30 degrees. The airplane will handle normally throughout its speed range during instrument flight. Limit maneuvers to gentle turns, climbs, and descents for maximum ease of control. Use the autopilot, when possible, to relieve pilot fatigue.

DESCENT

Except for long range descents, reduce power as required and maintain cruise airspeed. However, a reduction in airspeed may be required in control areas. Landing gear and wing flaps may be extended, when within airspeed limitations, to increase rate of descent.

CAUTION

Descents with landing gear or wing flaps extended under icing conditions should not be made when avoidable.

Note

At IAS over 220 knots, it is recommended that banks be limited to 15 degrees to provide a safe margin above buffeting range.

HOLDING

Holding procedures for the airplane when in a clean configuration normally present no problem concerning fuel consumption, regardless of altitude. The holding pattern may be flown throughout the cruising speed range; however, 155 knots IAS is a recommended speed to fly. The power required for holding will depend on the airplane weight, engine operating limits, etc.

INSTRUMENT APPROACHES

NOTE

- In accordance with the United States Standard for Terminal Instrument Procedures (TERPS), this airplane is placed in category "D."
- Instrument approaches are easily performed and the flight characteristics during range letdown, ILS, and radar approaches are satisfactory. (See figures 9-1 through 9-3.)
- In cases where a circling approach is required by the instrument approach chart being used, maintain pattern airspeed (140 knots normal) until final approach to the runway is initiated.
- Airspeeds listed are for an airplane weighing 130,000 lbs or less. For weights above this, airspeed will be 130 knots IAS or 125% of stall, whichever is greater.

INSTRUMENT APPROACH—4/6 ENGINES

1. Complete the DESCENT checklist prior to reaching initial station.
2. Start the BEFORE LANDING checklist after initial station passage. Maintain 155 knots IAS until wing flaps are extended, then 140 knots IAS; jets running.
3. After completing procedure turn inbound to low station, slow airplane to 130 knots IAS (140 knots IAS circling) until on final.
4. Make final wing flap setting when visual reference sufficient for landing is established.

INSTRUMENT APPROACH—ONE OR MORE ENGINES INOPERATIVE

1. Complete the DESCENT checklist prior to reaching initial station.
2. Start the BEFORE LANDING checklist after initial station passage. Maintain 155 knots IAS until wing flaps are extended, then 140 knots IAS; jets running.
3. After completing procedure turn inbound to low station, slow airplane to 130 knots IAS (140 knots IAS circling). If operating conditions are critical, landing gear may be lowered later at pilot's discretion.
4. Make final wing flap setting when visual reference sufficient for landing is established.

RADAR APPROACH— 4/6 ENGINES

1. Complete the DESCENT checklist prior to reaching designated radio fix.
2. Start the BEFORE LANDING checklist after passing radio fix or on downwind leg. Maintain 155 knots IAS until wing flaps are extended, then hold 140 knots IAS until final; jets running.
3. After turning final approach, slow airplane to 130 knots IAS. Maintain rate of descent as required by radar controller.
4. Make final wing flap setting when visual reference sufficient for landing is established.

RADAR APPROACH—ONE OR MORE ENGINES INOPERATIVE

1. Complete the DESCENT checklist prior to reaching the designated radio fix.
2. Start the BEFORE LANDING checklist after passing the radio fix or on downwind leg. Maintain 155 knots IAS until wing flaps are extended, then 140 knots IAS; jets running. If operating conditions are critical, landing gear may be lowered later at pilot's discretion.
3. After turning final approach, slow airplane to 130 knots IAS. Maintain rate of descent as required by radar controller.
4. Make final wing flap setting when visual reference sufficient for landing is established.

ILS—4/6 ENGINES

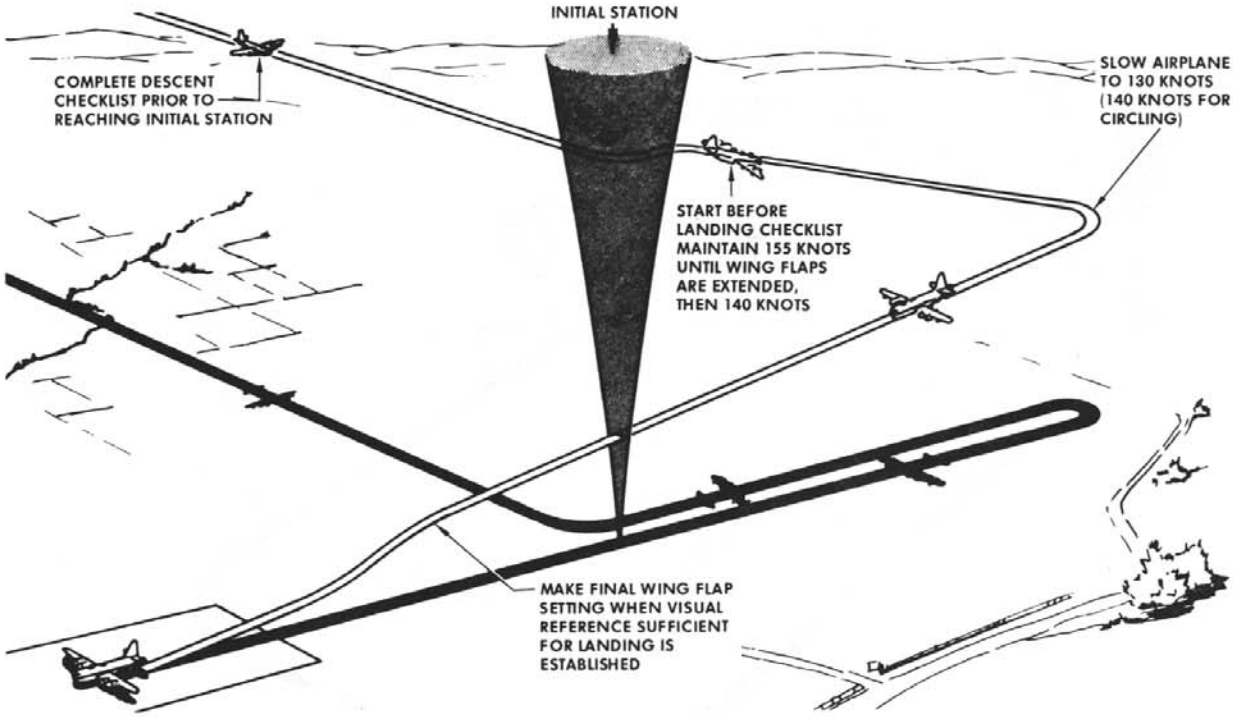
1. Complete the DESCENT checklist prior to reaching the radio fix.
2. Start the BEFORE LANDING checklist after passing the outer marker outbound. Maintain 155 knots IAS until wing flaps are extended, then 140 knots IAS.
3. After completing procedure turn inbound, slow airplane to 130 knots IAS.
4. Make final wing flap setting when visual reference sufficient for landing is established.

ILS—ONE OR MORE ENGINES INOPERATIVE

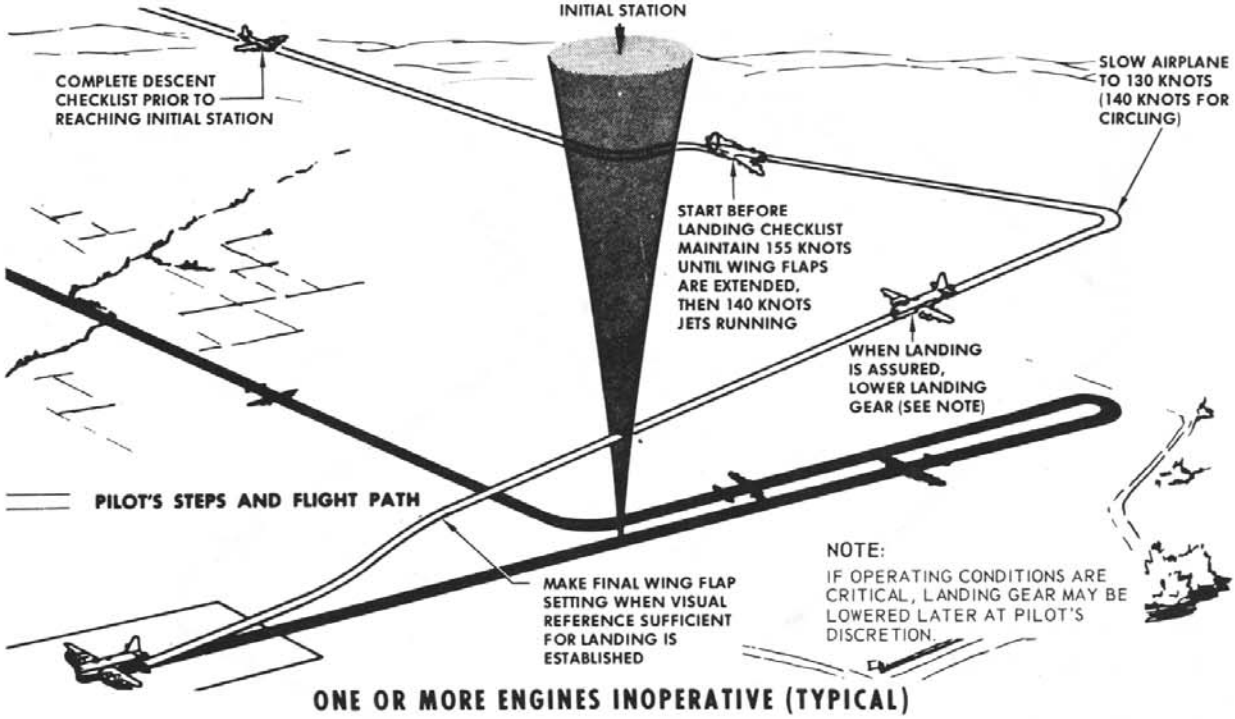
1. Complete the DESCENT checklist prior to reaching the radio fix.
2. Start the BEFORE LANDING checklist after passing the outer marker outbound. Maintain 155 knots IAS until wing flaps are extended, then 140 knots IAS; jets running. If operating conditions are critical, landing gear may be lowered later at pilot's discretion.
3. After completing procedure turn inbound, slow airplane to 130 knots IAS.
4. Make final wing flap setting when visual reference sufficient for landing is established.

LANDING

When the use of reverse thrust is planned with water, snow, or loose dirt on the runway, care should be exercised to prevent loss of visibility, especially in a light wind. Also, care should be taken that one or more engines do not stop during use of reverse thrust.

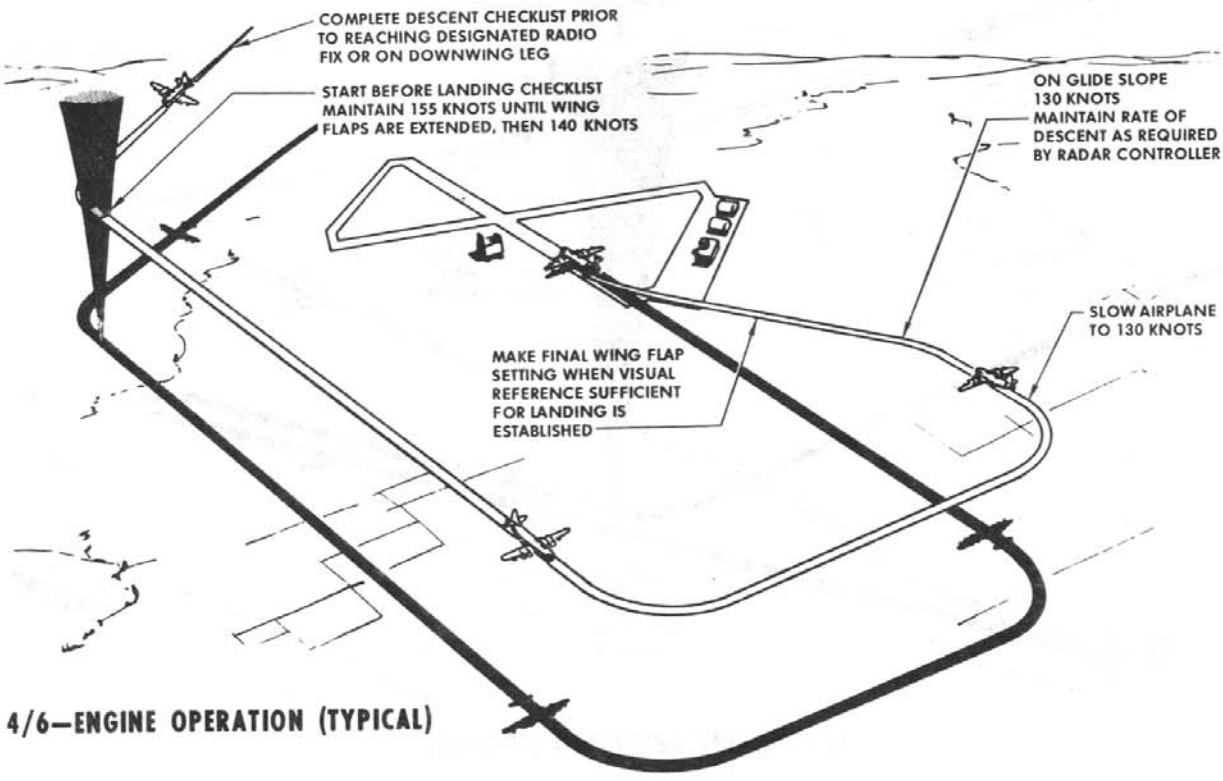


4/6—ENGINE OPERATION (TYPICAL)

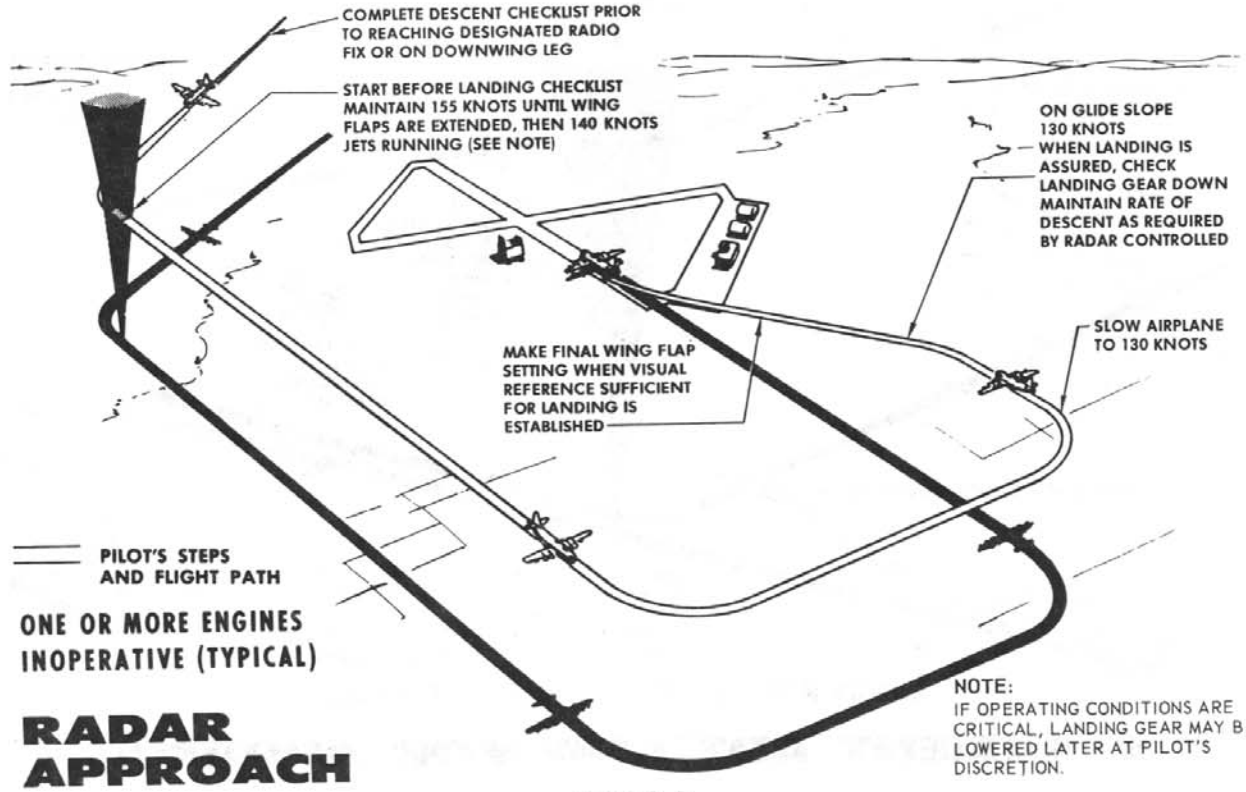


ONE OR MORE ENGINES INOPERATIVE (TYPICAL)

INSTRUMENT ADF AND VOR APPROACH



4/6—ENGINE OPERATION (TYPICAL)

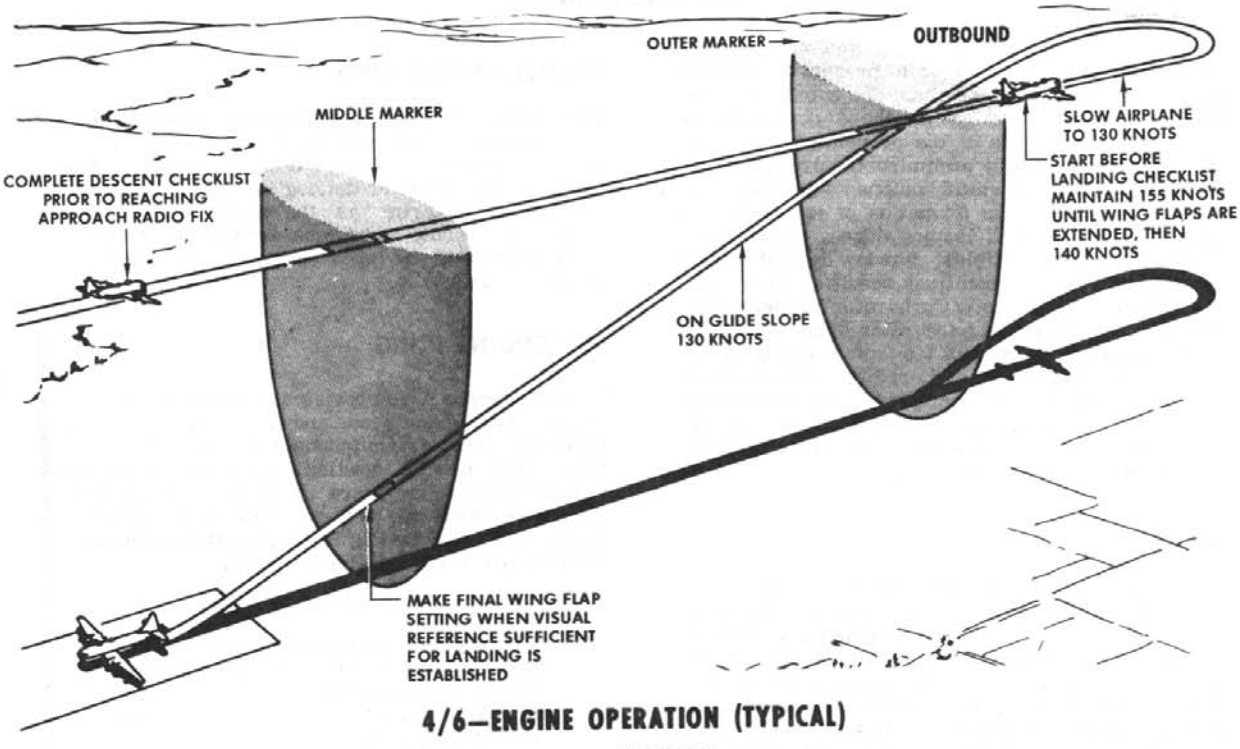


ONE OR MORE ENGINES INOPERATIVE (TYPICAL)

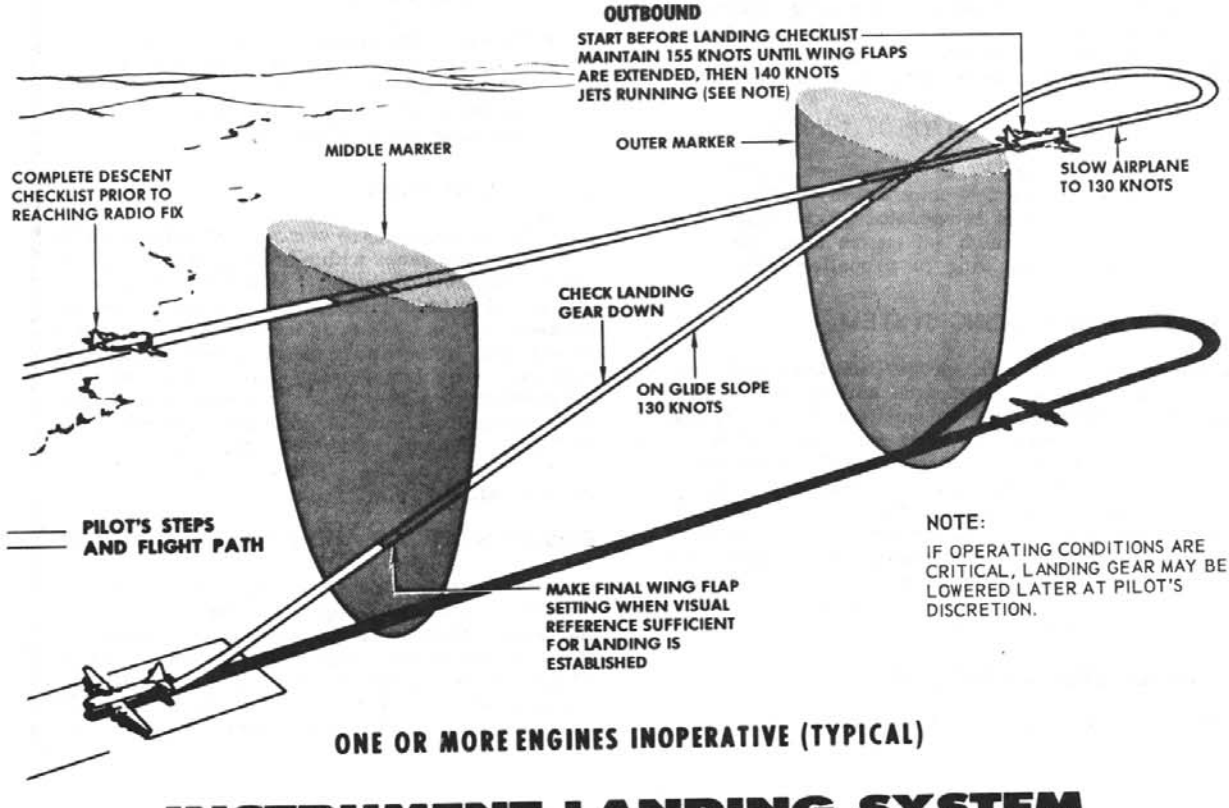
NOTE:
IF OPERATING CONDITIONS ARE CRITICAL, LANDING GEAR MAY B LOWERED LATER AT PILOT'S DISCRETION.

RADAR APPROACH

Figure 9–2



4/6—ENGINE OPERATION (TYPICAL)



ONE OR MORE ENGINES INOPERATIVE (TYPICAL)

INSTRUMENT LANDING SYSTEM

Figure 9–3

ICE AND RAIN

Flights through ice and rain present additional problems to the crew and should be avoided if possible. However, if flight in these conditions is necessary, proper use of the preventive and remedial equipment should minimize the problems encountered. The airplane is equipped with anti-icing systems to prevent the formation of ice on the jet engines, wing and tail leading edges, pitot heads, propellers, and windshields. Window defrosters are installed to alleviate conditions resulting from rain, frost, or traces of ice. Carburetor preheat provides protection against carburetor icing. No equipment is provided to prevent ice from forming on the nacelle air intake scoops; therefore, flights of long duration should not be attempted in moderate icing conditions. If moderate icing conditions are encountered, ascend or descend to an altitude where such conditions do not prevail.

ICING

Icing occurs because of supercooled water in visible moisture, such as fog, clouds, or rain. The most severe type of ice formation will generally occur at a temperature of approximately 23°F (-5°C). Icing conditions usually will not be encountered at altitudes above 25,000 feet, except in cumuliform clouds, such as thunderstorms. In such cloud formations, the horizontal extent of the icing conditions will be comparatively short, but normally the heaviest icing conditions will be encountered in these formations, and should be avoided if at all possible.

NOTE

From 0°C (32°F) to approximately 5°C (41°F) and the dew point within 4°C (7°F) of the ambient temperature, conditions exist under which jet engine icing can occur without wing or propeller icing.

SURFACE ANTI-ICING SYSTEM

The wings and the empennage each have their own anti-icing system. If icing is anticipated, turn on the entire system to give normal anti-icing. During critical icing conditions when sufficient heat is not available, the outboard wings, dorsal fin, and horizontal stabilizer only may be deiced by placing the limited anti-ice switches in the desired positions. For cases of extreme emergency, anti-ice switches allow bypassing of the automatic heat control and emergency cycling of the heaters as required. Under all conditions, it is advisable to monitor the heater duct temperatures closely.

CARBURETOR ANTI-ICING

Refer to CARBURETOR ICING, Section VII.

PROPELLER DEICING

When propeller icing conditions are suspected, place the propeller deice switch in the ON position to energize the circuit. Propeller deicing will be indicated by the propeller deicing indicators and by the loadmeter flickering as the timer selects each propeller. Should it become apparent that one or more propellers are not properly deicing, check the circuit breakers.

JET ENGINE ICING

The jet engines have provisions for anti-icing. The engine inlet guide vanes and front framestruts receive anti-icing air continuously during engine operation. The nacelle cowling, accessory dome and engine island fairings are anti-iced by hot air from the engine which can be turned OFF or ON by the jet engine anti-icing switch. See Section IV for additional information on the anti-icing system.

NOTE

- If jet engine icing conditions are encountered or anticipated, it is recommended that the jet engines be started and anti-ice turned on prior to entering icing conditions if operationally feasible.
- Since the jet engines receive heat for anti-icing from the compressor section it will be necessary for the jet engines to be operating at 85% rpm or above before anti-icing can be effective.

GUIDE VANE ICING

Axial flow jet engines are seriously affected when ice forms on guide vanes within the engine inlet and restricts the flow of inlet air. This causes a loss of thrust and a rapid rise in EGT. As the airflow decreases, the fuel-air ratio increases, which in turn raises the temperature of the gases entering the turbine. Complete turbine failure from extreme overtemperature may occur in a matter of seconds after ice buildup in the engine inlet. Therefore, the EGT gages must be monitored whenever icing conditions are encountered. If an abnormal rise in EGT is detected, shut down the engine.

ENGINE NACELLE AND NOSE DOME ICING

Ice may accumulate on engine nacelles and the accessory nose dome during either engine operation or shutdown. While ice buildup around the engine inlet will not greatly affect engine performance, the possibility of ice buildup breaking off and entering the engine presents a potential hazard which may result in engine failure. If icing is detected in its early

stages and buildup or accumulation is minor, increase jet engine power and make certain that the jet engine anti-icing switch is ON. If the ice continues to build up and does not dissipate, the engine should be shut down if at all practical. If power is required from the jet engines, operate them at the lowest practical power setting with the anti-icing switch turned OFF since availability of anti-icing air to the nose dome and nacelles could partially melt the ice and permit ingestion of large chunks of ice into the engine. Depart the icing area by the most expeditious route.

CAUTION

Monitor engine instruments, nacelles, and nose domes closely to detect additional ice buildup. If detected, further reduce power on affected engines if possible, since engine damage from ice ingestion is more probable and more severe at higher power settings.

If at any time ice accumulates on engine nacelles and nose domes and goes unnoticed until an appreciable amount has accumulated, assure that the anti-icing switch is OFF. The affected engines should be shut down if at all practical. When clear of the icing area and ice is still visible on nacelles and nose domes, do not restart the engine until all ice has dissipated.

WINDOW HEATING AND DEFROSTING

The center row of windows at the forward end of the control cabin, with the exception of the last window on each side, is deiced by electric window heat. To obtain window deicing, place the alternator switches in the ON position. Power may then be selected from either alternator for the Nesa bus. Start with the window heat selector switch in the LOW position to allow more gradual and even heating of the glass.

RAIN DURING LANDING

The following information provides the vision limits that can be expected in various reported precipitation conditions, provided that wipers have been properly maintained:

1. If mist or light rain is reported, vision will not be significantly impaired during landing.
2. If moderate rain is reported, the wipers will be needed during landing to improve vision.
3. If heavy rain is reported, vision will be fair through wiper area.
4. If very heavy rain is reported, the wipers will provide little or no vision.

HYDROPLANING

A hydroplaning tire is either partially or totally supported by a thin layer of water and/or slush on the runway surface. If hydroplaning occurs during takeoff or landing, the pilot may have difficulty stopping the aircraft or controlling it directionally due to the reduction in friction between the tires and runway. Three types of tire hydroplaning have been identified: (1) dynamic, (2) viscous and (3) reverted rubber. All the types can occur singly or simultaneously, under the nose wheels or main wheels.

DYNAMIC HYDROPLANING

The possibility of partial or total dynamic hydroplaning, during airplane takeoff and landing, exists whenever water or slush stands on the runway.

Dynamic hydroplaning will occur whenever a rolling or skidding tire does not displace water or slush at a rate fast enough to permit the complete tire footprint area to contact the runway surface. As the airplane ground speed increases on takeoff, a wedge of water gradually extends into the tire footprint area, decreasing the contact area between the tire and ground. The portion of the tire footprint being kept off the runway surface by a film of fluid gradually increases as airplane speed increases. As the wedge of water penetrates the tire footprint area, hydrodynamic pressure is built up between the tire and pavement which lifts the tire from the runway surface. Hydroplaning is a gradual process, and partial hydroplaning exists long before total hydroplaning occurs. At total hydroplaning speed the airplane tires will ride entirely on the film, and tire contact with the runway will be lost.

It has been determined that the minimum total hydroplaning speed in knots (gound speed) for smooth tires or ribbed tires operating in fluid deeper than their tread depth, is approximately equal to nine times the square root of the tire inflation pressure ($V_H = 9\sqrt{p}$). There are many factors which influence or contribute to the hydroplaning condition of an aircraft tire.

1. Velocity of aircraft. Since the rate of buildup of hydrodynamic pressure ahead of the tire is proportional to the square of the aircraft ground speed, onset of partial hydroplaning for some conditions can occur at a relatively low indicated airspeed during the ground roll.
2. Tire inflation pressure. Partial and total dynamic hydroplaning speeds are proportional to the square root of tire inflation pressure which is a linear function of takeoff gross weight. Therefore, the tires should be properly inflated in order to keep the hydroplaning speeds as high as possible.
3. Depth of water or slush. Depths of about 0.1 inch or greater on non-grooved runways will cause dynamic hydroplaning at predicted airspeeds if the depth is equal to or greater than the average tire tread groove depth. Although 0.1 inch depth is approximately the minimum for dynamic hydroplaning, other types of hydroplaning exist at shallower depths or on a damp runway surface.

4. Slush. Hydroplaning speeds in slush are approximately 8% higher than on water.

5. Tire tread groove depth. Tests show that for tire tread groove depths which are less than the water/slush depth covering the runway, the tread pattern and wear have no effect on total dynamic hydroplaning speed, but if 50% or more of the tread depth remains, the braking coefficient of friction is increased in the partial hydroplaning region. If the average groove depth is greater than the water/slush depth, hydroplaning will be delayed to higher speeds since the water or slush will be allowed to escape from the tire footprint, relieving hydrodynamic pressure.

6. Runway surface texture. Open textured or coarse runway surfaces tend to relieve hydrodynamic pressures and delay slightly the onset of hydroplaning. Recent tests show that grooved runways (perpendicular to the runway centerline) have a very pronounced effect on hydroplaning, and may prevent it in some cases.

7. Tire geometry and design. Rib tread tires with circumferential grooves of optimum width are best for the relief of hydrodynamic pressure during the ground roll. Also for a given tire diameter, wider tires hydroplane earlier than the narrow ones.

VISCOUS HYDROPLANING

Viscous hydroplaning (or thin film lubrication) is potentially as much of a problem as dynamic hydroplaning. It can occur at lower airspeeds than dynamic hydroplaning on damp runway surfaces that are wet but without standing water. It is caused by the formation of a viscous film between the tire and the runway surface which prevents traction, especially when both surfaces are smooth. The more significant factors which influence this type of hydroplaning are as follows, although the magnitude of their effects are difficult to estimate.

1. Viscosity of water contaminants. The more contaminated the water film with viscous foreign materials such as oil, dust, etc., the higher the viscosity of the mixture and the greater the chance for hydroplaning. Conditions such as this result from a light rain shower following an extended dry period. The lubricating properties of these viscous contaminants adversely affect the braking friction coefficient.

2. Runway surface texture. Coarseness of the runway surface is a very important factor in the prevention of viscous hydroplaning since the depth of the film of fluid coating the runway is quite small and therefore only requires small openings in the surface to break up this film.

3. Tire tread design and wear. Viscous hydroplaning can be prevented on a coarse runway surface by proper tire tread grooving. Wet braking friction coefficients are higher on a grooved tire than on a smooth, badly worn tire.

REVERTED RUBBER SKIDDING

In addition to the problem of dynamic and viscous hydroplaning when decelerating on wet runway surfaces, there also exists the possibility of reverted rubber skidding. If the brakes lock, elevated tire footprint temperatures soon cause the rubber tread to revert to its uncured state. This may also happen momentarily at landing touchdown, prior to wheel spin-up. If the temperatures are high enough, super-heated steam may be generated and trapped in the forward part of the footprint, raising that portion off the runway similar to dynamic hydroplaning. Since the outer portion of the tread near the carcass sidewall is much softer than normal, due to its reverted rubber condition, it may prevent runway surface roughness from penetrating the film of water, thereby causing viscous hydroplaning. If this occurs, a seal is created which traps the water/steam mixture. This type of hydroplaning results in near zero braking friction coefficients and has been known to continue almost to the point of zero ground speed. The characteristic white skid marks associated with reverted rubber skidding are the result of a "steam cleaning" effect caused by the high temperature and velocity of the trapped water/steam mixture. Runway surface texture has little effect on the alleviation of reverted rubber skidding, although tests indicate that transverse grooving will raise the braking coefficient considerably.

EFFECTS OF HYDROPLANING

Hydroplaning results in a marked loss of coefficient of friction between the tire and runway surface. The loss in coefficient of friction also reduces the effectiveness of nose wheel steering and main wheel cornering, and consequently the ability of the pilot to cope with crosswinds.

Stopping distances increase considerably when braking traction is lost. Applying brakes to wheels which have already slowed down or nearly stopped due to hydroplaning will not improve the coefficient of friction between the tire and runway.

Steering and cornering of airplane tires is dependent upon tire contact with the runway surface. If tires lift completely off the pavement, ability to steer the airplane will be lost. Thus, the tires will be unable to develop resistance needed to couteract crosswinds. Unless aerodynamic controls are used and are effective, the pilot under these circumstances may be unable to keep the airplane from veering or sliding off the pavement.

PILOT TECHNIQUE FOR HYDROPLANING

As discussed under "Tire Hydroplaning," hydroplaning is a phenomenon with many variables.

However, certain factors should be considered in order to properly plan for takeoff or landing under hydroplaning conditions.

1. An approximate speed at which total dynamic hydroplaning occurs can be determined from Figure 3A. Refer to T.O. 1C-97G-1-1 (T.O. 1C-97(K)L-1-1) for airspeed position correction and density altitude correction and correct for wind to convert ground speed to KIAS. Smooth tires or tires with very little tread remaining will result in hydroplaning with less water depth on the runway.

2. Reverse thrust will provide the maximum effective deceleration during an aborted takeoff or landing roll. Caution must be exercised, however, when using reverse thrust when crosswind conditions exist. It is necessary to slightly crab the airplane into the crosswind to develop a main gear cornering force to overcome the side force due to the crosswind tending to blow the airplane off the runway. If reverse thrust is applied under this crabbed condition, an additional force (thrust component) will assist the crosswind and could cause the airplane to slide off the down wind side of the runway.

3. Areas of rubber deposits on the runway will have a detrimental effect on braking action. Therefore, reduce speed as much as possible prior to entering these areas.

4. Minimum landing run technique should be used to reduce the flare distance and allow more runway remaining after touchdown. (See Section II for discussion.)

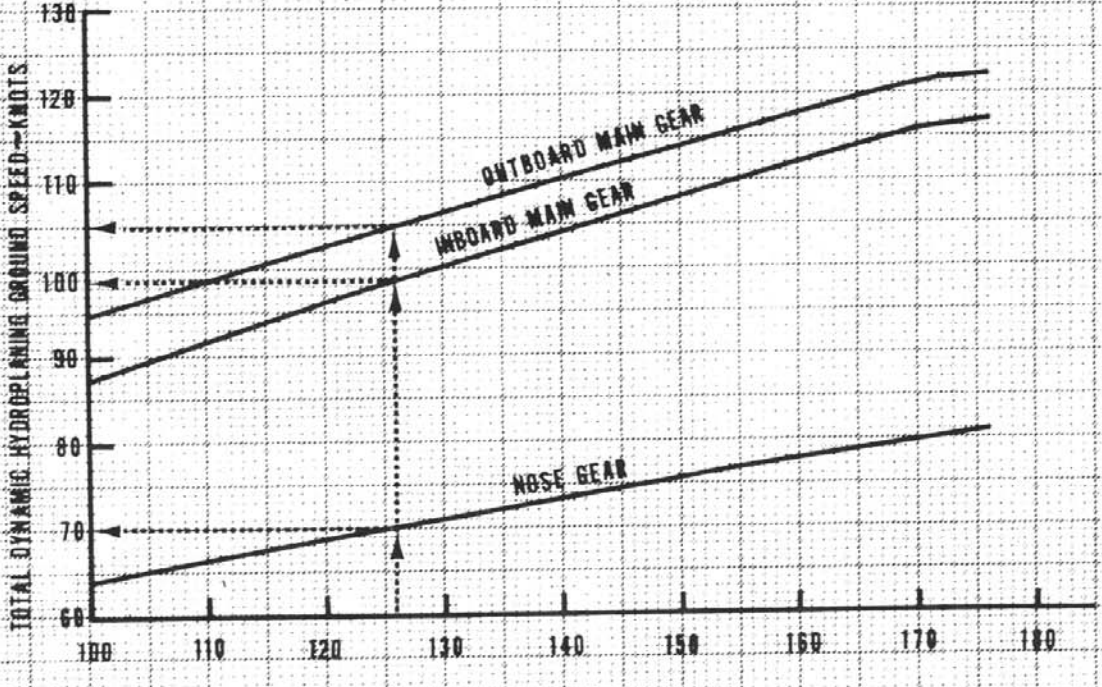
5. Tires should be properly inflated for the operating gross weight at takeoff. If the tire pressures are low, hydroplaning will occur at a lower speed.

6. In total dynamic hydroplaning conditions, steering and wheel braking are ineffective. Therefore, it is important to be properly aligned with the runway at touchdown.

7. The advantages of delayed landing or proceeding to an alternate should be considered when dynamic hydroplaning conditions exist with a crosswind.

NOTE: GROUND SPEED MUST BE CONVERTED TO KIAS BY CORRECTING FOR WIND, DENSITY ALT. AND POSITION ERROR

REMARKS: HYDROPLANING SPEEDS ARE BASED ON THE TIRE INFLATION SCHEDULE IN T. O. 1C-97(K)E(C)-2-7



HYDROPLANING SPEEDS

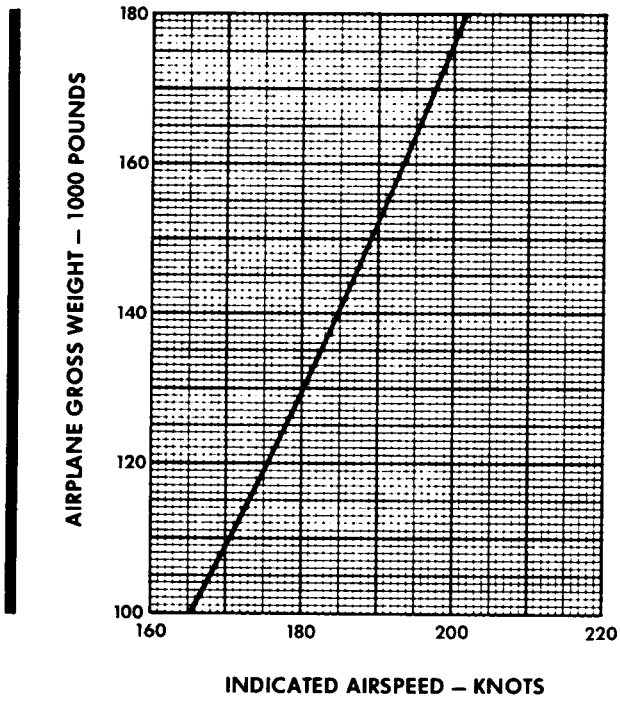
Figure 9-3A

FLIGHT IN TURBULENCE AND THUNDERSTORMS

CAUTION

Flight through thunderstorm activity or known severe turbulence is not recommended and should be avoided if at all possible. Careful judgement must be exercised by the pilot in determining capability to safely enter or circumnavigate areas of such weather activity. The appropriate corrective action to be taken if moderate or greater turbulence is forecast will be preplanned with assistance of the weather forecaster during the weather briefing for all flights.

Turbulence (gusts) increases in intensity with altitude to within 5000 to 10,000 feet below the tops of clouds (usually 16,000 to 22,000 feet above the terrain). Although turbulence is usually at a minimum near the bases and tops of the clouds, in some cases it may be severe in these areas. It is recommended that the pilot avoid the freezing level because of possible dangerous icing and turbulence. Since circumstances may force the pilot at some time to enter a zone of severe turbulence, he should be familiar with the recommended techniques for flying the airplane under such conditions. When flight in turbulence is anticipated, it is imperative that the airplane be prepared prior to entering the turbulent area.



TURBULENT AIR PENETRATION SPEEDS

Figure 9–4

A penetration speed must be established so that the airplane will neither reach limit load factors nor enter the stalling speed range. Power settings and pitch attitudes are the keys to proper flight techniques in maintaining this penetration speed once the turbulent zone is entered. If a constant power setting and pitch attitude are maintained throughout the storm, a more nearly constant airspeed will result, regardless of any false readings on the airspeed indicator. A safe, comfortable penetration speed for the airplane is **60 KNOTS IAS ABOVE POWER-OFF STALLING SPEED** for the weight and configuration being flown. (See figures 6–1 and 9–4.) Specific instructions for preparing to enter the storm and for flying in it are given in the following paragraphs.

CAUTION

Serious damage to the airplane can result, due to hail and/or turbulence, during flights in thunderstorm activity. If a thunderstorm penetration must be made, a suggested penetration altitude of 6000 feet or below should be adhered to.

JET ENGINE SURGE AND FLAMEOUT

Areas of turbulent air, hailstorms, or thunderstorms should be avoided when possible, because of the increased danger of jet engine flameout.

CAUTION

Flying in turbulent air or hail may increase inlet distortion at high altitudes; this distortion can result in engine surge and flameout.

Note

EGT and engine rpm should be monitored continuously during weather penetrations. EGT indications alone may come too late to enable the pilot to take corrective action.

APPROACHING THE STORM

It is imperative that you prepare the airplane prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity can be detected by radio crash static. The radar should be used to avoid the storms or to pick the best point of penetration. The radar echo shows the location of the moisture content of the storm. The greatest amount of turbulence is associated with these precipitation areas. The brighter the echo the heavier the precipitation (possible hail) and the greater the turbulence. The echoes should be avoided if at all possible. If a penetration must be made, the shortest course through the weakest echo should be chosen. Prepare the airplane as follows:

1. Autopilot – DISENGAGE; TRIM AIRPLANE.
2. Mixture Levers – AUTO RICH.
3. Master Propeller Synchronizer Lever – 2350 RPM FOR GYROSCOPIC STABILITY.
4. Pitot Heater and Surface Anti-Icing Switches – ON.
5. Carburetor Heat – AS REQUIRED.
6. Throttles – ADJUST AS NECESSARY TO OBTAIN PENETRATION SPEED.
7. Gyro Instruments – CHECK FOR PROPER SETTINGS.
8. Safety Belt – TIGHTENED (CHECK WITH CREWMEMBERS).
9. Radio Equipment – TURN OFF ANY RENDERED USELESS BY STATIC.
10. Cockpit Lights – FULL BRIGHT (TO MINIMIZE EFFECT OF LIGHTNING).

CAUTION

Do not lower landing gear and wing flaps, as they merely decrease the aerodynamic efficiency of the airplane.

IN THE STORM

Emphasis is placed on the following:

1. Maintain power setting and pitch attitude (established before entering the storm) throughout the storm. Hold these constant and airspeed will be constant regardless of the airspeed indicator.
2. Devote all attention to flying the airplane.
3. Expect turbulence, precipitation, and lightning and do not allow them to cause undue concern.
4. Maintain attitude. Concentrate principally on holding a level attitude by reference to the attitude indicator.
5. Do not chase the airspeed indicator, since doing so will result in extreme airplane attitudes. If a sudden gust should be encountered while airplane is in a nose-high attitude, a stall might easily result. A heavy rain, by partial blocking of the pitot tube pressure head, may decrease the indicated airspeed reading by as much as 60 knots.
6. Use as little elevator control as possible to maintain attitude in order to minimize the stress imposed on the airplane.
7. The altimeter is unreliable in thunderstorm flying because of differential barometric pressures within the turbulent area. A gain or loss of several thousand feet may be expected. Make allowance for this error in determining minimum safe altitude. Static electricity may appear on the propeller hubs and blades and around the cockpit windows in the form of a flickering blue light. This will cause severe static on HF and LF radio equipment. It is recommended that all radios not in use be turned off to prevent a discharge through a set.

NIGHT FLYING

It is important, when making a night takeoff and immediately afterwards, to hold the airplane at the proper attitude and to let the airspeed build up steadily without any loss of altitude at any time. Take off using normal procedures. On the approach for landing, whether visual or instrument approach, the copilot will monitor the altimeter and vertical velocity indicators; he will advise the pilot flying the airplane when the angle of bank exceeds 30 degrees, when airspeed falls below computed traffic pattern or final approach speeds, and when the airplane appears to be dangerously low to the ground or other obstructions (visual and altimeter cross-check). Leave about 15 inches MP on the engines for flareout and touchdown.

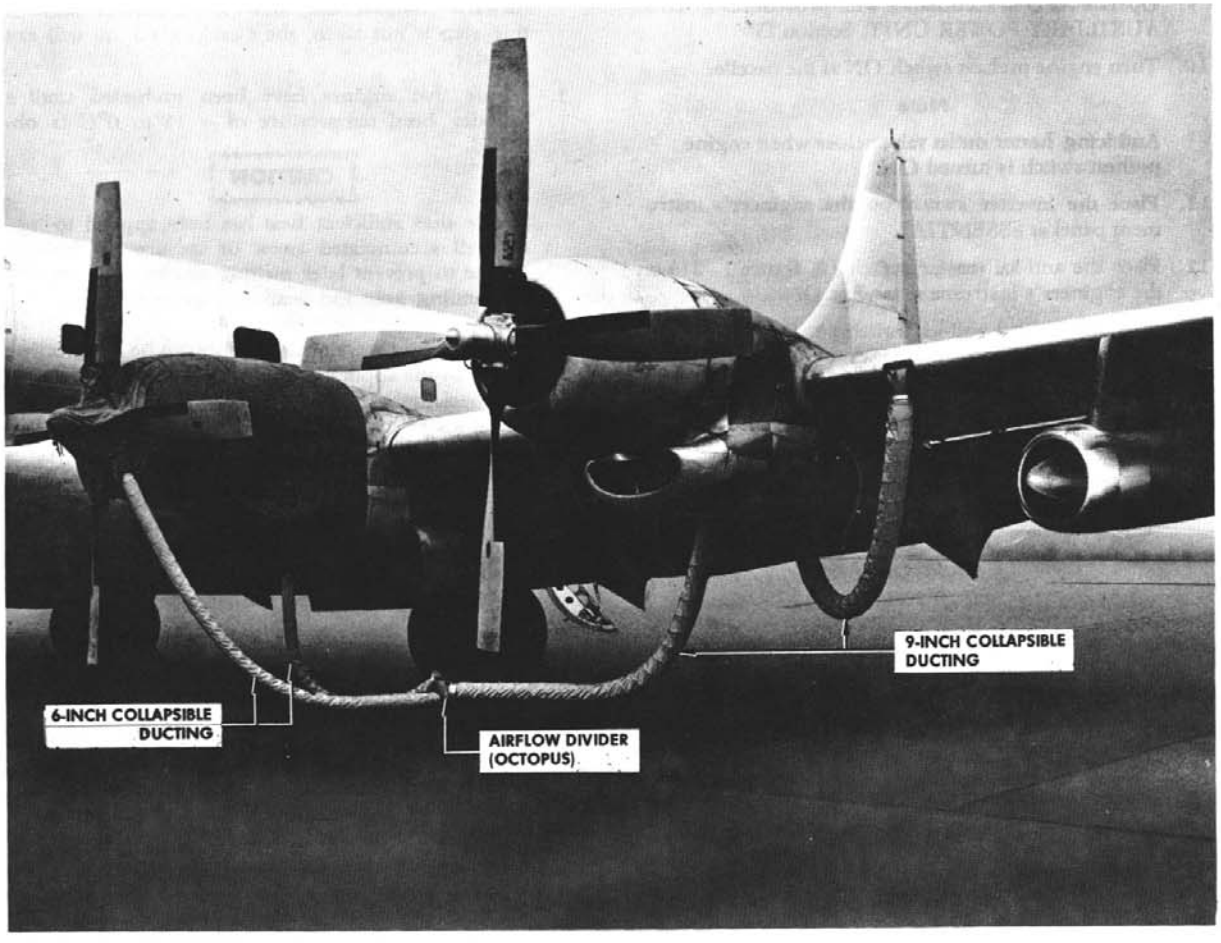
COLD WEATHER PROCEDURES

Successful cold weather operations depend upon the adherence by flight crews and maintenance crews to established procedures. A very important consideration for flight crews is the use of cold weather preflight, inflight, and postflight procedures. Maintenance crews must winterize the airplane before it can be operated successfully under cold conditions. This winterization program includes tightening of fittings in the fuel cell access doors, and the flexible fittings in the hydraulic lines and fuel lines of the air refueling system. These maintenance procedures should be accomplished prior to departure from warmer climates for the most satisfactory results. Cold weather operation requires careful planning of ground activities before takeoff. The central oil tank should be serviced during preflight rather than postflight to reduce the oil tank preheat requirement. Arrange preheating periods so that all airplane equipment will be inspected, warmed, ready, and operating at the time of starting engines. While preheating is being accomplished, ice and snow should be removed, inspections and operation checks made, electronic equipment warmed up, and other necessary activities conducted. Ground inspections and operational checks must be thorough, since cold weather may cause hidden difficulties such as ice and snow accumulation in control mechanisms; fuel, oil, and hydraulic hose brittleness with accompanying lowered resistance to pressure shocks; and plexiglas brittleness.

PREFLIGHT

ENGINE PREHEAT INSTRUCTIONS

With proper use of oil dilution, engine preheat will not be required at temperatures above -15°F (-26°C) for a layover or turn-around period of 4 to 6 hours. To preheat the engines using the APU, proceed as follows:



COLLAPSIBLE DUCTING ARRANGEMENT

Figure 9–5

1. Obtain preheat equipment from the storage space in the rear of the airplane.

Check against following list:

   a. Two 9-inch collapsible ducts for each wing (total, four).
   b. Four 6-inch collapsible ducts for each wing (total, eight).
   c. Airflow divider (octopus), one for each wing.
   d. Ram-air duct connection, one for each wing.
   e. Oil ventilator access adapter.
   f. Nacelle covers or plugs for each engine.

2. Open No. 1 and No. 4 engine nacelles and remove heater outlet cap.
3. Insert ram-air plug adapter in leading edge of each wing and attach 9-inch collapsible duct to plug. Attach other end of duct to blower outlet.
4. Attach second 9-inch collapsible duct to heater outlet. Attach other end of this duct to large opening of octopus.
5. Attach four 6-inch collapsible ducts to smaller openings of each octopus.
6. Install nacelle covers or plugs on engines.
7. Install adapter in oil ventilator access door. Attach one 6-inch collapsible duct from octopus to this adapter, and tee with straps.
8. Attach one 6-inch collapsible duct from octopus to nacelle cover or plug. (See figure 9–5.)

Note

The above instructions are typical for all four engines. If only one engine on each side is to be heated, attach two 6-inch collapsible ducts to nacelle cover or plug and two 6-inch adapters to oil vent for faster heating.

9. Operate APU in accordance with procedures given in AUXILIARY POWER UNIT, Section IV.
10. Turn engine preheat switch ON at the nacelle.

Note

Anti-icing heater outlet valves close when engine preheat switch is turned ON.

11. Place the inverter switch on the engineer's instrument panel at ESSENTIAL.
12. Place the anti-ice master switch (2, figure 1–21) on the engineer's instrument panel at ON.
13. Place the limited anti-ice switch (3, figure 1–21) on the engineer's instrument panel at ON.
14. Place wing anti-icing heater fuel valve switches on the engineer's instrument panel at ON as required for LH wing and RH wing No. 1, 2, and 3 heaters.
15. Operate APU in accordance with AUXILIARY POWER UNIT (APU), Section IV.

CAUTION

After completing preheat operation, engine preheat switch must be returned to the OFF position.

Preheat Shutdown Procedures

1. Wing-Anti-Icing Heater Switches – OFF.
2. Limited Anti-Ice Switch – OFF.
3. Anti-Ice Master Switch – OFF.
4. Engine Preheat Switch – OFF

   Nacelle blower operation, for approximately 2 minutes after fuel shutoff, is required to purge and cool wing anti-icing heaters.
5. Collapsible ducting and Adapters – DISASSEMBLE AND STOW.
6. Heater Outlet Cap – REPLACE.
7. Heater Cavity Doors – CLOSE.
8. APU – LEAVE ON THE LINE FOR IMMEDIATE ENGINE START (IF REQUIRED).

BEFORE ENTERING THE AIRPLANE

The following procedures will be adhered to during cold weather operations:

1. At temperatures below 15°F (–9°C), preheat the engines and cabin as required.
2. Insure that adequate heat has been applied to the central oil tank, the oil transfer lines in the lower forward compartment, and the oil transfer valve. If this step is not taken, the congealed oil will not transfer.
3. Insure that engines have been preheated until a cylinder head temperature of – 15°to 0°C is obtained.

CAUTION

Insure that sufficient heat has been applied to melt all accumulated snow or ice around the engine to prevent later melting and freezing on the landing gear and leading edge of the wing.

4. A malfunctioning unit frequently can be made operational by the application of external heat. This is true of wheel brakes, air refueling boom sliding seal, flap actuators, selector valves, etc.
5. Check the main tires for flat spots. If the airplane has been parked more than 48 hours in temperatures of –40°C (–40°F) or below, particularly with a full load, the tires must be heated and rotated. Heat should be left on the tires for at least 15 minutes after rotation to eliminate the flat spots.
6. Insure that sheltered air inlet filters have been removed.
7. Use external power.
8. Insure that ice, snow, and frost have been removed from wings, control surfaces, and control surface hinges. Depending on the weight of snow and ice accumulated, takeoff distances and climbout performance 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.
9. Check fuel vents, limit switches, and actuating arms that fold for accumulation of snow and ice.

CAUTION

When directing heat to the induction system from ground heaters, limit to a maximum of 20 minutes to prevent damage to the butterfly valves.

ON ENTERING THE AIRPLANE

Have the APU and battery warmed sufficiently to enable the APU to be started and to maintain smooth operation. Start cabin heating system to defrost windows and to warm flight instruments, radios, and other equipment within the airplane. If the cabin heating system does not supply adequate heat in cold weather, heat from external

heaters can be introduced into the forward and aft compartments through entrance doors.

Note

Do not utilize Nesa heat to defrost windshield unless normal defrosting system is inadequate.

BEFORE STARTING ENGINES

The following procedures will be adhered to before starting the engines in cold weather:

1. Have all ground heating equipment removed. Have oil immersion heaters removed if used. Hold the time interval between removal of ground heating equipment and engine start to a minimum.
2. Turn off cabin heaters and all other unnecessary equipment.

WARNING

The cabin heaters must be turned off because the amount of electrical power required to start the engines will reduce the voltage to the ground blower and thereby reduce the volume of air for a combustible mixture. This overly rich mixture will result in burning gasoline being vented overboard beneath the fuselage, causing a critical fire hazard.

STARTING ENGINES

Open cowl flaps and start engines in the normal manner, as described in Section II, provided adequate external heat has been applied. If adequate external heat has not been applied, the cowl flaps, sheltered air doors, and intercooler flaps must not be moved until after the engines are started and the cylinder head temperature has reached 150°C. Use the following procedure for cold weather starting:

1. After 15 blades, position boost pump switch to EMERGENCY and prime; after 20 blades, turn on ignition and apply ignition boost.

CAUTION

Do not prime engine before engaging starter. To prevent hydraulic lock, avoid every possibility of liquid fuel collecting in the intake pipes or cylinders.

Note

- All normal starts will be made on prime. Refer to Section VII for starting procedures.
- Twenty blades are required for any start made after a 1-hour shutdown. Eight blades will insure detection of hydraulic lock and are sufficient for engine starts made within 1-hour of last shutdown.

2. If there is no oil pressure after 30 seconds running, or if the oil pressure drops after a few minutes of ground operation, shut down the engine and have the ground crew check for blown lines or coolers, and recheck for congealed oil or ice in the Y drain or oil tank sump drain. If oil pressure is registered but is consistently low, or if fluctuating oil pressure is experienced, have instrument pressure transmitter line checked for congealed oil or air lock.
3. If oil pressure becomes too high for a prolonged period (200 psi or above for more than 30 seconds), the oil may be diluted slightly by actuating the dilution switch intermittently to bring down the oil pressure. If 30 seconds of this intermittent dilution fails to reduce the excessive pressure, discontinue the use of the dilution switch; the oil pressure will drop as the oil warms.
4. With an extremely cold engine, the initial warmup may have to begin at a lower speed if backfiring occurs at 1000 rpm.

ENGINE GROUND OPERATION

WARNING

The oil cooler may not be fully diluted due to the action of the 60°C vernatherm, which bypasses the oil coolers at desired dilution oil temperatures of 50°C. It may have partially congealed oil in the cores. After engine start, the oil cooler doors should be kept closed by manual control until normal oil temperatures exist. (Refer to ICING OR CONGEALING OIL, this section, for instructions for icing or congealing of oil systems.)

It may become necessary to close the cowl flaps to minimum flight opening in order to raise the cylinder head temperature enough to obtain smooth engine operation for engine check. Ground operation with cowl flap openings of less than 1 inch may cause the ignition harness to bake; therefore, extended operation under these conditions should be avoided. Turn on cabin heat. Accomplish as much of the ground check as possible with the wheels blocked to prevent slipping on a slick surface. To eliminate congealing of oil lines in the oil transfer system, accomplish the following:

1. Test oil transfer system for proper operation by transferring 1 gallon to each nacelle tank. If system is inoperable (cannot transfer) and heat to central tank and transfer line has been applied, it is an indication the transfer lines in the wing are congealed.
2. To warm the oil transfer lines, manually close turbo waste gates, open preheat valves, and advance throttles to 2000 rpm. Maintain cabin air flow of at least 2 inches Hg. The resultant CAT. rise should be approximately 40°C in 3 to 4 minutes. This will aid in decongealing the oil, because the oil transfer lines are lagged to the cabin air bleed ducts. This will also aid in developing desirable CAT. for takeoff.

3. Retest oil transfer system. Repeat step 2 as required.

WARNING

Insure that all instruments have warmed up sufficiently for normal operation. Check for sluggish instruments during taxiing.

TAXI

CAUTION

- The nose wheel steering is not dependable on icy strips and runways. Use throttles primarily for directional control. This also applies for takeoffs and landings.
- Insure that all engines have reached 40°C oil temperature before increasing power to initiate taxi roll. This is to assure that adequate oil flow and lubrication exist prior to increasing engine rpm.

Cold weather taxiing presents two problems. Soft snow and congealed wheel bearing lubricants will retard the taxi roll, causing a higher power requirement than for normal taxiing operation. Once the wheel bearing lubricant has warmed, the problem is reversed; rolling action is no longer retarded, and it becomes a problem of braking the roll on a slippery surface. The taxiing roll may best be slowed by intermittent use of the brakes. Never ride the brakes on a slick surface. When the brakes are ineffective, use reverse thrust to slow or stop the airplane.

CAUTION

- Use of reverse thrust causes uneven and inefficient cooling of the engine, even in cold weather, and continued use for ground operations will result in serious overheating of parts of the engine. This overheating is not readily detectable on the engine instruments.
- Avoid contacting snow, ice, or slush with the propellers, and exercise caution when operating in areas where ice, slush, or snow may be blown into propellers, as extensive damage to propellers, engines, and engine mounts may result.
- On ice-covered taxiways and runways, and on painted areas that are moisture covered, taxi with extreme caution. High crosswind or excessive speed during turns may start the skid. Also, be alert for extreme slipperiness at the approach end of snow-covered runways. The intense heat produced by jet engine blasts may form ice due to melting and refreezing.

BEFORE TAKEOFF

The following procedure should be accomplished in addition to the normal instructions in Section II.

1. If an instrument takeoff is anticipated, check all flight instruments for proper operation. Insure that all instruments have warmed up sufficiently for normal operation. Check for sluggish instruments during taxiing.
2. Operate wing flaps through at least one complete cycle.

POWER STAGING

Power staging is necessary prior to takeoff in order to minimize spark plug fouling at higher power settings during the takeoff run. It allows the spark plug core and tip temperatures to rise evenly to the desired temperatures, and prevents carbonaceous (lead salts) fouling which occurs during rapid advancement of the throttles.

The following power staging procedures should be accomplished prior to takeoff, when temperatures are 32°F (0°C) or below:

1. Advance throttles slowly to 2100 rpm and hold for 30 seconds.
2. Set power at 2100 rpm and 40 inches of manifold pressure and hold for 10 seconds.
3. Return propeller master synchronizing lever to full increase, advance throttles slowly to 2650 rpm, and hold for 10 seconds or until takeoff cylinder head temperatures are reached. Scan all engine instruments for proper pressures and temperatures.
4. If immediate takeoff is not planned, retard throttles to the desired setting.

Note

- For the purpose of the above procedures, the definition of slow throttle movement is: 5 seconds per 100 rpm or 1 inch of manifold pressure in the normal range, and 1 second per 100 rpm or 1 inch of manifold pressure in the restricted range. Restricted rpm ranges are presented in Section V.
- Power staging may be discontinued at any point in the above procedure when takeoff CHT limits are reached.

TAKEOFF

The following procedure will always be adhered to during cold weather takeoffs:

1. Set cowl flap opening at 1.5 inches while holding brakes. Allow the cylinder head temperature to rise to a desired 180°C before takeoff.
2. During periods of high humidity and carburetor air temperature below + 7°C, use sheltered air.

CAUTION

Turbos will not be used for takeoff, because this will damage the engine.

3. Maintain carburetor air temperature at + 15°C, if possible, to aid fuel vaporization.
4. At subzero temperatures, maximum power output will be obtained at reduced manifold pressure due to the increase in air density. The torquemeters may be utilized to determine when maximum power is being delivered.
5. The pilots should be cognizant of the fact that the attitude indicators are unreliable at cabin temperatures below −45°F (−43°C) and that all flight instruments must be cross checked.

AFTER TAKEOFF — CLIMB

The following procedures are in addition to the normal instructions in Section II:

1. After the first power reduction is made after takeoff, adjust the carburetor preheat as necessary to maintain the proper carburetor air temperature.
2. Insure that surface anti-icing systems are in operation if precipitation is encountered.
3. If gross weight and climb conditions permit, operate landing gear through one complete cycle to remove accumulated slush and snow.

CLIMB

Climb with cowl flaps closed to minimum opening, or as needed to keep cylinder head temperature below maximum limit for AUTO RICH operation. When visible moisture conditions exist, the following procedures will eliminate the possibilities of carburetor icing:

1. Keep intercooler flaps closed at all times below carburetor air temperature of −15°C.
2. Use the turbo system to avoid operation with a carburetor air temperature between −10° and + 7°C.
3. Maintain a minimum of 2 inches Hg cabin air flow throughout the flight to warm the oil transfer lines.

CRUISE

Erratic engine operation and inefficient performance may be encountered sometimes due to poor fuel vaporization, a low carburetor air temperature, or a low cylinder head temperature encountered at low power settings. If this develops, check to be certain that the carburetor air temperature is within the proper operating limits. If the carburetor air temperature is at the low limit, raise it to the high limit. If difficulty persists, increase mixture strength by use of the mixture lever to obtain smooth engine operation or change power setting to increase cylinder head temperature.

ALTIMETRY ERROR CORRECTIONS

Altimeter errors obtained during flight in the arctic areas will usually be taken care of by the 1000- or 2000-foot terrain clearance requirements. In the arctic regions where low lapse rates cause dangerous computer errors, a higher terrain clearance requirement should be established. These low lapse rate errors could also be taken care of during planning or during flight if the computer is modified to allow adjustment for the mean lapse rate for the route.

ICING OR CONGEALING OIL

Cold or icing conditions may result in icing of the oil cooler or congealing of the oil in the oil cooler core, with resultant oil temperature rise. With oil cooler flap switches in AUTO, the oil cooler flaps will automatically be opened farther, causing increased ice accumulation and higher oil temperature. If this situation occurs, as indicated by wide open oil cooler flaps and high oil temperature, close the oil cooler flaps manually. The oil temperature will rise above the red line, but 1 to 3 minutes at this high temperature will relieve the icing or congealing condition. Normal operation with the oil cooler flap switches in AUTO may then be resumed. To reduce the possibility of oil congealing in the transfer lines, some oil should be transferred to each engine oil tank at 10- to 15-minute intervals. Make a complete cycle of the oil tank selector switch positions. Stop at each position and hold the oil transfer pump switch to ON for 10 seconds.

DESCENT

Temperature inversions are common in winter in arctic regions. Thus, the air may be 15° to 30°C (27° to 54°F) colder on the ground than at altitude. Therefore, care must be taken to avoid rapid cooling when letting down. Landing gear and partial wing flaps may be extended to reduce airspeed if icing conditions are not present.

APPROACH

In addition to the normal approach procedure, the following should be observed during cold weather operations:

1. Use sheltered air as necessary.
2. Close the cowl flaps to minimum opening. Make a long, low approach for landing, using engine power. This will aid in keeping cylinder head temperatures above critically low values.

LANDING

In addition to the landing instructions in Section II, the following procedures should be followed during cold weather operation:

CAUTION

Avoid contacting snow with propellers, as extensive damage to propellers, engines, and engine mounts may result.

Figure 9-6 Deleted

1. On runways covered with loose snow of undetermined depth, accomplish landings using only 55 to 80 percent wing flaps to prevent possible damage to the wing flap trailing edges.

2. Manually open oil cooler doors immediately after landing to permit oil to cool while taxiing. This will permit oil dilution on arrival at the ramp.

3. Use reverse thrust on inboard engines only to decelerate on snow or ice, and use brakes only if necessary after landing roll speed has been reduced.

CAUTION

During reverse thrust operation at slow speeds, loose snow may be blown ahead of the airplane with resultant loss of visibility.

ENGINE SHUTDOWN

The following oil dilution procedures in addition to normal procedures in Section II, will be used prior to stopping engines. Oil dilution is required if the expected minimum temperature is to be at or below 0° F (-18° C).

1. Service the oil tank to 24 gallons from the central oil system.

2. Idle engines at 1000 rpm with cowl flaps and oil cooler flaps open until cylinder head temperature has been reduced below 150° C (302° F) and oil temperature has decreased to a minimum, not to exceed 60° C (140° F). If temperatures are appreciably higher, the effectiveness of oil dilution is reduced by boil-off.

3. Dilute oil at 1000 rpm. Turn fuel boost pump switches "OFF." Turn oil dilution switch "ON" and hold master dilution switch "ON" for two minutes.

Note

If oil temperature rises above 60° C (140° F) or if oil pressure drops below 15 psi during dilution, record amount of time of dilution accomplished and shut engine down and allow it to cool to 55° C (131° F) or below before continuing.

4. At end of dilution period, move mixture control to "FUEL CUT-OFF". Hold master dilution switch ON until the propellers stop rotating.

CAUTION

Oil dilution in excess of 10%, two minutes dilution time, may result in engine damage. To supplement oil dilution use preheat as required in the engine and accessory section before engine start. Keep the cylinder head temperature (CHT) at 5° F (-15° C) to 32° F (0° C) during preheat period.

5. Leave cowl flaps approximately two inches open.

6. Only one oil dilution will be accomplished for each flight.

7. Redilution is not required unless the aircraft has flown after the initial dilution since boil-off during ground operation of engine is minimal.

POSTFLIGHT CHECK

The following items are in addition to the normal instructions in Section II:

1. After diluting oil, have a small amount of oil drained from the Y drains and oil tank sump drains. This will eliminate stagnate, undiluted oil from these low points and reduce the possibility of clogged drains.

2. Have a small amount of fuel drained from fuel drains and strainers to eliminate any moisture which may have collected.

All data on pages 9-14A and 9-14B deleted.

Figure 9-7 Deleted

3. In temperatures below −20°F (−29°C), have the battery removed after flight if airplane is to remain outside 24 hours or longer, so that when reinstalled, the battery will be able to deliver full capacity immediately.
4. Have central oil tank and system drained if subzero temperature is expected, where practical.

CAUTION

In addition to established requirements for reporting any system defects and 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.

DESERT AND HOT WEATHER PROCEDURES

PREFLIGHT

BEFORE ENTERING THE AIRPLANE

In addition to the normal instructions in Section II, check the following for hot weather operations:

1. Insure that all filters are installed and are clean of dust, corrosion, and mold.
2. Insure that oleos and surface control hinge points are free of dust and sand. Check inflation of oleos and tires frequently. Changes in air pressure caused by wide changes in temperature result in improper inflation. Overinflation is most often encountered.
3. Check for leaks in hydraulic system, since heat and moisture cause valve packings to swell.
4. Check airplane position in relation to other airplanes. Sand blown by operating engines of one airplane can add hours to the maintenance problems of other airplanes.

ON ENTERING THE AIRPLANE

After entering the airplane, complete the following:

1. When external power is connected, or when the APU is operating, turn the air conditioning master switch ON and the cabin air selector switches to NORMAL to operate the ground blowers for air circulation.
2. Open windows, hatches, bulkhead doors, and forward cargo and entrance doors to ventilate the airplane.
3. Check equipment for evidence of corrosion.
4. Position carburetor air switches to SHELT if dusty.

BEFORE STARTING ENGINES

If the APU is used for starting engines, turn the air conditioning master switch OFF to prevent electrical power drain until at least one engine has been started.

STARTING ENGINES

Do not overprime engines, since fuel vaporization will be rapid in high temperatures.

ENGINE GROUND OPERATION

In all hot weather and desert operations, it is imperative that engine operation and ground tests be conducted in a minimum length of time to prevent high cylinder head temperatures that will exceed the maximum temperature allowable for start of takeoff run. Insure airplane is clear of other airplanes during ground operations. Use a platform or hard stand to check engines when possible.

TAXI

When taxiing, keep adequate distance between airplanes to prevent propellers from blowing sand and causing damage to following airplanes. Use the brakes as little as possible, since it will be difficult to cool them in hot weather operation.

TAKEOFF

Hot weather operations require the pilot to be more cautious of stalling speeds and temperature limitations. Emphasis is placed on the following:

1. Takeoffs during hot periods of the day require longer runs. Efficiency up to 10 percent is lost to heat at this time.
2. Takeoffs with sheltered air may require longer runs because of the power loss resulting from the use of sheltered air.

Note

For more complete information on sheltered air power loss, refer to POWER AVAILABLE FOR TAKEOFF in the appendix, T. O. 1C-97(K)L-1-1.

3. Close observance of stalling speeds is necessary.
4. Close observance of cylinder head temperatures is necessary.

AFTER TAKEOFF — CLIMB

Retract wing flaps with caution, watching for settling tendencies of the airplane due to loss of lift.

CLIMB

Climb at not less than specified climbing speed. Lower climb speeds cause high cylinder head temperature. Return carburetor air switches to RAM when airplane is above dust layer. Refer to Section V for airspeed limitations during operation of sheltered air doors.

DESCENT

Before entering dust layer, position carburetor air switches to SHELT. Refer to Section V for airspeed limitations during operation of sheltered air doors.

LANDING

Landing ground rolls are longer than those in normal temperatures. Ground speed increases with the same indicated airspeed due to thinner air.

POSTFLIGHT CHECK

Cover all ducts and air intakes as soon as possible to prevent the entry of blowing sand. Leave windows, hatches, and doors open for ventilation in a hot weather region only if blowing sand is not excessive. Close sheltered air doors.

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